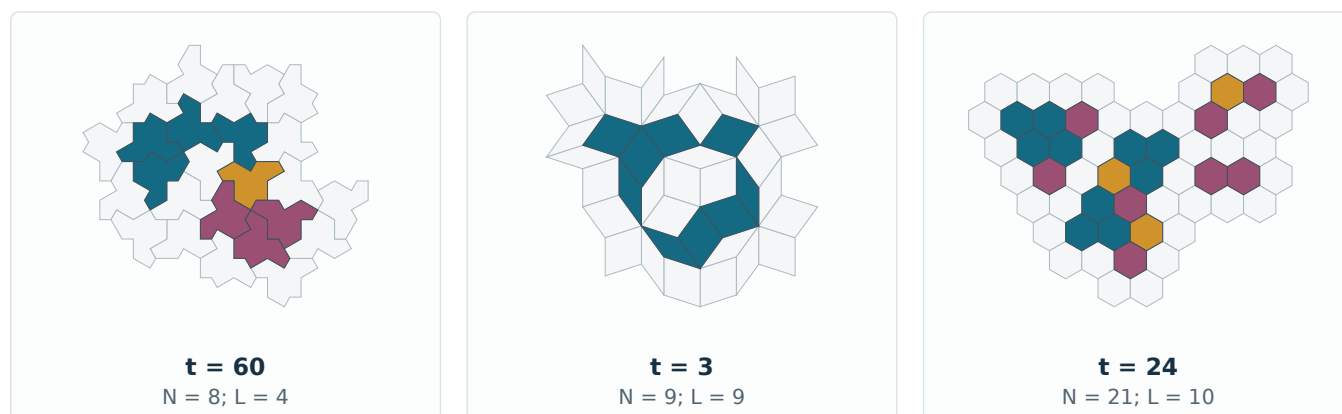


Aperiodic Life

Complete preset catalogue

89 configurations | 56 complete rules | 12 rule templates

Version 3.7.4 | Catalogue revision 2 | 14 October 2026



Abstract

This catalogue documents all 89 curated configurations in Aperiodic Life 3.7.4: 22 on the Einstein-hat tiling, 21 on Penrose rhombs, 36 on the hexagonal lattice and 10 on the square lattice. Every entry has its exact rule, initialisation, production-engine illustrations, computational evidence and attribution. All 56 complete rule-sets are registered, and all 12 named rule presets are described separately.

Scope of originality

The catalogue identifies 55 configurations original to this package for which no exact precedent was found in the literature reviewed to 14 October 2026. A further package search result, [P09](#), may be Owens and Stepney's published fireworks oscillator [\[5\]](#), [\[6\]](#); its identity remains unresolved. Four deliberate package constructions, 25 published examples and four adaptations complete the 89 entries. Each adaptation names its parent pattern or rule and states what changed.

Authorship and status

AI generated following prompts by Murdoch J. Gabbay. Catalogue revision 2, 14 October 2026, for Aperiodic Life 3.7.4. The software package was vibe-coded by Murdoch J. Gabbay. This catalogue reports computational checks and source comparisons; it is not a peer-reviewed paper. Each reproduced pattern and rule names its source with a numbered reference.

[Start with the rule guide \(p. 3\)](#) | [Browse the pattern directories \(pp. 10-14\)](#) | [Rule index \(p. 104\)](#)

1. Scope and attribution

Origin / status	Count	Meaning
Original package configurations	55	No exact precedent identified in literature reviewed to 14 October 2026
Possible earlier match	1	P09 : Owens-Stepney fireworks [5], [6]; identity unresolved
Package constructions	4	C01-C04 : explicitly named mechanism and construction
Published examples	25	Author, named pattern and numbered source on each page
Adaptations	4	Named parent pattern/rule and precise change on each page

What is included

Every entry in discoveries.js appears once, with a stable identifier and a linked rule reference. The 12 named options in the separate rule selector also appear. The Custom option, arbitrary painted states and arbitrary random seeds are not finite preset lists. Penrose sun/star selects geometry, not a cellular-automaton pattern. Spectre and Goucher API-only tables are distinguished from the UI presets.

Original to this package, or already known?

ORIGINAL TO THIS PACKAGE identifies a configuration generated by this package's search, with no exact precedent identified in the literature reviewed to 14 October 2026. It does not attribute an established update rule or travelling mechanism to this package, and the review cannot exclude unexamined or unpublished earlier work. CONSTRUCTED HERE identifies a deliberate assembly and names its underlying rule or principle. PUBLISHED names the author, pattern or mechanism and numbered source. ADAPTATION names that predecessor, its source and the change. **P09** is labelled POSSIBLE PUBLISHED MATCH, not original.

What has been compared

The audit uses Owens and Stepney's Penrose catalogue [5], [6], Goucher's Penrose-glider paper [4], Edmond's paper and compendium [2], [3], the hexagonal seed records identified in **X23-X35**, Stephen Silver's Life Lexicon [24], [25], [26], [27], [29], [30], [32], and retained exact-state comparisons. Eleven hexagonal precedents have executable comparison records. Coverage is incomplete: the wider hexagonal databases and unpublished work have not been exhausted. A failed search or inaccessible web page is not evidence of originality.

How to use this document

Start with the plain-language rule guide, then the neighbourhood diagrams and rule-status definitions. Tiling directories link to every illustrated configuration. H, P, X and S label Hat, Penrose, hexagonal and square entries; **C01-C04** retain the earlier catalogue's constructed-example labels. **R01-R56** denote complete rule-sets. **U01-U12** denote rule-selector templates, which need a chosen graph. These labels are document references, not standard names.

2. Reading the rules

Update convention

Each polygon is one cell. All cells update simultaneously using the states before the update. A complete rule specifies the tiling, neighbour relation, transition rule and total state count C . A B/S string alone does not specify all four. The cell itself is never counted as its neighbour.

Worked example: R40

R40 is B234/S245 with $C = 5$ on the shared-edge hexagonal graph. An empty cell is born with exactly 2, 3 or 4 live neighbours. A live cell survives with exactly 2, 4 or 5. The six neighbours are precisely the edge-sharing hexagons. Thus R40:S5 means survival with exactly five of those six neighbours live. S5 is one clause, not an entire rule. The example is X08, the ten-step knightship launcher.

States and refractory time

State 0 is empty and state 1 is live. Only state 1 contributes to B/S neighbour counts. With $C = 2$, a live cell that fails survival becomes 0. With $C > 2$, it becomes state 2; refractory states then advance one step each generation, regardless of neighbours, through 2, 3, ..., $C-1$ and back to 0. A refractory cell cannot be born until it is 0 again. In R40 the death sequence is 1, 2, 3, 4, 0.

Exact counts, not thresholds

B12 means one or two neighbours, not twelve. B2/S has no survival counts, whereas B2/S0 permits survival with zero live neighbours. A multi-digit count is bracketed, for example B[10]/S[9,10]. None of R01-R56 needs a multi-digit B/S count. By contrast, priority-table conditions $n_i \geq k$ mean at least k neighbours in state i , including $i = 0$.

Priority tables are different

Named TABLE rules count each neighbour state separately and take the first matching ordered row. All conditions in that row must hold. No match gives state 0. The higher states are signals, with no automatic refractory ageing. The complete ordered rows, including defaults and state totals, appear in the rule register.

X08 (p. 65) demonstrates R40:S5. R40 (p. 119) supplies the complete definition and prior-use status. Neighbourhood diagrams (p. 6).

3. Reading a priority table

These three tables use Hat edge-or-point contacts and $C = 4$. n_i counts neighbours in state i , including empty state 0. All conditions must hold; the first matching row wins, otherwise the next state is 0. “Any” permits every own state. Higher states do not age automatically.

R15 / TABLE:HAT-WAKE - Package-evolved table; no identified precedent

Row	Own state	All required conditions	Next
R15.1	1	$n_0 \geq 3$ and $n_2 \geq 1$	2
R15.2	0	$n_0 \geq 4$ and $n_2 \geq 1$	1
R15.3	1	$n_0 \geq 4$	3
R15.4	0	$n_1 \geq 1$ and $n_2 \geq 1$	3

R10 / TABLE:HAT-A - Published rule: James Edmond’s Hat A

Row	Own state	All required conditions	Next
R10.1	0	$n_2 \geq 2$	0
R10.2	any	$n_1 \geq 3$	3
R10.3	2	$n_1 \geq 1$ and $n_0 \geq 1$	1
R10.4	1	$n_2 \geq 1$	3
R10.5	0	$n_1 \geq 1$	2

R11 / TABLE:HAT-B - Published rule: James Edmond’s Hat B

Row	Own state	All required conditions	Next
R11.1	0	$n_1 \geq 2$ and $n_0 \geq 1$	0
R11.2	0	$n_0 \geq 2$ and $n_2 \geq 2$	1
R11.3	0	$n_0 \geq 2$ and $n_3 \geq 1$	1
R11.4	1	$n_3 \geq 1$	3

HAT-A omits redundant duplicate/default-zero rows from James Edmond’s Hat A table [2], [3] without changing its transition. A dead-to-dead row may still block a later birth. HAT-B retains its state-2 row even when that state is unreachable from a particular seed. Missing external neighbours are absent, not additional state-0 cells. The six used tables are R10-R15.

4. What the evidence establishes

Exact cycles and regular-lattice spaceships

A stationary cycle satisfies $F^p(S) = S$ on the same graph; its least positive p is its period. A transient of a steps means that the first recurrent phase is $F^a(S)$. Equality concerns the entire labelled state. On an infinite translation-invariant lattice, $F^p(S) = T_d(S)$ with nonzero displacement d and a verified empty exterior implies $F^{kp}(S) = T_{kd}(S)$. The hexagonal unbounded reference supplies such exact certificates for the identified moving cycles.

Aperiodic motion is finite evidence

A translated cluster on an aperiodic graph need not encounter the same surroundings forever. The Hat and Penrose travel records therefore state finite horizons. They do not prove an immortal Einstein glider. Exact stationary cycles do recur on their fixed finite graph; boundary separation is reported where measured.

Launchers, emitters, guns and puffers

A launcher produces outgoing bodies once. A recurring emitter regenerates a source over the tested interval. An indefinite gun claim needs a repeatable source and proof that outgoing bodies never interfere with later emissions. [H03](#) is a finite aperiodic emitter. The identified hexagonal gun and puffers have separate separation certificates; a growing puffer's complete state is not a spaceship.

Measurements

N counts all nonzero cells; L counts state-1 cells. They differ for multistate rules. Cycle territory is the union of nonzero sites throughout a cycle. Boundary distance counts graph steps, with the outermost cells at zero. Polygon matches use the tolerances recorded in the evidence; they are not symbolic geometric proofs.

Figures

All 267 pattern panels are snapshots from the production engine and retain every nonzero cell. Pale cells are optional immediate zero-state context. Stationary cycle panels use one fixed view and scale; other panels are independently centred and scaled without rotation. The caption states the convention. Colours identify states. Every snapshot retains a complete-state hash and exact polygon coordinates in the source data.

5. Exactly which cells count?

Definition

Shared-edge means a common boundary segment of positive length. Touch means edge or boundary-point contact, including a corner meeting another tile's edge at a T-junction. The examined cell is excluded. Hat and Penrose neighbour counts vary with position.



Dark = examined cell; blue = edge neighbour; amber = point-contact-only neighbour. These colours show adjacency, not automaton states. The displayed Hat/Penrose counts are local examples, not universal degrees.

Regular lattices

A square touch neighbourhood has eight cells: four sharing edges and four diagonal corner contacts. A square edge neighbourhood has four. All ten curated square configurations use touch. The hexagonal edge and touch graphs coincide: at each vertex only three hexagons meet and every pair shares an edge. There are exactly six neighbours.

Coordinates and borders

Hexagonal axial neighbours differ by $(1,0)$, $(1,-1)$, $(0,-1)$, $(-1,0)$, $(-1,1)$, or $(0,1)$. A cell (q,r) has centre $(\sqrt{3}(q+r/2), 3r/2)$. Square coordinates are integer column/row coordinates.

Hat/Penrose tile IDs depend on the released builder, depth and seed. A border parameter b locks cells at graph-boundary distance less than b to state 0. There is no wraparound; external missing cells are not additional state-0 neighbours in a priority table.

6. Rule names and provenance

Complete rule identifiers

R01-R56 each fixes the tiling, neighbour relation, transition and C. The seed, patch size and locked border then specify an experiment. The same B/S digits on different graphs or with different C values describe different automata. R40:S5 uniquely identifies one survival clause; R15.1 identifies row 1 of the ordered R15 table.

Standard, previously used, or original?

Binary birth/survival, Generations refractory rules and ordered state-count tables are established formalisms. A rule card names its documented earlier author or user and the publication that contains it. If the package transfers standard counts to a different graph, the card names that standard rule and graph change. If no earlier use of a complete graph/update/state-count specification was identified, the card says so explicitly and dates that statement to 14 October 2026. An adapted table names its parent: R13 derives its mature mechanism from Edmond's Spectre relay [2], [3]; R14 derives from his Hat B table R11 [2], [3]. R15 was evolved in this package; Edmond's work is background for its search framework, not a source for that exact table.

Rules and patterns have separate credit

R10 and R11 are Edmond's published Hat rules. H02 and H03 are separately searched launch/source seeds under those rules and their known travelling mechanism. Calling B3/S23 Conway does not attribute a Hat, Penrose or hexagonal arrangement to Conway. The XOR construction uses a known additive principle. Each entry gives both its pattern status and a link to the rule's status.

Unresolved identity

P09, penrose-conway-p12, matches the period 12, territory 33 and minimum population 6 of Owens and Stepney's fireworks oscillator r-p12-33-6. These invariants do not determine identity. The exact geometric comparison is unresolved, and the pattern is not claimed original [5], [6].

7. Named rule presets

U labels identify the 12 named options in the rule selector. Choosing one changes the transition and C while retaining the chosen tiling and neighbour relation. Each becomes a complete rule only after that graph is specified. “Custom” is an editing state, not another named rule.

U01 Conway

B3/S23 | C = 2

Origin and earlier use: Standard published rule: John H. Conway; original public account by Martin Gardner (1970). Standard Conway Life uses the eight-neighbour square graph. On another selected graph this preset transfers the same counts, producing a different automaton.

Rule account: Gardner on Conway [13]; notation: Golly [14] | Complete graph example: R55 (p. 124)

U02 HighLife

B36/S23 | C = 2

Origin and earlier use: Standard published rule: The established square Moore-neighbour HighLife rule. Nathan Thompson’s 1994 replicator and David Bell’s investigations predate this package. Other selected graphs give adaptations of these counts.

HighLife rule and replicator: Eppstein [17]; notation: Golly [14] | Complete graph example: R56 (p. 124)

U03 Seeds

B2/S | C = 2

Origin and earlier use: Standard published rule: Established two-state Seeds rule on the square Moore neighbourhood; the empty survival set means every live cell dies at the next update. Applying the counts to another graph does not transfer authorship or establish a new rule.

Named rule source: Golly QuickLife, Seeds [14] | Complete graph example: R01 (p. 106)

U04 Brian’s Brain

B2/S | C = 3

Origin and earlier use: Standard published rule: Brian Silverman’s Brian’s Brain, conventionally on the square Moore neighbourhood. This is B2/S with three total states: failed survival gives state 2, which becomes 0 on the following update. The selected graph remains in force.

Brian Silverman attribution: Rucker and Walker [7]; framework: Golly [33] | Complete graph example: R19 (p. 112)

U05 Star Wars

B2/S345 | C = 4

Origin and earlier use: Standard published rule: Mirek Wójtowicz’s Star Wars, conventionally on the square Moore neighbourhood. This four-state Generations rule uses exact birth count 2 and exact survival counts 3, 4 or 5. No curated configuration currently selects this complete rule.

Named rule and authorship source: Golly Generations [33]

U06 Life without Death

B3/Sall | C = 2

Origin and earlier use: Standard published rule, graph-dependent survival list: A published rule studied by Griffeath and Moore (1996). Birth requires exactly three live neighbours; every live cell survives. Sall is a descriptive menu shorthand: the app expands it to every count from 0 to the maximum degree of the selected graph. On square touch this is B3/S012345678; on hex edge it is B3/S0123456.

Published rule study: Griffeath and Moore (1996) [34]

7. Named rule presets (continued)

U labels identify the 12 named options in the rule selector. Choosing one changes the transition and C while retaining the chosen tiling and neighbour relation. Each becomes a complete rule only after that graph is specified. “Custom” is an editing state, not another named rule.

U07 Hat glider A - Edmond table

TABLE:HAT-A | C = 4

Origin and earlier use: Published table: James Edmond’s published four-state Hat A table, reproduced in full as [R10](#). The cited glider behaviour uses Hat boundary-contact neighbours; selecting this menu option does not change the graph.

Published Hat A table: James Edmond’s paper and compendium [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R10](#) (p. 109)

U08 Hat glider B - Edmond table

TABLE:HAT-B | C = 4

Origin and earlier use: Published table: James Edmond’s published four-state Hat B table, reproduced in full as [R11](#). The published complete rule uses Hat boundary-contact neighbours; another selected graph gives a different automaton.

Published Hat B table: James Edmond’s paper and compendium [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R11](#) (p. 109)

U09 Hat glider C - Edmond table

TABLE:HAT-C | C = 4

Origin and earlier use: Published table: James Edmond’s published four-state Hat C table, reproduced in full as [R12](#). His previously demonstrated triple launch is catalogued as [H21](#) with a separately selected placement. The cited rule uses Hat boundary-contact neighbours.

Published Hat C table and launch behaviour: Edmond [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R12](#) (p. 109)

U10 Hat glider - three-state table

TABLE:HAT-SIMPLE | C = 3

Origin and earlier use: Adaptation of Edmond’s Hat B ([R11](#)): The package removes a state unused by [H20](#)’s launch, relabels and drops an empty-neighbour birth guard. [R14](#) agrees on the checked launches but differs on other inputs. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Parent table: Edmond’s Hat B, [R11](#) [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R14](#) (p. 110)

U11 Hat wake traveller

TABLE:HAT-WAKE | C = 4

Origin and earlier use: Package-evolved table; no identified precedent: [R15](#) records the full table, obtained by the package’s independent random-initialised search and reduction. No earlier exact specification was identified in literature reviewed as at 14 October 2026. Edmond’s framework is background, not the source of this table.

Background framework, not this exact table: Edmond [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R15](#) (p. 110)

U12 Hat two-row relay - Spectre variant

TABLE:HAT-RELAY | C = 3

Origin and earlier use: Adaptation of Edmond’s Spectre relay: [R13](#) was reduced during the package’s investigation of [R15](#). [H16](#)’s checked mature trajectory matches Edmond’s Spectre relay after state relabelling; ignition and global guards differ.

Adapted travelling mechanism: Edmond’s Spectre relay [\[2\]](#), [\[3\]](#) | Full Hat/touch table: [R13](#) (p. 110)

The Core API additionally exposes TABLE:SPECTRE, James Edmond’s Spectre table [\[2\]](#), [\[3\]](#), and TABLE:PENROSE-GOUCHER, Adam P. Goucher’s Penrose table [\[4\]](#). Their full rows are in catalogue-data.json, field ruleTables. They have no named UI preset or additional curated seed in this release. The app’s Einstein backend is Hat, not Spectre.

8. Einstein-hat configurations

Code / page	Configuration	Rule / origin
H01 (p. 15)	Hat wake traveller	R15; original*
H02 (p. 16)	Hat A six-way launcher	R10; original*
H03 (p. 17)	Hat B recurring emitter - finite verification	R11; original*
H04 (p. 18)	Hat rotating wave - period 39	R02; original*
H05 (p. 19)	Hat rotating wave - period 219	R04; original*
H06 (p. 20)	Hat eight-tile refractory clock - period 11	R03; original*
H07 (p. 21)	Hat directional transient - extinction 83	R08; original*
H08 (p. 22)	Hat Conway p6	R09; original*
H09 (p. 23)	Hat Conway p9	R09; original*
H10 (p. 24)	Hat Conway p26	R09; original*
H11 (p. 25)	Hat edge-graph p15	R06; original*
H12 (p. 26)	Hat Seeds p8	R01; original*
H13 (p. 27)	Hat B23/S p20	R05; original*
H14 (p. 28)	Hat B23/S p24	R05; original*
H15 (p. 29)	Hat B23/S p28	R05; original*
H16 (p. 30)	Hat two-row relay - Spectre variant	R13; adaptation
H17 (p. 31)	Hat glider B - Edmond rule	R11; published
H18 (p. 32)	Hat glider A - Edmond rule	R10; published
H19 (p. 33)	Hat glider C - Edmond rule	R12; published
H20 (p. 34)	Hat glider - three-state variant	R14; adaptation
H21 (p. 35)	Hat triple launcher - two-cell seed	R12; published
C04 (p. 36)	Hat B1 wave field	R07; constructed

* Original to this package: no exact literature precedent identified in the sources reviewed to 14 October 2026. The linked entry identifies what was created here and names any published parent or mechanism. “Unresolved” denotes P09’s possible Owens-Stepney antecedent [5,6].

8. Penrose configurations

Code / page	Configuration	Rule / origin
P01 (p. 37)	Penrose twelve-traveller launcher	R22; original*
P02 (p. 38)	Penrose five-traveller launcher	R21; original*
P03 (p. 39)	Penrose six-traveller launcher	R22; original*
P04 (p. 40)	Penrose compact oscillator - period 822	R17; original*
P05 (p. 41)	Penrose three-state oscillator - period 14	R28; original*
P06 (p. 42)	Penrose Conway p4	R27; original*
P07 (p. 43)	Penrose Conway p5	R27; original*
P08 (p. 44)	Penrose Conway p7	R27; original*
P09 (p. 45)	Penrose Conway p12	R27; unresolved
P10 (p. 46)	Penrose edge-graph p4	R18; original*
P11 (p. 47)	Penrose compact traveller	R20; original*
P12 (p. 48)	Penrose five-state traveller	R21; original*
P13 (p. 49)	Penrose six-state traveller	R22; original*
P14 (p. 50)	Penrose B24 launcher traveller	R24; original*
P15 (p. 51)	Penrose B2/S4 survival launcher	R23; original*
P16 (p. 52)	Penrose B26/S birth launcher	R25; original*
P17 (p. 53)	Penrose B27/S4 dual-clause launcher	R26; original*
P18 (p. 54)	Penrose Conway diehard - 293	R27; original*
P19 (p. 55)	Penrose Conway methuselah - 289	R27; original*
C02 (p. 56)	Penrose B12/S p840 field	R16; constructed
C03 (p. 57)	Penrose excitable field	R19; constructed

* Original to this package: no exact literature precedent identified in the sources reviewed to 14 October 2026. The linked entry identifies what was created here and names any published parent or mechanism. “Unresolved” denotes P09’s possible Owens-Stepney antecedent [5,6].

8. Hexagonal configurations

Code / page	Configuration	Rule / origin
X01 (p. 58)	Hexagonal p6 single-cell-trail puffer	R47; original*
X02 (p. 59)	Hexagonal three-cell twin-puffer launcher	R47; original*
X03 (p. 60)	Hexagonal p48 long-cycle spaceship	R42; original*
X04 (p. 61)	Hexagonal three-cell glider	R30; original*
X05 (p. 62)	Hexagonal four-cell diagonal launcher	R39; original*
X06 (p. 63)	Hexagonal five-cell p43 launcher	R50; original*
X07 (p. 64)	Hexagonal six-cell p9 knightship launcher	R35; original*
X08 (p. 65)	Hexagonal six-cell p10 knightship launcher	R40; original*
X09 (p. 66)	Hexagonal Conway p2	R53; original*
X10 (p. 67)	Hexagonal Conway p3	R53; original*
X11 (p. 68)	Hexagonal Conway p6	R53; original*
X12 (p. 69)	Hexagonal Conway p4 half-turn rotor	R53; original*
X13 (p. 70)	Hexagonal Conway p5	R53; original*
X14 (p. 71)	Hexagonal Conway p8	R53; original*
X15 (p. 72)	Hexagonal p269 clock	R54; original*
X16 (p. 73)	Hexagonal p57 pulsator	R48; original*
X17 (p. 74)	Hexagonal p128 half-turn rotor	R46; original*
X18 (p. 75)	Hexagonal p4104 long clock	R41; original*

* Original to this package: no exact literature precedent identified in the sources reviewed to 14 October 2026. The linked entry identifies what was created here and names any published parent or mechanism. “Unresolved” denotes P09’s possible Owens-Stepney antecedent [5,6].

8. Hexagonal configurations (continued)

Code / page	Configuration	Rule / origin
X19 (p. 76)	Hexagonal p372 sixfold rotor	R33; original*
X20 (p. 77)	Hexagonal p248 giant breather	R45; original*
X21 (p. 78)	Hexagonal p138 wandering spaceship	R36; original*
X22 (p. 79)	Hexagonal p23 fast spaceship	R38; original*
X23 (p. 80)	Hexagonal B2/S35 p5 traveller	R34; published
X24 (p. 81)	Hexagonal B245/S3 p10 traveller	R48; published
X25 (p. 82)	Hexagonal B235/S146 four-state launcher	R44; adaptation
X26 (p. 83)	Hexagonal B235/S134 five-state launcher	R43; adaptation
X27 (p. 84)	Hexagonal p25 diagonal spaceship	R49; published
X28 (p. 85)	Hexagonal p48 half-turn rotor	R32; published
X29 (p. 86)	Hexagonal three-way spaceship gun	R51; published
X30 (p. 87)	Hexagonal oscillator-trail puffer	R52; published
X31 (p. 88)	Hexagonal p999 threefold rotor	R31; published
X32 (p. 89)	Hexagonal p13 diagonal spaceship	R37; published
X33 (p. 90)	Hexagonal p158 wandering spaceship	R31; published
X34 (p. 91)	Hexagonal self-repairing wall	R32; published
X35 (p. 92)	Hexagonal p2044 billiard table	R32; published
C01 (p. 93)	Hexagonal seven-copy replicator	R29; constructed

* Original to this package: no exact literature precedent identified in the sources reviewed to 14 October 2026. The linked entry identifies what was created here and names any published parent or mechanism. “Unresolved” denotes P09’s possible Owens-Stepney antecedent [5,6].

8. Square configurations

Code / page	Configuration	Rule / origin
S01 (p. 94)	Block still life	R55; published
S02 (p. 95)	Blinker - period 2	R55; published
S03 (p. 96)	Pulsar - period 3	R55; published
S04 (p. 97)	Pentadecathlon - period 15	R55; published
S05 (p. 98)	Glider - diagonal spaceship	R55; published
S06 (p. 99)	Lightweight spaceship	R55; published
S07 (p. 100)	HighLife replicator	R56; published
S08 (p. 101)	Diehard - extinction at 130	R55; published
S09 (p. 102)	R-pentomino methuselah	R55; published
S10 (p. 103)	Acorn methuselah	R55; published

* Original to this package: no exact literature precedent identified in the sources reviewed to 14 October 2026. The linked entry identifies what was created here and names any published parent or mechanism. “Unresolved” denotes P09’s possible Owens-Stepney antecedent [5,6].

H01 Hat wake traveller

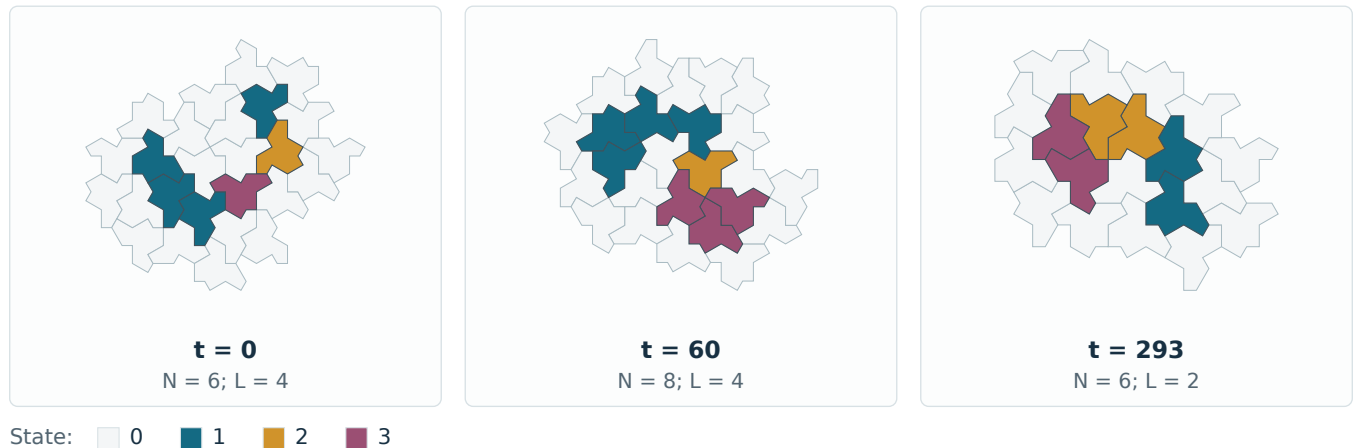
hat-wake-traveller

Original to this package: seed and evolved rule [R15](#); no exact precedent identified in the literature reviewed as at 14 October 2026. Edmond's Hat/Spectre framework is prior work [\[2\]](#), [\[3\]](#).

TABLE:HAT-WAKE | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R15](#) (p. 110). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A compact traveller under a separately evolved four-state priority table. The six-cell catalogue seed is verified for 293 generations on the depth-5 Hat touch graph. A polygon-preserving placement of the same labelled seed on the depth-6 patch remains nonzero for 1,000 generations, visits 2,447 tiles, and displaces its nonzero-cell centroid by 1,071.983213 coordinate units; at most nine cells are nonzero at any instant.

Catalogue replay through t = 293.

Exact initial configuration (tile ID,state)

(7392,2) (7396,1) (7307,3) (2948,1) (2955,1) (2952,1)

Interpretation and limits

Finite aperiodic travel only: neither indefinite flight nor historical priority is established. The instantaneous support may have two connected components. The 341 failed state projections distinguish the observed mature local transitions from six stored reference tables, not every possible travelling mechanism. The state-3 wake is not proven necessary for transport. No earlier exact configuration or table was identified in the reviewed sources.

Pattern provenance and credit (H01)

The table arose in a fresh random evolutionary lineage (evaluation 358893, epoch 11). Four rows reproduce the retained seven-row trajectory. No exact precedent was identified in the literature reviewed to 14 October 2026. Edmond's published framework and gliders remain prior work [\[2\]](#), [\[3\]](#).

Earlier Hat/Spectre framework and travelling patterns; not an exact identification of this seed or evolved rule: [\[2\]](#), [\[3\]](#).

Evidence in release: research/continued-search/hat-relay/campaigns.json. Complete source and evidence lists are in catalogue-data.json.

H02 Hat A six-way launcher

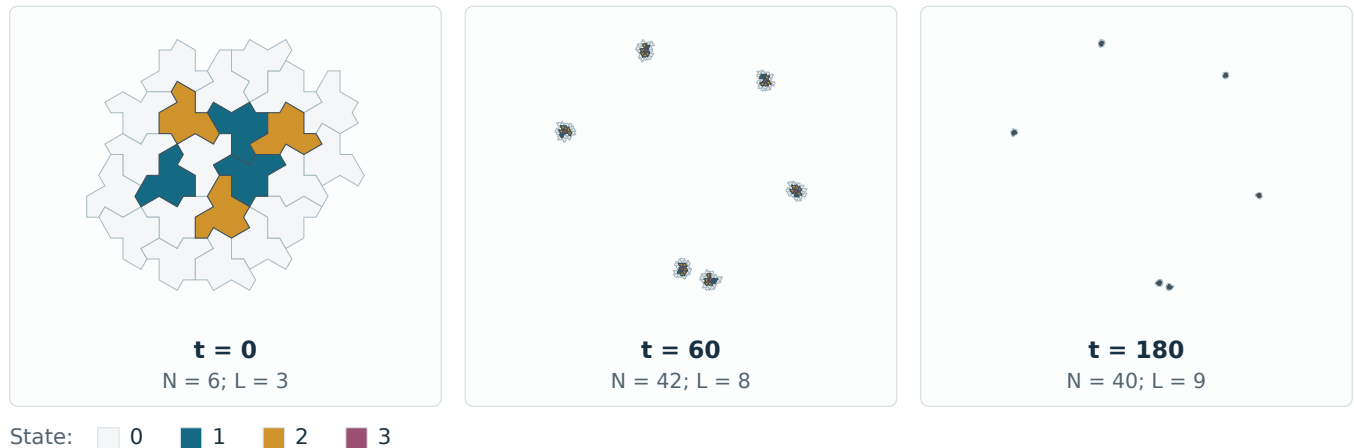
hat-edmond-a-six-way-launcher

Original to this package: six-cell launch configuration; no exact precedent identified in the literature reviewed as at 14 October 2026. Uses James Edmond's published Hat A rule and gliders [2], [3].

TABLE:HAT-A | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R10](#) (p. 109). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A connected six-cell launch under Edmond's unchanged Hat A table produces six independently evolving compact travelling bodies. From generation 60 through 180, independently evolving the six separated bodies reconstructs the complete labelled state at every generation. Each body has a checked translated return of its occupied polygons and three surrounding empty neighbour rings.

Catalogue replay through $t = 180$.

Exact initial configuration (tile ID,state)

(24180,2) (24181,1) (24717,2) (24718,1) (24722,1) (24724,2)

Interpretation and limits

A finite one-off launcher, not a repeating gun. The rule and glider mechanism were published by James Edmond; the contribution catalogued here is the searched launch configuration. No claim of an indefinitely traversable outgoing corridor or historical priority is made. All proper nonempty subsets fail to reproduce the checked full endpoint, which does not establish globally minimal seed size among all placements.

Pattern provenance and credit (H02)

The package found this interacting six-cell seed. The local rule and travelling mechanism belong to Edmond [2], [3]. Failure of all 31 initial bipartitions and all proper seed subsets to reproduce the checked outcome does not prove global seed minimality.

Source of the Hat A rule and travelling mechanism; this six-cell launch seed was found in the package: [2], [3].

Evidence in release: [research/continued-search/hat-emitters/README.md](#). Complete source and evidence lists are in [catalogue-data.json](#).

H03 Hat B recurring emitter - finite verification

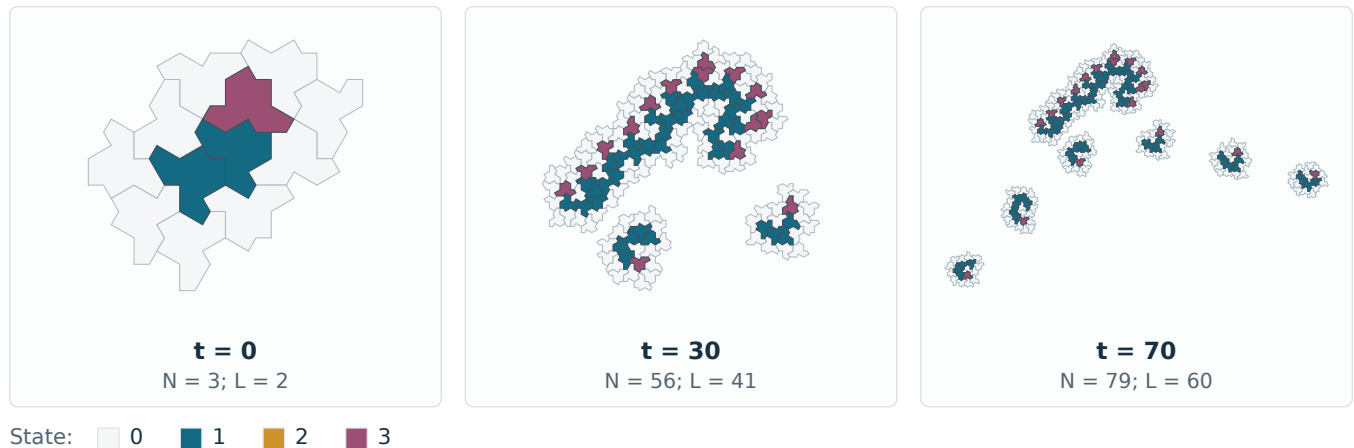
hat-edmond-b-periodic-emitter

Original to this package: three-cell emitting configuration; no exact precedent identified in the literature reviewed as at 14 October 2026. Uses James Edmond's published Hat B rule and gliders [2], [3].

TABLE:HAT-B | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R11 \(p. 109\)](#). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A three-cell seed under Edmond's Hat B table reaches a 56-cell source C at parent generation 30. For the complete nonzero state, $F^{40}(C)$ is the disjoint union of C and a 23-cell emitted packet E. The packet decomposes into four independently travelling bodies in two streams, with successive bodies in each stream delayed by 20 generations. Independent cohort evolution reconstructs every source state from time 0 through 180. Source time 0 is parent generation 30, so source time 180 corresponds to parent generation 210.

Catalogue replay through $t = 180$.

Exact initial configuration (tile ID,state)

(23821,1) (23824,3) (23836,1)

Interpretation and limits

This verifies four complete 40-generation emission intervals on the checked finite substrate, not a least source period of 40 or perpetual gun operation. The source is the entire state at parent generation 30 and needs no external feed during the checked interval. An earlier 38-cell crop is not this certificate. James Edmond's Hat B table and gliders are the published rule and mechanism [2], [3]; no exact precedent for this emitting seed was identified in the literature reviewed to 14 October 2026.

Pattern provenance and credit (H03)

The package found this three-cell source seed under Edmond's unchanged Hat B rule. Credit for the rule and travelling mechanism belongs to Edmond [2], [3]. No exact precedent for this emitting configuration was identified in the literature reviewed to 14 October 2026.

Source of the Hat B rule and travelling mechanism; this three-cell emitting seed was found in the package: [2], [3].

Evidence in release: [research/continued-search/hat-emitters/README.md](#). Complete source and evidence lists are in [catalogue-data.json](#).

H04 Hat rotating wave - period 39

hat-b2s1-c3-rotor-p39

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S1 | C = 3 | shared-edge

Complete rule and prior use: [R02 \(p. 106\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An exact least-period-39 oscillator under B2/S1 with three states and edge adjacency. The complete labelled state advances by a 120-degree clockwise rotation after every 13 generations. The recurrent support consists of 39 Hat tiles, all of whose state histories have least temporal period 39.

Least period $p = 39$; transient = 0; cycle $L = 3-8$; cycle territory = 39 tiles; cycle minimum boundary distance = 22.

Exact initial configuration (tile ID,state)

(2729,1) (2731,1) (3380,1) (3395,2) (3396,1)

Interpretation and limits

The rotation maps the recurrent occupied territory and its induced adjacency graph. It does not assert rotational symmetry of the entire Hat tiling. Instantaneous support can be disconnected. This is a bounded rotating oscillator with zero net translation, not a spaceship.

Pattern provenance and credit (H04)

Found by the package's compact-seed oscillator search under three-state B2/S1 on the shared-edge graph. The retained phase is an exact period-39 rotating wave. Its original search record identifies trial 44 of the B2/S1 edge-orbit follow-up. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H05 Hat rotating wave - period 219

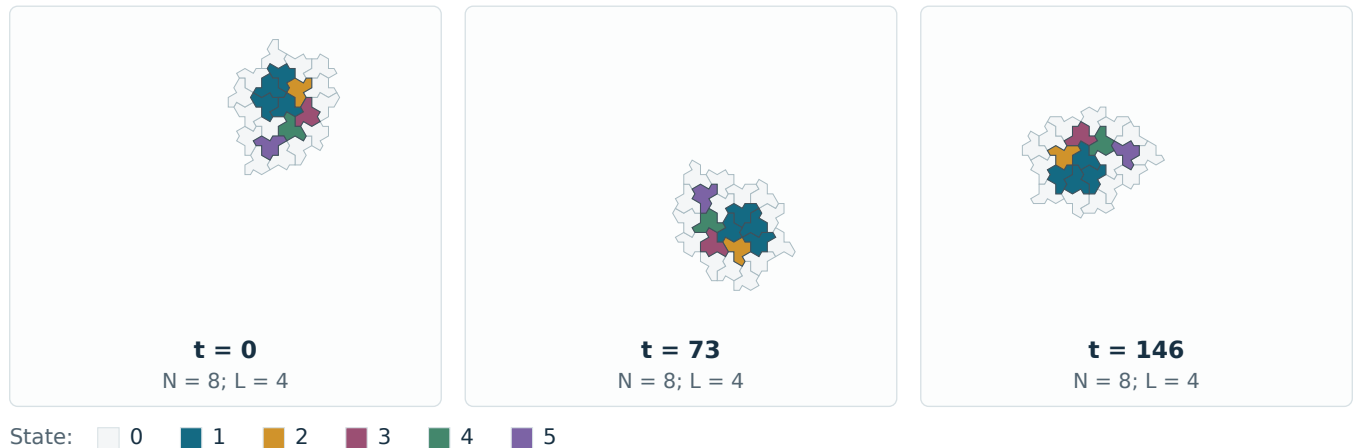
hat-b2s23-c6-rotor-p219

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S23 | C = 6 | shared-edge

Complete rule and prior use: [R04 \(p. 107\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An exact least-period-219 oscillator under B2/S23 with six states and edge adjacency. The complete labelled state advances by a 120-degree clockwise rotation after every 73 generations. Its recurrent support has 300 tiles, each with least temporal period 219, so the period is not just the least common multiple of independent shorter clocks.

Least period $p = 219$; transient = 0; cycle $L = 4$ -36; cycle territory = 300 tiles; cycle minimum boundary distance = 21.

Exact initial configuration (tile ID,state)

(1696,5) (1701,4) (3372,1) (3373,1) (3375,1) (3389,2) (3390,1) (3401,3)

Interpretation and limits

The verified rotational relation concerns the recurrent support and its induced graph, not a symmetry of the whole Hat tiling. The object is a bounded oscillator, not a translating glider; instantaneous support can be disconnected.

Pattern provenance and credit (H05)

Found by the package's compact-seed oscillator search under six-state B2/S23 on the shared-edge graph. The retained phase is an exact period-219 rotating wave. Its original pilot record identifies trial 122 for that rule and state count. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H06 Hat eight-tile refractory clock - period 11

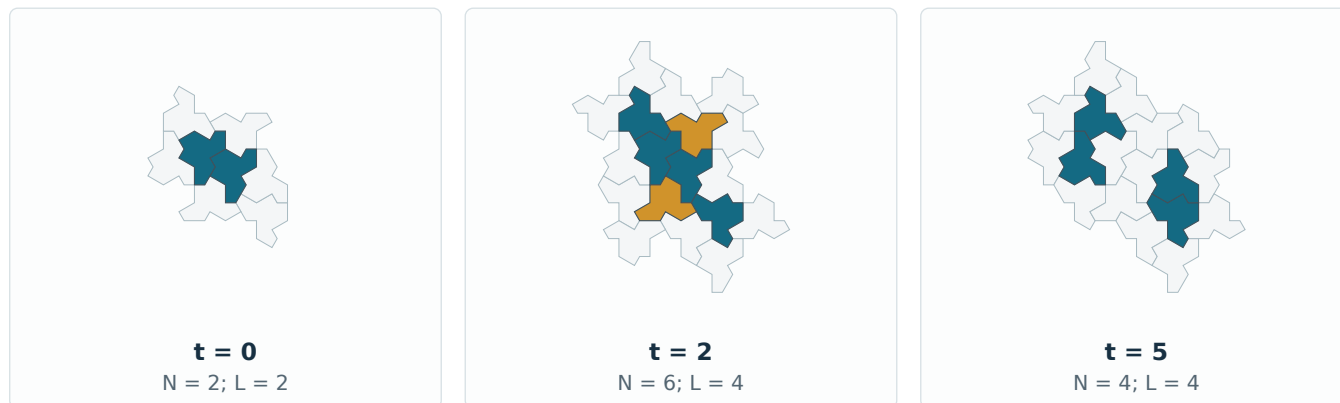
hat-b2s13-c4-clock-p11

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S13 | C = 4 | shared-edge

Complete rule and prior use: [R03 \(p. 106\)](#). Notation (p. 3).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1 2 3

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A two-live-cell seed produces an exact least-period-11 oscillator under B2/S13 with four states and edge adjacency. The union of occupied tiles over a cycle contains eight tiles. Using the same two-cell seed, every state count C from 4 through 255 was independently checked to give least period $2C+3$, with the same eight-tile support and an identically zero 12-tile exterior halo.

