A102780

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# Merit Factor Records

The following is a list of the largest known merit factors of binary sequences.

Where possible, sequences of length 60 or more are attributed to their original discoverers. The history of the sequences of length less than 60 is not completely clear. The list of best known merit factors published by Marcel Golay in [Golay82] is used as a starting point. Together with the results of his own computation [Golay77], the list compiled the earlier work of Lindner (an exhaustive computation up to length 40 [Lindner]) and Turyn (an exhaustive computation up to 32). Besides a couple of typos, it contained the maximal merit factors of all sequences of lengths up to 40 and of skew-symmetric sequences up to length 59. Recently, the merit factors of all sequences of lengths up to 60 have been computed exhaustively by Stephan Mertens and Heiko Bauke [Mertens]. It's interesting to note that it took 25 years from when Golay first published the sequence at length 59 in 1977 to confirm that it is indeed the maximal merit factor. That should give some idea of the computational magnitude of the problem! The attributions for the records are derived from the following sources:


[Bauke] Heiko Bauke, a student of Stephan Mertens, found the sequences at lengths 59, 60, 61, 62, and 64 in Feb. 2002.

[BCH] G.F.M. Beenker, T.A.C.M. Claasen, and P.W.C. Hermens, "Binary sequences with a maximally flat amplitude spectrum", *Philips J. Res.*, vol. 40, pp 289-304, 1985.

[Golay77] M.J.E. Golay, "Sieves for low autocorrelation binary sequences", *IEEE Trans. on Information Theory,* vol. 23, pp. 43-51, 1977.

[Golay82] M.J.E. Golay, "The merit factor of long low autocorrelation skew-symmetric binary sequences", *IEEE Trans. on Information Theory*, vol. 28, pp. 543-549, 1982.

[GH] M.J.E. Golay and D.B. Harris, "A new search for skewsymmetric binary sequences with optimal merit factors", *IEEE Trans. on Information Theory,* vol. 36, pp. 1163-1166, 1990.

[Jedwab] Jonathan Jedwab, first reported the merit factor at length 81.

[Lindner] J. Lindner, "Binary sequences up to length 40 with best possible autocorrelation function", *Electronics Letters*, vol. 2, pp. 507, 1975.

[Mertens] S. Mertens, "Exhaustive search for low-autocorrelation binary sequences", *J. Phys. A.*, vol. 29, pp. L473-L481, 1996. Up to date results can be found at: Ground states of the Bernasconi model with open boundary conditions.

[MZB] B. Militzer, M. Zamparelli, D. Beule, "Evolutionary search for low autocorrelated binary sequences", *IEEE Transactions on Evolutionary Computation*, (submitted). Results can be found on Burkhard Militzer's website Low autocorelated binary sequences.

[Reinholz] : Andreas Reinholz's website, "The aperiod Autocorrelation Problem of binary sequences".

The site is no longer availible.

Our own results are highlighted in **bold** font.

Note that in [BCH] a sequence of length 75 with merit factor 9.248 is reported. Careful examination of the paper reveals that this is a misprint, the sequence presented has merit factor 8.248.

Please let me know if any of these records are not attributed correctly or you have results that you would like added.

About the sequences:

- Records at lengths that have an "*" appended were not determined by exhaustive methods, larger merit factors may exist.
- Where possible, all sequences that achieve the maximal merit factor are listed.
- Since 1) reversing the sign of all elements in a sequence, 2) reversing the order of the elements of a sequence, and 3) reversing the sign of every second element in a sequence do not affect the energy, we only list unique sequences up to these three symmetries.
- Sequences are encoded in run-length format (i.e. 2 1 1 2 = {+1, +1, -1, +1, -1, -1}).
- To see a detailed description of each sequence click the Go! button next to it.

Comma-separated sequences.
Maple format sequences.

| Length ($N$) | Energy ($E$) | Merit Factor ($N^2/2E$) | Sequences | Date Found | Ref. |
|---|---|---|---|---|---|
| 4 | 2 | 4 | 3 1, Go! | . | |
| 5 | 2 | 6.25 | 3 1 1, skew-symmetric, Go! | . | |
| 6 | 7 | 2.5714 | 4 1 1, Go!<br>3 2 1, Go!<br>3 1 2, Go!<br>2 1 1 2, Go! | . | |
| 7 | 3 | 8.1667 | 3 2 1 1, skew-symmetric, Go! | . | |
| 8 | 8 | 4 | 4 2 1 1, Go!<br>2 4 1 1, Go! | . | |
| 9 | 12 | 3.375 | 4 2 1 1 1, skew-symmetric, Go!<br>3 2 2 1 1, skew-symmetric, Go!<br>2 5 1 1, Go!<br>3 1 1 2 2, Go! | . | |

