Occultation Newsletter

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Occultation Newsletter is published by the International Occultation Timing Association. Editor and compositor: H. F. DaBoll; 6N106 White Oak Lane; St. Charles, Il 60175; 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; 1177 Collins; Topeka, KS 66604-1524; U.S.A.
Co-editor for this issue: Joan Bixby Dunham; 7006 Megan Lane; Greenbelt, MD 20770.

FROM THE PUBLISHER

For subscription purposes, this is the fourth and final issue of 1989. It is the fourteenth issue of Volume 4.

Since moving our headquarters to Topeka, we have been unable to re-establish our VISA and MasterCard capability. Payments to IOTA should temporarily be made only in check, money order, or cash form. You could check on progress by phoning (913)232-3693.

IOTA membership dues, including O.N. and any supplements	
for U.S.A., Canada, and Mexico	$17.00
for all others to cover higher postal rates	22.00
O.N. subscription[1] (1 year = 4 issues)	
by surface mail	
for U.S.A., Canada, and Mexico[2]	14.00
for all others	14.00
by air (AO) mail[3]	
for area "A"[4]	16.00
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O.N. 2 (1) through O.N. 3 (13), each	1.00
O.N. 3 (14) through O.N. 4 (1), each	1.75
O.N. 4 (2) and later issues, each	3.50
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O.N. 2 (1) through O.N. 3 (13), each	1.45
O.N. 3 (14) through O.N. 4 (1), each	2.20
O.N. 4 (2) and later issues	5.00

There are sixteen issues per volume, all still available.

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

Local circumstance (asteroidal appulse) predictions (entire current list for your location)	1.00
Graze limit and profile prediction (each graze)	1.50
Papers explaining the use of the predictions	2.50

Asteroidal occultation supplements will be available at extra cost: for South America through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand through Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan through 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.) by surface mail at the low price of 1.18 or by air (AO) mail at 1.96

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. See also IOTA/ES News on p. 337.

[1] Single issue at ¼ of price shown
[2] Price includes any supplements for North American observers.
[3] Not available for U.S.A., Canada, or Mexico
[4] Area "A" includes Central America, St. Pierre and Miquelon, Caribbean Islands, Bahamas, Bermuda, Colombia, and Venezuela. If desired, area "A" observers may order the North American supplement by surface mail at $1.18, or by air (AO) mail at $1.50.
[5] Area "B" includes the rest of South America, Mediterranean Africa, and Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.).

IOTA NEWS

David W. Dunham

1989 IOTA Meeting. The 1989 annual meeting of IOTA was held at the Lunar and Planetary Institute in Houston, TX, as planned and announced on p. 321 of the last issue. The executive secretary's report of the meeting is given on p. 337. The triannual election of officers was held, with the most important change being that Craig and Terri McManus, Topeka, KS, are now the secretary and treasurer; see the masthead and their separate note on p. 337. We should all appreciate their willingness to perform this important service to IOTA. We wish them the best in their efforts to streamline our operations by their future attempts to perform many of Derald Nye's and Joseph Senne's current duties. Please give them your support.

Pleiades Predictions in Next Issue. Unfortunately, this issue is far behind schedule. It contains the most time-critical information, especially my predictions of occultations by Solar System objects starting on p. 341. More information on some of the items mentioned only briefly will appear in the next issue, which will probably be smaller than this issue and follow it by only about 10 days, in order to include details of the March 3rd Pleiades passage (evening of March 2, local time) visible from Canada and the U.S.A. (especially the northern states) before that event. The March 3rd passage will also be covered in the March issue of Sky and Telescope. Earlier, we had hoped to distribute this issue in time for the February 9th total lunar eclipse, visible from the Eastern Hemisphere. But in mid-January, it was clear that could not be done, so a separate supplement about occultations during that eclipse was mailed separately to IOTA and IOTA/ES members, and to O.N. subscibers, in the region of visibility. In addition to the Pleiades passage data, the next issue will contain recommended corrections to current grazing occultation predictions, and progress on the 1989 July 3rd occultations of 28 Sagittarii by Saturn and Titan.

FROM THE CO-EDITOR

Joan Bixby Dunham

Mr. DaBoll was unable to complete the prepration of this issue of the Occultation Newsletter. Joan Dunham published this issue and will publish the next issue. Health permitting, Mr. DaBoll will prepare the final issue of Volume 4.

North Americans who have expiration notices enclosed with this issue should send their dues payment to Topeka promptly, to ensure receipt of the next issue before March 3. We hope to mail the next issue on either February 24 or 26, so if you are a little late mailing your payment, you might telephone the McManuses at (913)232-3693 to let them know you are renewing, so that a copy of the next issue can be mailed to you.

If you have a contribution that you want to appear in the next issue, it must be received by Joan Dunham; 7006 Megan Lane; Greenbelt, MD 20770-3012; USA by February 20. Telephone (301)474-4722 if you want to contribute something, and have not already sent it. This issue and the next are being assembled and distributed by Joan. We plan to distribute the following issue, #16, in May or June; contributions for it should be sent to H. F. DaBoll at the address in the masthead. We are very thankful for DaBoll's tremendous effort as editor and compositor of this newsletter, and for the high standards that he has established for it. He has been able to maintain these standards in spite of serious problems during the last few years; we hope that he recovers from his current illness in time to produce the last issue of this volume.

The McManuses have a supply of back-issues of recent issues of O.N.; all requests for back issues should be sent to them. However, Derald Nye, Tucson, AZ, now has the bulk of the back issues; we thank him for storing them for IOTA.

My setbacks for this year's predictions (being two months late with this issue, missing Sky and Telescope's deadline for my 1990 planetary occultation article, not being able to produce supplements for any of the late 1989 Praesepe passages) were caused mainly by a combination of work for last August's lunar eclipse and the numerous trips that I made during the last half of the year. Things should be better for 1991, partly because fewer trips are planned this year, but mainly because Sky and Telescope insists on having my 1991 material to them by early September this year. Since I start generating IOTA predictions just after that, the IOTA data for 1991 should be distributed nearly two months earlier than they were for 1990. To help meet the earlier schedule, I would like to get some help with some of the computer prediction work; some local help would be especially helpful and welcome.

Next IOTA Meeting. The 1990 IOTA meeting will probably be held the weekend of August 18-19 in San Antonio, TX, a good location for the southern-limit graze of Jupiter by a 5% moon, as shown on my map on p. 69 of the January issue of Sky and Telescope. More information about it will be in issue #16.

L-catalog Predictions from USNO. L- and P-catalog total lunar occultation predictions for 1990 were distributed to observers on the U. S. Naval Observatory's (USNO's) active list in August-September, 1989, and a special subset of these (good Pleiades passages and the 1990 lunar eclipses) were sent to Eastern Hemisphere IOTA and IOTA/ES members for whom I have coordinates but who are not on USNO's list in late January. Some observers are confusing the two catalogs, especially in North America, where incorrect designations were given for some of the events in the chronological lists. USNO reference numbers prefixed with P in the main prediction list are stars from Eichhorn's Pleiades catalog, while those prefixed with L are from the 1989 L-catalog, which gives extended coverage for particular areas of the sky, described in O.N. 4 (11), 263-266 (1989 March). In the table on p. 265, the last two entries said "not yet in L". Those parts were added in May, and corrected in July, 1989; the L-No. ranges are 24201 - 24384 for the 1990 Aug. 6 lunar eclipse field and 24385 - 24935 for the 1989 Aug. 17 lunar eclipse field.

Occultation Videos. I have received a few requests for copies of some of the occultation videotapes that have been mentioned in previous issues. I have created a 2-hour tape with the best parts of the most interesting events recorded through July 1989, and will sell a copy to those who send a check or money order, for $10 payable to me, at 7006 Megan Lane; Greenbelt, MD 20770-3012; USA. There is an additional charge of $100 for converting from American NTSC format to a different format. Any profits from this will be contributed to IOTA and IOTA/ES (which recorded some of the events). I cannot provide copies before March.

Requests for Magnetic Tapes, etc. With the relentless pressure of preparing articles for Sky and Telescope and other journals, and getting predictions and newsletters to you, I have had little time to answer individual requests, especially for star catalogs on magnetic tape, some requests for which are now even two years old. I apologize for these intolerably long delays in answering your letters and requests; I will make every effort to fill them promptly after the March Pleiades passage.

1983 PALLAS OCCULTATION PAPER TO BE PUBLISHED IN THE ASTRONOMICAL JOURNAL

David W. Dunham and Joan Bixby Dunham

Our paper about the 1983 May 29 occultation of 1 Vulpeculae by (2) Pallas, with 44 co-authors, was sent to the Astronomical Journal at the end of November. It was recently accepted for publication, and will appear in their May issue. If you are one of the co-authors, we need to know if you need more than about 15 reprints. Regional coordinators will be sent at least enough reprints to distribute to all of the observers in their region who are mentioned in the article (this includes those who reported a miss, and those who attempted the event but were clouded out, as well as everyone who sent in timings). If you sent a report of that occultation or appulse to your regional coordinator, and have moved since then, you should notify him of your new address. The regional coordinators are all at their 1983 addresses except for Richard Nolthenius, the coordinator for California, who is now at Cabrillo College, Aptos, CA 95003.

Next, we plan to complete analyses of, and submit journal articles for publication, for the 1983 September occultation by (51) Nemausa, some other observed asteroidal occultations, and various eclipses, especially those in China in 1987 and in Sudan in 1985. Other analyses need to be performed as well; more local help for this is needed!

SECRETARY/TREASURER NEWS

Craig and Terri McManus

As was stated in previous newsletters, we have assumed the duties of Secretary and Treasurer from Homer DaBoll. We received the materials from Homer at the end of December and have been very busy sorting through renewals and updates. It is very important that all correspondence concerning requests for graze data, membership renewal, graze manuals, observer information sheets and all NON-EDITORIAL newsletter needs be addressed to us at the address below. (EDITORIAL items continue to go through Home DaBoll in St. Charles, IL.) We hope to keep the same high level of efficiency that Homer had in updating and keeping current any and all changes that you may have. However, we are new at the job and ask for a little patience here at the beginning. Part of your patience concerns the use of MC and VISA to renew your memberships. At this time we have not secured permission from either of the two bank card centers in Kansas to open and account. We hope to have this secured soon, but for now renewals and other items that require purchase need to be done by check or money order in US funds. We are sorry for the inconvenience that this may cause some of you. Please bear with us.

If you move or change your observation site, please send us updated coordinates to insure your receipt of accurate and useful predictions.

Craig and Terri McManus
1177 Collins
Topeka, KS
66604-1524 USA

IOTA/ES NEWS

Eberhard Bredner

As secretary of the European Section of IOTA, my address remains: Astrag VHS Hamm; P.O. Box 2449-41; D-4700 Hamm 1; German Federal Republic. The telephone number there is 49-2381-172534, while the fax number is 49-2381-36770. Please note my new As secretary of the European Section of IOTA, my address remains: Astrag VHS Hamm; P.O. Box 2449-41; D-4700 Hamm 1; German Federal Republic. The telephone number there is 49-2381-172534, while the fax number is 49-2381-36770. Please note my new home telephone number: 49-2381-31774; the old number given on the IOTA/ES forms is no longer valid. The DM 40 IOTA/ES dues should be paid only by postal money order. If there is no other possibility, you may send a check payable to me, but in this case, you must pay DM 50, because there are expensive fees from the bank. Perhaps a better arrangement will be possible after IOTA/ES elects a new treasurer at a meeting (ausserordentliche Mitgliederversammlung) on March 24 in Hannover. For information about that meeting, contact Hans Bode at the address given in "From the Publisher", or telephone him at 49-511-424696.

Also, contact Mr. Bode if you are interested in joining an IOTA/ES expedition of about 10 people to travel to Siberia to observe the total solar eclipse of July 22. They will join the IOTA and Kiev University Observatory expedition; see p. 354.

The 9th European Symposium on Occultation Projects (ESOP IX) will be held in Jena, German Democratic Republic, August 24-28. Mr. Bode and I will go to East Berlin on February 22-23 to start preparations. Please let us know if you might be interested in attending this meeting.

IOTA ANNUAL REPORT - 1989

Gary D. Nealis, Executive Secretary

The 1989 annual meeting of the International Occultation Timing Association was held on Dec. 16 at the Lunar and Planetary Institute, Houston, TX. The meeting was called to order at 9:07 am CST by president David Dunham. 15 members were present, including the Dunhams from Greenbelt, MD; the McManuses and Rex Easton from Topeka, KS; Kent Okasaki from San Jose, CA; and Robert Sandy from Blue Springs, MO; the others were all from the Houston, TX, area. Officers present included David Dunham, the McManuses, Paul Maley, and myself.

IOTA business was discussed first. Homer DaBoll's treasurer's report was read; the IOTA balance was about the same in late September, 1989, as it was a year earlier, showing that the dues increase at the end of 1988 had the desired effect. The balance as of the meeting was about $1000, so no dues increase was recommended. Terri and Craig McManus discussed the arrangements that they were making for assuming the job of secretary-treasurer; see their article on this page. Topeka member Richard Wilds will be added to the new IOTA bank account signature list, in case something happens to both McManuses. This was approved.

At 9:30 the membership report was given by David Dunham; there are nearly 300 members, about the same as last year. The secretary-treasurer maintains the official records, while Derald Nye in Tucson, AZ, maintains the computerized records on an IBM PC diskette, using instructions from the secretary-treasurer. Nye generates address labels and files of station data for predictions, as needed.

The election of officers began at 9:40. A total of 134 ballots were received by mail. 68 voted for the slate, 55 designated executive secretary Nealis as proxy, 7 did both, 1 designated Don Stockbauer proxy, 2 David Dunham, and 1 Homer DaBoll. 7 members present who had not mailed a ballot voted for the slate. The slate of officers was unanimously elected, with enough ballots to constitute a valid election by a wide margin. The officers for the next three years are:

President: David Dunham
Executive Vice President: Paul Maley
Executive Secretary: Gary Nealis
Secretary and Treasurer: Terri and Craig McManus
V.P. for Grazing Occ'n Services: Joseph Senne
V.P. for Planetary Occ'n Services: Joseph Carroll
V.P. for Lunar Occ'n Services: Walter Morgan
Occultation Newsletter Editor: Homer DaBoll

A design for a lunar IOTA graze patch was passed around; see Richard Wild's article on page 339.

Occultation manuals were discussed. IOTA's Preliminary Occultation Manual (POM) is too long for some purposes. David Dunham sent the McManuses a copy of his one-page "Grazing Occultation Check List", which may serve the purpose of a "quick guide". The Dunhams solicited help for finishing the incomplete sections of POM, so that it might be published in "final" form and distributed to all members.

Eclipses, and possible expeditions for them, were discussed starting at 10:10. The February 9th lunar eclipse was described. See p. 354 for information on solar eclipses.

Starting at 11:20, Bob Sandy showed a Memorabilia slide show dating from 1960 to the present. This showed grazes, planetary and stellar occultations (by the Moon), and personnel and equipment for them. It described the work of Dr. C. B. Watts, including a description of Watts angle and its derivation, the history of lunar grazes, and early techniques. Then different techniques of data reduction and plotting of grazes were shown. Finally, pictures of aurorae and several cartoons were shown. It provided a good historical summary of a lot of what IOTA is about.

From noon to 13:30, attendies went to lunch at the local Piccadilly Cafeteria. After this, David Dunham discussed 1990 asteroidal occultations. The data shown would be in the February issue of _Sky and Telescope_. No occultations are outstanding for North America, with the brightest involving 8th-magnitude stars.

Starting at 14:02, David discussed lunar grazes for 1990. Plots are in the January issues of _Astronomy_ and _Sky and Telescope_. On Aug. 18, Jupiter will be occulted, with the southern limit crossing the San Antonio and Houston areas. It is on the bright limb of a 5% sunlit waning Moon, near sunrise, and 4 days after a Pleiades passage. Aug. 18-19 is the tentative 1990 meeting date (it must be in Texas) to coincide with these events.

Starting at 14:29, David discussed 1989 asteroidal and lunar occultation observations. Occultations by Bamberga in March (when two short occultations near the northern limit were apparently timed by an observer in Albuquerque), Emita in May in AZ and WI, and Endymion and Eunomia in Australia in April were described. On Aug. 17, double grazes (at north and south limits) during a total lunar eclipse were attempted in the Midlands of England, in Egypt, and in Kenya. Apparently, no attempt was actually made in Kenya, and Bode's effort in Egypt was clouded out. However, the England expeditions had excellent skys and got many events. Two days later, the Vesta occultation led to establishment of several stations (National Geographic, National Science Foundation, etc.) in Ecuador and French Guiana, with mixed results. Derald Nye also viewed a Eunomia occultation from the Amazon in November. The September occultation by Hermentaria in s. Florida generated one data point; there was no astrometric update. On Dec. 2, an occultation by Helio occurred in parts of IL, IN, and OH; it was cloudy in most other areas along the path. Urbana, IL, got a 1.5-second occultation. The July 3rd occultations of 28 Sagittarii, described in previous issues, were discussed. Videotapes of these events, as well as of several outstanding lunar events recorded during the past year, were shown.

At 16:19, European section news was discussed. The ESOP VIII meeting in Freiburg, German Federal Republic, was described. See also p. 337.

Starting at 16:50, computer-related developements were discussed. Tom Campbell has a Basic program (EASYILOC) that searches its data base (map data), generates plotting coordinates, and fills observation report forms. There is a new bulletin board called PINET; see p. 339. Help was requested for production of tables for total occultation predictions and for automated generation of graze reduction profiles.

Starting at 17:33, IOTA publications were discussed. An article about the December 1987 Bamberga occultation, with heavy IOTA involvement, was published in the _Astron. J._. The large article about the 1983 May 29 Pallas occultation was sent to the _Astron. J._. Articles are planned for other asteroidal occultations and for eclipses. We need to publish more to get help from professional groups.

At 17:56, the meeting adjourned. I went home, but several attendies continued discussions over dinner at a nearby restaurant. Don Oliver described progress with his effort to generate graze expedition summary information from a USNO graze observation database including all observed events that predate _O.N._ He needs help from David Dunham to overcome a problem in a libration subroutine.

We thank the Lunar and Planetary Institute for use of their facilities.