Least period $p = 11$; transient = 0; cycle $L = 2-6$; cycle territory = 8 tiles; cycle minimum boundary distance = 33.

Exact initial configuration (tile ID,state)

(3519,1) (3522,1)

Interpretation and limits

The family formula is computationally verified for $4 \leq C \leq 255$; no extrapolation beyond that range is claimed. C counts state 0 as well as live and refractory states. The browser exposes state counts only through 32, although the core supports the larger checked range.

Pattern provenance and credit (H06)

Developed from an eight-tile clock found by the package's B2/S13 search at ten states (trial 1730). The catalogue keeps the same two-live-cell phase and changes the state count to four, giving period 11. The relation period = $2C + 3$ was then checked for $C = 4$ through 255. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H07 Hat directional transient - extinction 83

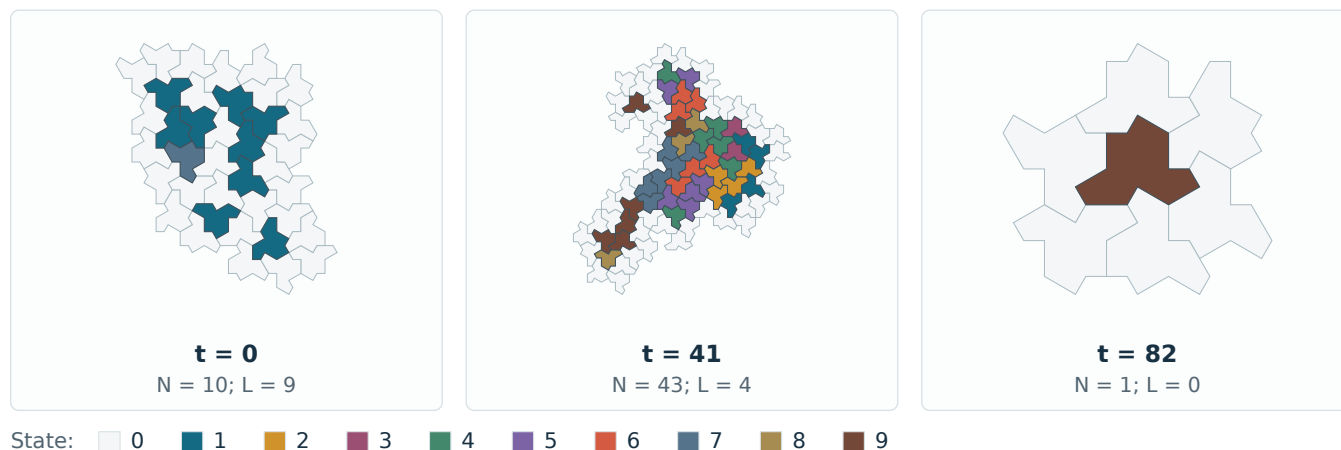
hat-directional-transient-83

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S1 | C = 10 | edge-or-point contact (touch)

Complete rule and prior use: [R08](#) (p. 108). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A ten-cell labelled phase under B2/S1 with ten states and touch adjacency generates a directional transient. No live cells remain from generation 75; the remaining refractory states have all vanished at generation 83. Its total visited support contains 344 tiles, and its maximum instantaneous nonzero population is 76.

Full extinction at $t = 83$.

Exact initial configuration (tile ID,state)

(7788,1) (7789,1) (17211,1) (17212,1) (17296,1) (17298,1) (17301,1) (17303,1) (17305,7) (17319,1)

Interpretation and limits

Complete extinction is verified. This is not a glider or spaceship. The seed contains nine state-1 cells and one state-7 refractory cell, so describing it as ten live cells would be incorrect. The occupied support is not connected at every time.

Pattern provenance and credit (H07)

Selected from the package's Hat B/S motion search and reduced to a ten-cell complete phase, including one refractory cell. The reduction preserves the retained parent state at generation 40. All activity ends at generation 83; the example is a directional transient, not a glider. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H08 Hat Conway p6

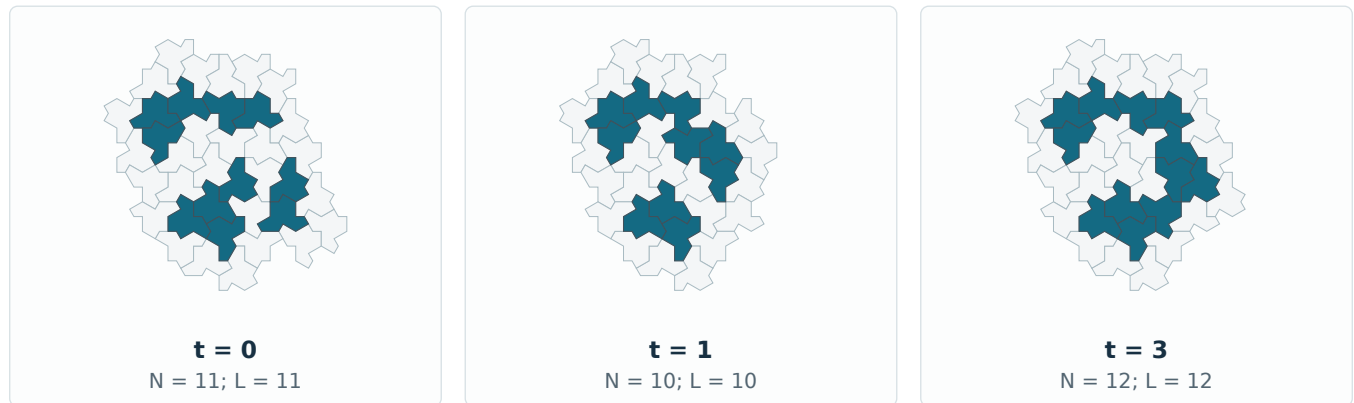
hat - conway - p6

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R09 (p. 108). Notation (p. 3).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 6 under B3/S23 with two states on the Hat touch graph. The union of occupied tiles over its complete cycle has 15 tiles, while the instantaneous live population ranges from 10 to 13.

Least period $p = 6$; transient = 0; cycle $L = 10$ -13; cycle territory = 15 tiles; cycle minimum boundary distance = 25.

Exact initial configuration (tile ID,state)

(3261,1) (3264,1) (3285,1) (3287,1) (3289,1) (3358,1) (3359,1) (3362,1) (3547,1) (3548,1) (3549,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H08)

Extracted from a deterministic soup by the package's oscillator miner: source seed hat-touch-B3/S23-2-osc-v3-2285, density 0.35. The isolated component has period 6. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H09 Hat Conway p9

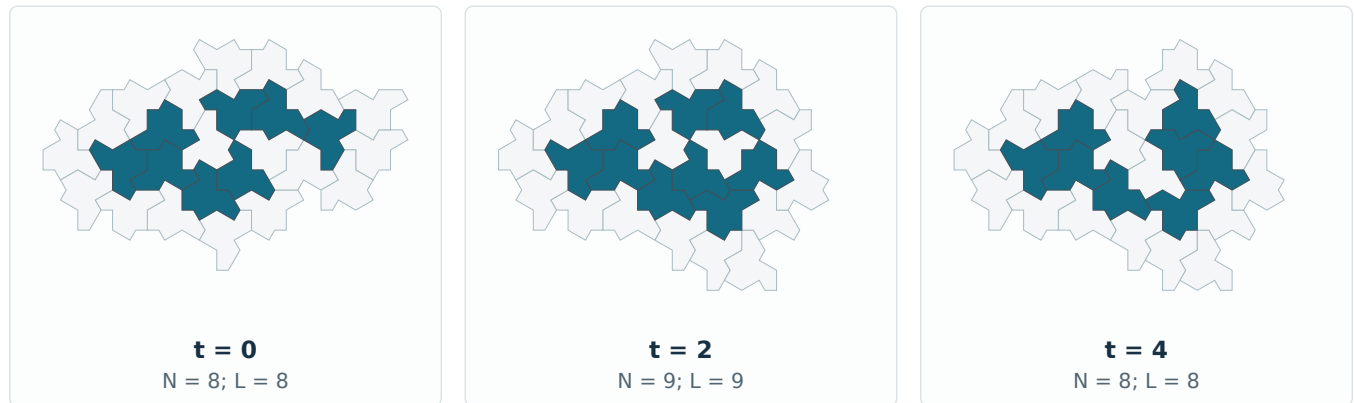
hat - conway - p9

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R09](#) (p. 108). Notation (p. 3).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 9 under B3/S23 with two states on the Hat touch graph. The union of occupied tiles over its complete cycle has 11 tiles, while the instantaneous live population ranges from 8 to 9.

Least period $p = 9$; transient = 0; cycle $L = 8-9$; cycle territory = 11 tiles; cycle minimum boundary distance = 16.

Exact initial configuration (tile ID,state)

(1509,1) (1595,1) (1596,1) (1600,1) (1602,1) (3444,1) (3448,1) (3449,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H09)

Extracted from the package's deterministic Conway-rule soup hat-touch-osc-61 at density 0.30. The whole soup has period 18; the isolated catalogue component has period 9. The name credits Conway's B3/S23 rule, not authorship of this hat configuration. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H10 Hat Conway p26

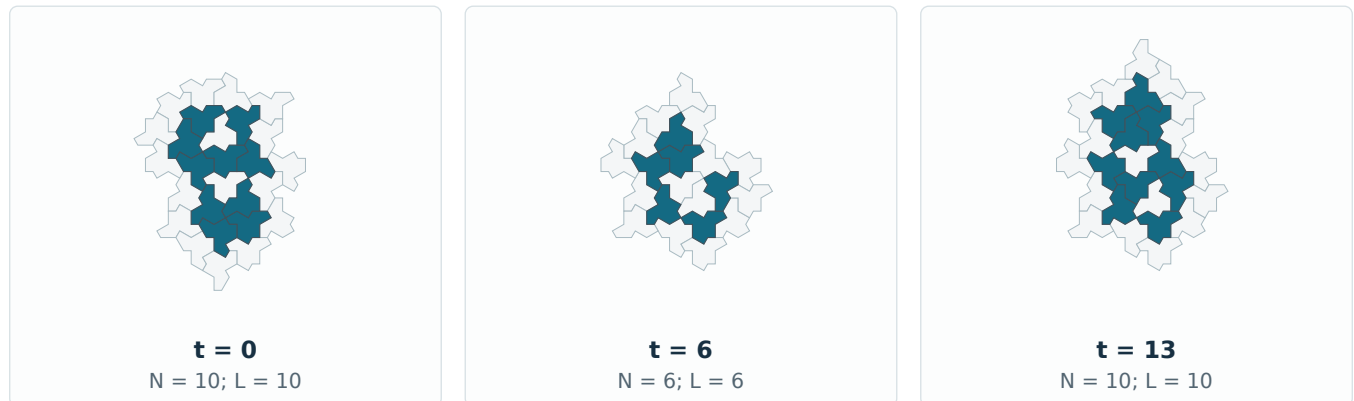
hat - conway - p26

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R09 (p. 108). Notation (p. 3).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 26 under B3/S23 with two states on the Hat touch graph. The union of occupied tiles over its complete cycle has 14 tiles, while the instantaneous live population ranges from 6 to 10.

Least period $p = 26$; transient = 0; cycle $L = 6-10$; cycle territory = 14 tiles; cycle minimum boundary distance = 30.

Exact initial configuration (tile ID,state)

(3468,1) (3469,1) (3470,1) (3473,1) (3475,1) (3480,1) (3485,1) (3486,1) (3487,1) (3488,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H10)

Extracted from the package's deterministic Conway-rule soup hat-touch-osc-27 at density 0.35. The isolated catalogue component has period 26. The name credits Conway's B3/S23 rule, not authorship of this hat configuration. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H11 Hat edge-graph p15

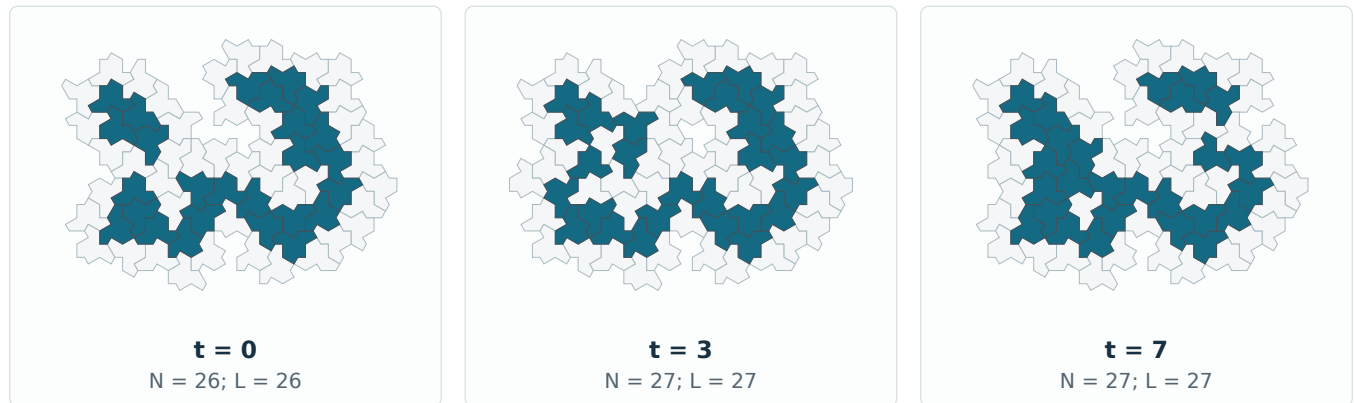
hat-edge-conway-p15

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R06 \(p. 107\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 15 under B3/S23 with two states on the Hat shared-edge graph. The union of occupied tiles over its complete cycle has 31 tiles, while the instantaneous live population ranges from 24 to 29.

Least period $p = 15$; transient = 0; cycle $L = 24$ -29; cycle territory = 31 tiles; cycle minimum boundary distance = 6.

Exact initial configuration (tile ID,state)

(2899,1) (2907,1) (2908,1) (2909,1) (2910,1) (2914,1) (2915,1) (2940,1) (7297,1) (7298,1) (7299,1)
 (7301,1) (7302,1) (7315,1) (7319,1) (7322,1) (7325,1) (7326,1) (7327,1) (7335,1) (7337,1) (7340,1)
 (7403,1) (7406,1) (7416,1) (7417,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H11)

Extracted from a deterministic soup by the package's oscillator miner: source seed
 hat-edge-B3/S23-2-osc-v3-467, density 0.35. This is an exact period-15 component on the shared-edge hat graph, using Conway's B3/S23 counts. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H12 Hat Seeds p8

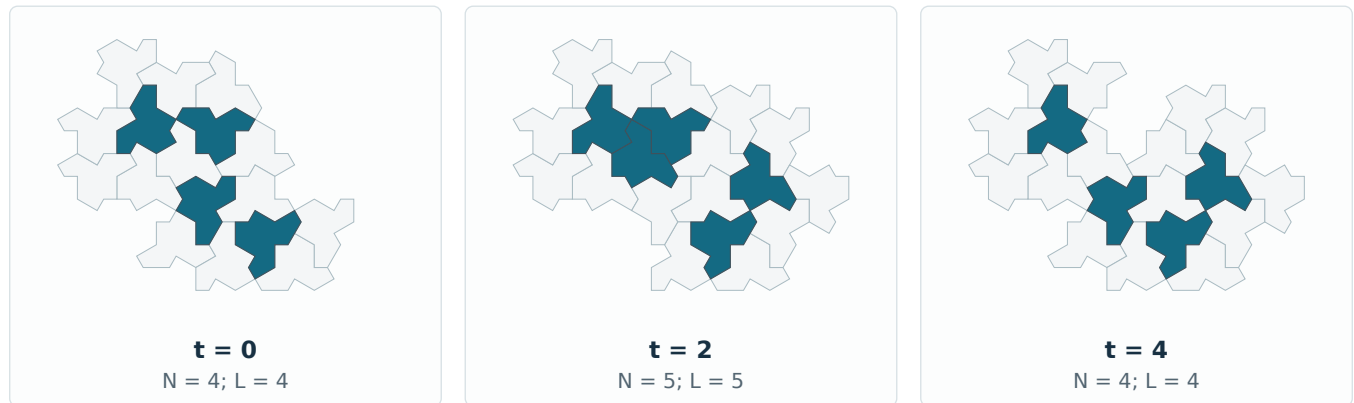
hat-seeds-p8

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 2 | shared-edge

Complete rule and prior use: [R01 \(p. 106\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 8 under B2/S with two states on the Hat shared-edge graph. The union of occupied tiles over its complete cycle has 12 tiles, while the instantaneous live population ranges from 4 to 5.

Least period $p = 8$; transient = 0; cycle $L = 4-5$; cycle territory = 12 tiles; cycle minimum boundary distance = 13.

Exact initial configuration (tile ID,state)

(2484,1) (2492,1) (2493,1) (2498,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H12)

Extracted from a deterministic soup by the package's oscillator miner: source seed hat-edge-B2/S-2-osc-v3-97, density 0.04. The four-live-cell catalogue phase has period 8 on the shared-edge hat graph. Seeds names the B2/S rule family; it does not identify a published source for this particular configuration. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H13 Hat B23/S p20

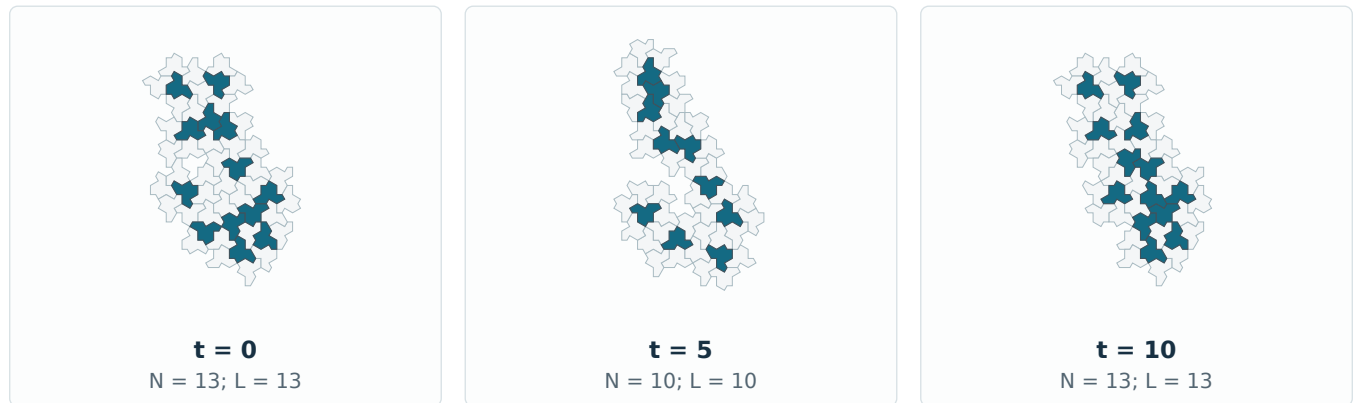
hat-b23-p20

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S | C = 2 | shared-edge

Complete rule and prior use: [R05 \(p. 107\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 20 under B23/S with two states on the Hat shared-edge graph. The union of occupied tiles over its complete cycle has 32 tiles, while the instantaneous live population ranges from 10 to 16.

Least period $p = 20$; transient = 0; cycle $L = 10$ -16; cycle territory = 32 tiles; cycle minimum boundary distance = 15.

Exact initial configuration (tile ID,state)

(1102,1) (1112,1) (1115,1) (1129,1) (1130,1) (1134,1) (1139,1) (2612,1) (2616,1) (3197,1) (3209,1)
(3222,1) (3257,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H13)

Extracted from a deterministic soup by the package's oscillator miner: source seed hat-edge-B23/S-2-osc-v3-333, density 0.12. The whole soup has period 60; the isolated catalogue component has period 20. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: [discoveries.js](#). Complete source and evidence lists are in [catalogue-data.json](#).

H14 Hat B23/S p24

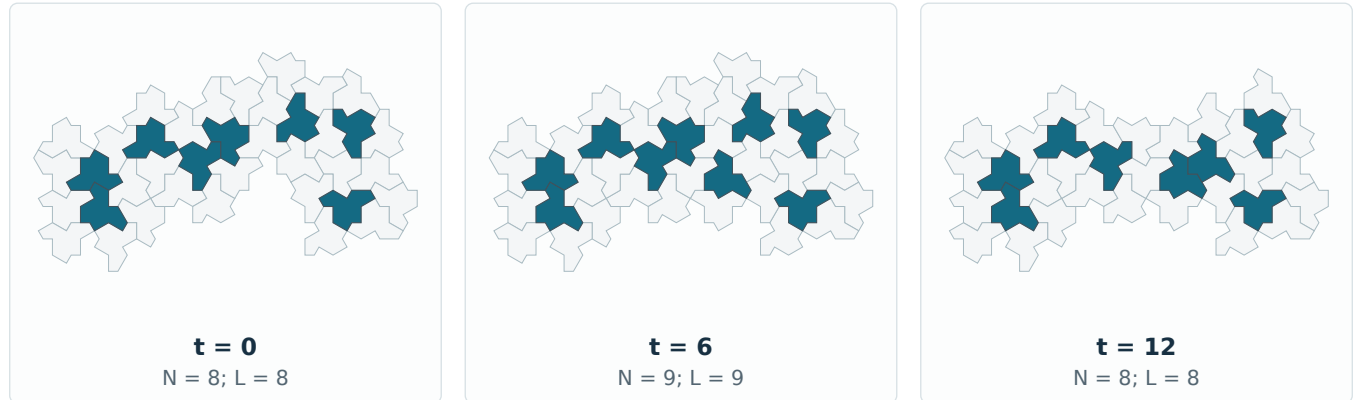
hat-b23-p24

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S | C = 2 | shared-edge

Complete rule and prior use: [R05 \(p. 107\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 24 under B23/S with two states on the Hat shared-edge graph. The union of occupied tiles over its complete cycle has 21 tiles, while the instantaneous live population ranges from 8 to 11.

Least period $p = 24$; transient = 0; cycle $L = 8-11$; cycle territory = 21 tiles; cycle minimum boundary distance = 21.

Exact initial configuration (tile ID,state)

(2641,1) (2643,1) (2649,1) (2703,1) (2715,1) (2733,1) (2818,1) (3302,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H14)

Extracted from a deterministic soup by the package's oscillator miner: source seed hat-edge-B23/S-2-osc-v3-748, density 0.10. The eight-live-cell catalogue phase has period 24. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: [discoveries.js](#). Complete source and evidence lists are in [catalogue-data.json](#).

H15 Hat B23/S p28

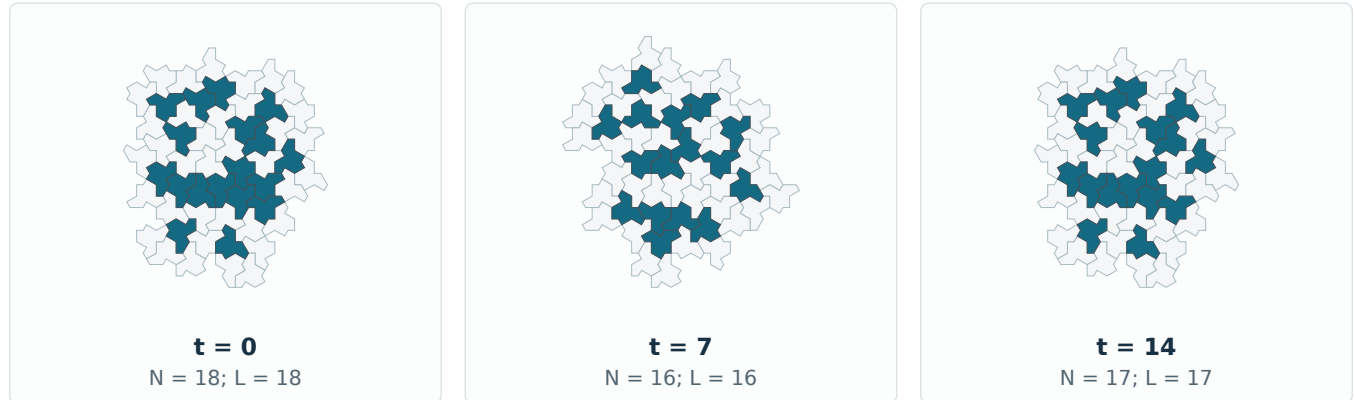
hat-b23-p28

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S | C = 2 | shared-edge

Complete rule and prior use: [R05 \(p. 107\)](#). [Notation \(p. 3\)](#).

Depth 4; 7,921 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An isolated oscillator of exact least period 28 under B23/S with two states on the Hat shared-edge graph. The union of occupied tiles over its complete cycle has 37 tiles, while the instantaneous live population ranges from 14 to 20.

Least period $p = 28$; transient = 0; cycle $L = 14$ -20; cycle territory = 37 tiles; cycle minimum boundary distance = 7.

Exact initial configuration (tile ID,state)

(634,1) (636,1) (639,1) (641,1) (642,1) (644,1) (659,1) (673,1) (4451,1) (4538,1) (4539,1) (4540,1)
(4650,1) (4663,1) (4664,1) (4665,1) (4667,1) (4668,1)

Interpretation and limits

The standard rule-family name does not imply that this Hat configuration was published previously. No exact precedent was identified in the literature reviewed to 14 October 2026; unexamined or unpublished earlier work may exist. The full labelled state, not a population count or partial image, is used for recurrence verification.

Pattern provenance and credit (H15)

Extracted from a deterministic soup by the package's oscillator miner: source seed hat-edge-B23/S-2-osc-v3-694, density 0.16. The whole soup has period 56; the isolated catalogue component has period 28. No exact precedent identified in the literature reviewed to 14 October 2026.

Evidence in release: discoveries.js. Complete source and evidence lists are in catalogue-data.json.

H16 Hat two-row relay - Spectre variant

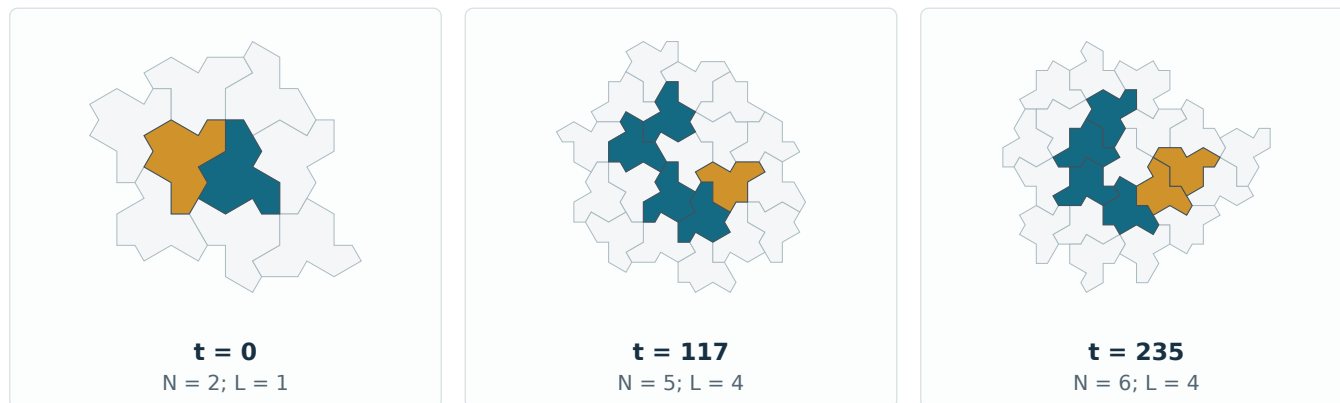
hat-two-row-relay

Adapted mechanism: James Edmond's Spectre relay [2], [3]; changed three-state rule R13 and ignition. Mature trajectories agree after state relabelling.

TABLE:HAT-RELAY | C = 3 | edge-or-point contact (touch)

Complete rule and prior use: R13 (p. 110). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A two-cell seed travels under the three-state, two-row rule R13. Generations 60-235 match James Edmond's Spectre relay [2], [3] after state relabelling. Verified through 235 finite generations; the complete support can split.

Catalogue replay through t = 235.

Exact initial configuration (tile ID,state)

(7293,2) (7295,1)

Interpretation and limits

The checked mature trajectories agree; the complete transition rules do not. R13 and Edmond's Spectre table [3] have different ignition and transition conditions outside that trajectory. Finite travel does not prove indefinite propagation.

Pattern provenance and credit (H16)

R13 was obtained by simplifying the package's evolved wake rule R15. Its mature trajectory matches James Edmond's Spectre relay in The Glider Compendium [3], with package states (0,1,2) mapped to Edmond states (0,3,1). The global transition conditions and ignition differ. Edmond's paper [2] supplies the published framework; this entry does not claim an independent discovery of the reproduced travelling mechanism.

Source of the Spectre travelling mechanism matched by the mature trajectory under state relabelling; not the same global rule: [2], [3].

Evidence in release: research/continued-search/hat-relay/final-rules.json. Complete source and evidence lists are in catalogue-data.json.

H17 Hat glider B - Edmond rule

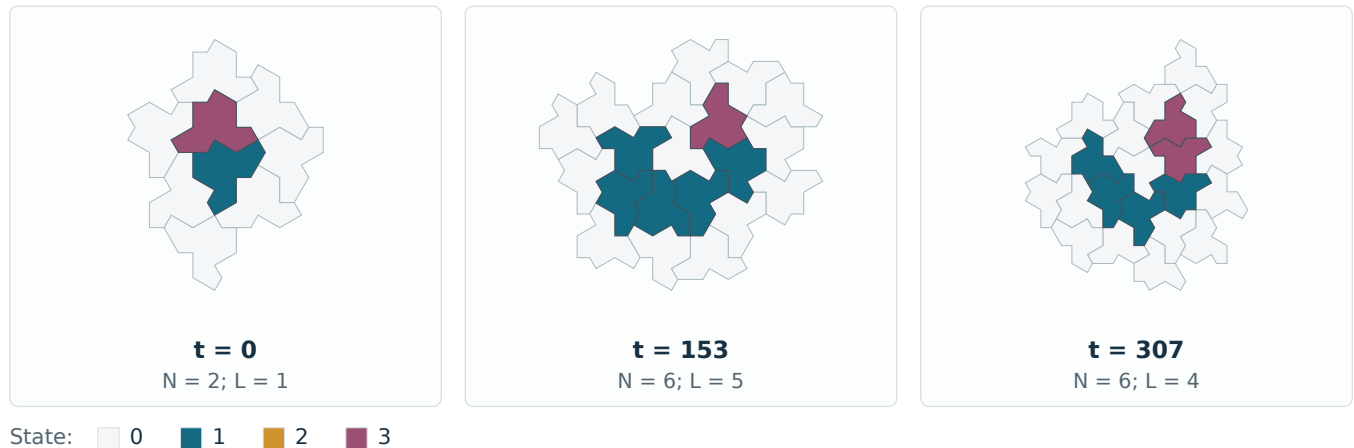
hat-edmond-b-glider

Published rule and travelling mechanism: James Edmond, Hat B in The Glider Compendium [2], [3]. The two-cell placement on this patch was selected by the package.

TABLE:HAT-B | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: R11 (p. 109). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Verified behaviour

A two-cell seed launches a compact Hat glider under James Edmond's published B priority table. Verified through 307 generations with a dead boundary buffer; no immortality or first-discovery claim. The recorded trajectory contains at most 13 nonzero cells and stays at least 4 graph rings from the boundary.

Catalogue replay through t = 307.

Exact initial configuration (tile ID,state)

(2945,1) (2943,3)

Interpretation and limits

The package verifies this particular placement through generation 307 with at least four boundary rings. The Hat B rule and travelling behaviour are published by James Edmond [2], [3]; neither indefinite travel nor independent historical priority is inferred from this finite run.

Pattern provenance and credit (H17)

James Edmond - Hat B; seed placement found for Aperiodic Life [2], [3], [18]. Uses Edmond's published Hat B transition rule and previously demonstrated travelling behaviour. Aperiodic Life independently selected this two-cell placement on its own finite hat patch; its tile numbering and recorded trajectory are not an import of Edmond's saved run. The package's finite replay does not establish indefinite propagation.

Source of the published Hat rule and travelling or launch behaviour; the patch placement was selected by the package: [2], [3], [18].

Evidence in release: research/fixtures/published-priority-rules.json. Complete source and evidence lists are in catalogue-data.json.

H18 Hat glider A - Edmond rule

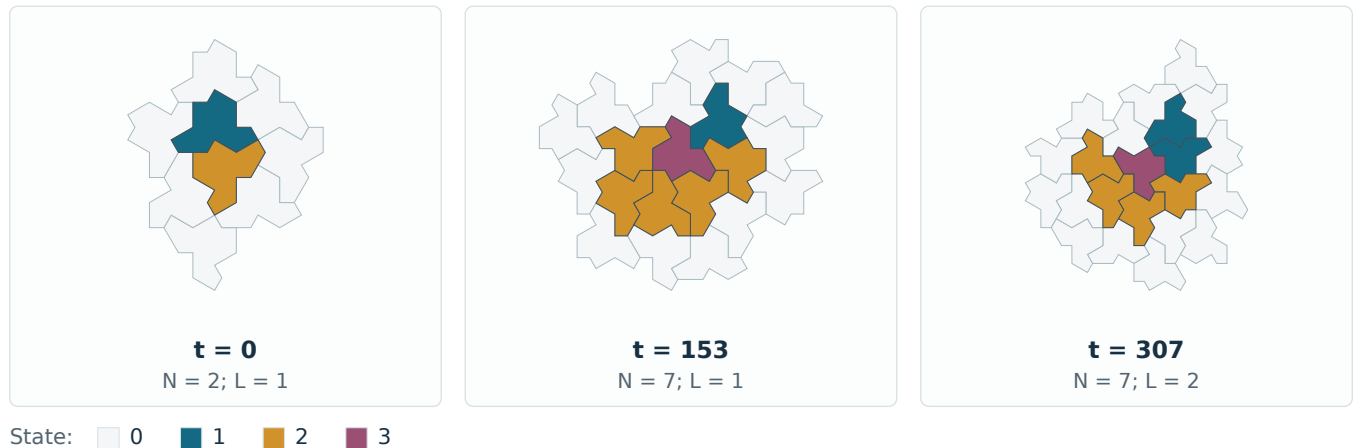
hat-edmond-a-glider

Published rule and travelling mechanism: James Edmond, Hat A in The Glider Compendium [2], [3]. The two-cell placement on this patch was selected by the package.

TABLE:HAT-A | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: R10 (p. 109). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Verified behaviour

A two-cell seed launches a compact Hat glider under James Edmond's published A priority table. Verified through 307 generations with a dead boundary buffer; no immortality or first-discovery claim. The recorded trajectory contains at most 14 nonzero cells and stays at least 4 graph rings from the boundary.

Catalogue replay through $t = 307$.

Exact initial configuration (tile ID,state)

(2945,2) (2943,1)

Interpretation and limits

The package verifies this particular placement through generation 307 with at least four boundary rings. James Edmond's Hat A rule and travelling behaviour appear in The Glider Compendium [3] and paper [2]. Aperiodic Life's different seed placement does not establish a new glider discovery.

Pattern provenance and credit (H18)

James Edmond - Hat A; seed placement found for Aperiodic Life [2], [3], [18]. Uses Edmond's published Hat A transition rule and previously demonstrated travelling behaviour. Aperiodic Life independently selected this two-cell placement on its own finite hat patch; its tile numbering and recorded trajectory are not an import of Edmond's saved run. The package's finite replay does not establish indefinite propagation.

Source of the published Hat rule and travelling or launch behaviour; the patch placement was selected by the package: [2], [3], [18].

Evidence in release: research/fixtures/published-priority-rules.json. Complete source and evidence lists are in catalogue-data.json.

H19 Hat glider C - Edmond rule

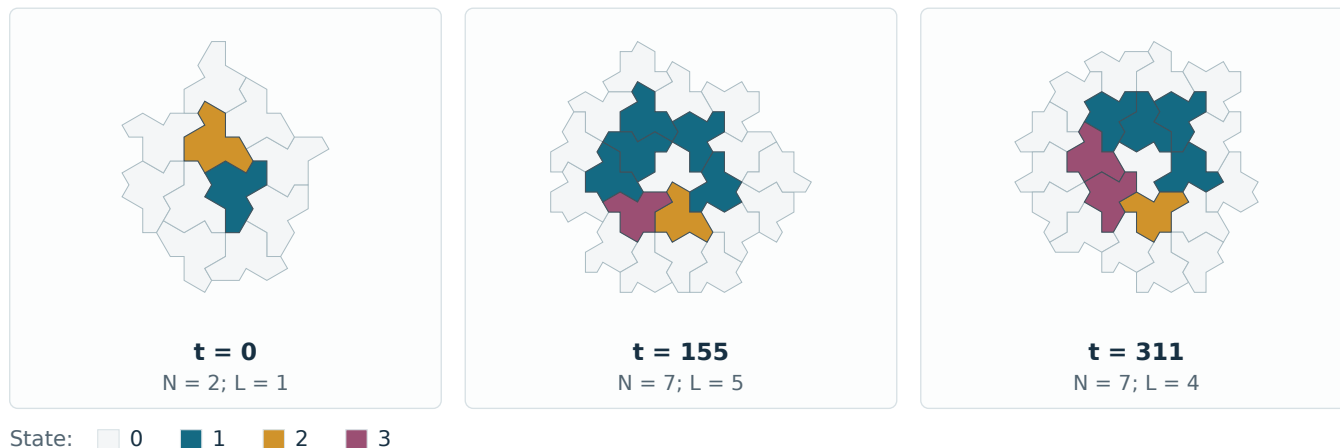
hat-edmond-c-glider

Published rule and travelling mechanism: James Edmond, Hat C in The Glider Compendium [2], [3]. The two-cell placement on this patch was selected by the package.

TABLE:HAT-C | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: R12 (p. 109). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Verified behaviour

A two-cell seed launches a compact Hat glider under James Edmond's published C priority table. Verified through 311 generations with a dead boundary buffer; no immortality or first-discovery claim. The recorded trajectory contains at most 18 nonzero cells and stays at least 4 graph rings from the boundary.

Catalogue replay through t = 311.

Exact initial configuration (tile ID,state)

(7267,1) (7283,2)

Interpretation and limits

The package checks this placement through generation 311 with at least four boundary rings. A finite translated local neighbourhood is not a proof that the full future substrate will repeat. James Edmond's Hat C rule and travelling behaviour are published in The Glider Compendium [3] and paper [2].

Pattern provenance and credit (H19)

James Edmond - Hat C; seed placement found for Aperiodic Life [2], [3], [18]. Uses Edmond's published Hat C transition rule and previously demonstrated travelling behaviour. Aperiodic Life independently selected this two-cell placement on its own finite hat patch; its tile numbering and recorded trajectory are not an import of Edmond's saved run. The package's finite replay does not establish indefinite propagation.

Source of the published Hat rule and travelling or launch behaviour; the patch placement was selected by the package: [2], [3], [18].

Evidence in release: research/fixtures/published-priority-rules.json. Complete source and evidence lists are in catalogue-data.json.

H20 Hat glider - three-state variant

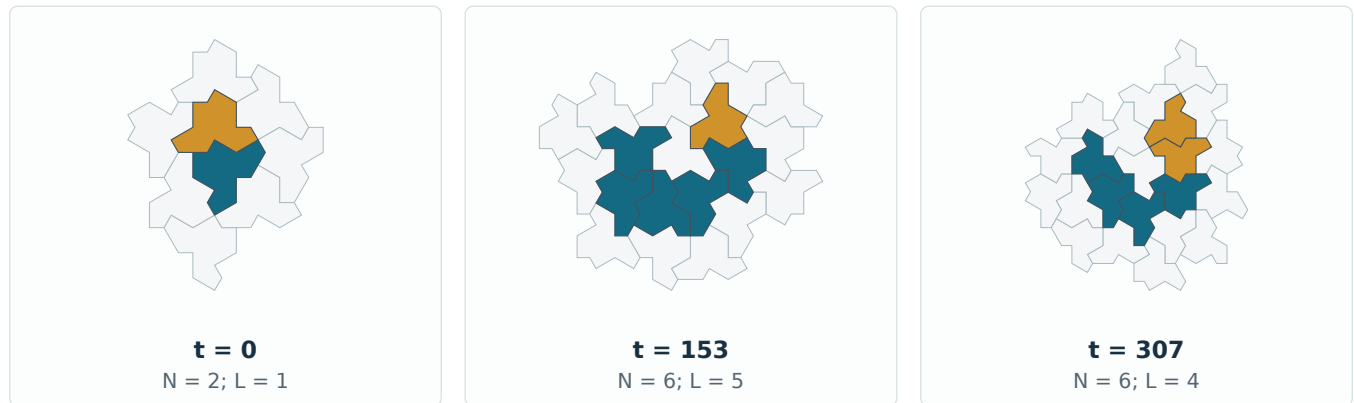
hat-simple-glider

Adapted rule: James Edmond's Hat B [2], [3]. R14 removes a state unreachable from the checked launch, relabels 3 as 2 and drops the empty-neighbour birth condition.

TABLE:HAT-SIMPLE | C = 3 | edge-or-point contact (touch)

Complete rule and prior use: R14 (p. 110). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

R14 is a three-state modification of James Edmond's Hat B rule R11 [2], [3]. It reproduces the tested compact flights after relabelling, but differs on other inputs. The recorded trajectory contains at most 13 nonzero cells and stays at least four graph rings from the boundary.

Catalogue replay through $t = 307$.

Exact initial configuration (tile ID,state)

(2945,1) (2943,2)

Interpretation and limits

Agreement holds for the checked trajectories, not every input. A retained counterexample separates R14 from Edmond's Hat B rule R11 [3]. Finite agreement does not prove endless travel.

Pattern provenance and credit (H20)

R14 modifies James Edmond's Hat B rule R11 [2], [3]: remove the state unreachable from the checked two-cell launch, relabel parent state 3 as 2, and drop the empty-neighbour birth condition. These changes give three states and preserve the checked launches, but alter other inputs. The parent rule and travelling mechanism are Edmond's; the package contributes this simplification, without claiming that no earlier equivalent simplification exists.

Source of Hat B, the parent transition rule and travelling mechanism: [2], [3].

