Occultation Newsletter

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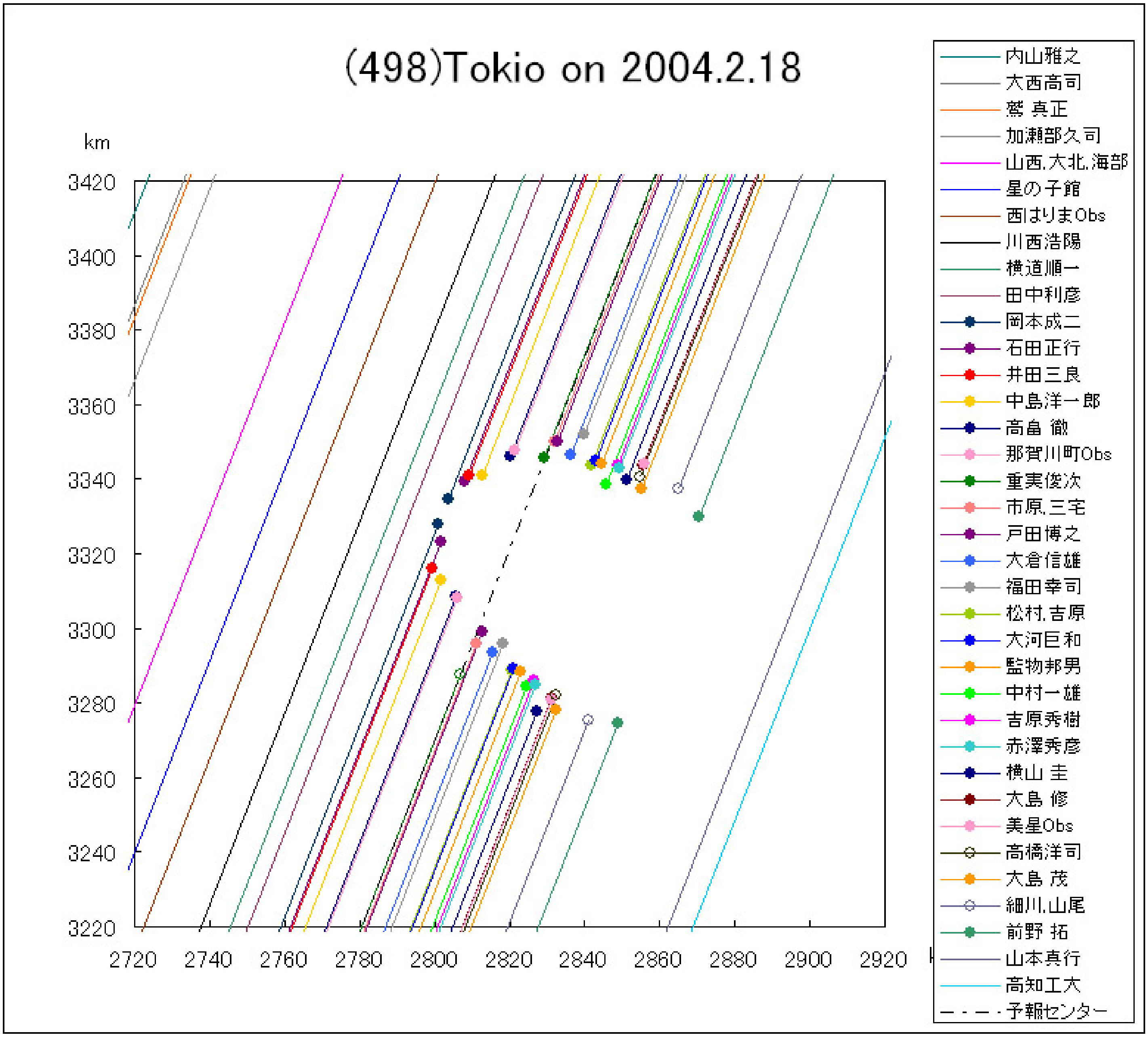

Profile of (498) Tokio

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ON THE COVER:

Profile of (498) Tokio

Profile derived from data acquired during the 2004 February 17 (UT) occultation of 7.3-mag. SAO 119951 by (498) Tokio observed from 24 locations in Japan; it was the best-observed asteroidal occultation of 2004.

This profile can be found on the WWW at: http://uchukan.satsumasendai.jp/data/occult/0402tokio.html.
Data reduction by Tsutomu Hayamizu of Sendai-uchukan.

