

OCCULT V4.0.7.0
Released 20 October, 2009

OCCULT 4.0.7.0 is now available for download from the IOTA site. This release involves a number of significant changes, which I will describe in several additional emails. They relate to implementing UCAC3, ability to compare star positions from several catalogues in the context of asteroidal occultation predictions, a range of changes associated with double stars for both asteroidal and lunar occultations, revised XZ catalogue data for lunar occultations, and revised historical occultation observations.

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UPDATING OCCULT TO 4.0.7.0

For those who already have Occult4 installed, the update file can be downloaded directly from:

<http://www.lunar-occultations.com/occult4/occult407%20update.zip>

Merely unzip the contents into your existing Occult 4 directory. The next step is to update the data files used in Occult. Run Occult, and go directly to the Maintenance/Downloads page. From there, download:

- 1. Latest Lunar observations (5th item in the download list)
- 2. Historical files of Lunar Occultations (1st item in the bottom group in the download list)
- 3. XZ catalogue. (2nd item in the bottom group in the download list) [**This download is ESSENTIAL. Without it, lunar predictions will crash.**]
- 4. WDS Catalogue (3rd from bottom in the download list)
- 5. Interferometric catalog (2nd from bottom in the download list)
- 6. AAVSO Variables (last item in the download list)

[These last three downloads are not essential - but are highly desirable.]

UCAC3 'installation' :

If you have a copy of the UCAC3 DVD, Occult can conduct searches for asteroidal occultations against that catalogue, draw star charts using that catalogue, and reduce observations using that catalogue.

To use the UCAC3 catalogue:

- a. copy the entire contents of the UCAC3 DVD (both sides) to a single directory anywhere on your system.
- b. in the Maintenance/User Settings form, set that directory location in the group 'Paths for optional catalogues'. A tree-structure dialogue is now available to make this easy.
- c. The UCAC3 catalogue as supplied has a very coarse index in RA. For efficient searching, Occult creates a much finer index in RA. The button to create this index [Index UCAC3] is located just below the location for specifying the directory location. IMPORTANT. The index will take some time to complete. Most machines will take at least 20 minutes. Old or slow computers may take over an hour.... Indexing progress is displayed.

Once the index is completed, UCAC3 is available for use in almost every area where the UCAC2 catalogue is available.

Finally - in case anyone is concerned. This update process will not affect any data files that you may have in the Occult system.

A. Occult 4.0.7.0 - UCAC3 notes

Occult 4.0.7.0 can use the new UCAC3 catalogue. There has been much discussion about UCAC3 in several non-occultation groups. Unfortunately much of the tone has been dictated by a small number of vocal critics, with many issues being highly overstated. The following comments from the UCAC3 people explain the practical situation:

I think people got spoiled by UCAC2, which is a very clean catalog, and thus very suited for reference stars. The price you pay is, a lot of stars are just missing, cut due to various reasons. With UCAC3 we moved into the "real world" regime, allowing problem cases to go into the catalog. Most of these can be avoided if attention is paid to the flags and explanations more to come in the release paper, but most is already explained in the readme file.

UCAC3 is poor on the percent level of stars, which is a lot of "crap" with 100 million entries total. {my rewording.... several percent of stars have problems. But with a 100 million stars that is numerically a lot of stars}. However, about 95% of it is really good. This situation can't be helped easily - other catalogs have bigger problems. One size does not fit all. The user needs to decide what to use for his/her purpose. UCAC3 is definitely an improvement in many aspects, not in all, over UCAC2.

In short, UCAC3 should generally be an improvement over UCAC2, but there are a number of particular issues.

The identified negative issues with UCAC3 are:

- there are just over 1 million UCAC2 stars that are not in UCAC3. But while 1 million sounds a lot of stars, they are hard to find if you compare a plot of stars from UCAC2 and UCAC3. The reasons for they not being in UCAC3 is not known - although they must have failed a selection criteria for creating UCAC3. At this stage there is no strong assumption that the UCAC2 position of such stars is poor.