Evidence in release: research/fixtures/published-priority-rules.json. Complete source and evidence lists are in catalogue-data.json.

H21 Hat triple launcher - two-cell seed

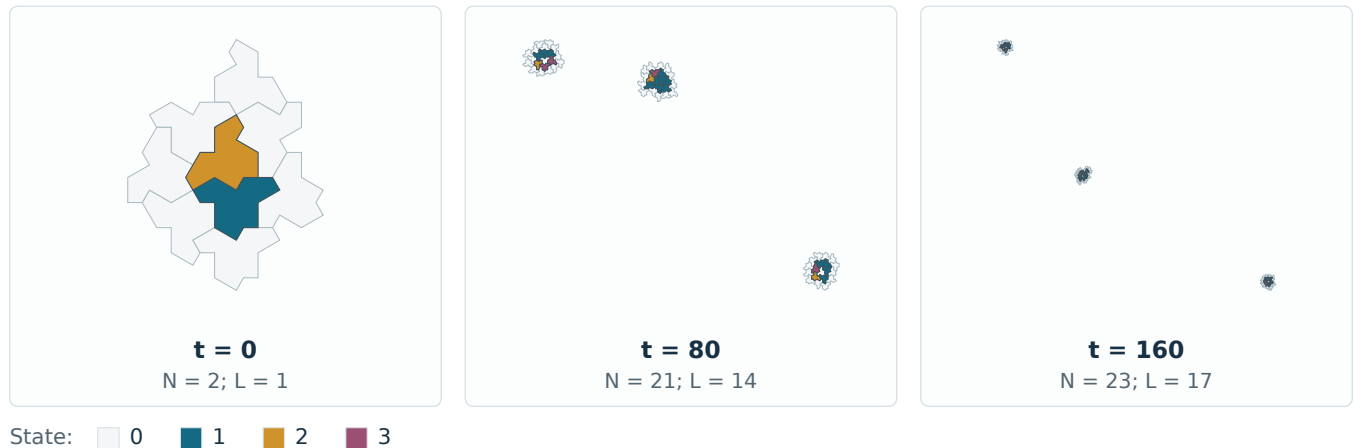
hat-edmond-c-triple-launcher

Published launch behaviour: James Edmond's two-cell Hat C triple launch in The Glider Compendium [3]. The placement on this patch was selected by the package.

TABLE:HAT-C | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: R12 (p. 109). Notation (p. 3).

Depth 5; 54,289 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Two cells under Edmond's C rule emit three separated compact travellers. Their complete independent evolutions reproduce the whole configuration through generation 160, with no leftover debris. This is a finite launcher, not a repeating gun. The recorded trajectory contains at most 39 nonzero cells and stays at least 34 graph rings from the boundary.

Catalogue replay through t = 160.

Exact initial configuration (tile ID,state)

(23905,1) (23907,2)

Interpretation and limits

This is a finite launch, not a repeating gun. Edmond's Glider Compendium [3] already demonstrates Hat C triple emission; the package independently selected a placement and verifies its finite evolution.

Pattern provenance and credit (H21)

James Edmond - Hat C triple launch; seed placement found for Aperiodic Life [2], [3], [18]. Edmond's compendium already demonstrates a two-cell Hat C seed producing three gliders. This catalogue entry uses the same published rule with a placement independently selected on Aperiodic Life's patch. Its three separated travellers are verified through the stated finite horizon. It is a reproduction of published launch behaviour, not a claim to the first triple launcher or a repeating gun.

Source of the published Hat rule and travelling or launch behaviour; the patch placement was selected by the package: [2], [3], [18].

Evidence in release: research/fixtures/published-priority-rules.json. Complete source and evidence lists are in catalogue-data.json.

C04 Hat B1 wave field

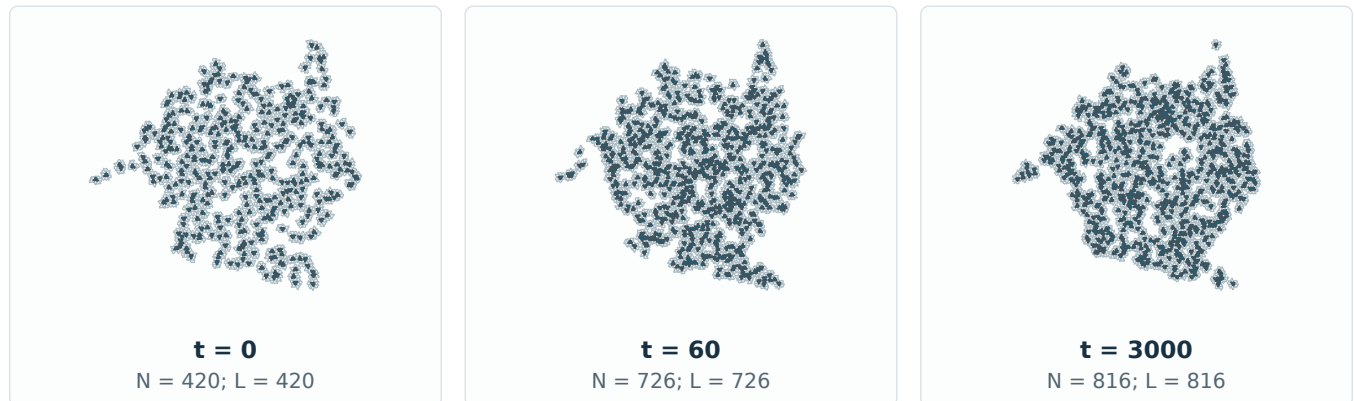
hat-b1-field

Package-generated field under B1/S, $C = 2$ on the Hat touch graph (R07). The seed and finite-board demonstration are package contributions; no new update principle is claimed.

B1/S | $C = 2$ | edge-or-point contact (touch)

Complete rule and prior use: R07 (p. 108). Notation (p. 3).

Depth 4; 7,921 cells; dead border rings = 8.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A deterministic pseudorandom B1/S field with two states, touch adjacency, density 0.12, random seed hat-touch-B1/S-2 and eight locked dead boundary rings remains dynamically active through 3,000 generations on the 7,921-tile depth-4 Hat patch.

Catalogue replay through $t = 3000$.

Exact initialisation recipe

`simulation.randomize(0.12, 'hat-touch-B1/S-2')`; initial nonzero cells are state 1. Complete realised tile states are in `catalogue-data.json` under this entry's `reproduction.initialCellStates`.

Interpretation and limits

A constructed finite-board demonstration of collective activity, not a compact discovered structure or a novel rule. Persistence to 3,000 does not prove nonperiodic behaviour, indefinite persistence on an infinite tiling, or lack of a finite-board eventual cycle. It is classified as a package construction, C04.

Pattern provenance and credit (C04)

A reproducible pseudorandom field constructed for the package's rule survey, using seed hat-touch-B1/S-2, density 0.12 and an eight-ring dead border. It was selected because it remains active through 3,000 generations. This is a finite-board demonstration of collective dynamics, not an attributed compact pattern or a claim of a newly discovered rule.

Evidence in release: `discoveries.js`. Complete source and evidence lists are in `catalogue-data.json`.

P01 Penrose twelve-traveller launcher

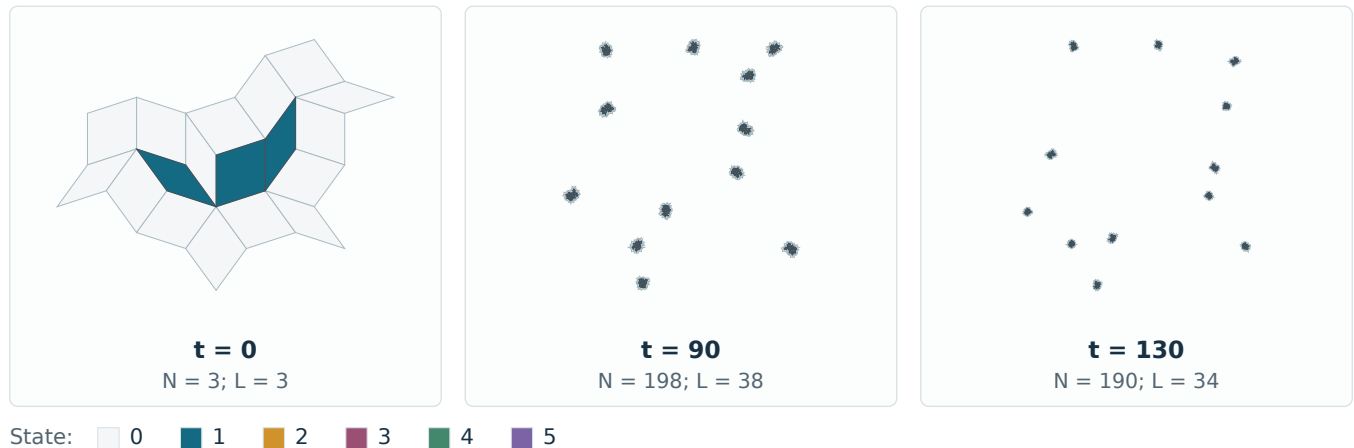
penrose-b2-c6-twelve-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 6 | edge-or-point contact (touch)

Complete rule and prior use: [R22](#) (p. 113). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



Verified behaviour

Three initially live cells produce twelve compact bodies whose independent evolutions reconstruct the entire configuration at every generation from 90 through 130. All twelve have observed translated full-state/polygon returns; five also have a verified matching three-ring neighbourhood return.

Catalogue replay through $t = 130$.

Exact initial configuration (tile ID,state)

(46186,1) (51676,1) (51680,1)

Interpretation and limits

A finite, placement-dependent one-off launcher in the B2/S six-state travelling family [R22](#), illustrated by [P13](#). It is neither a repeating gun nor evidence for a new propagating mechanism. Locally matching transplants do not necessarily preserve the twelve-body outcome.

Pattern provenance and credit (P01)

Three live cells selected by the connected/phased-seed campaign launch twelve independent compact bodies from generation 90 to 130, with a minimum observed boundary distance of seven graph steps. All twelve have translated full-state and polygon returns, while five have radius-three halo returns within that horizon. All six nonempty proper seed subsets differ at generation 130. This is a finite launcher using the package travelling family [R22](#) ([P13](#)), not a new glider mechanism or repeating gun. Larger locally matching placements need not preserve this outcome. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/continued-search/penrose/campaigns.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

P02 Penrose five-traveller launcher

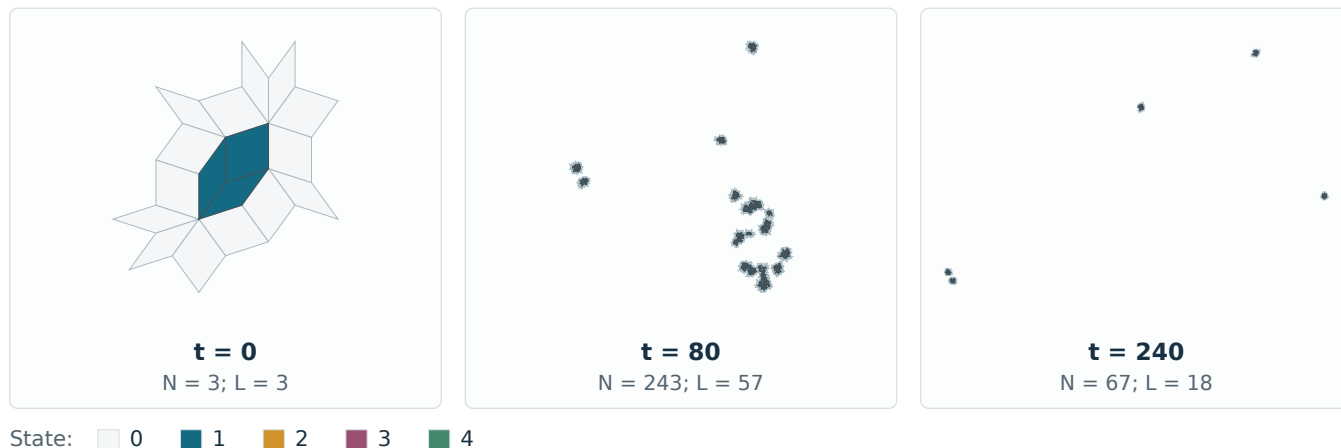
penrose-b2-c5-five-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 5 | edge-or-point contact (touch)

Complete rule and prior use: [R21](#) (p. 112). Notation (p. 3).

Depth 11; sun seed; 143,010 cells; dead border rings = 0.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Three initially live cells yield five compact five-state travelling bodies. From generation 120 through 240 the five independently simulated bodies reproduce the complete state; each has an observed full-state translated return with matching tile polygons and three neighbourhood rings.

Catalogue replay through t = 240.

Exact initial configuration (tile ID,state)

(120863,1) (120865,1) (120867,1)

Interpretation and limits

A finite one-off launch using the B2/S travelling family; no repeating source or indefinite continuation has been established.

Pattern provenance and credit (P02)

This three-live-cell launch and its depth-11 placement were located by the package's connected-seed search and polygon-matched transplants. Its five emitted bodies use the B2/S five-state family [R21](#) ([P12](#)), with finite verification through generation 240. This identifies the origin of this recorded launch, not a first-discovery claim for the rule or propagating mechanism. Goucher's earlier published Penrose gliders use a different rule [\[4\]](#).

Related literature; not an identified exact source for this configuration: [\[4\]](#).

Evidence in release: research/exhaustive-search/penrose/campaigns.json. Complete source and evidence lists are in catalogue-data.json.

P03 Penrose six-traveller launcher

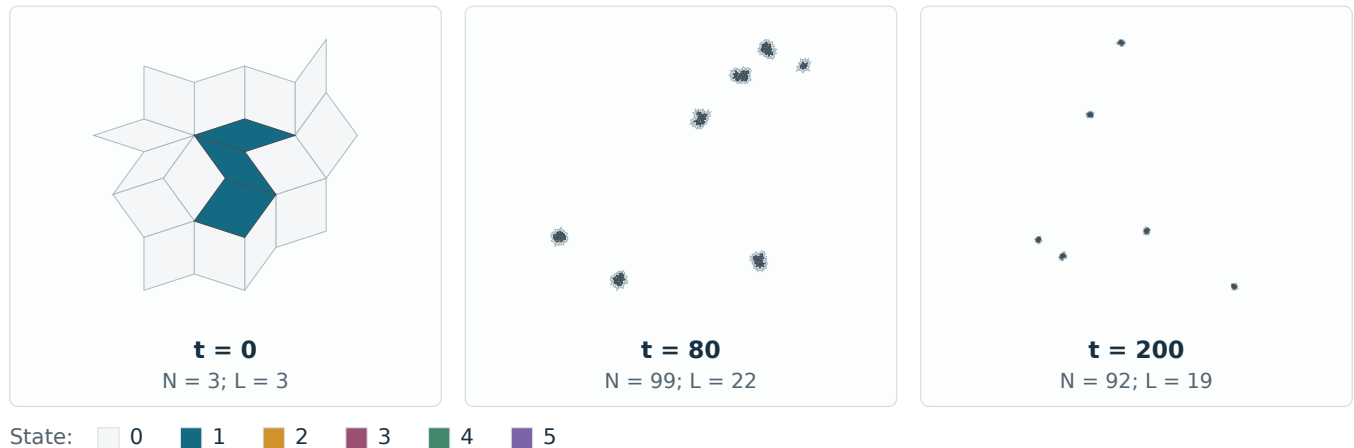
penrose-b2-c6-six-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 6 | edge-or-point contact (touch)

Complete rule and prior use: [R22](#) (p. 113). Notation (p. 3).

Depth 11; sun seed; 143,010 cells; dead border rings = 0.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Three initially live cells yield six compact six-state travelling bodies. From generation 120 through 200 their independent evolutions reproduce the complete state; each has an observed full-state translated return with matching tile polygons and three neighbourhood rings.

Catalogue replay through $t = 200$.

Exact initial configuration (tile ID,state)

(65275,1) (65271,1) (65274,1)

Interpretation and limits

A finite one-off launch using the B2/S travelling family; no repeating source or indefinite continuation has been established.

Pattern provenance and credit (P03)

This three-live-cell launch and its depth-11 placement were located by the package's connected-seed search and polygon-matched transplants. Its six emitted bodies use the B2/S six-state family [R22](#) ([P13](#)), with finite verification through generation 200. This identifies the origin of this recorded launch, not a first-discovery claim for the rule or propagating mechanism. Goucher's earlier published Penrose gliders use a different rule [\[4\]](#).

Related literature; not an identified exact source for this configuration: [\[4\]](#).

Evidence in release: [research/exhaustive-search/penrose/campaigns.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

P04 Penrose compact oscillator - period 822

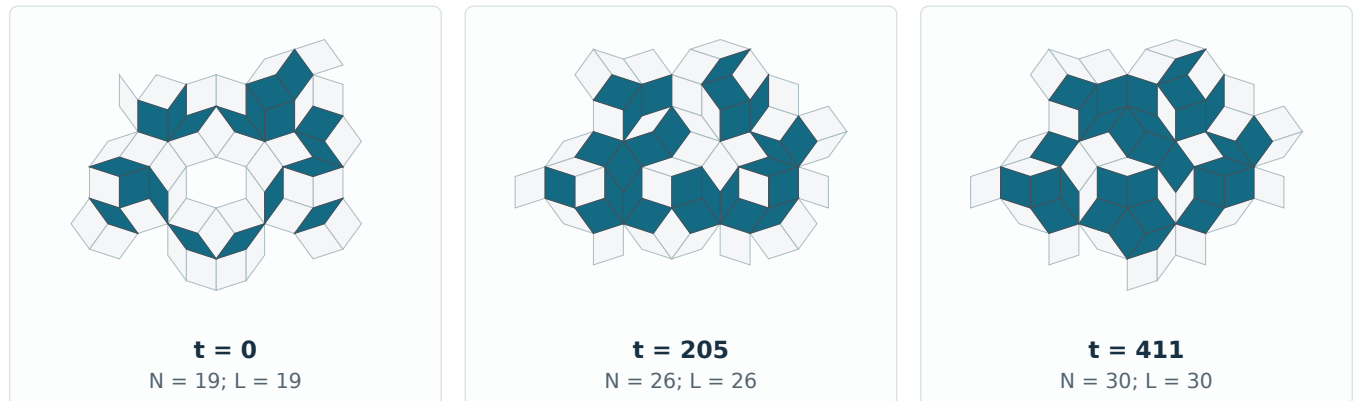
penrose-edge-b23s23-p822

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S23 | C = 2 | shared-edge

Complete rule and prior use: [R17 \(p. 111\)](#). [Notation \(p. 3\)](#).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An exact least-period-822 stationary oscillator starts from nineteen live tiles and visits a total of forty-six tiles. Thirty-nine individual sites have least temporal period 822, excluding an explanation solely as independent smaller-period oscillators.

Least period $p = 822$; transient = 0; cycle $L = 19-37$; cycle territory = 46 tiles; cycle minimum boundary distance = 40.

Exact initial configuration (tile ID,state)

(5116,1) (5117,1) (5118,1) (5887,1) (5888,1) (5889,1) (5892,1) (5893,1) (5909,1) (5911,1) (5922,1)
(5924,1) (5925,1) (5926,1) (5932,1) (5940,1) (5947,1) (5950,1) (5952,1)

Interpretation and limits

Uses B23/S23 with edge adjacency, not ordinary Conway B3/S23 on the contact graph. The rule, graph and complete state are essential to the identity.

Pattern provenance and credit (P04)

Recovered in the package's focused B23/S23 edge search, then transplanted from depth 7 to depth 8. The recorded full period is 822 and 39 individual sites have that period. Owens-Stepney is earlier work on Penrose oscillators, but its Conway touch-graph catalogue does not establish authorship of this different-rule edge-graph pattern. No exact precedent was identified in the literature reviewed to 14 October 2026. Earlier Penrose oscillator catalogue: Owens and Stepney [5].

Related literature; not an identified exact source for this configuration: [5].

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P05 Penrose three-state oscillator - period 14

penrose-conway-c3-p14

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 3 | edge-or-point contact (touch)

Complete rule and prior use: [R28 \(p. 115\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

Four live and two refractory tiles initiate an exact least-period-14 stationary oscillator, using three-state B3/S23 Generations on the contact graph.

Least period $p = 14$; transient = 0; cycle $L = 4-8$; cycle territory = 27 tiles; cycle minimum boundary distance = 16.

Exact initial configuration (tile ID,state)

(1944,1) (2003,1) (2004,1) (2007,1) (2710,2) (2747,2)

Interpretation and limits

This is a three-state rule. A binary Penrose oscillator of the same period is not thereby a precedent for the same pattern.

Pattern provenance and credit (P05)

Recovered in the package's multistate oscillator survey and transplanted from depth 7 to depth 8. This is a three-state B3/S23 Generations oscillator; it must not be identified with a published binary Penrose oscillator merely by period. No exact precedent was identified in the literature reviewed to 14 October 2026. Earlier Penrose oscillator catalogue: Owens and Stepney [\[5\]](#).

Related literature; not an identified exact source for this configuration: [\[5\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P06 Penrose Conway p4

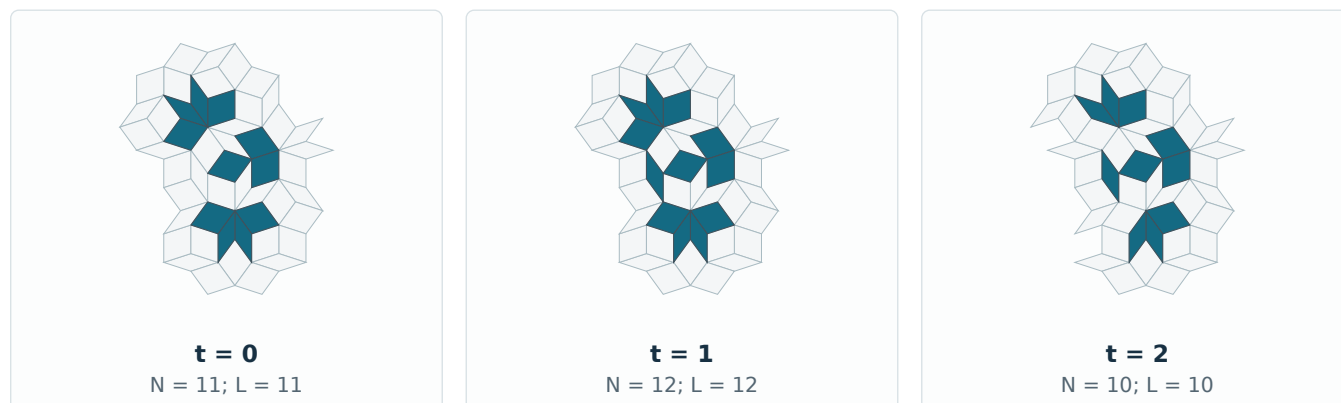
penrose-conway-p4

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R27 \(p. 114\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An eleven-live-tile phase belongs to a least-period-4 contact-graph Conway oscillator; twelve tiles occur in its cycle support and its live population ranges from nine to twelve.

Least period $p = 4$; transient = 0; cycle $L = 9-12$; cycle territory = 12 tiles; cycle minimum boundary distance = 25.

Exact initial configuration (tile ID,state)

(4316,1) (4319,1) (4321,1) (4326,1) (4327,1) (5095,1) (5098,1) (5101,1) (5102,1) (5107,1) (5108,1)

Interpretation and limits

Owens and Stepney's Penrose Life catalogue [\[5\]](#) is relevant earlier work. An exact identification with its illustrated patterns has not been established; independent recovery from soup is not proof of originality.

Pattern provenance and credit (P06)

The package record recovers this exact phase from deterministic soup penrose-touch-B3/S23-2-osc-v3-6566, density 0.16. It has 12 support tiles and minimum population 9. Penrose Conway oscillators were catalogued by Owens and Stepney, but an exact identification with their illustrated patterns has not been established; this is a package search attribution, not a worldwide originality claim. Earlier Penrose oscillator catalogue: Owens and Stepney [\[5\]](#).

Related literature; not an identified exact source for this configuration: [\[5\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P07 Penrose Conway p5

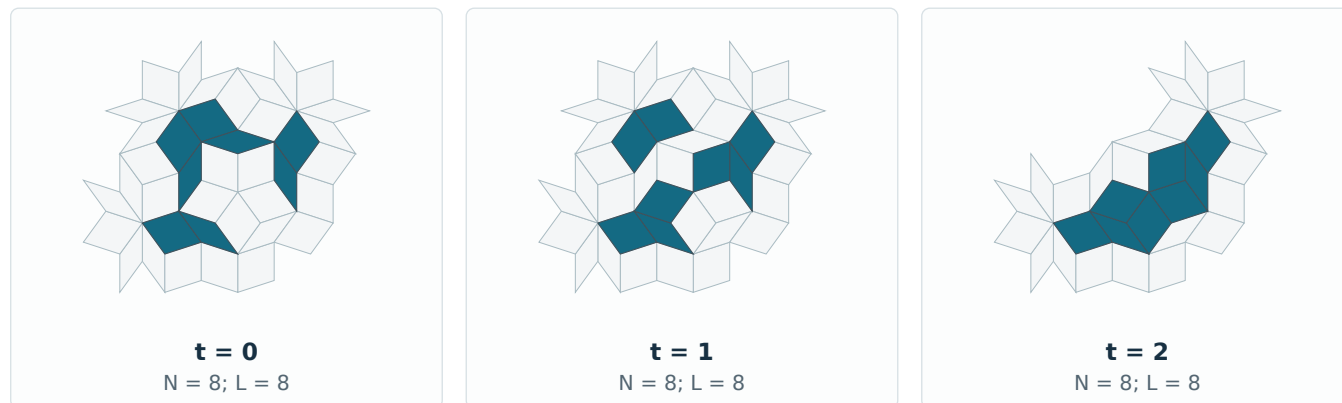
penrose-conway-p5

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R27 \(p. 114\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An eight-live-tile phase belongs to a least-period-5 contact-graph Conway oscillator with eighteen-tile cycle support and live population between eight and ten.

Least period $p = 5$; transient = 0; cycle $L = 8-10$; cycle territory = 18 tiles; cycle minimum boundary distance = 16.

Exact initial configuration (tile ID,state)

(376,1) (433,1) (1070,1) (1116,1) (1120,1) (1127,1) (1225,1) (1228,1)

Interpretation and limits

Its support and minimum population differ from the published r-p5-14-7 juggler, excluding that particular invariant match. Other possible antecedents have not been ruled out.

Pattern provenance and credit (P07)

The exact phase is recorded under soup penrose-touch-B3/S23-2-osc-v3-1151, density 0.35. It has 18 support tiles and minimum population 8. It is not identified with the published r-p5-14-7 juggler: those support/population invariants differ. No exact earlier match was identified in the literature reviewed to 14 October 2026. Earlier Penrose oscillator catalogue: Owens and Stepney [\[5\]](#).

Related literature; not an identified exact source for this configuration: [\[5\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P08 Penrose Conway p7

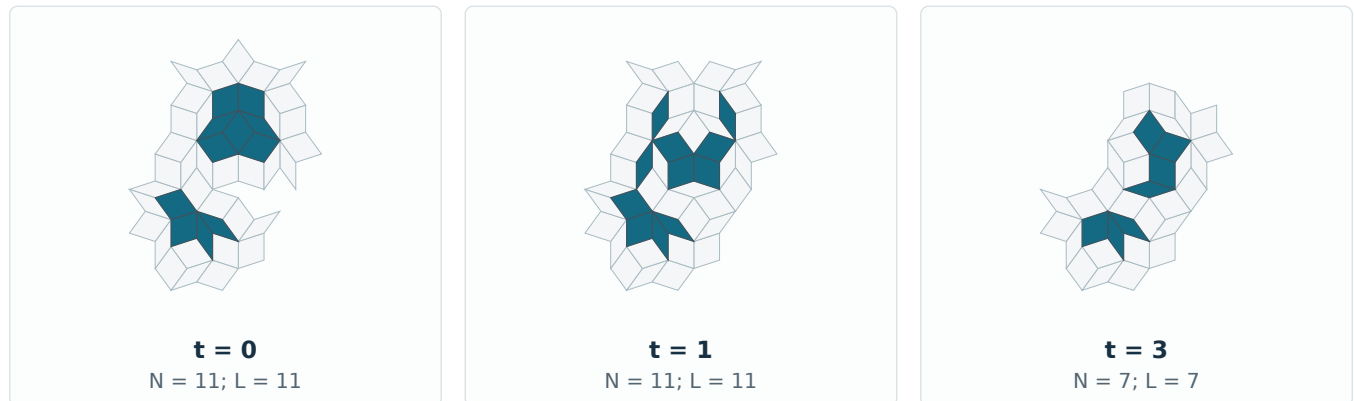
penrose-conway-p7

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R27 \(p. 114\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

An eleven-live-tile phase belongs to a least-period-7 contact-graph Conway oscillator; twenty tiles occur during the cycle and the live population ranges from seven to eleven.

Least period $p = 7$; transient = 0; cycle $L = 7$ -11; cycle territory = 20 tiles; cycle minimum boundary distance = 7.

Exact initial configuration (tile ID,state)

(5545,1) (5546,1) (5549,1) (6188,1) (6189,1) (6200,1) (6216,1) (6225,1) (6226,1) (6227,1) (6230,1)

Interpretation and limits

Owens and Stepney's Penrose oscillator catalogue [\[5\]](#) is directly relevant; exact earlier-pattern identity remains unresolved.

Pattern provenance and credit (P08)

The package soup replay records seed penrose-touch-osc-149, density 0.16, and this exact isolated period-7 phase. It has 20 support tiles and minimum population 7. No exact earlier match was identified in Owens and Stepney's Penrose oscillator catalogue [\[5\]](#) in the review to 14 October 2026.

Related literature; not an identified exact source for this configuration: [\[5\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P09 Penrose Conway p12

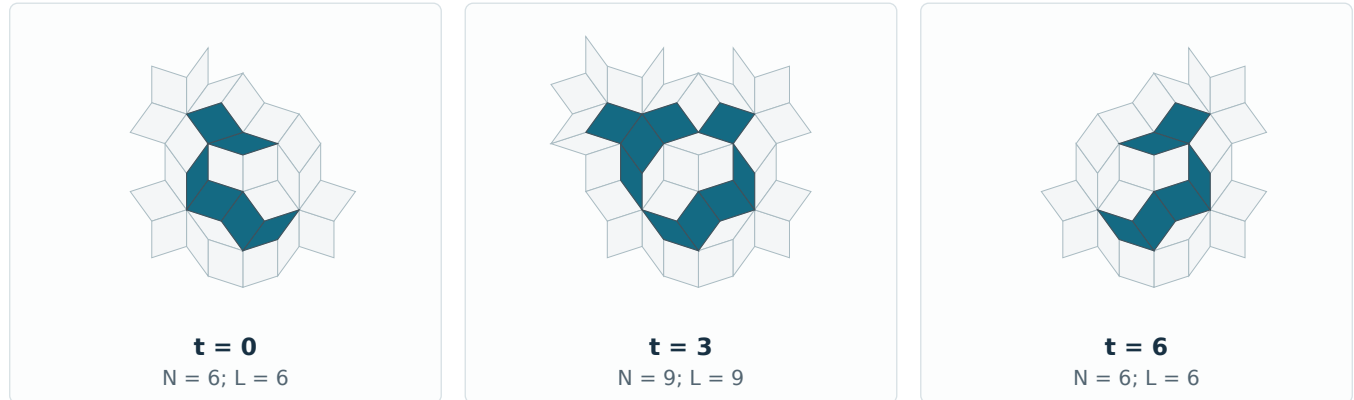
penrose-conway-p12

Possible published antecedent; identity unresolved: Owens-Stepney fireworks oscillator r-p12-33-6 [5], Fig. 18.96; [6], Fig. 6. This entry is not claimed original.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R27 (p. 114). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A six-live-tile phase belongs to a least-period-12 contact-graph Conway oscillator with thirty-three-tile cycle support and live population between six and fourteen.

Least period $p = 12$; transient = 0; cycle $L = 6-14$; cycle territory = 33 tiles; cycle minimum boundary distance = 17.

Exact initial configuration (tile ID,state)

(3566,1) (3596,1) (3600,1) (3607,1) (3608,1) (3609,1)

Interpretation and limits

The published fireworks oscillator has matching period, territory and minimum population, but those invariants do not uniquely identify an oscillator. The possible antecedent remains unresolved; no originality claim is made.

Pattern provenance and credit (P09)

POSSIBLE PUBLISHED ANTECEDENT: the Owens-Stepney fireworks pattern r-p12-33-6 shares its period, territory and minimum population [5], [6]. Complete phase-and-neighbourhood identity has not been established. Treat priority as unresolved, not original.

Possible antecedent: fireworks oscillator r-p12-33-6, [5] Fig. 18.96 and [6] Fig. 6; exact phase geometry not compared: [5], [6].

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P10 Penrose edge-graph p4

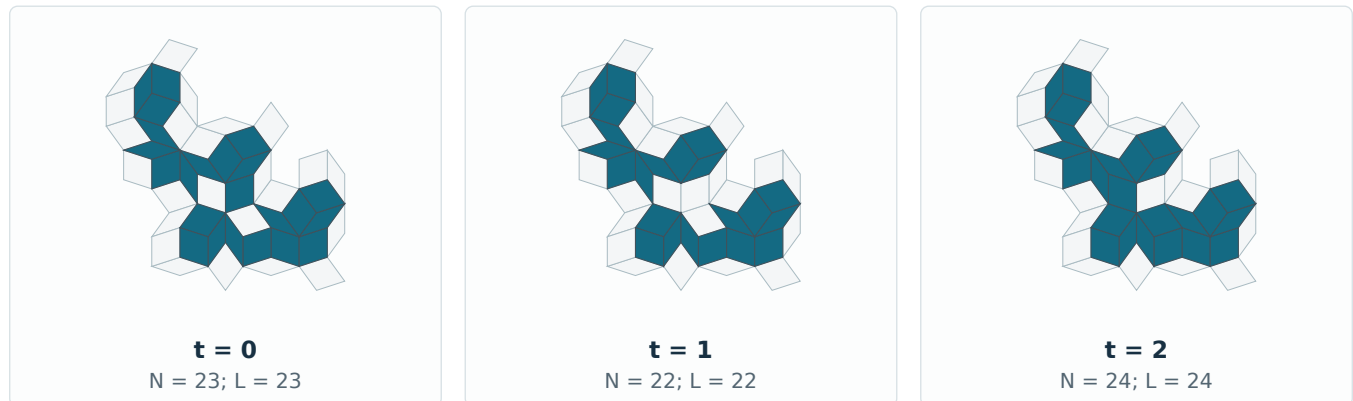
penrose-edge-conway-p4

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R18 \(p. 111\)](#). [Notation \(p. 3\)](#).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: ■ 0 ■ 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A twenty-three-live-tile phase initiates a least-period-4 edge-graph Conway oscillator with twenty-five-tile cycle support and live population between twenty-two and twenty-five.

Least period $p = 4$; transient = 0; cycle $L = 22$ -25; cycle territory = 25 tiles; cycle minimum boundary distance = 41.

Exact initial configuration (tile ID,state)

(1135,1) (1136,1) (1137,1) (1141,1) (1157,1) (1171,1) (1176,1) (1177,1) (1178,1) (1179,1) (1192,1)
 (1194,1) (1195,1) (1199,1) (1200,1) (1201,1) (1203,1) (1917,1) (1919,1) (1922,1) (1975,1) (1976,1)
 (1977,1)

Interpretation and limits

The edge graph differs from the generalised Moore/contact graph used in the cited Owens-Stepney catalogue. Shared rule notation and period do not establish identity.

Pattern provenance and credit (P10)

The exact phase is recorded under soup penrose-edge-B3/S23-2-osc-v3-4732, density 0.30. This example uses edge adjacency, unlike the generalised Moore contact graph in the cited Penrose Conway catalogue. Same rule name or period alone does not identify an earlier exact pattern; no exact precedent was identified in the literature reviewed to 14 October 2026. Earlier Penrose oscillator catalogue: Owens and Stepney [\[5\]](#).

Related literature; not an identified exact source for this configuration: [\[5\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P11 Penrose compact traveller

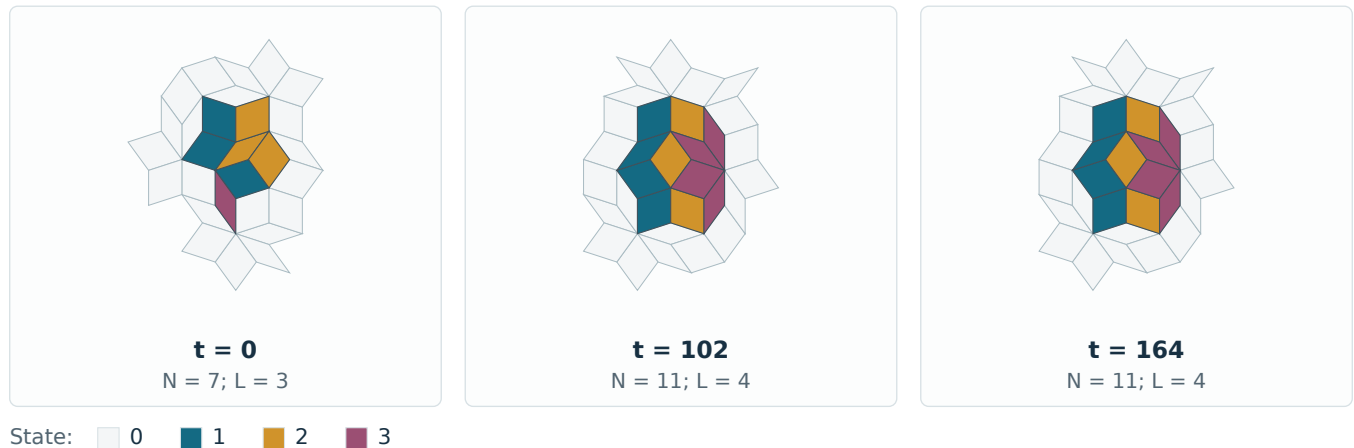
penrose-b2-c4-compact-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R20 \(p. 112\)](#). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A seven-nonzero-tile phased seed remains connected and compact through 220 generations, traversing 193.270 tile-edge units with seven to eleven nonzero tiles. Generations 102 and 164 have a complete-state translated return with matching three-ring local neighbourhoods.

Verified through t = 220; N = 7-11; 220-step replay minimum boundary distance = 9.

Exact initial configuration (tile ID,state)

(5,1) (11,1) (12,3) (20,2) (21,1) (23,2) (27,2)

Interpretation and limits

Finite propagation only: a translated return of the occupied state and three surrounding graph rings does not prove that the aperiodic tiling ahead continues to provide equivalent neighbourhoods indefinitely. Adam P. Goucher's Penrose gliders [\[4\]](#) use a different transition rule.

Pattern provenance and credit (P11)

The package retains an explicit source phase and a polygon-preserving transplant verifier. It is a 4-state B2/S live-front/refractory-wake example with a finite 220-generation certificate. Earlier published Penrose gliders use a different rule; no exact-pattern identity with them is asserted. The general refractory idea is established, and no worldwide first-discovery claim is made for this Penrose phase. Earlier Penrose glider work under a different rule: Goucher [\[4\]](#).

Related literature; not an identified exact source for this configuration: [\[4\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P12 Penrose five-state traveller

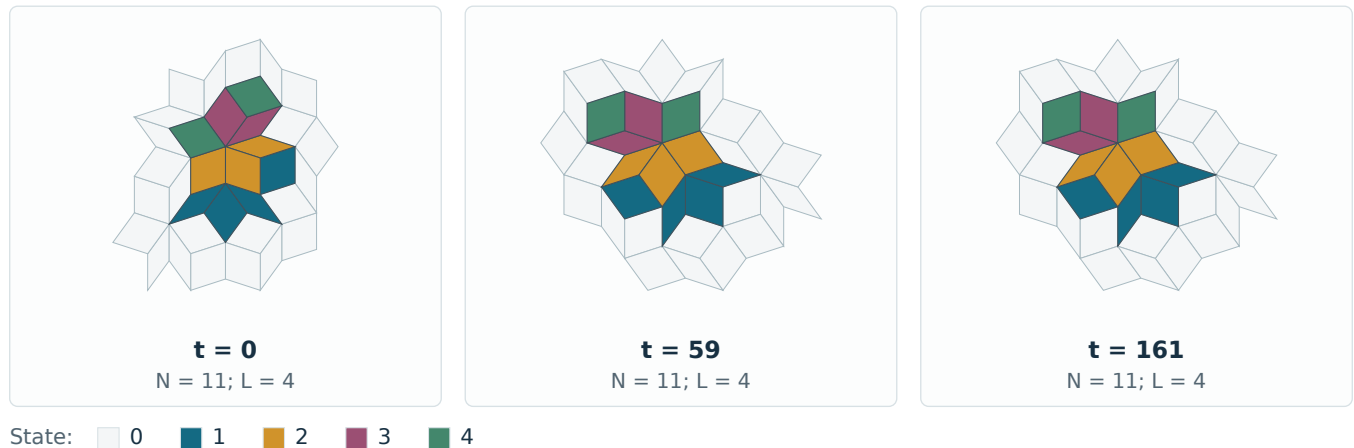
penrose-b2-c5-compact-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 5 | edge-or-point contact (touch)

Complete rule and prior use: [R21](#) (p. 112). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

An eleven-nonzero-tile phased seed remains connected and compact through 220 generations, traversing 192,391 tile-edge units with eleven to fourteen nonzero tiles. Generations 59 and 161 have a complete-state translated return with matching three-ring local neighbourhoods.

Verified through $t = 220$; $N = 11-14$; 220-step replay minimum boundary distance = 12.

Exact initial configuration (tile ID,state)

(17168,2) (17169,2) (17172,2) (17173,1) (17174,1) (17185,1) (17187,1) (17219,4) (17220,3) (17221,3) (17228,4)

Interpretation and limits

Finite propagation only: a translated return of the occupied state and three surrounding graph rings does not prove that the aperiodic tiling ahead continues to provide equivalent neighbourhoods indefinitely. Adam P. Goucher's Penrose gliders [\[4\]](#) use a different transition rule.

Pattern provenance and credit (P12)

The recorded depth-10 phase is taken from the package's five-state traveller campaign. It is a 5-state B2/S live-front/refractory-wake example with a finite 220-generation certificate. Earlier published Penrose gliders use a different rule; no exact-pattern identity with them is asserted. The general refractory idea is established, and no worldwide first-discovery claim is made for this Penrose phase. Earlier Penrose glider work under a different rule: Goucher [\[4\]](#).