GRAZE PATCH

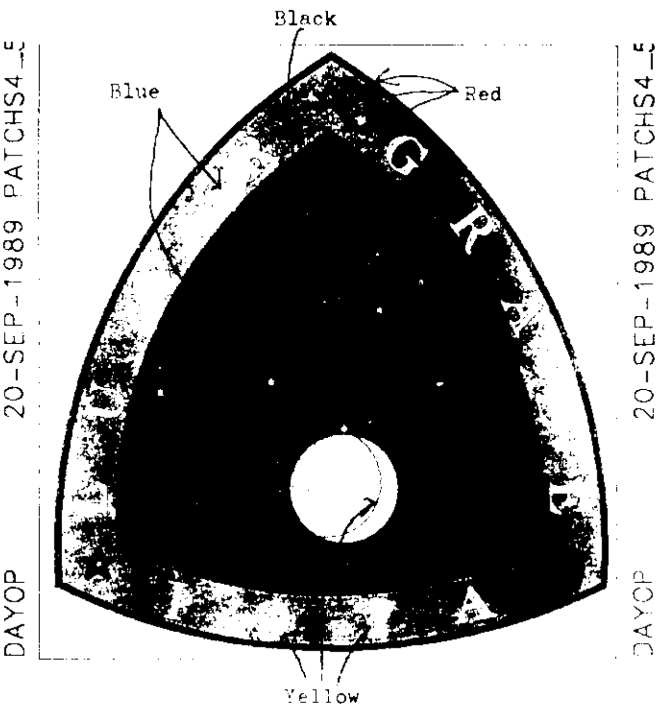
Richard E. Wilds

The Graze team of the Northeast Kansas Amateur Astronomers' League would like to propose a patch for IOTA graze observers. The patch was drawn by Don Stotz of Dallas, Texas. It is a stunning multicolored view of the Moon going through the Pleiades. The Moon is a crescent with plenty of earthshine. One of the Seven Sisters, Merope, is about to be grazed by the northern limb of the Moon. At the same time the Moon is about to occult the beautiful chain of 8-th magnitude stars just south of the main cluster stars.

We have had very good growth in our graze team in Topeka, Kansas. One of the reasons has been the reward of a pictoral reduction of a graze publicly awarded to each observer at local astronomy groups meetings. Since Messier certificates and Herschel awards for deep sky observing have become popular, we thought it might be worthwhile to have a shoulder patch honoring grazes. The patch would be awarded to any person who has observed a graze.

The NEKAAL team is willing to arrange for the patches and offer them to IOTA members for a nominal fee to cover expenses. The profits, if any, would be given to IOTA. Before we take this step, however, we want to know how much interest there is among IOTA members. We expect that the patch will cost $5.00 each. Are you interested? Let me know by writing to the address below. If there is enough interest, we will announce the availability of the patches in a future issue of Occultation Newsletter.

Richard P. Wilds
710 Grandview
Topeka,
Kanses
66606 USA



ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

Network Memberships CompuServe - David now has a CompuServe membership, with ID 71321,1746. I have a Pinet membership, with ID jbd. Pinet is the American Institute of Physics network. It is unclear how useful Pinet will be. There are not very many members, as shown by the 3-letter ID. Pinet gives access to BITNET, Telex, FAX, and a few other networks (GSFCMAIL), but I have not discovered how to receive messages from other networks, only send. One of the reasons we got these memberships was to send and receive files electronically. If you want to send (or have sent) us a data set via one of these networks, let us know. Otherwise, it could be days before we notice the file. Also, be patient. We are just learning how to use these services. We will have more to say as we gain experience with them.

David also has a SPAN address, nssdca::dunham, as reported in the O.N. 4 (12), p. 289 and we both have GSFCMAIL accounts. David is DDUNHAM and I am JDUNHAM.

History The changing of the decade is a good time to reflect for a moment on the recent history of computing equipment. The last thirty years have seen very rapid changes in computing equipment. Computers are no longer the enormous, power guzzling heat generators owned by a few govenment agencies and universities. The single-user computing tool of the past was a slide rule or a Frieden adding machine and a 9 place log table. Mechanical calculators and their clunking computations have virtually disappeared, and slide rule manufacturers have turned to other fields. The evolution of calculating equipment is one of continued decrease in price and increase in capability. The pace of hardware development has outrun our ability to develope software and applications. Even if the hardware development were to freeze with the INTEL 80586 (Look for '586 computers in about 2 years), we would probably not see much slowing in the rate of change as we find new applications for what we already have.

EASYILOC 2.0 Tom Campbell is distributing version 2 of his graze organizer's software and is now working on version 3. We demonstrated his map finding software at the IOTA business meeting, although the demonstration did not proceed very far because it needed a printer, and we had not brought one. We discussed this software earlier, in O.N. 4 (11), p. 269-270. The purpose of EASYILOC is to assist in graze planning and reduction, and in help in preparing a disk version of the final ILOC report. The software is in BASIC and runs on MS-DOS machines. Contact Tom Campbell at 5405 98th Ave, Temple Terrace, FL 33617 for more information.

Digitizers One of the most time consuming parts of reducing a graze is measuring accurate coordinates from a map. I have been investigating inexpensive digitizers, trying to determine if they are accurate enough and work well enough to be useful. Digitizers are tablets with a mouse that has a crosshair that communicate the (X,Y) location of the crosshair on the tablet to the computer as mouse is moved about the tablet. These are very similar to graphics tablets that help an artist make a freehand drawing in graphics software. To me, the difference between a graphics tablet and a digitizer is that the tablet cannot give accurate measurements across the tablet, while the digitizer can. Many people, though, use the terms interchangeably, and consider "digitizer" a fancy word for graphics tablet. Some of the newer small digitizers retail for under $200, and even include some graphics software.

Aside from whether or not a given digitizer or graphics tablet can give accurate measurements, I also noticed that there can be significant physical hindrances to using some of the tablets with the large maps. No inexpensive digitizer has an active area big enough to hold an entire map. Aside from the undesirable cost and bulk of such a device, it is probably not necessary to have an entire map on the digitizer at one time. The maps include enough reference tics so that an area of the size of a standard page, 8.5 by 11 inches, is probably all that is necessary. However, some of the digitizers are designed so that the only practical way to work with just a portion of a map is to cut it into pieces, and I will not do that.

What I want is a digitizer that can work with parts of the map, getting measurements of locations on the map to an absolute accuracy of 0.01 inch, and generating data in a form that can be recognized by some of the more widely used pieces of software, such as Dr. Halo, Harvard Graphics, or Lotus 123. The quoted resolution accuracies of some digitizers are the accuracy with which the digitizer can detect the stylus has moved, and not the accuracy of measured points from the tablet. It may be that a digitizer with an ability to detect movement to a resolution of 1000+ lines per inch also can measure the relative separations of two points across its face to a high degree of accuracy. When the manufacturer does not give that information, however, it suggsts that the measurement accuracy is not very high.

THE GRAZE AT MCCOOL JUNCTION

Gary Hug

It's a far cry from the days of my youth, when I would drag the 3" Gilbert reflector from under my bed and set it up in the field across the street to gaze at the Moon. Several decades later, the field has been replaced with a school and associated megalights, my equipment involves 10" and 13" scopes, drive correctors, inverters, CCD cameras, computer imaging, and CB radio, and my setup areas now involve many miles of driving, including out-of-state travel. There is a tremendous amount of preparation involved now.

Last October 7-8 I used a 10", as a member of a graze team that travelled 200 miles to a site near York, Nebraska. Actually, I didn't really look through the telescope. Mounted in the focuser was a Panasonic CCD camera with nearly a quarter million pixels located on the ½-inch (diagonal) chip. Once the camera was focused by way of a camcorder monitor, the modified tangent-arm drive was engaged on the scope to track the Moon and the star it was about to graze.

The short-wave radio was tuned to WWV and a microphone was placed near the speaker. The cord from the microphone was plugged into the jack on the camcorder. Wires were running everywhere. It seemed to take hours to get everything hooked up and checked. Eventually, after changin the battery in the camcorder, the image of the sourthern tip of the first quarter Moon and the star SAO 187717 (7th magnitude), were in view on the tiny monitor. The 0.5-lux CCD camera was easily capable of picking up the star as it closed in on the lunar surface.

Forty minutes before predicted graze time, clouds had overrun the Moon. Taking my eye off the monitor, I began searching in hope of clear stretches of sky along the horizon. Dreading the worst, I began to question the saneness of all thre preparation, driving, and setting up an electrician's nightmare of wires. Time passes, and the clouds seemed motionless. Yet Venus, in the southwest, had popped back into view; there was still hope. Now there were twenty minutes before the 3-minute-duration graze. There were some patches of clear sky, but still numerous clouds blocked the view.

Finally, ten minutes before graze time, the clouds puffed away, leaving the monitor with the lunar sunlit peaks and the star quite close together.

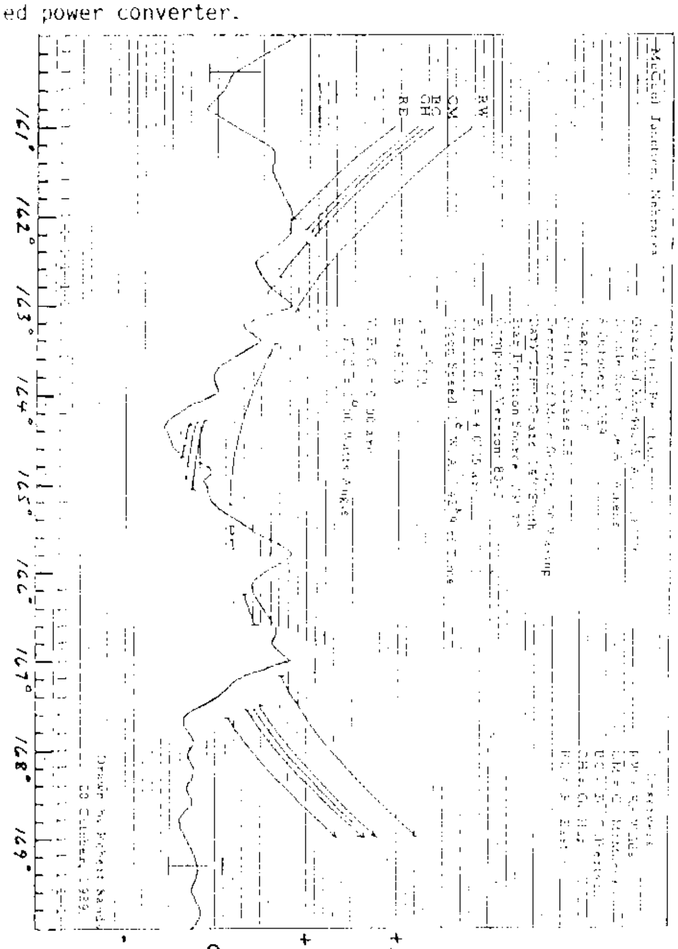
I went through a mental checklist, making sure all components were turned on. With only moments to go I adjusted the field of view by nudging the telescope tube slightly, and intensified my scanning of the monitor. The atmosphere was very turbulent, but the first lunar peak blocked the starlight in an instant. That was to be the first of six events recorded by the the video equipment (see Bob Sandy's reduction profile).

During the star's apparent motion past the lunar terrain, I noticed a reappearance that seemed to be a stepped event; the star seemed to brighten gradually rather than instantly. Talking to the rest of the observers later by CB, I found they also reported a slow reappearance of the star. It is likely, while the star is known to have a companion roughly 45 seconds of arc away, there is a third star in this system, previously undetected. Although it may be some time before the third star can be verified, we may have been the first humans in all of history to have realized this particular star's existence.

You may note on the reduction profile how much difference exists between the lunar terrain as it was charted with old data and after the information was applied from this graze. Although not directly shown on the reduction, most of the graze team independently reported slow fades or reappearances in the report sent to IOTA.

Also, it may be noted that the mountain peak at WA 163° was seen to be shifted to 163°3. The valley at 164°3 is shifted to 164°6. The mountain at 165°6 can be seen at 165°9. In summary, it can be seen the entire profile was observed to be shifted 0°2 to 0°4 in Watts angle. Possibly in future predictions, a horizontal shift may be applicable.

Special thanks to all the participants of the McCool Junction, Nebraska graze; David Costales, Brenda Culbertson, Craig McManus, Rex Easton, Rich Wilds. Thanks also to Sharon Fahay for loaning a much-needed power converter.



SOLAR SYSTEM OCCULTATIONS DURING 1990

David W. Dunham

The 1990 Asteroidal Occultation Supplement for North American Observers, prepared by Edwin Goffin with finder charts annotated by David Werner, were distributed with the last issue of O.N. for IOTA members and O.N. subscribers in North America. Copies of Goffin's predictions and charts applicable to other parts of the world were sent by Jim Stamm a few months ago to regional coordinators for distribution to members and subscribers in their regions. Goffin has continued to improve the orbits for many asteroids, and we have both used these for our predictions. Also, since Goffin used my Combined Catalog (CC), and my version of Fresneau's Astrographic Catalog (FAC), for his calculations, a much larger fraction of our predicted events are in common, and our predicted paths for the common events are in better agreement, than was the case for predictions for previous years. A practical advantage of this is that we need to publish fewer finder charts in the regular issues of O.N., since they have already been distributed with Goffin's predictions. In a few cases, we will publish 1° charts for some of the more crowded star fields on Goffin's charts, to facilitate locating the star to be occulted (the "target star"). These will be published alone, to be used in conjunction with Goffin's broader-field charts. Remember that the 1° charts are generated mostly from FAC data, which used blue-sensitive photographic plates. Comparison with the True Visual Magnitude Atlas (TVMA) often shows that some FAC stars are brighter, fainter, or very faint relative to their plotted magnitude, indicated with B, F, or VF, respectively. "N" indicates that the star is not shown in TVMA.

There are a few minor problems with Goffin's use of the CC and FAC. The most significant problem was caused by an error that I made in creating the CC: The sign of the proper motion in declination of Yale catalog stars was inadvertantly omitted. This is usually not a serious problem, since correct data for virtually all Yale stars are given in the SAO and other catalogs, all of which had more priority than Yale when CC was created. The main purpose for merging Yale into CC was to obtain a few hundred Yale stars with southern declinations whose proper motions were not determined (zero used) and which are not in the SAO or most other catalogs. For stars with large negative proper motion in declination, the coordinate matching used to create CC did not work, resulting in many "false" stars whose only source was Yale. Two of Goffin's 1990 predictions involve these "false" stars, so the actual occultations will not be visible from the Earth's surface, including the occultations by (97) Klotho on March 14 that Goffin predicted for South America, and by (205) Martha on December 31 that he predicted for North America and Europe. Also, Goffin assigned sequential numbers to some of the catalog sources, including the FAC, where the stars remain unnumbered in my version. For the five different Lick-Voyager catalogs, he assigns one sequence number, rather than retaining the separate sequence numbers for the individual catalogs used both by Lowell Observatory in their predictions and by myself. Similarly, Goffin assigned one sequence number to the Astrographic Catalog (AC) stars in the CC, rather than retain the zone designations that I use.

Tables 1 and 2. My predictions of occultations of stars by major and minor planets during 1990 are given in two tables below, which are presented in virtually the same format as those for 1989 published in O.N. 4 (10), 244. Four good events that occur early in 1991 are listed at the end, to give advance notice for planning purposes. A few changes from the tables for years before 1988, especially parameters for path computation, are described in O.N. 4 (6), 150. The previous tables are described in detail in O.N. 4 (1) (July, 1986). See also O.N. 4 (3), 45-47 for star designations and new source codes. For the 1990 calculations, I used the same version of the combined catalog as that for the 1989 predictions, with the updates described in O.N. 4 (10), 244. Many new orbits have been calculated for asteroids involved with occultations, so the accuracy of the predictions should continue to improve.

No values are listed under Δm for occultations by major planets except in the cases where the star is less than five magnitudes fainter than the planets. In the latter case, the extent of the planet, and the fact that events can occur against its dark side, make Δm meaningless. Similarly, no value is listed under the Table 2 RSOI column, since this is always greater than 99999 km. Asterisks (*) and pluses (+) given after some dates indicate new and revised events, respectively; these are explained in the local circumstances/appulse prediction section. A slash (/) given after three dates indicate events that, for some unknown reason, are not plotted on my quarterly maps of the Western Hemisphere; Europe, Africa, and Middle East; and Australasia; although they should have been. Two of these events involve major planets whose centerlines miss the Earth and whose region of visibility is described under "Possible Path". The path for (165) Loreley on March 25 is described in an individual note. Also not on the quarterly maps are the new (*) events, polar-region paths entirely north of latitude +65° or south of latitude -50°, and all asteroidal occultations where the path does not intersect the Earth's surface at locations where the star is sufficiently above the horizon and the Sun enough below it for possible observation.

In Table 2, under Comparison Data, Shift, a "B" precedes the value if the comparison data (shift and time) are for the path of the star's B-component relative to the A-component, rather than the second star source catalog relative to the main source catalog. In these cases, the latter is the same for both components, so it is sufficient to list the second source catalog comparison only for the primary (A-component).

Possible Path. A change this year is the "Possible Path" in Table 1, called "Possible Area" in previous years. The time it took me to inspect maps to give a description of the location of each path became too great, so I spent the time this year to add code to the computer program to produce the path information automatically. Three pairs of numbers are now listed, giving in integral degrees the longitude (Lo_, east of Greenwich positive) and latitude (La_) of the first (suffix "1"), middle ("m"), and last (or end, "e") points of the predicted observable occultation path, respectively. The corresponding central time for the first and last points are given under the Universal Time column. The path coordinates can be used to locate the paths on my quarterly maps showing the paths of all events worldwide, just as the coordinates for the center of graze paths are used to locate lunar occultation limits plotted in the grazing occultation supplements. You should know your own longitude and latitude so that you can tell which events are near you, but it is easier to estimate this from the direct calculations in the local circumstance predictions distributed by Carroll and Bode, or from examination of the regional maps. The "Moon Up" information is also

