Occultation Newsletter

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A Compact Video Occultation Observation System

In this Issue

ON THE COVER:

This equipment was set up in a small church parking lot in Eagle, Colorado to record the occultation of 1 Trianguli by (89) Julia on 2005 August 13. David Dunham set up the equipment that was operated by James Thompson, who took the photo. The telescope is an old 4" Meade ETX bought from a seller on Astromart with a 9 x 50 finder scope that I purchased from Orion. A Meade f/3.3 focal reducing lens is attached to the telescope, followed by a standard SCT eyepiece holder, a short 1.25" to video cylinder from Adirondack Video, and a PC164C camera from Supercircuits. The telescope was roughly polar-aligned and is shown pointing in the direction of the target star at the time of its occultation (the pointing was good; the occultation occurred near the center of the video field). Dunham pre-pointed the telescope to this direction two hours beforehand using stars near alpha Andromedae that had the same declination as the target star.

More information is at http://iota.jhuapl.edu/mp089824.htm with results of the occultation by James and 8 other observers at http://iota.jhuapl.edu/mp089.htm . -- David Dunham

Publication Date for this issue: December 2005

Please note: The date shown on the cover is for subscription purposes only and does not reflect the actual publication date.

The next issue, Volume 12, Number 3 will be published in early January.

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IOTA Publications

Although the following are included in membership, nonmembers will be charged for:

Local Circumstances for Appulses of Solar System Objects with Stars predictions US$1.00
Graze Limit and Profile predictions US$1.50 per graze.
Papers explaining the use of the above predictions US$2.50
IOTA Observer's Manual US$5.00

Asteroidal Occultation Supplements will be available for US$2.50 from the following regional coordinators:
South America--Orlando A. Naranjo; Universidad de los Andes; Dept. de Fisica; Mérida, Venezuela
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Australia and New Zealand--Graham Blow; P.O. Box 2241; Wellington, New Zealand
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All other areas-Jan Manek; (see address at left)

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Millisecond Video Timing for the Masses

Sam Herchak, annespam1@flica.net

It seems every few years, products become affordable that greatly increase the accuracy of occultation timings. In the late 1990's, the GPS averaging function became available in handheld units, which allowed a user to determine their location with far greater accuracy than maps. More recently, inexpensive and easily adapted security cameras (like the Supercircuits PC-164) have allowed modest telescopes to record asteroid occultations on video down to 11th magnitude, without expensive light intensifiers. Now we have an extremely accurate and affordable VTI (Video Time Inserter), which will stamp any video recording with the correct Universal Time (UTC) down to the millisecond! When using VTI, the real limit in getting an exact time of an occultation is the slow field rate of common video cameras and properties of starlight such as the Fresnel effect—more on that later.

Many years ago, IOTA developed a handful of unique units which could insert time stamps onto a video recording after-the-fact, triggered by the unique tone broadcast every minute over WWV (and similar), provided the quality of the recorded audio and video were adequate. This worked pretty well since only the recordings with hits needed to be processed. But it still required shipping the tape to an individual who had the equipment and knowledge to process it. Besides the inconvenience, a much larger factor has motivated others to find another way—the loss of time broadcasts by nations trying to cut costs. An obvious source for accurate time signals was already in place—GPS, whose satellites transmit time signals accurate to few hundred nanoseconds. But when would an accurate and affordable unit be produced? The time is now.

As far as I know, a few real-time VTI units have been developed previously in Japan, Germany, the United Kingdom, and the United States, but each had issues such as cost, availability, or accuracy. Those problems seem to have been overcome with the KIWI-OSD (Picture from website?), distributed worldwide by PFD Systems in Bethesda, Maryland. The cost is actually much less than most eyepieces these days.

KIWI comes from Kiwi Geoff Hitchcox who lives in New Zealand, the developer and creator of the all important processor code, while OSD stands for On Screen Display. The video output from any NTSC, PAL, SECAM or MESECAM video camera is fed to the KIWI-OSD, which then time stamps the video fields in milliseconds before passing it on to be recorded by a device of your choice. A key component of the timing device is the sophisticated Garmin18 GPS unit, which has many features such as GPS averaging and WAAS (Wide Area Augmentation System, developed to enhance accuracy for aircraft conducting approaches using GPS). All the specifications and details of the KIWI-OSD are available online at the resources listed at the end of the article. I will provide an overview however, based on several months of research and testing.