Related literature; not an identified exact source for this configuration: [\[4\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P13 Penrose six-state traveller

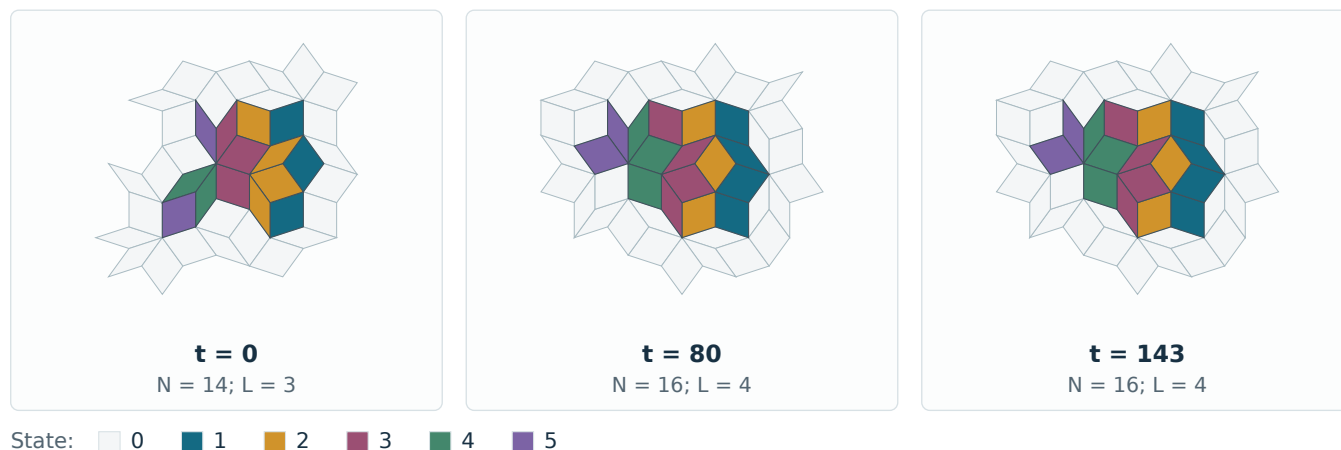
penrose-b2-c6-compact-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S | C = 6 | edge-or-point contact (touch)

Complete rule and prior use: [R22 \(p. 113\)](#). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



Verified behaviour

A fourteen-nonzero-tile phased seed remains connected and compact through 220 generations, traversing 192.268 tile-edge units with fourteen to eighteen nonzero tiles. Generations 80 and 143 have a complete-state translated return with matching three-ring local neighbourhoods.

Verified through $t = 220$; $N = 14-18$; 220-step replay minimum boundary distance = 11.

Exact initial configuration (tile ID,state)

(30966,1) (30970,1) (30976,4) (30977,3) (30978,5) (30980,4) (30983,5) (30984,2) (30985,2) (30987,2)
(30988,3) (30989,3) (36409,2) (36419,1)

Interpretation and limits

Finite propagation only: a translated return of the occupied state and three surrounding graph rings does not prove that the aperiodic tiling ahead continues to provide equivalent neighbourhoods indefinitely. Adam P. Goucher's Penrose gliders [\[4\]](#) use a different transition rule.

Pattern provenance and credit (P13)

The recorded depth-10 phase is taken from the package's six-state traveller campaign. It is a 6-state B2/S live-front/refractory-wake example with a finite 220-generation certificate. Earlier published Penrose gliders use a different rule; no exact-pattern identity with them is asserted. The general refractory idea is established, and no worldwide first-discovery claim is made for this Penrose phase. Earlier Penrose glider work under a different rule: Goucher [\[4\]](#).

Related literature; not an identified exact source for this configuration: [\[4\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P14 Penrose B24 launcher traveller

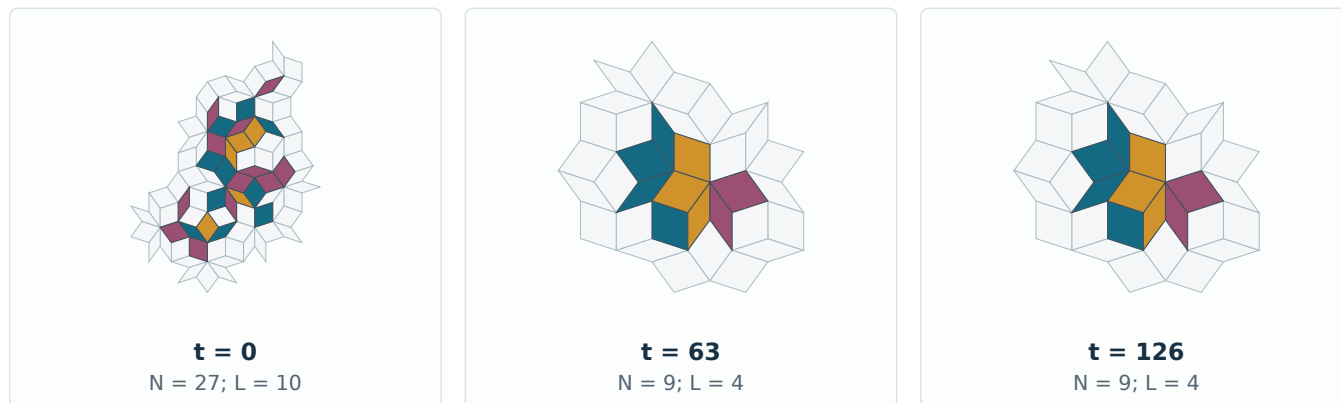
penrose-b24-c4-launcher-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B24/S | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R24](#) (p. 113). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



State: 0 1 2 3

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A phased seed of twenty-seven nonzero tiles (ten live and seventeen refractory) produces eight [R24:B4](#) (birth with exactly four edge-or-point-contact live neighbours) births by generation 14 before settling into a compact B2/S-type wave. The complete configuration traverses 171.841 tile-edge units through generation 200, becoming continuously connected from generation 27.

Verified through t = 200; N = 7-37; 200-step replay minimum boundary distance = 14.

Exact initial configuration (tile ID,state)

(53164,3) (53272,1) (53285,3) (53293,3) (53174,3) (53176,1) (53171,3) (53172,1) (53113,2) (53114,3)
 (53273,1) (53117,3) (53282,1) (53121,3) (53127,2) (53128,1) (3971,3) (4020,1) (53269,2) (53270,1)
 (53208,3) (4109,2) (4113,1) (53206,2) (4110,3) (4052,3) (4053,1)

Interpretation and limits

The added [R24:B4](#) clause affects launch; the mature recurrent body belongs to the B2/S family. The recorded seed and launch are distinct catalogue objects, not a new recurrent glider mechanism.

Pattern provenance and credit (P14)

The package's altered-rule search supplied this 27-cell phased launcher. Eight [R24:B4](#) births affect its launch; its mature travelling core belongs to the package's B2/S family. This attributes the recorded seed and launch mechanism, not a new recurrent glider core or a proved immortal Penrose glider. No external exact-pattern source has been established.

Evidence in release: [research/fixtures/catalogue-verification.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

P15 Penrose B2/S4 survival launcher

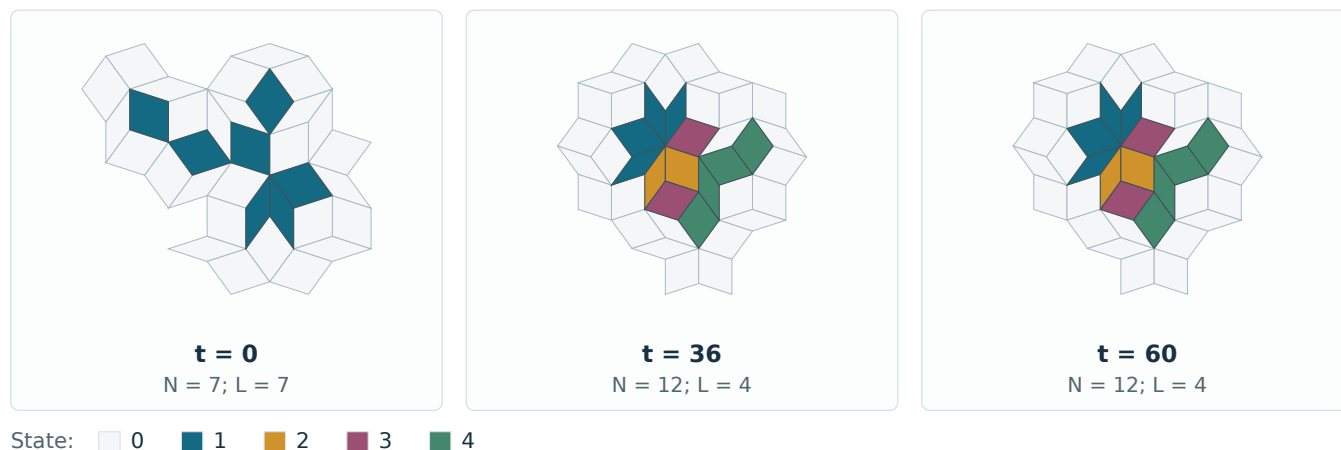
penrose-b2s4-c5-survival-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S4 | C = 5 | edge-or-point contact (touch)

Complete rule and prior use: [R23](#) (p. 113). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Seven initially live tiles undergo two [R23:S4](#) (survival with exactly four edge-or-point-contact live neighbours) survivals by generation 7 and launch a five-state B2/S-type wave. The configuration traverses 170.831 tile-edge units in 200 generations, becoming continuously connected from generation 14.

Verified through t = 200; N = 7-31; 200-step replay minimum boundary distance = 17.

Exact initial configuration (tile ID,state)

(53470,1) (53474,1) (53475,1) (53620,1) (53619,1) (53622,1) (53789,1)

Interpretation and limits

[R23:S4](#) affects ignition but does not establish a new mature travelling mechanism. This is a finite one-off launch.

Pattern provenance and credit (P15)

This seven-live-cell seed comes from the package's Penrose traveller search. Two [R23:S4](#) survivals distinguish its launch before it settles into the established B2/S-type wave. The exact seed, clause ablation and finite traversal are documented; no exact precedent for this launch was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/catalogue-verification.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

P16 Penrose B26/S birth launcher

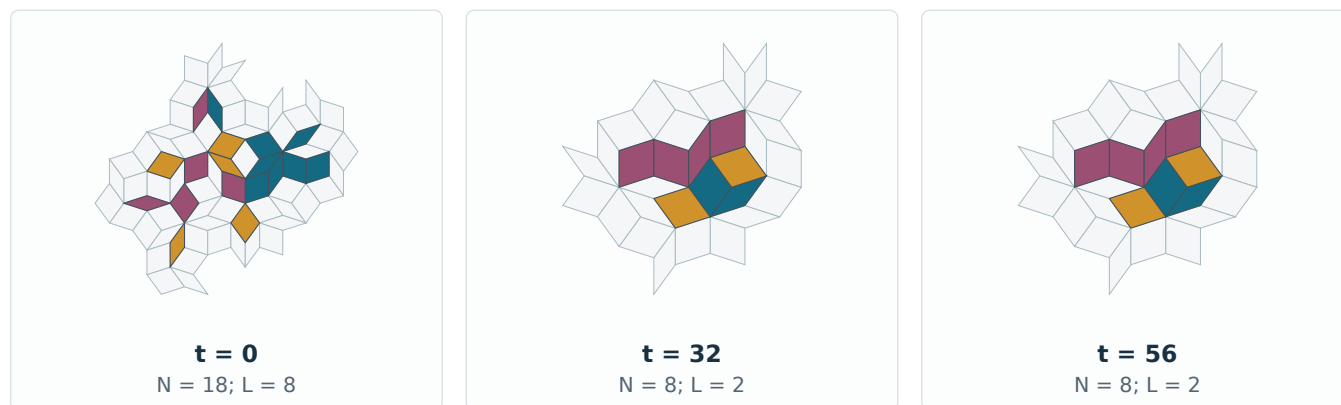
penrose-b26s-c4-birth-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B26/S | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R25](#) (p. 114). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



State: 0 1 2 3

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

An eighteen-nonzero-tile phased seed uses one [R25:B6](#) (birth with exactly six edge-or-point-contact live neighbours) birth at the first update, then self-cleans into a four-state B2/S-type wave. It traverses 175.890 tile-edge units in 200 generations and remains connected from generation 5.

Verified through t = 200; N = 7-20; 200-step replay minimum boundary distance = 15.

Exact initial configuration (tile ID,state)

(20355,2) (20356,2) (20357,3) (20361,1) (20364,1) (20367,1) (20369,1) (20370,1) (20373,1) (20375,1)
(20376,1) (25826,2) (25798,3) (25800,3) (25806,2) (26236,3) (25814,2) (25822,3)

Interpretation and limits

The extra [R25:B6](#) birth is an ignition event. The eventual travelling body uses the established B2/S mechanism; no indefinite continuation is established.

Pattern provenance and credit (P16)

The package search supplied this eighteen-cell phased seed. One [R25:B6](#) birth genuinely affects the launch; its eventual recurrent wave uses the B2/S four-state mechanism [R20](#) ([P11](#)). It is a separately recorded launcher rather than evidence of a new recurrent rule mechanism. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P17 Penrose B27/S4 dual-clause launcher

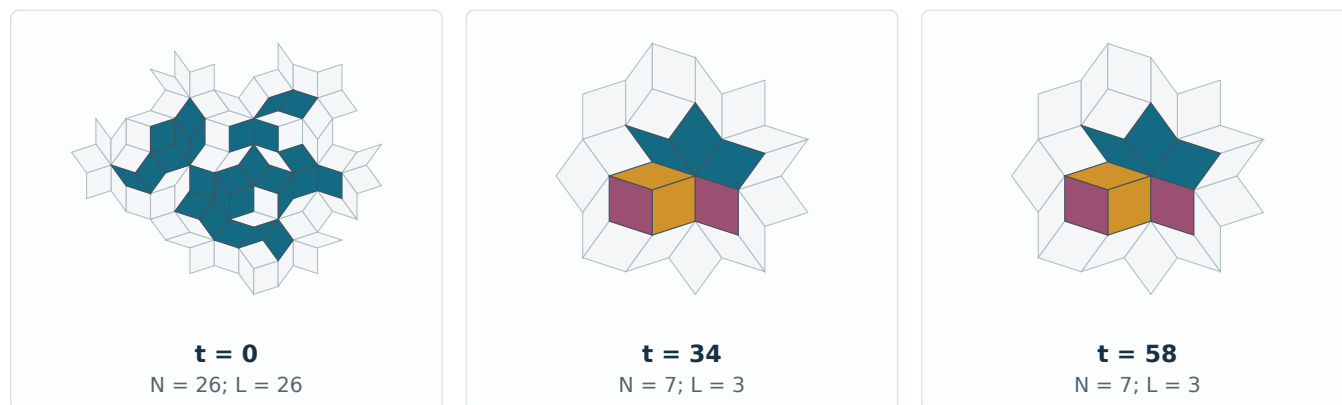
penrose-b27s4-c4-dual-clause-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B27/S4 | C = 4 | edge-or-point contact (touch)

Complete rule and prior use: [R26](#) (p. 114). Notation (p. 3).

Depth 10; sun seed; 54,560 cells; dead border rings = 0.



State: 0 1 2 3

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Twenty-six live tiles use four [R26:B7](#) (birth with exactly seven edge-or-point-contact live neighbours) births at the first update and seven [R26:S4](#) (survival with exactly four edge-or-point-contact live neighbours) survivals by generation 4, then self-clean into a four-state B2/S-type wave. The configuration traverses 177.349 tile-edge units in 200 generations, becoming continuously connected from generation 6.

Verified through $t = 200$; $N = 7\text{--}54$; 200-step replay minimum boundary distance = 15.

Exact initial configuration (tile ID,state)

(42184,1) (42599,1) (42185,1) (42614,1) (42613,1) (42180,1) (42618,1) (42591,1) (42596,1) (42195,1)
 (42606,1) (42595,1) (42616,1) (42610,1) (42598,1) (42611,1) (47629,1) (42200,1) (42619,1) (42194,1)
 (42197,1) (42183,1) (42620,1) (42189,1) (42609,1) (42608,1)

Interpretation and limits

Both added clauses affect launch, but the mature core belongs to the B2/S family. This is neither a new recurrent rule mechanism nor a repeating gun.

Pattern provenance and credit (P17)

The recorded 26-live-cell launch comes from the package's altered-rule campaign. Both added clauses fire during launch: [R26:B7](#) births and [R26:S4](#) survivals. The mature core belongs to the B2/S travelling family. This identifies the package search that produced the seed; no exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/catalogue-verification.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

P18 Penrose Conway diehard - 293

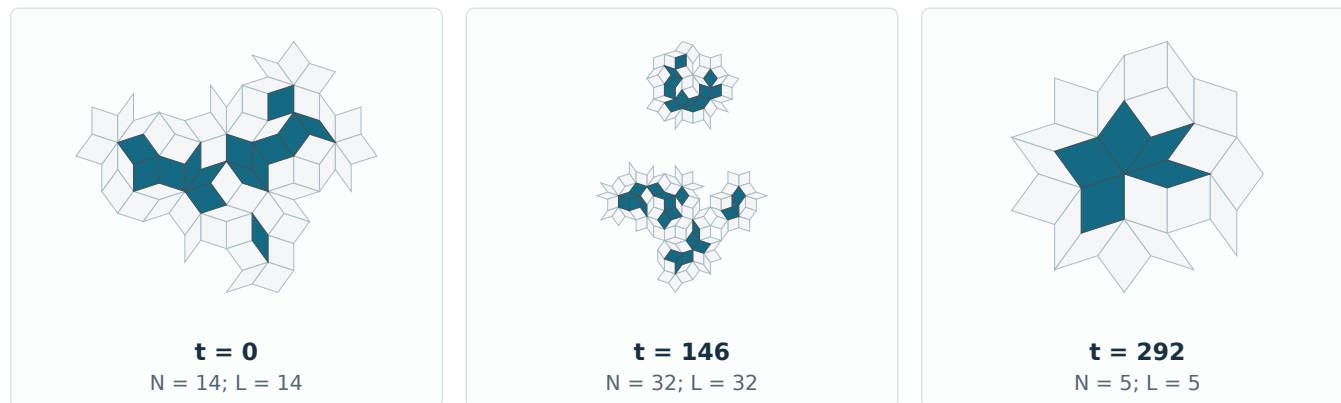
penrose-conway-diehard-293

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R27 \(p. 114\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Fourteen initially live tiles remain nonempty through generation 292 and become completely extinct at generation 293; the maximum live population is seventy-nine.

Full extinction at $t = 293$.

Exact initial configuration (tile ID,state)

(5101,1) (5898,1) (5899,1) (5902,1) (5903,1) (5904,1) (6680,1) (6682,1) (6683,1) (6684,1) (6688,1)
(7484,1) (7490,1) (7491,1)

Interpretation and limits

This is an exactly reproduced lifetime in the recorded finite patch, not a claim to a Penrose lifetime record. Earlier Penrose Life statistical studies do not by themselves identify the exact seed.

Pattern provenance and credit (P18)

This exact fourteen-cell seed is the retained extinction-at-293 result of the package's 5,000-candidate transient campaign, deterministic seed penrose-touch-B3/S23-2-transient-v1. Earlier Penrose Life lifetime studies provide context, but do not identify this exact initial state. No world-record or original-discovery claim is made. Earlier statistical investigation, not the source of this seed: Owens and Stepney [\[10\]](#).

Related literature; not an identified exact source for this configuration: [\[10\]](#).

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

P19 Penrose Conway methuselah - 289

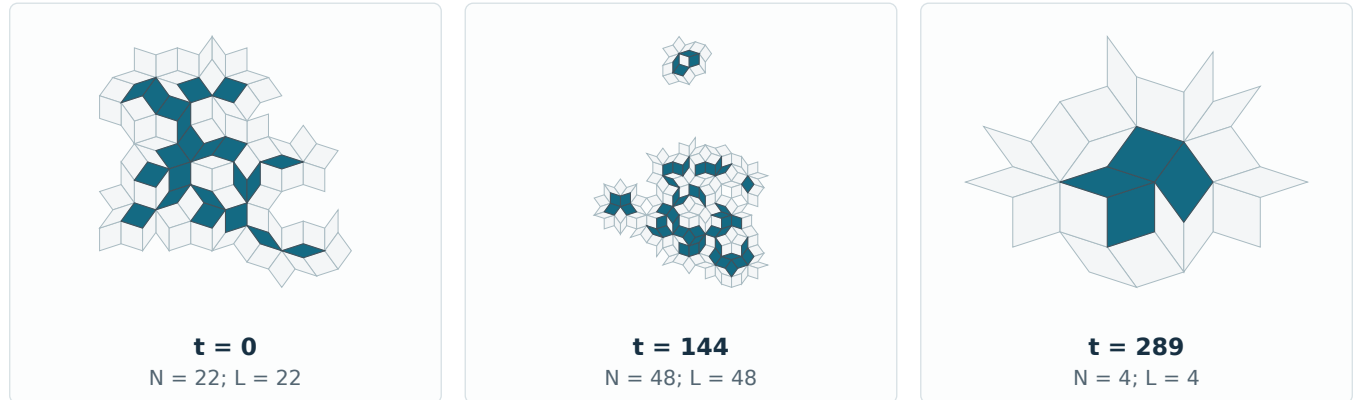
penrose-conway-methuselah-289

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: [R27 \(p. 114\)](#). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Twenty-two initially live tiles reach a four-live-tile fixed point after a transient of exactly 289 generations.

Least period $p = 1$; transient = 289; cycle $L = 4$ -4; cycle territory = 4 tiles; cycle minimum boundary distance = 22.

Exact initial configuration (tile ID,state)

(2729,1) (3514,1) (3515,1) (3517,1) (3518,1) (4310,1) (4312,1) (4313,1) (4316,1) (5091,1) (5095,1)
(5098,1) (5100,1) (5108,1) (5894,1) (5896,1) (5900,1) (5901,1) (6676,1) (6680,1) (6686,1) (7483,1)

Interpretation and limits

The displayed seed is a long transient, not a moving body or an oscillator of period 289. No longest-known or first-discovery claim is justified.

Pattern provenance and credit (P19)

The exact 22-live-cell seed is the retained result of the package's 35,000-candidate campaign [penrose-touch-b3s23-transient-v2](#). Its transient is 289 generations before a fixed point. This is a locally documented search result, not an attribution of the underlying Conway rule or a claim to the longest known Penrose transient. Earlier statistical investigation, not the source of this seed: Owens and Stepney [\[10\]](#).

Related literature; not an identified exact source for this configuration: [\[10\]](#).

Evidence in release: [research/fixtures/catalogue-verification.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

C02 Penrose B12/S p840 field

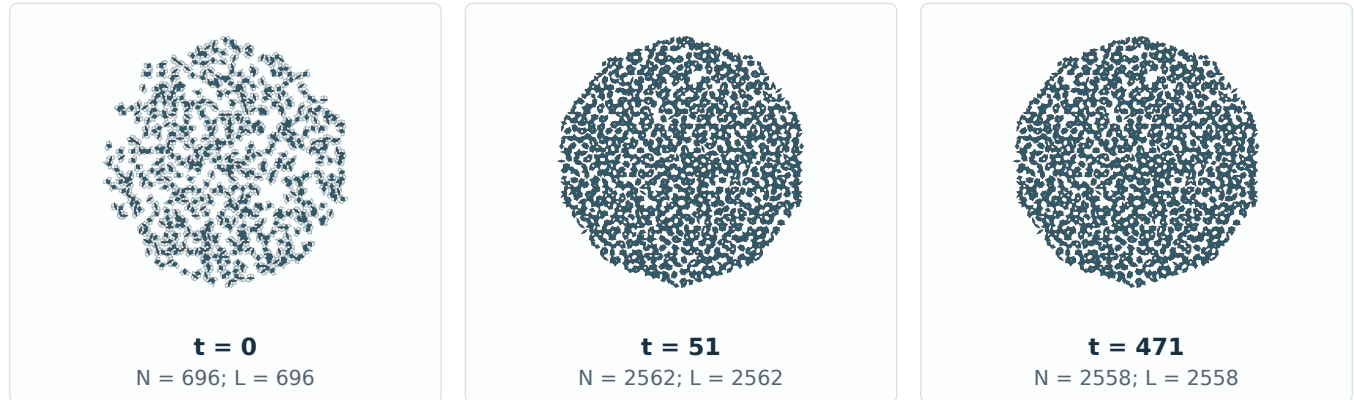
penrose-b12-p840-field

Package-generated field under B12/S, $C = 2$ on the Penrose edge graph (R16). The seed and finite-board demonstration are package contributions; no new update principle is claimed.

B12/S | $C = 2$ | shared-edge

Complete rule and prior use: R16 (p. 111). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 8.



State: ☐ 0 ☒ 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A deterministic finite random field reaches a complete-state cycle of least period 840 after a transient of 51 generations. During the cycle 5,252 tiles are nonzero at some time and the live population ranges from 2,553 to 2,587.

Least period $p = 840$; transient = 51; cycle $L = 2553-2587$; cycle territory = 5252 tiles; cycle minimum boundary distance = 8.

Exact initialisation recipe

simulation.randomize(0.12, 'penrose-edge-B12/S-2'); initial nonzero cells are state 1. Complete realised tile states are in catalogue-data.json under this entry's reproduction.initialCellStates.

Interpretation and limits

A package-generated field, not an indivisible local oscillator. Its period may combine smaller local periods. Neither an original rule nor a novel mechanism is claimed.

Pattern provenance and credit (C02)

The initial field is generated by the package from seed penrose-edge-B12/S-2, density 0.12 and eight dead border rings. The finite field has transient 51 and period 840. This is a reproducible seeded demonstration, not a claim to an independently indivisible period-840 oscillator or an original cellular-automaton rule.

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

C03 Penrose excitable field

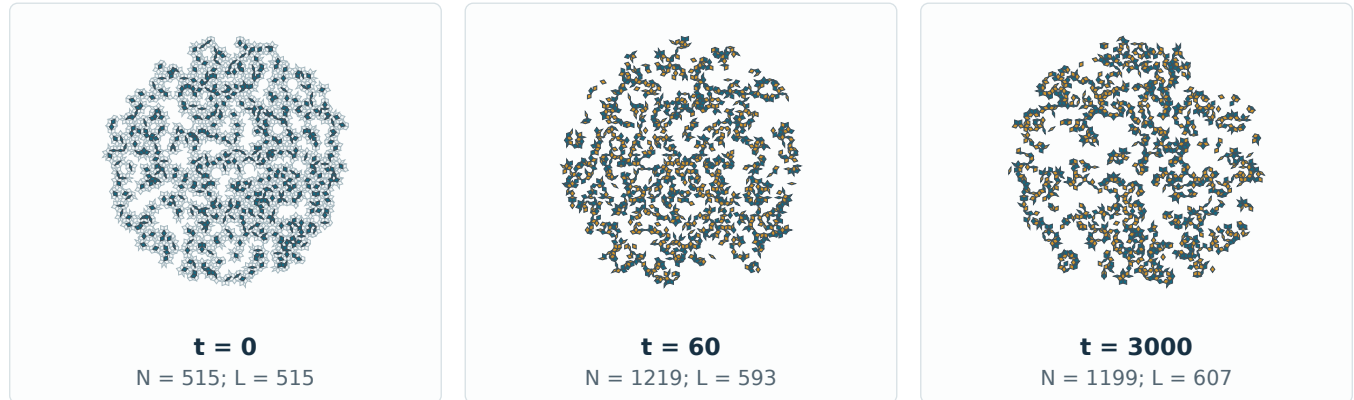
penrose-brain-field

Package-generated Penrose field using Brian Silverman's Brain transition, documented in Rucker-Walker's CellLab manual [7]. Rule R19 changes the neighbourhood to Penrose touch adjacency.

B2/S | C = 3 | edge-or-point contact (touch)

Complete rule and prior use: R19 (p. 112). Notation (p. 3).

Depth 8; sun seed; 7,920 cells; dead border rings = 8.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A deterministic finite initial field remains active through generation 3,000 under three-state B2/S on the Penrose contact graph; generation 3,000 has 607 live tiles.

Catalogue replay through t = 3000.

Exact initialisation recipe

simulation.randomize(0.12, 'penrose-touch-B2/S-3'); initial nonzero cells are state 1. Complete realised tile states are in catalogue-data.json under this entry's reproduction.initialCellStates.

Interpretation and limits

The state transition is Brian Silverman's established Brain rule, transferred to a different graph. This is a seeded field demonstration, not an unpreceded fixed pattern, periodicity proof, or infinite-activity proof.

Pattern provenance and credit (C03)

The B2/S three-state transition is Brian Silverman's Brain rule, documented in Rucker and Walker's CellLab manual [7], here applied to the Penrose touch graph instead of its usual square neighbourhood. The exact random field is package-generated from seed penrose-touch-B2/S-3 at density 0.12 with eight border rings. Its 3,000-generation observation is a finite demonstration, not a published fixed pattern or a first-discovery claim.

Source for Brian Silverman's Brain local transition; the Penrose neighbourhood and generated seed are package choices: [7].

Evidence in release: research/fixtures/catalogue-verification.json. Complete source and evidence lists are in catalogue-data.json.

X01 Hexagonal p6 single-cell-trail puffer

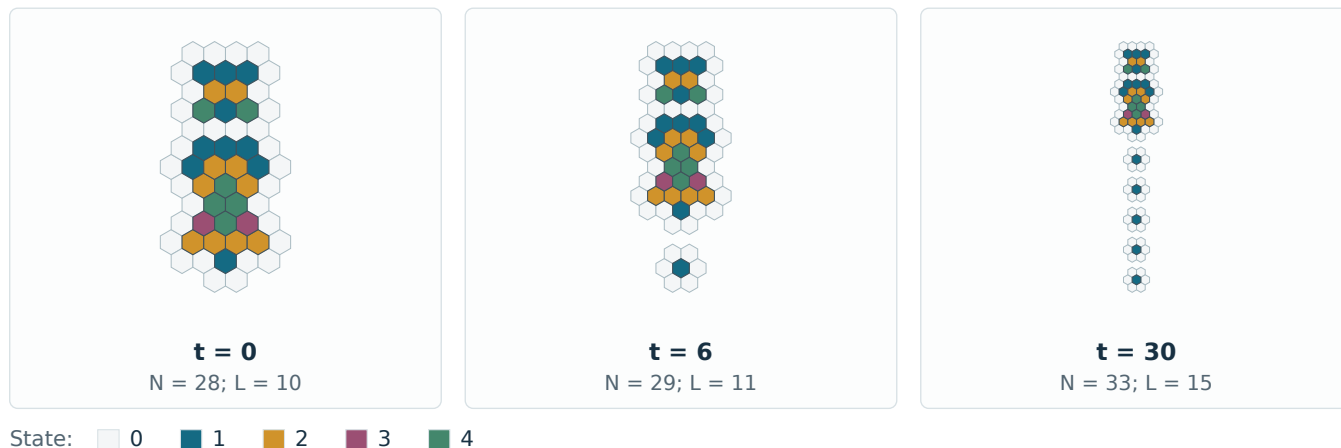
hex-b245s02-c5-p6-puffer

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B245/S02 | C = 5 | shared-edge

Complete rule and prior use: [R47 \(p. 121\)](#). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A five-state puffer shifts by axial (-2,4) every six generations, depositing one stationary live cell each cycle. Exact separation certificates prove continued propagation on the infinite hexagonal lattice.

Catalogue replay through $t = 120$.

Exact initial configuration (q,r,state)

(-3,5,1) (-2,3,4) (-2,4,2) (-2,5,1) (-1,0,1) (-1,1,1) (-1,3,1) (-1,4,2) (-1,5,1) (0,-1,2) (0,0,2)
 (0,1,1) (0,3,4) (1,-4,2) (1,-3,3) (1,-2,4) (1,-1,4) (1,0,2) (1,1,1) (2,-4,2) (2,-3,4) (2,-2,4)
 (2,-1,2) (2,0,1) (3,-5,1) (3,-4,2) (3,-3,3) (4,-4,2)

Interpretation and limits

Period 6 is the head-plus-deposit recurrence interval; the entire ever-growing trail is neither an oscillator nor a finite spaceship. [R47:B5](#) (birth with exactly five edge-sharing live neighbours) is inactive on this established puffer orbit.

Pattern provenance and credit (X01)

A moving head extracted from the three-cell mixed-state seed. Its complete period-6 recurrence and permanent separation from every deposit are certified. [R47:B5](#) is unused in flight; the three-cell launch uses [R47:B5](#) twice. This is a newly verified package example, not a claim of first discovery.

Evidence in release: [research/continued-search/hex/campaigns.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X02 Hexagonal three-cell twin-puffer launcher

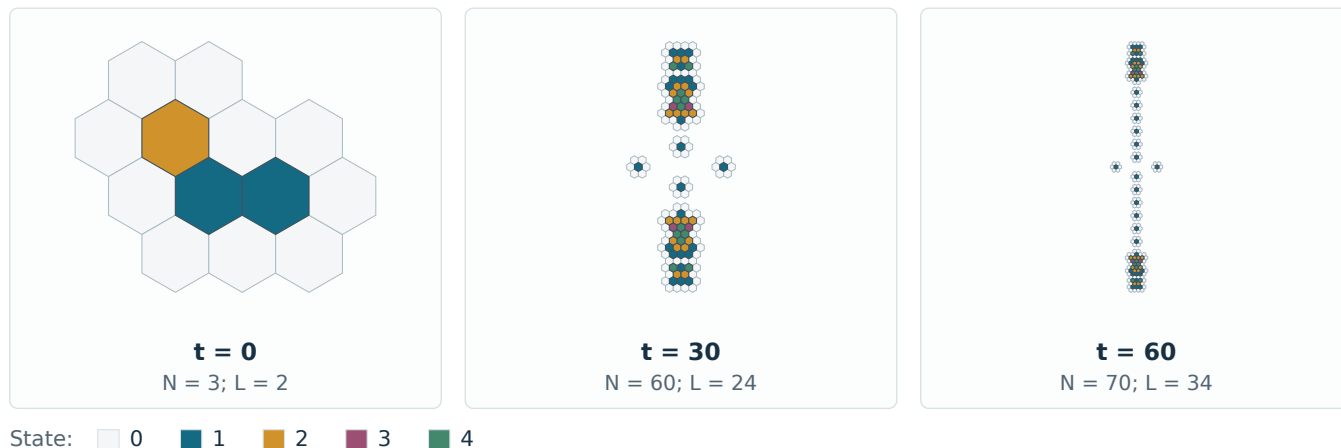
hex-b245s02-c5-three-cell-twin-puffer-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B245/S02 | C = 5 | shared-edge

Complete rule and prior use: [R47](#) (p. 121). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Two live cells and one refractory cell launch two opposite puffers. By generation 30 they have separated from four stationary cells; each puffer then deposits one live cell every six generations.

Catalogue replay through $t = 120$.

Exact initial configuration (q,r,state)

(0,1,2) (1,0,1) (2,0,1)

Interpretation and limits

This is a one-off launch of two moving emitters, not a stationary gun. Generation 30 is the first successful split among tested generations divisible by six, not a universal earliest-decomposition claim. [R47](#):B5 (birth with exactly five edge-sharing live neighbours) is used twice during ignition.

Pattern provenance and credit (X02)

Mixed-state exhaustive campaign, seed mixed-n3-c5-s10. Complete replay gives two opposite certified p6 puffers and four stationary live cells at generation 30. This is a finite launch, not a stationary gun. A related four-live-cell seed had remained unclassified in the earlier exhaustive campaign; no exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/continued-search/hex/campaigns.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X03 Hexagonal p48 long-cycle spaceship

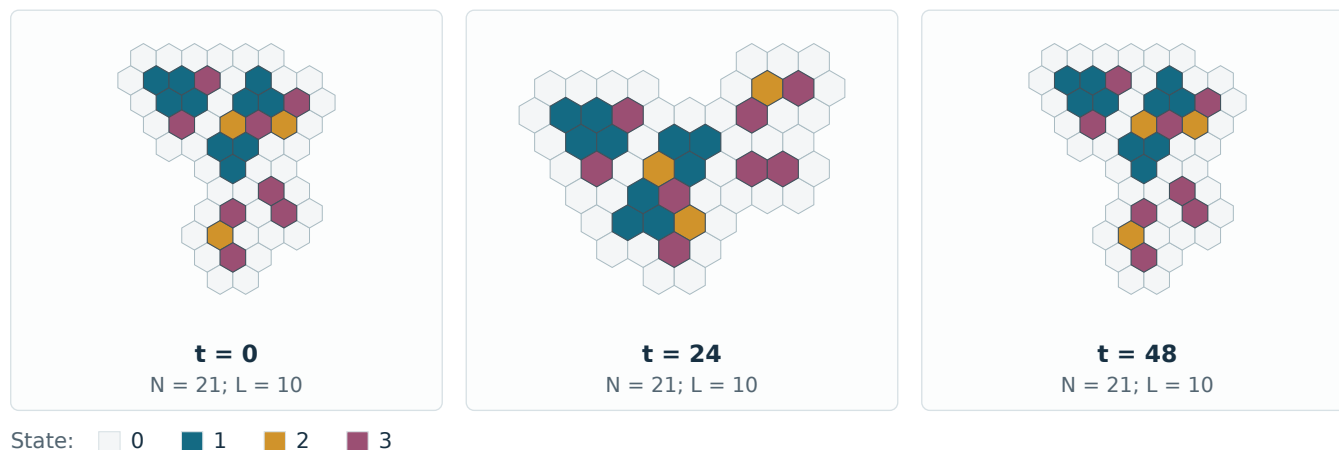
hex-b2345s24-c4-p48-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2345/S24 | C = 4 | shared-edge

Complete rule and prior use: [R42 \(p. 119\)](#). [Notation \(p. 3\)](#).

Radius 192; 111,169 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 4-state configuration has least translated period 48, with axial displacement $(-32, 16)$. Its recurrent orbit contains 10-23 live cells and 21-50 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 48$; transient = 0; axial shift = $(-32, 16)$; cycle $L = 10-23$; cycle $N = 21-50$.

Exact initial configuration (q,r,state)

$(-4,4,1) (-3,3,1) (-3,4,1) (-2,2,3) (-2,3,1) (-2,4,3) (0,1,1) (0,2,2) (0,3,1) (0,4,1) (1,0,1)$
 $(1,1,1) (1,2,3) (1,3,1) (2,-3,2) (2,-2,3) (2,2,2) (2,3,3) (3,-4,3) (3,-1,3) (4,-2,3)$

Interpretation and limits

R42:B5 (birth with exactly five edge-sharing live neighbours) is inactive throughout this recurrent orbit; the searched rule B2345/S24 is retained. D6/phase comparison excludes matches only within the preceding 33-entry package catalogue. Independent decomposition finds one persistent body plus short-lived sparks, not an independently repeating convoy.

Pattern provenance and credit (X03)

Seven-cell exhaustive campaign, seed n7c4s245: seven live cells settle after 16 generations into this exact period-48 ship. The displayed recurrent phase was centred for viewing. Full D6/phase comparison finds no match in the preceding 33-entry hexagonal catalogue. Independent decomposition at every phase confirms one persistent body with short-lived sparks, rather than a convoy of independently recurring ships. No worldwide priority claim is made.

Evidence in release: [research/continued-search/hex/campaigns.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X04 Hexagonal three-cell glider

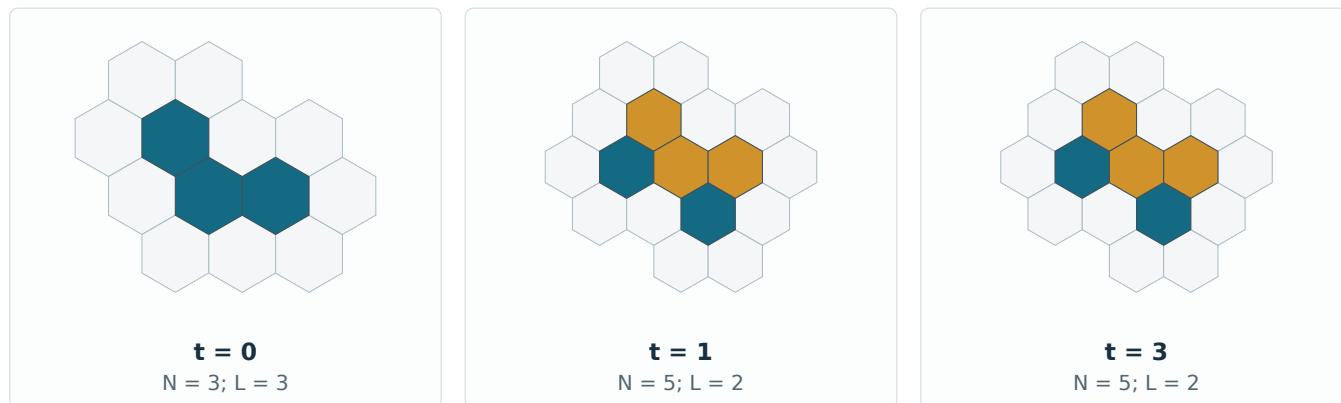
hex-b2s0-c3-three-cell-glider

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S0 | C = 3 | shared-edge

Complete rule and prior use: [R30 \(p. 115\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 3-state configuration has least translated period 2, with axial displacement (0, -1). Its recurrent orbit contains 2-3 live cells and 3-5 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 2$; transient = 0; axial shift = (0, -1); cycle L = 2-3; cycle N = 3-5; 120-step replay minimum boundary distance = 68.

Exact initial configuration (q,r,state)

(0,1,1) (1,0,1) (2,0,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X04)

Campaign small, enumerated seed 3, recorded trial 101391. Three live cells already form a period-2 spaceship in B2/S0 with three states; complete-state translation is (0,-1). The campaign enumerated connected all-live seeds of one to six cells up to translations, rotations and reflections, with all 8,192 quiescent binary birth/survival rules and state counts 2-6, subject to its documented simulation limits. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hex-exhaustive-evidence.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X05 Hexagonal four-cell diagonal launcher

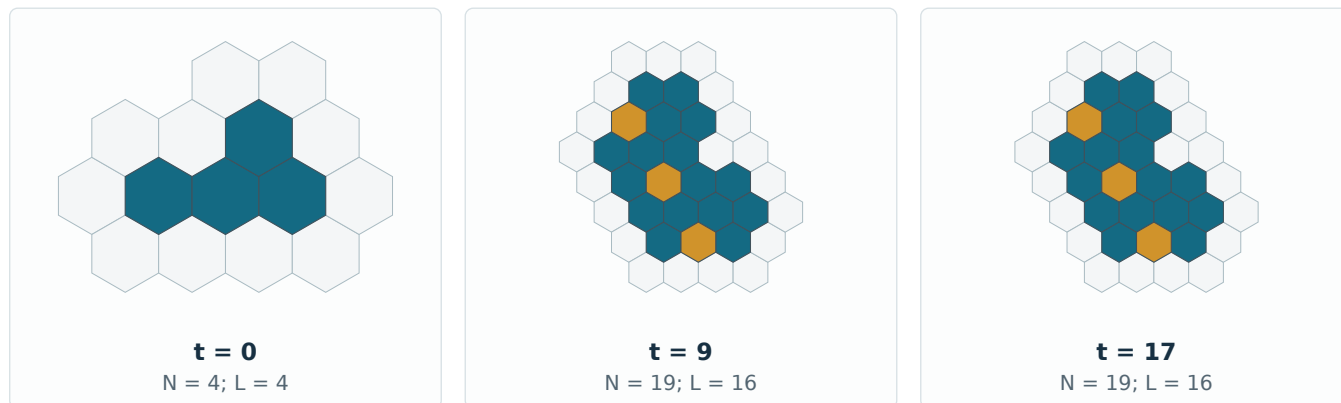
hex-b234s1346-c3-four-cell-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B234/S1346 | C = 3 | shared-edge

Complete rule and prior use: [R39 \(p. 118\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 3-state configuration has least translated period 8, with axial displacement (1, 1), after a 9-generation transient. Its recurrent orbit contains 7-19 live cells and 12-27 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 8$; transient = 9; axial shift = (1, 1); cycle L = 7-19; cycle N = 12-27; 120-step replay minimum boundary distance = 97.

