Lunar occultations - prediction explanation

Example predictions

The following predicted occultations have been selected to illustrate the range of prediction outputs. [Because of this, there are far more information messages in this example than would usually occur!]

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Occultation prediction for Kambah
E. Longitude  149  3 48.9,  Latitude -35 23 49.3,  Alt.  582m;  Telescope dia 35cm;  dMag 1.0

      day  Time   P   Star  Sp  Mag  Mag    % Elon Sun  Moon   CA   PA  VA  AA Libration   A   B   RV   Cct   durn R.A. (J2000)  Dec   Mdist   SV
 y   m  d  h  m  s      No  D    v    r V  ill     Alt Alt Az   o    o   o   o   L    B   m/o m/o  "/s   o   sec  h  m   s    o  m  s   Mm   m/s
07 Aug 22  5 42 44 d    2405SA2  6.6     s  62+ 104  21 50  92  49S 137 250 129 -3.9 +6.5 +0.5-2.6 .344  -27.9     16 44 17.4 -27 27 22 393.8 752.2
      2405 is triple: AB 6.58 10.15 2.03"  15.3, dT = -3sec : AC 6.6 14.0 24.6" 195.9, dT = +37sec
      2405 = NSV 7935, 6.58, range 0.03, V, Type E:
07 Aug 22  8 41  0 d  184665 G1  8.9  8.4   63+ 105     82  18  87N  92 256  85 -4.5 +6.6 +2.5-0.2 .312    8.5     16 49  8.1 -27 34 15 391.9 608.2
07 Aug 22 10 38 41 m  184699 F5  8.8  8.6   64+ 106     67 281   3S 182  68 175 -4.9 +6.6 +9.9+9.9 .000  -90.0     16 50 46.5 -27 54  7 392.0 637.1
   Distance of 184699 to Terminator = 13.8"; to 3km sunlit peak = 0.0"
07 Aug 23 12 44 22 d X145167 M0  8.6  6.9V  73+ 118     53 269  67N  65 313  64 -5.9 +6.1 +1.1+1.9 .375   13.4 .04 17 52  0.7 -28  1 21 387.9 734.4
   X145167 = KW Sgr, 11.0 to 13.2, pg, Type SRC, Period 670. days
07 Aug 23 13 25 43 D  185893 A0  8.3  8.3   74+ 118     44 263  88N  86 333  85 -6.0 +6.1 +1.1+1.2 .409   -8.7     17 53 21.2 -28  3 26 388.4 788.2
07 Aug 23 14 23 19 d X145957     9.0  7.7v  74+ 119     33 257  83S  95 340  94 -6.1 +6.0 +0.8+1.0 .436  -18.0     17 55 13.2 -28  0 22 389.2 872.5
   X145957 = V0776 Sgr, 10.6 to 11.1, pg, Type LB
07 Aug 25  6 38 26 m    2864dB8  4.6  4.6   88+ 140  11 28 102   8N 355 113   3 -5.0 +4.6 +9.9+9.9 .000   90.0     19 36 42.4 -24 53  1 380.8 887.1
   R2864 = 52 Sagittarii
      2864 is double: AB 4.7 9.2 2.4" 173.9
   Distance of 2864 to Terminator = 6.9"; to 3km sunlit peak = 0.0"
07 Aug 25  6 39  5 Gr   2864dB8  4.6  4.6   88+ 140  11 28 ** GRAZE: CA  8.3N; Dist. 61km in az. 203deg. [Lat =-35.99-0.35(E.Long-149.06)]
   Distance of 2864 to Terminator = 12.2"; to 3km sunlit peak = 1.9"
07 Aug 27  8 54 19 d    3157cF6  7.3        99+ 167     29  90  25S 131 252 148 -4.1 +1.8 +0.6-4.4 .222  -62.8     21 33 40.2 -16 12  3 369.8 875.8
      3157 is double: AB 7.33 10.00 0.90"  11.7, dT = -2sec
      3157 is a close double. Observations are highly desired
   Distance of 3157 to Terminator = 4.6"; to 3km sunlit peak = 0.0"
07 Aug 27 15 13 25 D    3177cA9  5.9  5.7   99+ 169     58 304  64N  41 265  59 -5.0 +1.2 +1.0+2.1 .429   11.8     21 43  4.4 -14 23 59 366.3 790.2
   R3177 = 44 Capricorni
      3177 is double: ** 6.8 6.8 0.10"  90.0, dT = +0.15sec
      3177 has been reported as non-instantaneous (OCc1608). Observations are highly desired
   Distance of 3177 to Terminator = 13.8"; to 3km sunlit peak = 4.4"
07 Aug 28  9 30 56 R  165076 G5  9.6  9.0   33E 180     23  86  44S 216 340 236 -3.1 +0.1 +0.6+0.8 .459 -153.3     22 26 25.0 -10  0  0 366.3 918.6
07 Aug 28 10  2 46 D  146111 G0  7.7  7.4    0E 179     29  81  57U 109 234 129 -3.2 +0.1 +1.0-2.3 .333  -47.6     22 29  4.9 - 9 44 28 365.6 882.7
07 Aug 28 10  8 56 D    3301DK0  8.8  8.0    0E 179     30  80  49U  97 222 117 -3.2 +0.1 +1.0-1.6 .396  -36.2     22 29 18.6 - 9 39 46 365.5 876.2
      3301 is double: AB 8.8 11.7 8.5" 291.6, dT = -21sec
07 Aug 29 13 22 11 Gr 146693 G5  7.5  7.1   98- 164     49 ** GRAZE: CA 10.9N; Dist. 11km in az. 143deg. [Lat =-35.53+0.61(E.Long-149.06)]
   Distance of 146693 to Terminator = 2.1"; to 3km sunlit peak = 0.0"