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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 11, Number 3 will be published in mid January. Please send submissions for that issue to editor@occultations.org no later than 12 January 2005.

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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:
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Analysis of a Lysistrata "Blink"

Robert L. Sandy

I was informed by e-mail on 11/17/03 about a possible occultation of the 6.6-mag, target star, SAO 144313 (Spectral Class K5--Orange) by the faint, and very fast-moving 15th-mag. asteroid Lysistrata. The occultation was predicted to occur at about 2:20 on 11/19/03 UTC, or 8:20 p.m. CST on the evening of the 18th. This was a very favorable time for my home location at 94d 20m 42.3s west longitude and 39d 01m 40.2s north latitude. Also the predictions showed that the target star/asteroid would be at an altitude of 23-degrees at azimuth 240-degrees for my location. The 28% waning phase moon would not even have to be considered, since it would not rise till 2:a.m. the next morning.

The predictions supplied by Steve Preston indicated that I would be near the extreme southern edge of the path. Also, very noteworthy, the Preston predictions showed that Lysistrata was "really moving out" at a shadow speed of one second of time per degree of longitude across the earth's surface in the direction southwest to northeast.

About a month before this event, I decided to purchase a twice used Celestron 8", f/10 GPS Nexstar SCT. I found that the target star was on the Nexstar's menu of SAO numbered stars, --how good could it get?

Now another noteworthy item is that I came very close to moving straight east to a high hill instead of staying here at home in a mobile home park, since I had thought that the target star might be behind a tree to the southwest during the occultation period. I'm very glad I did not, since, if I had, I most likely would have had a miss.

I observed using the 8-inch, f:10, Celestron Nexstar and recorded with the PC23C camera. WWV was recorded on the audio channel. I thought I saw a "blink" at one time and commented so on the audio recording. On replay and single step I observed what I thought was a single frame occultation.

On the same occasion Walt Robinson reported a 1.1 second occultation. Walt's location is about 2 miles north and 38 miles west of mine. That seemed consistent with a path generally a bit north of his location and the 24 km diameter of the asteroid. Intrigued by the "blink", Art Lucas volunteered to try to do a digital analysis of the tape.

At Art's lab the tape was copied with arbitrary time insertion using the STVASTRO by Blackbox so as to tag each field. Several seconds of the tape were copied to computer memory field-by-field using a Panasonic, 4-head VCR and a Pixelsmart frame grabber. The several hundred images were titled and arranged for automatic analysis. An analysis program was written in Microsoft QuickBasic 4.5. The advantage of operating in this mode was that it provided for flexible "what if" of the result.

The final analysis was done by placing a box around the star, finding its peak pixel in the box, shifting the box so that the peak pixel was in the center and summing the pixels in the box. A ring of pixels around the box was used to subtract background signal.

The value of the average brightness was recorded along with the peak brightness and the x,y location of the peak. This provided some evaluation of the stability of the "seeing" as the peak moved about in the turbulent air. Typically, the peak pixel moved by as much as 5 pixels. The motion was relatively slow. It seemed to have a period of approximately one second which would seem to be explicable in terms of air turbulence. The motion in the x-direction was similar to that in the y-direction indicating that the motion was not correlated with electronic interference.

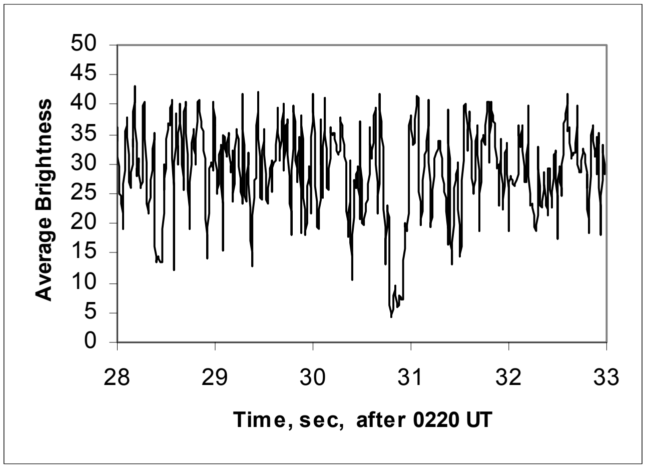

Figure 1: Brightness data during the blink

Figure 1 shows the data in a 5 second range about the identified "blink". A clear event is shown near 31 seconds. These several seconds of data provide assurance that the data are real and not just a statistical anomaly. Note that a similar, less credible, event occurs at about 28.4 seconds. The shortness of that event along with its similarity to single, statistical, occurrences leaves one with not sufficient certainty to report it as an occultation.

