Occultation Newsletter

Volume VI, Number 3   July, 1994   ISBN 0737-6766

Published quarterly by the International Occultation
Timing Association
Joan Bixby Dunham, Editor

Occultation Newsletter

Volume VI, Number 3 July, 1994 ISBN 0737-6766

Occultation Newsletter is published by the International Occultation Timing Association. Editor: Joan Bixby Dunham; 7006 Megan Lane; Greenbelt, MD 20770-3012; U.S.A. Please send editorial matters to the above. Send new and renewal memberships and subscriptions, back issue requests, address changes, graze prediction requests, reimbursement requests, special requests, and other IOTA business, but not observation reports, to: Craig and Terri McManus; 2760 SW Jewell Ave.; Topeka, KS 66611-1614; U.S.A.

FROM THE PUBLISHER

For subscription purposes, this is the first issue of 1994. It is the third issue of Volume 6. IOTA annual membership dues, including ON and supplements for U.S.A., Canada, and Mexico $25.00
for all others 30.00

Annual IOTA membership dues may be paid by check drawn on an American bank, money order, cash, or by charge to Visa or MasterCard. If you use Visa or MasterCard, include your account number, the expiration date, and your signature.

ON subscription (1 year = 4 issues)
for U.S.A., Canada, and Mexico 20.00
for all others 25.00

Single issues are 1/4 of the price shown.

Although they are available to IOTA members without charge, nonmembers must pay for these items:

Local circumstance (asteroidal appulse) predictions 1.00
Graze limit and profile predictions (per graze) 1.50
Papers explaining the use of the predictions 2.50

Asteroidal occultation supplements will be available at extra cost: for South America via Orlando A. Naranjo (Universidad de los Andes; Dept. de Fisica; Merida, Venezuela), for Europe via Roland Boninsegna (Rue de M ariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa via M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand via Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan via Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (11781 N. Joi Drive; Tucson, AZ 85737; U.S.A.) for $2.50.

Observers from Europe and the British isles should join IOTA/ES, sending DM 40.- 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.

IOTA NEWS

David W. Dunham

This Issue: This issue is being distributed with issue 2 of Volume 6. This issue contains notices about meetings, articles about previous observations and double stars, and predictions. Information on possible occultations and impacts by Comet Shoemaker-Levy 9 starts on the next page.

IOTA Annual Meeting: The 12th annual meeting of IOTA was held in El Paso, Texas, on May 7-8, 1994, as intended from the announcement on p. 2 of last November's issue. Walter Morgan, Livermore, Calif., made the arrangements for the meeting, and the McManuses distributed a notice about it to the membership so that they would receive it more than 30 days before the information. This partly repeats what was said in that notice, for the official record.

The IOTA meeting was held at Insights--El Paso Science Museum, 505 North Santa Fe Street, in downtown El Paso, Texas. The Science Museum's Physics Classroom was used by IOTA from 10am - 5pm on Saturday, May 7, and from 9am - noon on Sunday, May 8. Each person attending paid the Center's usual $2.00 admission fee for Saturday (Sunday was free since the center was closed to the public then), but there was no other charge. Walter Morgan took minutes of the meeting, and his report will appear in the next issue.

ESOP-XII Abstracts: Abstracts of the 12th meeting of the European Symposium on Occultation Projects held in Roden, the Netherlands, last August [**ON 5** (11), pp. 280-281 and **ON 6** (1), p. 1] were published early this year in Dutch and in English by the Werkgroep Sterbedekkingen of the Nederlandse Vereniging voor Weer- en Sterrenkunde (Dutch Occultation Association) and were distributed to participants of the meeting.

Next Issue and 1994 Planetary Occultation Data: The main purpose of the next issue will be to describe IOTA's planetary occultation predictions for the rest of 1994 (also in the next issue will be an article by Edwin Goffin giving predictions for some of the better occultations by the larger asteroids during the rest of this century). It was not possible to generate the 1994 planetary/asteroidal occultation information for this issue due to the work needed for generation of the lunar total and grazing occultation predictions in a new, distributed way (see "Lunar Occultation Prediction News" starting on p. QQ). In the meantime, you can rely on Edwin Goffin's predictions for 1994, which were distributed last year, mainly with last November's issue of **ON** for North American subscribers.

We want to produce the next issue by mid July, so any time-critical contributions for it need to be received by the first week of July. In addition to the planetary occultation predictions, the next issue will include a report of last month's IOTA meeting and an article about the impact of the Hipparcos and Clementine missions on occultation work. Although the Clementine spacecraft failed before the planned (1620) Geographos flyby, its lunar mapping mission was very successful.

The computer database for the IOTA 1994 planetary/asteroidal/cometary occultations will be ready sometime in late June, and will be distributed to the lunar occultation prediction coordinators, who will then use PC software to generate and distribute the local circumstance appulse predictions to IOTA members. Joe Carroll has done a good job generating and distributing these predictions for many years; he can now concentrate on other work, such as getting caught up with the lunar total occultation tallies.

There are many new developments, and much activity, regarding astrometric updates for asteroidal occultations. Petr Pravec and colleagues at Ondrejov Observatory in the Czech Republic have led this work. Some details of this will be in the next issue.

ESOP - XIII

The 13th European Symposium on Occultation Projects will be held at the Polonia Institute of the Jagiellonian University in Przegorzaly, a suburb of Cracow, Poland, from Friday, August 12th to Wednesday, August 17th, 1994. It will be hosted by the Polish Amateur Astronomers Society (PTMA), Section of Observation of Positions and Occultations, together with the Planetarium and Astronomical Observatory of Lodz. Registration and Lecture Specification forms have been distributed by IOTA/ES and to a few IOTA members in the U.S.A.; copies are available from either IOTA or IOTA/ES at the addresses given on the back page of this issue, or by E-mail from the organizers, whose Internet address is: esop@mitr.p.lod.edu.pl), or by anonymous FTP from the /pub/esop directory of mitr.p.lod.edu.pl (193.59.42.130).

The main part of the meeting will start the evening of Aug. 12 with a meeting of IOTA/ES. Scientific sessions will be held on Sat., Aug. 13, and the morning of Sun., Aug. 14, followed by sightseeing in Cracow. Aug. 15 - 17 will include optional excursions to other interesting places in and near Cracow, and to the Gorce mountains.

Cracow is served by direct flights from major European airports. In addition, there are rapid train connections approximately hourly from Warsaw. The symposium fee of $60 for participants (but not their guests) includes the closing dinner and symposium documentation, should be paid by June 30th to an account given in the registration materials; after June 30th, the fee increases to $90. The daily accommodation costs are about $22 for a double room and about $15 for dinner.

The dates in the first ESOP-XIII announcement distributed in January were one week later than those given above. But those dates were in the middle of the 2-week General Assembly of the International Astronomical Union in Hague, the Netherlands. So the dates were changed to those specified above in another announcement that was distributed at the end of March.

Contributed papers are welcome; about 20 minutes will be allowed for each. The symposium languages will be English and German. Papers, which can be submitted by E-mail, were due May 31, but abstracts can be accepted a month later. Requirements for papers should be directed to Marek Zawilski; Planetarium and Astronomical Observatory; ul. Pomoska 16; 91-416 Lodz, Poland, telephone (48 42) 331363, 555975, or 841500 (answering machine), or by E-mail to the above Internet address. Already more than three dozen observers have registered, representing Belgium, the Czech Rep., England, Finland, France, Germany, the Netherlands, Portugal, Russia, Ukraine, the USA, and Poland, so it promises to be an interesting meeting.

COMET SHOEMAKER-LEVY 9: CLOSE APPULSES TO STARS AND JUPITER IMPACT OBSERVATIONS

Edwin Goffin and David W. Dunham

History of Appulse Predictions: Steve Edberg suggested to David that possible occultations and appulses to stars by the fragments of Comet Shoemaker-Levy 9 (SL-9) be predicted. Remembering the dismal experience with occultations by Halley's Comet and a few other comets, just many unconfirmed dimmings that could have all been Earth-atmospheric in origin, David was not enthusiastic about this and was deeply occupied with matters that he felt were more important for IOTA.

In late February, R. Vasundhara, Indian Inst. of Astrophysics, Bangalore, sent an article, "Appulses of faint stars by fragments of Comet Shoemaker-Levy 9", in LaTeX format via e-mail to David for distribution. Vasundhara used orbital elements for 9 fragments provided by D. Yeomans and P. Chodas at JPL last December. David forwarded the article by e-mail to a few others, and Wayne Warren printed the article using the LaTeX format.

In early March, David asked Edwin to verify Vasundhara's calculations. Edwin used orbital elements computed in February and confirmed only one of Vasundhara's events. Since none of Edwin's events occurred until June and David was heavily occupied with grazing occultation work at the time, nothing more was done until early April. Then David noticed that Edwin had used 10 km as the diameter of the fragments, which is a large value for them, but Edwin's search program only selects events when the motion is mainly in declination for such small objects. Edwin increased the size and generated predictions for dozens of appulses, including one of a 7th-mag. star that was favorable for most of the Americas on April 15th. That event had been identified by Vasundhara as the best one that he found, but Edwin's predictions were needed for verification and to determine the region of visibility. There was only time to distribute predictions of it by e-mail.

