

Occultations by major and minor planets in 2018

Edwin Goffin
Aartselaarstraat 14
B-2660 Hoboken
Belgium

2018 April 23

The accompanying graphs contain the predicted occultations of catalogue stars by major and minor planets in the year 2018. They are a selection from a much larger number of events found by the computer programme. The selection was made taking into account the star's magnitude, the duration of the occultation, the distribution of potential observers and the altitude above the local horizon.

1 Star catalogues

Two *merged catalogues* were created from the following star catalogues, the order given being the order of precedence in the merging process:

1. TGAS, from the Gaia Data Release 1 (2016)
2. HSOY (Altmann M. et al., 2017)
3. FK6, Part I (Wielen R. et al., 1999) and Part III (Wielen R. et al., 2000)
4. Hipparcos 2 (van Leeuwen F., 2007)
5. UCAC4, the fourth USNO CCD Astrograph Catalog (Zacharias et al., 2013)
6. Tycho-2 catalogue (Høg E. et al., 2000)
7. PPMX (Röser S. et al., 2008)

The *first catalogue* contains all stars of visual magnitude $V \leq 12.50$. The *second catalogue* contains stars of visual magnitude: $12.50 < V \leq 15.00$. For the merging, stars from different catalogues were considered to be the same if their mutual distance was less than $2''$ and the magnitude difference was less than 1.

Table 1 gives the total number of stars in each catalogue as well as the number retained after eliminating multiple entries.

2 Selection criteria for the planets

The first star catalogue was used for comparison with the ephemerides of the 8 major planets and of 3032 minor planets: numbered ones larger than 40 km and also objects with multi-opposition orbits and semi-major axis larger than 5.40 AU (Centaur, Kuiper Belt Objects, ...). For the major planets, only occultations of stars brighter than visual magnitude 10 were selected.

Table 1: Mergend star catalogues used for the predictions.

Star catalogue	Total stars	Stars in Catalogue 1	Stars in Catalogue 2
TGAS	2 057 050	1 958 186	33 205
HSOY	583 001 653	2 988 253	30 394 639
FK6	4 150	1 529	0
Hipparcos 2	117 955	11 118	121
UCAC4	113 780 093	256 440	6 935 623
Tycho-2	2 311 925	5 021	66 000
PPMX	18 088 919	386 018	809 126
Total		5 606 565	38 238 714

The second catalogue was used for a special search with 2010 objects with semi-major axis larger than 5.40 a.u.

Diameters have been taken from the WISE or IRAS surveys to which some occultation diameters were added. In case no diameter was published an approximate value was computed from the formula

$$\log D = 3.62 - 0.20M$$

where D is the diameter in km and M the absolute visual magnitude constant.

3 Explanation of the graphs

The results are presented as one PDF file for each predicted occultation, each file containing two pages.

3.1 First page

- The top line gives the name of the major or minor planet and the star designation. The latter is only used to identify the star ¹ ².
- The second line gives the instant of closest geocentric approach (in U.T.).
- Under the heading "Planet" the following data are given:
 - a = semi-major axis, e = eccentricity of the orbit
 - V. mag. = visual magnitude of the planet
 - Diam. = absolute diameter in km and apparent diameter in seconds of arc.
 - μ = instantaneous motion at closest approach, in seconds of arc per hour.
 - π = horizontal equatorial parallax in seconds of arc.
 - Ref. = source for the orbital elements.
- Under the heading "Star" are given:

¹The HSOY catalogue identifies stars by their PPMXL number, a 64-bit (19-digit) number. For practical reasons, I replaced this by the sequential number of the star in the input catalogue file.

²Since the PPMX has no star names of its own, my PPMX number simply is the sequential number in the catalogue when reading in the 24 data files from north to south.