Photo courtesy of PFD Systems

The plastic all-purpose hobby box contains the guts of the unit, and has a reset button at one end, with 5 cables coming out the other end. Two are for the video feed; another powers the unit; another connects to the GPS, and the last allows the Garmin 18 to be connected to a computer via serial port. The order you connect the cables is unimportant, although I prefer to connect the power cord last so I can monitor everything the KIWI-OSD does from the start. The complete unit uses a miniscule amount of power from any 12 VDC source (9-15 VDC technically), far less than even the PC-164 camera. Although the video RCA cables are not colored the customary yellow, it is straightforward what they are for and how they are connected. The Garmin 18 is connected and powered via a DIN-5 plug.

Since the unit's primary purpose is timing information, the Garmin is pre-configured to provide information immediately after it acquires a less accurate 2 D position fix (this can result in a position error for mobile observers, which I'll address later). As soon as

the Garmin has valid GPS time information, accurate to 1 millionth of a second, it drives a red LED that flashes precisely at each second, and the KIWI-OSD begins its validation process for time stamping. You then get several messages visible at the bottom of the video display cycling through in a specific sequence, giving position information before the video signal is stamped with time information. Unless you are in an area with many obstructions resulting in exceptionally bad sky coverage (like inside an observatory dome), time stamping will begin in just a couple of minutes.

Except for video experts, most people aren't aware that video cameras integrate and output in fields, referred to as odd and even (you may hear these referred to as half-frames). Both of these fields are combined to make up each frame. For NTSC cameras common in the US, there are almost 30 frames per second, and just under 60 fields per second. Many playback devices are capable of stepping through each field by using their frame by frame function, effectively doubling the time resolution of the camera. The KIWI-OSD is so precise, it marks the millisecond each field begins and ends! Each NTSC field has a duration of about 17 milliseconds, which is the only reason you can't time any event to 1 millisecond accuracy—the camera fields take too long to be acquired.

With such resolution, a problem arises for users of the KIWI-OSD—if a star dims over several fields, when did the actual occultation occur? The current guidance from David Dunham is this:

For most stars, the frame to use is the one with the star at 1/4th its unocculted level; that is the point corresponding to geometric occultation of a point source, according to calculations of the Fresnel diffraction pattern. But for a few very large red giant stars, such as Antares and Aldebaran, the star's angular diameter is significantly larger than the approximately 10m scale of diffraction so for them the geometrical occultation occurs when the star is at 1/2 its unocculted level. (Note: substitute field for frame in the first sentence.)

I don't feel it's a bad thing when you have to choose between several possible fields and interpolate between 17 milliseconds in time, do you? What a nice problem to have.

Geoff was adamant about ensuring the accuracy of this VTI, and wrote several validation checks into the code that controls the unit (as well as a backup procedure if the final validation reports a problem). Whenever a timing run is ended by pressing the reset button, the KIWI-OSD verifies that its time information is still within 1 millisecond of the current UTC. If not, a message is displayed to use the field counter to calculate the exact times for the fields containing an event (see the user manual online for how this is done). Pressing the button again resets the unit and it starts the whole process over from the start. This is the primary way to display (and easily record) additional position information.

So now is a good time for me to summarize GPS positions, which change constantly, even when your receiver isn't moving. The primary GPS satellites are moving constantly in the sky (12 hour orbits), so the number, distance, and sky position of the satellites used by the GPS receiver are always changing. Sometimes the satellite constellation is optimal and allows a precise fix; sometimes it is not. What is easily demonstrated however, is that over a period of time, GPS can provide a position that is accurate to less than 5 meters (16 feet). This is not possible with a topographic map, which for the most part, are not accurate to 15 meters to begin with.

The key is to use the GPS to take several short averages, spaced minutes apart. Thanks to Scott Degenhardt, I began doing this about 6 years ago. Even before the signal scrambling that only allowed the military full precision was turned off (selective availability, or S/A), Scott and I went to benchmarks certified in accuracy to millimeters, and proved simple GPS averaging techniques provide extremely accurate fixes.