Edwin sent charts of the events to David for distribution to observers. Most IOTA members can not effectively monitor stars fainter than mag. 11, especially for the quick, small changes in brightness that were expected. About 7 events through the end of May involved stars this bright, and predictions for them were distributed by e-mail. Edwin's charts for the two remaining events visible from North America were included in the mailing for the May 10th annular eclipse described in the last issue.

So far, as for previous cometary appulses, only a few unconfirmed dimmings have been reported. When observing though the Earth's atmosphere, photometric or good CCD or video observations at two nearby stations are really necessary for comfirmation; visual observations are not very effective for monitoring these events.

Future Appulses: No more of the appulses to stars brighter than 12th mag. will be visible from North America. Before the impacts, there will be 3 close approaches (with possible occultations by fragments) of SL-9 to PPM stars listed in Table 1; two of the events might be seen in Europe and Africa. Edwin has calculated predictions for appulses of several GSC stars that are not in the PPM, but they involve stars fainter than mag. 12.0 so they are not included. In the table, the number of the fragment that will pass closest to the star is given under "frg. #". The range of times of closest approach, taking into account horizontal parallax, are given in the last columns, giving the UT hour, then the range of minutes counted from the start of that hour. Thus, "20 40-100" means 20:40 UT to 21:40 UT.

PPM 228342 occulted on June 23rd = SAO 158378, spectral type K2, and PPM 228380 occulted on July 8th = SAO 158388, spectral type K5. As a guide to help locate the target stars, the approximate J2000 coordinates of Jupiter are given in Table 2, for differential offsetting with setting circles. More accurate J2000 coordinates of two nearby bright stars that might also be used for this purpose are: λ Virginis, R.A. 14h 19m 07s, Dec. -13° 22.'3 and α^2 Librae, R.A. 14h 50m 53s, Dec. -16° 02.'4. The stars occulted on June 23, July 3, and July 8 are each circled and labelled with the day of the month on Goffin's detailed chart, and Jupiter's approximate positions on the corresponding dates are also shown. The speed of SL-9 past the stars is 2.4, 5.0, and 7.1 km/sec on June 23, July 3, and July 8, respectively, so even an occultation by a fragment, each of which is probably less than 2 km across, will be brief.

The world views are from the occulted star at the times shown, based on April predictions. As you can tell from Table 1, the events are now predicted to occur about half an hour later, based on late May orbital elements. Consequently, the heavy curve crossing each chart actually represents the locus where the setting Sun is about 7° below the horizon, rather than the originally-calculated sunset terminator.

Impact Observations: Extensive information about observing the impacts is given in the July 1994 issue of **Sky and Telescope**, pages 31-35. Some IOTA members have CCD cameras which, when used with large telescopes, and possibly filtration or aperture stops to allow imaging of Jupiter's cloud bands and large spots, might be able to record some effects of the impacts.

As noted on p. 34 of **S&T**, observers in Australia and New Zealand are best positioned for seeing an impact reflection from an eclipse satellite, Europa when fragment K impacts just after 10h U.T. July 19. The impacts might also illuminate Jupiter's ring, part of which will always be eclipsed, but the ring will have to be illuminated many times more brilliantly than by the Sun to become readily visible.

Impact Predictions: World maps by L. Wasserman at Lowell Obs. show the regions of visibility of each of the impacts on p. 34 of the July **S&T**, using times predicted as of late April. Updated times will be available by

Table 1. Remaining Close Appulses of Comet Shoemaker-Levy-9 Fragments to PPM Stars

1994 Date	Star PPM	mag.	R.A. 2000 h m s	Dec. 2000 ° ' "	R.A. 1950 h m s	Dec. 1950 ° ' "	frg. #	UT Range h m m
Jun 23	228342	8.3	14 22 20.500	-14 25 28.7	14 19 36.903	-14 11 50.16	1	20 40-100
Jul 3	228372	9.7	14 17 48.560	-13 52 23.5	14 15 05.624	-13 38 33.69	14	20 35- 60
Jul 8	228380	8.9	14 16 43.776	-13 43 58.2	14 14 01.001	-13 30 05.76	5	14 0- 30

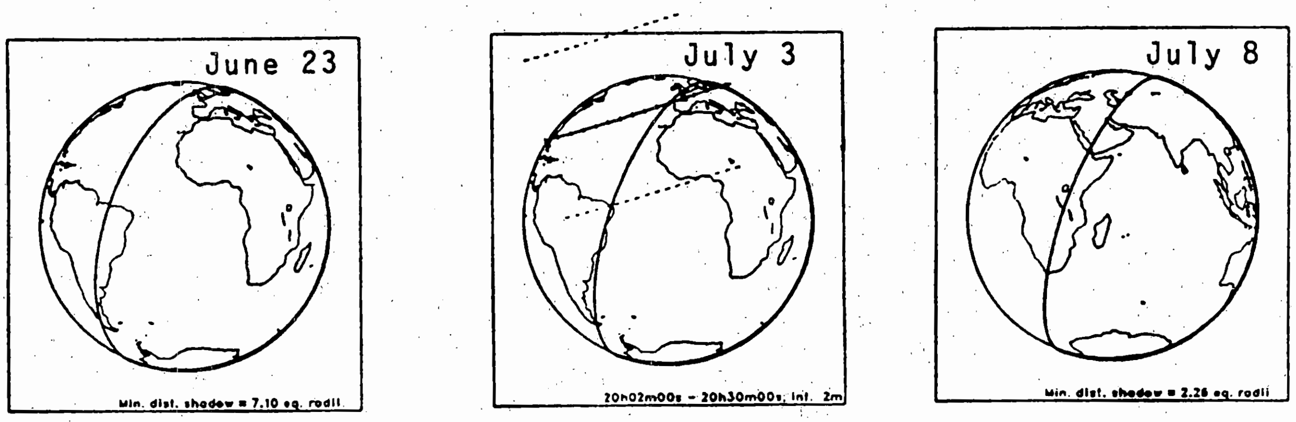
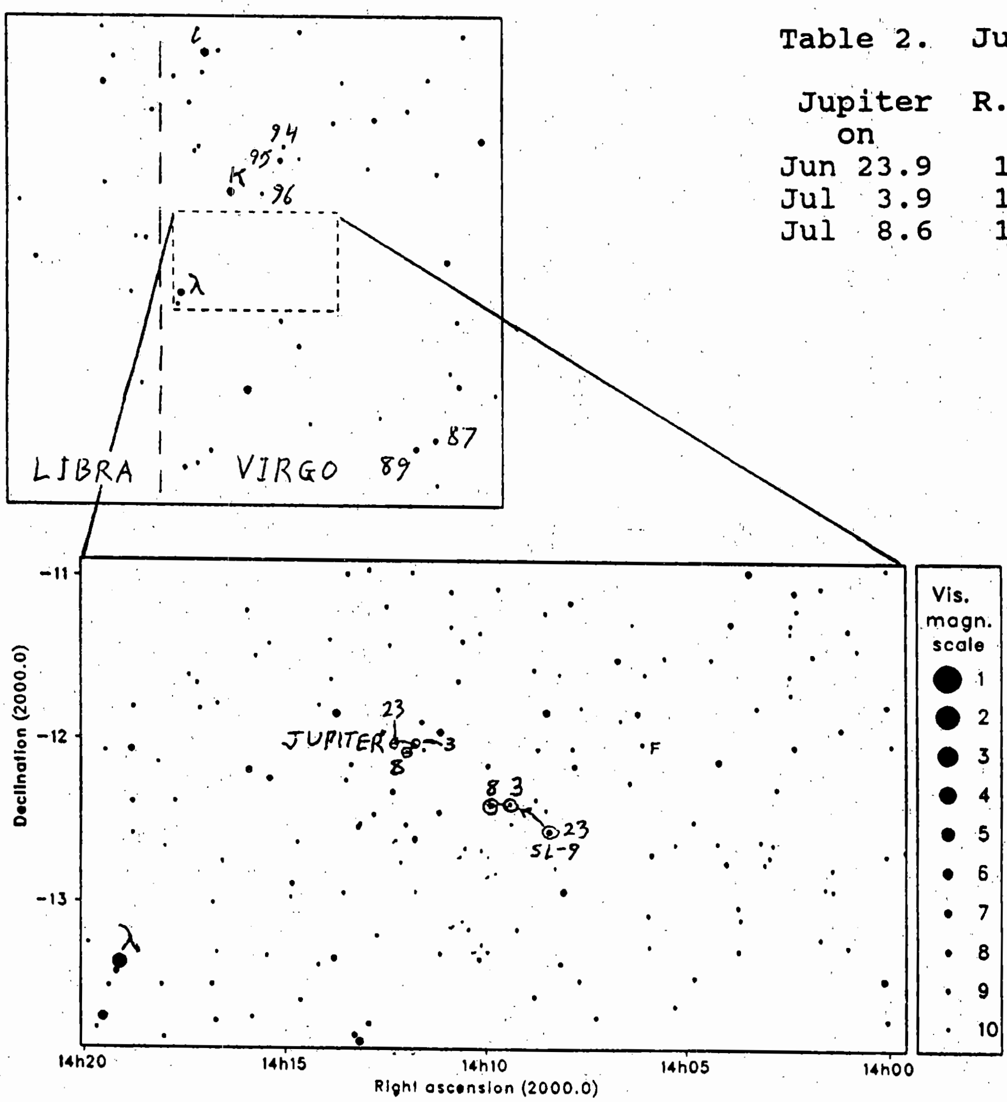