- there are many instances of very close double stars (separation typically less than 1 arc sec) which are false. This was caused by a software issue. In asteroidal predictions, these will become apparent by way of separate predictions for the two stars. In such instances, the 'correct' star can generally be identified as it has an associated 2MASS star number, and the incorrect star does not. In any case, any instance of apparent double star predictions need to be carefully checked.

- for faint northern stars, there are many instances where the proper motion appears to be erroneously large. This has arisen as a result of reliance on Schmidt plates for proper motion determination. For stars used for usual asteroidal occultation predictions, this is unlikely to be an issue.

The positive issues with UCAC3 are:

- whole sky coverage at high precision in a single catalogue
- the majority of positions in UCAC3 should be better than UCAC2 - although only time and observations will establish whether this is the case;
- UCAC3 gives color magnitudes for most stars;
- UCAC3 coverage is better than UCAC2 at both the bright and faint end (although this will probably have little significance for normal asteroidal occultation predictions.)

At this time I am not planning on revising the 'Tycho2 catalogue' as used in Occult to use UCAC3 positions. Such a revision is a major task. My intention is to defer any such revision until UCAC4 comes out - hopefully before the end of 2010.

B. Occult 4.0.7.0 - changes associated with Asteroid predictions

Two changes of significance have been implemented (in addition to UCAC3 search capability). Double star issues, and Catalogue Comparisons.

1. Double star issues.

When a search for asteroidal occultations is conducted, each event is checked against the Washington Double Star Catalogue, and the 4th Interferometric Catalog, to determine whether there is any record of the star being a double star. [For this purpose, it is ESSENTIAL for anyone conducting searches to download the WDS and Interferometric catalogues every few months, to make sure they have the latest available information..] If the star is (or might be) a double star, a flag is written into the occultation elements file.

When such an event is displayed, a message that the star is a double star will appear on the top-left of the prediction plot, just below the header. Users viewing the event in Occult can find out full double-star details by right-clicking on the plot, and selecting the new menu item 'Display WDS and Interferometric data'. Provided you have downloaded the WDS and Interferometric catalogues, full catalogue information will be displayed. If you have also downloaded the AAVSO Index data, variable star information (if the star is a known variable) will also be displayed.

There are some limitations on the double star identification. The identification is made on the basis of a comparison of coordinates. For a number of reasons associated with double star data, the check looks for stars within about 1 arc min of the relevant star, and assumes that any star in the double star catalogues corresponds to the star we are interested in. This is valid for about 95% of the time. But there will be instances where the double star is not the star being occulted, or where more than one double star is identified. Consequently, in all instances where a star is flagged as a double star, a check needs to be made that the double star is in fact the star being occulted.

There is also a question of relating the double star information to the effects on the occultation.

In broad terms, they are:

- if the separation is wide ($>10''$), the companion star will have almost no effect (unless the event is being recorded with a short focal length system.)
- separation $2''$ to $10''$. The primary issue is whether the companion star will affect the visibility of the light drop in the star being occulted. It is unlikely that the companion will undergo a separate occultation anywhere in the vicinity of the predicted star. And the effect of the companion on the catalogue position of the occulted star should be small (although increasing with small separations.)
- separation $<2''$. The astrometric position of the star being occulted may be suspect; the light from the companion star will almost certainly affect the occultation visibility; and there is a real possibility of an occultation of the companion star somewhere in the region.

Anyone planning on observing an occultation of such a double star should seek advice on their local group, about the best way to handle the particular event.

It will take some months for the double star indication to be incorporated routinely in all asteroid predictions accessed by OccultWatcher. However several of the regional predictors have been generating predictions with the indicator included (as part of the testing of this new version.)

2. Star catalogue comparisons

For asteroidal occultation predictions (in particular) it can be useful to have some insight into the degree of agreement between recent astrometric catalogues on the position of the star being occulted. Thanks to some HTML query code and XML interpretation code from Hristo, Occult can now query VizieR to obtain catalogue positions from (currently) 10 catalogues, and plot those positions for the epoch of the occultation in a way that can show the scatter of the positions, the differences in the proper motions - all relative to the size of the asteroid and its motion relative to the stars.