08 Dec 29 10  6 53 D Jupiter    -1.8 -1.8    3+  20  -9  5 248  68S 101 335 111 -3.6 +0.7 -0.1+0.9 .446  -34.0 .02 20  1 33.0 -20 55 10 403.71055.8
   Duration of planetary disk occultation: predicted time +/-33.1 secs
08 Dec 29 10 21  8 d Callisto    6.4  6.4    3+  20 -11  3 246  62S 107 340 117 -3.6 +0.6 -0.2+0.7 .425  -39.1     20  2  2.1 -20 53 35 404.01075.4
   Duration of planetary disk occultation: predicted time +/-1.2 secs

10 Nov 29 23 41 49 r Juno       10.2 10.2   38-  76  58 38 301  36N 346 211 323 -0.9 +6.3 +0.5-2.3 .318  136.1     11 21 19.9 - 0 52 37 365.7 791.6
   Duration of planetary disk occultation: predicted time +/-0.2 secs

14 Aug 20 20 15  2 r X 87595k   10.1  9.9   19-  52  -5 27  37  17N 342 130 340 +5.5 +5.7 +3.3-6.4 .103  107.7      6 24 58.0  19 19 21 399.0 659.4
   *** A light curve is desired as X 87595 is in the Kepler2 program \{ID = 202071576\}
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Item	Meaning
Day	The day of the event. Occult searches for events on the basis of geocentric conjunctions that occur within a 24hr - with that period starting at the UT indicated in the date selection box. Users should ensure that the period starts near the middle of their day.
Time	The predicted UTC, in hours, mins and secs.

P	The Phase of the event. Values are: • D - disappearance • d - disappearance, but star is less than 1 mag brighter than the predicted visibility limit. • R - reappearance • r - reappearance, but star is less than 1 mag brighter than the predicted visibility limit. • Gr - grazing occultation at site. At mid-occultation, or closest approach, the star is less than 4" from the limb of the moon (either above or below). • gr - grazing occultation at site, but star is less than 1 mag brighter than the predicted visibility limit. • M - miss. At closest approach, the star is more than 4" above the limb of the moon • m - miss, but star is less than 1 mag brighter than the predicted visibility limit.
Star	The star identifier. Three formats are used: • nnnn - A ZC star. When reporting occultations, the catalogue is identified with 'R'. • nnnnn, or nnnnnn - An SAO star. When reporting occultations, the catalogue is identified with 'R'. • X nnnnnn - an XZ star. When reporting occultations, the catalogue is identified with 'X'.
D	The double star code
Sp	Star's spectral type. Only basic spectral type information is provided
Mag v	The star's visual magnitude
Mag r	The star's red magnitude. For observers using CCD video cameras, the red magnitude provides a better indication of visibility.
D	The variable star code
% ill	the percent illumination of the moon. If followed by a +, values are for a waxing moon; - for a waning moon; and E for illumination during a lunar eclipse.
Elon	the elongation of the moon from the sun, in degrees. [Strictly, the quantity is calculated as the elongation of the star from the sun]
Sun Alt	the altitude of the sun. The field is blank if the sun is lower than -12 deg. (Nautical twilight)
Moon Alt	the altitude of the moon
Moon Az	the azimuth of the moon
CA	Cusp Angle - the angle of the event around the limb of the moon, measured from the nearest cusp. -'ve values indicate a bright limb event. The cusps are usually N (north) or S (south), but near full moon can be E (East) or W (west). If a lunar eclipse is in progress, CA gives is the % distance from the centre of the umbra, and is followed by a 'U'. Values up to 103% are possible. Where an event occurs more than 103% of the umbral radius, the usual Cusp Angle value is displayed.
PA	Position Angle - the angle of the event around the limb of the moon, measured from true north
VA	Vertex Angle - the angle of the event around the limb of the moon measured anticlockwise from the vertex of the lunar limb - i.e. the point on the limb highest from the horizon
AA	Axis Angle - the angle of the event around the limb of the moon, measured eastward from the moon's north pole. Essential for reappearance, as it locates the event with reference to lunar features. To use, mark a map of the moon around the circumference at 10 deg intervals, starting at the north pole. Mare Crisium is at about 300 deg. [Note - the so-called Watts Angle differs from the Axis Angle by 0.21 deg. The term Watts Angle is limited to the context of accessing the Watts Charts. In all other situations, the term Axis Angle is preferred.]
Libration L	the libration of the moon in longitude, as seen from the site at the time of the event
Libration B	the libration of the moon in latitude, as seen from the site at the time of the event
A	coefficient for correcting the prediction for changes in site location. The units are minutes of time per degree (or seconds of time per minute of arc). The correction to the prediction for a change in site, in seconds of time, is found by multiplying A by the change in site longitude (+'ve for changes towards the East) from the prediction site.