For mobile users of the KIWI-OSD, there is a possible trap with the initial position from the unit. To begin a timing run in the shortest possible time, the Garmin 18 is pre-configured for 2 D fix. This means the unit will display information before the GPS has acquired enough satellites to determine its current elevation. Because GPS units store the last known position and elevation when powered off, in the 2 D fix mode, the GPS has to assume the elevation hasn't changed since last stored. This can severely skew the calculated surface position. I one of my tests, I moved the setup about 60 nautical miles (NM) and climbed about 1,000 meters in elevation. When the KIWI-OSD displayed the initial 2 D position, it was off by 0.7 NM, a gross error by any standard.

The best solution is to GPS average. Take a 5 minute average; wait 10 minutes, reset the unit and take another 5 minute average. Do this 3 times, mathematically average the position and elevation readings, and your position should be accurate to within 5 meters. Be sure to report both the Mean Sea Level elevation and the Geoidal separation. An averaged position is so accurate, IOTA may need to adjust the elevation figure with a GEOID correction (the Earth's surface is not a perfect sphere). Also, if you use an extension cable on the Garmin (to raise it outside your dome for example), be sure to correct for the distance between your telescope objective and the GPS receiver. This is another type of problem we should be happy to have.

The other solution is to change the Garmin 18 configuration from 2 D fix, to 3 D fix required. Now the KIWI unit will not start a timing run until the elevation has been updated. I have not found any real delay in the field by requiring the 3 D fix (changing your location a significant distance or poor sky coverage will slow the process down a few minutes though). If you haven't changed locations, none of this necessary, but you still might want to use your computer and the small application from Garmin to enable the WAAS function, which is available in several areas of the world and further enhances accuracy.

The KIWI-OSD can be purchased from PFD Systems as a complete ready to go package for $150 USD and the Garmin 18 is also available from PFD Systems for an additional $85.00 USD.

All the testing to date shows the KIWI-OSD to be a reliable, accurate VTI, and I highly recommend it for anyone timing events with video. Check out the resources below which are full of information on video, GPS, time insertion, and the KIWI-OSD. Your comments and experiences are welcomed at the email address above.

http://www.pfdsystems.com/kiwiosd.html

http://www.geocities.com/kiwi_36_nz/kiwi_osd/kiwi_osd.htm

http://groups.yahoo.com/group/kiwiosd

http://www.edu-observatory.org/gps/height.html

http://www.geocaching.com/mark/nearest.aspx

http://www.ngs.noaa.gov/cgi-bin/GEOID_STUFF/geoid03_prompt1.prl

http://www.geocities.com/kiwi_36_nz ■

New Double Star Discoveries

Henk Bulder

It has been a long time since new double star discoveries have been published in ON. The last publication dates back to ON V8,2,AUG 2000. Since that publication Jean Bourgeois and Hal Povenmire published several interesting articles on double stars that can be discovered by observing regular occultations by the moon or asteroids.

The DSFILE system was updated in January 1999 by Mitsuru Soma to include double star discoveries by Hipparcos. In October 2000 DSFILE was updated again by Henk Bulder and distributed among known addresses of double star discoverers including A. Richichi whom has used the new ones to include in his photometry program to confirm any suspected doubles. The October 2000 update included creating several files containing wide doubles, faint doubles, suspected doubles etc. Those files formed the basis for the redesign Dave Herald has undertaken. In June 2002 Dave Herald completed the redesign generating the new XZ80Q catalog. This catalog for predictions of occultations by the moon is complete for stars down to magnitude 11.5 and contains quite a number of fainter stars as well. As a result XZ numbers will replace (most if not) all Guide star catalog numbers for predicted occultations.

As a result of the redesign double star codes have been simplified. The new codes have the following meaning.

C = double, component in XZ80Q, Separation <1"
c = double, component not in XZ80Q, Separation <1"
D = double, component in XZ80Q, Separation <10"
d = double, component not in XZ80Q, Separation <10"
W = double, component in XZ80Q, Separation >10"
w = double, component not in XZ80Q, Separation >10"
M = multiple system, all components in XZ80Q
S = multiple system, some but not all in XZ80Q

New discoveries of double stars will most of the time get c or S codes. Confirmations of double stars with codes c or S will be of interest for publication.