To access this functionality from Occult, display the map of the occultation event. Right-click, and select the new menu item 'Compare star catalogue positions'. The form that appears will be pre-populated with certain data, and will automatically have started the VizieR query. It will take a few seconds to complete. If nothing is returned, most likely the VizieR system is down (which is the case as I write this!)

This functionality provides information. It does not provide any answers! But with experience we may be able to learn from the information provided. The form has a lengthy Help topic. Anyone using this functionality needs to take the time to read the help topic carefully and thoroughly - on numerous occasions!

C. Occult 4.0.7.0 - Historical occultation data

As part of this release, we have taken the opportunity to include the latest revision of the historical lunar occultation observations. Apart from progress towards obtaining a reliable dataset for archiving, it also provides a solid basis for other investigations (such as double stars).

The biggest change has been a cleaning up of the observations in so far as they relate to grazing occultations. The problem with the graze data set has been multiple sources in various formats, with the data not always consistent. Dave Gault and I are working through the datasets to remove all duplicates, and to flag clearly erroneous observations. This work is not yet complete. But graze profiles produced with the new dataset are much cleaner, with the frequency of stray observations being drastically reduced.

Another issue with grazes, which is being handled by Dave Gault assisted by Ken Coles, is the retrieval of graze observations that have never made it to either RGO or ILOC. This includes events going back to 1966. Dave G has made a comparison of grazes that are 'in the system' with reports in Occultation Newsletter. Somewhat disturbingly he notes:

"I'm appalled to see that out of the 1283 events listed by ON for the period 1974 to 1985, there are 216 events missing from the archive, that's data from 721 stations and 3003 events, missing."

Clearly we still have some work to do to ensure we have collected all graze observations!

Additionally there is a potential issue for ordinary occultations. When ILOC took over the responsibility for collecting occultation observations, they clearly had serious problems with the transition. Most notably, Brian Loader (New Zealand) discovered that none of the 200+ observations for 1980 that he reported were included in the dataset. Presumably his reported observations were lost in the transition. If anyone else has observations from that period that were similarly lost, now is the time to get them included - before we do a formal archive of all observations. Accordingly I encourage observers who were active with lunar occultations in the period 1979 to 1983 to check that their observations are in the dataset. Dave Gault or myself can provide guidance on how this can be easily done.

D. Occult 4.0.7.0 - Double and Variable star data

Occult has maintained data for double and variable stars for use in lunar occultations, as well as data on occultation discoveries.

There are sound reasons for maintaining files of double and variable stars for use with lunar occultations. However such files should be treated as subsets of the 'official' double star catalogues - the Washington Double Star catalog, and the 4th Interferometric Catalog. Unfortunately for a number of reasons, this has never been the case.

With this version of Occult, the double and variable star files have been revised, so that they are properly subsets of the official catalogues, and can be easily updated when the official catalogues are updated.

One effect of this revision of the double star file (XZDoubles.dat) is that the data for over 95% of the entries has been updated. Furthermore the number of pairs has increased by almost 100%. For XZVariables.dat, the number of entries has increased by well over 100%. For both these files, routines are in place to allow easy 'administrator' updating from the WDS and AAVSO catalogues - with an expectation that updates of the XZ catalogue system may be needed every 6 months or so.

In addition: there have been a number of revisions to the file of Occultation discoveries. Firstly entries were created for 520 stars in XZDoubles that were not in the WDS catalogue. A status flag was added, to indicate whether the star was definitely a double, a possible double, or definitely not double. A flag was included for future 'discoveries' to indicate whether a light curve is available, and if so whether the evidence for the star being a double is definite or inconclusive. And identifications in the Interferometric catalogue were added. The status flag is carried through to the XZDoubles file, and from there can be accessed in predictions.

E. Occult 4.0.7.0 - Lunar occultations - double star predictions and observations

Lunar occultations are a potential source of valuable measurements of double stars. This potential has been poorly handled in the past. Neither RGO nor ILOC processed double star observations in any meaningful way. In particular, double star measurements in lunar occultations have been treated as peripheral to the occultation observation, with no effective processes to have the data reported to the double star community. That situation is changing....