Table 2. Jupiter Positions

Jupiter on	R.A.2000 h m	Dec.2000
Jun 23.9	14 12.3	-12° 01'
Jul 3.9	14 11.9	-12 01
Jul 8.6	14 12.1	-12 03



telephone at 1-617-497-4168 and 1-900-884-6722. The updated times could differ from those given in the **S&T** article by more than an hour; even updated times that will probably be given in the August issue could still be off by a large fraction of an hour. When assessing the region of visibility figures, compare the times used with the updated times. For example, if the updated time is an hour later than the used time, the Earth will have rotated 15° farther from west to east.

Table 3. SL-9 Fragment Impact Time Predictions, JPL, June 12

Fragment	Impact Date/Time July (UT)	h m	Error m	Note
A = 21	16	19:50	±22	
B = 20	17	02:46	20	
C = 19	17	06:50	20	
D = 18	17	11:11	23	
E = 17	17	15:17	14	
F = 16	18	00:16	18	
G = 15	18	07:36	13	
H = 14	18	19:35	13	
K = 12	19	10:26	13	II ecl.
L = 11	19	22:24	13	
N = 9	20	10:09	22	
P2= 8b	20	14:58	21	Split
Q2= 7b	20	19:40		"Theory"
Q1= 7a	20	20:07	12	
R = 6	21	05:47	17	
S = 5	21	15:39	14	
T = 4	21	18:28	41	
U = 3	21	22:52	68	
V = 2	22	03:54	28	
W = 1	22	08:21	17	

For IOTA members for whom we have geographical coordinates, we plan to include the SL-9 impact predictions with the planetary/asteroidal appulse/local circumstance predictions so that you will have the altitudes and azimuths of Jupiter, the Sun, and the Moon computed for your site. We will use the best-available impact times as of late June for the calculations. The impact times, based on early June orbital elements, including observations through 1994 June 8, are in Table 3. The notes also indicate that fragment K will impact during an eclipse of Europa and that fragment P=8b has split, but that separate predictions of the impact times for its two parts cannot be made now. Fragments J=13, M=10, and P1=8a have faded away and are not included in the table. Fragment 7b is the fainter of the split Q fragments that were first seen separately in January HST images; its orbit has not been separately determined except from a theoretical calculation based on an assumed rate of motion from the brighter fragment 7a.

ASTEROIDAL SATELLITES REVISITED

David W. Dunham

On March 23, a press conference was held at the Jet Propulsion Laboratory (JPL) to release a photo taken by the Galileo spacecraft of 243 Ida and a small satellite nearby. By now, you have probably seen the picture, which was published in many newspapers and magazines, and has been shown in many television newscasts. Of course, this is an important development, since it is the first conclusive evidence that satellites exist now in orbit about asteroids. However, there have been many observations of "secondary occultations" seen during asteroidal occultations that IOTA has accumulated, and Maley and I suggested that satellites of asteroids were probable in 1977, see **ON 1** (11), pp. 115-117 and **Bull. Amer. Astron. Soc. 9**, p. 621. So I take strong exception to headlines such as "First Asteroid Moon Found" above a picture of Ida and its satellite on p. 18 of the July 1994 issue of **Astronomy** magazine.

Based on information that I had provided, earlier evidence for satellites of asteroids "from sightings in the late 1970's" was mentioned at the press conference, but there was no explicit mention that these sightings involved occultations and were made primarily by amateur astronomers.

Apparently, we haven't been completely overlooked; Robert Sandy reported that on one of the morning talk shows, the subject was introduced with a sentence something like this: "Galileo has now proven what the amateur astronomers have been saying all along, that asteroids can have moons of their own". And the article showing the Galileo image of Ida and the satellite in **Science News 145** (14), p. 214 concluded: "Some scientists recording the decline in light when an asteroid passes in front of a star have reported a brief 'blinkout' before or after the actual eclipse. They have attributed these blinkouts to asteroid moons. The discovery of Ida 2 may lend more credibility to these reports, the Galileo team says." I am interested in any publicity that you find out IOTA gets from this.

The best occultation evidence for an asteroidal satellite remains a secondary occultation of a 6th-mag. star by (532) Herculina that was observed visually by the late James McMahon, and photoelectrically by Ted Bowell and Mike A'Hearn at Lowell Observatory in June 1978. For details, see "532 Herculina as a Double Asteroid", on p. 210 of the September, 1978, issue of **Sky and Telescope**; an abstract, "A Possible Satellite of Herculina", published in the **Bull. Amer. Astron. Soc. 10**, p. 594; and more information in **ON**, Vol. 1 (15), pp. 151-152 and Vol. 2 (1), pp. 2-3, which includes the final version of the figure showing McMahon's 7 observed extinctions and the chords of the other observers.

A chapter, "Satellites of Asteroids", by Van Flandern, Tedesco, and Binzel, was published in the 1979 **Asteroids** book published by the University of Arizona Press and discusses the subject rather thoroughly. An article from the opposition, "The Absence of Satellites of Asteroids", published in **Icarus** in 1987, reports extensive negative ground-based direct searches for asteroidal satellites. Such efforts are bound to fail due to the blurring caused by the atmosphere, the faintness of asteroidal satellites, and their close proximity to the much brighter "primary". Space-based observations have the best chance for revealing these objects, followed by radar and occultations. The idea of asteroidal satellites has gained more favor during the last few years with the radar discovery of the contact-binary nature of Castalia and Toutatis, but the occultation evidence and now Galileo have demonstrated that asteroids have satellites in orbit about them now.

More about Ida: On March 28-29, a meeting of the American Astronomical Society's Division on Dynamical Astronomy was held in Kingsville, Texas. The first presentation the morning of March 29th was a late paper addition about the Ida satellite given by Paul Weissman and Alan Harris of JPL. They gave an interesting account of how the satellite was discovered from the scanty data that could be transmitted only slowly from Galileo's low-gain antenna, and commented on the implications of the satellite. Weissman and Don Yeomans gave an update at a NASA Small Bodies Science Working Group meeting in Washington, DC, on May 20th. Three visual images of Ida showing the satellite at different times were shown. The orbit is poorly determined due to the unlucky coincidence that the plane of Galileo's flyby trajectory is very close to the satellite's orbit plane, and the location of Ida's center of mass is not known well. The preliminary density of Ida is 4 gm/cm^3. More images yet to be downloaded will help this problem, and one of them is likely to have 3 times the resolution of the image of the satellite that has been released and widely published.

After the talk about Ida on March 29th, I gave a talk entitled "Natural and Artifical Satellites of Asteroids", the abstract of which was published in the current issue of **Bull. Amer. Astron. Soc. 26** (2), p. 1020. I presented the history of secondary occultation observations discussed in this article.

A Call for More Obervations: Now that the existence of asteroidal satellites has been proven, this means that anyone observing an appulse within 10 asteroid diameters has a chance for seeing a secondary occultation. As many as possible should observe such appulses, not just those for which last-minute astrometry indicates a good chance of seeing the main event in your area. But, as I stated over 15 years ago, especially those outside of the probable main event area should get someone else to observe preferably more than 1 km away alongtrack to ensure independent confirmation. What is needed are independently-confirmed observations made at high altitude under good conditions, preferably with one of the stations making a photoelectric or video record of the event. With the many asteroidal appulses and occultations that I have observed, I have seen no secondary extinctions that I would claim are not terrestrial. Although the gravitational sphere of influence of most asteroids is about 100 diameters, I think that the odds decrease rapidly with distance from the asteroid. Most reported secondary occultations are within 10 diameters of the asteroid.

Effectively seconding this call, Roger Sinnott writes on p. 92 of the 1994 July issue of **Sky and Telescope**: "Occultations of stars, long a popular pursuit among highly mobile and dedicated observers, are suddenly attracting wide attention as a technique for revealing the peculiar shapes and satellites of asteroids in the wake of such discoveries for 4769 Castalia and 243 Ida."