It is far too complicated for me to describe all the efforts that have been undertaken by all three of us in great detail. Believe me that it has been a heck of a job. I like to express my gratitude to both Mitsuru Soma and Dave Herald.

All new double star discoveries get a unique OCCxxxx number and are kept in a file XZDoubles.dat. The dates of any confirmatory observations of OCCxxxx stars are maintained in the file XZDoubles Discoveries.dat. I will be seperately maintaining a file XZConfirmations.dat, which will contain observer details for confirmation observations. New discoveries and relevant confirmations will result in an updated XZDoubles.dat file. Updates of this file will periodically be made available, and users of winOCCULT will be able to update the version of the XZ80Q catalog used in winOCCULT to include the new double star information. I'm now in the process of making a new update for all observations made in 2000-2004 period. They will be published in the next issue of ON, with an update of XZDoubles.dat and XZDoubles Discoveries.dat being released at that time.

First I will present the new double stars discoveries that were in the October 2000 update (and are already included in the XZDoubles.dat and XZDoubles Discoveries.dat files). These concern observations till 1-1-2000. The reports resulted in the following new double stars (table 1 in XZ order). I have included the new OCC numbering as well in this table.

OCC	X	SAO/ZC	MAG1	MAG2	SEP	PA	DATE	DISCOVER
917	1179		6.6	8.8	.049	99	19941027	A RICHICHI
712	1826	193	8.7	8.7	.1	133	19870203	D BUETTNER
1009	2639	110199	9.6	9.6	.1	41	19980202	G L BOOTS
975	3666	404	4.8	7.4	.036	9	19961220	A RICHICHI
1010	3680	93088	10.0	10.0	.27	21	19980203	J BOURGEOIS
901	3891	433	4.5	8.1	.237	238	19931224	A RICHICHI
596	3972	444	6.7	6.7	.1	161	19800221	D BUETTNER
1020	4405	491	6.8	6.8	.1	159	19990126	H POVENMIRE
1015	4728	93548	8.3	10.5	.03	276	19980815	J BOURGEOIS
1011	5635	93890	9.8	9.8	.1	40	19980304	H BULDER
1008	6182	94138	8.0	8.8	.02	72	19980109	J BOURGEOIS
1026	7541	94839	7.6	10.2	.05	246	19990904	J BOURGEOIS
1025	7600	94857	7.9	10.5	.03	206	19990904	J BOURGEOIS
632	9023	78355	7.3	7.3	.1	87	19820331	D BUETTNER
1022	9626	96011	9.4	9.4	.05	144	19990324	J BOURGEOIS
923	9810	96110	7.5	10.9	.309	53	19950211	A RICHICHI
780	9923	1046	7.8	7.8	.1	57	19900206	D BUETTNER
957	10577	96566	8.6	8.6	.1	89	19960327	D BUETTNER
916	11691	97246	9.4	9.4	.1	53	19941026	A RICHICHI
915	11705	97258	6.6	8.2	.019	256	19941026	A RICHICHI
1018	14338	98587	8.1	9.5	.02	292	19981111	J BOURGEOIS
1012	14418	1405	7.2	9.4	.08	30	19980504	S DEGENHARDT
708	17900	1732	7.6	7.6	.1	129	19860615	D BUETTNER
1023	19766	139582	8.9	9.5	.04	129	19990526	J BOURGEOIS
1024	19785	139592	8.1	8.7	.02	97	19990526	J BOURGEOIS
1019	21126	159140	8.8	8.8	.36	324	19990112	J BOURGEOIS
857	21513	2227	3.4	8.9	.01	102	19920613	A RICHICHI
940	22828	160179	7.7	8.3	.017	55	19950902	A RICHICHI
1021	24260	160938	9.1	9.8	.03	325	19990311	J BOURGEOIS
1017	26016	187395	9.7	9.7	.07	140	19981026	J BOURGEOIS
964	26119	2755	4.4	7.9	.036	232	19960603	A RICHICHI
994	26854	2828	3.7	6.7	.021	106	19970816	A RICHICHI
1016	29186	164069	8.6	9.5	.05	130	19981001	J BOURGEOIS
1013	29208	3076	8.2	9.2	.04	144	19980518	J BOURGEOIS
1027	29463	164248	9.7	9.7	.05	63	19991115	H BULDER
946	29578	3121	5.6	7.9	.017	112	19951031	A RICHICHI
944	29632	164360	6.7	8.5	.009	32	19951031	A RICHICHI
945	29648	164371	6.6	8.8	.031	92	19951031	A RICHICHI
947	31941	128391	9.7	10.0	.024	228	19951130	A RICHICHI