Table 1, Part A

1990 Date	Universal Time	PLANET Name	m_v	Δ AU	STAR SAO NO	m_v	Sp	R.A. (1950)	Dec.	Occultation Δm	dur	df	P	Possible Path Lo1 La1	Lom Lam	Loe Lae	El Sun	MOON El	%Snl	Up	Ephem. Source
Jan 1	5ʰ 1ᵐ-17	Nuwa	12.4	1.980		9.7		5ʰ46ᵐ.2	20°27'	2.8	13ˢ	23	18	-15° 11°	-82° 2°	153° -9°	166°	118°	17+	w117W	MPC11508
Jan 2	20 5-18	Leonora	13.3	1.888		11.5	F0	8 48.3	17 25	2.0	7	26	35	166 56	68 58	-2 38	152	139	32+	w 34E	MPC13443
Jan 8	4 56-71	Arsinoe	12.6	1.707	78678	9.1	K0	6 40.7	27 2	3.5	7	19	25	-11-16	-79 22	-167 23	171	32	88+	w 28W	MPC14930
Jan 8	22 9-24	Leonora	13.2	1.868		10.1	G5	8 43.3	17 16	3.2	7	23	34	125 38	37 43	-38 24	159	51	93+	w113E	MPC13443
Jan 14	1 51-51	Mars	1.5	2.233	185139	9.2	G5	17 9.2	-23 6		141	6	1	29-22	34-24	41-28	35	109	91-	all	NA0001
Jan 16	10 42-56	Stereoskopia	13.0	2.437		9.4	F4	7 42.9	25 14	3.6	12	21	20	-75 13	-150 47	102 40	176	66	73-	e172E	MPC12306
Jan 16	19 0-16	Mnemosyne	11.3	2.016	135273	9.4	F8	7 53.6	-1 45	2.1	9	23	25	158 3	81 13	-4 28	157	63	69-	e 49E	MPC12189
Jan 18	18 16-34	Chloris	13.5	2.655	93964	9.1	G5	4 26.6	17 47	4.4	18	46	30	90-42	47-18	3 0	130	138	51-	e 71E	EMP 1984
Jan 19	3 5- 6	Eunomia	10.0	2.493		11.3	K	23 31.9	8 2	0.3	8	9	13	-139 45	-117 47	-90 47	59	146	48-	none	Goffin87
Jan 22	1 8-25	Gaspra	14.6	1.288		12.3		8 59.3	10 54	2.4	2	21	117	70 21	-1 38	-89 39	166	111	22-	e 31E	Yeomans
Jan 22	14 48-66	Gaspra	14.6	1.288	98298	8.7	G0	8 58.7	10 56	5.9	1	21	117	-134 10	150 28	61 29	166	118	17-	e173W	Yeomans
Jan 27	23 57-75	Gaspra	14.5	1.287		9.5		8 52.6	11 13	5.0	1	20	117	80-13	4 6	-78 8	172	169	2+	w 78W	Yeomans
Jan 30	23 53-87	Beatrix	12.1	1.574	119541	8.0	F2	12 39.5	0 46	4.1	23	68	27	-19-11	20-20	62-38	121	170	20+	none	Goffin89
Feb 2	10 41-55	Gaspra	14.5	1.295		12.8		8 46.5	11 33	1.9	1	20	117	-79 31	-145 50	113 56	174	93	46+	w143W	Yeomans
Feb 2	14 3-11	Chiron	15.6	10.408		12.3		6 46.1	15 45	3.4	12	37	75	-156 31	143 50	55 55	148	62	48+	w165E	Marsdn88
Feb 4	1 37-37	Minerva	12.5	2.926		10.6	G1	17 38.3	-29 38	2.1	4	8	25	22-14	34-21	48-29	49	156	65+	none	MPC11508
Feb 5	8 37-92	Hilda	13.5	3.271	157376	9.3	F5	12 32.6	-11 7	4.3	86	175	27	-42 64	-101 42	-158 35	124	112	78+	all	EMP 1989
Feb 12	0 18-61	Lilaea	13.3	2.102		11.6		13 15.3	0 23	1.9	22	75	36	-23-22	12 15	1 73	125	30	95-	all	EMP 1988
Feb 12	2 8-23	Gaspra	14.7	1.329		11.0		8 36.2	12 10	3.7	2	23	121	38 28	-26 49	-126 58	164	41	94-	e 99W	Yeomans
Feb 15	12 24	Flora	11.5	2.801	160716	8.7	F5	17 35.9	-19 31	2.9	4	10	29	-122 42	-108 37	-93 33	62	54	71-	all	Goffin86
Feb 15	18 51-53	Urania	11.7	2.228	92841	5.7	K5	2 10.3	15 3	6.0	3	10	31	-4 -3	18 -1	45 -5	69	176	68-	none	MPC12680
Feb 16*	0 13-30	Sophrosyne	11.9	1.529		11.0	F5	10 47.2	12 0	1.3	9	21	21	80 -2	6 10	-59 5	167	59	66-	e 24W	MPC12191
Feb 21/	4 39-45	Venus	-4.6	0.404	162858	9.1	M	19 36.8	-15 29		2185	22	1	Niger, Libya, Italy, Balkans			39	16	19-	all	NA0001
Feb 27	16 48-63	Lamberta	13.1	2.449	53069	8.8	A5	5 24.8	35 27	4.3	17	39	26	24 41	51 15	93-16	104	73	7+	w 51E	MPC11620
Mar 1	9 15-39	Gaspra	15.1	1.449		13.0		8 22.7	13 12	2.2	3	40	131	-92 18	-141 39	139 61	144	91	21+	w160W	Yeomans
Mar 2	20 11-13	Sylvia	13.1	3.601		10.8		17 38.5	-22 36	2.4	12	16	13	106 36	122 29	141 21	76	149	36+	none	MPC11507
Mar 3	0 25-26	Flora	11.4	2.600		9.5		17 59.4	-19 37	2.0	5	12	27	6-47	25-54	54-61	72	145	38+	none	Goffin86
Mar 10	6 44-48	Palma	11.7	2.128		10.5	F8	4 59.8	41 7	1.5	8	12	16	(E. Canada, E. USA)?s			89	78	99+	all	EMP 1989
Mar 11	21 39-58	Gyptis	12.9	2.530	96103	8.1	A5	6 44.3	11 6	4.8	23	42	22	-44 -7	-8 23	48 37	110	74	100-	all	MPC14930
Mar 13	0 3-17	Semiramis	12.8	2.008	95992	8.5	A5	6 38.3	18 37	4.4	7	33	52	-81 40	-34 26	8 8	107	90	98-	e 68W	MPC14930
Mar 13+	11 44-65	Diana	11.6	1.390	79735A	9.8	G0	7 47.3	24 40	2.0	20	38	16	103 26	129 -7	154-49	122	81	96-	e116E	MPC12189
Mar 13+	11 48-72	Diana	11.6	1.390	79735B	9.8	G0	7 47.3	24 40	2.0	20	38	16	104 37	135 0	166-45	122	81	96-	e118E	MPC12189
Mar 13	23 9-27	Beatrix	11.2	1.257	119415	9.3	K0	12 25.4	1 44	2.1	10	26	22	96 25	34 39	-49 54	167	18	94-	e 36W	Goffin89
Mar 18	1 10-18	Laetitia	10.8	2.139		10.5		13 17.3	0 58	1.0	13	23	20	65 21	37 45	18 79	158	53	65-	e 26E	MPC12686
Mar 18	9 39-42	Titan	8.7	10.416	138468	9.2	G5	19 39.3	-21 17	0.5	295	31	4	W.Antarctic;Americas?n			64	40	62-	none	JPL NAIF
Mar 19*	6 22-24	Winchester	12.0	2.202		10.0	F5	4 56.2	13 37	2.1	6	10	18	-171 42	-142 46	-110 44	77	164	53-	none	Landgraf
Mar 19/	14 44-52	Jupiter	-2.3	5.032	77995	9.1	K0	6 4.7	23 29		6419	40	2	Asia, nw Australia		1	93	175	50-	none	NA0001
Mar 25/	22 20-93	Loreley	12.9	2.774	97660	8.9	F0	8 10.6	16 35	4.0	87	178	25	-54 29	-52-15	-51-63	117	129	1-	none	Goffin89
Mar 29	9 23-25	Pax	14.1	2.652	142666	8.9	F0	18 47.3	-8 55	5.3	4	17	52	-111 45	-88 43	-64 43	86	119	10+	none	MPC14930
Mar 29	14 45-52	Juno	10.6	2.558	140699	8.1	K5	15 38.7	-5 49	2.7	29	34	14	(Hawaii, Alaska)?w			133	161	11+	none	Goffin86
Apr 2	8 27-30	Semele	14.7	3.220		12.0		18 42.6	-22 44	2.7	9	24	37	-84 40	-69 35	-52 31	92	177	49+	none	EMP 1987
Apr 2	17 49-51	Nephele	14.1	2.858	163445	5.5	K0	20 16.5	-19 17	8.6	3	11	42	118-13	146-20	-179-22	70	164	53+	none	EMP 1986
Apr 4	10 59-73	Hilda	13.0	2.846	138614	9.3	K2	12 7.1	-8 17	3.7	12	23	24	-90-46	-179-23	111 12	169	56	71+	w150W	EMP 1989
Apr 4	13 19-21	Ceres	8.6	2.638		12.6		6 1.6	29 5	0.03	40	14	4	97 53	124 44	149 32	77	40	72+	all	MPC12187
Apr 14	23 50-73	Melpomene	10.6	1.951		11.6		10 41.3	14 10	0.4	32	59	19	40 13	6 34	-35 65	132	101	80-	e 5W	Goffin87
Apr 15	0 31	Chloris	14.3	3.864		10.5		5 10.4	22 14	3.9	4	13	44	-75 42	-58 38	-41 32	54	175	80-	none	EMP 1984
Apr 20	19 33-82	Sylvia	12.5	2.868		11.3	G4	18 4.6	-24 12	1.5	73	90	15	80 38	108-13	148-69	119	60	24-	e100E	MPC11507
Apr 21	0 45-46	Lucina	13.7	3.103	78136	8.9	K2	6 11.9	28 57	4.5	5	12	32	-70 55	-47 46	-27 35	63	119	23-	none	MPC15384
Apr 21+	2 23-105	Klotho	11.7	1.973	99210	7.6	A0	10 34.4	13 8	4.2	40	128	33	-75-68	-68 -5	-18 29	125	174	22-	none	MPC15525

now computed automatically, whereas I manually inserted this information previously. If the centerline of the occultation misses the Earth's surface, the system breaks down, in which case, I have manually inserted a discription of the possible region of visibility, as before.

Stellar Angular Diameters. Information relating to the estimated angular diameter of the occulted stars is given in Table 3 only for events for which the stellar angular diameter is large enough for the edge of the asteroid to require more than 0.05 second to geometrically pass across the star during a central occultation. For these events, the effect of the stellar diameter might be noticed by visual observers, especially for nearly grazing events when the observer is near one of the edges of the occultation path. The star's double star code is

Table 2, Part A

1990 Date	MINOR PLANET No.	Name	km-Diam.	-//	RSOI	Type	Motion °/Day	P.A.	STAR SAO No	DM/Id No	D	Min. Geocentric U. T.	Sep.	S	Comparison Data AGK3	No	Shift	Time	APPARENT R.A.	Dec.
Jan 1	150	Nuwa	157	0.11	746	CX	0.201	269°1		A20°44211		5h 8m9	1"36S	C					5h48m6	20°28'
Jan 2	696	Leonora	79	0.06	253	XC	0.186	262.3				20 11.0	3.19N	XA	N17°	958	-0"06	1m3	8 50.6	17 16
Jan 3	404	Arsinoe	101	0.08	351	C	0.268	291.4	78678	+27 1211		5 3.4	0.25S	UX	N27	715	-0.17	0.1	6 43.2	27 0
Jan 3	696	Leonora	79	0.06	254	XC	0.211	264.5		+17 1931		22 16.4	2.18N	XA	N17	942	-0.02	0.8	8 45.6	17 7
Jan 14		Mars	6782	4.19			0.711	95.7	185139	C23 13200		1 53.1	1.68S	UX			-0.04	0.0	17 11.6	-23 9
Jan 16	566	Stereoskopia	175	0.10	1019	C	0.195	284.4		L 4 2542		10 49.1	1.46N	H					7 45.4	25 8
Jan 16	57	Mnemosyne	116	0.08	474	S	0.204	283.0	135273	- 1 1892		19 7.9	1.22N	A	S 1	1150	-0.32	-0.1	7 55.7	-1 51
Jan 18	410	Chloris	128	0.07	629	C	0.087	295.4	93964	+17 734	X	18 29.0	1.45S	UX	N17	396	0.36	-1.6	4 29.0	17 52
Jan 19	15	Eunomia	272	0.15	1248	S	0.474	70.9		+ 7 5057		3 3.4	1.62N	A	N 8	3243			23 34.0	8 16
Jan 22	951	Gaspra	16	0.02	19	S	0.273	280.3				1 16.6	3.15N	C					9 1.5	10 45
Jan 22	951	Gaspra	16	0.02	19	S	0.275	280.5	98298	+11 1961		14 57.1	2.10N	UR	N10	1163	0.31	0.1	9 0.9	10 46
Jan 23	951	Gaspra	16	0.02	19	S	0.284	281.8		L 1 4864		0 6.0	0.59S	H					8 54.8	11 4
Jan 31	83	Beatrix	34	0.07	223	X	0.077	111.2	119541	+ 1 2739		0 16.7	3.02S	UZ	N 0	1595	0.27	0.5	12 41.6	0 33
Feb 2	951	Gaspra	16	0.02	19	S	0.282	283.0				10 47.8	4.49N	C					8 48.7	11 24
Feb 2	2060	Chiron	200	0.03	4100	B	0.054	280.3				14 7.2	0.53N	C					6 48.5	15 42
Feb 4	93	Minerva	173	0.08	705	CU	0.450	96.4		C29 13862		1 39.3	0.84S	H					17 40.9	-29 39
Feb 5	153	Hilda	175	0.07	1164	P	0.021	251.7	157376	-10 3504		9 4.4	2.23N	US			0.01	9.4	12 34.7	-11 21
Feb 12	213	Lilaea	35	0.06	281	F	0.060	27.9		L 2 1705		0 39.6	2.56N	H					13 17.4	0 10
Feb 12	951	Gaspra	16	0.02	19	S	0.251	285.1				2 15.9	4.30N	C					8 38.4	12 1
Feb 15	8	Flora	141	0.07	537	S	0.372	92.0	160716	-19 4677		12 25.9	2.36N	UX			-0.62	-0.3	17 38.3	-19 32
Feb 15	30	Urania	104	0.06	286	S	0.451	72.2	92841	+14 357	V	18 49.7	1.66S	FU	N15	185	-0.02	0.0	2 12.5	15 14
Feb 16*	134	Sophrosyne	107	0.10	357	C	0.251	275.2		+12 2263		0 21.5	0.21S	XA	N12	1262	0.06	0.3	10 49.3	11 47
Feb 21/		Venus	12220	41.68			0.458	95.1	162858	-15 5419		4 56.9	26.57N	UH			0.08	0.5	19 39.0	-15 24
Feb 27	187	Lamberta	135	0.08	577	C	0.106	120.8	58069	+35 1113		16 49.7	0.13N	A	N35	534			5 27.5	35 29
Mar 1	951	Gaspra	16	0.02	19	S	0.136	292.2				9 28.2	3.60N	C					8 25.0	13 4
Mar 2	87	Sylvia	271	0.13	2013	P	0.211	98.6		B23 65574		20 14.8	1.51N	C					17 40.9	-22 37
Mar 3	8	Flora	141	0.07	534	S	0.339	89.6		L 3 1919		0 27.7	2.42S	H					18 1.7	-19 37
Mar 10	372	Palma	195	0.13	820	BFC	0.371	117.0		+40 1152		6 46.1	4.20N	A	N41	507			5 2.7	41 10
Mar 11	444	Gyptis	170	0.09	862	C	0.098	48.1	96103	+11 1302		21 43.6	0.34S	UR	N11	739	0.37	-0.5	6 46.5	11 4
Mar 13	584	Semiramis	56	0.04	135	S	0.140	103.4	95992	+18 1304		0 5.6	1.43N	UH	N18	627	-0.10	-0.4	6 40.7	18 35
Mar 13+	78	Diana	125	0.12	377	C	0.147	144.1	79735	+24 1783	A	11 49.2	1.80S	UH	N24	889	0.45	0.5	7 49.8	24 33
Mar 13+	78	Diana	125	0.12	377	C	0.147	144.1	79735	+24 1783	B	11 54.8	0.74S	UH	N24	889	B1.06	5.6	7 49.8	24 33
Mar 13	83	Beatrix	84	0.09	222	X	0.227	285.2	119415	+ 2 2544		23 17.7	4.40N	UX	N 1	1465	0.03	-0.2	12 27.5	1 30
Mar 18	39	Laetitia	159	0.10	796	S	0.195	309.5		L 2 1813		1 13.5	3.21N	H					13 19.4	0 45
Mar 18		Titan	6062	0.80			0.065	85.6	188468	-21 5489		9 43.8	0.98S	U					19 41.7	-21 11
Mar 19*	747	Winchester	178	0.11	672	C	0.444	66.1		+13 757		6 20.6	1.30N	A	N13	394			4 58.5	13 41
Mar 19/		Jupiter	140904	19.30			0.072	89.3	77995	+23 1204		14 43.1	14.51N	UX	N23	607	0.18	-0.7	6 7.2	23 29
Mar 25/	165	Loreley	160	0.08	372	CD	0.022	166.1	97660	+16 1665		22 37.7	0.70W	UX	N16	869	0.01	4.7	8 12.9	16 28
Mar 29	679	Pax	74	0.04	227	I	0.229	84.8	142666	- 9 4849		9 26.0	2.65N	US			-0.46	0.0	18 49.6	-8 52
Mar 29	3	Juno	267	0.14	1865	S	0.121	325.0	140699	- 5 4139		14 44.0	2.91N	US			-0.90	-1.3	15 40.8	-5 57
Apr 2	86	Semele	127	0.05	628	C	0.151	89.8		B23 74398		8 31.3	2.17N	C					18 45.0	-22 42
Apr 2	431	Nephele	98	0.05	336	B	0.340	77.7	163445	-19 5776	A	17 52.2	0.03S	UH			0.41	-0.5	20 18.8	-19 9
Apr 4	153	Hilda	175	0.08	1143	P	0.168	301.3	138614	- 7 3354		11 6.3	0.75S	UP			0.59	-1.9	12 9.2	-8 31
Apr 4	1	Ceres	946	0.49	9721	G	0.295	88.5				13 16.8	1.54N	C					6 4.2	29 5
Apr 15	18	Melpomene	148	0.10	632	S	0.079	304.0				0 4.1	3.10N	C					10 43.4	13 57
Apr 15	410	Chloris	128	0.05	630	C	0.261	79.8		A22 39167		0 28.2	0.80N	C					5 12.8	22 17
Apr 20	87	Sylvia	271	0.13	1992	P	0.043	152.8		C24 13917		20 0.6	0.53S	H					18 7.1	-24 11
Apr 21	146	Lucina	140	0.06	595	C	0.311	88.5	78136	+28 1053		0 43.5	1.56N	UR	N28	627	0.17	0.3	6 14.5	28 56
Apr 21+	97	Klotho	87	0.06	280	M	0.036	29.1	99210	+13 2280		3 4.0	2.38S	UZ	N13	1057	-0.26	-2.1	10 36.5	12 55

asteroid's distance from the Earth. The time in milliseconds that it takes the edge of the asteroid to geometrically pass across the star during a central occultation is given under time. Lastly, under df, the subtended diameter of the star is expressed in units of Fresnel diffraction fringe given in the "D" column immediately after the SAO number. Parameters relating to the stellar angular diameter are given in the last four columns. The first of these, under m", is the angular diameter in milliarcseconds (units of 0".001). Under m is given the distance in meters that the star subtends at the