B	same as for A, but for changes in latitude (+'ve to the north).
RV	Radial Velocity - the radial rate of motion of the star relative to the lunar limb, in arcsecs per second.
Cct	Contact Angle - the difference between the normal to the lunar limb and the direction of lunar motion. values range between -180 and +180. Disappearance have values in the range +90 to -90; reappearances are in the range 90 to 180, or -90 to -180. The sign of Cct indicates whether the star is to the north (+'ve) or south (-'ve) of the direction of motion.
durn	Some stars have an appreciable diameter, such that the occultation will not be instantaneous. When this is likely, this column gives an estimate of the duration. [Note: the value is an estimate only, with the diameter being calculated on the basis of the star's magnitude and colour.]
RA	The J2000 RA of the star. For planets and asteroids, the position is for an integral hour closest to the time of geocentric conjunction - although the prediction includes full allowance for the object's motion... **NOTE:** The 'Apparent position' of a star can be displayed instead of the J2000 position. Go to the **Maintenance Tab, User settings, Lunar Occultation Predictions...** box, and check the item **In lunar predictions, display Apparent star....**
Dec	The J2000 Declination of the star.- as for Right Ascension.
Mdist	The distance of the lunar limb from the observer - in mega-meters. [Multiply by 1000 to give the distance in km.]
SV	The Shadow Velocity of the moon's shadow relative to the observer - in the direction of the moon's apparent motion - in metres/sec.

The following messages can appear

Item	Meaning
Star name	If the star is brighter than 5.0, and has a proper name, Bayer letter or Flamsteed number, this is given in a line like: R2864 = 52 Sagittarii
Double star details	If the star is a double star, the details are given in a line like: 2405 is triple: AB 6.58 10.15 2.03" 15.3, dT = -3sec : AC 6.6 14.0 24.6" 195.9, dT = +37sec The information provided for each pairing is the magnitude of each component,the separation; the PA; and the expected time difference between the 1st and 2nd components of the pairing. Pairings are separated by colons. A double asterisk (**)indicates the pairing is an occultation discovery that has not been confirmed. Where an orbit is available for the pairing, the separation and PA are computed for the date of the occultation. Where there is no orbit, the separation and PA are estimated by linear extrapolation of the values in the double star catalogue.
Close and suspected Double stars	Two additional message lines may appear for double stars. If the star is a close double, with a separation less that 2.0" and greater than 0.01", an alert line will appear like: 3157 is a close double. Observations are highly desired Where there are observations which suggest that a star *might* be a double star, an alert line will appear like: 3177 has been reported as non-instantaneous (OCc1608). Observations are highly desired The OCC number in brackets gives the identification of the star in the file XZDoubles Discoveries. This message is generated for all double stars where the double star identifier is one of 'OCc', ' ', '---', 'S ' and 'GC '.

Stars in Kepler2	If the star is a target star in The Kepler2 mission, that fact is tagged, together with the EPIC identifier used in the Keppler2 mission. Most messages will state *** A light curve is desired as... , but for some stars the message is *** A light curve is highly desired as... These stars are a relatively small number of stars in the Kepler2 mission that are measured more frequently than most stars as they are considered to have a greater likelihood of having exoplanets.
Variable star details	If the star is a variable star, the details are given in a line like: X145167 = KW Sgr, 11.0 to 13.2P, Type SRC, Period 670. days For regular variables with a known epoch, the phase in the current cycle is also provided.
Object diameter	For planets, moons and asteroids, the prediction is for the center of the object. The prediction also includes a line like: Duration of planetary disk occultation: predicted time +/-33.1 secs To indicate the time difference from the start and end of the occultation of the object's disk. In this example, it will take 66 secs for the moon to cover the disk of the object. *Note: the displayed value assumes a circular object. No correction for the oblateness of Jupiter or Saturn is included.*
Graze nearby	Where an 'observable' grazing occultation occurs within the graze travel distance for the site, a separate prediction line appears - like: 07 Aug 29 13 22 10 Gr 146693 G5 7.5 7.1 98- 164 49 ** GRAZE: CA 10.9N; Dist. 12km in az. 143deg. [Lat =-35.53+0.61(E.Long-149.06)] The first part of the line is the same as for any other prediction line. The additional information provided is: Cusp angle at mid-graze the distance from the site to the closest point on the graze path (in km) the azimuth of the direction to the graze path a simple formula to give the latitude of a point on the graze path for a specified longitude. In this example, you get the following latitudes by inserting the longitude into the formula • E. Longitude = +149.06 => latitude = -35.53 • E. Longitude = +150.06 => latitude = -34.92 For observers in US/Canada, remember that your longitude is -'ve.
Terminator distance	If a dark-limb occultation occurs less than 20" from the terminator, the distance to the terminator, and to a theoretical 3" high mountain beyond the terminator which could be sunlit, is given in a message like: Distance of 2864 to Terminator = 12.2"; to 3km sunlit peak = 1.9" The distance to the terminator is calculated on an assumption that the moon is perfectly smooth. The distance to a 3km sunlit peak indicates a 'worst-case' scenario of the effect of a high mountain (which could be on the near or far side of the moon).

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Double star codes

With the revision of the double star system for use with the XZ catalogue, a new set of double star codes was introduced with the following definitions:

code	Meaning
C	double, component in XZ, Separation <1"
c	double, component not in XZ, Separation <1"
D	double, component in XZ, Separation <10"
d	double, component not in XZ, Separation <10"
W	double, component in XZ, Separation >10"
w	double, component not in XZ, Separation >10"
M	multiple system, all components in XZ
S	multiple system, some but not all in XZ
K	star in K2 catalogue, short cadence
k	star in K2 catalogue, long cadence
P	star in K2 catalogue, short cadence, and one of the other double star flags apply
p	star in K2 catalogue, long cadence, and one of the other double star flags apply

As a simple reminder: C stands for Close D stands for Double W stands for Wide
And upper case means that the component is listed in XZ80, while lower case means the component is not in XZ80.