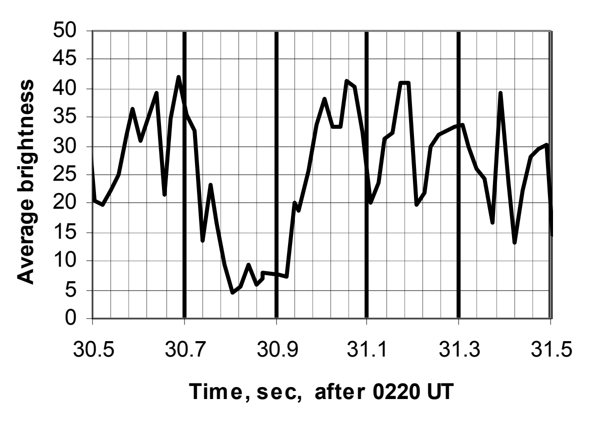

Figure 2: Expanded view of the event

Figure 2 shows an expanded view of the 31 second event. Note the sloping sides of the box indicating diffraction fringes similar to those described by Frank Anet at the 2003 IOTA meeting. While the data are available field-by-field with resolution of 16 ms, the limiting resolution of the measurement is eventually established by these diffraction effects.

We conclude that the track of the occultation passed a bit north of Walt Robinson's location and just grazed my location. The closeness of the absolute times of the measurements leaves little possibility that this was an observation of a satellite of the asteroid. The numerical analysis provides clear, statistically valid, evidence that the "blink" was not an aberration or a "blink of the eye". ■

The Probable Detection of a Moon of Asteroid 1024 Hale

Roger Venable, rjvmd@knology.net

The occultation The 41-km diameter asteroid 1024 Hale occulted the 10.8-magnitude star TYC 2372-00323 on UT February 26, 2002, at 03:35.5 geocentric, along a path across the United States from northern California to central Georgia. Since Hale was at magnitude 15.7, the occultation would appear as a disappearance of the star as seen by either visual or video observers. The predicted duration of a central occultation was 2.6 seconds. Predictions were generated by Edwin Goffin, Steven Preston, and others, and published on the Internet. The star has a color index of 0.557 and is not known to be binary. The asteroid has not had a lightcurve observation.

The observations Edward Morana observed by video from Livermore, California, 4.4 pathwidths south of the predicted centerline. He used a Watec 902H videocamera on a Newtonian telescope of 150-mm aperture, at the f /4.9 prime focus. He noted an occultation of 2.1 seconds duration, consistent with an off-center chord. The time of the occultation was within one second of the predicted time, although the one-sigma timing uncertainty in the prediction by Steven Preston was 6 seconds . Observing by video near Swainsboro, Georgia, the author recorded the appulse from a site 1.5 pathwidth north of the predicted centerline. He used a Watec 902K videocamera at the f /10 prime focus of a Schmidt-Cassegrain telescope of 280-mm aperture. The videotaped record shows the star's image stability to be good, and though there is no event consistent with a primary occultation, there is a blink 15 seconds after the predicted time. Field-by-field step-through of the blink reveals that the star is not distinguishable from the background noise on the tape for 8 consecutive fields, or 0.133 seconds.

Analysis. The blink was analyzed probabilistically using the technique promulgated by the author (See, “A statistical method to differentiate an occultation blink from atmospheric scintillation when recording on videotape,” in this issue.) Review of 600 fields on the video record around the time of the blink and including the blink itself yields 76 fields in which the star is not distinguishable from the background noise of the field, for a p value of 0.1267. A duration of observation of 60 asteroid diameters is equivalent to 156 seconds, which, at 60 fields per second, yields a value for N of 9360. The expected number of randomly occurring runs of invisibility of length 8 fields or longer in N is 0.000541, and the standard deviation is 0.0233. The occurrence of one run of length 8 is thus 43.0 standard deviations more than the expected number. It is highly unlikely that this blink was due to atmospheric scintillation, and it is highly likely that it was due to a moon of 1024 Hale.

The moon was detected at a distance on the sky of 340 km (8.25 diameters of Hale) from the primary, so this is the minimum radius of the actual orbit. Assuming that the median occultation chord is 0.87 diameter, the diameter of the moon is about 2.4 km. These figures lead to an angular separation of 0.19 arcseconds and brightness of magnitude 21.9 on the night of the occultation.