Table 1. Part 5

1990 Date	Universal Time	PLANET Name	PLANET m_v	PLANET ΔAU	STAR SAO NO	STAR m_v	STAR Sp	STAR R.A. (1950)	STAR Dec.	Occultation Δm	Occultation dur	Occultation df	Occultation P	Possible Path LolLal	Possible Path LomLam	Possible Path LoeLae	El Sun	MOON El	MOON %Snl	MOON Up	Ephem. Source
Apr 21	13 53h-74	Tercidina	12.1	1.508	159545	9.4	K5	15h48m.9	-15°46'	2.8	11s	27	22	-117°53°	162°20°	101°19°	152°	102°	18-	e169W	MPC13442
Apr 22	3 15-41	Athor	12.0	1.376	183899	9.5	B9	15 50.8	-28 3	2.6	7	33	43	35 -9	-30-45	-128-39	149	108	13-	e 2W	MPC11041
Apr 28	3 38-39	Mars	0.9	1.561	165147	6.4	F0	22 29.0	-11 10		192	7	1	-17-19	5-20	32-18	62	104	13+	none	NA0001
Apr 28	12 22-26	Diana	12.5	1.909		10.7		8 32.4	18 43	2.0	6	13	22	106 34	135 18	165 2	88	41	16+	w140E	MPC12189
Apr 30	3 38-39	Ceres	8.8	2.933		11.1		6 40.3	29 0	0.12	30	11	4	-130 14	-114 7	-96 -1	60	10	32+	all	MPC12187
May 2	19 11	Julia	12.2	3.151		10.6	A3	6 24.6	27 39	1.8	5	10	29	11 44	24 36	39 27	54	48	60+	all	MPC12190
May 3	3 42-44	Leda	14.3	3.339	146135	6.1	F8	22 28.7	-6 49	8.1	4	13	40	-22-10	2 -8	28 -1	66	171	64+	none	MPC14158
May 3*	9 28-37	Minerva	11.7	1.898	211865	10.2		20 6.4	-31 12	1.7	14	22	16	-151-22	-112-45	-47-56	105	144	66+	w128W	MPC11508
May 3*	22 48	Winchester	12.5	2.822		10.0		6 19.6	19 20	2.6	5	8	23	-70-22	-57-24	-41-28	52	63	71+	all	Landgraf
May 6	2 26-27	Semiramis	13.6	2.824		11.1	F5	7 33.9	16 22	2.6	2	12	73	-105 27	-86 20	-64 13	68	71	88+	all	MPC14930
May 10	15 56-68	Minerva	11.6	1.816	211943	8.2	A0	20 13.0	-31 24	3.4	18	27	15	96-32	136-59	-115-72	110	60	99-	all	MPC11508
May 13	18 47-79	Protogeneia	14.0	2.704	118683	8.1	K0	11 5.9	3 30	6.0	40	96	29	8 30	45 26	87 22	114	109	86-	e 44E	EMP 1982
May 15*	10 39-56	Peraga	12.7	1.725	158578	9.3	K0	14 25.1	-18 59	3.4	8	22	25	-87-27	-171-25	116 8	166	76	73-	e166E	Herget78
May 16	9 50-61	Dione	13.1	2.835	139390	4.7	M0	13 29.4	-6 0	8.4	13	29	28	(w. North America?)s			148	105	65-	e145W	EMP 1982
May 18	19 14-24	Daphne	11.0	1.396		10.7	F8	19 12.7	2 16	0.9	30	38	11	174-56	158-37	153-14	123	52	40-	all	MPC13294
May 25	10 44-54	Neptune	7.9	29.427		10.3		18 58.8	-21 52	.11	2975	63	1	w. N. America, Hawaii			140	153	2+	none	JPLDE130
May 28	0 47-49	Gaspra	16.6	2.582		10.1		9 16.8	11 43	6.6	1	12	234	-105-32	-84-39	-58-48	72	24	17+	w 73W	Yeomans
May 30	18 43-62	Thisbe	10.3	1.510	184196	9.7	F0	16 7.9	-25 24	1.1	23	24	9	168-36	66-41	-7 -3	174	93	44+	w 64E	Goffin89
Jun 6	15 35-60	Flora	9.7	1.408	161981	9.1	A2	18 52.5	-19 35	1.1	19	31	14	-158 11	136 -8	67 -3	153	48	97+	w170W	Goffin86
Jun 7	11 4- 5	Vesta	8.3	3.061	110334	7.8	F2	2 3.3	5 26	1.0	15	9	8	-7-74	-7-73	-6-72	45	145	99+	all	Goffin86
Jun 7	17 24-44	Aegina	13.0	1.919		9.9		19 2.7	-25 49	3.2	12	29	24	-175-14	113-34	37-20	152	36	99+	all	Goffin87
Jun 10	15 51-66	Semele	13.5	2.310	187211	9.9	A0	18 41.5	-23 53	3.6	11	26	26	-148-24	138-43	46-36	159	4	95-	all	EMP 1987
Jun 14	6 0- 2	Hegwig	13.8	2.367	118131	6.6	F0	10 6.1	1 24	7.2	5	13	34	-177 -7	-150-14	-119-17	71	171	70-	none	EMP 1989
Jun 16	3 27-28	Hegwig	13.8	2.368	118148	9.3	K5	10 8.3	1 15	4.5	5	13	35	-110 37	-99 35	-85 33	70	160	51-	none	EMP 1989
Jun 16	13 39-51	Semele	13.4	2.274		11.3		18 37.1	-24 5	2.3	10	24	26	-142 30	159 10	99 18	166	81	46-	e156E	EMP 1987
Jun 25	8 44	Venus	-3.9	1.317	93670	8.0	F5	3 52.2	18 27		259	5	1	(Que., Ont., neUSA)?s			33	68	9+	none	NA0001
Jun 28+	9 54-71	Pandora	11.8	1.954	207573	10.3	A0	16 17.1	-31 19	1.8	7	29	42	-79-37	-166-55	115-27	150	79	35+	w169W	MPC15524
Jul 2+	2 17-18	Patientia	12.4	3.349		10.2		3 1.5	5 0	2.4	7	11	21	16-17	32-14	50-10	56	160	70+	none	MPC15529
Jul 2	8 42-61	Flora	9.2	1.300	186855	7.4	A0	18 26.9	-20 59	2.0	13	21	13	-56 11	-134-18	137-13	176	60	73+	w105W	Goffin86
Jul 5+	15 12-22	Philomela	10.9	2.031		11.1	F7	18 4.8	-27 41	0.6	13	24	20	153 45	113 28	70 32	168	15	94+	all	MPC15528
Jul 5+	15 42-55	Tisiphone	13.4	2.575	163870A	8.8	G5	20 43.8	-12 29	4.6	9	24	31	-131-45	138-40	65-19	152	55	95+	w141W	MPC12305
Jul 5+	15 35-50	Tisiphone	13.4	2.575	163870B	11.0		20 43.8	-12 29	2.5	9	24	31	-139-36	141-30	70 -9	152	55	95+	w151W	MPC12305
Jul 6	9 30-42	Hebe	10.8	2.458	120195	9.1	G5	13 55.2	6 25	1.9	17	28	19	157 35	177 -1	-146-28	100	63	97+	all	Goffin86
Jul 9	2 19-31	Laetitia	11.9	2.965	119674	3.4	M0	12 53.1	3 40	8.5	9	19	27	143 47	-121 20	-45-10	85	107	99-	e108W	MPC12686
Jul 9	7 23-42	Flora	9.3	1.300		10.1	F0	18 19.0	-21 24	0.4	14	22	13	-50 12	-119-14	159-14	168	26	98-	e165E	Goffin86
Jul 10	2 37-56	Daphne	10.4	1.294		10.5		18 45.0	3 58	0.7	21	26	10	32-10	-26-28	-107-62	153	38	96-	all	MPC13294
Jul 10+	15 17-34	Philomela	10.9	2.048		11.0	K3	18 0.7	-27 48	0.7	13	25	20	-160-20	130-49	31-42	162	48	93-	e 50E	MPC15528
Jul 10	17 34-50	Semele	13.3	2.226		10.9	M9	18 16.3	-24 46	2.5	10	23	25	159 0	90-25	7-17	166	45	93-	e 30E	EMP 1987
Jul 11	9 28-29	Hestia	13.1	2.188		11.1	F5	2 17.9	13 26	2.1	5	10	24	-118 18	-101 24	-80 33	72	69	89-	all	Yeomans
Jul 12	7 1	Astraea	12.0	3.111	93962	7.0	G0	4 26.5	17 26	5.0	3	8	36	-55 17	-44 21	-31 26	42	89	82-	all	Goffin86
Jul 12	11 34-55	Pauly	11.8	1.331		11.2		20 10.2	-18 42	1.1	7	28	34	-128 47	178 2	112-13	169	41	81-	e142E	EMP 1986
Jul 13*	14 44-56	Pretoria	13.1	2.498		11.5	G5	23 11.8	22 3	1.8	17	29	21	-169-55	-165-11	-162 33	110	21	70-	all	MPC11333
Jul 15	16 15-24	Juno	11.0	2.927	140133	9.1	K0	14 44.2	-1 29	2.1	41	51	16	16-43	16-60	-6-78	106	157	47-	none	Goffin86
Jul 17*	5 32-53	Pauly	11.7	1.321		11.1		20 6.8	-19 19	1.1	6	26	34	-3 3	-57-38	177-64	174	108	30-	e 51W	EMP 1986
Jul 19	4 1-13	Pax	12.2	1.421		9.9	G7	18 23.3	-17 6	2.4	5	17	28	-43 55	-92 13	-146-12	159	157	12-	e 50W	MPC14930
Jul 20*	13 8-17	Isolda	12.9	2.516	109369	6.5	F5	0 38.6	9 5	6.4	15	31	25	150 11	-179 26	-148 52	105	83	3-	e157W	MPC12304
Jul 21	22 53-56	Laetitia	12.0	3.131	119760	9.0	F0	13 3.0	2 21	3.0	7	16	29	-59 10	-35 0	-6 -6	75	78	0-	none	MPC12686
Jul 23	20 53-55	Laetitia	12.0	3.155		10.4	G0	13 4.6	2 9	1.8	7	15	29	-37-16	-14-25	15-32	74	52	4+	w 24W	MPC12686
Jul [illegible]	14 11-36	Flora	9.6	1.360		8.7	B3	18 1.3	-22 30	1.3	21	34	14	-162-16	139-46	33-58	146	67	41+	w143E	Goffin86

separation. If it is 3 or larger, diffraction will be negligible and the occultation lightcurve will be essentially geometric. If it is 0.3 or less, the star's angular diameter will manifest itself only as a very slight modification to a point-source Fresnel diffraction pattern, which could only be measured from a high signal-to-noise-ratio photoelectric recording. Between these values, the occultation lightcurve will be a complex combination of the two effects. This information is available for all events listed in Tables 1 and 2, of possible use to those who want to analyze high signal-to-noise photoelectric records, upon request to me at: 7006 Megan Lane; Greenbelt, MD 20770-3012; USA.

Local circumstances/appulse predictions. Joseph E. Carroll; 4261 Queen's Way; Minnetonka, MN 55345, USA, computes the IOTA appulse predictions for all

Table 2, Part B

1990 Date	MINOR PLANET No.	Name	km-Diam.	-//	RSOI	Type	Motion °/Day	P.A.	STAR SAO No	DM/Id	No	D	Min. Geocentric U.T.	Sep.	S	Comparison Data AGK3	No	Shift	Time	APPARENT R.A.	Dec.
Apr 21	345	Tercidina	100	0.09	314	C	0.196	307°.4	159545	-15°	4203		14^h $2^m.7$	1".32S	UX			-0".39	$1^m.1$	$15^h 51^m.2$	-15°54'
Apr 22	161	Athor	46	0.05	92	M	0.168	244.3	183899	C27	10629		3 26.6	1.53S	S					15 53.4	-28 10
Apr 28		Mars	6782	5.99			0.747	69.3	165147	-11	5855	V	3 41.1	0.23N	7P			-0.46	-0.2	22 31.2	-10 57
Apr 28	78	Diana	125	0.09	384	C	0.362	113.5		A19	64195		12 21.5	1.73N	C					8 34.7	18 34
Apr 30	1	Ceres	946	0.44	9677	G	0.360	92.9					3 35.9	0.31S	C					6 42.9	28 58
May 2	89	Julia	159	0.07	694	S	0.364	102.7		+27	1115		19 9.1	1.67N	XA	N27	667	0.09	0.0	6 27.2	27 37
May 3	38	Leda	120	0.05	519	C	0.281	62.8	146135	- 7	5797		3 45.9	0.80N	UZ			-0.22	0.2	22 30.8	-6 36
May 3*	93	Minerva	173	0.13	693	CU	0.214	95.6	211865	C31	17347		9 35.4	1.98S	S					20 8.9	-31 5
May 3*	747	Winchester	178	0.09	716	C	0.460	81.5		A19	48053		22 46.6	2.11S	C					6 22.0	19 18
May 6	584	Semiramis	56	0.03	141	S	0.325	101.0		L 4	1822		2 23.7	1.13N	H					7 36.2	16 16
May 10	93	Minerva	173	0.13	693	CU	0.177	99.5	211943	C31	17436		16 4.1	3.23S	S					20 15.5	-31 16
May 13	147	Protogeneia	137	0.07	671	C	0.041	94.9	118683	+ 3	2463		18 51.1	1.46N	UX	N 3	1463	0.08	0.6	11 8.0	3 16
May 15*	554	Peraga	99	0.08	345	FC	0.231	292.0	158578	-18	3824		10 48.0	0.30S	UX			-0.11	0.1	14 27.3	-19 10
May 16	106	Dione	147	0.07	857	U	0.135	283.1	139390	- 5	3714		9 55.8	3.38N	7P			-0.12	0.2	13 31.5	-6 13
May 18	41	Daphne	182	0.18	672	C	0.145	9.3		+ 2	3833		19 27.3	3.47E	A	N 2	2405			19 14.7	2 20
May 25		Neptune	50184	2.35			0.019	264.5		N	57		10 47.9	1.24N	H					19 1.2	-21 49
May 28	951	Gaspra	16	0.01	20		0.333	104.7					0 45.4	2.13S	C					9 19.0	11 33
May 30	88	Thisbe	232	0.21	1148	CF	0.223	289.2	184196	C25	11411		18 52.4	1.62S	UX			-0.28	0.4	16 10.4	-25 30
Jun 6	8	Flora	141	0.14	508	S	0.176	255.7	161981	-19	5227		15 46.7	1.45N	UX			0.28	0.6	18 54.9	-19 32
Jun 7	4	Vesta	561	0.25	4201	V	0.414	72.3	110334	+ 5	280		11 5.0	2.78S	UX	N 6	221	-0.40	0.3	2 5.4	6 38
Jun 7	91	Aegina	114	0.08	448	CP	0.160	259.4		B25	65330		17 33.3	0.56S	C					19 5.2	-25 45
Jun 10	86	Semele	127	0.08	605	C	0.166	258.6	187211	C23	14675		15 58.2	1.50S	HU			0.15	0.9	18 44.0	-23 51
Jun 14	476	Hegwig	121	0.06	465	P	0.297	105.7	118131	+ 1	2406		5 58.2	0.14S	UA	N 1	1266	-0.03	-0.1	10 8.2	1 12
Jun 16	476	Hegwig	121	0.06	465	P	0.302	106.0	118148	+ 1	2410		3 25.6	2.30N	UR	N 1	1269	0.01	0.1	10 10.4	1 3
Jun 16	86	Semele	127	0.08	603	C	0.184	259.7		B25	64292		13 44.8	2.26N	C					18 39.6	-24 2
Jun 25		Venus	12220	12.79			1.184	76.6	93670	+18	557		8 45.7	12.98N	UR	N18	299	0.01	0.0	3 54.5	18 34
Jun 28+	55	Pandora	68	0.05	208	M	0.163	285.3	207573	C31	12786		10 3.8	1.64S	S					16 19.8	-31 25
Jul 2+	451	Patientia	230	0.09	1304	CU	0.335	76.2					2 19.8	0.22S	C					3 3.7	5 9
Jul 2	8	Flora	141	0.15	499	S	0.273	257.0	186885	-21	5025		8 51.6	0.26N	UH			-0.02	-0.4	18 29.3	-20 58
Jul 5+	196	Philomela	146	0.10	689	S	0.190	261.0		C27	12439		15 17.2	3.58N	H					18 7.4	-27 40
Jul 5+	466	Tisiphone	121	0.06	601	C	0.167	282.3	163870	-12	5833	A	15 48.5	1.71S	UX			-0.07	0.4	20 46.1	-12 20
Jul 5+	466	Tisiphone	121	0.06	601	C	0.167	282.3	163870	-12	5833	B	15 42.0	1.15S	UX			B0.56	-6.5	20 46.1	-12 20
Jul 6	6	Hebe	186	0.10	923	S	0.147	147.8	120195	+ 6	2814		9 33.0	1.58N	A	N 6	1665	-0.21	-0.6	13 57.3	6 13
Jul 9	39	Laetitia	159	0.07	786	S	0.196	119.0	119674	+ 4	2669		2 25.1	0.95N	FU			0.29	-0.2	12 55.1	3 27
Jul 9	8	Flora	141	0.15	497	S	0.263	256.6		L 3	6216		7 32.5	0.62N	HC			0.11	-0.6	18 21.5	-21 23
Jul 10	41	Daphne	182	0.19	711	C	0.219	242.5					2 46.5	4.18S	C					18 47.0	4 1
Jul 10+	196	Philomela	146	0.10	689	S	0.177	262.0		L 3	2191		15 26.1	1.79S	H					18 3.3	-27 48
Jul 10	86	Semele	127	0.08	594	C	0.192	262.8		C24	14176		17 42.2	0.11S	H					18 18.9	-24 45
Jul 11	46	Hestia	131	0.08	406	P	0.432	73.0		+13	374	P	9 30.9	2.20N	XA	N13	190	0.00	-0.1	2 20.1	13 37
Jul 12	5	Astraea	125	0.06	440	S	0.440	82.4	93962	+17	731		7 3.4	1.15N	UX	N17	393	0.14	0.0	4 28.8	17 32
Jul 12	537	Pauly	56	0.06	126	DU:	0.205	231.4		L 5	2856		11 44.6	3.07N	H					20 12.5	-18 35
Jul 13*	790	Pretoria	176	0.10	903	P	0.140	5.4					14 54.2	0.14E	A	N22	2519			23 13.8	22 16
Jul 15	3	Juno	267	0.13	1886	S	0.074	150.2	140133	- 1	2985		16 11.5	1.86S	UA	S 1	1862	0.51	-2.2	14 46.4	-1 39
Jul 17*	537	Pauly	56	0.06	126	DU:	0.216	232.4		L 5	2701		5 42.1	2.95S	H					20 9.2	-19 12
Jul 19	679	Pax	74	0.07	197	I	0.324	230.7		L 3	7190		4 7.2	3.09N	HC			-0.08	0.2	18 25.7	-17 5
Jul 20*	211	Isolda	148	0.08	682	C	0.132	56.5	109369	+ 8	94	K	13 15.1	2.43N	UR	N 9	51	-0.11	1.3	0 40.7	9 18
Jul 21	39	Laetitia	159	0.07	785	S	0.238	117.1	119760	+ 2	2620		22 51.3	0.94N	UH	N 2	1641	0.15	0.1	13 5.0	2 8
Jul 23	39	Laetitia	159	0.07	784	S	0.244	116.9		+ 2	2624		20 50.8	0.35S	HA	N 2	1644	0.51	-1.7	13 6.7	1 56
Jul 28	8	Flora	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	251.0		-22	4543		14 24.5	3.40S	HY			-0.07	1.2	18 3.8	-22 30

IOTA members. Hans-Joachim Bode distributes similar predictions to IOTA/ES members. Carroll's predictions are computed and listed in the same format as those for 1988 discussed in O.N. 4 (6), 149. Carroll generated the predictions for 1990 in late December, and distributed them during the first week of January. He distributed with it a page of finder charts for January and early February events, and a note of explanation noting that this issue of O.N. would be late, prepared by me. Unfortunately, at the end of January, I received the February issue of the Astronomical Journal, which listed several