The previous double star code letters were defined as follows.

A	Listed by Aiken or Burnham
B	Close double, with third star nearby with separate XZ entry
C	Listed by Innes, Couteau, or other visual observers
D	Primary of double, secondary has separate XZ entry
E	Secondary of double, primary has separate XZ entry
F	Following component
G	A or C with second star either M, J, U or V, with a third star referred to second star
H	Triple: J or U or V, and M
I	O, with secondary either J, U, or V (third star's data referred to secondary)
J	One-line spectroscopic binary, separation probably <".01
K	U or V, but duplicity doubtful
L	Triple: J or U, and V; or all V; or all J
M	Mean position of close pair
N	North component
O	Orbital elements available
P	Preceding component
Q	Triple; J or U or V, and O
R	Triple; O and O
S	South component
T	Triple, V, and A or C; or all A and/or C

U	Separation <.01" (usually a double-line spectroscopic binary)
V	Separation >.01" but not visual (occultation, interferometric or speckle component)
W	Triple; J or U, and A or C
X	Probably a close double, but not certain
Y	Triple; K or X, and A or C
Z	Triple; O, and A or C or V or X or L
$	G except M rather than A or C for 1-2 stars

Variable star types

The variable star code following the magnitude, has the following definitions:

Code	Meaning
E	Eclipsing variable (E, EA, and EB), magnitude range >0.5
e	Eclipsing variable (E, EA, and EB), magnitude rang <0.5, or unknown
S	Suspected variables, magnitude range >0.5
s	Suspected variables, magnitude range <0.5, or not indicated
V	All other types of variables, magnitude range >0.5
v	All other types of variables, magnitude range <0.5

In the detailed message for variable stars, the following type identifiers (with definitions from the GCVS) are used:

Code	Classification according to the components' physical characteristics
ACV	Alpha2 Canum Venaticorum variables. These are main-sequence stars with spectral types B8p-A7p and displaying strong magnetic fields. Spectra show abnormally strong lines of Si, Sr, Cr, and rare earths whose intensities vary with rotation. They exhibit magnetic field and brightness changes (periods of 0.5-160 days or more). The amplitudes of the brightness changes are usually within 0.01-0.1 mag in V.
ACVO	Rapidly oscillating Alpha2 CVn variables. These are nonradially pulsating, rotating magnetic variables of Ap spectral type (DO Eri). Pulsation periods are in the range of 6-12 mmag (0.004-0.01 days), while amplitudes of light variation caused by the pulsation are about 0.01 mag in V. The pulsational variations are superposed on those caused by rotation.
ACYG	Variables of the Alpha Cygni type, which are nonradially pulsating supergiants of Bep-AepIa spectral types. The light changes with amplitudes of the order of 0.1 mag often seem irregular, being caused by the superposition of many oscillations with close periods. Cycles from several days to several weeks are observed.
BCEPH	Variables of the Beta Cephei type (Beta Cep, Beta CMa), which are pulsating O8-B6 I-V stars with periods of light and radial-velocity variations in the range of 0.1 - 0.6 days and light amplitudes from 0.01 to 0.3 mag in V. The light curves are similar in shape to average radial-velocity curves but lag in phase by a quarter of the period, so that maximum brightness corresponds to maximum contraction, i.e., to minimum stellar radius. The majority of these stars probably show radial pulsations, but some (V649 Per) display nonradial pulsations; multiperiodicity is characteristic of many of these stars.
BE	It becomes more and more clear that, although the majority of Be stars are photometrically variable, not all of them could be properly called GCAS variables. Quite a number of them show small-scale variations not necessarily related to shell events; in some cases the variations are quasi-periodic. By now we are not able to present an elaborated system of classification for Be variables, but we adopt a decision that in the cases when a Be variable cannot be readily described as a GCAS star we give simply BE for the type of variability.
BY	BY Draconis-type variables, which are emission-line dwarfs of dKe-dMe spectral type showing quasiperiodic light changes with periods from a fraction of a day to 120 days and amplitudes from several hundredths to 0.5 mag in V. The light variability is caused by axial rotation of a star with a variable degree of nonuniformity of the surface brightness (spots) and chromospheric activity. Some of these stars also show flares similar to those of UV Cet stars, and in those cases they also belong to the latter type and are simultaneously considered eruptive variables.