NEAR Mission: I look forward to the first artificial satellite of an asteroid. If current plans are followed, this will occur in February 1999 when the Near Earth Asteroid Rendezvous (NEAR) spacecraft is put into orbit about the largest near-Earth asteroid, (433) Eros. If Eros has any natural satellites, NEAR will be an even more interesting mission; a brief unconfirmed secondary occultation was reported by Larry Nadeau during the 1975 January occultation of κ Geminorum by Eros. I am currently working on trajectory design for NEAR at the Johns Hopkins University's Applied Physics Laboratory in Laurel, MD.

LUNAR OCCULTATION PREDICTION NEWS

David W. Dunham

Detailed Total Occultation Predictions: Do you need detailed total lunar occultation predictions for the rest of 1994? If so, contact the national or regional coordinator who is now providing these (formerly "USNO") predictions for your area using the PC version of the EVANS program described on pages 16-18 of last November's **ON**. In the instructions that I sent to the coordinators, I recommended that they send printed predictions covering only Jan. - March, 1994, and that those needing printed predictions for April - Dec. would get them from the International Lunar Occultation Centre (ILOC) in Tokyo via a print file of these predictions that I would supply on magnetic tape. Nearly all of the coordinators didn't follow this advice, and distributed predictions for the whole year to all of their active observers. Most of the observers are receiving predictions on PC diskettes, and all of them received predictions for the full year. Last November, I sent a tape with a print file of the 1994 EVANS (IOTA) predictions for all of the observers with photoelectric option to ILOC, and they printed and distributed it. I have not had time to prepare a tape for the others to send to ILOC, so for those few observers who may not have predictions for the later part of 1994, we'll just supply them upon request.

Observers in Germany and nearby countries were informed that they would need to join IOTA/ES if they wanted to receive the 1994 predictions, and were not currently members. IOTA plans to do the same for 1995, but IOTA membership was not a requirement for the 1994 predictions. IOTA will prepare a price list for the predictions, and identify those in the PC-EVANS prediction address files who are current IOTA members. Many IOTA members for whom we have accurate geographical positions are not in the PC-EVANS address file. I have given information to Walter Morgan so that he can assign address and station codes to these observers and incorporate them into the system so that they can receive predictions. But before he can do this, he needs the telescope aperture used by these observers to determine the observability code that is used to limit the predictions to observable events. He will distribute forms requesting this. I know that the European coordinators have added many stations and observers to provide a more comprehensive prediction service in their countries.

For 1994, most observers outside of Europe and North America received predictions calculated by ILOC with their own program rather than PC-EVANS predictions. The ILOC predictions have none of the special features of the EVANS predictions described on p. 16 of the November **ON**, and they do not include the event vertex angle, about which one observer made an inquiry. Unfortunately, we do not yet have a good coverage of PC-EVANS prediction service for most areas outside of Europe and North America. I am seeking coordinators in those areas who have the necessary resources described on pages 17 and 18 of the November **ON**. If you are on the "USNO" active list and have only ILOC predictions, you can request EVANS predictions from the coordinator for your region, or from Walter Morgan if there is no coordinator for your region.

Below is a list of countries, USA States, and regions, including region and subregion codes in parentheses and the name of the coordinator supplying predictions for the region. Addresses, and often telephone numbers and e-mail addresses, are given in the 1993 May Combined IOTA/IOTA-ES Roster, or below if new.

NORTH AMERICA:
DC, MD, VA, WV, NC e. of 80° (A1,A4) - D. Dunham
Ohio, Penn. (A6, A8) - American Lunar Society (Francis Graham), 412-8291485; 216-3853805 after August
Rest of n.e. USA, e. Canada (Rest of A, XB) - Brad Timerson
Florida (D1) - Tom Campbell, Jr.
Rest of s.e. USA (Rest of D) - Mike Kazmierczak; 624 Edgewater Circle; Conyers, GA 30208; 404-760-8502
Midwest, Manitoba (C) - Richard Wilds
South-central USA (E) - Rocky Harper
West USA, PR, w. Canada, Mexico (B, F, H, P, XR, XN) - Walter Morgan

EUROPE, U.K, and IRELAND:
U.K., Ireland (U1, U6) - Andrew Elliott
Netherlands-DOA (U7) - Henk Bril
Netherlands-NADIR (UN) - Henk Bulder

Belgium, France (I5, U5, U8) - Pierre Vingerhoets
Poland (Z5) - Marek Zawilski
Sweden, Norway (U9) - Paul Schlyter
Finland (XE) - Matti Suhonen
Other central, n.w., & s.e. Europe, Malta (U2,U3, U4,Z1,Z2,Z4,Z7,Z8) - Reinhold Büchner
Spain, Portugal (I1, I2, XA) - Joaquim Garcia
Italy (Z6) - Claudio Costa

OTHER AREAS:
Southeast Asia (K, O5, O6, Q, XP, XV) - W. C. Yue

Henk Bril is actually using his own prediction program, which largely duplicates the PC-EVANS predictions; Ton Shoenmaker has the PC-EVANS program and files in the Netherlands. Rick Frankenberger and Michael McCants (Austin) also have PC-EVANS in Texas, and may be generating some of the predictions for observers there in 1995. Local coordinators may soon be able to supply PC-EVANS predictions in Japan, New Zealand, and Australia; if so, they will be announced in future **ON**'s.

Nearby-Station Predictions: The OCCLIST program by Henk Bulder reads a prediction file generated by PC-EVANS and uses the **a** and **b** factors to produce an output file for a nearby station whose coordinates you specify. A range of dates and a higher observability-code limit can be specified, and the output is in chronological order, unlike the main EVANS predictions. OCCLIST can effectively replace the STANCOV program. OCCLIST needs no special standard-station file, takes up only about 50 kilobytes, and doesn't need a math co-processor. So virtually any observer who can receive predictions on diskette could use OCCLIST to generate neighboring-station predictions, useful for graze expeditions and other purposes when PC-EVANS predictions can not be generated easily. The OCCLIST package contains a 376-kilobyte sample prediction file that can be deleted after the program is installed and tested. Just read the occlist.doc file for directions on how to use it. The input prediction file needs to have the standard format; the program will not work with condensed-format or photoelectric-option prediction files. "Graze nearby" and other EVANS special message lines are not included in the output file. OCCLIST will be distributed by the coordinators to those who receive data on diskette with the next prediction distribution.

New OCCULT Program: A new version (2.0) of David Herald's OCCULT program is now available. The widely-distributed first version is discussed in **ON 5** (12), pp. 306-307. The new version works nearly the same way as the first version, making it possible to calculate predictions for any year from 0 to 9999 A.D., if you can specify Delta-T values for the year in question (the supplied Delta-T table extends from 1860 to 1999). Some of the new features of OCCULT 2.0 are:

1. Occultations of major planets are now included.
2. Component magnitudes, separations, and p.a.'s of double and triple stars are given. These are given in the IOTA graze predictions, but not in the PC-EVANS predictions. In the graze predictions, the sep. and p.a. are calculated from orbital elements, when the latter are available, but OCCULT only gives the semi-major axis as the "sep." in these cases, with no p.a. Besides fixing this problem, it would also be useful to use the event radial rate and p.a., and magnitudes, to calculate the predicted durations and mag. drops of step events, something that I've wanted to do with the EVANS program, but never had time to implement.
3. OCCULT 2.0 includes more detailed variable star information than that given by EVANS.
4. OCCULT 2.0 has provision for a few of the major geodetic datums, resulting in more accurate predictions, agreeing within 1 second of the PC-EVANS times in most cases.
5. If the distance to the terminator is less than 20″, it is included in a statement in the predictions.
6. Predictions of Q-catalog stars are possible, but these are not so useful now that the 1992 and 1993 lunar eclipses are past.
7. Schaefer's observability calculations are now used. The program asks for the telescope aperture and an offset for the observability threshold, in case more experienced observers want data for more events than might normally be visible with their telescope. The program indicates those events that are within a magnitude of the threshold.

The major problem with OCCULT 1.0 was that events, especially grazes, within an hour or so of 0h U.T. were often skipped, due to the way the predictions are calculated on a daily basis. Unfortunately, this problem has not been fixed with OCCULT 2.0, so observers in eastern N. America, S. America, Europe, and Africa will need another source of predictions if they want complete night coverage. Nevertheless, OCCULT is very useful for predictions for temporary sites and other special purposes, and will give much more accurate times than OCCLIST, especially for locations more than 20 km or so from the base station.

A copy of this new OCCULT program will be distributed to each of the graze computors and PC-EVANS coordinators the next time other material is distributed to them on diskettes. The program can be purchased by others from Walter Morgan; 10961 Morgan Territory Rd.; Livermore, CA 94550; USA. The cost is $5.00 for IOTA members and $10.00 for others, with a check drawn in US funds made out to Walter V. Morgan. OCCULT 2.0 is provided on 3 high-density 3.5-inch

MSDOS diskettes and needs a VGA monitor and about 4 Megabytes. If you have the original OCCULT, version 1.0, you need to remove it before installing 2.0. Although the problem was corrected for some of the later installations, the OCCULT 1.0 install process made the Watts dataset a read-only dataset that prevents its deletion with the usual DOS del command. Before deleting it, you need to go to the \occult\watts subdirectory and type: attrib watts.dat -r [enter]. It would have been better if the OCCULT 2.0 package included a .bat file that would delete the OCCULT 1.0 directories and their contents (save any desired prediction output files before doing this). As far as I can tell, the OCCULT 2.0 installation does not force the watts.dat file to be read-only.