Table 1, Part 6

1990 Date	Universal Time	PLANET Name	PLANET m_v	PLANET Δ,AU	STAR SAO NO	STAR m_v	STAR Sp	STAR R.A. (1950)	STAR Dec.	Occultation Δm	Occultation dur	Occultation df	Occultation P	Possible Path Lo1La1	Possible Path LomLam	Possible Path LoeLae	El Sun	MOON El	MOON %Snl	MOON Up	Ephem. Source
Jul 28	15h11m-38	Flora	9.6	1.361		9.0	B3	18h 1m.3	-22°30'	1.1	21s	34	14	160° 3°	100°-26°	15°39°	146°	66°	42+	w106E	Goffin86
Jul 28	19 4-31	Flora	9.6	1.361	186216	7.3	B0	18 1.2	-22 30	2.4	21	35	14	118 3	57-27	-27-40	145	64	43+	w 65E	Goffin86
Jul 29	4 34-57	Flora	9.6	1.363	186209	9.4	B9	18 0.9	-22 32	0.8	22	35	14	-49 38	-99 11	-153 0	145	59	46+	w 84W	Goffin86
Aug 1	15 30	Triton	13.5	29.294	187435	9.3	K0	18 51.5	-22 3	4.2	81	52	38	Australia,NZ,Japan,HI?			153	30	78+	all	NA0001
Aug 9	16 48-67	Hygiea	10.2	2.295		10.2	F8	23 23.3	0 57	0.7	51	36	8	-163-23	137-34	64-45	144	3	89-	all	Goffin86
Aug 9	21 8-14	Pax	12.4	1.493	186343	6.6	A2P	18 5.6	-21 27	5.8	7	24	29	-24 41	-29 21	-41 2	135	86	88-	none	MPC14930
Aug 9	23 37-37	Hermione	13.3	3.695		12.8		5 31.6	22 40	1.0	7	11	25	34 51	38 53	45 56	53	85	87-	all	MPC12191
Aug 10	11 49-62	Semele	13.7	2.387		11.3	G5	17 57.8	-25 15	2.6	27	64	27	161 48	139 38	114 33	132	96	83-	e130E	EMP 1987
Aug 12	0 17-17	Hermione	13.3	3.674		11.0		5 34.2	22 44	2.4	7	12	25	21 46	29 50	40 56	54	58	68-	all	MPC12191
Aug 13	3 38-47	Urhixidur	12.8	1.735	191313	8.8	G0	22 37.4	-27 33	4.1	7	22	31	(swEurope,neN.Amer.)?s			160	75	56-	all	EMP 1986
Aug 18	8 49-49	Metis	11.0	2.552		10.1		6 9.1	23 31	1.3	5	8	19	-76-14	-63 -9	-49 -4	52	25	6-	e 65W	MPC11234
Aug 19	20 3-20	Leda	12.8	1.971	127831	9.2	M2	22 52.2	0 27	3.6	10	24	24	138 12	66 2	-9 -7	160	152	1-	e138E	MPC14158
Aug 20	18 33-39	Kleopatra	11.6	2.575		10.9		6 5.4	17 17	1.2	4	9	27	126 -3	141 0	160 2	56	59	0+	none	Goffin89
Aug 22	1 31-45	Ida	14.0	1.386	146520	8.9	F0	23 5.2	-5 22	5.2	3	25	83	64-21	4-43	-89-60	163	176	3+	none	Yeomans
Aug 27	16 29-36	Vesta	7.8	2.201		12.1		3 47.9	12 8	0.02	44	23	6	121 -9	153 -2	-170 1	96	167	44+	none	Goffin86
Aug 28	19 26-47	Juewa	12.9	2.443	109768	8.7	K5	1 13.2	9 24	4.2	24	44	22	144 25	83 32	20 28	134	130	55+	w 46E	MPC12303
Aug 28	23 19-20	Kleopatra	11.6	2.509		11.5		6 20.7	16 33	0.8	4	9	27	38 47	50 49	68 52	60	155	56+	none	Goffin89
Aug 30	14 16	Kleopatra	11.6	2.495		10.4		6 23.6	16 23	1.5	4	9	26	175 36	-167 39	-146 41	61	169	71+	none	Goffin89
Sep 1+	8 54-56	Terpsichore	13.6	2.434	77865	9.2	K0	5 59.0	30 0	4.4	4	10	28	-122 35	-103 47	-76 61	68	156	85+	w110W	MPC15524
Sep 2	4 5-26	Pax	12.8	1.659	186284	8.7	K0	18 3.5	-25 29	4.1	9	30	33	-120 55	-106 -8	-41-33	112	32	91+	all	MPC14930
Sep 2	12 17-18	Metis	11.0	2.411		11.0		6 40.5	23 39	0.7	6	9	18	-152 27	-137 34	-115 41	60	152	93+	w137W	MPC11234
Sep 2	12 53-70	Interamnia	10.1	1.706		12.1		22 25.7	16 32	0.2	31	24	7	-127-17	163 -9	91-25	155	43	93+	all	Schmadel
Sep 6	0 6-28	Campania	12.5	1.614	109317	9.0	K2	0 35.0	9 22	3.5	13	35	25	80 -1	27-23	-35-57	150	17	99-	all	MPC14160
Sep 7	2 53-54	Kleopatra	11.5	2.431		11.5		6 36.9	15 36	0.8	4	10	26	(Iceland,UK,Scandin.)?n			65	89	95-	all	Goffin89
Sep 7	5 32-33	Jupiter	-1.9	5.969	97812	9.4	G5	8 23.5	19 41		2011	14	2	nwAfrica,Portugal,Azores			40	112	94-	all	NA0001
Sep 7	18 4-18	Urhixidur	12.9	1.743	190967	6.2	A2	22 10.1	-26 35	6.7	6	21	32	176-43	72-51	-1-15	156	57	91-	e 35E	EMP 1986
Sep 8	3 49-80	Harmonia	9.8	1.242	190308	9.2	F2	21 22.1	-21 52	1.1	19	38	16	-17 28	-78 0	-147 -6	151	70	88-	e116W	MPC12687
Sep 9	8 59-62	Adelheid	13.9	2.832	94292	8.6	A0	5 1.8	12 38	5.3	7	18	32	-139 53	-101 55	-62 47	90	36	77-	all	EMP 1989
Sep 11	4 41-61	Massalia	11.3	1.664	164484	8.0	G5	21 31.6	-13 42	3.3	15	27	17	-18 4	-80-19	-160-36	153	108	58-	e 76W	MPC11982
Sep 15	16 52-53	Aquitania	11.5	2.211	141022	4.9	A2	16 9.3	-9 56	6.6	3	9	30	(Finland, Russia)?n			71	111	12-	none	MPC14161
Sep 16	7 49-52	Hermione	13.1	3.264		10.5		6 13.2	23 34	2.7	11	18	22	-106 22	-80 34	-45 44	80	47	8-	e 70W	MPC12191
Sep 17	14 9-10	Kleopatra	11.5	2.338		12.1		6 54.1	14 20	0.5	5	11	25	175 23	-163 25	-137 23	71	53	2-	e143W	Goffin89
Sep 21	17 58-60	Kleopatra	11.5	2.300		12.0		7 0.5	13 47	0.5	5	11	24	123-15	143-14	167-17	73	104	8+	none	Goffin89
Sep 23	0 29-30	Eunomia	10.4	2.746		12.2		8 11.8	22 32	0.2	8	10	15	11 58	27 62	52 66	59	105	15+	none	Goffin87
Sep 24	0 19-23	Fortuna	11.0	1.823	77846	9.1	B8	5 58.2	22 33	2.0	10	15	15	-11 36	21 48	69 55	91	147	23+	none	MPC13923
Sep 24	1 21-22	Dejopeja	14.3	3.330		12.5		7 20.2	23 8	2.0	3	14	71	-4 42	17 49	46 54	72	129	23+	none	EMP 1983
Sep 26	0 26-28	Kleopatra	11.4	2.260		12.0		7 6.8	13 13	0.5	5	12	24	32-35	48-36	65-41	76	151	40+	none	Goffin89
Sep 27	10 55-57	Kleopatra	11.4	2.247		11.6		7 8.8	13 0	0.7	5	12	24	-145 42	-119 43	-89 40	77	165	54+	none	Goffin89
Sep 29	3 38-43	Fortuna	10.9	1.770	78008	9.0	B9	6 5.1	22 28	2.1	11	16	15	-65 38	-29 50	20 56	94	153	70+	w 51W	MPC13923
Sep 30	5 8-51	Nemausa	11.7	1.780	163983	8.0	K0	20 52.7	-11 30	3.8	29	55	19	-161 51	-137-15	-49-72	126	5	79+	all	Goffin87
Sep 30+	13 58-172	Patientia	11.5	2.203		11.8		4 16.2	7 24	0.6	204	259	14	126 17	145-10	121-54	122	105	83+	all	MPC15529
Oct 2	4 58-60	Metis	10.8	2.108	79607	5.9	K5	7 38.0	23 8	4.9	7	11	16	-46-11	-21 -2	7 3	75	134	93+	w 16W	MPC11234
Oct 3	8 58-59	Metis	10.8	2.096		10.3	M4	7 40.0	23 6	1.0	7	11	16	-85-36	-74-32	-60-28	75	119	98+	w 63W	MPC11234
Oct 3	13 6- 9	Semele	14.3	2.984	186641	8.9	G5	18 16.0	-25 33	5.4	7	19	34	102-67	139-57	166-44	84	83	99+	all	EMP 1987
Oct 6+	9 2	Lutetia	13.1	3.460	98991A	6.8	F5	10 9.0	13 36	6.3	3	10	50	-75-13	-67-12	-55-11	43	111	95-	all	EMP 1984
Oct 6+	9 2	Lutetia	13.1	3.460	98991B	7.6		10 9.0	13 36	5.5	3	10	50	-75-13	-67-12	-55-11	43	111	95-	all	EMP 1984
Oct 7	0 2- 3	Eunomia	10.4	2.613		11.1		8 32.7	20 49	0.4	10	12	14	29 16	52 20	77 20	68	78	91-	all	Goffin87
Oct 7	2 32-33	Flora	10.7	1.987		11.6		18 35.5	-24 53	0.4	7	14	20	-122 35	-109 38	-94 44	85	131	91-	e116W	Goffin86
Oct 8	2 27-31	Pax	13.1	1.978		10.5	B4	18 35.7	-29 48	2.7	4	15	39	-122 9	-95 7	-67 16	84	146	83-	e 87W	MPC14930

new events in an article, "Occultations of stars by Solar System objects. VIII. Occultations of catalog stars by asteroids, planets, Titan, and Triton in 1990 and 1991" by Lowell astronomers L. Wasserman, E. Bowell, and R. Millis [Astron. J. 99 (2), 723-734]. These events, not in Carroll's predictions, are indicated with an * after the date in Tables 1 and 2 here; more information about them is given in the major and minor planet sections below. Also, in the basic data that I sent to Carroll, I did not have time to include data for the separate components of three double stars, nor for updates to the predictions based on new orbital elements calculated at the Leningrad Institute for Theoretical Astronomy published in the late December Minor Planet Circulars #15524-15529; these are indicated with a + following the date in Tables 1 and 2. These differeneces, which have been

Table 2, Part C

1990 Date	No.	MINOR PLANET Name	km-Diam.	-//	RSOI	Type	Motion °/Day	P.A.	STAR SAO No	DM/Id No	D	Min. Geocentric U. T.	Sep.	S	Comparison Data AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Jul 28	8	Flora	141	0.14	490	S	0.162	250°9		C22°12512		16h25m9	1"28S	HY		-0"56	0m4	18h 3m8	-22°30'
Jul 28	8	Flora	141	0.14	490	S	0.161	250.8	186216	-22 4541	C	19 19.2	1.35S	UH		0.19	-1.2	18 3.7	-22 30
Jul 29	8	Flora	141	0.14	490	S	0.159	250.5	186209	C22 12499		4 47.8	3.14N	UH		-0.10	-0.5	18 3.4	-22 32
Aug 1		Triton	1680	0.08			0.023	263.7	187435	C22 13407		15 30.0	0.81N	U				18 54.0	-22 00
Aug 9	10	Hygiea	429	0.26	3631	C	0.120	258.1		+ 0 4995		16 56.5	2.16S	XA	N 0 2899	-0.13	2.1	23 25.4	1 11
Aug 9	679	Pax	74	0.07	190	I	0.224	211.3	186343	-21 4866		21 14.0	4.04N	HZ		0.56	0.3	18 8.1	-21 27
Aug 9	121	Hermione	217	0.08	1314	C	0.299	83.9				23 38.9	1.92N	C				5 34.1	22 42
Aug 10	86	Semele	127	0.07	583	C	0.066	260.9		C25 12569		11 59.4	3.20N	H				18 0.3	-25 15
Aug 12	121	Hermione	217	0.08	1315	C	0.295	84.1				0 18.9	1.86N	C				5 36.7	22 46
Aug 13	501	Urhixidur	80	0.06	250		0.220	270.4	191313	C27 16005		3 42.8	5.31N	S				22 39.7	-27 20
Aug 18	9	Metis	190	0.10	707	S	0.490	87.9		A24 47549		8 51.4	1.14S	C				6 11.5	23 30
Aug 19	38	Leda	120	0.08	498	C	0.195	259.6	127831	- 0 4433		20 11.3	0.20N	UA	N 0 2856	-0.22	2.3	22 54.3	0 41
Aug 20	216	Kleopatra	137	0.07	449	M	0.464	100.3				18 40.5	1.01S	C				6 7.7	17 17
Aug 22	243	Ida	33	0.02	70	S	0.188	249.3	146520	- 5 5931		1 37.6	2.95S	UX		-1.62	0.5	23 7.3	-5 9
Aug 27	4	Vesta	561	0.35	4308	V	0.191	87.2				16 36.6	0.70S	C				3 50.2	12 15
Aug 28	139	Juewa	164	0.09	874	CP	0.094	276.5	109768	+ 8 199		19 33.2	1.30N	UX	N 9 109	0.73	0.7	1 15.4	9 37
Aug 28	216	Kleopatra	137	0.08	452	M	0.448	102.7				23 21.9	1.88N	C				6 23.1	16 32
Aug 30	216	Kleopatra	137	0.08	452	M	0.445	103.2				14 18.5	1.28N	C				6 26.0	16 22
Sep 1+	81	Terpsichore	124	0.07	403	C	0.409	83.6	77865	+29 1078		8 56.7	2.35N	UX	N29 648	0.18	0.2	6 1.6	30 0
Sep 2	679	Pax	74	0.06	184	I	0.170	154.4	186284	C25 12715		4 15.8	2.72N	HX		0.42	2.1	18 6.0	-25 29
Sep 2	9	Metis	190	0.11	707	S	0.470	90.5		A24 51241		12 19.9	1.49N	C				6 43.3	23 36
Sep 2	704	Interamnia	333	0.27	2078	F	0.208	265.7				13 1.9	2.31S	C				22 27.7	16 44
Sep 6	377	Campania	95	0.08	303	PD	0.147	238.9	109317	+ 8 82		0 15.6	2.89S	UR	N 9 45	0.18	0.7	0 37.2	9 36
Sep 7	216	Kleopatra	137	0.08	455	M	0.423	105.4				2 55.8	3.09N	HC		-2.91	-1.0	6 39.2	15 33
Sep 7		Jupiter	140904	16.27			0.194	103.0	97812	+19 2009		5 34.4	1.56N	UX	N19 828	0.40	-0.1	8 25.9	19 33
Sep 7	501	Urhixidur	80	0.06	248		0.237	289.2	190967	C25 16033		18 11.4	2.07S	PY		-0.68	0.7	22 12.5	-26 22
Sep 8	40	Harmonia	111	0.12	328	S	0.155	253.6	190308	C22 15377		4 5.7	2.29N	UX		-0.43	1.3	21 24.5	-21 41
Sep 9	276	Adelheid	127	0.06	555	X	0.216	117.2	94292	+12 719		9 4.4	1.35N	UR	N12 511	0.30	0.3	5 4.1	12 41
Sep 11	20	Massalia	140	0.12	555	S	0.184	249.6	164484	-14 6070		4 51.9	1.15S	UZ		0.09	0.6	21 33.8	-13 31
Sep 15	387	Aquitania	106	0.07	296	S	0.469	117.1	141022	- 9 4324		16 52.4	4.78N	PY		0.02	0.0	16 11.5	-10 2
Sep 16	121	Hermione	217	0.09	1333	C	0.206	85.1		A24 47735		7 53.5	1.13N	C				6 15.7	23 33
Sep 17	216	Kleopatra	137	0.08	459	M	0.401	108.8				14 12.4	0.12N	C				6 56.4	14 17
Sep 21	216	Kleopatra	137	0.08	460	M	0.389	110.3				18 0.6	2.38S	HC		-0.38	0.0	7 2.8	13 44
Sep 23	15	Eunomia	272	0.14	1381	S	0.386	108.3				0 31.7	2.01N	C				8 14.2	22 25
Sep 24	19	Fortuna	171	0.13	602	G	0.324	92.7	77846	+22 1139		0 23.9	2.60N	UX	N22 623	-0.08	0.0	6 0.7	22 33
Sep 24	184	Dejopeja	68	0.03	229	X	0.250	97.6		A23 55295		1 24.4	1.39N	C				7 22.6	23 3
Sep 26	216	Kleopatra	137	0.08	462	M	0.376	111.9				0 27.7	3.40S	C				7 9.1	13 9
Sep 27	216	Kleopatra	137	0.08	463	M	0.371	112.4				10 59.2	1.20N	HC		0.21	0.1	7 11.1	12 56
Sep 29	19	Fortuna	171	0.13	603	G	0.299	93.7	78008	+22 1183		3 43.3	2.76N	UX	N22 643	0.14	-0.1	6 7.6	22 27
Sep 30	51	Nemausa	137	0.11	517	CU	0.089	161.6	163983	-11 5463		5 29.0	0.09S	UX		0.35	0.4	20 54.9	-11 21
Sep 30+	451	Patientia	230	0.14	1287	CU	0.017	157.7				14 55.4	3.12S	C				4 18.4	7 30
Oct 2	9	Metis	190	0.12	708	S	0.408	94.1	79607	+23 1780		5 1.8	1.42S	UH	N23 853	-0.32	-0.2	7 40.4	23 2
Oct 3	9	Metis	190	0.13	708	S	0.404	94.2		L 4 2319		9 0.7	3.23S	H				7 42.5	23 0
Oct 3	86	Semele	127	0.06	562	C	0.202	89.3	186641	C25 13004		13 5.2	2.06S	HX		-0.14	-0.5	18 18.6	-25 32
Oct 6+	21	Lutetia	100	0.04	362	M	0.355	109.0	98991	+14 2217	A	9 4.3	1.45S	UZ	N13 1023	0.09	0.1	10 11.1	13 24
Oct 6+	21	Lutetia	100	0.04	362	M	0.355	109.0	98991	+14 2217	B	9 4.1	1.44S	UZ	N13 1023	B0.01	-0.2	10 11.1	13 24
Oct 7	15	Eunomia	272	0.14	1396	S	0.350	111.2		A21 64155		0 5.5	0.46S	C				8 35.0	20 41
Oct 7	8	Flora	141	0.10	463	S	0.326	90.4		B25 63941		2 30.9	3.82N	C				18 38.0	-24 50
Oct 8	679	Pax	74	0.05	174	I	0.318	105.4		C29 15175		2 26.9	2.89N	H				18 38.3	-29 46

incorporated in Tables 1 and 2, and the quarterly maps, are listed in Table 4 on p. 350. In that table, the component of a double star is listed under D. The differences are in the sense, (Table 1 and 2 data as given here) minus (Carroll's early January prediction). The time correction given in the last column needs to be applied to the U.T. in Carroll's January prediction with the sign indicated. The separation correction should be added to the distance in arc seconds (//) in Carroll's January prediction if it is S above, and it should be subtracted if it is N, since the distance in the