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|---|---|---|---|---|
| 10 | 13 | 3.8462 | 5 2 1 1 1, Go!<br>4 2 2 1 1, Go!<br>4 1 1 2 2, Go!<br>3 3 1 2 1, Go!<br>3 1 1 1 2 2, Go! | . |
| 11 | 5 | 12.1 | 3 3 1 2 1 1, skew-symmetric, Go! | . |
| 12 | 10 | 7.2 | 5 2 2 1 1 1, Go!<br>4 1 1 1 2 2 1, Go! | . |
| 13 | 6 | 14.083 | 5 2 2 1 1 1 1, skew-symmetric, Go! | . |
| 14 | 19 | 5.1579 | 6 2 2 1 1 1 1, Go!<br>5 2 2 2 1 1 1, Go!<br>5 2 2 1 1 1 2, Go!<br>5 3 1 1 1 2 1, Go!<br>5 1 1 1 2 2 2, Go!<br>4 2 2 1 1 1 1 2, Go!<br>4 1 1 1 2 2 2 1, Go!<br>3 3 1 1 1 2 1 2, Go!<br>4 1 1 1 1 2 2 2, Go! | . |
| 15 | 15 | 7.5 | 5 2 2 2 1 1 1 1, skew-symmetric, Go!<br>3 3 1 3 1 2 1 1, skew-symmetric, Go! | . |
| 16 | 24 | 5.3333 | 6 3 2 2 1 1 1, Go!<br>3 4 1 2 1 3 1 1, Go!<br>2 2 5 1 1 1 1 2 1, Go!<br>2 1 1 2 1 1 3 1 3 1, Go! | . |
| 17 | 32 | 4.5156 | 4 2 2 1 2 1 1 1 1 2, Go!<br>4 4 1 2 1 3 1 1, Go!<br>3 6 1 1 1 2 2 1, Go!<br>2 5 2 2 1 1 1 2 1, skew-symmetric, Go!<br>2 3 1 3 1 1 2 1 1 2, Go!<br>2 1 1 1 1 4 2 2 1 2, Go! | . |
| 18 | 25 | 6.48 | 5 1 1 2 1 1 3 2 2, Go!<br>4 4 1 1 1 2 2 2 1, Go! | . |
| 19 | 29 | 6.2241 | 4 1 1 1 1 4 2 2 1 2, Go! | . |
| 20 | 26 | 7.6923 | 5 1 1 3 1 1 2 3 2 1, Go! | . |
| 21 | 26 | 8.4808 | 2 7 2 2 1 1 1 1 1 2 1, skew-symmetric, Go! | . |
| 22 | 39 | 6.2051 | 6 3 2 1 1 1 1 1 2 2 1 1, Go!<br>5 1 1 1 1 1 2 1 2 2 3 2, Go!<br>5 1 2 2 1 1 1 1 2 3 3, Go! | . |
| 23 | 47 | 5.6277 | 8 3 2 1 1 1 1 2 2 1 1, Go!<br>3 1 4 1 2 1 1 3 1 1 3 2, Go!<br>2 3 6 1 1 1 1 2 1 2 1 2, Go! | . |

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|---|---|---|---|---|
| 24 | 36 | 8 | 2 2 3 6 1 1 1 1 1 2 1 2 1, Go! | . |
| 25 | 36 | 8.6806 | 3 3 7 1 1 1 1 2 1 2 2 1, Go! | . |
| 26 | 45 | 7.5111 | 6 3 2 3 1 1 1 1 1 2 1 2 1 1, Go!<br>3 2 3 6 1 1 1 1 1 2 1 2 1 1, Go!<br>2 2 3 6 1 1 1 1 1 2 1 2 1 2, Go! | . |
| 27 | 37 | 9.8514 | 3 4 3 1 3 1 3 1 2 1 1 2 1 1,<br>skew-symmetric, Go! | . |
| 28 | 50 | 7.84 | 3 4 3 1 3 1 3 1 2 1 1 2 1 2, Go! | . |
| 29 | 62 | 6.7823 | 3 2 3 7 1 1 1 1 1 2 1 2 2 1 1,<br>skew-symmetric, Go!<br>2 1 2 1 1 2 1 3 1 3 1 3 4 3 1,<br>skew-symmetric, Go! | . |
| 30 | 59 | 7.6271 | 5 5 1 2 1 2 1 1 1 1 1 3 2 3 1, Go!<br>4 6 1 2 1 2 1 1 1 1 1 3 2 3 1, Go! | . |
| 31 | 67 | 7.1716 | 7 3 3 2 2 1 2 2 1 1 1 1 2 1 1 1, Go! | . |
| 32 | 64 | 8 | 7 1 1 1 2 1 1 1 1 3 3 2 2 1 2 2 1, Go! | . |
| 33 | 64 | 8.5078 | 7 4 2 1 1 2 1 1 1 1 1 1 1 2 2 2 2 1, Go! | . |
| 34 | 65 | 8.8923 | 8 4 2 1 1 2 1 1 1 1 1 1 1 2 2 2 2 1, Go! | . |
| 35 | 73 | 8.3904 | 7 1 2 2 1 2 2 1 1 1 1 2 1 1 1 1 3 3 2,<br>Go! | . |
| 36 | 82 | 7.9024 | 3 6 3 2 3 1 1 1 3 1 2 1 2 1 1 1 2 1 1,<br>Go! | . |
| 37 | 86 | 7.9593 | 8 4 4 2 1 1 2 1 1 1 1 1 1 2 2 2 2 1, Go! | . |
| 38 | 87 | 8.2989 | 8 4 4 2 1 1 2 1 1 1 1 1 1 1 2 2 2 2 1,<br>Go! | . |
| 39 | 99 | 7.6818 | 8 2 1 2 1 1 2 1 2 3 4 3 2 1 1 1 1 1 1 1,<br>skew-symmetric, Go!<br>2 3 2 4 1 1 7 1 1 1 1 1 4 1 1 2 2 1 2 1,<br>skew-symmetric, Go! | . |
| 40 | 108 | 7.4074 | 2 1 3 1 3 1 3 4 1 3 4 3 1 1 2 1 1 2 1 1 1,<br>Go! | . |
| 41 | 108 | 7.7824 | 3 4 3 1 1 1 1 1 1 2 2 2 2 8 1 2 1 1 2 1 1,<br>skew-symmetric, Go! | . |
| 42 | 101 | 8.7327 | 2 1 1 2 1 1 2 1 1 3 4 3 1 4 3 1 3 1 3 1 3,<br>Go! | . |
| 43 | 109 | 8.4817 | 3 1 2 2 1 1 2 1 2 7 1 1 1 1 1 2 3 4 2 3 1<br>1, skew-symmetric, Go! | . |
| 44 | 122 | 7.9344 | 2 5 5 2 2 5 1 4 1 3 1 2 1 1 1 2 2 1 1 1 1,<br>Go! | . |