A single lunar occultations of a double star can provide very useful measurement of a 'vector separation' of the two components. Observations from two or more spaced locations can allow the separation and position angle to be determined. Additionally, a video light curve allows an accurate measurement of the relative brightness of the components of a double star - something that is difficult for close double stars investigated by other techniques (such as speckle interferometry). In addition, double stars are routinely being discovered in lunar occultations - with separations generally smaller than doubles discovered by visual techniques.

Prior to the last 5 years or so, most lunar occultations were observed visually. When the event was non-instantaneous, possible causes are double star, stellar diameter, or Fresnel diffraction. However visual observations were poorly suited to distinguishing between the possible causes. As a result many stars were asserted to be double on the basis of a fade - with no independent means of verifying the status. A video recording doesn't have this problem - as now we can record a light curve and analyse it at leisure. Separations of less than 0.1" can be easily detected and precisely measured. And if distant observers cooperate to observe the same star on the same night, a precise separation and position angle can be measured.

A key element of the double star process is the reporting arrangements. There is no point in making observations if the results do not get to the appropriate location - which is either the WDS, or Interferometric catalogues. USNO operate on the basis of collecting observations that are published in any of a range of publications. For our activities, they have suggested that observations be published in the Journal of Double Star Observations (JDSO) - which is the path we are proceeding down. This means that there are two reporting streams for lunar occultations:

1. normal observation: report sent in normal way to regional coordinator. Regional coordinator collects observations and forwards a consolidation to a global coordinator. Global coordinator consolidates all observations, makes them available, and arranges archiving
2. double star observations: double star report sent to a coordinator. Coordinator periodically prepares a paper of consolidated observations for publication in the JDSO; USNO retrieves observations from the JDSO and incorporates them into the WDS and/or Interferometric catalogues; those observations then appear in the XZ files by periodic update based on the latest WDS and Interferometric catalogues.

This version of Occult has a range of changes intended to facilitate the observation, reporting and analysis of double stars. this includes ready access to the data in the Washington Double star Catalogue, and the 4th Interferometric catalog. The USNO (which is responsible for maintaining the double star catalogs) has provided guidance, and changed their download arrangements for the Interferometric catalog to facilitate our activities.

On the prediction side, the changes are:

- the lunar occultation predictions include some extra message lines. Firstly, if the star has been reported as a possible double star, that fact will be indicated in a message line, encouraging observations. Secondly, for known double stars with separations in the range of 0.01" to 2.0" (a range endorsed by the USNO double star experts) a message is given to indicate that the star is a close double star, and that observations are desired. [Double stars with a separation greater than 2" are not well suited to the lunar occultation technique, because of the lunar limb irregularities.]
- right-clicking on a prediction line has an option to display the full WDS and Interferometric catalogue details for the selected star.
- graze predictions involving a double star have the WDS and Interferometric details included as part of the listing.

On the observation side, the changes are:

On the observations editor, there is an extra menu item (enabled when the Events page is displayed) for a 'Double Star report'. Enter the details of the occultation of both components in the occultation report in the usual manner. Then highlight the line for the brighter component, and select Double Star report - Create double star report.... There are just a few things to add to the report:

- a. the time difference between the two components
- b. a light curve of the event. Using Limovie, copy the light curve to the clipboard. Then from this double star report retrieve the Light Curve.
- c. Add any comments you might think are appropriate
- d. Add the email addresses of the people you want to send the report to.

At this time, all reports should be sent at least to Brian Loader - palbrl at clear dot net dot nz

Note that you should report any observation made of a double star - even if you do not detect the companion.

On the reduction side, there is a new form for analysing double star observations to determine separation and Position Angle. [On the Lunar Observations tab, it is 'Solve double star PA and Separation'] When the observation is added (via a Paste), the lunar limb at the location of the occultation is displayed, allowing the person doing the analysis to measure the slope of the lunar limb on the basis of past occultation observations. When the observations are combined, the form displays the lunar limb for each event, and the current solution. The analysis uses a least squares if there are enough observations. The form also includes functionality to query Vizier to identify the star's identification in a range of other catalogues.to facilitate the preparation of papers for publication.

I shall provide more details about the publication process at a later time.....

Dave Herald
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