Table 1, Part D

1990 Date	Universal Time	PLANET Name	m_v	Δ AU	STAR SAO NO	m_v	Sp	R.A. (1950)	Dec.	Occultation Δm	dur	df	P	Possible Path LolLal LomLam LoeLae	El Sun	MOON El	%Snl	N Up	Ephem. Source
Oct 9	11h39m-40	Sylvia	12.9	3.524	185764	9.4	F2	17h44.7m	-28°37'	3.6	11	15	19	145°72° 168°63° 173°52°	71°	176°	69-	none	MPC11507
Oct 9*	12 14-15	Pallas	8.9	2.501	136625	7.6	K2	9 7.2	-9 44	1.6	15	9	7	-153-50 -139-55 -123-62	57	64	68-	all	Goffin87
Oct 11+	19 31-33	Philomela	12.1	3.092		10.7	K8	18 21.3	-28 4	1.6	6	15	31	-3-48 25-38 52-24	77	158	43-	none	MPC15528
Oct 14	0 55-58	Pauly	13.1	1.981	189034	9.2	A0	20 10.2	-25 1	3.9	4	18	51	(cen.&e.N.America)?s	99	153	21-	none	EMP 1986
Oct 15*	14 51-64	Havnia	12.3	1.515	109356	8.6	K2	0 37.2	0 44	3.7	9	23	23	-161 53 115 46 43 39	167	157	9-	e173W	EMP 1988
Oct 18	5 25-32	Astraea	10.9	1.877	96505B	10.1	G	7 4.3	16 55	1.2	8	18	22	-31 10 -43 16 -3 13	99	93	0-	none	Goffin86
Oct 18	5 45-49	Astraea	10.9	1.877	96505A	9.0	F8	7 4.3	16 55	2.1	8	18	22	(nArgentina,sAtlantic)?n	99	93	0-	none	Goffin86
Oct 22+	3 56-70	Lachesis	12.5	2.321	92355	8.9	K0	1 15.2	15 23	3.6	13	21	19	12 7 -66 4 -142-24	172	136	11+	w111W	MPC15526
Oct 22	18 1- 3	Eunike	12.7	2.836	117313	8.4	K0	8 55.7	2 16	4.4	7	14	25	112 -8 137-10 164-16	73	116	15+	none	HERGET77
Oct 22	18 46-56	Juewa	12.5	2.228		10.0	F5	0 31.9	7 45	2.6	12	22	20	139 56 51 50 -13 33	161	116	15+	w 5E	MPC12303
Oct 24	20 55-75	Vesta	6.8	1.631		10.7		3 50.8	10 38	0.03	59	27	4	127 22 57 12 -9 7	151	138	31+	w 19E	Goffin86
Oct 30	6 40-43	Hispania	13.4	3.234	80994	9.1	G0	9 41.5	25 28	4.3	8	17	29	-109 17 -80 26 -47 28	77	148	83+	w 91W	EMP 1986
Nov 6	0 57-58	Thisbe	12.1	2.865		10.1	B9	13 7.3	-22 24	2.2	6	8	18	(swCanada,w&cenUSA)?s	49	173	86-	none	Goffin89
Nov 6	5 23-33	Kleopatra	11.1	1.867		11.4		7 49.0	6 54	0.6	12	23	20	-86 2 -53-14 -34-48	105	33	84-	all	Goffin89
Nov 7	12 35-153	Fortuna	10.3	1.394	78566	8.5	K0	6 34.8	21 30	2.0	123	168	12	137 15-178 7-153-34	126	11	71-	e139E	MPC13923
Nov 12	4 8-18	Echo	10.6	1.089	93373	7.5	A0	3 15.1	13 40	3.2	7	25	25	120 84-125 66-158 44	176	120	24-	e146E	EMP 1986
Nov 13	8 13-36	Astraea	10.4	1.547		9.6	K7	7 25.2	15 46	1.2	23	45	18	-140 -7 -99 -5 -58-16	119	74	15-	e 86W	Goffin86
Nov 14	22 4-10	Metis	10.2	1.633	80375	9.0	M0	8 39.8	22 17	1.5	17	23	12	(Scandinavia,nUSSR)?s	105	72	6-	e161E	MPC11234
Nov 15	3 38-49	Interamnia	10.8	2.165		10.9		22 11.9	11 12	0.7	29	25	9	-152 43-102 31 -57 17	106	131	5-	none	Schmadel
Nov 17	9 28-46	Kleopatra	10.9	1.768		11.2		7 53.2	5 12	0.6	16	31	19	-152 64 -97 28 -79-20	114	113	0-	none	Goffin89
Nov 19	6 57-65	Eunomia	10.0	2.143		11.3		9 16.8	15 35	0.3	24	26	11	-100 2 -68 -2 40-20	99	120	3+	none	Goffin87
Nov 19	20 21-23	Pauly	13.6	2.461	189987	9.4	K	21 1.6	-22 43	4.2	2	1	64	6-51 24-41 43-31	75	48	5+	w 18E	EMP 1986
Nov 20	8 27-33	Interamnia	10.9	2.225		12.7		22 15.8	11 2	0.2	25	22	10	156-13-176-19-143-27	102	73	8+	w176W	Schmadel
Nov 24	5 14-25	Hermione	12.4	2.475		14.0		6 29.4	25 30	0.2	23	33	17	(Scandinavia,Alaska)?s	144	141	37+	w140W	MPC12191
Nov 29	8 37-53	Antiope	13.5	2.640		12.6		6 32.7	24 11	1.3	11	28	31	-48 18-115 32 174 18	149	73	87+	w 78W	MPC12190
Nov 30	21 20-41	Eunomia	9.9	2.016	98551	9.0	F5	9 21.7	14 25	1.3	39	40	11	25 30 74 15 101-25	110	91	97+	w 94E	Goffin87
Dec 4	13 39-40	Euphrosyne	12.3	3.306	119880	8.2	F5	13 17.1	5 44	4.2	8	12	19	-159 29-139 28-115 23	57	92	93-	all	MPC13294
Dec 5+	17 46-47	Camilla	13.5	4.349		10.5		20 3.6	-14 29	3.0	7	12	27	1 25 12 28 25 32	47	174	84-	none	MPC15525
Dec 9	3 22-26	Interamnia	11.1	2.450		11.3		22 34.0	10 55	0.7	16	15	11	-162 60-112 61 -64 55	88	165	49-	none	Schmadel
Dec 9*	11 54	Sophrosyne	14.1	3.630	183017	7.5	K0	14 53.6	-24 3	6.6	2	9	49	-102 20 -99 18 -92 14	29	56	46-	all	MPC12191
Dec 10	21 39-46	Patientia	10.9	1.939		12.7		3 30.8	7 59	0.2	20	24	12	88 46 47 63 -45 82	152	134	32-	e 64E	MPC15529
Dec 12	4 2-26	Kleopatra	10.6	1.596		9.4	A0	7 49.5	2 6	1.5	18	32	17	27 20 -30-12-103-43	137	84	21-	e 37W	Goffin89
Dec 14	20 23-35	Thetis	11.9	1.837		10.4		6 27.0	18 34	1.8	7	21	29	149 39 69 59 -29 48	165	139	5-	e138E	Goffin87
Dec 15	11 59-71	Hermione	12.2	2.385		11.1		6 14.2	26 22	1.4	16	22	16	-117-30-176 -6 118-14	169	151	3-	e124W	MPC12191
Dec 15	17 27-39	Hermione	12.2	2.385		10.9		6 14.0	26 22	1.6	16	22	16	-170 29 111 59 4 44	169	154	2-	e173W	MPC12191
Dec 19	11 1	Astraea	9.7	1.218		10.9	G3	7 21.2	15 44	0.3	20	35	14	(New Zealand)?n	156	173	5+	none	Goffin86
Dec 19	16 20-40	Patientia	11.1	1.999	111204	7.9	A5	3 25.0	8 36	3.2	24	29	13	157-10 90 20 2 47	143	116	6+	w 24E	MPC15529
Dec 19	21 41-55	Hermione	12.1	2.382		11.3		6 10.4	26 31	1.3	15	21	16	109 -8 36 20 -44 8	174	155	7+	w 33W	MPC12191
Dec 21	4 36-53	Astraea	9.6	1.208		10.4	A9	7 19.9	15 49	0.4	19	33	14	-26-46 -70-33-117-33	158	156	14+	w106W	Goffin86
Dec 25	8 31-42	Kleopatra	10.5	1.547	115840	8.1	B9	7 40.6	1 10	2.5	14	25	16	-65-35-108-44-163-54	149	112	52+	w137W	Goffin89
Dec 25	13 53-67	Hermione	12.1	2.388		11.5		6 5.5	26 41	1.1	15	21	16	-138-10 148 17 67 4	176	82	55+	w155E	MPC12191
Dec 25	20 43-57	Herculina	9.2	1.662		12.1		6 51.3	18 56	0.07	17	20	11	128 4 68 40 -38 52	170	90	58+	w 62E	Goffin88
Dec 26	10 33-42	Herculina	9.2	1.660		10.3		6 50.7	19 0	0.3	17	20	11	-134-55-175-26 138-19	171	82	64+	w156W	Goffin88
Dec 27	1 8-10	Interamnia	11.3	2.668		11.2		22 56.1	11 33	0.8	12	12	12	(Alaska, Greenland)?s	76	40	71+	all	Schmadel
1991																			
Jan 3	23 59-102	Vesta	7.4	1.908	93228	7.4	F5	2 57.4	10 27	0.8	145	70	5	-64-31 -79 26-159 70	122	101	86-	none	Goffin86
Jan 13*	11 50-63	Myrrha	13.5	2.565	95912	1.9	A0	6 34.8	16 27	11.6	8	21	30	-105-10 171 21 70 23	165	163	6-	e117W	MPC14161
Jan 19	5 6-21	Kleopatra	10.5	1.567	115296	9.1	G5	7 13.0	1 11	1.7	13	23	17	-5 29 -73 40-161 53	158	134	10+	w141W	Goffin89
Apr 11	3 26-26	Vesta	8.4	3.117		10.6	K0	4 29.8	20 2	0.14	16	10	8	-119 42-107 40 -91 35	49	95	16-	none	Goffin86

appulse prediction is the distance that the star is from the asteroid (or other object; negative if the star is south of the object). The new orbit for 196 Philomela shows that its occultation on May 23 will not be visible from the Earth's surface, so it is not listed in Tables 1 and 2, although it is in Carroll's early January predictions. Also, in his predictions distributed in early January, Carroll used a smaller diameter for (4) Vesta than the 561 km value used in Tables 1 and 2 here, based on the 1989 August occultation recorded by Millis *et al.* in Ecuador reported in *Bull. Amer. Astron. Soc.* 21 (4), p. 1247. A revised list for these (+ in Tables 1 and 2) events, and appulse/local circumstance data for the new (*) events, will be supplied upon request to Carroll at the address above; interested observers in the USA should send him a long SASE.

Table 2, Part D

1990 Date	No.	MINOR PLANET Name	km-Diam.	-//	RSOI	Type	Motion °/Day	P.A.	STAR SAO No	DM/Id	R No	D	Min. U.T.	Geocentric Sep.	S	Comparison Data AGK3	No	Shift	Time	APPARENT R.A.	Dec.
Oct 9	*7	Sylvia	271	0.11	1920	P	0.238	92°6	185764	C28°	13592		11h37m3	1"94S	XS					17h47m3	-28°38'
Oct 9*	2	Pallas	533	0.29	3371	B	0.472	107.3	136625	- 9	2755		12 14.9	3.21S	PS			0"76	0m1	9 9.2	-9 54
Oct 11	+196	Philomela	146	0.07	689	S	0.251	86.9		C28	14541		19 29.4	1.17S	H					18 23.8	-28 3
Oct 14	537	Pauly	56	0.04	127	DU:	0.258	83.5	189034	C25	14619		0 55.0	4.66N	UX			-1.32	3.4	20 12.6	-24 54
Oct 15*	362	Havnia	97	0.09	307	XC	0.232	262.6	109356	+ 0	98		14 57.3	4.16N	UX	N 0°	51	-0.14	0.0	0 39.4	0 58
Oct 18	5	Astraea	125	0.09	405	S	0.266	100.8	96505	+17	1495	B	5 31.6	0.24S	HX	N16	722	0.08	0.7	7 6.6	16 51
Oct 18	5	Astraea	125	0.09	405	S	0.266	100.8	96505	+17	1495	A	5 49.0	5.42S	UH	N16	723	-0.29	-0.5	7 6.7	16 51
Oct 22	+120	Lachesis	178	0.11	1012	C	0.200	252.2	92355	+14	196		4 2.9	0.80S	UA	N15	115	0.23	-0.1	1 17.4	15 36
Oct 22	185	Eunike	165	0.08	744	C	0.268	107.2	117313	+ 2	2114		18 4.8	1.36S	UR	N 2	1213	0.28	0.2	8 57.9	2 7
Oct 22	139	Juewa	164	0.10	862	CP	0.203	256.4		+ 7	72		18 51.4	2.64N	XA	N 7	61	0.03	0.2	0 34.1	7 58
Oct 24	4	Vesta	561	0.47	4363	V	0.192	255.8					21 3.7	0.40N	C					3 53.1	10 46
Oct 30	804	Hispania	161	0.07	833	PC	0.210	104.6	80994	+25	2146		8 45.3	0.01S	UA	N25	1097	0.21	-0.6	9 43.9	25 17
Nov 6	88	Thisbe	232	0.11	1064	CF	0.456	86.8		C22	12646		0 56.5	2.94N	H					18 9.8	-22 23
Nov 6	216	Kleopatra	137	0.10	480	M	0.206	139.7					5 28.5	3.46S	C					7 51.2	6 48
Nov 7	19	Fortuna	171	0.17	615	G	0.033	132.6	78566	+21	1310		13 40.9	3.09S	UH	N21	703	-0.44	-3.7	6 37.2	21 28
Nov 12	60	Echo	62	0.08	131	S	0.254	246.9	93373	+13	535		4 13.3	7.36N	UR	N13	263	0.05	0.3	3 17.4	13 49
Nov 13	5	Astraea	125	0.11	397	S	0.117	106.9		L 4	1126		8 30.0	2.60S	H					7 27.6	15 41
Nov 14	9	Metis	190	0.16	715	S	0.221	88.8	80375	+22	1976		22 8.3	5.80N	UX	N22	1024	-0.02	0.0	8 42.2	22 8
Nov 15	704	Interamnia	333	0.21	2050	F	0.176	103.2					3 41.3	1.92N	C					22 14.0	11 25
Nov 17	216	Kleopatra	137	0.11	485	M	0.157	159.9					9 40.8	0.44S	HC			-0.49	0.7	7 55.4	5 5
Nov 19	15	Eunomia	272	0.18	1445	S	0.175	128.2					7 3.8	2.51S	C					9 19.1	15 24
Nov 19	537	Pauly	56	0.03	129	DU:	0.380	75.4	189987	C23	16675		20 20.1	2.48S	XS					21 4.0	-22 33
Nov 20	704	Interamnia	333	0.21	2049	F	0.199	98.1					8 25.4	1.56S	C					22 17.9	11 14
Nov 24	121	Hermione	217	0.12	1370	C	0.126	289.5					5 17.7	3.48N	C					6 32.0	25 29
Nov 29	90	Antiope	125	0.07	634	C	0.145	277.3		A24	50120		8 43.8	0.42N	C					6 35.2	24 9
Nov 30	15	Eunomia	272	0.19	1458	S	0.114	145.1	98551	+14	2088		21 33.7	1.86S	UX	N14	1013	-0.28	0.1	9 24.0	14 14
Dec 4	31	Euphrosyne	248	0.10	1454	C	0.309	116.3	119880	+ 6	2727		13 42.0	0.11N	UR	N 5	1819	-0.18	-0.2	13 19.1	5 31
Dec 5	+107	Camilla	237	0.08	1765	C	0.268	84.2		L 5	2528		17 44.4	1.06N	H					20 5.9	-14 22
Dec 9	704	Interamnia	333	0.19	2046	F	0.275	86.6					3 22.6	2.74N	C					22 36.1	11 8
Dec 9*	134	Sophrosyne	107	0.04	401	C	0.392	111.5	183017	C23	11977		11 56.2	0.23N	US			-0.55	0.0	14 56.0	-24 13
Dec 10	+451	Patientia	230	0.16	1280	CU	0.195	288.8					21 42.6	3.99N	C					3 33.0	8 7
Dec 12	216	Kleopatra	137	0.12	498	M	0.159	234.0		+ 2	1809		4 12.7	0.87S	HA	N 2	1017	0.27	0.7	7 51.6	2 0
Dec 14	17	Thetis	93	0.07	323	S	0.232	276.7		L 1	944		20 29.0	3.11N	H					6 29.4	18 32
Dec 15	121	Hermione	217	0.13	1382	C	0.194	281.0					12 4.9	2.02S	C					6 16.8	26 21
Dec 15	121	Hermione	217	0.13	1382	C	0.194	280.9					17 33.3	2.00N	C					6 16.6	26 21
Dec 19	5	Astraea	125	0.14	388	S	0.169	283.3		L 4	901		10 55.5	7.08S	H					7 23.5	15 40
Dec 19	+451	Patientia	230	0.16	1279	CU	0.161	299.2	111204	+ 8	519		16 30.0	1.29N	UR	N 8	360	0.05	-0.2	3 27.2	8 44
Dec 19	121	Hermione	217	0.13	1385	C	0.198	279.9					21 47.7	0.42S	C					6 13.0	26 30
Dec 21	5	Astraea	125	0.14	388	S	0.180	283.7		L 4	829		4 43.6	5.74S	H					7 22.3	15 44
Dec 25	216	Kleopatra	137	0.12	505	M	0.208	257.1	115840	+ 1	1888		8 35.1	3.95S	HA	N 1	937	0.35	0.0	7 42.7	1 4
Dec 25	121	Hermione	217	0.13	1388	C	0.198	278.6					13 59.8	0.59S	C					6 8.1	26 41
Dec 25	532	Herculina	217	0.18	1086	S	0.258	297.2					20 49.5	2.10N	C					6 53.7	18 53
Dec 26	532	Herculina	217	0.18	1085	S	0.259	297.2		L 1	1939		10 37.3	4.14S	H					6 53.2	18 57
Dec 27	704	Interamnia	333	0.17	2045	F	0.332	80.5					1 7.7	3.64N	C					22 58.2	11 47
1991																					
Jan 4	4	Vesta	561	0.41	4400	V	0.067	352.3	93228	+10	399		0 15.2	0.91W	UR	N10	317	0.01	-0.5	2 59.6	10 37
Jan 13*	351	Myrrha	124	0.07	627	C	0.196	287.9	95912	+16	1223		11 56.5	0.38N	F					6 37.2	16 24
Jan 19	216	Kleopatra	137	0.12	518	M	0.225	282.3	115296	+ 1	1778		5 13.3	3.71N	HA	N 1	881	-0.14	3.0	7 20.2	1 7
Apr 11	4	Vesta	561	0.25	4396	V	0.383	77.2		+19	734		3 23.6	1.01N	XA	N20	416	0.03	0.0	4 32.2	20 7

Table 3. Stellar Angular Diameter Information.