The author thanks Edward Morana for his assistance in preparing this report. ■

A Note About January 2005 Occultation Events in North America

David Dunham, President, IOTA

Seven charts of asteroidal occultations visible from North America during January 2005 are enclosed for subscribers and IOTA members in North America. These are the usual charts by Edwin Goffin, annotated by David Werner. The full Asteroidal Occultation Supplement for 2005 for North American Observers, including the charts for the rest of 2005, will either be distributed separately, or with the next ON, in January. These charts can also be accessed on the WWW. Links are provided on the O.N. page in the Member’s Section of the I.O.T.A. web pages at: http://www.occultations.org/on/index.html ■

A Statistical Method To Differentiate An Occultation Blink From Atmospheric Scintillation When Recording On Videotape

Roger Venable, rjvmd@knology.net

Introduction

Here's the problem. You are reducing data from your videotape of a lunar grazing occultation and you notice a slight blink. Is it a momentary occultation by the lunar limb, or is it a prominent scintillation? Or, you may be reducing the data from your video of an asteroidal appulse to a star, and you notice a blink. Have you discovered a small asteroidal moon?

Fortunately, atmospheric scintillation is a random process, and as such we can analyze it statistically. The statistical problem is that of determining the likelihood of a run of consecutive events when the probability of a single event is known. In this context, the event is the recording of a single video field that, due to scintillation, doesn't show the star. We ascertain the probability of this event by laboriously counting the video fields that do not show the star though no occultation is in progress. We may then calculate the probability of a run of such events occurring during the observing period, and we compare this probability to the value of one, because one such run was observed as an occultation blink.

This technique depends upon the star disappearing from view during the occultation. If the star appears to dim but does not disappear, this technique is not directly applicable.

Doing the math

I'm going to give you some equations here, but don't get excited -- I'll solve them for you. If you wish, you may skip to the next section, but some of you will want to muscle through the equations yourselves, so here they are:

let N = the sample size, i.e., the total number of video fields.

let p = the fraction of N that does not show the star.

let q = the fraction of N that does show the star, so that $p + q = 1$.

let L = the number of consecutive fields not showing the star in the possible occultation.

let m = the mean, expected number of runs of length L or longer in N.

let s = the standard deviation of the number of runs of length L or longer in a group of N-sized samples from video.

let c = the number of standard deviations from m that one run of length L or longer is.

then $m = p^L [(N-1)q + 1]$

and $s = \{m (1 - m) + p^{2L} q (N - 2L) [2 + (N - 2L -1) q]\}^{1\backslash 2}$

and lastly, $c = (1 - m) / s$

In occultation work, the critical time encompassed by N is the entire interval in which an occultation is likely. For a graze, this is a couple of minutes, and will be different for different grazes. For an asteroidal appulse, it is the time it takes the asteroid to move, say, 40 asteroid diameters (20 diameters before the predicted primary event and 20 diameters after it). Assuming that this critical time is two minutes and you are recording at 60 fields per second, N = 120 x 60, or 7200. Among that many fields, it is not practical to count those in which the star is unseen due to scintillation, so just count a few hundred and calculate p from the ones you count. In doing this, it is good to count a series of fields that are very near the time of the questionable occultation, and it is best to actually include the questionable occultation in the count. Statistically, it makes no difference whether you count fields or frames, but be consistent: 30 frames per second for two minutes yields an N of 3600 while 60 fields per second yields an N of 7200.

Since you suspect that your observed run of length L is an occultation, you expect no such runs to occur by the random scintillation process. That is, you expect m to be less than one -- typically, it is only a small fraction of unity. The standard deviation s is also typically much less than one. Given that m and s are so small, c conveys the significance of the run of length L. The equations for m and s are taken from Diem K and Lentner C., Eds. (1970). “Scientific Tables.” CIBA-GEIGY Limited, Basle, Switzerland; p195.

Working an example.

In a video of a lunar grazing occultation, you find a blink that is so brief as to be barely detectable upon full-speed playing of the tape. In field-by-field step through, you find it to contain 5 fields in which the star is not visible. Then you perform a field-by-field step through of 600 fields within a few seconds of the blink, and you find that in 42 of them the star is not distinguishable from the background noise of the field. From this, you calculate p by dividing 42 by 600, and get 0.07. Therefore, q is 0.93.The entire graze occurred over a period of 92 seconds from its first event to its last, so you decide that another 10 seconds on each side of the graze is a reasonable grazing period to study -- 112 seconds at 60 fields per second makes N equal to 6720 fields. Using L = 5, p = 0.07, q = 0.93, and N = 6720 in the equations, you calculate that the expected number m of runs of length 5 or longer during the 112 seconds is 0.0105. The standard deviation s is 0.0125. Thus, c is 9.67, which means that the occurrence of one run of length 5 or longer is 9.67 standard deviations more than the expected number. You can then rightly conclude that it is highly unlikely that your run of 5 occurred due to random scintillations, and it is highly likely that it represents an occultation by a lunar mountain peak.