CEP	Cepheids. Radially pulsating, high luminosity (classes Ib-II) variables with periods in the range of 1-135 days and amplitudes from several hundredths to 2 mag in V (in the B band, the amplitudes are greater). Spectral type at maximum light is F; at minimum, the types are G-K. The longer the period of light variation, the later is the spectral type. The maximum of the surface-layer expansion velocity almost coinciding with maximum light.
CST	Nonvariable stars, formerly suspected to be variable and hastily designated. Further observations have not confirmed their variability.
CW	Variables of the W Virginis type. These are pulsating variables of the galactic spherical component (old disk) population with periods of approximately 0.8 to 35 days and amplitudes from 0.3 to 1.2 mag in V. They obey a period-luminosity relation different from that for Delta Cep variables (see DCEP). For an equal period value, the W Vir variables are fainter than the Delta Cep stars by 0.7 - 2 mag. The light curves of W Vir variables for some period intervals differ from those of Delta Cep variables for corresponding periods either by amplitudes or by the presence of humps on their descending branches, sometimes turning into broad flat maxima. W Vir variables are present in globular clusters and at high galactic latitudes.
CWA	W Vir variables with periods longer than 8 days (W Vir).
CWB	W Vir variables with periods shorter than 8 days (BL Her).
DCEP	These are the classical Cepheids, or Delta Cep-type variables. Comparatively young objects that have left the main sequence and evolved into the instability strip of the Hertzsprung-Russell (H-R) diagram, they obey the well-known Cepheid period-luminosity relation and belong to the young disk population. DCEP stars are present in open clusters. They display a certain relation between the shapes of their light curves and their periods.
DCEPS	These are Delta Cep variables having light amplitudes <0.5 mag in V (<0.7 mag in B) and almost symmetrical light curves (M-m approx. 0.4 - 0.5 periods); as a rule, their periods do not exceed 7 days. They are probably first-overtone pulsators and/or are in the first transition across the instability strip after leaving the main sequence (SU Cas). Traditionally, both Delta Cep and W Vir stars are quite often called Cepheids because it is often impossible to discriminate between them on the basis of the light curves for periods in the range 3 - 10 days. However, these are distinct groups of entirely different objects in different evolutionary stages. One of the significant spectral differences between W Vir stars and Cepheids is the presence, during a certain phase interval, of hydrogen-line emission in the former and of Ca II H and K emission in the latter.
DSCT	Variables of the Delta Scuti type. These are pulsating variables of spectral types A0-F5 III-V displaying light amplitudes from 0.003 to 0.9 mag in V (usually several hundredths of a magnitude) and periods from 0.01 to 0.2 days. The shapes of the light curves, periods, and amplitudes usually vary greatly. Radial as well as nonradial pulsations are observed. The variability of some members of this type appears sporadically and sometimes completely ceases, this being a consequence of strong amplitude modulation with the lower value of the amplitude not exceeding 0.001 mag in some cases. The maximum of the surface layer expansion does not lag behind the maximum light for more than 0.1 periods. DSCT stars are representatives of the galactic disk (flat component) and are phenomenologically close to the SX Phe variables.
DSCTC	Low amplitude group of Delta Sct variables (light amplitude <0.1 mag in V). The majority of this type's representatives are stars of luminosity class V; objects of this subtype generally are representative of the Delta Sct variables in open clusters.
EA	Eclipsing binary systems. These are binary systems with orbital planes so close to the

	observer's line of sight (the inclination i of the orbital plane to the plane orthogonal to the line of sight is close to 90 deg) that the components periodically eclipse each other. Consequently, the observer finds changes of the apparent combined brightness of the system with the period coincident with that of the components' orbital motion. (Note the extra classification for eclipsing variables, given below)
EB	Beta Lyrae-type eclipsing systems. These are eclipsing systems having ellipsoidal components and light curves for which it is impossible to specify the exact times of onset and end of eclipses because of a continuous change of a system's apparent combined brightness between eclipses; secondary minimum is observed in all cases, its depth usually being considerably smaller than that of the primary minimum; periods are mainly longer than 1 day. The components generally belong to early spectral types (B-A). Light amplitudes are usually <2 mag in V. (Note the extra classification for eclipsing variables, given below)
ELL	Rotating ellipsoidal variables (b Per, Alpha Vir). These are close binary systems with ellipsoidal components, which change combined brightnesses with periods equal to those of orbital motion because of changes in emitting areas toward an observer, but showing no eclipses. Light amplitudes do not exceed 0.1 mag in V.
EW	W Ursae Majoris-type eclipsing variables. These are eclipsers with periods shorter than 1 days, consisting of ellipsoidal components almost in contact and having light curves for which it is impossible to specify the exact times of onset and end of eclipses. The depths of the primary and secondary minima are almost equal or differ insignificantly. Light amplitudes are usually <0.8 mag in V. The components generally belong to spectral types F-G and later. (Note the extra classification for eclipsing variables, given below)
GCAS	Eruptive irregular variables of the Gamma Cas type. These are rapidly rotating B III-IVe stars with mass outflow from their equatorial zones. The formation of equatorial rings or disks is often accompanied by temporary fading. Light amplitudes may reach 1.5 mag in V.
I	Poorly studied irregular variables with unknown features of light variations and spectral types. This is a very inhomogeneous group of objects.
IA	Poorly studied irregular variables of early (O-A) spectral type.
IB	Poorly studied irregular variables of intermediate (F-G) to late (K-M) spectral type.
IN	Orion variables. Irregular, eruptive variables connected with bright or dark diffuse nebulae or observed in the regions of these nebulae. Some of them may show cyclic light variations caused by axial rotation. In the Spectrum-Luminosity diagram, they are found in the area of the main sequence and subgiants. They are probably young objects that, during the course of further evolution, will become light-constant stars on the zero-age main sequence (ZAMS). The range of brightness variations may reach several magnitudes. In the case of rapid light variations having been observed (up to 1 mag in 1-10 days), the letter "S" is added to the symbol for the type (INS).
INA	Orion variables of early spectral types (B-A or Ae). They are often characterized by occasional abrupt Algol-like fadings (T Ori).
INB	Orion variables of intermediate and late spectral types, F-M or Fe-Me (BH Cep, AH Ori). F-type stars may show Algol-like fadings similar to those of many INA stars; K-M stars may produce flares along with irregular light variations.
INT	Orion variables of the T Tauri type. Stars are assigned to this type on the basis of the following (purely spectroscopic) criteria: spectral types are in the range Fe-Me. The spectra of most typical stars resemble the spectrum of the solar chromosphere. The feature specific to the type is the presence of the flourescent emission lines Fe II 4046, 4132 A (anomalously intense in the spectra of these stars), emission lines [Si II] and [O I], as well as the