1990 Date	PLANET No.	Name	SAO Number	D m''	Stellar Diameter m	time	df
Feb 5	153	Hilda	157376	0.10	226	111	0.6
Feb 15	30	Urania	92841V	3.00	4853	160	16.5
Feb 21		Venus	162858	2.50	733	131	5.8
Mar 19		Jupiter	77995	0.31	1146	104	2.6
Mar 25	165	Loreley	97660	0.10	193	105	0.6
Mar 29	3	Juno	140699	0.85	1569	168	5.0
Apr 2	431	Nephele	163445A	1.66	3441	117	10.3
Apr 21	97	Klotho	99210	0.11	162	75	0.6
Apr 21	345	Tercidina	159545	0.46	499	56	2.1
May 13	147	Protogeneia	118683	0.50	983	290	3.0
May 16	106	Dione	139390	5.22	10742	930	32.3
Jul 9	39	Laetitia	119674	9.08	19525	1110	57.5
Jul 15	3	Juno	140133	0.32	678	103	2.0
Jul 20	211	Isolda	109369K	0.34	616	61	2.0
Aug 1		Triton	187435	0.53	11227	542	10.5
Aug 9	679	Pax	186343	0.61	665	66	2.8
Aug 19	38	Leda	127831	0.68	971	83	3.5
Aug 28	139	Juewa	109768	0.62	1095	157	3.6
Sep 6	377	Campania	109317	0.33	386	54	1.5
Sep 30	51	Nemausa	163983	0.53	684	144	2.6
Oct 2	9	Metis	79607	2.91	4444	171	15.5
Nov 7	19	Fortuna	78566	0.41	418	300	1.8
Nov 14	9	Metis	80375	1.51	1786	163	7.[illegible]
1991							
Jan 4	4	Vesta	93228	0.23	317	82	1.2
Jan 13	381	Myrrha	95912	1.27	2364	156	7.5

Table 4. Revisions to Carroll's early January appulse predictions for 1990.

1990 Date	Asteroid	D	Differences in Separation	Time
Mar. 13	78 Diana	A	0".53 S	−2.8 min.
Mar. 13	78 Diana	B	0.53 N	+2.8 min.
Apr. 21	97 Klotho		1.34 N	−6.4 min.
June 28	55 Pandora		0.34 N	−1.8 min.
July 2	451 Patientia		0.18 N	+0.5 min.
July 5	196 Philomela		0.57 N	−2.1 min.
July 5	466 Tisiphone	A	0.06 S	+0.7 min.
July 5	466 Tisiphone	B	0.50 N	−5.8 min.
July 10	196 Philomela		0.57 N	−2.3 min.
Sep. 1	81 Terpsichore		0.28 N	+0.9 min.
Sep. 30	451 Patientia		0.50 S	+13.6 min.
Oct. 6	21 Lutetia	A	0.00	0.0 min.
Oct. 6	21 Lutetia	B	0.01 N	−0.2 min.
Oct. 11	196 Philomela		0.42 N	+1.0 min.
Oct. 22	120 Lachesis		0.02 S	−1.0 min.
Dec. 5	107 Camilla		0.20 N	+1.2 min.
Dec. 10	451 Patientia		0.20 N	−2.3 min.
Dec. 19	451 Patientia		0.00	−2.7 min.

Occultations by major planets and their satellites. The brightest star to be covered by a major planet this year will be 6.4-mag. SAO 165147 = Zodiacal Catalog (ZC) 3310 = 58 Aquarii, which is a spectroscopic binary. It will be occulted by Mars on April 28 in parts of Africa. For the first time, Wasserman et al. include predictions of occultations of the brighter stars by planets in their recent Astron. J. article, noting that such predictions were prepared by Gordon Taylor for many years. They note that since Taylor's retirement, such predictions have been restricted primarily to the outer three planets, although they have always been published in O.N., with the better events given in my annual articles in Sky and Telescope. For the inner five planets (excluding Earth), I have generated the predictions with computer searches since 1987, and used search results provided by Wasserman after Taylor's retirement and before 1987. In their article, Wasserman et al. list, for 1990, only the April 28th Mars occultation and an occultation of 8.8-mag. 186951 by Mercury, visible December 8 at about 21h 40m U.T. from Brazil with a solar elongation of 21°. Douglas Mink lists other occultations by Mercury, from 1987-1995, most of them very difficult events and most are close approaches rather than occultations, in Icarus 71 (3), pp. 578-481. I do not now have a machine-readable Mercury ephemeris for combined-catalog searches, although I plan to get one for 1991 predictions.

Only one event (Neptune on May 25) involving the outer three planets is in my tables, but data about other much more difficult events, requiring major observatory facilities, have been published by D. Mink and A. Klemola in Astron. J. 90 (9), 1894 (1985 September). The stellar identification for the May 25th event, N 57, is Mink and Klemola's designation. Some of the star fields are very crowded, which posed problems for the automatic plate scanning, so that some observable occultations may have been missed. Occultations of many stars even fainter than those found by Mink and Klemola, but suitable for monitoring in the infrared, have been published by P. Nicholson et al. in Astron. J. 95 (2), 562 (1988 February). Mink and Klemola are now working on predictions of occultations of the outer three planets during the next several years. A paper giving predictions of occultations by Pluto has just recently been sent to the Astronomical Journal. The new article will list some different events, even for 1990, from those given in the 1985 article due to recent improvements in Pluto's and Charon's ephemerides. The article for Uranus and Neptune events will be submitted in a few months; its preparation has just begun.

Wasserman used the Jet Propulsion Laboratory's NAIF ephemerides for Titan and Triton to find two events involving these satellites listed in the Astron. J. article noted above. He provided portions of these ephemerides for my own calculations of these events, which are listed for March 18 and August 1 in Tables 1 and 2. These are described more in individual notes about the events. The 1989 July 3 occultation of 28 Sagittarii by Titan was described in articles in the last issue of O.N. by Dunham et al. (p. 322-323) and Beisker et al. (p. 324-326). The diameter that I used for Titan is a half-intensity-level derived from a subset of those Titan occultation observations analyzed by Sicardy et al. in Nature 343 (6256), p. 351 (1990 Jan. 25) and by Hubbard et al. on p. 354 of the same issue of Nature. Wasserman supplied me with the preliminary Voyager diameter of Triton, which he got from B. A. Smith, Avia. Week Space Technol. 131, p. 18 (1989). However, the diameter of 2705 km given on p. 153 of this month's issue of Sky and Telescope is probably a better value, and would imply a central occultation duration of 130 seconds and an angular diameter of 0".13.

As far as I know, nobody is currently predicting occultations by the other natural satellites, including the Galilean satellites, the satellites of Saturn other than Titan, and the Uranian satellites. Whenever there is an occultation by Mars, an occultation by Phobos and/or Deimos is also likely in a narrow path across the Earth's surface.

Occultations by minor planets. I computed ephemerides for combined-catalog searches for asteroids for which Edwin Goffin predicted favorable occultations, omitting mainly his occultations of faint stars by asteroids with angular diameters less than 0".08. I also included the objects listed by Wasserman on p. 167 of the 1990 R.A.S.C. Observer's Handbook. In addition, I calculated searches for a few small asteroids of special interest, such as 951 Gaspra, which is a target for Galileo. This formed the basis for my first set of predictions, which were used by Carroll and Bode to compute appulse predictions, as noted above. But several favorable events not in Goffin's predictions were in Wasserman et al.'s recent Astron. J. article, noted above, so I added those asteroids also to my searches. FAC searches were performed only for the larger or more important asteroids, including numbers 1, 4, 6, 15, 18, 31, 41, 121, 146, 216, 243, 451, 532, 704, 951, 2060, 3123, and the giant comet Schwassmann-Wachmann 1 (P/SW-1). Other large or important asteroids, such as 2 and 51, were not searched against FAC since those objects remained south of the southern edge of FAC coverage, declination about +3°S, during 1990. CC searches were performed for asteroid numbers 1-6, 8-10, 15, 18-20, 30, 31, 38-41, 46, 51, 55, 57, 60, 78, 81, 83, 86-91, 93, 97, 106, 107, 120, 121, 134, 139, 146, 147, 150, 153, 161, 165, 184, 185, 187, 196, 211, 213, 216, 243, 276, 345, 362, 372, 377, 387, 404, 410, 431, 444, 451, 466, 476, 501, 511, 521, 532, 537, 554, 566, 584, 624, 679, 696, 704, 747, 790, 804, 951, 2060, 3123, and P/SW-1. In addition, searches were performed for early 1991 for 4, 216, and 381. I was able to generate predictions for most of Wasserman et al.'s events (the "Lowell" events) given in this month's Astron. J. article, but there are some differences, due mainly to use of newer orbits by me in a few cases, and my use of Harrington's 1987 Zodiacal Zone (ZZ87) catalog data for several other events. I did not compute a few of the Lowell events that have already happened, or that will be visible only from areas with no known observers, such as the Indian Ocean or the South Atlantic Ocean. For one of the omitted events, involving (200) Dynamene and 9th-mag. SAO 80281 near the Praesepe on Feb. 9, the percent of Moon sunlit is given as 100. However, it is really be zero, since the event occurs near mid-totality of a lunar eclipse. The Moon is only 15° away. According to Goffin's and my calculations, 3 of the Lowell events, also listed on p. 167 of the 1990 R.A.S.C. Observer's Handbook, will not be visible from the Earth's surface. The first event is an occultation of 8.4-mag. SAO 139319 by (39) Laetitia on March 9. Lowell used Lick-Saturn (LS or L 2) data for the star, which they identify as LS 2057 with a declination of -0° 2' 43". However, in my version of the LS catalog, the declination is -0° 3' 20", which agrees with the SAO and ZZ87 positions for this star, so I am confident that the shadow will miss the Earth's surface by a wide margin. For an occultation of SAO 136298 by (8) Flora on September 9, Lowell used SAO data. However, in 1990, the star's declination in ZZ87 and the Lick-Uranus (LU) catalog differs from SAO by about 5" of arc; in a note at the end of the Astron. J. article, Wasserman concedes that the event will probably not happen for these reasons. Finally, on November 18, Lowell predicts that (508) Princetonia will occult a 12th-magnitude Pleiades star (#339) in northern Canada, but my position for this star is about 2" south of that used by Lowell, giving a miss by 0.3 Earth radii. This discrepency has not yet been resolved. For (19) Fortuna and (521) Brixia, Lowell does not refer to the mean motion corrections given in MPC 13923, but those corrections make little difference in the ephemerides computed for these asteroids.

My predictions are in better agreement with Goffin's, since we used the same star catalogs and, in most cases, the same orbits. However, for a few events, there are differences, apparently due to differing step sizes used in the computation of astrometric ephemerides from the orbital elements. I believe the largest discrepancy occurs for the September 30 occultation of SAO 163983 by (51) Nemausa, where Goffin's north-south path crosses California, about 2" east of my path in the Pacific Ocean. Wasserman computes a miss by about 5". The event occurs near a stationary point, where agreement has been hard to achieve in the past.

Occultations by (216) Kleopatra have special value, since radar and lightcurve data suggest that it is a dumbbell-shaped contact binary. I found several new events during late 1990 by an FAC search, and Arnold Klemola has refined the positions of the most important of these stars by measuring existing recent Lick Observatory plates.

Note that magnitudes from the AGK3 are photographic. The visual magnitudes will be considerably brighter, and the magnitude drops larger, for AGK3 stars of spectral type K and M.

Soma's world maps are published here only if the event is not included in Edwin Goffin's predictions; or if the star is mag. 8.0 or brighter; or if the star is double, and I have drawn a line showing the second component path on Soma's map; or if there has been a recent update to the asteroid's orbit.

Priority List. In Table 5 below, EAON is the European Asteroidal Occultation Network and I (IOTA) usually refers to attemts that will probably be made by William Penhallow in Rhode Island and possibly at Van Vleck Observatory in Middletown, CT. Arnold Klemola often helps by providing measurements of secondary faint reference stars from existing Lick Observatory plates. Some otherwise good events that occur during the lunar waning gibbous phases are excluded, since effective astrometry of faint asteroids is usually impossible near full moon, when the plates would have to be taken. The EAON events are from their "observational program"; astrometric updates may not be attempted for all of them. Similarly, events in the "I" column constitute an "observing program" of events on which North Americans should concentrate. Some of the EAON events are of asteroids with small angular sizes that are not in Tables 1 or 2. When possible, numbers give a relative ranking of the priority, with "1" indicating the highest priority. Lowell does not consider any of their 1990 predicted events to be worthy of astrometric updates, although I hope that they might help out for some of my new events, such as those involving (216) Kleopatra and (704) Interamnia in the table below. Similarly, EAON will probably add a few of my new events to their observation program.

Table 5. Priority List for Astrometric Updates.

1990 Date	Asteroid	EAON	I	1990 Date	Asteroid	EAON	I
Jan 8	404 Arsinoe	x	1	Sep 2	679 Pax		1
Jan 8	696 Leonora	x		Sep 2	9 Metis		2
Feb 5	153 Hilda		1	Sep 16	121 Hermione		1
Feb 12	213 Lilaea	x		Sep 24	19 Fortuna	x	
Mar 11	444 Gyptis	x		Sep 27	216 Kleopatra		1
Mar 13	584 Semiramis	x	2	Sep 29	19 Fortuna	x	
Mar 13	83 Beatrix	x		Sep 30	51 Nemausa		1
Mar 18	39 Laetitia	x		Oct 7	8 Flora		3
Mar 19	747 Winchester		1	Oct 14	537 Pauly		3
Mar 25	165 Loreley	x		Oct 22	139 Juewa	x	
Mar 29	679 Pax		2	Oct 24	127 Johanna	x	
Apr 2	86 Semele		3	Oct 30	804 Hispania		2
Apr 13	397 Vienna	x		Oct 30	506 Marion	x	
Apr 21	146 Lucina		2	Nov 6	88 Thisbe		3
Apr 30	1 Ceres		3	Nov 15	704 Interamnia		[illegible]
May 2	89 Julia	x		Nov 17	924 Toni	x	
May 6	584 Semiramis		3	Nov 17	216 Kleopatra		1
May 16	106 Dione		3	Nov 20	838 Seraphina	x	
Jun 16	476 Hegwig		2	Dec 4	31 Euphrosyne		3
Jul 4	176 Iduna	x		Dec 5	107 Camilla	x	
Jul 9	39 Laetitia		2	Dec 9	704 Interamnia		3
Jul 11	46 Hestia		2	Dec 10	451 Patientia	x	
Jul 28-9	8 Flora		1	Dec 12	216 Kleopatra		2
Aug 9	679 Pax	x		Dec 14	17 Thetis	x	
Sep 1	81 Terpsichore		1	Dec 25	216 Kleopatra		2

All of the 1991 events are IOTA priority 1 events, except possibly the Myrrha event, which may be priority 2. Astrometry will likely be attempted by Lick and/or Lowell Observatories for the 1991 Vesta and Kleopatra events in Tables 1 and 2. The EAON Dec. 31 occultation by (205) Martha is not included, since it involves a Yale false star, as noted above.

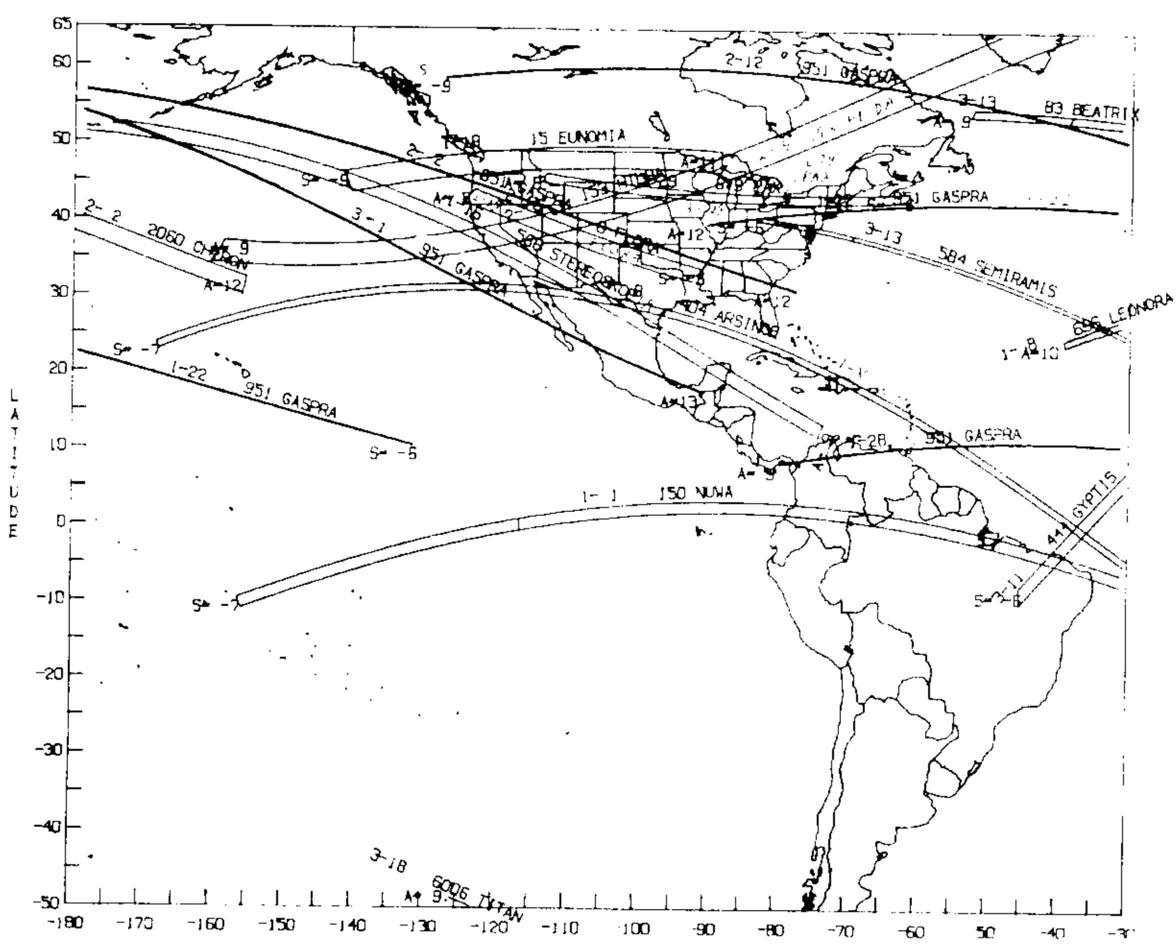
Notes about Individual Events.