Herald has found some differences with the EVANS observability calculations, and has requested intermediate output from EVANS to trace this down, but I have not had time to produce this information.

Detailed Grazing Occultation Predictions: Thanks to Herculean efforts by Eberhard Riedel in Munich, Germany, we now have a comprehensive PC-based grazing occultation service that is independent of the IBM mainframe computers that IOTA had used for its service for more than 25 years. This "Grazereg" software was distributed to the current grazing occultation computors listed in the last hemispheric grazing occultation supplements late last December, so we did have some problems getting predictions to observers during the first months of 1994. Some errors and deficiencies were found in the software that were mostly corrected in March. The new predictions give essentially the same information as the previous IOTA predictions; the few differences in the formats were explained in papers prepared by Riedel and included with the first predictions sent to the observers.

Besides the current graze computors, the following new computors are providing predictions for their regions; see the PC-EVANS coordinator list above, or the 1993 May IOTA/IOTA-ES roster, for addresses:
Brad Timerson: A-region, or Ontario, Quebec, and n.e. USA, n. of lat. +40°; I am the computor for the A-region s. of lat. +40°.
Tom Campbell: Florida
Mike Kazmierczak: D-region, or s.e. USA, except Fla.
H. Carpenter: United Kingdom
Henk Bulder: NADIR, the Netherlands
The graze predictions for Europe were previously computed in Hannover, Germany; now, they are all being computed and distributed by Riedel. Richard Wilds in Topeka also has the software for use in computing predictions for new IOTA members, a job that was previously handled by Joe Senne in Rolla, MO, who is still the computor for the C-region (Midwest part of USA) and a few other regions. Y. C. Yue in Hong Kong also has the software for possible use for s.e. Asian updates, and probably for 1995 predictions.

Riedel's predictions include profiles that are based only on W. Zimmermann's version of the USNO Watts limb data (see below). However, for grazes, there are large areas where, due to Cassini's 3rd Law of lunar rotational dynamics, there are no data in Watts' original work and for which the data files have bad information. Riedel's profiles give no warning of this situation, which occurs generally when the Watts angle is between 163° and 187° with negative latitude libration, or between 353° and 360° (and between 0° and 7°) with positive latitude libration. Reductions of observed graze data collected by IOTA between 1964 and 1981 were put into an "observed-graze" dataset that covered most of the Cassini regions, and also corrected some errors elsewhere in Watts' data. This dataset was used by the ACLPPP program to override Watts' incorrect data for the profiles distributed with the previous IOTA prediction. With manual work, it was possible to prepare ACLPPP profiles for a few of the early 1994 grazes predicted with Riedel's software. This was important for many of the southern-limit waxing-phase grazes that occurred at that time. Tom Campbell led an expedition for a graze of a 5th-mag. star in mid-January in Florida that was quite successful by using an ACLPPP profile; use of the Grazereg profile would have put the observers 2 - 3 km farther south where they all would have seen a miss. In late February, I completed software that automatically interfaced between Grazereg and ACLPPP, so that ACLPPP profiles can now be produced rather easily. Eventually, we want to get away from ACLPPP, since their production requires use of the XZ catalog, which for especially the fainter stars is not as accurate as the PPM-based zodical-region catalog that Riedel is using (a PPM version of XZ would also solve this problem; see the end of this article). At the IOTA meeting in May, I gave a copy of the observed graze dataset, and the ACLPPP software that applies some other empirical corrections, to Riedel, but I have not had time to adequately document this for incorporation into Grazereg, which Riedel is eager to do. For the northern-limit grazes during the last few months, which occurred in parts of the Moon with good-quality Watts data, Riedel's profiles often gave a better prediction than ACLPPP, apparently due to the better PPM data. During this transition time, comparison of the two profiles with observations is important. ACLPPP profiles can not be produced for those few Grazereg-predicted grazes involving stars that are not in the XZ catalog. We will want to rederive some of the empirical constants for the Grazereg predictions, and a long-term program to re-

reduce many of the previous graze observations would be the best way to do this.

Also in February, I produced and distributed "Grazeint" software that reads Riedel's prediction files, which give data at 10′ intervals of longitude, and produces new files interpolated to an input interval. This was necessary for the large numbers of graze observers in the USA, where the detailed topographic maps have a width of only 7.′5 of longitude. Grazeint also performed some other mainly "housekeeping" jobs that are now done by the latest version 3.3 of Grazereg (May 31st version), obviating the need for Grazeint outside of the USA. For the 1995 predictions, Riedel plans to include an option to produce the predictions at an input longitude interval. The goal is to be able to rely on only one program, Grazereg, to make the prediction process more efficient and less complicated for both the graze computors and the observers.

Harold Carney wrote a Basic program called "Grazecom" several years ago to manage the previous IOTA graze predictions. Tom Campbell has updated this program for use with Grazereg. It breaks the predictions into files for each event, and uses a summary table that the observer can use to check the predictions that he wants to print, similar in principal to a program called "Select" by Henk Bulder. Grazecom also uses a user-provided file of topographic map names and edge coordinates, and coastline-political boundaries, to produce regional maps, and a supplement to the predictions that tell how many millimeters north or south of fiducial marks on the edges of named maps to plot the graze line, easing the plotting job, especially if you do not have the plotting scales included with the draft IOTA Observer's Manual.

Graze Maps: Riedel has produced graze maps for hemispheric graze supplements for the rest of 1994, and preliminary 1995 graze maps for the **RASC Observer's Handbook** and for **Sky and Telescope**. The 1994 hemispheric supplements will probably be distributed with the next **ON**.

Station Project: Efforts to cross-reference the IOTA and the extensive PC-EVANS station data were mentioned above. This is the start of a larger station project to get relatively accurate positions not only of all active observatories and stations where lunar occultations are being observed, but also all potential sites where observations might be made. This would be especially useful for obtaining good coverage of updated asteroidal occultation predictions; I have programs that calculate the distance of many stations from the updated central line and produce a list sorted on this distance. This could also be used to find fixed-site stations in graze paths. A first step will be to merge the IOTA, IOTA/ES, and "USNO" (PC-EVANS) station files into one file; it has been suggested that the more precise USNO format be used with the IOTA-specific information appended to it. In addition, there are several other station datasets, including a file of accumulated observatories with some high-speed photoelectric capability and files of sites where asteroidal occultations have been reported in the past, among others.

Once the various station files have been combined and sorted in longitude order, they will be distributed to regional and local coordinators, who will be asked to identify which stations in the file are currently active, and to add as many other stations in their area as possible where observations could possibly be made. They should also collect telephone and/or e-mail contacts for each site for at least local use. Before this is done, we will publish Paul Maley's information for infrequent occultation observers and how he obtained coordinates of more than two dozen telescopes of 17-inch aperture and larger in the Houston area. This type of effort should be repeated around the world.

Watts Limb Data: Several years ago, David Herald discovered that the USNO machine-readable version of Watts' lunar limb correction data was completely wrong for Watts angle 36.°0. Mitsuru Sôma requested these data for use with his OCCRED program, which he is adopting to use W. Zimmermann's PC-based version of Watts data, which were derived from the USNO dataset. Remarkably, I found Herald's data and documentation for this on a diskette in the first place I looked for it. After adding some information relating the accuracy codes of the different Watts datasets, I distributed this information by e-mail to those whom I knew had Zimmermann's PC diskette, or USNO's magnetic tape, version of these data.

XZ Star Catalog: The availability of the XZ and other USNO lunar occultation catalogs from the Astronomical Data Center (ADC) at the Goddard Space Flight Center was described on p. 18 of last November's issue. That announcement was premature; those catalogs have only recently become available there. The delay was caused partly by ambiguities in the description of the last bytes of the XZ data for each star. At the ADC's Nancy Roman's request, I changed the documentation to include a clear description of this information. Besides providing that to her, I also distributed the new version of the document by e-mail to several others who already have the XZ catalog.

The next step will be to prepare a PPM version of the XZ. Towards this goal, Wolfgang Zimmermann has generated extensive cross-reference information between all of the important astrometric star catalogs covering the zodiacal region, and has identified hundreds of errors in the process. Eberhard Riedel is using a zodiacal version of the PPM catalog that has been cross-referenced with, and includes all of the non-positional information of, the XZ. It also includes many stars, especially in the southern hemisphere, that are not in the XZ.