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|---|---|---|---|---|
| 45 | 118 | 8.5805 | 8 2 1 2 1 1 2 1 2 3 1 2 3 4 3 2 1 1 1 1 1 1 1, skew-symmetric, Got | . |
| 46 | 131 | 8.0763 | 8 2 3 4 3 1 2 3 1 2 1 1 2 1 2 2 1 1 1 1 1 1 1 1, Got<br>8 2 1 2 1 1 2 1 2 3 1 2 3 4 3 2 1 1 1 1 1 1 1 1, Got<br>2 3 4 2 3 2 1 3 7 1 1 1 2 1 2 2 1 2 1 1 1 1 1 1, Got | . |
| 47 | 135 | 8.1815 | 9 2 3 4 3 1 2 3 1 2 1 1 2 1 2 2 1 1 1 1 1 1 1 1, skew-symmetric, Got<br>4 2 9 4 2 2 2 2 2 1 1 2 1 1 1 1 1 1 1 1 2 2 1 1 1, skew-symmetric, Got<br>3 8 3 4 2 2 1 3 2 2 1 1 2 1 2 1 1 1 1 1 1 2 1 1, skew-symmetric, Got<br>2 1 2 10 2 1 1 2 1 2 3 4 2 1 1 1 1 1 1 1 1 2 3 1, skew-symmetric, Got<br>2 3 6 3 3 1 6 1 1 1 3 1 2 1 2 1 1 1 1 2 1 2 1, skew-symmetric, Got<br>2 4 2 1 2 4 2 1 3 1 3 1 1 3 1 4 1 1 1 2 1 1 1 4, Got | . |
| 48 | 140 | 8.2286 | 2 4 4 2 2 3 2 1 2 1 1 3 2 1 2 1 1 1 1 1 1 8 1 1, Got | . |
| 49 | 136 | 8.8272 | 3 3 3 7 3 1 3 2 2 1 3 1 2 1 1 1 1 1 2 1 2 1 2 1 1, skew-symmetric, Got<br>2 1 1 4 1 1 4 1 1 2 2 4 1 1 2 2 4 1 3 1 3 1 1 1 3 1, Got | . |
| 50 | 153 | 8.1699 | 2 4 1 1 4 1 1 4 2 2 1 1 4 2 2 1 1 3 1 3 1 5 1 2, Got<br>3 3 3 7 3 1 3 2 2 1 3 1 2 1 1 1 1 1 2 1 2 1 2 1 1 1, Got<br>3 4 5 2 1 8 1 3 2 2 2 1 1 2 1 1 1 2 2 1 1 1 1 1 1, Got | . |
| 51 | 153 | 8.5 | 2 3 4 3 2 1 1 1 1 4 1 3 1 3 1 1 6 2 1 2 1 1 2 1 2 1, skew-symmetric, Got | . |
| 52 | 166 | 8.1446 | 2 3 3 3 2 1 3 2 2 1 3 1 1 1 1 1 2 1 2 1 2 1 6 1 1 5, Got | . |
| 53 | 170 | 8.2618 | 2 2 11 4 4 2 2 2 2 1 1 2 1 1 2 1 1 1 1 1 1 1 1 2 2 1, skew-symmetric, Got<br>2 6 5 2 2 3 1 3 1 1 1 2 2 1 2 1 5 1 4 1 1 1 2 1 1 1, Got | . |
| 54 | 175 | 8.3314 | 2 9 2 2 2 4 3 3 1 1 3 1 1 1 2 2 2 1 1 1 1 2 1 1 1 2 1 1, Got | . |