- Source cat. = an abbreviation for the source catalogue from which the positional data for the star are taken:
 - * TGAS = Gaia Data Release 1
 - * HSOY = Hot Stuff for One Year
 - * FK6 = FK6 Catalogue (Parts I and III)
 - * HIP-2 = Hipparcos catalogue
 - * TYC2 = Tycho-2 catalogue; the suffix "p" indicates Tycho data referring to the photocentre of two entries
 - * UCAC4 = Fourth USNO CCD Astrograph Catalog
 - * PPMX = PPMX catalogue
- α = right ascension (J2000.0) at the epoch of occultation
- δ = declination (J2000.0) at the epoch of occultation
- V/Rmag = visual magnitude of the star if given, else the red magnitude if given, else blank
- B/Imag = blue magnitude of the star if given, else the infrared magnitude if given, else blank
- The last line contains information about the occultation:
 - Δm = drop in magnitude
 - Max. dur. = maximum duration for an observer on the central line (in seconds of time)
 - Sun = elongation of the Sun (in degrees)
 - Moon = elongation (in degrees) and illuminated fraction (in %) of the Moon
- The small star chart shows a portion of the sky of about 15 by 15°. Only stars of visual magnitude 7.0 and brighter are included. The dashed rectangle indicates the part shown by the larger chart.
- The large star chart is based on the merged catalogue or on both catalogues. The star to be occulted is encircled and is always in the middle. A visual-magnitude scale is added to the right, mostly ranging from 1 to 10; for faint stars the range may be 2–11, 3–12, etc. The star chart also shows the path of the minor planet with crosses indicating the daily position at 0h UT.
- The world map shows the Earth as seen from the star, i.e. the centre of the disk is the point on the Earth's surface where the star is in the zenith. The night side is the part within the heavy lines. The shadow path is indicated by the central line and the northern and southern limits (including the effect of the Earth's rotation). The dashed lines show the position of the central line for a shift of 1" perpendicular to the predicted shadow path (i.e. for a difference of $\pm 1''$ in the shortest geocentric distance planet-star). The times written at the bottom refer to the first and last cross lines; also the interval between two cross lines is given.

3.2 Second page

This page contains a larger version of the world map, with a much higher resolution for the coastal data and with country borders added. In addition, cities with more than 500 000 inhabitants are represented by small circles roughly proportional to the population.

4 Availability of the files

The PDF files can be obtained from the following FTP site of the "Vereniging voor Sterrenkunde" (VVS, the Flemish Astronomical Association):

<http://bedekkingen.vvs.be/predictions/Asteroids2018>

5 Distribution of the graphs

A selected number of predictions is sent to Edwin Mathlener (The Netherlands) for inclusion in the "Sterrengids", and to Tim Haymes (UK) for preparing the BAA Handbook.

6 Mailing Lists and Web Sites

European observers are advised to subscribe to the PlanOccult mailing list, maintained by Jan Van Gestel (Belgium): <http://vps.vvs.be/mailman/listinfo/planoccult>

For more up-to-date information on predictions, finder charts and occultation news, consult the web site <http://www.asteroidoccultation.com> that has links to asteroidal occultation resources in Europe, N. America, Australia/New Zealand, and Japan.

7 Acknowledgements

Eric Broens (VVS) and Bart Vandenbussche (KULeuven) were of great help in making the files available on the Web.

8 References

- Altmann M. et al., 2017: Hot Stuff for One Year (HSOY), a 580 million star proper motion catalogue derived from Gaia DR1 and PPMXL (<https://arxiv.org/abs/1701.02629>, accepted for publication in A&A letters)
- Gaia Data Release 1, 2016: http://gaia.esac.esa.int/documentation/GDR1/Miscellaneous/sec_credit_and_citation_instructions.html
- Høg E. et al., 2000: The Tycho-2 catalogue of the 2.5 million brightest stars, A&A 355, L27
- van Leeuwen F., 2007: Astron. & Astrophys. 474, 653
- Röser S. et al., 2008: Astron. & Astrophys. 488, 401
- Wielen R. et al., 1999: Veröffentlichungen des Astronomisches Rechen-Instituts Heidelberg, No. 35
- Wielen R. et al., 2000: Veröffentlichungen des Astronomisches Rechen-Instituts Heidelberg, No. 37
- Zacharias N. et al., 2013: The fourth US Naval Observatory CCD Astrograph Catalog (UCAC4), Astron. Journal 145, 44