	absorption line Li I 6707 A. These variables are usually observed only in diffuse nebulae. If it is not apparent that the star is associated with a nebula, the letter "N" in the symbol for the type may be omitted, e.g., IT (RW AUR).
IN(YY)	Some Orion variables (YY Ori) show the presence of absorption components on the redward sides of emission lines, indicating the infall of matter toward the stars' surfaces. In such cases, the symbol for the type may be accompanied by the symbol "YY".
IS	Rapid irregular variables having no apparent connection with diffuse nebulae and showing light changes of about 0.5 - 1.0 mag within several hours or days.
L	Slow irregular variables. The light variations of these stars show no evidence of periodicity, or any periodicity present is very poorly defined and appears only occasionally. Like for the type I, stars are often attributed to this type because of being insufficiently studied. Many type L variables are really semiregulars or belong to other types.
LB	Slow irregular variables of late spectral types (K, M, C, S); as a rule, they are giants (CO Cyg). This type is also ascribed, in the GCVS, to slow red irregular variables in the case of unknown spectral types and luminosities.
LBV	For comparatively long-period pulsating B stars (periods exceeding one day).
LC	Irregular variable supergiants of late spectral types having amplitudes of about 1 mag in V (TZ Cas).
M	Mira (Omicron) Ceti-type variables. These are long-period variable giants with characteristic late-type emission spectra (Me, Ce, Se) and light amplitudes from 2.5 to 11 mag in V. Their periodicity is well pronounced, and the periods lie in the range between 80 and 1000 days. Infrared amplitudes are usually less than in the visible and may be <2.5 mag. For example, in the K band they usually do not exceed 0.9 mag. If the amplitudes exceed 1 - 1.5 mag , but it is not certain that the true light amplitude exceeds 2.5 mag, the symbol "M" is followed by a colon, or the star is attributed to the semiregular class with a colon following the symbol for that type (SR).
NL	Novalike variables, which are insufficiently studied objects resembling novae by the characteristics of their light changes or by spectral features. This type includes, in addition to variables showing novalike outbursts, objects with no bursts ever observed; the spectra of novalike variables resemble those of old novae, and small light changes resemble those typical for old novae at minimum light. However, quite often a detailed investigation makes it possible to reclassify some representatives of this highly inhomogeneous group of objects into other types.
PVTEL	Variables of the PV Telescopii type. These are helium supergiant Bp stars with weak hydrogen lines and enhanced lines of He and C. They pulsate with periods of approximately 0.1 to 1 days, or vary in brightness with an amplitude of 0.1 mag in V during a time interval of about a year.
RCB	Variables of the R Coronae Borealis type. These are hydrogen-poor, carbon- and helium-rich, high-luminosity stars belonging to the spectral types Bpe-R, which are simultaneously eruptive and pulsating variables. They show slow nonperiodic fadings by 1-9mag in V lasting from a month or more to several hundred days. These changes are superposed on cyclic pulsations with amplitudes up to several tenths of a magnitude and periods in the range 30-100 days.
RR	Variables of the RR Lyrae type, which are radially-pulsating giant A-F stars having amplitudes from 0.2 to 2 mag in V. Cases of variable light-curve shapes as well as variable periods are known. Traditionally, RR Lyrae stars are sometimes called short-period Cepheids or cluster-type variables. The majority of these stars belong to the spherical