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| 55 | 171 | 8.845 | 9 2 1 2 1 2 3 2 1 2 1 1 4 3 2 1 2 3 3 2 1 1 1 1 1 1 1 1, skew-symmetric, Go! 3 2 3 2 10 4 1 1 2 4 1 1 2 1 1 1 1 1 1 1 1 2 2 1 2 2 1 1, skew-symmetric, Go! | . | |
| 56 | 192 | 8.1667 | 7 6 1 2 2 3 1 1 2 3 2 4 1 1 1 1 1 3 2 1 1 2 1 2 2 1 1 1, Go! | . | |
| 57 | 188 | 8.6409 | 3 3 2 3 2 6 3 1 1 1 1 1 2 7 1 2 1 1 1 1 2 2 1 2 2 1 2 1 1, skew-symmetric, Go! | . | |
| 58 | 197 | 8.5381 | 6 1 3 2 1 2 3 1 2 1 1 1 1 1 1 3 1 1 2 3 4 1 2 2 1 1 2 1 2 4 1, Go! | . | |
| 59 | 205 | 8.4902 | 7 7 2 4 1 2 2 4 2 1 1 2 2 3 1 1 2 2 1 1 1 1 2 1 1 1 1 1 1, skew-symmetric, Go! 2 4 2 1 2 1 1 2 2 1 4 3 2 1 1 3 1 1 1 1 1 1 2 1 3 2 1 2 3 1 6, Go! | . | |
| 60 | 218 | 8.2569 | 2 2 2 1 1 2 2 2 3 1 1 2 4 2 1 1 3 1 1 1 1 1 4 1 2 1 1 1 6 7, Go! 2 4 1 1 1 1 4 4 1 1 1 1 3 1 1 2 1 1 2 2 1 1 6 1 5 2 2 2 2 2 1, Go! | 02/10/02 | [Bauke] |
| 61* | 226 | 8.2323 | 3 1 4 1 6 2 3 3 1 2 1 1 1 1 1 1 3 1 1 1 2 1 2 5 6 2 1 2 1 1, Go! | 02/10/02 | [Bauke] |
| 62* | 235 | 8.1787 | 2 2 1 2 2 2 1 1 5 1 2 1 1 4 5 1 1 1 7 1 1 1 1 1 2 3 2 3 2 3, Go! 10 2 3 2 2 3 2 1 2 1 3 5 3 1 1 2 2 1 1 1 1 1 1 2 1 1 3 1 1 2, Go! | 02/10/02 | [Bauke] |
| **63*** | **207** | **9.5870** | **2 2 1 2 2 2 1 1 5 1 2 1 1 4 5 1 1 1 7 1 1 1 1 1 2 3 2 3 2 3 1,** Go! | . | |
| 64* | 208 | 9.8462 | 2 1 2 2 1 2 2 1 2 7 1 1 1 1 1 5 1 1 1 2 1 1 4 3 1 1 1 4 2 2 3 2 2, Go! | 02/10/02 | [Bauke] |
| **65*** | **240** | **8.8021** | **3 2 3 2 2 4 1 1 1 3 4 1 1 2 1 1 1 5 1 1 1 1 1 7 2 1 2 2 1 2 2 1 2,** Go! | . | |
| **66*** | **257** | **8.4747** | **2 4 5 4 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 11 2 2 2 1 1 2 1 1 1 2 1 1 2,** Go! | . | |
| 67* | 241 | 9.3133 | 11 4 1 2 3 2 3 4 4 1 1 2 1 1 2 1 2 2 1 2 3 1 1 2 1 1 1 1 1 1 1 1 1 1, skew-symmetric, Go! 2 4 5 4 2 2 2 1 1 1 1 1 1 1 1 1 1 2 2 2 11 2 2 2 1 1 2 1 1 1 2 1 1 2 1, skew-symmetric, Go! 6 2 1 6 1 2 1 2 2 5 3 3 1 2 1 2 1 1 1 2 2 3 3 1 1 1 1 3 2 1 1 1 1 1, skew-symmetric, Go! | . | [BCH] |

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| **68*** | **250** | **9.248** | **10 1 1 4 1 1 2 1 1 1 1 1 2 2 1 2 3 2 1 2 2 1 1 1 3 1 1 3 4 2 2 3 3 1,** Go! | . | |
| **69*** | **274** | **8.6880** | **11 1 1 4 1 1 2 1 1 1 1 1 2 2 1 2 3 2 1 2 2 1 1 1 3 1 1 3 4 2 2 3 3 1,** Go! | . | |
| **70*** | **295** | **8.3051** | **2 4 1 2 4 4 1 2 4 1 7 2 2 2 2 1 1 1 1 3 1 1 2 3 1 1 2 1 1 2 3 1 1 2,** Go! **9 1 2 3 2 1 1 1 2 4 1 1 1 1 3 1 1 3 2 2 2 1 1 1 1 1 4 3 1 1 2 1 1 2 2 1 2 1,** Go! | . | |
| 71* | 275 | 9.1655 | 2 4 1 2 4 4 1 2 4 1 7 2 2 2 2 1 1 1 1 3 1 1 2 3 1 1 2 1 1 2 3 1 1 2 1, skew-symmetric, Go! | . | [BCH] |
| **72*** | **300** | **8.64** | **2 2 2 4 2 2 2 2 1 2 4 1 2 2 1 1 5 1 1 7 1 4 4 4 1 1 1 4 1 1 1 1 1 1,** Go! | . | |
| **73*** | **308** | **8.6510** | **4 7 3 2 2 3 1 7 1 4 1 1 2 1 2 1 1 1 3 1 1 2 2 1 1 3 2 1 1 3 2 1 1 1 1 1 1,** Go! | . | |
| **74*** | **341** | **8.0293** | **3 2 4 2 2 1 2 5 1 5 1 2 2 1 1 1 1 2 2 4 1 2 1 1 1 1 2 1 3 5 1 1 4 1 1 3 1,** Go! **6 5 2 1 2 5 1 6 2 2 2 1 3 3 2 4 2 2 1 1 1 1 1 1 1 1 2 1 1 1 2 1 2 1 1 1 1,** Go! **5 3 5 11 2 2 1 1 2 2 1 2 1 3 2 2 2 1 1 1 1 3 1 1 1 2 3 2 1 1 1 2 1 1 1 1 1,** Go! | . | |
| **75*** | **329** | **8.5486** | **7 1 1 1 5 1 1 1 1 4 4 3 3 2 1 1 1 1 4 3 1 3 2 2 2 1 3 2 1 2 1 2 1 2 2 1 1,** Go! | . | |
| **76*** | **334** | **8.6467** | **7 1 1 1 5 1 1 1 1 4 4 3 3 2 1 1 1 1 4 3 1 3 2 2 2 1 3 2 1 2 1 2 1 2 2 1 2,** Go! | . | |
| 77* | 358 | 8.2807 | 5 1 2 1 7 4 1 1 2 1 2 2 1 1 2 2 2 1 3 2 2 4 2 3 4 1 1 2 1 1 1 1 1 3 3 1 1 1 1, skew-symmetric, Go! | . | [GH] |
| **78*** | **347** | **8.7666** | **5 3 3 3 1 3 3 3 1 1 9 2 1 2 2 1 2 1 2 1 1 1 2 1 2 3 1 2 1 1 1 1 3 2 1 1 1 1 1 2,** Go! | . | |
| **79*** | **339** | **9.2050** | **7 2 2 1 2 2 1 2 1 2 1 3 3 1 2 6 1 1 1 1 2 1 1 2 1 1 1 2 2 3 2 1 1 1 1 1 1 1 1 4 3 3 1,** Go! | 02/23/03 | |
| **80*** | **352** | **9.0909** | **11 1 1 6 4 1 1 3 1 2 2 1 1 1 1 3 2 1 1 3 3 3 2 2 2 2 1 1 2 1 1 1 1 2 2 1 1 2 1 1 1,** Go! | 02/06/03 | |
| 81* | 372 | 8.8185 | 2 4 1 1 1 1 3 3 3 7 1 1 1 1 1 1 2 1 1 5 1 4 2 1 1 2 1 1 3 1 5 2 1 2 2 2 2 3 1 2 1, Go! | . | [Jedwab] |