ASCII file editor available: For those who do not have good software for editing the large prediction files now supplied to many on diskette, one that I find more convenient than the standard DOS edit is now available. It is called PCWRITE; the company that produced it has gone out of business, so it is now shareware with no licensing needed. Unlike WORDPERFECT and other powerful editors, it works directly with ASCII files rather than files with special formats. Yet it has many of the features wanted in an editor, including spellchecking, local and global find and replace, and block editing, allowing one to move, copy, and delete rows of numbers, useful for such jobs as editing a prediction file to publish a shorter table in a local newsletter. Although they aren't standard ASCII characters and can't be sent by e-mail, characters such as °, δ, and ü can be produced and printed. The PCWRITE files take about 360 kilobytes. If there is some demand for this, it can be distributed with predictions on diskette.

GRAZING OCCULTATION OBSERVATIONS

Richard P. Wilds

This quarter's report has a number of interesting points of note. There has been an increase in the number of grazes with negative cusp angles. Video recording of grazes has made a strong return. Finally, we have a preliminary listing of observations made during the November lunar eclipse.

We begin down under with a 1991 report forwarded from Graham Blow of the Royal Astronomical Society of New Zealand of a graze observed by R. Dickie near the crater de Sitter. This is followed by a delayed report from Robert Sandy of a graze in the Doerfel Mountains. Guy Nason makes a 1992 report of a difficult bright side graze at an unnamed crater between the craters Shi Shen and Petermann. The last of our "old business" reports is from Jim Stamm who observed a tough terminator graze at Beta Leibnitz.

This year's reports begin with a very successful set of grazes from The Milwaukee Astronomical Society. G. Samolyk, their Observatory Director, led both grazes in an area of the Moon between the craters Brianchon and Sylvester. He reports they had assistance from a number of other groups in the area and used a 20 pen chart recorder, connected to a two mile cable, as their method of recording observations. This was followed by another northern graze around the crater Froelich observed by Mark Lang and his team from North Carolina. Robert Sandy returns with a southern graze in the crater Drygalski.

H.A.R.T. makes a return, but your author muffs his first attempt at a visual graze with his new 7 inch refractor. It was good that Wayne Warren was out the same night with a bigger graze team and was able to out-stretch the shift. This was followed by an Arizona graze by Jim Stamm and an Ohio graze by Robert Modic. These four grazes were all between the craters Byrd, Peary and Plaskett.

H.A.R.T. problems continue when your author attempted a solo graze. The graze was going great up to about ten seconds before the first event when a van suddenly appeared with its brights on in a friendly attempt to help me see! This was the first graze I had used all the safety gear for warning motorists. I do not know when I will use it again!

Wayne Hutchinson led another northern graze that was successful. The problem was that the Evans program prediction he had received was one of those rare profiles we get that are weird and useless. I sent him a profile from the occult prediction program and he determined a shift from it. I have labeled it as "O" for Occult under "PP" for Prediction Program. This will be very important this year since the prediction process is in a period of change and many organizers could be using up to six different programs - i.e. Evans (using "graze nearby" messages; this is discouraged, since the other predictions include profiles and are more accurate), Occult-1.0, Occult-2.0 (more accurate than 1.0 since it includes the major geodetic datums), Riedel (Grazereg or the equivalent Grazeint), ACLPPP (version 85A or higher, using OCCRED) and ACLPPP (version 80N, using OCC, has been IOTA's standard for many years and is still preferred during 1994 while we are trying to transition to the Grazereg system). We will work toward a standard by this year's end; see the graze section of the prediction article on p. ZZ. In the meantime, when reporting graze shifts, it is very important to mention which prediction was used.

Craig McManus of H.A.R.T. and Walter Robinson each observed a graze in the area south of the crater Le Gentil. These were followed by four grazes on 09/09/93. Robert Modic's team produced the most timings. All teams reported the star difficult to see as it came through the first half of the graze. The only one to get a good view was the H.A.R.T. CCD run by Craig McManus. Your author was very upset due to the fact that this appears to be the very first tape of the illusive dust storm we have been hoping to catch on film. I was upset because I was not there. We have begun the computerized reduction of the tape using a photometric subroutine from the MIRA image processing software. The results should be published soon.

Joaquim Garcia and Rui Goncalves from Portugal were one of our bright side graze observing teams. Their 41% Moon was more difficult than the 19% faced by John Holtz just two nights later.

Hal Povenmire teamed up with Tom Campbell to produce a video of a graze around the crater Malapert. Hal then went for a graze in the Doerfel Mountains on 09/21/93. He was joined there on the next night by Guy Nason. The next five grazes were all in front of the craters Scott and Demonax. The most successful was led by Robert Sandy.

The next six grazes were observed in the Cassini region of the Doerfel Mountains. The graze of 11/22/93 was very exciting since the star was a known occultation double, which turned effectively into two grazes upon lunar contact. The H.A.R.T. video is beautiful and the two stars of the double appear to possibly be double themselves. Hal Povenmire and Mike Kazmierczak both had successful grazes in this area.

THE NOVEMBER LUNAR ECLIPSE

This is a preliminary look at the grazes of the November Lunar Eclipse. Robert Stewart observed the graze of SAO 76548 from North Carolina while Hal Povenmire's team observed it from Mississippi. Katie Izor Povenmire reported her 14 events on this graze as the best she had seen. Our H.A.R.T. video was back with 16 events on tape of an 8.7 mag. star. We thought this was pretty good until we heard from Roger Venable, who caught 9.9 mag.
Q 716 for an unpredicted graze. This appears to be the faintest graze caught on tape up to this time. They were waiting for SAO 76565. We consoled ourselves with timing 16 total events during the rest of the eclipse.

Jim Stamm started the observations of SAO 76565. He was followed by Hal Povenmire on the second of his Mississippi double graze extravaganza. He was followed by Mike Kazmierczak and Roger Venable. These teams covered quite an area around the north pole of the Moon.

We will discuss the eclipse again in the next issue, because we received E-mail news of other successful grazes. Most notable were the observations of the northern and southern grazes of the star ZC 646. Doug Hube led the northern expedition near Fort Nelson, British Columbia in Canada. They report success despite clouds. They also report seeing caribou, moose, coyotes and bald eagles. "Just a typical astronomical weekend in the frozen north!" Paul Maley led the southern expedition into the Mexican Baja. His team used a GPS receiver to determine their coordinates and to do some investigations into mapping problems known in that area. He reports the skies were cloud free and the graze observed as well as totals.

We finish up this report with two December grazes. John Holtz reported a graze on Beta Leibnitz. His observation was from Slippery Rock, PA. I thought that was humorous. The last graze was another bright side graze, but this was of the easy type. The star was brilliant blue through my 7 inch refractor and overpowered the lunar light of the thin crescent. We would have had another fantastic video, but technical problems wiped out the video site.

REMEMBER to apply the following shifts, which past experience has shown to be useful when using the ACLPPP (version 80N) profiles:

1. Northern limit, waxing-phase, dark-limb grazes tend to have a 0.″3 south shift from your predicted graze path. One should spread out, however, since star errors could increase this shift or reduce it to a 0 shift.
2. Southern limit, waxing-phase, dark-limb Cassini region grazes tend to have a 0.″4 - 0.″5 south shift from your predicted graze path. Cassini region grazes have profile points from 3 to 7. Southern-limit Cassini grazes will also have negative latitude librations. This correction should continue into the waning-phase grazes to Watts angle 187°.

Also, read the cautions in the graze section of the prediction article on p. 55.

Please report all grazes to:
Richard P. Wilds
3630 S.W. Belle Ave
Topeka, KS 66614-4542
USA

and to the

International Lunar Occultation Centre (ILOC)
Geodesy and Geophysics Division
Hydrographic Department
Tsukiji-5, Chou-ku
Tokyo, 104 Japan