	component of the Galaxy; they are present, sometimes in large numbers, in some globular clusters, where they are known as pulsating horizontal-branch stars. Like Cepheids, maximum expansion velocities of surface layers for these stars practically coincide with maximum light.
RRAB	RR Lyrae variables with asymmetric light curves (steep ascending branches), periods from 0.3 to 1.2 days, and amplitudes from 0.5 to 2 mag in V;
RRC	RR Lyrae variables with nearly symmetric, sometimes sinusoidal, light curves, periods from 0.2 to 0.5 days, and amplitudes not greater than 0.8 mag in V (SX UMa).
RS	Eruptive variables of the RS Canum Venaticorum type. This type is ascribed to close binary systems with spectra showing Ca II H and K in emission, their components having enhanced chromospheric activity that causes quasi-periodic light variability. The period of variation is close to the orbital one, and the variability amplitude is usually as great as 0.2 mag in V (UX Ari). They are X-ray sources and rotating variables. RS CVn itself is also an eclipsing system.
RV	Variables of the RV Tauri type. These are radially pulsating supergiants having spectral types F-G at maximum light and K-M at minimum. The light curves are characterized by the presence of double waves with alternating primary and secondary minima that can vary in depth so that primary minima may become secondary and vice versa. The complete light amplitude may reach 3-4 mag in V. Periods between two adjacent primary minima (usually called formal periods) lie in the range 30-150 days (these are the periods appearing in the Catalogue).
RVA	RV Tauri variables that do not vary in mean magnitude (AC Her).
RVB	RV Tauri variables that periodically (with periods from 600 to 1500 days and amplitudes up to 2 mag in V) vary in mean magnitude (DF Cyg, RV Tau).
SDOR	Variables of the S Doradus type. These are eruptive, high-luminosity Bpec-Fpec stars showing irregular (sometimes cyclic) light changes with amplitudes in the range 1-7 mag in V. They belong to the brightest blue stars of their parent galaxies. As a rule, these stars are connected with diffuse nebulae and surrounded by expanding envelopes (P Cyg, Eta Car).
SR	Semiregular variables, which are giants or supergiants of intermediate and late spectral types showing noticeable periodicity in their light changes, accompanied or sometimes interrupted by various irregularities. Periods lie in the range from 20 to >2000 days, while the shapes of the light curves are rather different and variable, and the amplitudes may be from several hundredths to several magnitudes (usually 1-2 mag in V).
SRA	Semiregular late-type (M, C, S or Me, Ce, Se) giants displaying persistent periodicity and usually small (<2.5 mag in V) light amplitudes (Z Aqr). Amplitudes and light-curve shapes generally vary and periods are in the range of 35-1200 days. Many of these stars differ from Miras only by showing smaller light amplitudes.
SRB	Semiregular late-type (M, C, S or Me, Ce, Se) giants with poorly defined periodicity (mean cycles in the range of 20 to 2300 days) or with alternating intervals of periodic and slow irregular changes, and even with light constancy intervals (RR CrB, AF Cyg). Every star of this type may usually be assigned a certain mean period (cycle), which is the value given in the Catalogue. In a number of cases, the simultaneous presence of two or more periods of light variation is observed.
SRC	Semiregular late-type (M, C, S or Me, Ce, Se) supergiants (Mu Cep) with amplitudes of about 1 mag and periods of light variation from 30 days to several thousand days.
SRD	Semiregular variable giants and supergiants of F, G, or K spectral types, sometimes with emission lines in their spectra. Amplitudes of light variation are in the range from 0.1 to 4

	mag, and the range of periods is from 30 to 1100 days (SX Her, SV UMa).
SXARI	SX Arietis-type variables. These are main-sequence B0p-B9p stars with variable-intensity He I and Si III lines and magnetic fields. They are sometimes called helium variables. Periods of light and magnetic field changes (about 1 day) coincide with rotational periods, while amplitudes are approximately 0.1 mag in V. These stars are high-temperature analogs of the ACV variables.
SXPHE	Phenomenologically, these resemble DSCT (Delta Sct) variables and are pulsating subdwarfs of the spherical component, or old disk galactic population, with spectral types in the range A2-F5. They may show several simultaneous periods of oscillation, generally in the range 0.04-0.08 days, with variable-amplitude light changes that may reach 0.7 mag in V. These stars are present in globular clusters.
UG	U Geminorum-type variables, quite often called dwarf novae. They are close binary systems consisting of a dwarf or subgiant K-M star that fills the volume of its inner Roche lobe and a white dwarf surrounded by an accretion disk. Orbital periods are in the range 0.05-0.5 days. Usually only small, in some cases rapid, light fluctuations are observed, but from time to time the brightness of a system increases rapidly by several magnitudes and, after an interval of from several days to a month or more, returns to the original state. Intervals between two consecutive outbursts for a given star may vary greatly, but every star is characterized by a certain mean value of these intervals, i.e., a mean cycle that corresponds to the mean light amplitude. The longer the cycle, the greater the amplitude. These systems are frequently sources of X-ray emission. The spectrum of a system at minimum is continuous, with broad H and He emission lines. At maximum these lines almost disappear or become shallow absorption lines. Some of these systems are eclipsing, possibly indicating that the primary minimum is caused by the eclipse of a hot spot that originates in the accretion disk from the infall of a gaseous stream from the K-M star. According to the characteristics of the light changes, U Gem variables may be subdivided into three types: SS Cyg, SU UMa, and Z Cam.
UGSS	SS Cygni-type variables (SS Cyg, U Gem). They increase in brightness by 2-6 mag in V in 1-2 days and in several subsequent days return to their original brightnesses. The values of the cycle are in the range 10 days to several thousand.
UGSU	SU Ursae Majoris-type variables. These are characterized by the presence of two types of outbursts called "normal" and "supermaxima". Normal, short outbursts are similar to those of UGSS stars, while supermaxima are brighter by 2 mag, are more than five times longer (wider), and occur several times less frequently. During supermaxima the light curves show superposed periodic oscillations (superhumps), their periods being close to the orbital ones and amplitudes being about 0.2-0.3 mag in V. Orbital periods are shorter than 0.1 days; companions are of dM spectral type.
UGZ	Z Camelopardalis-type stars. These also show cyclic outbursts, differing from UGSS variables by the fact that sometimes after an outburst they do not return to the original brightness, but during several cycles retain a magnitude between maximum and minimum. The values of cycles are from 10 to 40 days, while light amplitudes are from 2 to 5 mag in V.
UV	Eruptive variables of the UV Ceti type, these are K Ve-M Ve stars sometimes displaying flare activity with amplitudes from several tenths of a magnitude up to 6 mag in V. The amplitude is considerably greater in the ultraviolet spectral region. Maximum light is attained in several seconds or dozens of seconds after the beginning of a flare; the star returns to its normal brightness in several minutes or dozens of minutes.