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| **82*** | **377** | **8.9178** | **8 6 1 3 4 3 4 1 3 1 3 1 2 1 3 2 1 1 1 1 3 3 1 1 1 1 2 3 1 2 2 1 1 2 1 2 1 1 2 1,** Go! | . | |
| 83* | 377 | 9.1366 | 3 2 3 6 3 3 2 3 1 1 7 2 6 1 1 1 1 2 2 1 1 1 1 1 4 1 2 2 1 2 1 2 1 1 1 1 2 1 2 2 1 1, skew-symmetric, Go! | . | [GH] |
| **84*** | **430** | **8.2047** | **2 2 1 2 2 1 2 2 1 7 5 2 6 3 1 1 1 1 1 1 1 1 2 1 1 1 1 1 4 1 2 1 1 1 2 1 2 1 4 2 3 2 3,** Go! | . | |
| **85*** | **414** | **8.7258** | **2 1 3 1 3 2 3 3 1 3 1 6 1 3 4 4 3 1 1 6 3 1 2 1 2 5 1 1 2 1 2 1 1 1 1 2 1 2 1 1 1,** Go! | . | |
| **86*** | **439** | **8.4237** | **3 1 2 1 3 3 1 2 1 3 6 1 6 1 1 2 3 1 2 2 1 1 2 2 1 4 1 1 1 1 2 4 1 3 4 2 1 1 1 3 3 1,** Go! | 03/23/03 | |
| **87*** | **431** | **8.7807** | **9 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 4 7 4 3 2 1 1 2 3 1 2 1 2 2 1 2 1 1 2 1 1 2 2 2 3 2 2 2 2 1,** Go! | 03/18/03 | |
| **88*** | **448** | **8.6429** | **9 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 4 7 4 3 2 1 1 2 3 1 2 1 2 2 1 2 1 1 2 1 1 2 2 2 3 2 2 2 2 2,** Go! | 03/18/03 | |
| **89*** | **432** | **9.1678** | **10 2 1 2 1 2 1 2 4 2 1 2 1 3 2 1 2 5 2 2 3 4 1 1 2 1 1 1 1 2 1 1 3 3 2 1 1 1 1 3 1 1 1 1 1 2,** Go! | 02/06/03 | |
| **90*** | **453** | **8.9404** | **10 2 1 2 1 2 1 2 4 2 1 2 1 3 2 1 2 5 2 2 3 4 1 1 2 1 1 1 1 2 1 1 3 3 2 1 1 1 1 3 1 1 1 1 1 3,** Go! | 03/14/03 | |
| 91* | 477 | 8.6803 | 2 1 2 1 4 1 6 1 1 2 2 1 1 2 1 1 1 1 1 2 1 1 3 2 1 2 2 2 3 2 1 4 7 4 2 4 1 1 1 1 3 1 1 3 3 1, skew-symmetric, Go! | . | [GH] |
| **92*** | **498** | **8.4980** | **12 6 5 1 1 3 2 2 2 2 2 3 1 1 1 1 1 1 1 2 1 1 2 1 1 1 1 2 2 1 1 2 2 1 2 1 1 2 3 3 3 3 2 1 1 1,** Go! | 03/18/03 | |
| **93*** | **486** | **8.8981** | **13 6 5 1 1 3 2 2 2 2 2 3 1 1 1 1 1 1 1 2 1 1 2 1 1 1 1 2 2 1 1 2 2 1 2 1 1 2 3 3 3 3 2 1 1 1,** Go! | 03/18/03 | |
| **94*** | **499** | **8.8537** | **13 6 5 1 1 3 2 2 2 2 2 3 1 1 1 1 1 1 1 2 1 1 2 1 1 1 1 2 2 1 1 2 2 1 2 1 1 2 3 3 3 3 2 1 1 2,** Go! | 03/18/03 | |
| 95* | 479 | 9.4207 | 3 2 2 3 2 2 3 5 8 1 1 5 1 1 1 3 5 1 1 1 2 1 5 1 1 1 4 1 1 1 1 1 1 2 1 1 1 2 1 2 2 2 1 2 2 2 1 1, skew-symmetric, Go! | . | [GH] |