Interpreting the numbers

I'll be so bold as to suggest a reasonable way to interpret these numbers. The interpretation of statistics is subjective, and you may prefer an interpretation different from mine.

The significance of c should be interpreted one-tailed, which doubles its significance. A "trend" toward significance is often considered to be present when the probability of an occurrence is found to be less than one out of ten. A probability of less than one in 100 is often considered to be highly significant. For an event in which an occultation is expected -- that is, you think you are near the shadow of a lunar mountain peak and you are looking for a blink near this moment -- I suggest that the range of one-tailed probability from one in ten to one in one hundred is "medium probability," while less than one chance of a random occurrence in a hundred is "high probability." The values of c corresponding to these one-tailed probabilities are 1.28 to 2.33 for "medium probability" and greater than 2.33 for "high probability."

If your expectation of an occultation is lower, then you need a more extreme statistic to convince you that an occultation has occurred. If you think that the chance of discovering an asteroidal moon is about one out of 50 videotapes of appulses, then you need c to be 50 times as significant as you do for the case of an expected event. Similarly, if you consider the chance of discovering a new lunar mountain peak in a well-documented lunar profile to be one out of 50 grazes, then you need statistics 50 times as significant to convince you that your video record represents a real occultation. I think that the factor of 50 in each of these cases is realistic, and I propose that we use them. Accordingly, a one-tailed probability greater than one in 500 is "low probability," while from one in 500 to one in 5000 is "medium probability," and less than one chance of a random occurrence in 5000 is "high probability." The dividing lines at 1:500 and 1:5000 correspond to values of c of 2.88 and 3.54.

To save you the trouble of working the equations, I have set up a spreadsheet that computes c. Anyone who wants an accurate calculation can write to me at rjvmd@knology.net with the values of L, N, and p, and I'll run the solution. Meanwhile, most of your needs may be met by using the following table. You will note that the transition from low significance to high significance is very rapid as L increases beyond a certain value for each value of p. ■

Table: Values of c for N = 7200, for given p and L

Likelihood of *expected* occultation: low < 1.28; 1.28 < medium < 2.33; 2.33 < high.
Likelihood of *unexpected* occultation: low < 2.88; 2.88 < medium < 3.54; 3.54 < high.
Negative values indicate that m is greater than 1.

L

		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
	.01	0.34	11.8	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.01
	.02	-1.1	3.97	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.02
	.04	low	0.84	7.39	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.04
	.06	low	-0.38	3.08	13.7	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.06
	.08	low	-1.3	1.40	6.64	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.08
	.10	.	low	0.44	3.68	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.10
	.12	.	low	-0.27	2.12	7.14	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.12
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	.16	.	.	low	0.46	2.82	7.72	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.16
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	.20	.	.	.	low	1.04	3.41	8.12	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.20
	.24	.	.	.	low	-0.04	1.50	3.83	high	.	.	.	.	.	.	.	.	.	.	.	.	.	.24
	.28	.	.	.	.	low	0.36	1.82	4.04	high	.	.	.	.	.	.	.	.	.	.	.	.	.28
	.32	.	.	.	.	.	low	0.63	2.00	4.03	high	.	.	.	.	.	.	.	.	.	.	.	.32
	.36	.	.	.	.	.	.	low	0.78	2.03	3.82	high	.	.	.	.	.	.	.	.	.	.	.36
	.40	.	.	.	.	.	.	.	low	0.82	1.93	3.45	5.71	high	.	.	.	.	.	.	.	.	.40
	.45	.	.	.	.	.	.	.	.	low	0.51	1.39	2.51	4.02	high	.	.	.	.	.	.	.	.45
	.50	.	.	.	.	.	.	.	.	.	.	low	0.85	1.67	2.69	4.04	high	.	.	.	.	.	.50
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	.60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	low	0.74	1.31	1.97	2.76	3.73	high	.60

The Probable Detection of a Moon of Asteroid 98 Ianthe

Roger Venable

The occultation: The 109-km diameter asteroid 98 Ianthe occulted the 10.5-magnitude star TYC 2452-00577-1 on UT May 16, 2004, at 01:59 geocentric, along a path in the eastern United States. Since Ianthe was at magnitude 13.6, the occultation would appear as a disappearance of the star as seen by video observers. The predicted duration of a central occultation was 2.8 seconds. Predictions were generated by Edwin Goffin, Steven Preston, and others, and published on the Internet.