Exact initial configuration (q,r,state)

(0,0,1) (1,0,1) (1,1,1) (2,0,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X05)

Campaign small, enumerated seed 6, recorded trial 120894. Four live cells settle after nine generations into a period-8 spaceship translating (1,1). This is a finite launch, not a periodically emitting gun. The campaign enumerated connected all-live seeds of one to six cells up to translations, rotations and reflections, with all 8,192 quiescent binary birth/survival rules and state counts 2-6, subject to its documented simulation limits. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hex-exhaustive-evidence.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X06 Hexagonal five-cell p43 launcher

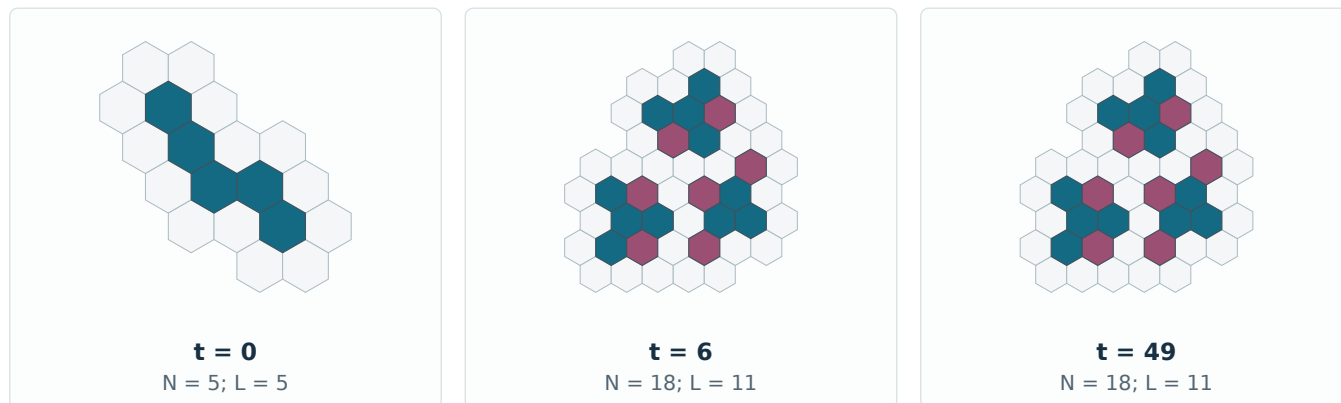
hex-b2456s1345-c4-five-cell-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2456/S1345 | C = 4 | shared-edge

Complete rule and prior use: [R50 \(p. 122\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2 3

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 4-state configuration has least translated period 43, with axial displacement $(-6, 3)$, after a 6-generation transient. Its recurrent orbit contains 5-32 live cells and 9-48 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 43$; transient = 6; axial shift = $(-6, 3)$; cycle L = 5-32; cycle N = 9-48; 178-step replay minimum boundary distance = 102.

Exact initial configuration (q,r,state)

(0,3,1) (1,2,1) (2,1,1) (3,1,1) (4,0,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X06)

Campaign n5, enumerated seed n5s19, recorded trial 525071. Five live cells settle after six generations into a period-43 spaceship translating $(-6,3)$. This is a finite launch, not a periodically emitting gun. The campaign enumerated connected all-live seeds of one to six cells up to translations, rotations and reflections, with all 8,192 quiescent binary birth/survival rules and state counts 2-6, subject to its documented simulation limits. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hex-exhaustive-evidence.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X07 Hexagonal six-cell p9 knightship launcher

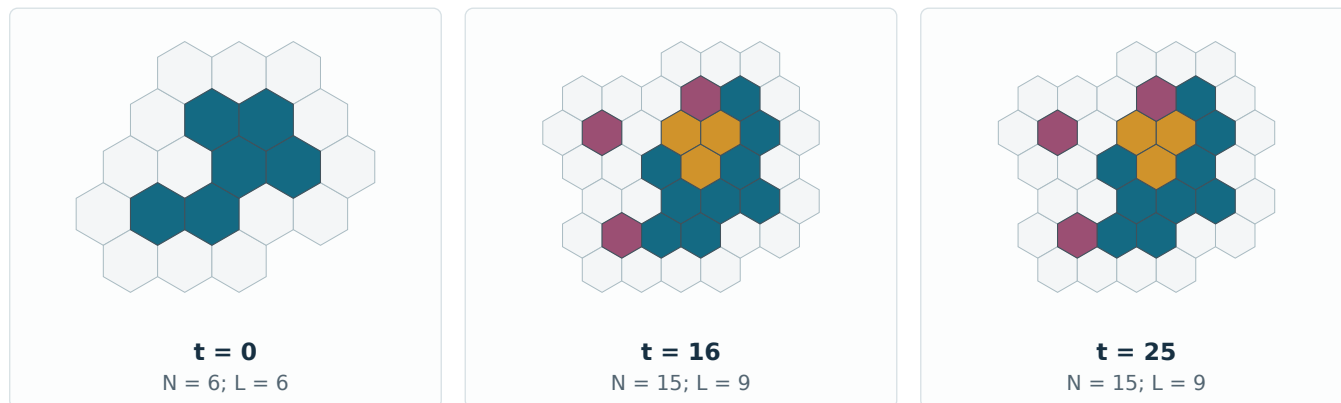
hex-b23s13-c4-p9-knightship-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S13 | C = 4 | shared-edge

Complete rule and prior use: [R35 \(p. 117\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2 3

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 4-state configuration has least translated period 9, with axial displacement (5, -4), after a 16-generation transient. Its recurrent orbit contains 7-15 live cells and 15-33 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 9$; transient = 16; axial shift = (5, -4); cycle $L = 7-15$; cycle $N = 15-33$; 120-step replay minimum boundary distance = 61.

Exact initial configuration (q,r,state)

(0,0,1) (0,2,1) (1,0,1) (1,1,1) (1,2,1) (2,1,1)

Interpretation and limits

The term knightship identifies an oblique displacement outside the hexagonal axes and their bisectors; it does not imply that oblique hexagonal spaceships are historically new.

Pattern provenance and credit (X07)

Campaign n6, enumerated seed n6s14, recorded trial 1407298. Six live cells settle after sixteen generations into a period-9 spaceship translating (5,-4). Its oblique heading is outside the edge-axis and angle-bisector directions; this does not establish a first such hexagonal spaceship. The campaign enumerated connected all-live seeds of one to six cells up to translations, rotations and reflections, with all 8,192 quiescent binary birth/survival rules and state counts 2-6, subject to its documented simulation limits. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hex-exhaustive-evidence.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X08 Hexagonal six-cell p10 knightship launcher

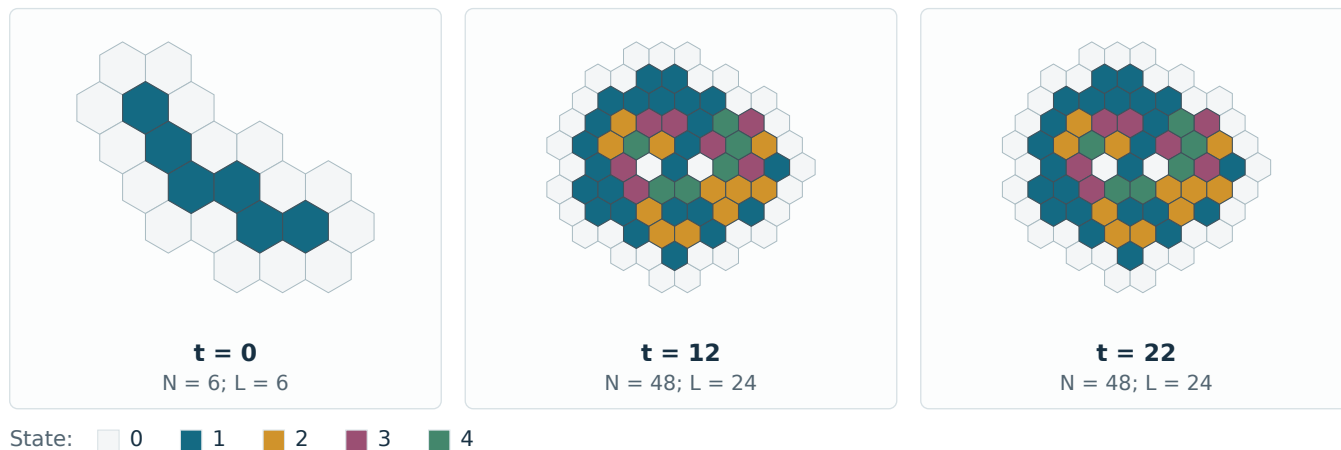
hex-b234s245-c5-p10-knightship-launcher

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B234/S245 | C = 5 | shared-edge

Complete rule and prior use: [R40](#) (p. 119). [Notation](#) (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 5-state configuration has least translated period 10, with axial displacement (1, 2), after a 12-generation transient. Its recurrent orbit contains 7-24 live cells and 22-58 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 10$; transient = 12; axial shift = (1, 2); cycle $L = 7-24$; cycle $N = 22-58$; 120-step replay minimum boundary distance = 85.

Exact initial configuration (q,r,state)

(0,3,1) (1,2,1) (2,1,1) (3,1,1) (4,0,1) (5,0,1)

Interpretation and limits

Deleting [R40:S5](#) (survival with exactly five edge-sharing live neighbours) changes [R40](#) to B234/S24 with $C = 5$ and the same six edge-sharing neighbours. Applied from generation 0 to this seed, that changed rule fails to produce the recorded spaceship. [R40:S5](#) is enabled throughout the original run, although it is needed only during launch and never fires in the eventual cycle. This is a one-off launcher, not a repeating gun.

Pattern provenance and credit (X08)

Campaign n6, enumerated seed n6s78, recorded trial 2166518. Six live cells settle after twelve generations into a period-10 spaceship translating (1,2). Survival clause [R40:S5](#) acts during the launch, although inactive in the eventual orbit; removing it before launch destroys the example. This is a finite launch, not a gun. The campaign enumerated connected all-live seeds of one to six cells up to translations, rotations and reflections, with all 8,192 quiescent binary birth/survival rules and state counts 2-6, subject to its documented simulation limits. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hex-exhaustive-evidence.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X09 Hexagonal Conway p2

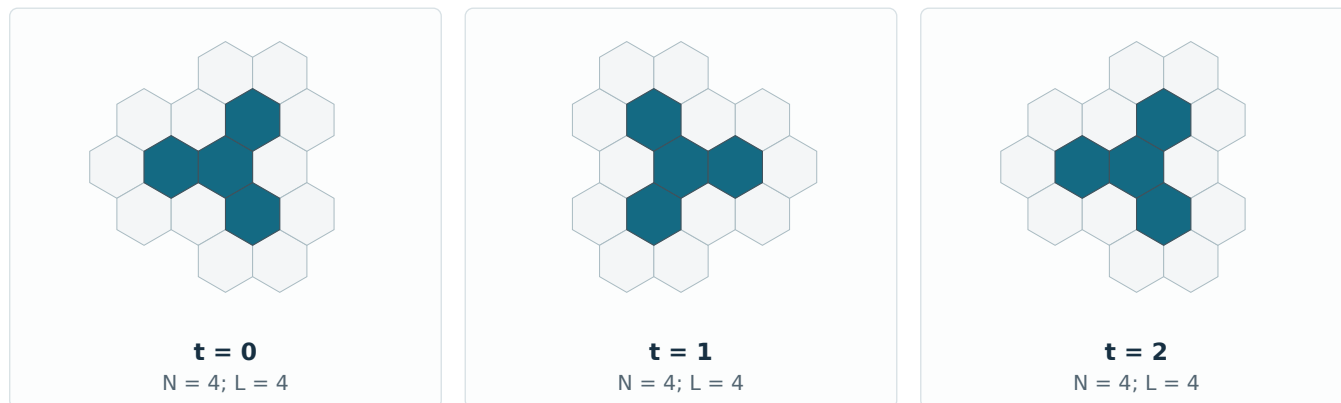
hex-conway-p2

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 2, with 4-4 live cells and 4-4 nonzero cells. Its full cycle visits 7 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 2$; transient = 0; cycle $L = 4$ -4; cycle minimum boundary distance = 31.

Exact initial configuration (q,r,state)

(-1,0,1) (0,0,1) (0,1,1) (1,-1,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X09)

Recovered campaign provenance: deterministic soup seed hex-conway-v31-2, B3/S23 with six edge neighbours, hexagonal depth 32, density 0.12, transient 6, period 2. The archived soup campaign covered indices 0-4,999 and used a 1,200-generation limit. Exact full-orbit comparison with the archived result confirms the curated pattern. The old campaign archive was examined in the handover workspace; it is not part of the fresh release. “Conway” describes the birth/survival rule notation and is not a claim that John Conway discovered this hexagonal pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/mine-oscillators.js](#). Complete source and evidence lists are in [catalogue-data.json](#).

X10 Hexagonal Conway p3

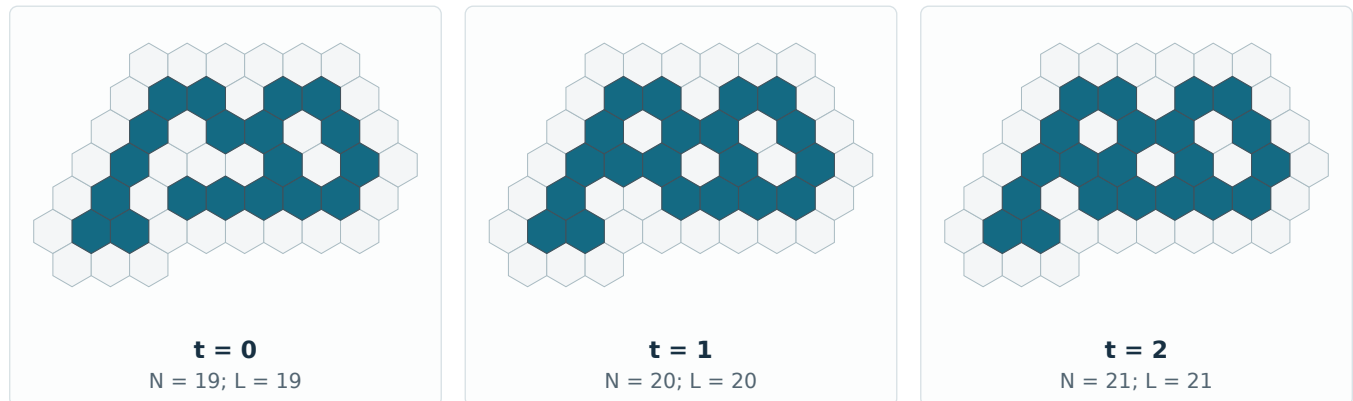
hex-conway-p3

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 3, with 19-21 live cells and 19-21 nonzero cells. Its full cycle visits 21 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 3$; transient = 0; cycle $L = 19-21$; cycle minimum boundary distance = 24.

Exact initial configuration (q,r,state)

(0,0,1) (0,1,1) (0,2,1) (0,3,1) (0,4,1) (1,0,1) (1,4,1) (2,1,1) (2,3,1) (3,1,1) (3,3,1) (3,4,1)
(4,1,1) (4,2,1) (4,4,1) (5,1,1) (5,3,1) (6,1,1) (6,2,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X10)

Recovered campaign provenance: deterministic soup seed hex-conway-v31-3851, B3/S23 with six edge neighbours, hexagonal depth 32, density 0.35, transient 28, period 3. The archived soup campaign covered indices 0-4,999 and used a 1,200-generation limit. Exact full-orbit comparison with the archived result confirms the curated pattern. The old campaign archive was examined in the handover workspace; it is not part of the fresh release. “Conway” describes the birth/survival rule notation and is not a claim that John Conway discovered this hexagonal pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/mine-oscillators.js](#). Complete source and evidence lists are in [catalogue-data.json](#).

X11 Hexagonal Conway p6

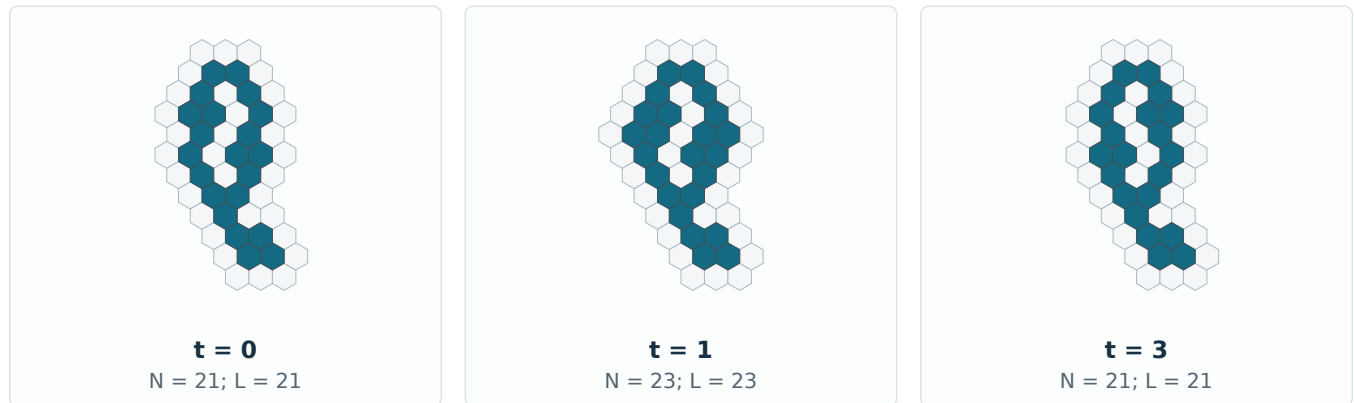
hex-conway-p6

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 6, with 19-23 live cells and 19-23 nonzero cells. Its full cycle visits 25 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 6$; transient = 0; cycle $L = 19-23$; cycle minimum boundary distance = 23.

Exact initial configuration (q,r,state)

(0,-2,1) (0,-1,1) (0,0,1) (1,-4,1) (1,-3,1) (1,-2,1) (1,0,1) (2,-5,1) (2,-1,1) (3,-6,1) (3,-4,1)
(3,-3,1) (3,-2,1) (4,-7,1) (4,-6,1) (4,-5,1) (4,-4,1) (5,-8,1) (6,-9,1) (6,-8,1) (7,-9,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X11)

Recovered campaign provenance: deterministic soup seed hex-conway-v31-2813, B3/S23 with six edge neighbours, hexagonal depth 32, density 0.35, transient 39, period 6. The archived soup campaign covered indices 0-4,999 and used a 1,200-generation limit. Exact full-orbit comparison with the archived result confirms the curated pattern. The old campaign archive was examined in the handover workspace; it is not part of the fresh release. “Conway” describes the birth/survival rule notation and is not a claim that John Conway discovered this hexagonal pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/mine-oscillators.js](#). Complete source and evidence lists are in [catalogue-data.json](#).

X12 Hexagonal Conway p4 half-turn rotor

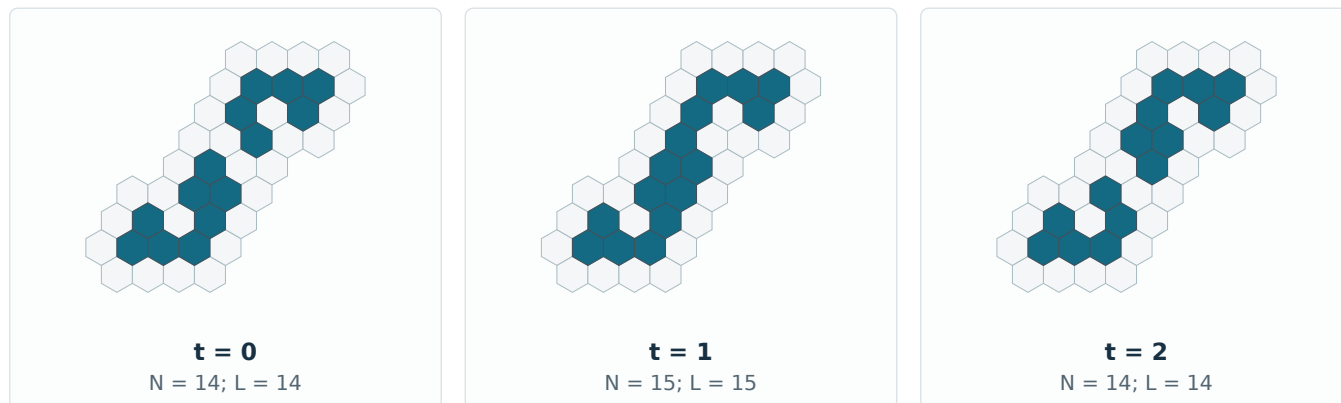
hex-conway-p4

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 4, with 14-15 live cells and 14-15 nonzero cells. Its full cycle visits 16 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. At every cycle phase, 2 further steps give a half-turn of the complete labelled state about the same fixed centre.

Least period $p = 4$; transient = 0; cycle $L = 14-15$; cycle minimum boundary distance = 26.

Exact initial configuration (q,r,state)

(-1,-2,1) (0,-2,1) (1,-2,1) (-1,-1,1) (1,-1,1) (0,0,1) (1,0,1) (0,1,1) (1,2,1) (0,3,1) (2,3,1)
(0,4,1) (1,4,1) (2,4,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X12)

Oscillator miner source seed 272632, radius 8, initial density 60%, soup transient 19; the displayed phase is offset 1 within the resulting orbit. The computational evidence files listed for this entry retain the replayable initial state and resulting cycle. Known rule notation does not establish authorship of this exact pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X13 Hexagonal Conway p5

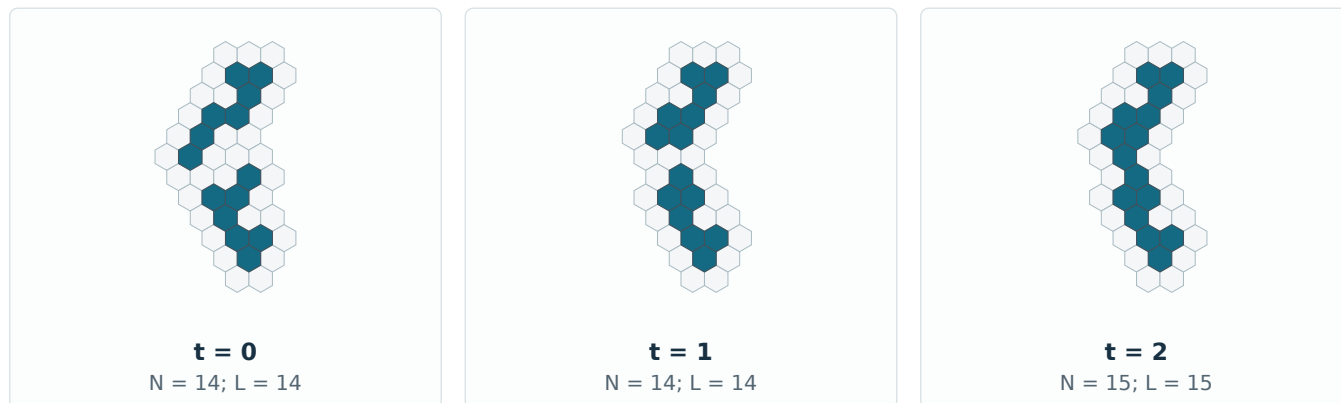
hex-conway-p5

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 5, with 14-16 live cells and 14-16 nonzero cells. Its full cycle visits 19 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 5$; transient = 0; cycle $L = 14-16$; cycle minimum boundary distance = 27.

Exact initial configuration (q,r,state)

(3,-4,1) (2,-3,1) (3,-3,1) (1,-2,1) (0,-1,1) (1,-1,1) (1,0,1) (-2,1,1) (-2,2,1) (-2,3,1) (-1,3,1)
 (-1,4,1) (-2,5,1) (-1,5,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X13)

Oscillator miner source seed 1045970, radius 6, initial density 67%, soup transient 10; the displayed phase is offset 0 within the resulting orbit. The computational evidence files listed for this entry retain the replayable initial state and resulting cycle. Known rule notation does not establish authorship of this exact pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X14 Hexagonal Conway p8

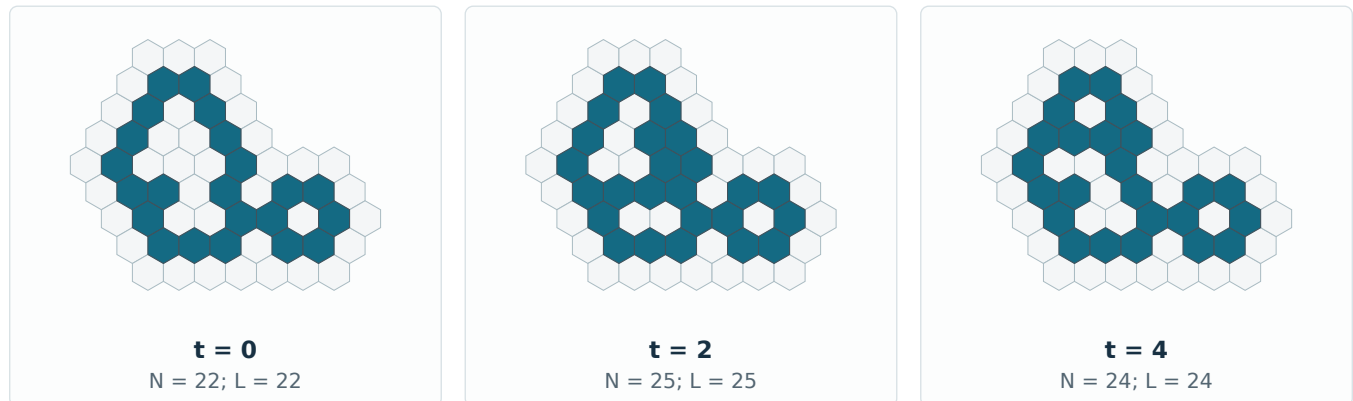
hex-conway-p8

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B3/S23 | C = 2 | shared-edge

Complete rule and prior use: [R53 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 8, with 22-25 live cells and 22-25 nonzero cells. Its full cycle visits 27 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 8$; transient = 0; cycle $L = 22-25$; cycle minimum boundary distance = 27.

Exact initial configuration (q,r,state)

(0, -2, 1) (1, -2, 1) (2, -2, 1) (4, -2, 1) (5, -2, 1) (-1, -1, 1) (2, -1, 1) (3, -1, 1) (5, -1, 1) (-2, 0, 1) (-1, 0, 1)
(1, 0, 1) (3, 0, 1) (4, 0, 1) (-3, 1, 1) (1, 1, 1) (-3, 2, 1) (0, 2, 1) (-3, 3, 1) (-1, 3, 1) (-3, 4, 1) (-2, 4, 1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X14)

Oscillator miner source seed 511247, radius 9, initial density 46%, soup transient 25; the displayed phase is offset 6 within the resulting orbit. The computational evidence files listed for this entry retain the replayable initial state and resulting cycle. Known rule notation does not establish authorship of this exact pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X15 Hexagonal p269 clock

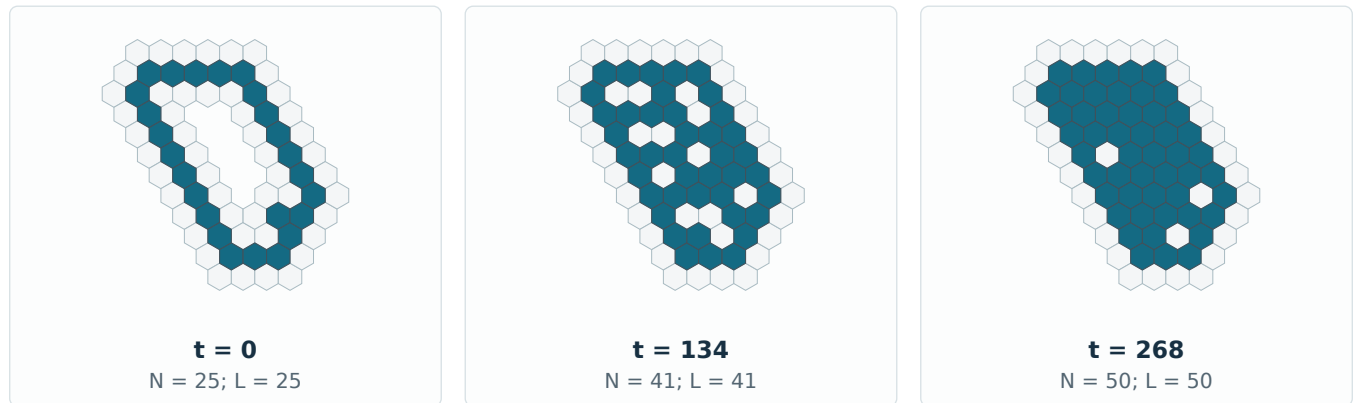
hex-b34s234-p269

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B34/S234 | C = 2 | shared-edge

Complete rule and prior use: [R54 \(p. 123\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 269, with 25-50 live cells and 25-50 nonzero cells. Its full cycle visits 53 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. Twenty-nine individual sites have least period 269, so the period is not merely a combination of independent shorter clocks.

Least period $p = 269$; transient = 0; cycle $L = 25-50$; cycle minimum boundary distance = 27.

Exact initial configuration (q,r,state)

(3, -4, 1) (4, -4, 1) (5, -4, 1) (2, -3, 1) (5, -3, 1) (1, -2, 1) (4, -2, 1) (5, -2, 1) (0, -1, 1) (5, -1, 1) (-1, 0, 1)
 (4, 0, 1) (-2, 1, 1) (3, 1, 1) (-3, 2, 1) (2, 2, 1) (-4, 3, 1) (1, 3, 1) (-5, 4, 1) (0, 4, 1) (-5, 5, 1) (-4, 5, 1)
 (-3, 5, 1) (-2, 5, 1) (-1, 5, 1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X15)

Oscillator miner source seed 15338, radius 6, initial density 18%, soup transient 182; the displayed phase is offset 266 within the resulting orbit. The computational evidence files listed for this entry retain the replayable initial state and resulting cycle. Known rule notation does not establish authorship of this exact pattern. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X16 Hexagonal p57 pulsator

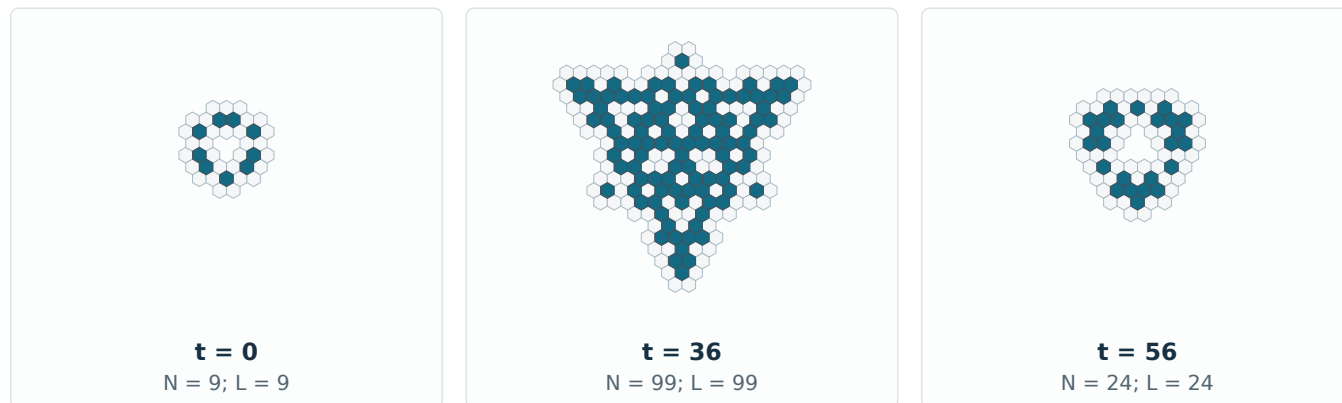
hex-b245s3-p57-pulsator

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B245/S3 | C = 2 | shared-edge

Complete rule and prior use: [R48 \(p. 121\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 57, with 9-99 live cells and 9-99 nonzero cells. Its full cycle visits 231 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice.

Least period $p = 57$; transient = 0; cycle $L = 9-99$; cycle minimum boundary distance = 20.

Exact initial configuration (q,r,state)

(-2,2,1) (-1,0,1) (-1,3,1) (0,-1,1) (0,3,1) (2,-2,1) (2,2,1) (3,-1,1) (3,0,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X16)

Binary campaign seed 20261011, trial 2586, mode 1, transient 7, chosen cycle phase offset 34. The computational evidence files listed for this entry retain the initial state and verification evidence. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X17 Hexagonal p128 half-turn rotor

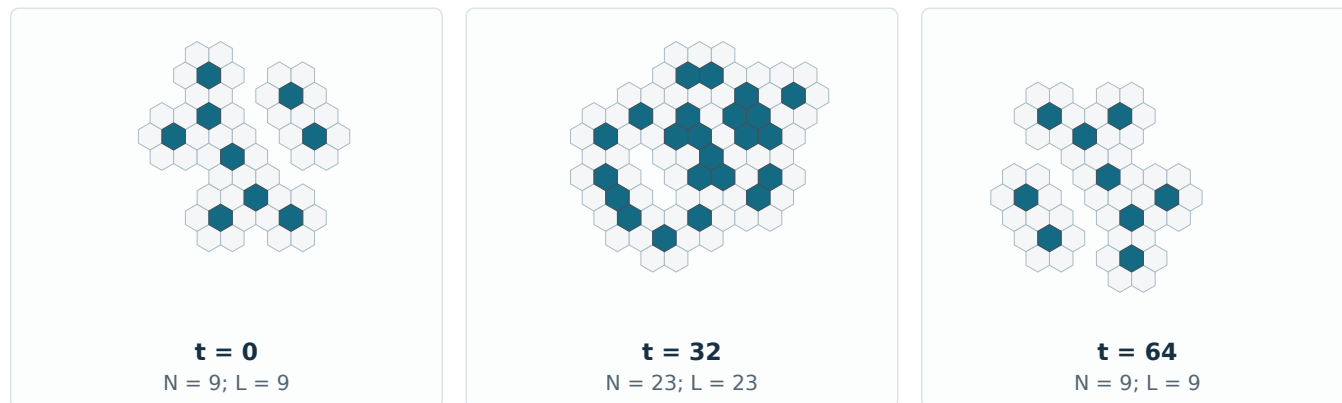
hex-b24s3-p128-rotor

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B24/S3 | C = 2 | shared-edge

Complete rule and prior use: [R46 \(p. 121\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 128, with 9-34 live cells and 9-34 nonzero cells. Its full cycle visits 118 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. At every cycle phase, 64 further steps give a half-turn of the complete labelled state about the same fixed centre.

Least period $p = 128$; transient = 0; cycle $L = 9-34$; cycle minimum boundary distance = 24.

Exact initial configuration (q,r,state)

(-3,1,1) (-3,4,1) (-2,2,1) (0,0,1) (1,-3,1) (1,3,1) (2,-2,1) (3,1,1) (4,-3,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X17)

Binary campaign seed 908020261011, trial 53543, mode 3, transient 25, chosen cycle phase offset 67. The computational evidence files listed for this entry retain the initial state and verification evidence. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X18 Hexagonal p4104 long clock

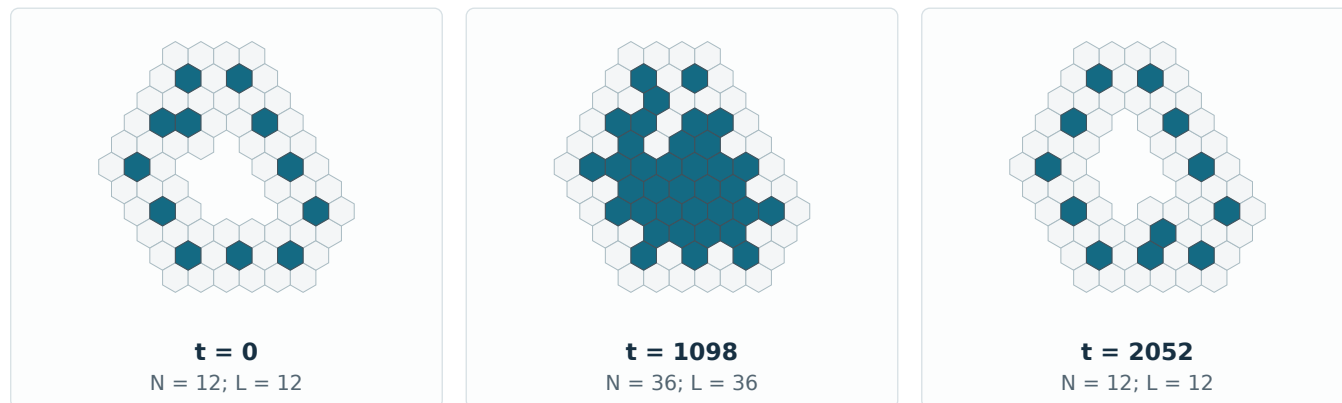
hex-b234s3-p4104

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B234/S3 | C = 2 | shared-edge

Complete rule and prior use: [R41 \(p. 119\)](#). [Notation \(p. 3\)](#).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 4104, with 12-36 live cells and 12-36 nonzero cells. Its full cycle visits 50 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. Twenty-six individual sites have least period 4104, excluding an explanation solely as independent shorter clocks.

Least period $p = 4104$; transient = 0; cycle $L = 12-36$; cycle minimum boundary distance = 28.

Exact initial configuration (q,r,state)

(-4,0,1) (-4,2,1) (-4,4,1) (-3,2,1) (-2,-2,1) (-2,4,1) (0,-4,1) (0,2,1) (2,-4,1) (2,0,1) (4,-4,1) (4,-2,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X18)

Binary campaign seed 60520261011, trial 127, mode 2, transient 802, chosen cycle phase offset 2268. The computational evidence files listed for this entry retain the initial state and verification evidence. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X19 Hexagonal p372 sixfold rotor

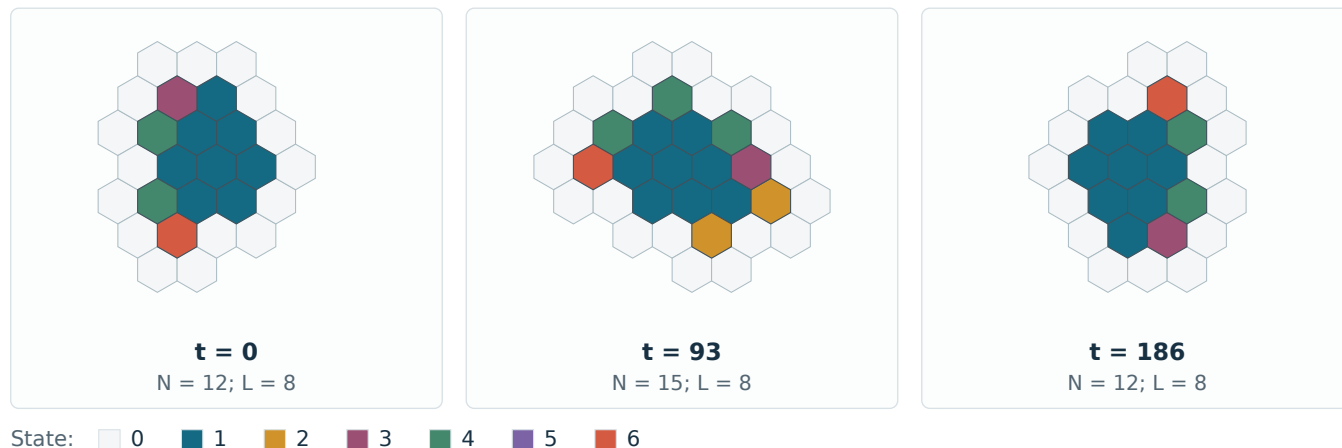
hex-b2s3456-c7-p372-rotor

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B2/S3456 | C = 7 | shared-edge

Complete rule and prior use: [R33](#) (p. 116). [Notation](#) (p. 3).

Radius 32; 3,169 cells; dead border rings = 1.



Verified behaviour

The complete configuration has least period 372, with 7-13 live cells and 12-21 nonzero cells. Its full cycle visits 37 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. At every cycle phase, 62 further steps give a 60-degree rotation of the complete labelled state about the same fixed centre.

Least period $p = 372$; transient = 0; cycle L = 7-13; cycle N = 12-21; cycle minimum boundary distance = 28.

Exact initial configuration (q,r,state)

(-1,1,4) (-1,2,3) (0,-1,4) (0,0,1) (0,1,1) (0,2,1) (1,-2,6) (1,-1,1) (1,0,1) (1,1,1) (2,-1,1) (2,0,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X19)

Generations campaign first, random seed 7522551138070962214, trial 75416, original rule B25/S3456, source transient 13. The displayed rule B2/S3456 removes [R33](#):B5 (birth with exactly five edge-sharing live neighbours), which is inactive throughout the verified periodic orbit. Rule simplification certifies the selected complete-state orbit; it does not assert that the original preperiodic soup takes the same route under the simplified rule. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X20 Hexagonal p248 giant breather

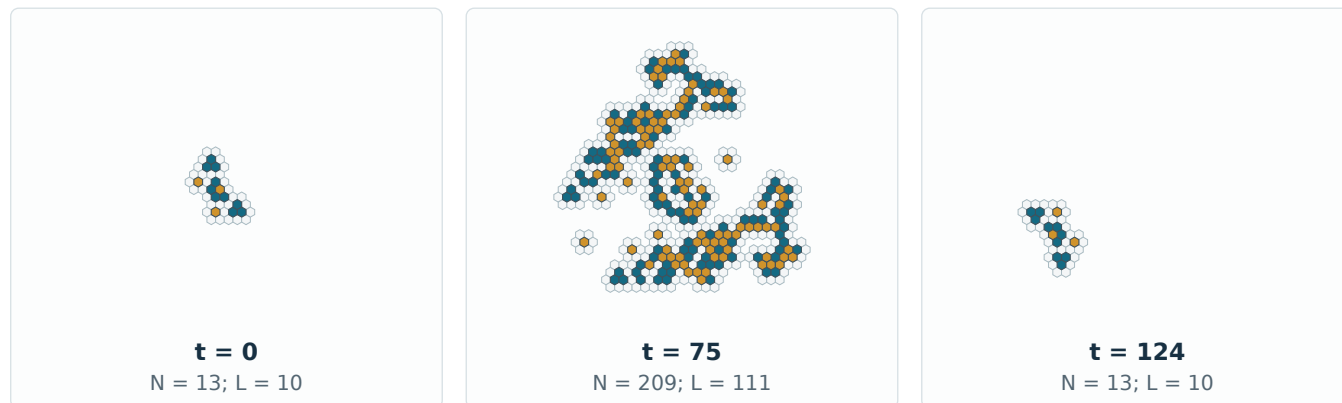
hex-b24s16-c3-p248-breather

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B24/S16 | C = 3 | shared-edge

Complete rule and prior use: [R45 \(p. 120\)](#). [Notation \(p. 3\)](#).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The complete configuration has least period 248, with 9-124 live cells and 13-209 nonzero cells. Its full cycle visits 1281 distinct lattice sites. The exact finite return proves indefinite periodic continuation on the unbounded hexagonal lattice. At every cycle phase, 124 further steps give a half-turn of the complete labelled state about the same fixed centre.