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| **96*** | **520** | **8.8615** | **3 15 1 1 4 6 4 3 3 3 2 1 1 1 2 1 1 2 1 1 1 1 1 1 1 1 1 2 2 1 2 1 1 2 2 2 1 1 2 2 2 2 2 2 2 1,** Go! | 03/18/03 | |
| 97* | 536 | 8.7771 | 5 1 1 1 4 1 5 3 2 1 1 3 2 2 2 1 1 3 2 1 4 3 1 2 1 1 3 2 1 4 2 2 2 1 4 2 1 2 1 1 1 3 1 1 5 1 1 1 1, skew-symmetric, Go! 4 15 1 1 4 6 4 3 3 3 2 1 1 1 2 1 1 2 1 1 1 1 1 1 1 1 1 2 2 1 2 1 1 2 2 2 1 1 2 2 2 2 2 2 2 1 , Go! | . | [GH] |
| **98*** | **545** | **8.8110** | **4 15 1 1 4 6 4 3 3 3 2 1 1 1 2 1 1 2 1 1 1 1 1 1 1 1 1 2 2 1 2 1 1 2 2 2 1 1 2 2 2 2 2 2 2 1 1,** Go! | 03/18/03 | |
| 99* | 577 | 8.4931 | 5 2 5 5 2 1 2 2 1 2 10 3 1 1 2 2 4 1 1 2 2 4 1 2 1 1 1 1 1 1 1 1 1 2 3 2 3 2 1 1 1 2 1 1 1 2 2 1 1 1 1, skew-symmetric, Go! | . | [MZB] |
| **100*** | **578** | **8.6505** | **6 2 5 5 2 1 2 2 1 2 10 3 1 1 2 2 4 1 1 2 2 4 1 2 1 1 1 1 1 1 1 1 1 2 3 2 3 2 1 1 1 2 1 1 1 2 2 1 1 1 1,** Go! | . | |
| 101* | 578 | 8.8244 | 6 2 5 5 2 1 2 2 1 2 10 3 1 1 2 2 4 1 1 2 2 4 1 2 1 1 1 1 1 1 1 1 1 2 3 2 3 2 1 1 1 2 1 1 1 2 2 1 1 1 1, skew-symmetric, Go! | . | [MZB] |
| **102*** | **567** | **9.1746** | **3 5 6 4 2 4 3 3 1 1 1 2 1 2 2 1 1 1 1 1 3 1 1 1 2 2 2 2 3 2 2 1 1 2 1 9 1 2 1 1 1 1 2 1 1 1 1 2 1 3 1 2,** Go! | 03/24/03 | |
| 103* | 555 | 9.5577 | 2 4 5 2 6 8 1 2 2 2 2 1 3 1 1 1 2 2 5 1 1 1 2 2 5 1 3 2 2 2 3 1 1 1 1 1 1 2 1 1 1 1 2 2 1 1 1 2 1 1 2 1, skew-symmetric, Go! | . | [Bernasconi] |
| **104*** | **612** | **8.8366** | **3 4 5 2 6 8 1 2 2 2 2 1 3 1 1 1 2 2 5 1 1 1 2 2 5 1 3 2 2 2 3 1 1 1 1 1 1 2 1 1 1 1 2 2 1 1 1 2 1 1 2 1,** Go! | 02/06/03 | |
| 105* | 620 | 8.8911 | 10 1 2 1 1 1 2 1 1 2 1 4 1 1 2 1 3 1 1 2 1 3 2 2 2 1 2 2 3 2 2 2 1 3 4 1 3 4 1 1 3 4 5 3 1 1 1 1 1 1 1 1 1, skew-symmetric, Go! | . | [GH] |
| **106*** | **701** | **8.0143** | **5 1 2 2 6 5 5 1 2 2 2 4 5 1 5 1 1 2 2 4 1 1 1 3 1 1 1 2 1 1 2 2 2 3 1 1 1 2 1 1 1 2 1 1 1 1 2 2 3 1 1 1 2,** Go! **2 2 7 3 1 1 8 3 1 1 1 1 2 2 4 1 1 3 3 4 2 2 2 1 1 2 1 2 1 4 1 1 2 2 6 1 2 1 1 1 1 1 1 4 1 2 1 1 1 1 1 2 2,** Go! | 02/11/03 | |