TABLE 1 New double star discoveries till 1-1-2000

Confirmations of earlier discoveries are in the next table (table 2 in OCCxxxx order).

OCC	X	SAO/ZC	DATE	CONFIRMER
0000	1889	197	19890210	D BUETTNER
0000	4465	93439	19981229	J BOURGEOIS
0000	4530	93469	19981229	J BOURGEOIS
0000	6351	94227	19800902	D BUETTNER
0000	6351	94227	19980109	J BOURGEOIS
0000	7729	94922	19980110	J BOURGEOIS
0000	9633	96015	19980208	H BULDER
0000	19895	139669	19980730	J BOURGEOIS
205	8622	95419	19951015	A RICHICHI
224	6040	76721	19930105	A RICHICHI
235	4831	76140	19881220	A RICHICHI
235	4831	76140	19890919	A RICHICHI
242	8041	77819	19890922	A RICHICHI
256	31123	146402	19951129	A RICHICHI
353	5772	93955	19981230	J BOURGEOIS
360	10550	96561	19990121	J BOURGEOIS (NOT USED)
379	11854	97348	19790502	D BUETTNER
383	104056		19750516	J AFRICANO
388	40523		19751011	J AFRICANO
424	4818	76131	19880127	A RICHICHI
425	22017	159682	19830622	D BUETTNER (NOT USED)
464	24780	161153	19950711	A RICHICHI
464	24780	161153	19980514	J BOURGEOIS
465	24839	161190	19980515	J BOURGEOIS
488	10484	96515	19951016	A RICHICHI
493	7805	94961	19980110	J BOURGEOIS
502	10846	96746	19970317	A RICHICHI
508	12107	97503	19950312	D BUETTNER
518	22368	159933	19780813	D EDWARDS
551	6957	94554	19981106	A RICHICHI
561	10951	96810	19960229	A RICHICHI
586	24875	161202	19970814	A RICHICHI
690	12881	97881	19810509	D BUETTNER
916	11691	97246	19950408	J BOURGEOIS
986	7602	94858	19980110	J BOURGEOIS

TABLE 2 Confirmations of double star discoveries till 1-1-2000

In table 2 several stars have OCC number 0000 which means there is no corresponding OCC reference number. It concerns double stars for which the discoverer is unknown (empty discoverer field in XZDoubles), and which had not been identified as being discovered in an occultation.

In table 2 there are two entries that mention "NOT USED". It concerns stars that were previously discovered to be double when observing occultations by the moon. However, they have since been confirmed to be double by other means, for instance speckle interferometry. I have included them in the list just to confirm the previous discovery by lunar occultations.

In the next issue of ON I will publish some corrections on previous new double star discoveries followed by all new discoveries made in 2000-2004 period, as well as all confirmations made in the same period. ■

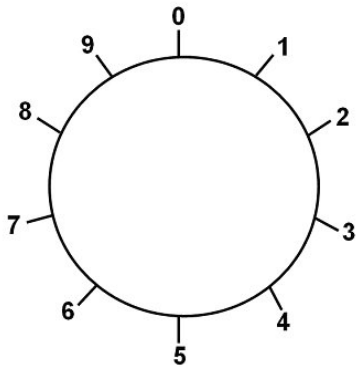
A Method to Reduce Video Occultation Times that Eliminates Personal Equation