The star has a color index of 0.453 and is not known to be binary. The asteroid is class C, in Main Belt Zone IIa, and has had a single light curve determination published. This showed a rotation period of 16.5 hours, with a brightness variability of 0.32 magnitude suggesting a change in the projected cross section by a factor of 1.34.

The observation: Observing from near Fayetteville, North Carolina, the author made a videotape of the appulse from a site 0.014 pathwidth south of the predicted centerline of the path. He used a Watec 902K videocamera on a Schmidt-Cassegrain telescope of 280-mm aperture with a focal reducer yielding $f/3.7$. The videotaped record shows the star's image stability to be good. The primary occultation lasted 2.8 seconds, and there was a blink 60 seconds after the primary event. Field-by-field step-through of the blink reveals that the star is not distinguishable from the background noise on the tape for 7 consecutive fields, or 0.117 seconds.

Analysis: The blink was analyzed probabilistically using the technique promulgated by the author (See, “A Statistical Method To Differentiate An Occultation Blink From Atmospheric Scintillation When Recording On Videotape,” on page 6 of this issue). Review of 600 fields on the video record around the time of the blink and including the blink itself yields 17 fields in which the star is not distinguishable from the background noise of the field, for a **p** value of 0.0283. A duration of observation of 60 asteroid diameters is equivalent to 168 seconds, which, at 60 fields per second, yields a value for **N** of 10,080. The expected number of randomly occurring runs of invisibility of length 7 fields or longer in **N** is 0.000 000 143, and the standard deviation is 0.00038. The occurrence of one run of length 7 is thus more than 2600 standard deviations greater than the expected number. It is highly unlikely that this blink was due to atmospheric scintillation, and it is highly likely that it was due to a moon of 98 Ianthe.

The moon was detected at a distance on the sky of 2340 km (21.5 diameters of Ianthe) from the primary, so this is the minimum radius of the actual orbit. Assuming that the median occultation chord is 0.87 diameter, the diameter of the moon is about 5.2 km. These figures lead to a brightness of magnitude 20.2 and an angular separation of 1.2 arcseconds on the night of the occultation.

Comment: According to S. J. Weidenschilling, such a small moon at such a distance from the primary will not cause tidal locking of the primary's rotation within the lifetime of the solar system. It is unclear how much this moon has contributed to the relatively slow rotation of Ianthe. ■

Publication Schedule of the Occultation Newsletter in 2005

John Graves, Editor

While I must admit publication of the Occultation Newsletter has not been exactly on the regular schedule for which I had hoped, there have been four issues released in 2004 and I consider that a good year.

In 2005, I hope to publish 6 issues and finally realize my long-time goal of actually releasing issues during the month of their cover date. To this end I am publishing my intended schedule for publication of Occultation Newsletter for the upcoming year.

Volume 11, Number 3, the July 2004 issue, will be published in mid January 2005.

Volume 11, Number 4, the October 2004 issue, will be published in mid March 2005.

Volume 12, Number 1, the January 2005 issue, will be published in late April 2005.

Volume 12, Number 2, the April 2005 issue, will be published in mid June 2005.

Volume 12, Number 3, the July 2005 issue, will be published in mid August 2005.

Volume 12, Number 4, the October 2005 issue, will be published in late October 2005.

You can help me make this goal a reality by submitting your articles for publication to: editor@occultations.org. Despite the difficulties in getting issues out on a regular schedule in the past, I pledge that I will do my best to make these publication dates as outlined above.

Recently I’ve learned of many submissions that did not reach me due to email problems. These problems have been resolved and I assure you that any future submissions will be printed promptly. I sincerely thank all of you for your submissions and your continued support. ■

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 20,00 to the account IOTA/ES; Bartoldknaust Strasse 8; D-30459 Hannover, Germany; Postgiro Hannover 555 829-303; bank code number (Bankleitzahl) 250 100 30. 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.

IOTA's Telephone Network

The Occultation Information Line at 301-474-4945 is maintained by David and Joan Dunham. Messages may also be left at that number. When updates become available for asteroidal occultations in the central USA, the information can also be obtained from 708-259-2376 (Chicago, IL).