UVN	Flaring Orion variables of spectral types Ke-Me. These are phenomenologically almost identical to UV Cet variables observed in the solar neighbourhood. In addition to being related to nebulae, they are normally characterized by being of earlier spectral type and greater luminosity, with slower development of flares (V389 Ori). They are possibly a specific subgroup of INB variables with irregular variations superimposed by flares.
XI	X-ray irregulars. Close binary systems consisting of a hot compact object surrounded by an accretion disk and a dA - dM-type dwarf. These display irregular light changes on time scales of minutes and hours, and amplitudes of about 1 mag in V. Superposition of a periodic variation because of orbital motion is possible (V818 Sco);
XNG	X-ray, novalike (transient) systems with an early-type supergiant or giant primary component and a hot compact object as a companion. Following the main component's outburst, the material ejected by it falls onto the compact object and causes, with a significant delay, the appearance of X rays. The amplitudes are about 1-2 mag in V (V725 Tau);
ZAND	Symbiotic variables of the Z Andromedae type. They are close binaries consisting of a hot star, a star of late type, and an extended envelope excited by the hot star's radiation. The combined brightness displays irregular variations with amplitudes up to 4 mag in V. A very inhomogeneous group of objects.

For eclipsing variables (Types E, EA, EB, and EW) two further classifications may be given, separated by a solidus ("/"). Examples are: E/DM, EA/DS/RS, EB/WR, EW/KW, etc.

Code	**Classification according to the components' physical characteristics**
GS	Systems with one or both giant and supergiant components; one of the components may be a main sequence star.
PN	Systems having, among their components, nuclei of planetary nebulae (UU Sge).
RS	RS Canum Venaticorum-type systems. A significant property of these systems is the presence in their spectra of strong Ca II H and K emission lines of variable intensity, indicating increased chromospheric activity of the solar type. These systems are also characterized by the presence of radio and X-ray emission. Some have light curves that exhibit quasi sine waves outside eclipses, with amplitudes and positions changing slowly with time. The presence of this wave (often called a distortion wave) is explained by differential rotation of the star, its surface being covered with groups of spots; the period of the rotation of a spot group is usually close to the period of orbital motion (period of eclipses) but still differs from it, which is the reason for the slow change (migration) of the phases of the distortion wave minimum and maximum in the mean light curve. The variability of the wave's amplitude (which may be up to 0.2 mag in V) is explained by the existence of a long-period stellar activity cycle similar to the 11-year solar activity cycle, during which the number and total area of spots on the star's surface vary.
WD	Systems with white-dwarf components.
WR	Systems having Wolf-Rayet stars among their components (V 444 Cyg).

Code	**Classification based on the degree of filling of inner Roche lobes**
AR	Detached systems of the AR Lacertae type. Both components are subgiants not filling their inner equipotential surfaces.

D	Detached systems, with components not filling their inner Roche lobes.
DM	Detached main-sequence systems. Both components are main-sequence stars and do not fill their inner Roche lobes.
DS	Detached systems with a subgiant. The subgiant also does not fill its inner critical surface.
DW	Systems similar to W UMa systems in physical properties (KW, see below), but not in contact.
K	Contact systems, both components filling their inner critical surfaces.
KE	Contact systems of early (O-A) spectral type, both components being close in size to their inner critical surfaces.
	Contact systems of the W UMa type, with ellipsoidal components of F0-K spectral type. Primary components are main-sequence stars and secondaries lie below and to the left of the main sequence in the (MV,B-V) diagram.
SD	Semidetached systems in which the surface of the less massive component is close to its inner Roche lobe.

Variable star identifiers/source

The variable star identifiers come in the following form

Identifier Style	Source
RV Tau	Traditional variable star identifier, from General Catalogue of Variable Stars
V1206 Tau	Traditional variable star identifier, from General Catalogue of Variable Stars
NSV 1724	Identifier in the New Catalogue of Suspected Variable Stars, and its supplements
alf Sco	Traditional variable star identifier, based on the Bayer identifier for the star. Note that the three characters used to represent the greek letter are a transliteration from the Cyrillic characters used for that purpose in the General Catalogue of Variable Stars
NSVS J0340308+221959	Northern Sky Variability Survey. Some entries have an 8-digit serial number. Other entries give the J2000 RA and dec after a 'J'.
ASAS J034022+2220.2	3rd All Sky Automated Survey. The string of numbers after the 'J' give the J2000 RA and dec.
Downes TT Ari	A catalog and atlas of cataclysmic variables
GSC	Guide Star Catalogue
GUVV J125428.5+003739.5	The Galex Ultraviolet Variability (GUVV) Catalog
GUVV-2 J165503.1-223057.4	The Second Galex Ultraviolet Variability (GUVV-2) Catalog
IBVS 5700-62	Information Bulletin on Variable Stars
OGLEII DIA BUL-SC14 V3764	Phase 2 data of the Optical Gravitational Lensing Experiment (OGLE-II),

1SWASP J034936.53+241745.8	Superwasp - Wide-angle search for planets
TSVSC1 TN-N231310023-1-67-1	TAROT suspected variable star catalog
VSX J234128.4-031921	AAVSO Variable star Index. The string of numbers after the 'J' give the J2000 RA and dec.