Least period $p = 248$; transient = 0; cycle $L = 9-124$; cycle $N = 13-209$; cycle minimum boundary distance = 31.

Exact initial configuration (q,r,state)

(-3,1,2) (-3,3,1) (-3,4,1) (-2,3,1) (-1,0,1) (-1,1,1) (0,-1,1) (0,0,2) (1,-3,2) (1,-1,1) (3,-3,1)
(3,-2,1) (4,-3,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X20)

The rule used in the original search was B24/S16, $C = 3$; this thirteen-cell recurrent phase was retained. No exact earlier pattern match was identified in the literature reviewed to 14 October 2026. Its period-248 recurrence has been independently replayed on the unbounded lattice; this does not establish discovery priority.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X21 Hexagonal p138 wandering spaceship

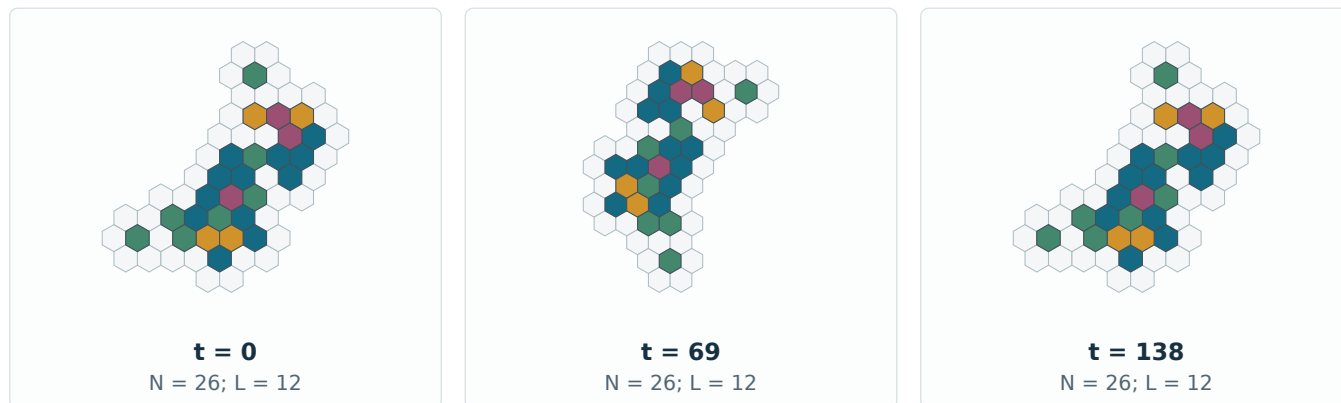
hex-b23s13-c5-p138-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B23/S13 | C = 5 | shared-edge

Complete rule and prior use: [R36](#) (p. 117). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2 3 4

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 5-state configuration has least translated period 138, with axial displacement (0, -8). Its recurrent orbit contains 9-40 live cells and 26-103 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 138$; transient = 0; axial shift = (0, -8); cycle $L = 9-40$; cycle $N = 26-103$.

Exact initial configuration (q,r,state)

(-2, -3, 4) (-1, -2, 4) (-1, 5, 4) (0, -3, 4) (0, -2, 1) (0, -1, 1) (0, 0, 1) (0, 1, 1) (0, 3, 2) (1, -3, 2) (1, -2, 4)
 (1, -1, 3) (1, 0, 1) (1, 1, 4) (1, 3, 3) (2, -4, 1) (2, -3, 2) (2, -2, 1) (2, -1, 4) (2, 1, 1) (2, 2, 3) (2, 3, 2)
 (3, -3, 1) (3, 0, 1) (3, 1, 1) (3, 2, 1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X21)

Generations campaign million, random seed 7529271334792788165, trial 106888, original rule B235/S13, source transient 53. The displayed rule B23/S13 removes [R36](#):B5 (birth with exactly five edge-sharing live neighbours), which is inactive throughout the verified travelling orbit. Rule simplification certifies the selected complete-state orbit; it does not assert that the original preperiodic soup takes the same route under the simplified rule. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X22 Hexagonal p23 fast spaceship

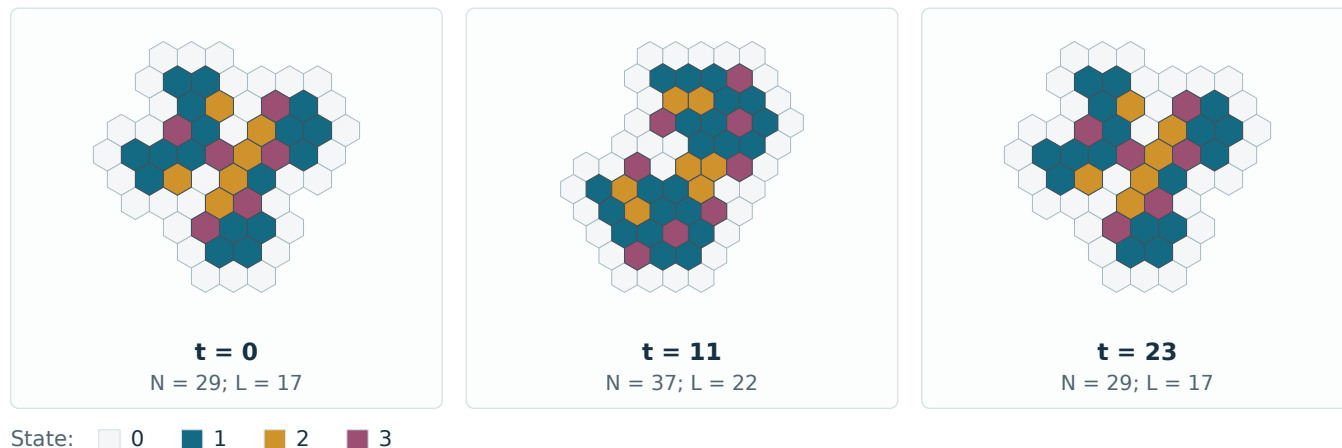
hex-b234s13-c4-p23-traveller

Original to this package: configuration; no exact literature precedent identified in the reviewed sources as at 14 October 2026.

B234/S13 | C = 4 | shared-edge

Complete rule and prior use: [R38](#) (p. 118). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The complete 4-state configuration has least translated period 23, with axial displacement (10, -5). Its recurrent orbit contains 15-30 live cells and 29-62 nonzero cells. Translation invariance gives indefinite recurrence on the unbounded hexagonal lattice.

Least period $p = 23$; transient = 0; axial shift = (10, -5); cycle $L = 15-30$; cycle $N = 29-62$.

Exact initial configuration (q,r,state)

(-3,1,1) (-3,4,1) (-2,0,1) (-2,1,1) (-2,2,3) (-2,3,1) (-2,4,1) (-1,0,2) (-1,1,1) (-1,2,1) (-1,3,2)
 (0,1,3) (1,-2,3) (1,-1,2) (1,0,2) (1,1,2) (1,2,2) (1,3,3) (2,-3,1) (2,-2,1) (2,-1,3) (2,0,1) (2,1,3)
 (2,2,1) (2,3,1) (3,-3,1) (3,-2,1) (3,1,1) (3,2,1)

Interpretation and limits

No earlier exact-pattern match has been identified; worldwide discovery priority is not established. The browser board is finite. Infinite-lattice conclusions, where given, concern the mathematical hexagonal lattice.

Pattern provenance and credit (X22)

Generations campaign first, random seed 7522551138070962214, trial 50, original rule B2345/S135, source transient 15. The displayed rule B234/S13 removes [R38](#):B5 (birth with exactly five edge-sharing live neighbours) and [R38](#):S5 (survival with exactly five edge-sharing live neighbours), which are inactive throughout the verified travelling orbit. Rule simplification certifies the selected complete-state orbit; it does not assert that the original preperiodic soup takes the same route under the simplified rule. This identifies the package search that produced the configuration. No exact precedent was identified in the literature reviewed to 14 October 2026.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

X23 Hexagonal B2/S35 p5 traveller

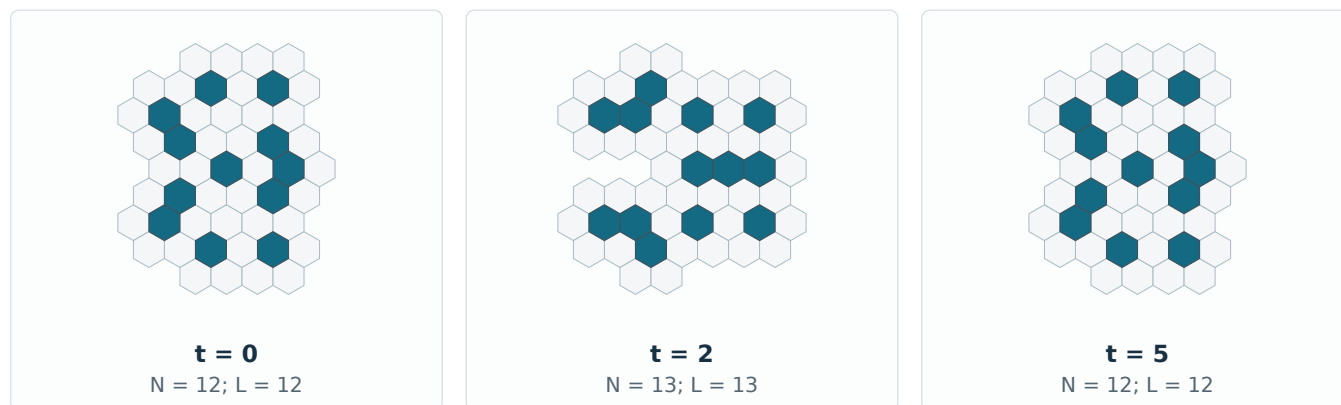
hex-b2s35-p5-traveller

Previously published spaceship: John Cerman's B2/S35 RLE (2016) [15]; Carter Bays describes this rule and motion in 2005 [11], [19], Fig. 3. Independently recovered here.

B2/S35 | C = 2 | shared-edge

Complete rule and prior use: R34 (p. 117). Notation (p. 3).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A 12-cell phase of the published B2/S35 hexagonal spaceship translates by one axial cell every five generations; the complete state return is exact.

Exact initial configuration (q,r,state)

(-3,2,1) (-2,1,1) (-2,3,1) (-1,-2,1) (-1,-1,1) (0,0,1) (0,3,1) (1,-3,1) (1,1,1) (2,-1,1) (2,0,1)
(3,-3,1)

Interpretation and limits

The exact translated recurrence establishes indefinite travel on the unbounded uniform hexagonal lattice, before any finite-board boundary effect. A different phase or orientation is not a separate discovery.

Pattern provenance and credit (X23)

John Cerman's 22 January 2016 B2/S35 RLE [15] is 2bo\$o3bo\$2bo\$bo2bo\$6bo\$2bo2bo\$4bo!. Full-orbit comparison under $(q,r)=(x,y-x)$ proves exact equivalence: phase shift 2, rotation by one 60-degree step, no reflection, translation (3,0). Carter Bays's 2005 paper [11], [19], Figure 3, describes the same rule, period and displacement; its drawing was not independently transcribed. Independent recovery by the package does not make this a new spaceship.

Executable seed source: John Cerman's 2016 RLE, compared through its full orbit: [15].

Earlier scholarly account: Bays (2005), Figure 3; the drawing was not independently transcribed: [11], [19].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X24 Hexagonal B245/S3 p10 traveller

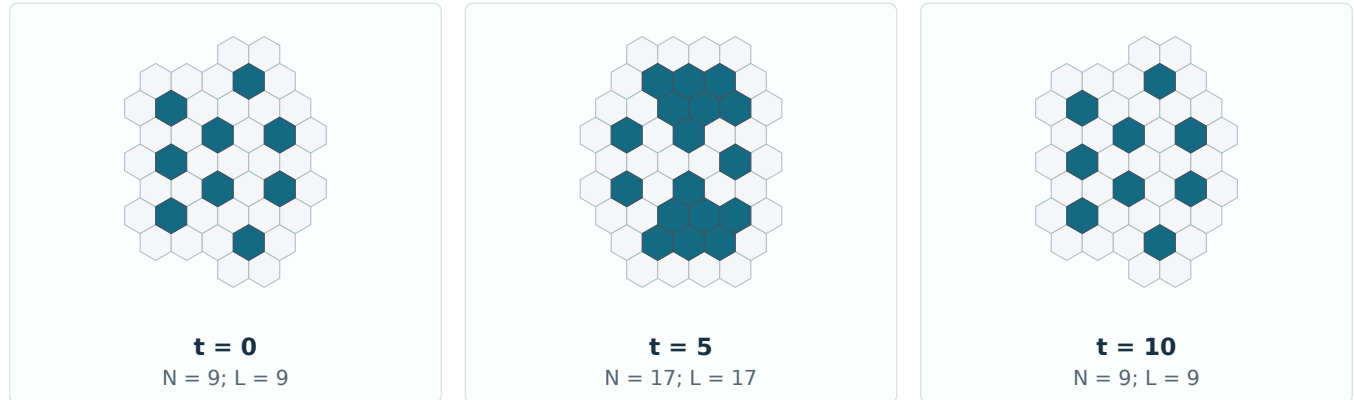
hex-b245s3-p10-traveller

Previously published spaceship: Golly's B245/S3H QuickLife example [14]. Carter Bays documents the rule and motion in 2005 [11], [19], Fig. 4; the executable seed is Golly's.

B245/S3 | C = 2 | shared-edge

Complete rule and prior use: R48 (p. 121). Notation (p. 3).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

This nine-cell two-state spaceship translates by two axial cells every ten generations. Its exact recurrence and the use of every B245/S3 rule clause are verified.

Exact initial configuration (q,r,state)

(-2,2,1) (-1,0,1) (0,-2,1) (0,1,1) (0,3,1) (1,-1,1) (2,1,1) (3,-3,1) (3,-1,1)

Interpretation and limits

All B245/S3 clauses are used somewhere in the cycle. The finite browser board eventually truncates travel; the unbounded-lattice cycle follows from exact translation recurrence.

Pattern provenance and credit (X24)

The exact executable source is Golly's QuickLife hexagonal example [14], RLE obo\$4bo\$2bo\$bo2bobo\$3bo\$5bo!. The catalogue is D6-equivalent under $(q,r)=(x,y-x)$; full-state replay verifies period 10 and a two-cell displacement. Carter Bays's 2005 paper [11], [19], Figure 4, describes the rule and motion. Golly's page does not name Bays; the executable-source comparison and the earlier scholarly account are separate evidence.

Executable seed source: Golly's official QuickLife example, compared through its full orbit: [14].

Earlier scholarly account: Bays (2005), Figure 4: [11], [19].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X25 Hexagonal B235/S146 four-state launcher

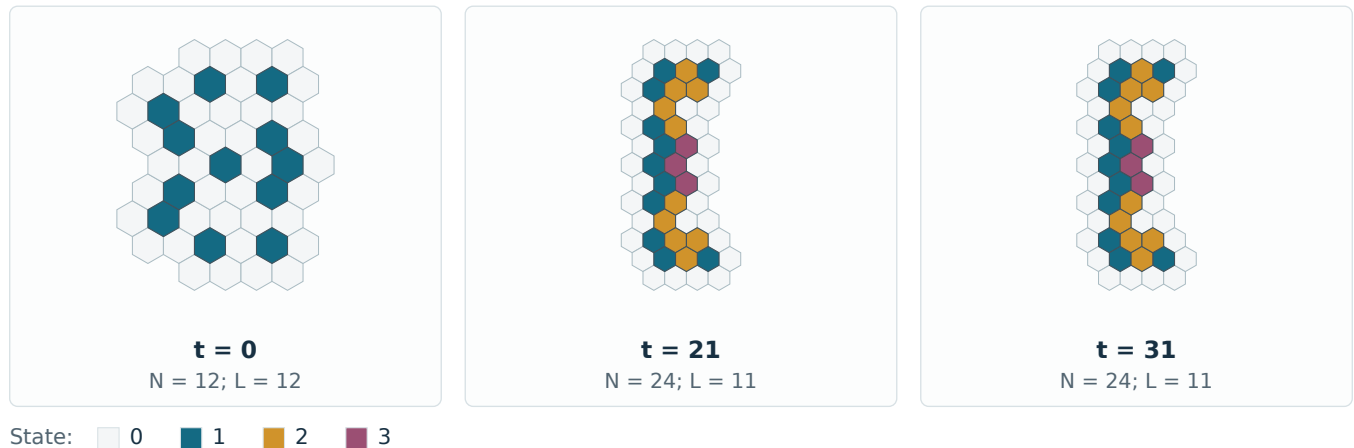
hex-b235s146-c4-launcher-traveller

Adapted seed: John Cerkan's published B2/S35 spaceship (X23) [15], with Bays's earlier account [11]. The twelve live cells now use B235/S146, C = 4 (R44).

B235/S146 | C = 4 | shared-edge

Complete rule and prior use: R44 (p. 120). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A twelve-cell seed uses three launch-only clauses before settling at generation 21 into an exact period-10 traveller that advances five axial cells per cycle.

Verified through t = 200; N = 12-53; 200-step replay minimum boundary distance = 28.

Exact initial configuration (q,r,state)

(-3,2,1) (-2,1,1) (-2,3,1) (-1,-2,1) (-1,-1,1) (0,0,1) (0,3,1) (1,-3,1) (1,1,1) (2,-1,1) (2,0,1)
(3,-3,1)

Interpretation and limits

This is a one-off launch from the X23 spaceship seed, not a gun. Under R44, births at five live edge-neighbours and survivals at four or six occur only during ignition. Absence from the final cycle does not make those clauses dispensable for launch. John Cerkan's RLE [15] supplies the parent seed; the changed-rule dynamics are package results.

Pattern provenance and credit (X25)

The twelve live-cell coordinates are identical to X23, the B2/S35 spaceship matched to John Cerkan's published RLE [15]. Carter Bays gives an earlier account of the parent rule and motion [11], Figure 3. The update changes from binary R34 to B235/S146 with four states, R44. The seed settles after 21 generations into a period-10 spaceship translating (-5,0). This is a verified package adaptation; worldwide first discovery of the altered dynamics is not established.

Exact parent seed: Cerkan's B2/S35 spaceship, reproduced in catalogue entry X23; the changed rule is R44: [15].

Earlier scholarly account of the parent B2/S35 rule and motion: Bays (2005), Figure 3: [11].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X26 Hexagonal B235/S134 five-state launcher

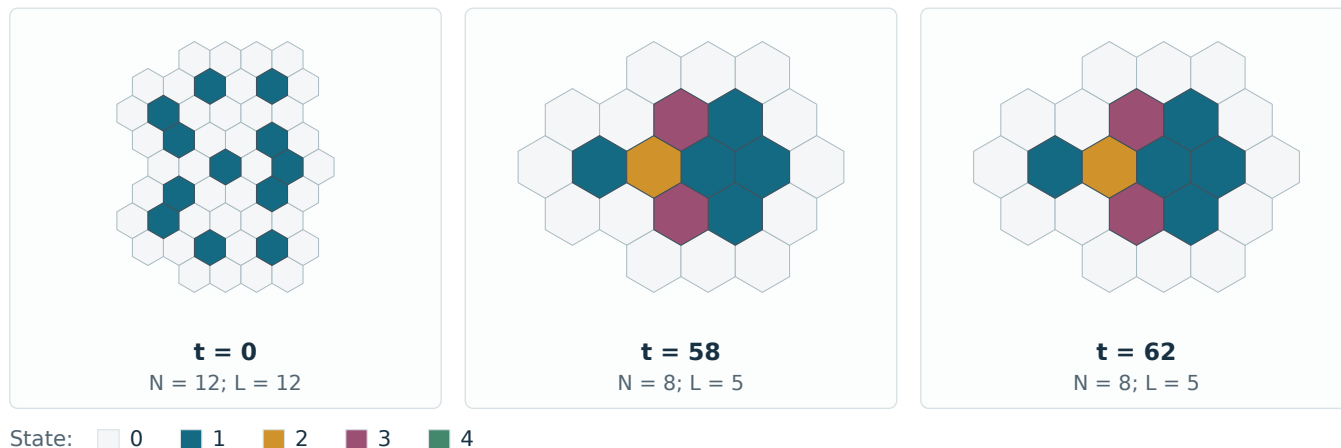
hex-b235s134-c5-launcher-traveller

Adapted seed: John Cerkar's published B2/S35 spaceship (X23) [15], with Bays's earlier account [11]. The twelve live cells now use B235/S134, C = 5 (R43).

B235/S134 | C = 5 | shared-edge

Complete rule and prior use: R43 (p. 120). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



Verified behaviour

The twelve-cell X23 spaceship seed, now under five-state rule R43, uses seven essential R43:B5 (birth with exactly five edge-sharing live neighbours) births, then condenses into an eight-to-ten-cell period-4 traveller at generation 58.

Verified through t = 200; N = 8-94; 200-step replay minimum boundary distance = 50.

Exact initial configuration (q,r,state)

(-3,2,1) (-2,1,1) (-2,3,1) (-1,-2,1) (-1,-1,1) (0,0,1) (0,3,1) (1,-3,1) (1,1,1) (2,-1,1) (2,0,1) (3,-3,1)

Interpretation and limits

Seven births with exactly five live edge-neighbours occur during ignition, last entering generation 32; removing R43:B5 before launch changes the example. This is a one-off launch from John Cerkar's published X23 seed [15], with a changed rule. Worldwide first discovery of the altered dynamics is not established.

Pattern provenance and credit (X26)

The twelve live-cell coordinates are identical to X23, the B2/S35 spaceship matched to John Cerkar's published RLE [15]. Carter Bays gives an earlier account of the parent rule and motion [11], Figure 3. The update changes from binary R34 to B235/S134 with five states, R43. The seed settles after 58 generations into a period-4 spaceship translating (2,0). The package establishes this adaptation and verifies its launch and complete-state recurrence.

Exact parent seed: Cerkar's B2/S35 spaceship, reproduced in catalogue entry X23; the changed rule is R43: [15].

Earlier scholarly account of the parent B2/S35 rule and motion: Bays (2005), Figure 3: [11].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X27 Hexagonal p25 diagonal spaceship

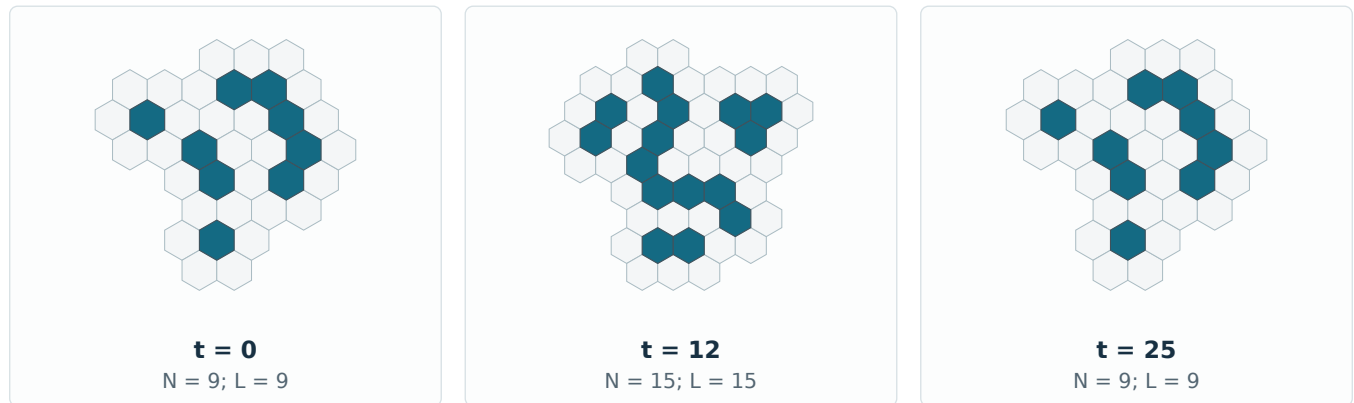
hex-b245s35-p25-traveller

Previously published by muzik (2019): B245/S35H period-25 spaceship in Outer-totalistic hexagonal rules with spaceships [9]. Independently recovered here.

B245/S35 | C = 2 | shared-edge

Complete rule and prior use: R49 (p. 122). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

An exact B245/S35 spaceship: its complete state shifts by axial (1,1) every 25 generations, with 9-24 live cells during the cycle.

Exact initial configuration (q,r,state)

(-2,2,1) (0,1,1) (0,3,1) (1,0,1) (1,3,1) (2,-2,1) (2,2,1) (3,0,1) (3,1,1)

Interpretation and limits

Rediscovery, reorientation and changing the displayed phase do not establish originality. The exact complete-state recurrence guarantees the unbounded-lattice spaceship; the finite display eventually meets its boundary.

Pattern provenance and credit (X27)

Published by muzik (2019), independently rediscovered by this package's search [9]. Outer-totalistic hexagonal rules with spaceships [9] credits muzik (2019) for B245/S35H RLE b3o\$bobo\$4o\$bo!. Independent full-orbit comparison with the catalogue succeeds after phase shift 5, rotation by four 60-degree steps, no reflection and translation (1,1), using (q,r)=(x,y-x). Thus the package's binary campaign seed 20261011, trial 483, mode 3, transient 57 recovered an already published spaceship. The displayed phase and orientation are not a distinct discovery.

Published pattern source and attribution: Published by muzik (2019), independently rediscovered by this package's search.: [9].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X28 Hexagonal p48 half-turn rotor

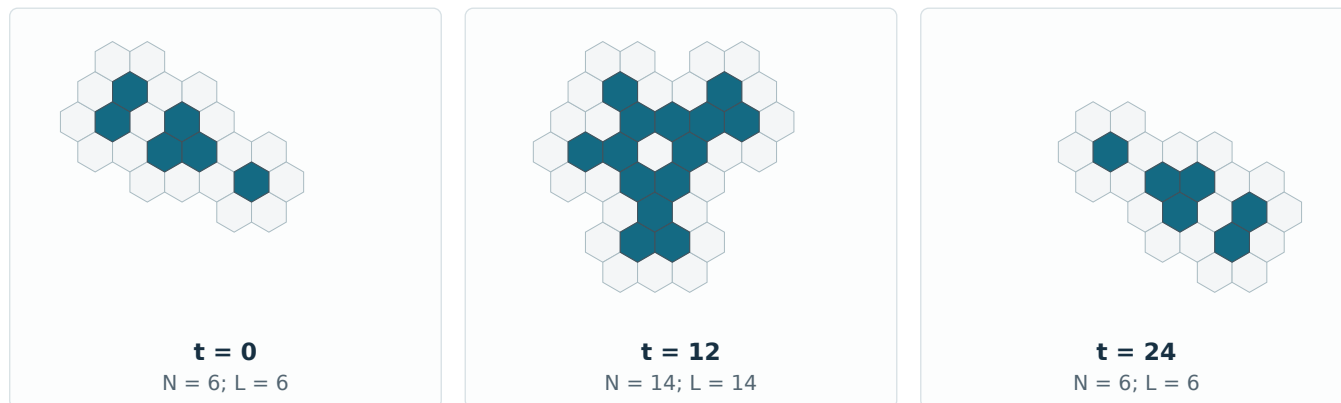
hex-b2s34-p48-rotor

Previously published by drc (18 January 2016): one component of the B2/S34 period-48 oscillator pair [20]. Independently recovered here.

B2/S34 | C = 2 | shared-edge

Complete rule and prior use: R32 (p. 116). Notation (p. 3).

Radius 32; 3,169 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

Six live cells expand and rearrange into a half-turn after 24 generations, returning exactly after 48. The cycle has 6-16 live cells.

Least period $p = 48$; transient = 0; cycle $L = 6$ -16; cycle territory = 78 tiles; cycle minimum boundary distance = 25.

Exact initial configuration (q,r,state)

(-2,1,1) (-2,2,1) (0,0,1) (0,1,1) (1,0,1) (3,-1,1)

Interpretation and limits

This is one independently evolving component of the pair published by drc. Extracting a component does not make it a new oscillator. The original discoverer, as distinct from this retrieved publication, is not asserted.

Pattern provenance and credit (X28)

Published by drc (2016), independently rediscovered by this package's search [20]. The 18 January 2016 RLE o16bo\$obo12b2o\$2b2o10bobo\$5bo9bo! contains two independently oscillating six-cell components. Catalogue coordinates translated by axial (2,-1) reproduce its first component exactly at generation zero. Extracting that independent component does not create a new oscillator. The package independently recovered it in binary campaign seed 20261011, trial 194, mode 4. Dean Hickerson also mentions earlier work on the rule, but the audit does not assign him priority for this particular oscillator.

Published pattern source and attribution: Published by drc (2016), independently rediscovered by this package's search.: [20].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X29 Hexagonal three-way spaceship gun

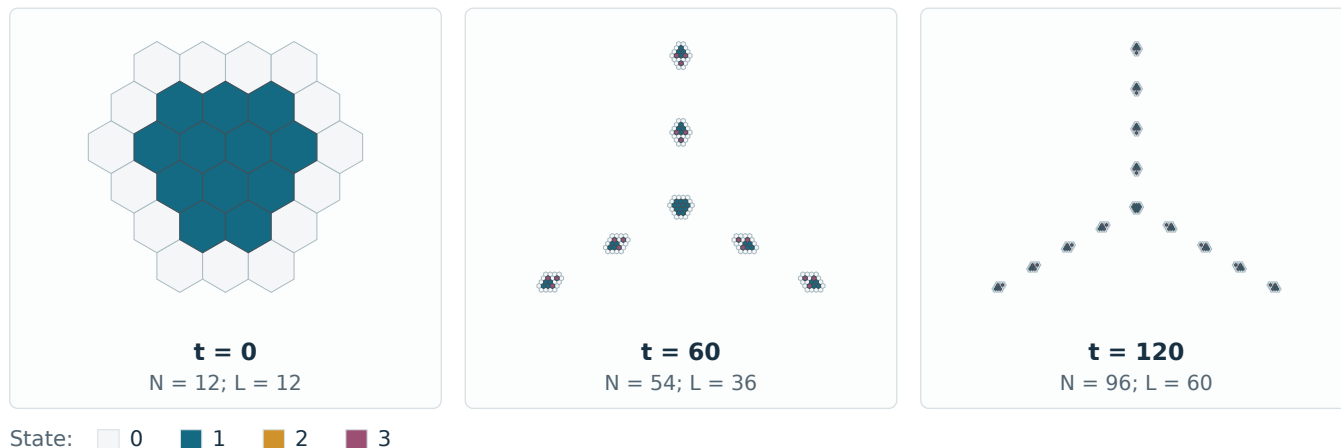
hex-b246s246-c4-p30-gun

Previously published by confocaloid (14 October 2024): B246/S246, C = 4, twelve-cell three-way gun in Hexagonal Generations [8]. The package adds an emission certificate.

B246/S246 | C = 4 | shared-edge

Complete rule and prior use: [R51 \(p. 122\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A 12-live-cell seed rebuilds its core every 30 generations while emitting three period-3 spaceships in different directions. Published by confocaloid; ships eventually reach this finite board's edge.

Catalogue replay through t = 120.

Exact initial configuration (q,r,state)

(-1,1,1) (-1,2,1) (0,0,1) (0,1,1) (0,2,1) (1,-1,1) (1,0,1) (1,1,1) (1,2,1) (2,-1,1) (2,0,1) (2,1,1)

Interpretation and limits

The certificate establishes indefinitely repeated three-way emission on the unbounded hexagonal lattice, not perpetual operation on the finite browser board. Confocaloid published the gun and seed in Hexagonal Generations [8]; the package contributes verification, not authorship.

Pattern provenance and credit (X29)

Published by confocaloid (2024) [8]. The package independently verifies indefinite three-way emission. Confocaloid published the twelve-live-cell seed 3A\$4A\$.3A\$2.2A! on 14 October 2024 in Hexagonal Generations Rules. Direct comparison confirms that the catalogue retains exactly the published initial states, after coordinate conversion and translation. The package adds a complete-state emission certificate for the period-30 core and three permanently separating output streams; that verification is not authorship of the gun.

Published pattern source and attribution: Published by confocaloid (2024). The package independently verifies indefinite three-way emission.: [8].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X30 Hexagonal oscillator-trail puffer

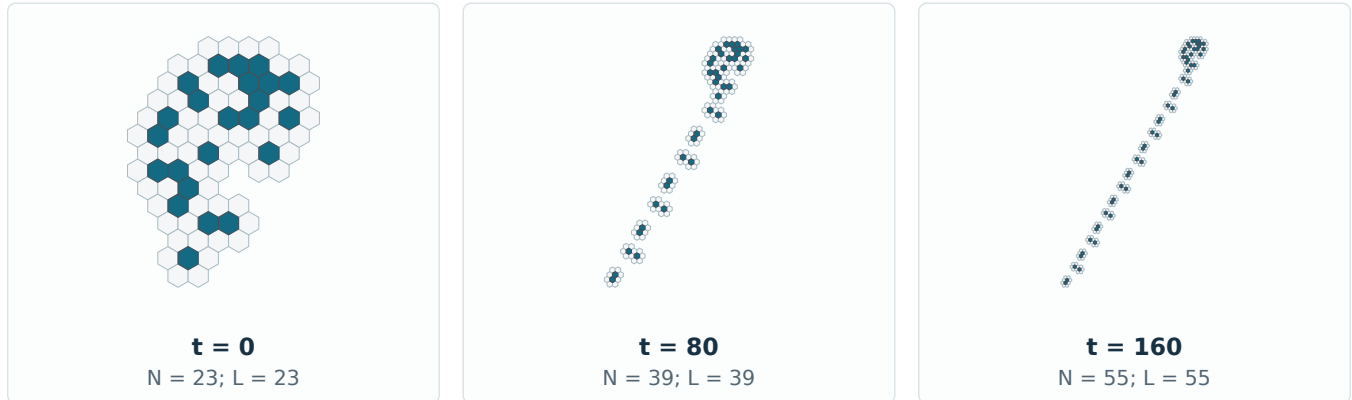
hex-b25s34-p20-puffer

Previously published by Naszvadi (1 February 2024): B25/S34H period-20 puffer [16]. Dmitry Maitak reports an earlier 2023 occurrence [21], [22]; the first discoverer is unconfirmed.

B25/S34 | C = 2 | shared-edge

Complete rule and prior use: R52 (p. 123). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The engine advances ten axial cells every 20 generations and leaves a period-2 oscillator behind. Published by Naszvadi, with an earlier pattern noted by Dmitry Maitak. The finite board eventually ends the trail.

Catalogue replay through t = 160.

Exact initial configuration (q,r,state)

(-3,2,1) (-3,3,1) (-3,5,1) (-2,0,1) (-2,4,1) (-2,6,1) (-1,0,1) (-1,6,1) (0,-2,1) (0,-1,1) (0,1,1)
 (0,3,1) (0,5,1) (0,6,1) (1,3,1) (1,4,1) (1,5,1) (2,-5,1) (2,-3,1) (2,5,1) (3,-3,1) (3,1,1) (3,3,1)

Interpretation and limits

The result is an unbounded-lattice puffer certificate. The finite browser eventually ends the trail. Naszvadi's retrieved 2024 seed is exactly matched; Maitak reports an earlier 2023 occurrence, but the first discoverer is unconfirmed, and no exact seed comparison with that earlier report is available [21], [22].

Pattern provenance and credit (X30)

Published by Naszvadi (2024); Dmitry Maitak points to an earlier 2023 occurrence [16], [21], [22]. The package independently verifies its persistent oscillator trail. Naszvadi's 1 February 2024 post supplies the exact twenty-three-cell RLE used here and describes it as probably known. Dmitry Maitak's later response links to a 2023 occurrence. This audit confirms the 2024 source and the report of earlier publication, but does not establish the original discoverer or independently compare the linked 2023 seed. Initial-state comparison confirms translation-only equivalence to the 2024 RLE. The package adds a certificate of period-20 translated core recurrence and independently separating period-2 deposits.

Executable seed source: Naszvadi's 1 February 2024 puffer post: [16].

Report and link for an earlier 2023 occurrence; not independently compared in this audit: [21], [22].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X31 Hexagonal p999 threefold rotor

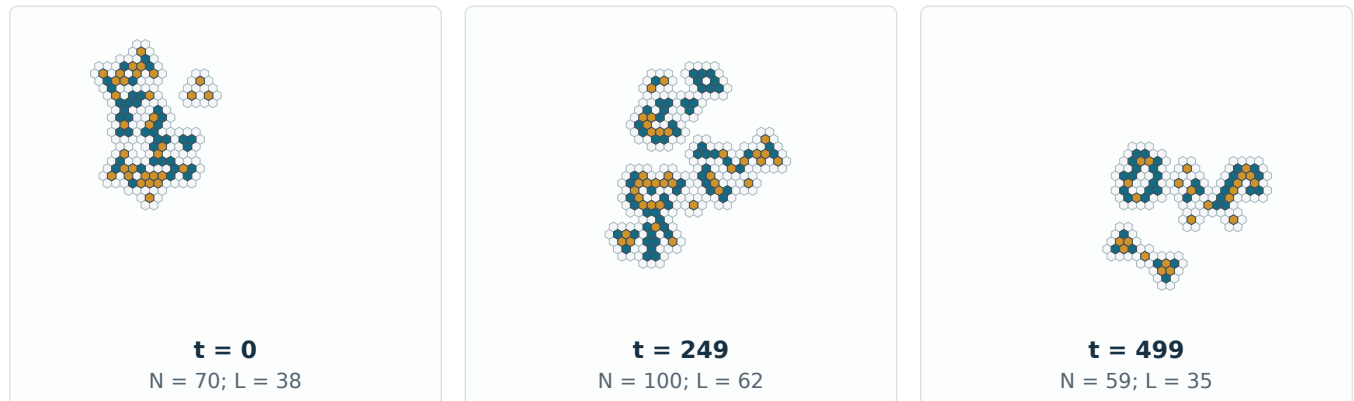
hex-b2s1-c3-p999-rotor

Previously published by c0b0p0 (27 February 2014): B2/S1, C = 3, period-999 rotor in Hexagonal Generations [8]. The catalogue replays the published complete seed.

B2/S1 | C = 3 | shared-edge

Complete rule and prior use: R31 (p. 116). Notation (p. 3).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A three-state rotating wave first returns after 999 generations, making a 120-degree turn every 333. Published by c0b0p0; all refractory states are part of the rotation.

Least period $p = 999$; transient = 0; cycle $L = 11-80$; cycle territory = 1335 tiles; cycle minimum boundary distance = 33.

Exact initial configuration (q,r,state)

70 assigned cells; the complete list is in catalogue-data.json, entry hex-b2s1-c3-p999-rotor, field coordinateStates. All unlisted cells start at 0. Canonical compact-JSON seed SHA-256:

09b1b536a2c5e880b63cade2ac568ca0 23a8625dd6107056bf4c3ca4d9350bac

Interpretation and limits

The full cycle contains 21-129 nonzero cells but only 11-80 live cells. Counting only live cells would discard the refractory information needed for a correct recurrence. The exact published seed is replayed without a novelty claim.

Pattern provenance and credit (X31)

Published by c0b0p0 (2014); independently replayed and verified for this package [8]. The Hexagonal Generations Rules post by c0b0p0 dated 27 February 2014 supplies this exact B2/S1 three-state period-999 rotor RLE. The catalogue retains every live and refractory initial state under $(q,r)=(x,y-x)$, followed only by a centring translation. The full-state dynamics are therefore a replay of the published object, not a new package discovery.

Published pattern source and attribution: Published by c0b0p0 (2014); independently replayed and verified for this package.: [8].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X32 Hexagonal p13 diagonal spaceship

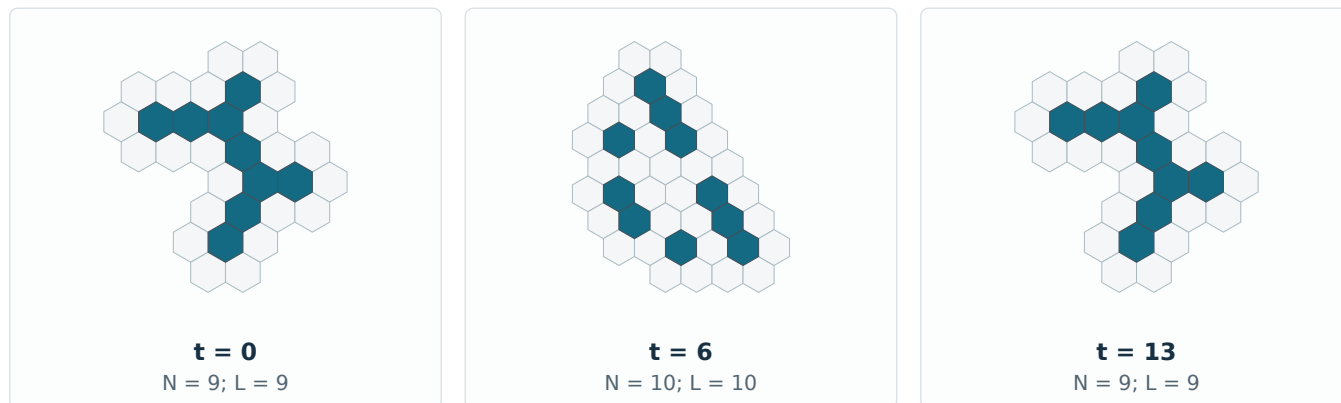
hex-b23s4-p13-traveller

Previously published by John Cerkar (15 March 2020): B23/S4H period-13 spaceship in Outer-totalistic hexagonal rules with spaceships [9]. The catalogue replays the published seed.

B23/S4 | C = 2 | shared-edge

Complete rule and prior use: [R37 \(p. 118\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

John Cerkar's B23/S4 spaceship returns exactly with axial shift (1,1) every 13 generations, using at most 15 live cells.

Exact initial configuration (q,r,state)

(-2,2,1) (-1,2,1) (0,2,1) (0,3,1) (1,1,1) (2,-2,1) (2,-1,1) (2,0,1) (3,0,1)

Interpretation and limits

The verified translation recurrence establishes a spaceship on the unbounded lattice. The package does not claim discovery of the seed or its dynamics.

Pattern provenance and credit (X32)

Published by John Cerkar (2020); independently replayed and verified for this package [9]. John Cerkar's 15 March 2020 post in Outer-totalistic hexagonal rules with spaceships gives RLE `o3bo$bo2bo$2b3o$2bo2bo!` for B23/S4H. The catalogue is exactly this nine-cell published seed after $(q,r)=(x,y-x)$ and a centring translation. The exact period and displacement were independently replayed. The published seed is in Cerkar's 15 March 2020 contribution to the thread in reference [9].