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|---|---|---|---|---|---|
| 107* | 677 | 8.4557 | 2 2 7 3 1 1 8 3 1 1 1 1 2 2 4 1 1 3 3 4 2<br>2 2 1 1 2 1 2 1 4 1 1 2 2 6 1 2 1 1 1 1 1<br>1 4 1 2 1 1 1 1 1 2 2 1,<br>skew-symmetric, Got | . | [GH] |
| **108*** | **702** | **8.3077** | **3 3 4 1 1 1 1 1 1 2 4 3 1 1 4 1 1 1 1 1 3**<br>**3 2 2 2 2 5 1 1 1 2 2 2 2 2 1 2 1 7 1 1 4**<br>**1 2 1 1 2 8 1 1 2 1 2 1,** Got | 02/11/03 | |
| 109* | 662 | 8.9736 | 3 3 4 1 1 1 1 1 1 2 4 3 1 1 4 1 1 1 1 1 3<br>3 2 2 2 2 5 1 1 1 2 2 2 2 2 1 2 1 7 1 1 4<br>1 2 1 1 2 8 1 1 2 1 2 1 1,<br>skew-symmetric, Got | . | [GH] |
| **110*** | **723** | **8.3679** | **2 7 7 1 2 4 1 2 2 4 1 1 3 3 1 1 1 1 3 3 3**<br>**2 2 2 1 2 1 2 1 6 1 2 1 4 1 1 2 2 3 1 1 2**<br>**3 1 1 1 1 1 2 1 1 1 1 1 2,** Got<br>**6 1 2 2 1 2 1 2 1 3 1 2 7 1 2 1 1 1 4 1 1**<br>**2 4 1 2 1 2 3 3 1 1 2 4 1 1 5 3 1 1 1 1 1**<br>**2 3 1 3 3 3 2 3 1 1 1 1 2,** Got | 02/11/03 | |
| 111* | 687 | 8.9672 | 2 1 1 1 1 3 2 3 3 3 1 3 2 1 1 1 1 1 3 5 1<br>1 4 2 1 1 3 3 2 1 2 1 4 2 1 1 4 1 1 1 2 1<br>7 2 1 3 1 2 1 2 1 2 2 1 6 1,<br>skew-symmetric, Got | . | [GH] |
| **112*** | **788** | **7.9594** | **3 4 3 1 3 4 4 3 1 3 2 1 1 1 1 1 1 1 1 1 1**<br>**3 3 4 1 2 2 2 3 1 1 2 1 2 1 1 2 2 1 3 1 2**<br>**1 1 2 1 1 2 1 3 1 2 1 1 2 1 2,** Got | 04/03/03 | |
| 113* | 752 | 8.4900 | 4 5 5 5 1 2 2 1 4 2 1 2 1 2 1 2 12 1 2 2<br>2 3 1 1 1 1 1 1 1 1 1 1 2 3 3 3 2 1 1 3 2<br>3 1 1 1 2 1 1 1 2 1 1 1 2 1 1 1,<br>skew-symmetric, Got<br>2 3 1 3 3 2 1 7 1 3 2 3 3 1 1 5 4 1 2 1 2<br>1 1 2 1 3 4 3 3 1 1 2 1 1 1 4 1 2 1 2 2 1<br>3 1 1 1 1 1 3 2 1 2 1 3 1 2 1,<br>skew-symmetric, Got | . | [GH] |
| **114*** | **817** | **7.9535** | **4 5 1 1 3 1 2 2 1 2 5 1 2 2 1 1 1 1 2 2 6**<br>**1 1 1 2 4 2 1 1 2 5 1 1 1 1 2 2 6 2 3 1 1**<br>**1 2 3 2 3 1 4 1 1 1 2 1 1 1 1 2,** Got | 04/03/03 | |
| 115* | 745 | 8.8758 | 5 5 1 1 1 3 5 1 4 5 3 1 1 1 2 2 1 1 3 1 2<br>1 2 2 2 2 2 2 2 3 3 1 4 2 5 1 2 1 1 1 2 1<br>1 3 1 1 1 2 1 5 1 1 1 2 1 1 1 1,<br>skew-symmetric, Got | . | [GH] |
| **116*** | **814** | **8.2654** | **5 5 1 1 1 3 5 1 4 5 3 1 1 1 2 2 1 1 3 1 2**<br>**1 2 2 2 2 2 2 2 3 3 1 4 2 5 1 2 1 1 1 2 1**<br>**1 3 1 1 1 2 1 5 1 1 1 2 1 1 1 1 1,** Got | 02/23/03 | |

| | | | | | |
|---|---|---|---|---|---|
| 117* | 786 | 8.7080 | 3 7 1 1 7 3 1 2 1 1 1 2 2 1 1 1 1 1 3 3 2 2 2 4 2 4 1 1 2 2 1 1 2 2 2 2 1 2 1 7 2 5 3 1 2 1 1 1 1 1 4 1 1 1 1 1 2 1 1, skew-symmetric, Go! | . | [GH] |
| **118*** | **847** | **8.2196** | **3 1 2 1 6 1 4 1 2 1 2 2 1 2 3 4 1 1 1 2 1 1 1 1 3 1 4 1 1 1 1 3 2 1 5 1 1 3 1 6 5 1 1 2 1 2 3 2 3 3 1 1 3 1 1 1 1 3 3 1,** Go! | 02/23/03 | |
| 119* | 835 | 8.4796 | 3 1 2 1 6 1 4 1 2 1 2 2 1 2 3 4 1 1 1 2 1 1 1 1 3 1 4 1 1 1 1 3 2 1 5 1 1 3 1 6 5 1 1 2 1 2 3 2 3 3 1 1 3 1 1 1 1 3 3 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **120*** | **872** | **8.2569** | **9 1 1 9 1 1 3 4 2 1 1 3 2 1 2 3 1 1 2 1 2 1 2 2 3 2 2 1 2 2 3 3 4 1 2 3 2 1 4 2 1 1 2 1 4 1 1 1 1 1 1 1 4 1 1 1 1 1 1 1,** Go! **4 1 2 1 6 1 4 1 2 1 2 2 1 2 3 4 1 1 1 2 1 1 1 1 3 1 4 1 1 1 1 3 2 1 5 1 1 3 1 6 5 1 1 2 1 2 3 2 3 3 1 1 3 1 1 1 1 3 3 1 1,** Go! | 02/28/03 | |
| 121* | 844 | 8.6736 | 9 1 1 9 1 1 3 4 2 1 1 3 2 1 2 3 1 1 2 1 2 1 2 2 3 2 2 1 2 2 3 3 4 1 2 3 2 1 4 2 1 1 2 1 4 1 1 1 1 1 1 1 4 1 1 1 1 1 1 1, skew-symmetric, Go! | . | [MZB] |
| **122*** | **885** | **8.4090** | **9 1 1 9 1 1 3 4 2 1 1 3 2 1 2 3 1 1 2 1 2 1 2 2 3 2 2 1 2 2 3 3 4 1 2 3 2 1 4 2 1 1 2 1 4 1 1 1 1 1 1 1 4 1 1 1 1 1 1 2,** Go! | 03/04/03 | |
| **123*** | **893** | **8.4709** | **2 2 1 2 2 1 1 3 1 1 3 1 1 2 5 3 3 1 1 2 3 1 6 2 1 1 1 1 1 2 1 1 1 1 6 7 2 1 1 1 1 3 1 2 4 1 2 1 2 1 1 1 2 4 1 4 1 4 2 3 2 1, skew-symmetric,** Go! | 03/06/03 | |
| **124*** | **922** | **8.3384** | **1 2 2 1 2 2 1 1 3 1 1 3 1 1 2 5 3 3 1 1 2 3 1 6 2 1 1 1 1 1 2 1 1 1 1 6 7 2 1 1 1 1 3 1 2 4 1 2 1 2 1 1 1 2 4 1 4 1 4 2 3 2 1,** Go! | 03/06/03 | . |
| 125* | 846 | 9.2346 | 3 3 4 4 1 1 1 1 1 4 2 3 1 1 1 1 8 2 3 3 1 4 1 1 3 2 2 2 2 2 1 4 1 1 3 1 2 1 2 2 1 1 1 1 1 1 6 1 2 2 1 1 7 1 1 2 1 1 2 1 2 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **126*** | **875** | **9.0720** | **4 3 4 4 1 1 1 1 1 4 2 3 1 1 1 1 8 2 3 3 1 4 1 1 3 2 2 2 2 2 1 4 1 1 3 1 2 1 2 2 1 1 1 1 1 1 6 1 2 2 1 1 7 1 1 2 1 1 2 1 2 1 1,** Go! | 03/06/03 | |