Graze List

UTDate YYMMDD	VP	PPStar #	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	Sh	N S	WA	B
1991															
910706		92783	8.5	32-	10.1N	Washpool, New Zealand	1	8	1	20	R. Dickie	0.3	S	353	-7.3
911019		145938	7.0	80+	17.0S	Amazonia, Missouri	2	15	1	9	Robert Sandy	0.0		164	-4.3
1992															
921004		187756	3.0	54+	-14.2N	Bewdley, Ont. Canada	5	19	3	15	Guy Nason	0.2	S	344	-1.8
921017		78045	6.0	69-	0.7S	Oro Valley, Arizona	1	4	1	20	Jim Stamm	0.0		183	1.1
1993															
930228		93309	7.7	34+	7.6N	Newburg, Wisconsin	6	38	1	32	G. Samolyk	0.5	S	9	-1.2
930301		76456	8.0	44+	11.2N	North Cape, Wisconsin	12	36	1	32	G. Samolyk	0.1	S	13	-1.2
930527		98267	4.3	31+	7.5N	Benson, North Carolina	6	40	1	10	Mark Lang	0.3	S	10	6.7
930727		158890	7.5	61+	6.9S	Horton, Missouri	2	18	2	15	Robert Sandy	0.0		171	3.5
930810		93081	6.5	53-	2.4N	Holton, Kansas	1	0	1	18	H.A.R.T. R. Wilds	>0.5	S	359	-2.2
930810		93118	5.8	52-	4.8N	Beltsville, Maryland	3	8	1	20	Wayne H. Warren Jr.	0.7	S	357	-2.4
930813		77313	6.7	22-	2.8N	Tucson, Arizona	1	4	1	20	Jim Stamm	0.0		358	2.0
930814		78395	6.6	15-	-0.5N	Huntsburg, Ohio	1	3	1	36	Robert J. Modic	0.7	S	359	3.5
930815		96944	9.5	7-	4.1S	Netawaka, Kansas	1	1	1	33	H.A.R.T. R. Wilds	0.0		179	4.8
930815	O	96995	7.8	7-	-0.4N	Cypress, Texas	1	3	?	?	Wayne Hutchinson	0.3	N	359	4.6
930825		184508	7.6	58+	12.3S	Scranton, Kansas	1	4	1	33	H.A.R.T. C. McManus	0.2	S	166	0.4
930825		184508	7.6	58+	12.0S	DeSoto, Kansas	1	6	2	25	Walter Robinson	0.0		166	0.4
930909		76920	4.7	50-	2.5N	Mantua, Ohio	6	43	2	11	Robert J. Modic	0.2	N	359	1.7
930909		76972	6.0	49-	3.4N	Oro Valley, Arizona	1	1	2	20	Jim Stamm	0.0		358	1.7
930909	V	76972	6.0	49-	3.2N	Mayetta, Kansas	1	12	1	25	H.A.R.T. C. McManus	0.1	S	359	1.7
930909		76972	6.0	49-	3.0N	St. Joseph, Missouri	2	6	2	15	Robert Sandy	0.0		359	1.7
930910		77578	5.9	41-	-2.2S	Landeira, Portugal	2	2	2	20	Garcia\Goncalves	0.0		179	2.8
930912		97429	6.2	19-	-1.6N	Bridgeport, W.VA.	1	7	2	25	John Holtz	0.5	S	359	5.5
930913	V	98267	4.3	10-	6.1S	Jekyll Island, Georgia	3	16	1	15	Hal Povenmire	0.1	N	181	6.2
930921		184251	7.4	31+	13.3S	Pompano Beach, Florida	1	7	1	32	Hal Povenmire	0.2	S	166	0.6
930922		185143	7.8	41+	9.8S	Barrie, Ont. Canada	1	8	1	20	Guy Nason	0.1	S	169	-0.7
931010		97951	9.2	32-	3.9S	Le Roy, Kansas	2	3	3	33	H.A.R.T. R. Wilds	0.2	S	183	6.2
931107		98440	7.7	48-	7.7S	Blessing, Texas	2	6	1	20	Wayne Hutchinson	0.2	S	188	6.7
931109		118620	7.9	26-	8.0S	Mound City, Kansas	4	18	1	15	Robert Sandy	0.0		185	7.0
931110		138485	7.1	16-	11.2S	Hialeah, Florida	1	8	1	25	Hal Povenmire	0.6	S	186	6.2
931111		157550	6.5	8-	9.9S	Eulonia, Georgia	2	8	1	15	Hal Povenmire	0.1	S	183	5.3
931119		163418	7.4	30+	11.4S	Auburn, Kansas	1	7	3	33	H.A.R.T. C. McManus	0.5	S	167	-5.4
931120		164203	8.7	40+	7.9S	Burlington, Kansas	1	3	1	33	H.A.R.T. C. McManus	0.0		171	-6.2
931122	V	146239	6.4	59+	12.2S	Corning, Kansas	2	22	1	25	H.A.R.T. R. Wilds	0.8	S	169	-6.3
931122		146239	6.4	59+	12.0S	Craig, Missouri	2	14	1	15	Robert Sandy	0.8	S	170	-6.0
931123		128186	4.9	69+	10.4S	Decatur, Georgia	2	16	1	15	Hal Povenmire	0.1	S	173	-6.2
931123		128186	4.9	69+	10.3S	Carl, Georgia	1	6	1	25	Mike Kazmierczak	0.1	S	173	-6.2
931129		76548	5.4	1E	34.0U	Jacksonville, N.C.	1	2	1	20	Robert Stewart	0.7	N	8	0.6
931129		76548	5.4	28E	U	Pope, Mississippi	2	20	1	15	Hal Povenmire	0.1	N	4	0.6
931129	V	76550	8.7	35E	75.0U	Olivet, Kansas	3	24	1	25	H.A.R.T. R. Wilds	0.0		2	0.7
931129	V	Q 716	9.9	00E	U	Augusta, Georgia	1	9	1	40	Roger Venable	?		11	0.7
931129		76565	7.1	00E	24.1U	Tucson, Arizona	1	4	1	20	Jim Stamm	0.0		1	0.7
931129		76565	7.1	11E	U	Pope, Mississippi	2	9	1	15	Hal Povenmire	0.3	S	9	0.7
931129		76565	7.1	23E	62.0U	Conyers, Georgia	1	2	1	25	Mike Kazmierczak	0.2	S	10	0.7
931129	V	76565	7.1	23E	86.4U	Augusta, Georgia	1	6	1	40	Roger Venable	0.7	S	11	0.7
931209		157922	8.3	20-	6.3S	Slippery Rock, PA	2	6	2	25	John Holtz	0.5	S	182	4.7
931211		159317	6.1	4-	-6.2N	Rock Creek, Kansas	1	4	1	18	H.A.R.T. C. McManus	0.7	N	2	1.5

NEW DOUBLE STARS

Tony Murray

Stellar Cross Reference

SAO #	ZC #	Other
92783		
145938		X 30466
187756	2797	π Sgr - Al Baldah
78045	928	14 B. Gem
93309		X 4132
76456		X 5352
98267	1341	α Cnc - Acubens
158890	2129	
93081	402	36 Ari
93118	415	40 Ari
77313	843	
78395	989	15 Gem
96944		X 11169
96995	1142	
184508	2388	
76920	752	ι Tau
76972	766	105 Tau
77578	881	
97429	1198	2 B. Cnc
184251		X 22186
185143	2471	
97951		X 13002
98440	1372	
118620		X 16554
138485	1723	20 B. Vir
157550	1845	343 B. Vir
163418		X 28192
164203		X 29395
146239	3326	207 B. Aqr
128186	3453	κ Psc
76548	633	53 Tau
76550		X 5590
Q 716		BD +20° 738 - GSC 12760246
76565		X 5624
157922		X 19367
159317	2214	150 B. Lib

This is the first article on new double stars in **ON** since the article in Volume V Number 9. Since then, we have received reports from 9 observers in 3 countries.

The table below contains 37 new double stars that will now be included in the IOTA Catalog of Double Stars of the Moon's Occultation Zone. Two of the new double stars were reported by David Evans and David Edwards in their article, "Photoelectric Observations of Lunar Occultations Number XI", in the **Astronomical Journal**, Volume 85, Number 4, page 488.

We also received correspondence with suggestions and questions which are greatly appreciated. Some of these will be addressed in this article.

A history of his obsevations of the star SAO 146210 = X30851 = ZC 3320 was sent by R. Sandy. Sandy has observed occultations of 146210 during two of its occultation series. This star has code C (listed by Innes, Couteau, or other visual observers) in the IOTA Catalog. The magnitude of the primary is 5.3, the secondary is 8.8, and separation of 262.4 seconds. First in 1974, Sandy observed a disappearance of the primary of 146210 on Sept 29 as a step event and again as a step event on Sept 11, 1992. The code in the catalog will now be T (triple).

Sandy requested that we suggest everyone report his double star observtions as soon as possible after the event. This is a good idea, especially if the event occurs near the beginning of the star's current series of occultations. The star's remaining occultations would present several opportunities for others to observe its occultations to confirm the discoverer's report. One of the purposes of publishing double-star information in **ON** is to alert observers to the known or possible nature of the stars occulted by the Moon. The data found in the table accompanying each double-star article are put into the IOTA catalog. In turn, the new or improved codes for the stars are inserted into the XZ catalog, where it is then used when generating the next set of predictions. So it follows that the double-star data will appear in the occultations earlier if they are reported earlier.

It is especially productive to pay attention to stars with code K or X when preparing your observing program. Both codes mean that past observations indicated that these stars may be double, with a K when the duplicity is doubtful, and X when it is probable. Confirming observations can change that code to a V, meaning that duplicity is certain. As an example, a star reported as a possible double by a single graze observer who saw one event as a fade will receive a code K, since a fade event during a graze may very likely be from diffraction effects from the Moon's limb than from actual duplicity. If a visual observation of a total occultation of the same star made at some later date also shows the same evidence of duplicity, a fade, then the code will be changed to an X, as duplicity is probable. If that total is observed to occur in steps (and even stronger, if the duration of the step events and the magnitude drop or increase is noted) then the code is changed to a V, meaning that duplicity is certain. Visual observers are making a real contribution when they time occultations that discover or confirm duplicity.