Published pattern source and attribution: Published by John Cerkar (2020); independently replayed and verified for this package.: [9].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X33 Hexagonal p158 wandering spaceship

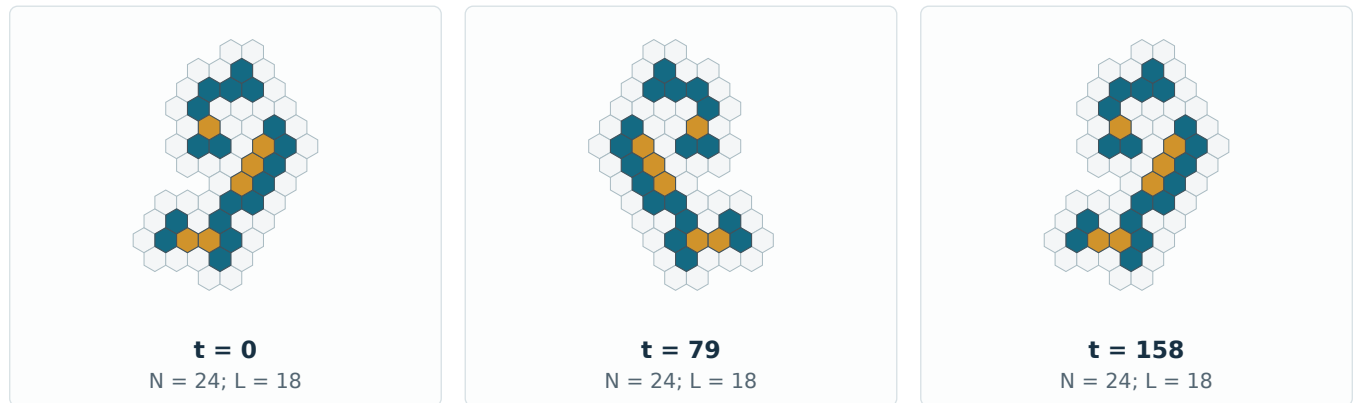
hex-b2s1-c3-p158-traveller

Previously published by c0b0p0 (27 February 2014): B2/S1, C = 3, period-158 spaceship in Hexagonal Generations [8]. The catalogue replays the published complete seed.

B2/S1 | C = 3 | shared-edge

Complete rule and prior use: [R31 \(p. 116\)](#). [Notation \(p. 3\)](#).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1 2

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Published by c0b0p0: this three-state spaceship changes shape dramatically and doubles back locally, then repeats its complete state shifted by axial (-11,22) after 158 generations.

Exact initial configuration (q,r,state)

(-2,3,1) (-2,4,1) (-1,1,1) (-1,2,2) (-1,4,1) (-1,5,1) (0,-4,1) (0,-3,1) (0,1,1) (0,4,1) (1,-4,2)
 (2,-4,2) (2,-3,1) (2,-2,1) (2,-1,2) (2,0,2) (2,1,2) (2,2,1) (3,-5,1) (3,-4,1) (3,-2,1) (3,-1,1)
 (3,0,1) (3,1,1)

Interpretation and limits

The live population sequence happens to repeat after 79 steps, but population is not a state: the least complete-state translational period is 158. The published c0b0p0 seed includes refractory states and is not a package discovery.

Pattern provenance and credit (X33)

Published by c0b0p0 (2014); independently replayed and verified for this package [8]. The Hexagonal Generations Rules post by c0b0p0 dated 27 February 2014 supplies this exact B2/S1 three-state period-158 spaceship RLE. The catalogue retains every live and refractory initial state under (q,r)=(x,y-x), followed only by a centring translation. The full-state dynamics are therefore a replay of the published object, not a new package discovery.

Published pattern source and attribution: Published by c0b0p0 (2014); independently replayed and verified for this package.: [8].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X34 Hexagonal self-repairing wall

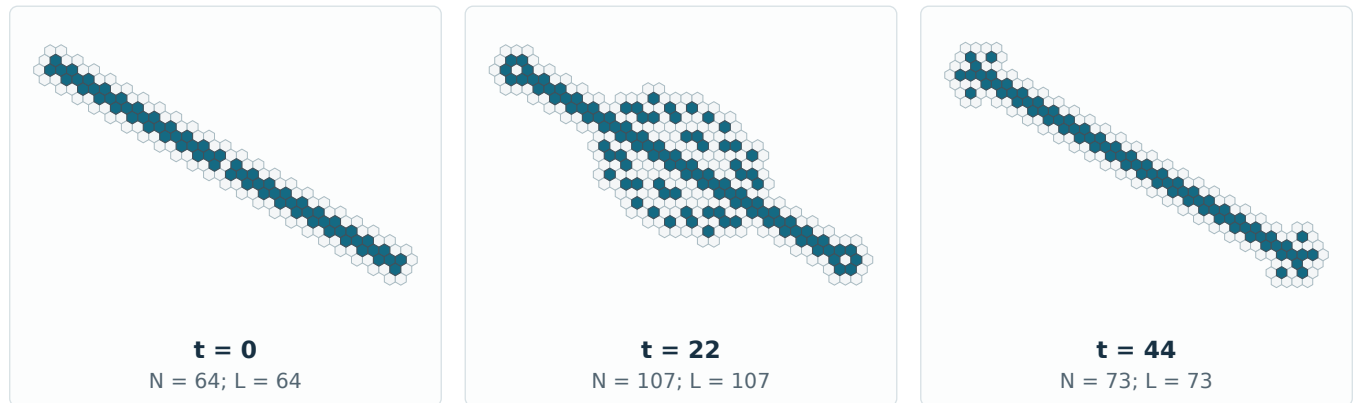
hex-b2s34-wall-repair

Previously published by Dean Hickerson (20 January 2016): B2/S34H damaged self-repairing wall [15], [23]. The package verifies reunion with the pristine wall at generation 44.

B2/S34 | C = 2 | shared-edge

Complete rule and prior use: R32 (p. 116). Notation (p. 3).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Dean Hickerson's oscillating wall repairs one missing cell. Its damaged evolution rejoins the pristine period-5 wall exactly at generation 44, after the exterior debris has disappeared.

Least period $p = 5$; transient = 44; cycle $L = 63-73$; cycle territory = 87 tiles; cycle minimum boundary distance = 42.

Exact initial configuration (q,r,state)

64 assigned cells; the complete list is in catalogue-data.json, entry hex-b2s34-wall-repair, field coordinateStates. All unlisted cells start at 0. Canonical compact-JSON seed SHA-256:

2f0ec3ecf327d78250fd34b14da8c29d 0ec3d7a60b61c1e61ed316737623c5ce

Interpretation and limits

The evidence concerns this specific one-cell defect. It does not establish recovery from arbitrary damage. Dean Hickerson's 20 January 2016 post [15] supplies this damaged seed and describes its repair.

Pattern provenance and credit (X34)

Self-repairing wall published by Dean Hickerson (2016) [15], [23]. The package independently verifies recovery of the complete state. The 20 January 2016 post supplies the exact damaged-wall RLE used here. Direct coordinate comparison confirms the catalogue changes only embedding and centring. Independent replay of damaged and pristine walls shows full-state reunion at generation 44, including exterior debris. Hickerson describes earlier investigations of the rule, but this audit dates the retrieved public example to 2016 rather than assigning an unverified earlier discovery date.

Published pattern source and attribution: Self-repairing wall published by Dean Hickerson (2016). The package independently verifies recovery of the complete state.: [15], [23].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

X35 Hexagonal p2044 billiard table

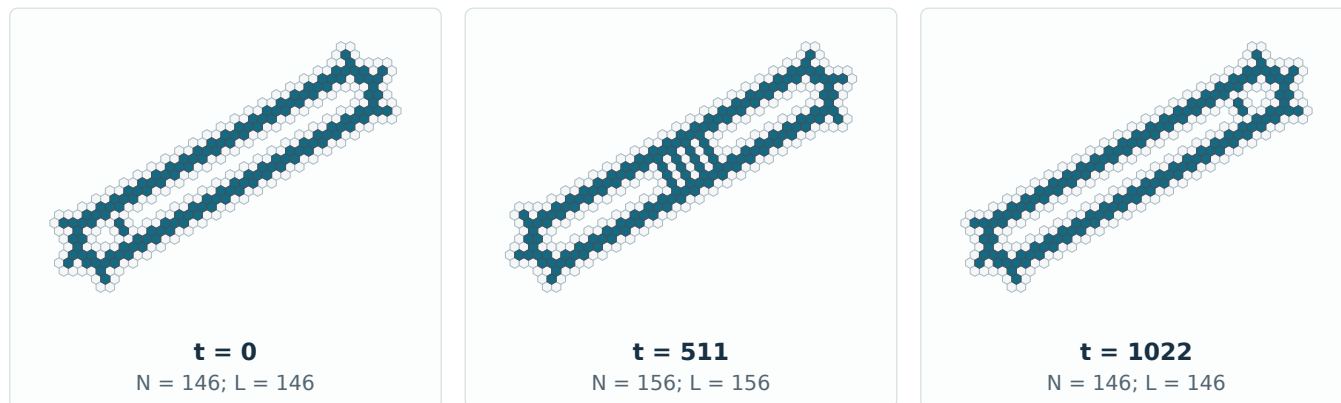
hex-b2s34-p2044-billiard

Previously published by Dean Hickerson (20 January 2016): B2/S34H period-2044 billiard table [15], [23]. The package independently verifies its complete-state period.

B2/S34 | C = 2 | shared-edge

Complete rule and prior use: R32 (p. 116). Notation (p. 3).

Radius 64; 12,481 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

Dean Hickerson's narrow B2/S34 enclosure contains a bouncing, branching signal with exact period 2,044. The construction illustrates an XOR-like one-dimensional evolution inside a hexagonal board.

Least period $p = 2044$; transient = 0; cycle $L = 146-198$; cycle territory = 243 tiles; cycle minimum boundary distance = 41.

Exact initial configuration (q,r,state)

146 assigned cells; the complete list is in catalogue-data.json, entry hex-b2s34-p2044-billiard, field coordinateStates. All unlisted cells start at 0. Canonical compact-JSON seed SHA-256:

931617d4620e5ae6d03d9b77eb275b0f 966f006d0f951d0618b06221c3aae39d

Interpretation and limits

This is a published bounded oscillator, not a newly discovered XOR mechanism. Exact recurrence includes the walls as well as the moving internal signal.

Pattern provenance and credit (X35)

Period-2044 billiard table published by Dean Hickerson (2016); independently verified for this package [15], [23]. The 20 January 2016 post supplies the exact B2/S34H period-2044 billiard-table RLE used here and describes the one-dimensional XOR behaviour inside its walls. Direct coordinate comparison confirms the catalogue changes only embedding and centring. The package's long complete-state replay verifies the published oscillator; it does not establish a new oscillator or a new XOR mechanism.

Published pattern source and attribution: Period-2044 billiard table published by Dean Hickerson (2016); independently verified for this package.: [15], [23].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

C01 Hexagonal seven-copy replicator

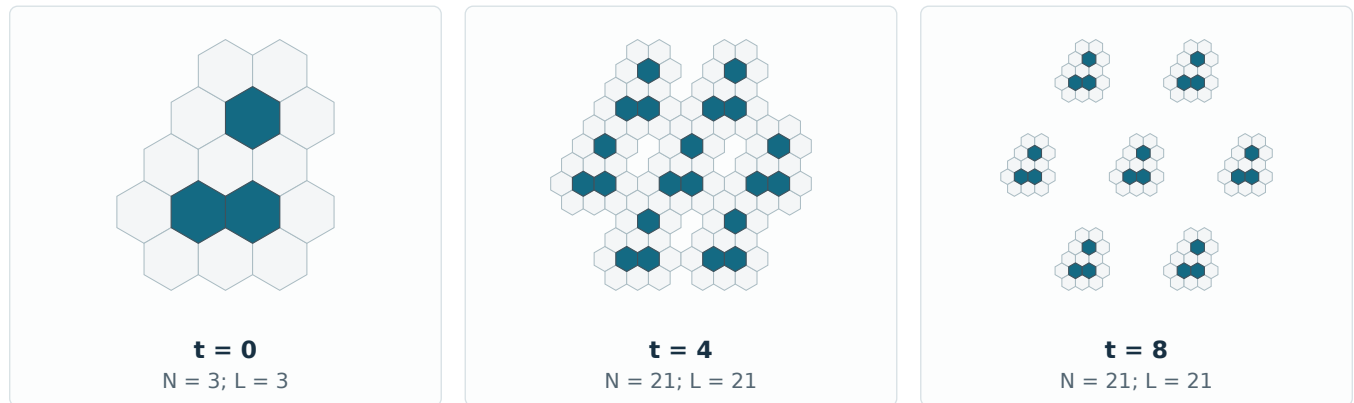
hex-parity-seven-copy

Package-constructed illustration of the established additive/XOR mechanism, using rule [R29](#). The three-cell arrangement and verification are package contributions; the replication principle is not new.

B135/S0246 | C = 2 | shared-edge

Complete rule and prior use: [R29](#) (p. 115). Notation (p. 3).

Radius 128; 49,537 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

Under binary B135/S0246 the next state is the XOR of the centre and its six neighbours. At times 2^k the evolution equals the XOR of seven translations of the seed. For this seed these seven copies are disjoint at times 8, 16 and 32, with 21 live cells.

Exact initial configuration (q,r,state)

(-1,0,1) (0,0,1) (-1,2,1)

Interpretation and limits

At other times, populations may exceed 21 and translated copies can overlap modulo 2.

Pattern provenance and credit (C01)

The three-live-cell initial pattern was assembled for the package, not mined from a soup or imported as an attributed published pattern. B135/S0246 computes the XOR of the centre and six neighbours. Over $\text{GF}(2)$, powers of two of this linear update yield translated copies, giving the seven-copy demonstration once their supports are disjoint. The package claims this illustrative arrangement and its exact verification only; neither XOR replication nor the underlying algebra is a new principle. No external source is asserted for this particular seed.

Evidence in release: [research/fixtures/hexagonal-sources.json](#). Complete source and evidence lists are in [catalogue-data.json](#).

S01 Block still life

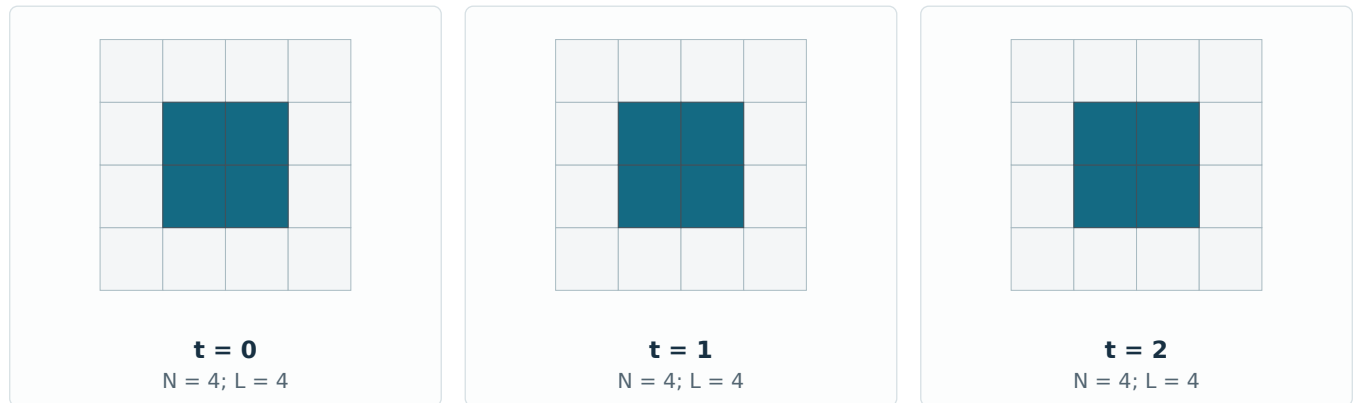
square-block

Published classical pattern: the four-cell block in Martin Gardner's original Conway Life article (1970) [13]; also Silver's Life Lexicon [24]. Individual discoverer unconfirmed.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The four-cell block is unchanged after every update: an exact period-1 still life in Conway Life.

Least period $p = 1$; transient = 0; cycle $L = 4$ -4; cycle territory = 4 tiles; cycle minimum boundary distance = 24.

Exact initial configuration (x,y,state)

(-1, -1, 1) (0, -1, 1) (-1, 0, 1) (0, 0, 1)

Interpretation and limits

This is a standard still life. Its fixed-state identity is exact and is independent of the distant finite boundary.

Pattern provenance and credit (S01)

The standard four-cell block appears in Martin Gardner's original Conway Life article (1970) [13] and Stephen Silver's Life Lexicon [24]. The package changes only its placement. These sources are cited for the published pattern, without assigning an individual discoverer.

Published pattern sources; neither is used to assign an individual discoverer: [13], [24].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S02 Blinker - period 2

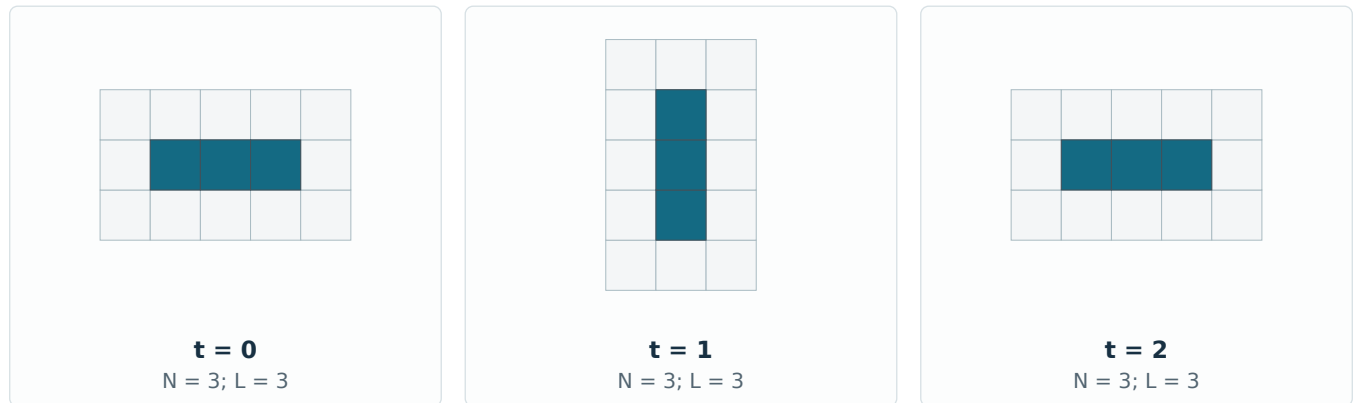
square-blinker

John H. Conway's blinker, attributed in Stephen Silver's Life Lexicon [24] and published in Martin Gardner's original Conway Life article (1970) [13].

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

The smallest Conway oscillator alternates between horizontal and vertical lines.

Least period $p = 2$; transient = 0; cycle $L = 3$ -3; cycle territory = 5 tiles; cycle minimum boundary distance = 24.

Exact initial configuration (x,y,state)

(-1,0,1) (0,0,1) (1,0,1)

Interpretation and limits

Exact first return at generation 2 establishes the least temporal period. It is a standard published oscillator.

Pattern provenance and credit (S02)

Stephen Silver's Life Lexicon [24] credits the blinker to John H. Conway. The period-2 three-cell oscillator also appears in Martin Gardner's original Conway Life article [13]. The package uses its standard horizontal phase, translated for display.

Published pattern source and attribution: John H. Conway: [13], [24].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S03 Pulsar - period 3

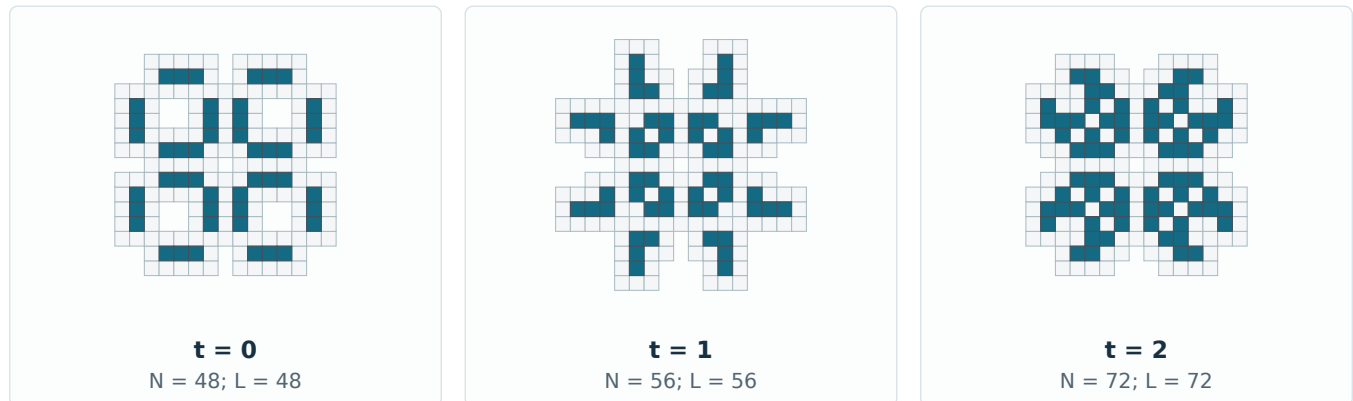
square-pulsar

John H. Conway's pulsar, attributed in Stephen Silver's Life Lexicon [25] and published in Martin Gardner's original Conway Life article (1970) [13].

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A symmetric 48-cell Conway oscillator with exact first-return period 3.

Least period $p = 3$; transient = 0; cycle $L = 48-72$; cycle territory = 88 tiles; cycle minimum boundary distance = 18.

Exact initial configuration (x,y,state)

(-4,-6,1) (-3,-6,1) (-2,-6,1) (2,-6,1) (3,-6,1) (4,-6,1) (-6,-4,1) (-1,-4,1) (1,-4,1) (6,-4,1)
 (-6,-3,1) (-1,-3,1) (1,-3,1) (6,-3,1) (-6,-2,1) (-1,-2,1) (1,-2,1) (6,-2,1) (-4,-1,1) (-3,-1,1)
 (-2,-1,1) (2,-1,1) (3,-1,1) (4,-1,1) (-4,1,1) (-3,1,1) (-2,1,1) (2,1,1) (3,1,1) (4,1,1) (-6,2,1)
 (-1,2,1) (1,2,1) (6,2,1) (-6,3,1) (-1,3,1) (1,3,1) (6,3,1) (-6,4,1) (-1,4,1) (1,4,1) (6,4,1)
 (-4,6,1) (-3,6,1) (-2,6,1) (2,6,1) (3,6,1) (4,6,1)

Interpretation and limits

The quoted period is for the complete state, not merely its population or appearance. This is the classical published pulsar.

Pattern provenance and credit (S03)

Stephen Silver's Life Lexicon [25] credits the pulsar to John H. Conway. Martin Gardner's original Conway Life article [13] describes its 48-cell phase. The package uses that published phase; placement and playback settings are package choices.

Published pattern source and attribution: John H. Conway: [13], [25].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S04 Pentadecathlon - period 15

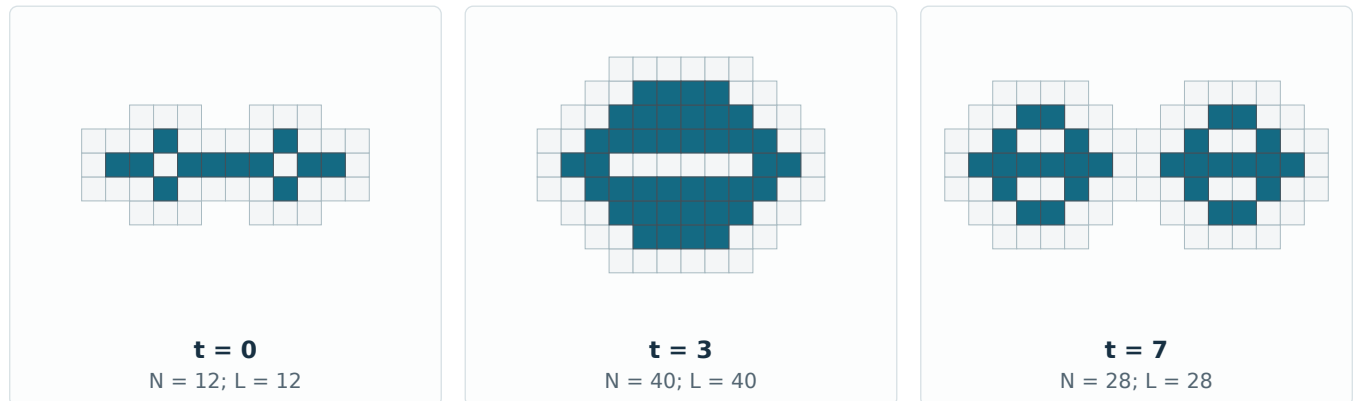
square-pentadecathlon

John H. Conway's pentadecathlon, attributed in Stephen Silver's Life Lexicon [25]. The catalogue uses its established twelve-cell phase.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; same fixed view/scale. N = nonzero; L = state 1.

Verified behaviour

A compact Conway oscillator whose complete state first returns after 15 generations.

Least period $p = 15$; transient = 0; cycle $L = 12-40$; cycle territory = 80 tiles; cycle minimum boundary distance = 17.

Exact initial configuration (x,y,state)

(-3,-1,1) (2,-1,1) (-5,0,1) (-4,0,1) (-2,0,1) (-1,0,1) (0,0,1) (1,0,1) (3,0,1) (4,0,1) (-3,1,1) (2,1,1)

Interpretation and limits

The complete state first returns after 15 updates. The package supplies a phase of the classical oscillator, not a newly discovered seed.

Pattern provenance and credit (S04)

Stephen Silver's Life Lexicon, entry "pentadecathlon" [25], credits John H. Conway's 1970 investigation of short rows. This is the published twelve-cell oscillator phase; the ten-cell row is a predecessor, not the displayed phase.

Pattern attribution and standard phase: Stephen Silver's Life Lexicon, pentadecathlon: [25].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S05 Glider - diagonal spaceship

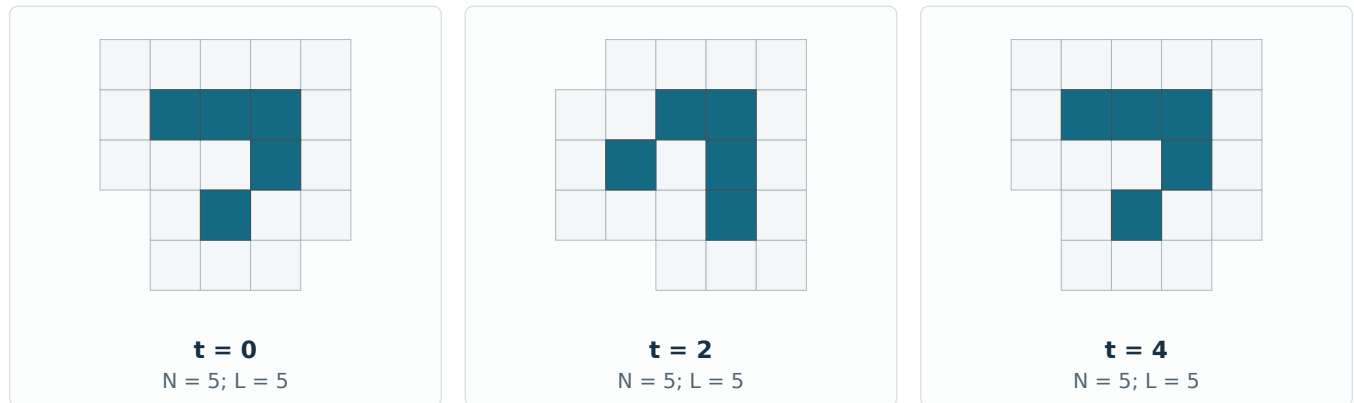
square-glider

Richard K. Guy's glider, attributed in Stephen Silver's Life Lexicon, entry "glider" [26]. The catalogue uses a rotated and translated standard glider phase.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The traditional Conway glider translates by one square in each axis every four generations.

Exact initial configuration (x,y,state)

(0, -1, 1) (1, 0, 1) (-1, 1, 1) (0, 1, 1) (1, 1, 1)

Interpretation and limits

Translation symmetry of the unbounded square lattice makes the verified translated recurrence repeat indefinitely there. On the finite browser board the glider eventually reaches the boundary.

Pattern provenance and credit (S05)

Stephen Silver's Life Lexicon, entry "glider" [26], explicitly credits Richard K. Guy. The package seed is a rotated and translated standard glider phase. No discovery year is asserted here.

Published pattern source and attribution: Richard K. Guy: [26].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S06 Lightweight spaceship

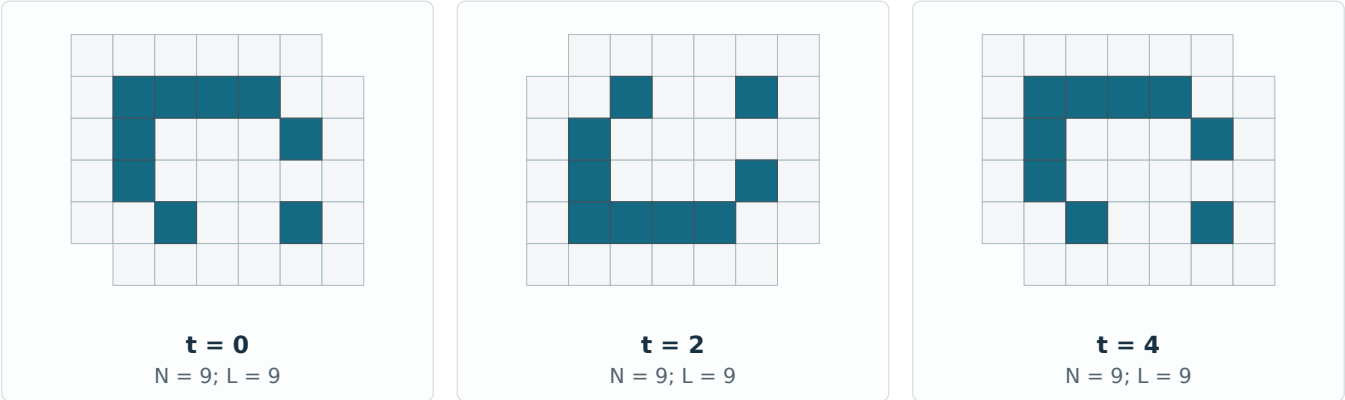
square-lwss

John H. Conway’s lightweight spaceship, attributed in Stephen Silver’s Life Lexicon, entry “LWSS” [27]. The catalogue uses its published nine-cell phase.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 51; 2,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The nine-cell LWSS translates two squares horizontally every four Conway generations.

Exact initial configuration (x,y,state)

(-1,-2,1) (2,-2,1) (-2,-1,1) (-2,0,1) (2,0,1) (-2,1,1) (-1,1,1) (0,1,1) (1,1,1)

Interpretation and limits

The infinite-lattice conclusion follows from the exact translated recurrence. The finite browser board is not infinite and eventually obstructs the flight.

Pattern provenance and credit (S06)

Stephen Silver’s Life Lexicon, entry “LWSS” [27], credits John H. Conway’s 1970 discovery of the lightweight spaceship. The package uses the published nine-cell phase, translated for display, under ordinary B3/S23.

Published pattern source and attribution: John H. Conway: [27].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S07 HighLife replicator

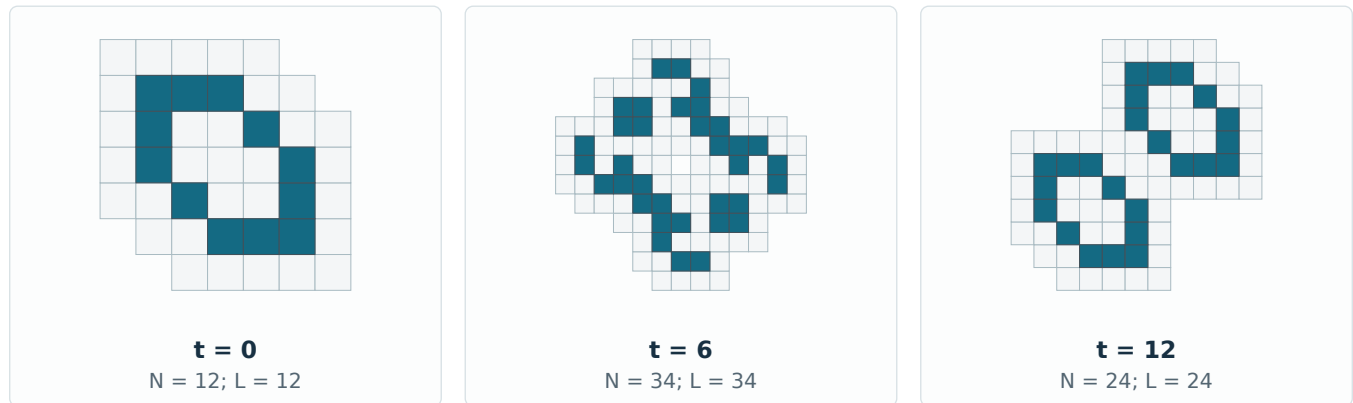
square-highlife-replicator

Nathan Thompson's HighLife replicator (1994), attributed by David Eppstein in Replicators: HighLife [17]; published seed [28].

B36/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R56 (p. 124). Notation (p. 3).

Side length 101; 10,201 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

At generation 12, the complete state is exactly the disjoint union of two copies of the 12-cell initial seed, translated by $(-2, -2)$ and $(2, 2)$ in square coordinates. This is the established B36/S23 HighLife replicator.

Exact initial configuration (x,y,state)

(0, -2, 1) (1, -2, 1) (2, -2, 1) (-1, -1, 1) (2, -1, 1) (-2, 0, 1) (2, 0, 1) (-2, 1, 1) (1, 1, 1) (-2, 2, 1) (-1, 2, 1) (0, 2, 1)

Interpretation and limits

The direct check establishes the stated replication event. It does not by itself prove independent binary doubling forever: copies later interact, and the finite board limits growth.

Pattern provenance and credit (S07)

David Eppstein's Replicators: HighLife [17] credits this replicator to Nathan Thompson in 1994. David Bell subsequently documented and investigated HighLife; he is not credited as this seed's discoverer. The package uses the published twelve-cell seed [28] and independently checks its two-copy return after twelve generations.

Explicit attribution to Nathan Thompson (1994): [17].

Published twelve-cell seed: [28].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S08 Diehard - extinction at 130

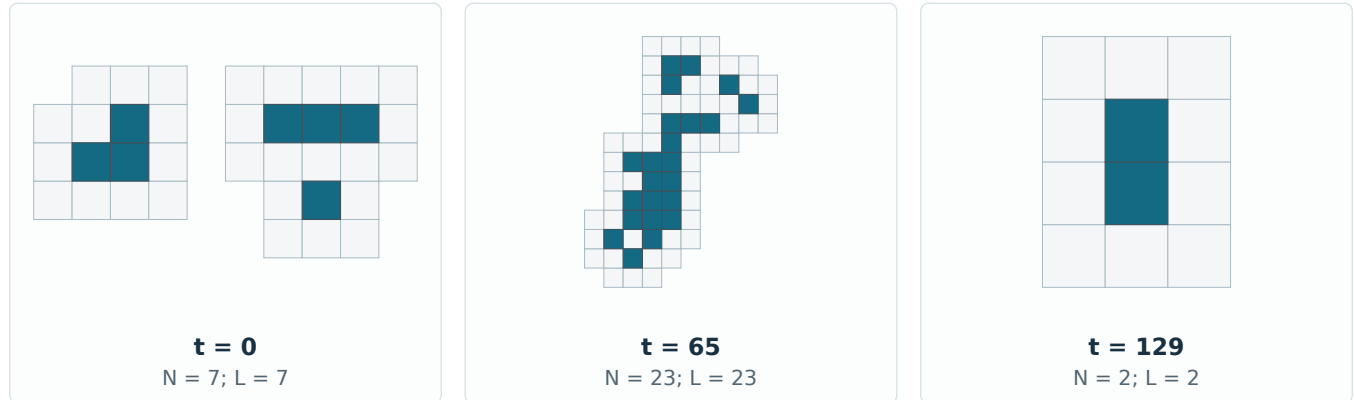
square-diehard

Published classical pattern: diehard in Stephen Silver's Life Lexicon [29]. The exact seven-cell seed is reproduced; its individual discoverer is unconfirmed.

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 101; 10,201 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

A famous seven-cell Conway methuselah that vanishes exactly at generation 130.

Full extinction at $t = 130$.

Exact initial configuration (x,y,state)

(2,-1,1) (-4,0,1) (-3,0,1) (-3,1,1) (1,1,1) (2,1,1) (3,1,1)

Interpretation and limits

This is an extinction transient, not an oscillator. The retained seed matches the classical published diehard; no individual discoverer is assigned without a source.

Pattern provenance and credit (S08)

The seven-cell seed matches diehard in Stephen Silver's Life Lexicon [29] exactly after translation. Its extinction at generation 130 is independently checked. The consulted source does not establish an individual discoverer; no personal attribution or new-discovery claim is made.

Published exact diehard seed; individual discoverer not established: [29].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S09 R-pentomino methuselah

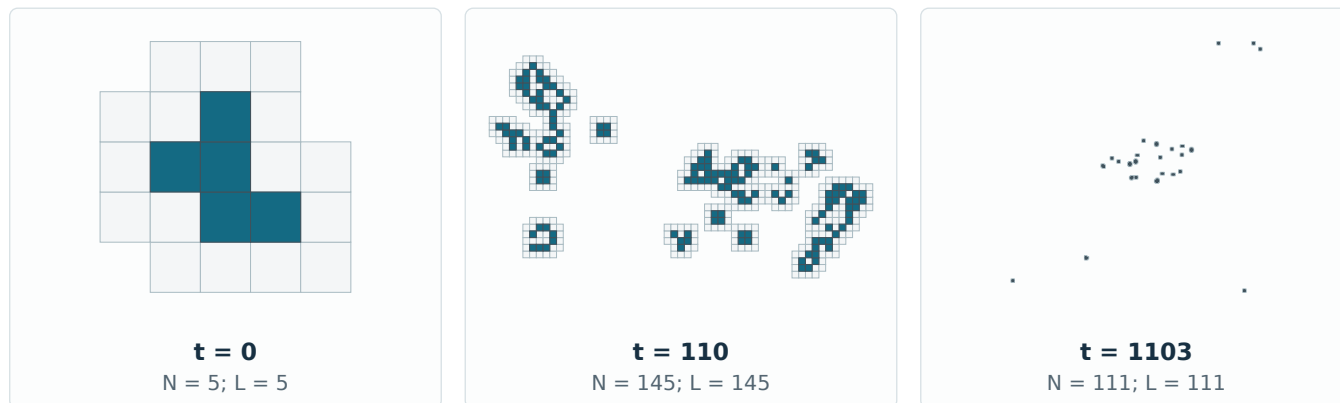
square-r-pentomino

Published classical pattern: the R-pentomino studied by John H. Conway in Martin Gardner's original article (1970) [13]; also Silver's Life Lexicon [30].

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 301; 90,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The standard five-cell seed remains active through generation 1,103 on the supplied finite board. Independent square-lattice replay first differs from that board at generation 641; at generation 1,103 the infinite-lattice and finite-board populations are 116 and 111 respectively.

Catalogue replay through t = 1103.

Exact initial configuration (x,y,state)

(0, -1, 1) (1, -1, 1) (-1, 0, 1) (0, 0, 1) (0, 1, 1)

Interpretation and limits

The browser uses a finite 301 by 301 board with a permanently dead outer ring. The endpoint and population of that run must not be presented as the infinite-plane final census; escaping objects can encounter its boundary.

Pattern provenance and credit (S09)

Martin Gardner's original Conway Life article [13] documents John H. Conway's study of the R-pentomino; Stephen Silver's Life Lexicon [30] records the same five-cell shape. Its finite-board check establishes activity through generation 1,103, not equality with the infinite-plane final census.

Published pattern source and attribution: John H. Conway's classical R-pentomino: [13], [30].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

S10 Acorn methuselah

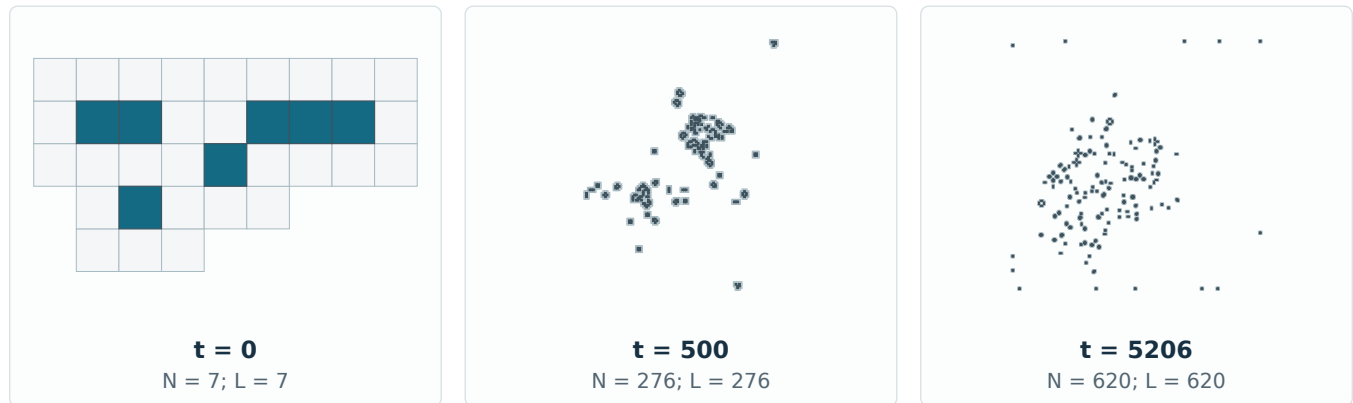
square-acorn

Charles L. Corderman's Acorn, credited in Robert Wainwright's Lifeline No. 3 (1971), p. 12 [31]; also Silver's Life Lexicon [32].

B3/S23 | C = 2 | edge-or-point contact (touch)

Complete rule and prior use: R55 (p. 124). Notation (p. 3).

Side length 301; 90,601 cells; dead border rings = 1.



State: 0 1

Complete nonzero states; independently centred/scaled panels. N = nonzero; L = state 1.

Verified behaviour

The published seven-cell seed remains active through generation 5,206 on the supplied finite board. Independent square-lattice replay first differs from that board at generation 812; at generation 5,206 the infinite-lattice and finite-board populations are 633 and 620 respectively.

Catalogue replay through t = 5206.

Exact initial configuration (x,y,state)

(-2,-1,1) (0,0,1) (-3,1,1) (-2,1,1) (1,1,1) (2,1,1) (3,1,1)

Interpretation and limits

The browser uses a finite 301 by 301 board with a permanently dead outer ring. Activity at generation 5,206 is a finite-board observation, not a certification of the infinite-plane ash or its stabilisation time.

Pattern provenance and credit (S10)

Robert Wainwright's Lifeline No. 3 (1971), page 12 [31], credits Acorn to Charles L. Corderman; Wainwright supplied the name. Stephen Silver's Life Lexicon [32] records the same seven-cell seed. The package translates it for display and checks finite-board activity through 5,206 generations, not the infinite-plane final ash.

Primary attribution to Charles L. Corderman: Lifeline No. 3 (1971), page 12: [31].

Published Acorn description and seed: [32].

Evidence in release: docs/catalogue/evidence/credited-independent-verification.json. Complete source and evidence lists are in catalogue-data.json.