| | | | | | |
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| 127* | 887 | 9.0919 | 5 3 2 3 1 3 2 6 3 2 8 4 1 3 3 4 2 1 1 5 1 3 1 1 1 4 2 1 1 2 1 2 1 3 1 1 2 1 1 1 1 1 2 2 1 2 1 1 1 1 2 2 1 3 1 2 2 1 2 1 1 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **128*** | **932** | **8.7897** | **5 3 2 3 1 3 2 6 3 2 8 4 1 3 3 4 2 1 1 5 1 3 1 1 1 4 2 1 1 2 1 2 1 3 1 1 2 1 1 1 1 1 1 2 2 1 2 1 1 1 1 2 2 1 3 1 2 2 1 2 1 1 1 1 1,** Go! | 03/06/03 | |
| 129* | 920 | 9.0440 | 3 3 2 3 5 3 2 3 2 2 3 2 1 1 1 4 7 1 10 1 1 1 2 1 3 5 1 1 1 1 1 1 1 1 3 1 1 1 1 1 2 1 1 5 2 1 2 2 2 1 2 2 1 2 1 1 1 2 1 2 2 1 2 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **130*** | **945** | **8.9418** | **4 3 2 3 5 3 2 3 2 2 3 2 1 1 1 4 7 1 10 1 1 1 2 1 3 5 1 1 1 1 1 1 1 1 3 1 1 1 1 1 2 1 1 5 2 1 2 2 2 1 2 2 1 2 1 1 1 2 1 2 2 1 2 1 1,** Go! | 03/06/03 | . |
| 131* | 913 | 9.3981 | 6 3 6 3 11 3 2 3 1 3 2 3 3 4 2 3 3 1 2 1 3 3 1 2 1 2 2 1 1 2 1 2 1 2 2 1 3 1 2 2 1 2 1 1 1 1 1 1 1 1 1 2 1 2 1 1 1 2 1 2 1 1 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **132*** | **1014** | **8.5917** | **6 3 6 3 11 3 2 3 1 3 2 3 3 4 2 3 3 1 2 1 3 3 1 2 1 2 2 1 1 2 1 2 1 2 2 1 3 1 2 2 1 2 1 1 1 1 1 1 1 1 1 2 1 2 1 1 1 2 1 2 1 1 1 2,** Go! | 03/06/03 | |
| 133* | 1010 | 8.7569 | 4 2 2 1 10 1 1 2 5 1 1 3 2 2 2 1 1 5 1 1 4 3 3 3 1 2 1 1 4 3 1 2 1 2 1 2 1 1 4 1 1 1 4 2 2 2 1 4 1 1 1 2 4 1 1 1 1 1 1 1 1 3 2 2 1 1 1, skew-symmetric, Go! | . | [Reinholz] |
| **134*** | **1063** | **8.4459** | **7 3 2 2 3 2 2 7 5 5 1 1 1 5 1 2 4 1 2 1 2 1 4 2 2 2 1 1 3 3 3 1 1 2 3 1 1 1 5 1 1 1 2 1 1 1 2 1 1 1 1 1 1 2 2 2 1 2 2 2 1 2 1 1 1 1 1 2,** Go! | 03/16/03 | |
| 135* | 1027 | 8.8729 | 2 1 1 1 1 1 2 1 2 2 2 1 2 2 2 1 1 1 1 1 2 1 1 1 2 1 1 1 5 1 1 1 3 2 1 1 3 3 3 1 1 2 2 2 4 1 2 1 2 1 4 2 1 5 1 1 1 5 5 7 2 2 3 2 2 3 7 1, skew-symmetric, Go! | . | [Reinholz] |
| **136*** | **1076** | **8.5948** | **2 1 1 2 1 1 1 2 1 1 1 1 2 1 1 1 1 1 2 2 2 2 2 1 2 1 4 1 2 1 1 2 2 1 1 2 3 1 1 1 1 1 1 1 1 1 2 12 1 2 4 2 4 3 1 1 3 3 2 2 2 2 7 6 5 4 2,** Go! | 03/06/03 | |