Henk Bril of The Netherlands wrote inquiring as to why we ask observers to report the position angle of the events, but not the contact angle. It is true that in considering the effects of diffraction by the Moon's limb, the contact angle will give a more accurate result. Because of its very nature (a fade can be caused by various circumstnaces no matter at which position angle or contact angle it occurs), a visual observation of a very close double star will give ambiguous results. The one piece of information obtained is that there is a possible companion star. The most likely position of the second star is more closely related to the event's position angle (in degrees, measured eastward from celestial north) because this relates its position to the lunar limb, while a contact angle (in degrees, measured relative to the direction of lunar motion) relates the star to the Moon's motion. The position angle is more useful for comparison with other types of double-star observations.

Jean Bourgeois of Belgium reports that he has begun observing regularly with a video CCD camera on a 30cm telescope while he observes visually with a 25cm reflector. This gives added credibility to his double-star observations. In addition, as many such video record observations with relatively high time resolution are made concurrently with visual observations, we will be able to compare visual fade and step events with what occurs as seen by the camera. In his reports thus far, Bourgeois' time estimates made visually compare very well with the video results.

Send your reports of double star observations to me at Rt. 1, Box 67, Georgetown, Georgia 31754, USA. If you do not have a copy of the USNO Double Star Codes, send me a self-addressed stamped envelope and I will send you one.

Notes on individual stars that are not included in the table:

SAO 078348: This star was already suspected of being double by visual observers. P. Schmidtke and J. Africano discovered that this star is triple with the 0.9-meter telescope at Kitt Peak National Observatory, Nov 05, 1982. The new data for 78348 are: Mag. 1 = 7.9, Mag 2 = 8.0, Sep = 0."06 sec, P.A. = 136°.4, Mag 3 = 8.0, Sep = 0."22 second and P.A. = 163°.2. This discovery was reported in their article, "KPNO Lunar Occultation Summary" Number I which appeared in **Astron. J. 89** (9), page 1374.

SAO 078919: This discovery was credited to R. Wilds in **ON 5** (9) p. 244. A later report shows that it was observed as a double by J. Bourgeois on April 9, 1992. This was a month before Wild's observation. The catalog is corrected.

SAO 109469: J. Bourgeois reports that this star is brighter than nearby DM +9° 0089, which is Mag. 8.6. SAO reports the magnitude as 7.0.

SAO 146210: See article.

In addition, the following 16 stars were reported as double. Their duplicity had been previously discovered or suspected.

SAO 076608: J. Bourgeios, 92 Aug 22. New code, now V
SAO 076954: J. Bourgeios, 92 Sep 19.
SAO 077606: J. Bourgeios, 92 Oct 17.
SAO 078390: H. Bril, 92 Nov13. New code, now X.
SAO 078852: J. Bourgeios, 92 Apr 09.
SAO 078953: J. Bourgeios, 92 Apr 09.
SAO 093052: D. Büttner, 93 Jan 03.
SAO 097084: T. Murray, 93 Apr 01. New code, now X.
SAO 097148: J. Bourgeios, 92 Oct 18.
SAO 098007: H. Bril, 91 Oct 03. New code, now V.
SAO 109075: J. Bourgeios, 92 Dec 31.
SAO 118105: J. Bourgeios, 92 Dec 15. New code, now X.
SAO 128212: J. Bourgeios, 92 Dec 30.
SAO 146307: J. Bourgeios, 92 Dec 29.
SAO 146334: J. Bourgeios, 92 Dec 29.
SAO 164461: H. Brill, 91 Sep 20. New code, now X.

Table of Double Stars

Star No (SAO)	M	N	Mag 1	Mag 2	Sep	PA	Date	Discoverer	Notes
075809	Q	V	9.6	9.6		214	93Sep17	J. Bourgeios	Reapp. in 3 steps
075810	T	K	5.8	5.8		96	92Mch09	H. Bril	
075977	T	X	9.0	9.0		104	89Apr08	H. Bril	
076283	T	X	8.6	8.6		24	92Apr06	H. Bril	
076438	Y	X	6.8	6.8		358	93Mch01	R. Wilds, C. McManus	Video obs.
076871	T	X	9.5	9.5		227	92Sep18	H. Bril	
077400	G	K	9.8	9.8		355	92Aug23	C. McManus	
077442	Q	X	9.2	9.2		252	92Oct16	J. Bourgeios	
077522	Q	V	9.5	9.5		300	92Oct17	J. Bourgeios	
077808	T	X	9.2	9.2		148	92Apr08	H. Bril	
077831	T	V	8.7	8.7		113	92Apr08	J. Bourgeios	ZC 907
078092	T	X	7.8	7.8		82	93Feb03	D. Büttner	ZC 939
078575	T	K	9.7	9.7		152	92May06	J. Bourgeios	
078788	T	X	9.2	9.2		104	93Mch31	J. VanNuland	
078796	T	V	9.3	9.3		272	92Oct18	J. Bourgeios	
078836	Y	X	9.9	9.9		101	92Apr09	J. Bourgeios	Video obs.
078858	Y	V	7.6	7.6		65	92Apr09	J. Bourgeios	
078958	T	X	9.8	9.8		83	92Apr09	H. Bril	
092204	T	K	9.0	9.0		52	93Jan01	D. Büttner	ZC 139
097200	T	V	9.2	9.2		135	92May07	J. Bourgeios	
097274	Q	K	9.8	9.8		334	92Oct19	J. Bourgeios	
109071	T	X	9.6	9.6		131	93Jan28	T. Murray	

Table of Double Stars

Star No (SAO)	M	N	Mag 1	Mag 2	Sep	PA	Date	Discoverer	Notes
109074	T	K	9.7	9.7		10	92Dec31	J. Bourgeios	
109469	T	X	9.6	9.6		82	92Feb08	J. Bourgeios	ZC 102
118135	T	V	7.6	7.6		272	92Jan22	J. Bourgeios	ZC 1489
128223	T	X	7.9	7.9		20	92Jan27	J. VanNuland	
138095	T	X	9.6	9.6		145	92May11	J. Bourgeios	
145886	T	X	10.0	10.0		88	91Dec12	H. Bril	
146210	T	T	6.1	6.1		93	74Sep29	R. Sandy	Note 1
158076	T	X	7.7	7.7		139	92Jan10	H. Bril	
158225	T	X	7.6	7.6		98	92May14	J. Bourgeios	
163401	Q	K	9.8	9.8		357	92Nov01	J. Bourgeios	
	P	V	9.8	11.0	.0267	44.6	82Mch31	P. Schmidtke, J. Africano	Note 2
	Q	V	10.8	10.8		261	92Apr09	J. Bourgeios	BD +21° 1387
	Y	X	11.7	11.7		155	92Apr09	J. Bourgeios	BD +21° 1439
	P	V	10.2	10.5	.027	63.1	79Apr05	D. Evans	Note 3
	P	V	8.2	9.9	.92	288.6	79Feb10	D. Evans	Note 4

Table Notes:

1. 3rd component with mag = 8.8, Sep = 263.4, PA= 249
2. BD +21° 0938, **Astron. J. 89**(9) p. 1374
3. BD +17° 1619, **Astron. J. 85(4)** p. 488
4. BD +16° 1667, **Astron. J. 84**(4) p. 488

The International Occultation Timing Association 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. IOTA is a tax-exempt organization under section 509(a)(2) of the (USA) Internal Revenue Code, and is incorporated in the state of Texas.

The ON is the IOTA newsletter and is published approximately four times a year. It is also available separately to non-members.

The officers of IOTA are:

President	David W. Dunham
Executive Vice President	Paul Maley
Executive Secretary	Rocky Harper
Secretary-Treasurer	Craig and Terri McManus
VP for Grazing Occultation Services	Joe Senne
VP for Planetary Occ'n Services	Joseph Carroll
VP for Lunar Occultation Services	Walter Morgan
ON Editor	Joan Bixby Dunham
IOTA/European Section President	Hans-Joachim Bode
IOTA/ES Secretary	Eberhard Bredner
IOTA/ES Treasurer	Alfons Gabel
IOTA/ES Research & Development	Wolfgang Beisker
IOTA/ES Public Relations	Eberhard Riedel

Addresses, membership and subscription rates, and information on where to write for predictions are found on the front page.

The Dunhams maintain the occultation information line at 301-474-4945. Messages may also be left at that number. When updates become available for asteroidal occultations in the central U.S.A., the information can also be obtained from either 708-259-2376 (Chicago) or 713-488-6871 (Houston).

Observers from Europe and the British isles should join IOTA/ES, sending DM 40.-- to the account IOTA/ES; Bartold-Knaust Strasse 8; 3000 Hannover 91; Postgiro Hannover 555 829 - 303; bank-code-number (Bankleitzahl) 250 100 30. Full membership in IOTA/ES includes the 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:

Eberhard Bredner	Hans-Joachim Bode
Ginsterweg 14	Bartold-Knaust-Str. 8
D-W-4730 Ahlen 4 (Dolberg)	D-W-3000 Hannover 91
Germany	Germany

Telephones (49- for Germany, or 0- within Germany)

-2388-3658	-511-424696
Fax -2381-36770	-511-233112