9. Rule-set index

Each linked R label specifies a complete automaton: graph, update and C. Status belongs to that full specification. U rule-selector templates are listed on pages 8-9.

Rule / page	Complete specification	Pattern codes
R01 (p. 106)	Hat; edge; B2/S; C=2	H12
R02 (p. 106)	Hat; edge; B2/S1; C=3	H04
R03 (p. 106)	Hat; edge; B2/S13; C=4	H06
R04 (p. 107)	Hat; edge; B2/S23; C=6	H05
R05 (p. 107)	Hat; edge; B23/S; C=2	H13, H14, H15
R06 (p. 107)	Hat; edge; B3/S23; C=2	H11
R07 (p. 108)	Hat; touch; B1/S; C=2	C04
R08 (p. 108)	Hat; touch; B2/S1; C=10	H07
R09 (p. 108)	Hat; touch; B3/S23; C=2	H08, H09, H10
R10 (p. 109)	Hat; touch; HAT-A; C=4	H02, H18
R11 (p. 109)	Hat; touch; HAT-B; C=4	H03, H17
R12 (p. 109)	Hat; touch; HAT-C; C=4	H19, H21
R13 (p. 110)	Hat; touch; HAT-RELAY; C=3	H16
R14 (p. 110)	Hat; touch; HAT-SIMPLE; C=3	H20
R15 (p. 110)	Hat; touch; HAT-WAKE; C=4	H01
R16 (p. 111)	Penrose; edge; B12/S; C=2	C02
R17 (p. 111)	Penrose; edge; B23/S23; C=2	P04
R18 (p. 111)	Penrose; edge; B3/S23; C=2	P10
R19 (p. 112)	Penrose; touch; B2/S; C=3	C03
R20 (p. 112)	Penrose; touch; B2/S; C=4	P11
R21 (p. 112)	Penrose; touch; B2/S; C=5	P02, P12
R22 (p. 113)	Penrose; touch; B2/S; C=6	P01, P03, P13
R23 (p. 113)	Penrose; touch; B2/S4; C=5	P15
R24 (p. 113)	Penrose; touch; B24/S; C=4	P14
R25 (p. 114)	Penrose; touch; B26/S; C=4	P16
R26 (p. 114)	Penrose; touch; B27/S4; C=4	P17
R27 (p. 114)	Penrose; touch; B3/S23; C=2	P06, P07, P08, P09, P18, P19
R28 (p. 115)	Penrose; touch; B3/S23; C=3	P05

9. Rule-set index (continued)

Each linked R label specifies a complete automaton: graph, update and C. Status belongs to that full specification. U rule-selector templates are listed on pages 8-9.

Rule / page	Complete specification	Pattern codes
R29 (p. 115)	Hex; edge; B135/S0246; C=2	C01
R30 (p. 115)	Hex; edge; B2/S0; C=3	X04
R31 (p. 116)	Hex; edge; B2/S1; C=3	X31, X33
R32 (p. 116)	Hex; edge; B2/S34; C=2	X28, X34, X35
R33 (p. 116)	Hex; edge; B2/S3456; C=7	X19
R34 (p. 117)	Hex; edge; B2/S35; C=2	X23
R35 (p. 117)	Hex; edge; B23/S13; C=4	X07
R36 (p. 117)	Hex; edge; B23/S13; C=5	X21
R37 (p. 118)	Hex; edge; B23/S4; C=2	X32
R38 (p. 118)	Hex; edge; B234/S13; C=4	X22
R39 (p. 118)	Hex; edge; B234/S1346; C=3	X05
R40 (p. 119)	Hex; edge; B234/S245; C=5	X08
R41 (p. 119)	Hex; edge; B234/S3; C=2	X18
R42 (p. 119)	Hex; edge; B2345/S24; C=4	X03
R43 (p. 120)	Hex; edge; B235/S134; C=5	X26
R44 (p. 120)	Hex; edge; B235/S146; C=4	X25
R45 (p. 120)	Hex; edge; B24/S16; C=3	X20
R46 (p. 121)	Hex; edge; B24/S3; C=2	X17
R47 (p. 121)	Hex; edge; B245/S02; C=5	X01, X02
R48 (p. 121)	Hex; edge; B245/S3; C=2	X16, X24
R49 (p. 122)	Hex; edge; B245/S35; C=2	X27
R50 (p. 122)	Hex; edge; B2456/S1345; C=4	X06
R51 (p. 122)	Hex; edge; B246/S246; C=4	X29
R52 (p. 123)	Hex; edge; B25/S34; C=2	X30
R53 (p. 123)	Hex; edge; B3/S23; C=2	X09, X10, X11, X12, X13, X14
R54 (p. 123)	Hex; edge; B34/S234; C=2	X15
R55 (p. 124)	Square; touch; B3/S23; C=2	S01, S02, S03, S04, S05, S06, S08, S09, S10
R56 (p. 124)	Square; touch; B36/S23; C=2	S07

10. Rule register: R01-R03

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R01 Hat | B2/S | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 live neighbours (R01:B2); otherwise stays 0.

Survival: State 1 always dies. Death gives state 0 immediately.

Origin and earlier use: Established Seeds counts on the Hat graph. Seeds supplies the B2/S counts; the package applies them to Hat shared-edge neighbours. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Count-rule source: Golly, Seeds: [14].

Used by: H12 (p. 26).

R02 Hat | B2/S1 | C = 3

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 live neighbours (R02:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly one live neighbour (R02:S1). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected in the package's Hat searches using the established refractory-state framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework source: Golly, Generations: [33].

Used by: H04 (p. 18).

R03 Hat | B2/S13 | C = 4

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 live neighbours (R03:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 1 or 3 live neighbours (R03:S1, R03:S3). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected in the package's refractory-clock search; the associated period family is recorded in H06. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework source: Golly, Generations: [33].

Used by: H06 (p. 20).

10. Rule register: R04-R06

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R04 Hat | B2/S23 | C = 6

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 live neighbours (R04:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R04:S2, R04:S3). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 5 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected in the package's Hat searches using the established refractory-state framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework source: Golly, Generations: [33].

Used by: H05 (p. 19).

R05 Hat | B23/S | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 or 3 live neighbours (R05:B2, R05:B3); otherwise stays 0.

Survival: State 1 always dies. Death gives state 0 immediately.

Origin and earlier use: Package-selected binary rule. Selected in the package's Hat shared-edge search within the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Notation and framework: Golly, QuickLife: [14].

Used by: H13 (p. 27), H14 (p. 28), H15 (p. 29).

R06 Hat | B3/S23 | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 3 live neighbours (R06:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R06:S2, R06:S3). Death gives state 0 immediately.

Origin and earlier use: Conway counts transferred to another graph. Conway's B3/S23 counts are applied to the Hat shared-edge graph. Gardner's source describes eight-neighbour square Life, not this complete rule. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Count-rule source: Conway, reported by Gardner (1970): [13].

Used by: H11 (p. 25).

10. Rule register: R07-R09

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R07 Hat | B1/S | C = 2

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly one live neighbour (R07:B1); otherwise stays 0.

Survival: State 1 always dies. Death gives state 0 immediately.

Origin and earlier use: Package-selected field-demonstration rule. Chosen for a deterministic field demonstration in the package, using the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Notation and framework: Golly, QuickLife: [14].

Used by: C04 (p. 36).

R08 Hat | B2/S1 | C = 10

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R08:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly one live neighbour (R08:S1). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 5 -> 6 -> 7 -> 8 -> 9 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected in the package's Hat searches using the established refractory-state framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework source: Golly, Generations: [33].

Used by: H07 (p. 21).

R09 Hat | B3/S23 | C = 2

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 3 live neighbours (R09:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R09:S2, R09:S3). Death gives state 0 immediately.

Origin and earlier use: Conway counts transferred to another graph. Conway's B3/S23 counts are applied to the Hat boundary-contact graph. Gardner's source describes eight-neighbour square Life, not this complete rule. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Count-rule source: Conway, reported by Gardner (1970): [13].

Used by: H08 (p. 22), H09 (p. 23), H10 (p. 24).

10. Rule register: R10-R12

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R10 Hat | TABLE:HAT-A | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R10.1: own=0, n₂≥2 -> 0
 R10.2: own=any, n₁≥3 -> 3
 R10.3: own=2, n₁≥1 and n₀≥1 -> 1
 R10.4: own=1, n₂≥1 -> 3
 R10.5: own=0, n₁≥1 -> 2

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Published rule: James Edmond's Hat A. Edmond's four-state Hat A table uses boundary-contact neighbours. The package reproduces that complete rule; its separately selected seed placements do not make the rule original.

Rule source: Edmond, Hat A paper and compendium: [2], [3].

Used by: H02 (p. 16), H18 (p. 32).

R11 Hat | TABLE:HAT-B | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R11.1: own=0, n₁≥2 and n₀≥1 -> 0
 R11.2: own=0, n₀≥2 and n₂≥2 -> 1
 R11.3: own=0, n₀≥2 and n₃≥1 -> 1
 R11.4: own=1, n₃≥1 -> 3

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Published rule: James Edmond's Hat B. Edmond's four-state Hat B table uses boundary-contact neighbours. The package reproduces that complete rule; its separately selected seed placements do not make the rule original.

Rule source: Edmond, Hat B paper and compendium: [2], [3].

Used by: H03 (p. 17), H17 (p. 31).

R12 Hat | TABLE:HAT-C | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R12.1: own=any, n₂≥1 and n₁≥3 -> 3
 R12.2: own=1, n₂≥1 -> 2
 R12.3: own=3, n₃≥3 -> 3
 R12.4: own=0, n₃≥2 -> 1
 R12.5: own=any, n₂≥1 -> 1

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Published rule: James Edmond's Hat C. Edmond's four-state Hat C table uses boundary-contact neighbours. The package reproduces that complete rule; its separately selected seed placements do not make the rule original.

Rule source: Edmond, Hat C paper and compendium: [2], [3].

Used by: H19 (p. 33), H21 (p. 35).

10. Rule register: R13-R15

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R13 Hat | TABLE:HAT-RELAY | C = 3

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R13.1: own=1, n₂≥1 -> 2

R13.2: own=0, n₀≥4 and n₂≥1 -> 1

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Adaptation of Edmond's Spectre relay. Obtained by simplifying R15. H16's mature generations 60-235 match Edmond's Spectre relay after [0,1,2] maps to [0,3,1]; ignition and global guards differ. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Adapted mechanism: Edmond's Spectre relay: [2], [3].

Used by: H16 (p. 30).

R14 Hat | TABLE:HAT-SIMPLE | C = 3

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R14.1: own=0, n₁≥2 -> 0

R14.2: own=0, n₂≥1 -> 1

R14.3: own=1, n₂≥1 -> 2

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Adaptation of Edmond's Hat B (R11). For H20, remove Hat B's unused state, relabel state 3 as 2 and drop the empty-neighbour birth guard. This agrees on checked launches, not all inputs. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Parent rule: Edmond's Hat B, reproduced as R11: [2], [3].

Used by: H20 (p. 34).

R15 Hat | TABLE:HAT-WAKE | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

R15.1: own=1, n₀≥3 and n₂≥1 -> 2

R15.2: own=0, n₀≥4 and n₂≥1 -> 1

R15.3: own=1, n₀≥4 -> 3

R15.4: own=0, n₁≥1 and n₂≥1 -> 3

First matching row wins; otherwise 0. n_i counts state i, including 0. No automatic refractory ageing.

Origin and earlier use: Package-evolved table; no identified precedent. Obtained by random-initialised evolutionary search and trajectory-preserving reduction; H01 records its derivation. No earlier exact specification was identified in literature reviewed as at 14 October 2026. Edmond supplies the earlier framework, not this exact table.

Framework background: Edmond's Hat/Spectre work: [2], [3].

Used by: H01 (p. 15).

10. Rule register: R16-R18

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R16 Penrose | B12/S | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 1 or 2 live neighbours (R16:B1, R16:B2); otherwise stays 0.

Survival: State 1 always dies. Death gives state 0 immediately.

Origin and earlier use: Package-selected field-demonstration rule. Chosen for a deterministic field demonstration in the package, using the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Notation and framework: Golly, QuickLife: [14].

Used by: C02 (p. 56).

R17 Penrose | B23/S23 | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 2 or 3 live neighbours (R17:B2, R17:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R17:S2, R17:S3). Death gives state 0 immediately.

Origin and earlier use: Package-selected binary rule. Selected in the package's Penrose shared-edge search. Owens and Stepney's R27 uses different counts and boundary-contact neighbours. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Different-rule background: Owens and Stepney: [5].

Used by: P04 (p. 40).

R18 Penrose | B3/S23 | C = 2

Neighbours: Tiles sharing a positive-length boundary segment; point-only contacts do not count.

Birth: 0 becomes 1 at exactly 3 live neighbours (R18:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R18:S2, R18:S3). Death gives state 0 immediately.

Origin and earlier use: Conway counts transferred to another graph. Conway's B3/S23 counts are applied to the Penrose shared-edge graph. Gardner's source describes eight-neighbour square Life, not this complete rule. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Count-rule source: Conway, reported by Gardner (1970): [13].

Used by: P10 (p. 46).

10. Rule register: R19-R21

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R19 Penrose | B2/S | C = 3

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R19:B2); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Brian's Brain transition on Penrose rhombs. Brian Silverman's three-state Brain transition is transferred to Penrose boundary-contact neighbours. The cited standard square-grid rule is not this full specification. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Transition source: Rucker and Walker, Brian's Brain: [7].

Used by: C03 (p. 57).

R20 Penrose | B2/S | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R20:B2); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. This 4-state B2/S rule was selected in the package's Penrose searches. Goucher's earlier gliders use a different priority table. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P11 (p. 47).

R21 Penrose | B2/S | C = 5

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R21:B2); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. This 5-state B2/S rule was selected in the package's Penrose searches. Goucher's earlier gliders use a different priority table. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P02 (p. 38), P12 (p. 48).

10. Rule register: R22-R24

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R22 Penrose | B2/S | C = 6

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R22:B2); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 3 -> 4 -> 5 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. This 6-state B2/S rule was selected in the package's Penrose searches. Goucher's earlier gliders use a different priority table. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P01 (p. 37), P03 (p. 39), P13 (p. 49).

R23 Penrose | B2/S4 | C = 5

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 live neighbours (R23:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 4 live neighbours (R23:S4). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected launch-rule variant. The package added S4 survivals to its R21 travelling-core rule, changing ignition. The later core is the package's R21 core, not Goucher's different mechanism. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P15 (p. 51).

R24 Penrose | B24/S | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 or 4 live neighbours (R24:B2, R24:B4); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected launch-rule variant. The package added B4 births to its R20 travelling-core rule, changing ignition. The later core is the package's R20 core, not Goucher's different mechanism. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P14 (p. 50).

10. Rule register: R25-R27

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R25 Penrose | B26/S | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 or 6 live neighbours (R25:B2, R25:B6); otherwise stays 0.

Survival: State 1 always dies. On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected launch-rule variant. The package added B6 births to its R20 travelling-core rule, changing ignition. The later core is the package's R20 core, not Goucher's different mechanism. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P16 (p. 52).

R26 Penrose | B27/S4 | C = 4

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 2 or 7 live neighbours (R26:B2, R26:B7); otherwise stays 0.

Survival: 1 stays 1 at exactly 4 live neighbours (R26:S4). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected launch-rule variant. The package added B7 births and S4 survivals to its R20 travelling-core rule, changing ignition. The later core is the package's R20 core, not Goucher's different mechanism. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Different-rule background: Goucher's Penrose gliders: [4].

Used by: P17 (p. 53).

R27 Penrose | B3/S23 | C = 2

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 3 live neighbours (R27:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R27:S2, R27:S3). Death gives state 0 immediately.

Origin and earlier use: Published Penrose Life rule. Owens and Stepney used binary B3/S23 on Penrose rhombs with boundary-contact neighbours. Their published full rule precedes this package; individual configurations require separate comparisons, including unresolved P09.

Rule source: Owens and Stepney (2010): [5], [10].

Used by: P06 (p. 42), P07 (p. 43), P08 (p. 44), P09 (p. 45), P18 (p. 54), P19 (p. 55).

10. Rule register: R28-R30

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R28 Penrose | B3/S23 | C = 3

Neighbours: All edge or boundary-point contacts, including corner contacts and T-junctions; exclude the cell itself.

Birth: 0 becomes 1 at exactly 3 live neighbours (R28:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R28:S2, R28:S3). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Package Generations extension of R27. Adds one refractory state to the binary Penrose Life rule R27. The three-state transition differs from Owens and Stepney's binary automaton. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Binary parent: Owens and Stepney's Penrose Life: [5], [10].

Refractory framework: Golly, Generations: [33].

Used by: P05 (p. 41).

R29 Hex | B135/S0246 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 1, 3 or 5 live neighbours (R29:B1, R29:B3, R29:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 0, 2, 4 or 6 live neighbours (R29:S0, R29:S2, R29:S4, R29:S6). Death gives state 0 immediately.

Origin and earlier use: XOR rule; illustrative package construction. The update equals XOR of the centre state and six neighbours. C01 explains the algebra and the three-cell illustrative seed assembled here. No new XOR replication principle is claimed.

Used by: C01 (p. 93).

R30 Hex | B2/S0 | C = 3

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 live neighbours (R30:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 0 live neighbours (R30:S0). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X04 (p. 61).

10. Rule register: R31-R33

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R31 Hex | B2/S1 | C = 3

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 live neighbours (R31:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly one live neighbour (R31:S1). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Previously published six-neighbour rule. c0b0p0's 27 February 2014 contribution supplies the B2/S1, C=3 period-999 rotor [X31](#) and period-158 ship [X33](#). These dated examples establish prior use of the full rule, without identifying its first proposer.

Prior use: c0b0p0, Hexagonal Generations Rules (2014): [\[8\]](#).

Used by: [X31](#) (p. 88), [X33](#) (p. 90).

R32 Hex | B2/S34 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 live neighbours (R32:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 or 4 live neighbours (R32:S3, R32:S4). Death gives state 0 immediately.

Origin and earlier use: Previously published six-neighbour rule. drc's 18 January 2016 oscillator record and Dean Hickerson's 20 January 2016 wall and billiard-table records use this full rule. The reproduced objects are [X28](#), [X34](#) and [X35](#).

Oscillator source: drc (18 January 2016): [\[20\]](#).

Wall/billiard sources: Dean Hickerson (20 January 2016): [\[15\]](#), [\[23\]](#).

Used by: [X28](#) (p. 85), [X34](#) (p. 91), [X35](#) (p. 92).

R33 Hex | B2/S3456 | C = 7

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 live neighbours (R33:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 3, 4, 5 or 6 live neighbours (R33:S3, R33:S4, R33:S5, R33:S6). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 5 -> 6 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [\[33\]](#).

Literature surveyed, not an exact-rule predecessor: [\[8\]](#).

Used by: [X19](#) (p. 76).

10. Rule register: R34-R36

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R34 Hex | B2/S35 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 live neighbours (R34:B2); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 or 5 live neighbours (R34:S3, R34:S5). Death gives state 0 immediately.

Origin and earlier use: Published six-neighbour rule. Bays (2005), Figure 3, describes the B2/S35 spaceship. X23 exactly matches Cerkan's 22 January 2016 RLE. The package does not claim either rule or ship as original.

Earlier rule and motion: Bays, Figure 3: [11], [19].

Matched seed source: John Cerkan (2016): [15].

Used by: X23 (p. 80).

R35 Hex | B23/S13 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 3 live neighbours (R35:B2, R35:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 1 or 3 live neighbours (R35:S1, R35:S3). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X07 (p. 64).

R36 Hex | B23/S13 | C = 5

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 3 live neighbours (R36:B2, R36:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 1 or 3 live neighbours (R36:S1, R36:S3). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X21 (p. 78).

10. Rule register: R37-R39

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R37 Hex | B23/S4 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 3 live neighbours (R37:B2, R37:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 4 live neighbours (R37:S4). Death gives state 0 immediately.

Origin and earlier use: Previously published six-neighbour rule. John Cerkán's 15 March 2020 contribution to Outer-totalistic hexagonal rules with spaceships supplies the retained B23/S4H seed, reproduced as X32. This establishes prior use of the complete rule.

Prior rule and seed: John Cerkán (15 March 2020): [9].

Used by: X32 (p. 89).

R38 Hex | B234/S13 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 4 live neighbours (R38:B2, R38:B3, R38:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 1 or 3 live neighbours (R38:S1, R38:S3). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X22 (p. 79).

R39 Hex | B234/S1346 | C = 3

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 4 live neighbours (R39:B2, R39:B3, R39:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 1, 3, 4 or 6 live neighbours (R39:S1, R39:S3, R39:S4, R39:S6). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X05 (p. 62).

10. Rule register: R40-R42

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R40 Hex | B234/S245 | C = 5

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 4 live neighbours (R40:B2, R40:B3, R40:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 2, 4 or 5 live neighbours (R40:S2, R40:S4, R40:S5). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X08 (p. 65).

R41 Hex | B234/S3 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 4 live neighbours (R41:B2, R41:B3, R41:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 live neighbours (R41:S3). Death gives state 0 immediately.

Origin and earlier use: Package-selected binary rule. Selected by the package's six-neighbour hexagonal search within the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Literature surveyed, not an exact-rule predecessor: [9].

Used by: X18 (p. 75).

R42 Hex | B2345/S24 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3, 4 or 5 live neighbours (R42:B2, R42:B3, R42:B4, R42:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 4 live neighbours (R42:S2, R42:S4). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X03 (p. 60).

10. Rule register: R43-R45

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R43 Hex | B235/S134 | C = 5

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 5 live neighbours (R43:B2, R43:B3, R43:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 1, 3 or 4 live neighbours (R43:S1, R43:S3, R43:S4). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package rule applied to the published X23 seed. The package changes R34 to B235/S134, C=5, while retaining X23's live-cell geometry. Cerkar supplies the matched seed; Bays describes the earlier B2/S35 ship. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Reused seed: John Cerkar's B2/S35 ship: [15].

Earlier B2/S35 ship, not this altered rule: Bays, Fig. 3: [11], [19].

Used by: X26 (p. 83).

R44 Hex | B235/S146 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 3 or 5 live neighbours (R44:B2, R44:B3, R44:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 1, 4 or 6 live neighbours (R44:S1, R44:S4, R44:S6). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package rule applied to the published X23 seed. The package changes R34 to B235/S146, C=4, while retaining X23's live-cell geometry. Cerkar supplies the matched seed; Bays describes the earlier B2/S35 ship. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Reused seed: John Cerkar's B2/S35 ship: [15].

Earlier B2/S35 ship, not this altered rule: Bays, Fig. 3: [11], [19].

Used by: X25 (p. 82).

R45 Hex | B24/S16 | C = 3

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 4 live neighbours (R45:B2, R45:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 1 or 6 live neighbours (R45:S1, R45:S6). On death, 1 becomes 2; then 2 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X20 (p. 77).

10. Rule register: R46-R48

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R46 Hex | B24/S3 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 4 live neighbours (R46:B2, R46:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 live neighbours (R46:S3). Death gives state 0 immediately.

Origin and earlier use: Package-selected binary rule. Selected by the package's six-neighbour hexagonal search within the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Literature surveyed, not an exact-rule predecessor: [9].

Used by: X17 (p. 74).

R47 Hex | B245/S02 | C = 5

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 4 or 5 live neighbours (R47:B2, R47:B4, R47:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 0 or 2 live neighbours (R47:S0, R47:S2). On death, 1 becomes 2; then 2 -> 3 -> 4 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [33].

Literature surveyed, not an exact-rule predecessor: [8].

Used by: X01 (p. 58), X02 (p. 59).

R48 Hex | B245/S3 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 4 or 5 live neighbours (R48:B2, R48:B4, R48:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 live neighbours (R48:S3). Death gives state 0 immediately.

Origin and earlier use: Published six-neighbour rule. Bays (2005), Figure 4, describes a B245/S3 spaceship. X24 exactly matches Golly's executable hexagonal example; Golly's page does not name Bays. X16's separate oscillator has its own provenance.

Earlier rule and motion: Bays, Figure 4: [11], [19].

Matched seed and rule: Golly, QuickLife: [14].

Used by: X16 (p. 73), X24 (p. 81).

10. Rule register: R49-R51

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R49 Hex | B245/S35 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 4 or 5 live neighbours (R49:B2, R49:B4, R49:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 or 5 live neighbours (R49:S3, R49:S5). Death gives state 0 immediately.

Origin and earlier use: Previously published six-neighbour rule. muzik's 2019 B245/S35H spaceship in Outer-totalistic hexagonal rules with spaceships matches [X27](#) over its complete orbit. The rule and spaceship precede this package.

Prior rule and matched ship: muzik (2019): [\[9\]](#).

Used by: [X27](#) (p. 84).

R50 Hex | B2456/S1345 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 4, 5 or 6 live neighbours (R50:B2, R50:B4, R50:B5, R50:B6); otherwise stays 0.

Survival: 1 stays 1 at exactly 1, 3, 4 or 5 live neighbours (R50:S1, R50:S3, R50:S4, R50:S5). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Package-selected Generations rule. Selected by the package's six-neighbour hexagonal search within the established Generations framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Framework: Golly, Generations: [\[33\]](#).

Literature surveyed, not an exact-rule predecessor: [\[8\]](#).

Used by: [X06](#) (p. 63).

R51 Hex | B246/S246 | C = 4

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2, 4 or 6 live neighbours (R51:B2, R51:B4, R51:B6); otherwise stays 0.

Survival: 1 stays 1 at exactly 2, 4 or 6 live neighbours (R51:S2, R51:S4, R51:S6). On death, 1 becomes 2; then 2 -> 3 -> 0 regardless of neighbours.

Origin and earlier use: Previously published four-state rule. confocaloid's 14 October 2024 contribution to Hexagonal Generations Rules supplies this rule and [X29](#)'s twelve-live-cell three-way gun seed. The package contributes independent verification.

Rule and gun source: confocaloid (14 October 2024): [\[8\]](#).

Used by: [X29](#) (p. 86).

10. Rule register: R52-R54

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims. Notation: p. 3; status definitions: p. 7.

R52 Hex | B25/S34 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 2 or 5 live neighbours (R52:B2, R52:B5); otherwise stays 0.

Survival: 1 stays 1 at exactly 3 or 4 live neighbours (R52:S3, R52:S4). Death gives state 0 immediately.

Origin and earlier use: Previously published six-neighbour rule. X30 exactly matches Naszvadi's 1 February 2024 puffer. Dmitry Maitak reports a 2023 occurrence, whose seed was not independently compared here. The original discoverer has not been identified by this audit.

Matched rule and seed: Naszvadi (1 February 2024): [16].

Reported earlier occurrence; seed comparison incomplete: [21], [22].

Used by: X30 (p. 87).

R53 Hex | B3/S23 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 3 live neighbours (R53:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R53:S2, R53:S3). Death gives state 0 immediately.

Origin and earlier use: Conway counts transferred to another graph. Conway's B3/S23 counts are applied to the six-neighbour hexagonal graph. Gardner's source describes eight-neighbour square Life, not this complete rule. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Count-rule source: Conway, reported by Gardner (1970): [13].

Used by: X09 (p. 66), X10 (p. 67), X11 (p. 68), X12 (p. 69), X13 (p. 70), X14 (p. 71).

R54 Hex | B34/S234 | C = 2

Neighbours: Six edge-sharing hexagons; the cell itself is excluded.

Birth: 0 becomes 1 at exactly 3 or 4 live neighbours (R54:B3, R54:B4); otherwise stays 0.

Survival: 1 stays 1 at exactly 2, 3 or 4 live neighbours (R54:S2, R54:S3, R54:S4). Death gives state 0 immediately.

Origin and earlier use: Package-selected binary rule. Selected by the package's six-neighbour hexagonal search within the established birth/survival framework. No earlier exact specification was identified in literature reviewed as at 14 October 2026.

Literature surveyed, not an exact-rule predecessor: [9].

Used by: X15 (p. 72).

10. Rule register: R55-R56

B/S counts are exact counts of state-1 neighbours. A known rule and a newly found seed are separate claims.
Notation: p. 3; status definitions: p. 7.

R55 Square | B3/S23 | C = 2

Neighbours: Eight surrounding squares: four edge-sharing and four diagonal; exclude the cell itself.

Birth: 0 becomes 1 at exactly 3 live neighbours (R55:B3); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R55:S2, R55:S3). Death gives state 0 immediately.

Origin and earlier use: Standard Conway Life. John Conway's binary B3/S23 rule on the square grid with eight boundary-contact neighbours, published by Martin Gardner in October 1970.

Published rule account: Gardner (1970), Conway's Life: [13].

Used by: S01 (p. 94), S02 (p. 95), S03 (p. 96), S04 (p. 97), S05 (p. 98), S06 (p. 99), S08 (p. 101), S09 (p. 102), S10 (p. 103).

R56 Square | B36/S23 | C = 2

Neighbours: Eight surrounding squares: four edge-sharing and four diagonal; exclude the cell itself.

Birth: 0 becomes 1 at exactly 3 or 6 live neighbours (R56:B3, R56:B6); otherwise stays 0.

Survival: 1 stays 1 at exactly 2 or 3 live neighbours (R56:S2, R56:S3). Death gives state 0 immediately.

Origin and earlier use: Established HighLife rule. The standard binary B36/S23 rule on the eight-neighbour square grid. Eppstein's account credits S07's replicator to Nathan Thompson (1994); that pattern credit does not establish who first proposed the rule.

Rule and replicator account: David Eppstein, HighLife: [17].

Used by: S07 (p. 100).

11. Reproduce and rebuild

From the application

Use the version 3.7.4 release accompanying this catalogue. Open `aperiodic-life-standalone.html`, locate the entry by title in Curated configurations, and press Load. The lower-case identifier printed on the page is its `discoveries.js` key. Step through the generations shown. Save state preserves all labelled states. The live website may later run a different release.

Machine-readable initial states

The PDF attachment `catalogue-data.json` contains every preset, exact seed, rule and measurement. The repository's `geometry/diagrams.json` additionally records complete snapshot geometry, graph hashes and the realised initial states of random fields. Where a long seed is not printed in full, the record key, population and SHA-256 of the canonical seed list identify the attached exact data. PDF readers may hide attachments; the same data is provided as a normal file beside this PDF.

Rebuilding the catalogue

The editable prose is `catalogue.md`. `catalogue-source.json` contains exact definitions, seeds, attributions and bibliography. `build_catalogue.py` reads both and produces the PDF plus `catalogue-data.json`. Install the optional documentation dependencies in `requirements.txt`, then run `python3 docs/catalogue/build_catalogue.py` from the repository root. The application itself still needs no installation or npm dependencies.

Regenerating scientific figures

Run `node docs/catalogue/export_geometry.js` to regenerate every snapshot from `core.js` and `discoveries.js`. Then rebuild the PDF. Re-run `node research/verify-catalog.js` and the cited specialised verifiers when changing seeds, geometry or dynamics. A larger aperiodic depth changes tile IDs: transfer by verified polygon correspondence, not by assuming the same numerical ID means the same location.

Exact seed example (from the repository root):

```
const C = require('./core.js');
const e = require('./discoveries.js')
  .find(x => x.id === 'hat-wake-traveller');
const p = C.buildPatch(e.tiling, e.depth);
const s = new C.Automaton(p, p.touchGraph, e);
for (const [i,v] of e.cellStates) s.state[i] = v;
s.refreshDerivedState();
for (let t=0;t<60;t++) s.step();
```

12. Data, checks and integrity

Double-checks

All 89 curated presets are included exactly once, all 12 named UI rule presets are inventoried, and all 56 complete rule definitions are mapped to their entries. Every panel is regenerated from the release engine. The full catalogue verifier and the eleven published hexagonal source comparisons were rerun. Independent period/displacement and aperiodic structure checks from the previous catalogue remain applicable to the unchanged seeds and engine; the evidence records state their actual horizons.

Reproducibility and scope

The embedded catalogue data and repository source identify the exact engine and discovery file by SHA-256. The PDF deliberately does not embed its containing release archive. That would create a circular dependency. Build and verification output paths are described in the catalogue README. Source claims are qualified separately from the runtime checks.

Corrections and citation

Cite Aperiodic Life 3.7.4, the stable preset ID, the full rule including C, and the graph. A useful earlier-match report supplies a dated source, complete multistate seed, rule and neighbourhood, and an explicit transformation or phase match. Please submit corrections and patches to the project repository. Neither this software nor this computational catalogue establishes global priority or replaces independent verification.

core.js SHA-256

d39d1a0b0ed3b1307a9d9a9bbbabb75e e4479e257301674ac38c6b2b622b6ef3

discoveries.js SHA-256

9f0d8e6969a0c6fe5fde89e29bc33437 c39fb87e6464fa125c1be9da28fc5187

13. References

Primary papers, author-maintained records and attributed pattern collections are listed below. The audit uses retained source comparisons dated 13-14 October 2026. Exact-pattern and background references are distinguished in the entries; citing a source is not a claim to have established its author's first-discovery priority.

[1] Gabbay, Murdoch J. Aperiodic Life, version 3.7.4. Software, curated configurations and computational evidence, 14 October 2026. Catalogue: AI generated following prompts by Murdoch J. Gabbay. Editable catalogue sources and exact-state evidence accompany the release.

<https://github.com/bellissimogiorno/aperiodic-life>

[2] Edmond, James. Gliders on Aperiodic Monotilings: Cellular Automata on the Hat and Spectre. arXiv:2609.22579, 2026. Primary source for the published Hat/Spectre framework and Hat A/B/C gliders.

<https://arxiv.org/abs/2609.22579>

[3] Edmond, James. The Glider Compendium. Author-maintained monotile-ca repository, GLIDERS.md. Rule tables, seed records and credit for reproduced behaviour.

<https://github.com/jamesedmond/monotile-ca/blob/main/GLIDERS.md>

[4] Goucher, Adam P. Gliders in cellular automata on Penrose tilings (2012). Primary paper describing earlier four-state Penrose travelling behaviour under a different update rule.

<https://cp4space.hatsya.com/wp-content/uploads/2012/11/2012-penrose-gliders.pdf>

13. References (continued)

[5] Owens, Nick and Stepney, Susan. The Game of Life Rules on Penrose Tilings: still life and oscillators. In A. Adamatzky (ed.), Game of Life Cellular Automata, chapter 18, pp. 331-378. Springer, 2010. Author-maintained catalogue and linked chapter.

<https://www-users.york.ac.uk/~ss44/bib/ss/nonstd/penroselife.htm>

[6] Stepney, Susan. The Art of Penrose Life. In A. Adamatzky and G. J. Martinez (eds.), Designing Beauty: The Art of Cellular Automata, pp. 103-109. Springer, 2016. DOI: 10.1007/978-3-319-27270-2_15. Figure 6 illustrates the published fireworks oscillator.

<https://www-users.york.ac.uk/~ss44/bib/ss/nonstd/AAGoL2016.pdf>

[7] Rucker, Rudy and Walker, John. CellLab manual, rule descriptions: Brian's Brain. Primary software documentation crediting Brian Silverman's three-state rule.

<https://www.fourmilab.ch/cellab/manual/chap4.html>

[8] ConwayLife forum contributors. Hexagonal Generations Rules, topic 1319. Retained dated sources include c0b0p0's 27 February 2014 B2/S1, C=3 rotor and ship (X31, X33), and confocaloid's 14 October 2024 B246/S246, C=4 gun (X29). Elsewhere this thread is explicitly cited as surveyed background, not evidence of an exact-rule precedent.

<https://conwaylife.com/forums/viewtopic.php?f=11&t=1319>

13. References (continued)

[9] ConwayLife forum contributors. Outer-totalistic hexagonal rules with spaceships, topic 3670. Retained records include muzik's 2019 B245/S35H ship (X27) and John Cerkán's 15 March 2020 B23/S4H ship (X32). Other uses are marked as surveyed background, not exact-rule predecessors.

<https://conwaylife.com/forums/viewtopic.php?f=11&t=3670>

[10] Owens, Nick and Stepney, Susan. Investigations of the Game of Life cellular automata rules on Penrose Tilings: lifetime, ash and oscillator statistics. *Journal of Cellular Automata* 5(3) (2010), 207-225.

<https://www-users.york.ac.uk/~ss44/bib/ss/nonstd/jca10.pdf>

[11] Bays, Carter. A Note on the Game of Life in Hexagonal and Pentagonal Tessellations. *Complex Systems* 15(3) (2005), 245-252. Earlier hexagonal spaceships, including examples in rules B2/S35 and B245/S3.

https://www.complex-systems.com/abstracts/v15_i03_a04/

[12] Smith, David; Myers, Joseph Samuel; Kaplan, Craig S.; and Goodman-Strauss, Chaim. An aperiodic monotile. arXiv:2303.10798, 2023. DOI: 10.48550/arXiv.2303.10798. Primary source for the Hat monotile substrate.

<https://arxiv.org/abs/2303.10798>

13. References (continued)

[13] Gardner, Martin. The fantastic combinations of John Conway's new solitaire game "life". Mathematical Games, Scientific American 223 (October 1970), 120-123. Original account of Conway's eight-neighbour, two-state rule; reproduced online.

<https://www.ibiblio.org/lifepatterns/october1970.html>

[14] Golly developers. QuickLife documentation: B/S notation, standard named rules and the B245/S3H hexagonal example. The H suffix denotes a hexagonal neighbourhood, specified separately in this catalogue.

<https://golly.sourceforge.io/Help/Algorithms/QuickLife.html>

[15] ConwayLife forum discussion reached through post 28428. Retained records identify John Cerkar's 22 January 2016 B2/S35H spaceship RLE (X23), and Dean Hickerson's 20 January 2016 B2/S34H wall and billiard-table records (X34, X35). The link locates the discussion, not a claim that both authors wrote the linked post. Exact comparisons are retained in `research/fixtures/hex-published-provenance.json`.

<https://conwaylife.com/forums/viewtopic.php?p=28428>

[16] Naszvadi. B25/S34H puffer, ConwayLife forum post, 1 February 2024. The post also notes earlier knowledge; it is evidence of prior use, not a first-discovery claim.

<https://conwaylife.com/forums/viewtopic.php?p=177053#p177053>

13. References (continued)

[17] Eppstein, David. Replicators: HighLife. Author-maintained cellular-automaton collection; two-state B36/S23 on the eight-neighbour square grid.

<https://ics.uci.edu/~eppstein/ca/replicators/b36s23.html>

[18] Edmond, James. Interactive Hat and Spectre cellular-automaton project, offlattice.org/monotile. Companion implementation for the published rule tables and travelling behaviours described in the paper [2] and compendium [3].

<https://offlattice.org/monotile/>

[19] Bays, Carter. A Note on the Game of Life in Hexagonal and Pentagonal Tessellations. *Complex Systems* 15(3) (2005), 245-252. Full text of [11]. Figure 3 describes a B2/S35 spaceship; Figure 4 describes a B245/S3 spaceship. The drawings were not independently transcribed: executable seed comparisons for X23 and X24 use Cerkar [15] and Golly [14].

<https://wpmedia.wolfram.com/uploads/sites/13/2018/02/15-3-4.pdf>

[20] drc. Pair of B2/S34H period-48 oscillators. ConwayLife forum, 18 January 2016, post 28430. One independently oscillating six-cell component is reproduced as X28; extracting that component does not make it a new oscillator.

<https://conwaylife.com/forums/viewtopic.php?p=28430>

13. References (continued)

[21] ConwayLife forum discussion linked in the retained B25/S34H puffer provenance, reached through post 162954. Includes Dmitry Maitak's report of an earlier occurrence. Used for the publication-history qualification in [X30](#), not as an independently matched seed source.

<https://conwaylife.com/forums/viewtopic.php?p=162954>

[22] ConwayLife forum post 163227 (2023), linked by Dmitry Maitak as an earlier B25/S34H puffer occurrence. Its seed has not been independently compared in this catalogue; see [X30](#). The reported antecedent does not establish first-discovery attribution.

<https://conwaylife.com/forums/viewtopic.php?p=163227#p163227>

[23] ConwayLife forum discussion containing Dean Hickerson's B2/S34H self-repairing wall and period-2044 billiard-table RLEs, dated 20 January 2016 in the retained provenance. Discussion locator: post 26919. Exact seed comparisons are documented in [X34](#) and [X35](#).

<https://conwaylife.com/forums/viewtopic.php?p=26919>

[24] Silver, Stephen. Life Lexicon, entries "block" and "blinker". Golly 3.2-2 distribution retained by Debian. Pattern descriptions for [S01](#) and [S02](#); the blinker entry credits John H. Conway.

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_b.htm

13. References (continued)

[25] Silver, Stephen. Life Lexicon, entries “pentadecathlon” and “pulsar”. Golly 3.2-2 distribution retained by Debian. Pattern descriptions and Conway attribution for [S04](#) and [S03](#) respectively.

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_p.htm

[26] Silver, Stephen. Life Lexicon, entry “glider”. Golly 3.2-2 distribution retained by Debian. Credits Richard K. Guy; source for [S05](#)’s standard glider and attribution.

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_g.htm

[27] Silver, Stephen. Life Lexicon, entry “LWSS” (lightweight spaceship). Golly 3.2-2 distribution retained by Debian. Credits John H. Conway; source for [S06](#).

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_l.htm

[28] LifeWiki contributors. “OCA:HighLife/Replicator”. Published twelve-cell B36/S23 seed used for [S07](#). Discovery credit to Nathan Thompson (1994) is taken from Eppstein [\[17\]](#).

<https://conwaylife.com/wiki/OCA:HighLife/Replicator>

13. References (continued)

[29] Silver, Stephen. Life Lexicon, entry “diehard”. Golly 3.2-2 distribution retained by Debian. Published seven-cell seed reproduced as [S08](#); this catalogue does not assign an individual discoverer.

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_d.htm

[30] Silver, Stephen. Life Lexicon, entry “R-pentomino”. Golly 3.2-2 distribution retained by Debian. Published five-cell configuration reproduced as [S09](#); Gardner [\[13\]](#) provides the contemporary account of Conway’s investigation.

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_r.htm

[31] Wainwright, Robert. Lifeline No. 3 (1971), p. 12. Credits the seven-cell Acorn seed to Charles L. Corderman; Wainwright supplied the name. The configuration is reproduced as [S10](#).

https://conwaylife.com/wiki/Lifeline_Volume_3

[32] Silver, Stephen. Life Lexicon, entry “acorn”. Golly 3.2-2 distribution retained by Debian. Published seed for [S10](#); the contemporary authorship source is Wainwright [\[31\]](#).

https://sources.debian.org/data/main/g/golly/3.2-2/Help/Lexicon/lex_a.htm

13. References (continued)

[33] Golly developers. Generations algorithm documentation. Defines the refractory-state update and lists named rule templates, including Brian's Brain and Star Wars. This is framework documentation unless a specific named template is identified at the point of citation.

<https://golly.sourceforge.io/Help/Algorithms/Generations.html>

[34] Griffeath, David, and Moore, Cristopher. Life Without Death is P-complete. *Complex Systems* 10 (1996), 437-447. Published study of the square-grid rule used as template U06; this citation does not identify its first inventor.

https://www.complex-systems.com/abstracts/v10_i06_a03/