Richard Nugent

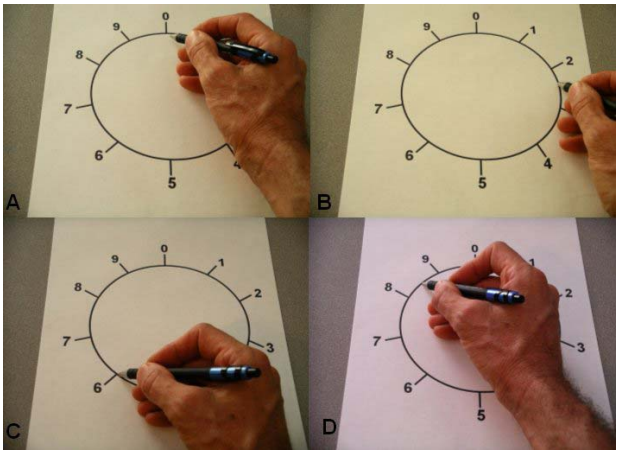
The method described here has been taken from the upcoming revised IOTA Observer's Manual, Chapter 6, *Timing Strategies for Occultation.*

With a video record of an occultation, including WWV audio, the event times can be extracted with far greater accuracy than a visual stopwatch time or from any non-video methods. A video can be played back one frame at a time to determine the duration of an event (asteroid occultations), and the exact frame in which the disappearance/reappearance occurs.

If you do not have your video tape time inserted, event times accurate to 0.1 – 0.2 second can be achieved by using the reference circle shown here. The reference circle has tick marks equally spaced from 0 to 9 representing tenths of a second (0.1 sec).



To use this technique move your hand holding a pen clockwise around the reference circle (as shown in the series of 4 photos) steadily. Move the pen at a rate of once around per second. Use the WWV second pulses to calibrate your clockwise motion around the circle. The pen should reach the top of the circle (the "0" tick mark) at the moment of each WWV second pulse. At the same time watch the video as it nears the disappearance event. As you continue to watch the video, at the moment of disappearance, *using your peripheral vision*, note the position of the pen on the reference circle, 0 – 9. Write this down. Replay the tape 4 or 5 more times and write down each position of the pen at the instant of disappearance. Then average the values (they should be fairly consistent), and you will have an accurate time of the event, usually to ±0.1 second.



With this accurate determination of the disappearance, now count how many frames until reappearance. Divide the total number of frames the star remained occulted by 30 and this gives the duration of the occultation to a precision of 1 frame or ±0.03 second. Thus without time insertion, you can extract a disappearance and reappearance to ±0.1 second.

This method eliminates reaction time from the reduction. This is because you are "seeing" the WWV second tones in real time (on the reference circle) as you watch the video. This method can also be used for audio recordings/tapes of voice call outs. When you hear the "D" or "R" on the tape, note the position of the pen around the timing circle. After determining the actual time of your "D" or "R" callout, then you apply your reaction time to this time. ■

IOTA's Mission

The International Occultation Timing Association, Inc. was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made.

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IOTA European Section (IOTA·ES)

Observers from Europe and the British Isles should join IOTA/ES, sending a Eurocheck for EURO 25,00 (bank-transfer-costs included) to the account IOTA/ES; Bartold-Knaust-Strasse 8; D-30459 Hannover, Germany; Postgiro Hannover 555 829-303; bank code number (Bankleitzahl) 250 100 30. Sending EURO 20 EU-members must use the IBAN- and BIC-code as additional bank-address (IBAN: DE97 2501 0030 0555 8293 03, BIC: PBNKDEFF). German members should give IOTA/ES an "authorization for collection" or "Einzugs-Ermaechtigung" to their bank account. Please contact the Secretary for a blank form. Full membership in IOTA/ES includes one supplement for European observers (total and grazing occultations) and minor planet occultation data, including last-minute predictions; when available. The addresses for IOTA/ES are:

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IOTA on the World Wide Web

(IOTA maintains the following web sites for your information and rapid notification of events.)

IOTA Member Site
http://www.occultations.org

This site contains information about the organization known as IOTA and provides information about joining IOTA and IOTA/ES, topics related to the *Occultation Newsletter*, and information about the membership--including the membership directory.

IOTA Lunar Occultations, Eclipses, and Asteroidal and Planetary Occultations Site
http://www.lunar-occultations.com

This site contains information on lunar occultations, eclipses, and asteroidal and planetary occultations and the latest information on upcoming events. It also includes information explaining what occultations are and how to report them.