Jan. 8, (404) Arsinoe: Penhallow's astrometry for the event indicated a considerable south shift from my prediction, so that the updated path was just a

Jan. 8, (404) Arsinoe: Penhallow's astrometry for the event indicated a considerable south shift from my prediction, so that the updated path was just a little north of Goffin's prediction in the 1990 Asteroidal Occultation Supplement for North American Observers. The updated path went north of Mexico City and over Maui, but with enough uncertainty that the other Hawaiian islands could be in the path. I notified observers in both areas. The only observation that I know of in the uncertainty area was negative, by William Albrecht at Pahala on the island of Hawaii.

Jan. 14: Mars was 96% sunlit, so the defect of illumination (maximum width of dark crescent) was a negligible 0"14.

PLANETARY OCCULTATIONS. 1990 JAN. - MAR.



Jan. 18: The star is probably a double, with vector separation 0".4 in position angle (p.a.) 108°, according to an occultation observed visually in Derby, England; see O.N. 1 (11), 120.

Jan. 30-31: The star is ZC 1823.

Feb. 5: Three exposures were obtained with the 20-inch refractor at Van Vleck Observatory on Feb. 1, measured at Yale Observatory, and reduced by Arnold Klemola at Lick Observatory using secondary reference stars from a 1984 Lick plate. The correction to my path prediction was 0".96 south ±0".07. The time correction was $+1^m \pm 2^m$, but the true error must have been larger than this formal value, since Hilda's motion was virtually nil, less than 1" during each 15-min. exposure. The updated path and its uncertainty included the southern Bahamas, eastern Cuba, Jamaica, Belize, most of Guatemala, and Chiapas state in Mexico. Unfortunately, I did not know of any observers in those areas to notify, and videorecorded a miss at my home in Greenbelt, MD.

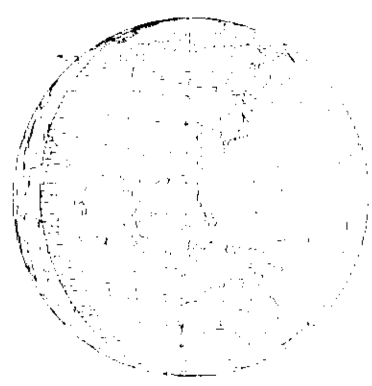
Feb. 15, (30) Urania: The star is ZC 326 = 19 Arietis, a spectroscopic binary, a suspected variable (#100168), and in the Zeta Her group.

Feb. 21: Disappearance will be on the sunlit side of Venus' 25%-sunlit disk. The southern-limit graze visible from northern Nigeria and vicinity will be on the dark side 8° from the south cusp.

Mar. 1: (951) Gaspra is likely to be the first asteroid visited by a spacecraft, by Galileo about two years from now.

Mar. 13, (78) Diana: The star is ADS 6394, with separation 2".3 in p.a. 171°; separate predictions are given for the two components. If seeing is so bad that the stars can not be resolved, the effective magnitude drop will be only 0.7 if one of the stars is occulted.

Mar. 16, (363) Padua: This event is in Goffin's 1990 Asteroidal Occultation Supplement for North American observers, but is not in Tables 1 and 2 due to the small angular size of Padua. David Werner notes that Uranus should be on Goffin's finder charts; see p. 66 of the January issue of Sky and Telescope for a chart locating Uranus.



Anonymous by ... 1990 Feb ?

Mar. 18, Titan: Lowell's prediction, using the Lickb-Neptune position for the star, is 0".4 north of my ZZ87 path. If they are right, the event will be visible from Chile south of about lat. -30°. But the uncertainty is such that even observers in the eastern USA should monitor the event; the small solar elongation will probably preclude a meaningful astrometric update. Titan will be 134" from the center of Saturn in p.a. 113°.

Mar. 19, (747) Winchester: The nominal path for this good event extends nearly due east-west from Oregon to Wyoming.

Mar. 19, Jupiter: Jupiter will be essentially full, with a negligible defect of illumination, 0".36.

Mar. 25: My nominal path extends almost due north to south across Brazil, in good agreement with Goffin's prediction.

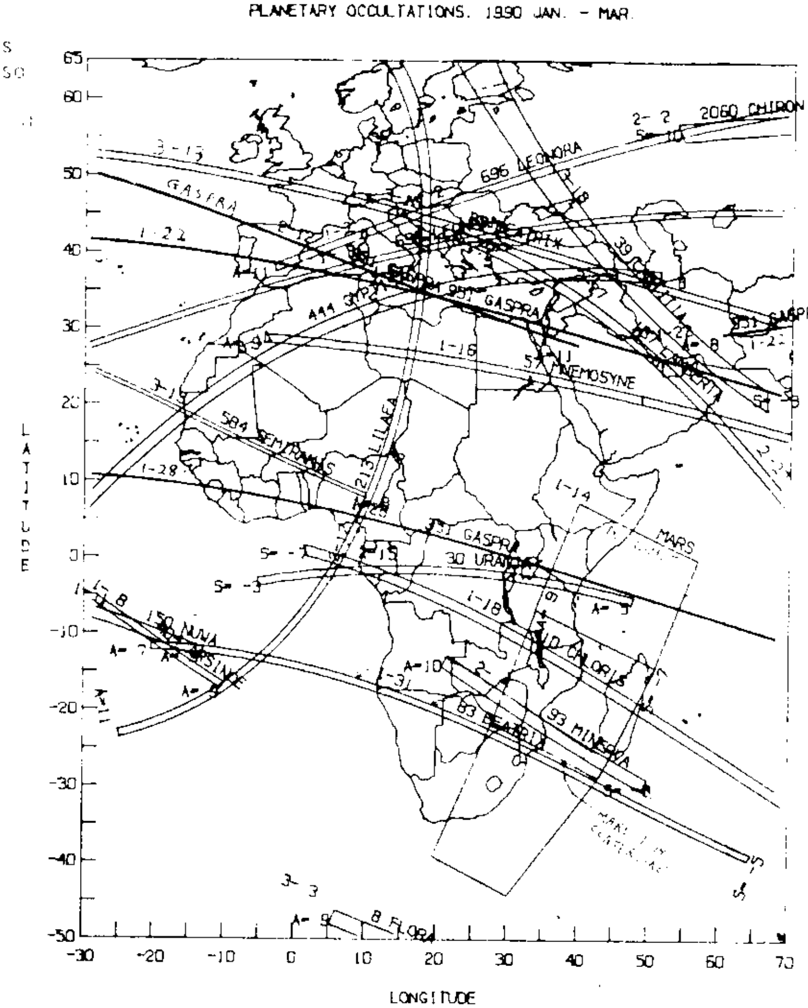
Apr. 2, (431) Nephele: The star is ZC 2963 = Sigma Capricorni = ADS 13675. Its 9.0-mag. companion, 55".9 away in p.a. 181°, will not be occulted.

Apr. 21, (97) Klotho: The star is ZC 1553.

Apr. 28, Mars: Mars' disk will be 89% sunlit. Emersion will be on the narrow dark crescent, whose maximum width will be 0".67. The star, 58 Aquarii (ZC 3310), is a spectroscopic binary.

Notes for occultations during May and later months will be given in the next issue.

PLANETARY OCCULTATIONS, 1990 JAN. - MAR.



SOLAR ECLIPSE NEWS

David W. Dunham

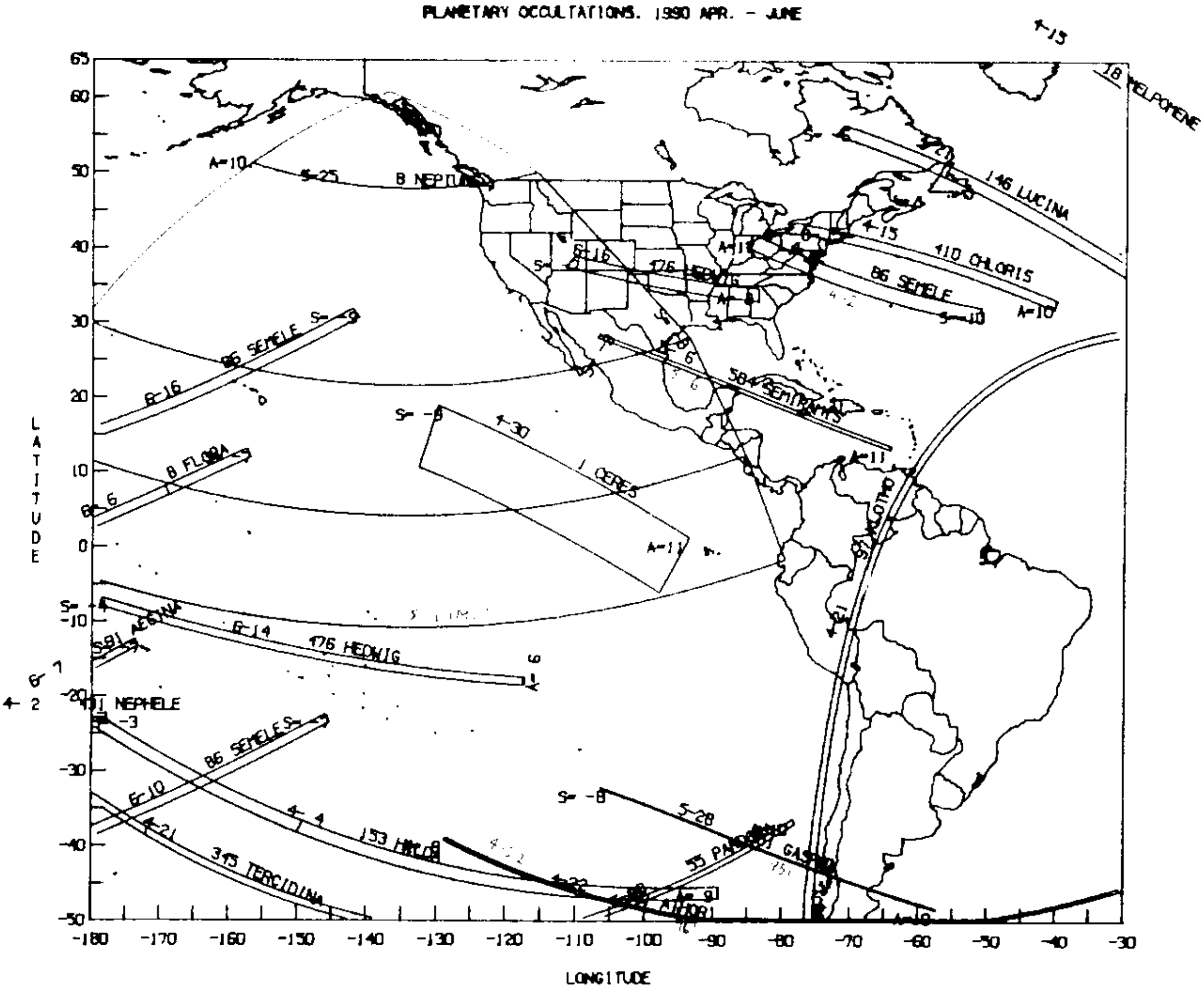
1990 July 22, total. If you are planing to observe this eclipse from Finland or the USSR, note that the best Pleiades passage of 1990 will occur the morning of July 18, 4 days before the eclipse, in the U.K., and central and southeastern Europe (not Scandinavia). More information about it will be in the next issue. Graze paths are shown in the 1990 European grazing occultation supplement, which was distributed to European members of IOTA and IOTA/ES at the end of 1989. One of the best will be the northern-limit graze of 4.0-mag. Maia, on the dark limb of the thin waning crescent, in Greece and near Kiev. If logistics permit it, some of the IOTA eclipse chasers may also try a Pleiades graze.

I know of 7 members interested in joining IOTA's expedition to Siberia to record Bailey's beads from a few km inside the path edges: David & Joan Dunham, Charles Herold, Paul Maley, Derald and Denise Nye, and Glenn Schneider. If you want to join this effort, please telephone me at 301-474-4722.

About November 20th, over two weeks after I had sent my material for the last issue and nearly two months after I had sent my "Lunar Occultation Highlights for 1990" article to Sky and Telescope, I telephoned Bering Air in Nome, Alaska, to ask about their service to Provideniya near the easternmost tip of Siberia. I was told that the service had been terminated just a few days before, when Soviet officials began strictly applying rules whose previous lax enforcement were crucial to the operation. Bering Air is seeking official approval to resume their flights to Siberia, but it will probably be no earlier than 1991 before the necessary arrangements are completed, too late for this year's eclipse. A recent inquiry showed no change in the situation. So we are planning to go to the eclipse via Moscow, which will unfortunately increase our costs. A note about this will be in the March Sky and Telescope.

Hans-Joachim Bode informs me that about 10 IOTA/ES members are also interested in this trip. We plan to join an expedition from Kiev State University Observatory, which plans to also observe from just inside the edges of the path of totality. In a recent letter from Kiev, Dr. V. Telnyuk-Adamchuk requested our help with the observations, and said that Kaperveem (or Keperveyem, as it is called on p. 39 of the USNO circular), near the northern limit closer to Cherskiy than to Markovo, would be the best area to observe the eclipse (they are also arranging sites near the southern limit).

PLANETARY OCCULTATIONS, 1990 APR. - JUNE



Paul Maley recently found out that there will be favorable geometry for GPS measurements near Markovo in July. Unfortunately, GPS has recently been downgraded to 100-m accuracy for civilian users. This is adequate for prediction and preliminary reduction purposes, but not for detailed reductions in the event (unfortunately also unlikely) that skies are clear enough at both limits to obtain high-quality Bailey's-beads observations.

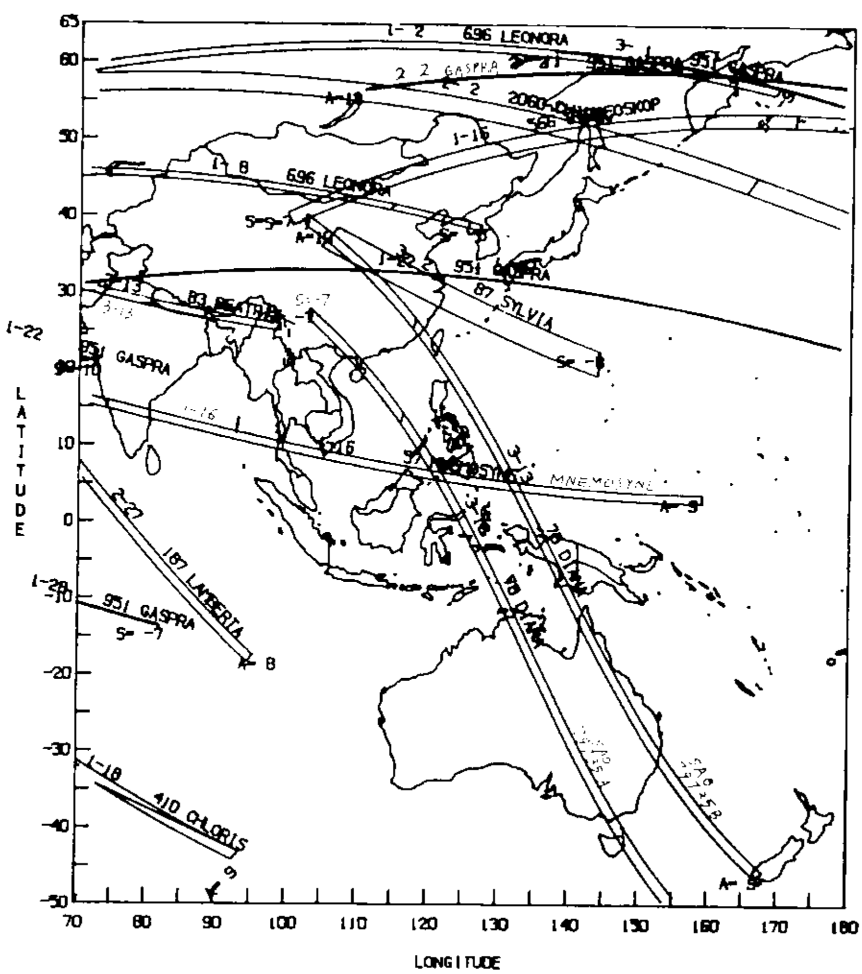
A detailed proposal for our effort will be sent to the Foreign Relations Department of the Soviet Astronomical Council soon. As soon as they inform me of amounts and arrangements for making payments, I will inform prospective members of the IOTA group. A minimal trip will likely cost about $2500, while a full 2-week tourist trip (which we are not planning) may be about $4000.

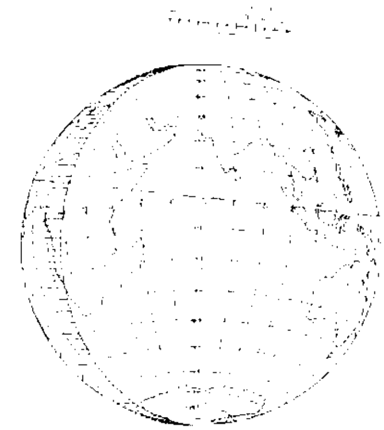
1991 January 15, annular. Both limits are easily accessible in New Zealand, where IOTA will probably concentrate its efforts, although Australians are sure to mount separate expeditions in their country. A 2-week tourist-type trip to New Zealand will probably cost more than $2500. We will fit the trip between the important (4) Vesta and (216) Kleopatra asteroidal occultations in the USA on Jan. 4 and 19, respectively; see my planetary occultation article starting on p. 341. But accommodating the Jan. 13 occultation of Gamma Geminorum (Alhena) by (381) Myrrha on Jan. 13, visible from the central Pacific and China, would be difficult; Alhena will be the brightest star to be occulted by an asteroid during both 1990 and 1991.

1991 July 11, total. If you are already planning to go to Baja California for this eclipse, please let me know, even if you do not plan to observe near the northern limit there (although that would be preferred). We want to coordinate all of the path-edge observations, and also want an IOTA presence at the Research Amateur Astronomy Symposium at La Paz on July 8-12. This is being organized by Steve Edberg, John Westfall, Norm Sperling, David Crawford, and others. To reserve your space in this symposium, send a check or money order for US $130 payable to: Corp. for Research Amateur Astronomy; PO Box 16542; San Francisco, California 94116; USA. Note also the favorable graze of ZC 551 that will occur in the La Paz area during the good Pleiades passage the morning of July 8, as shown on p. 322 of the last issue. The spectacular (perhaps naked-eye) graze of Atlas is only a little farther north, but the main highway intersects it closer to the west coast, where morning marine fog is more of a threat. We need advice from weather records about this.

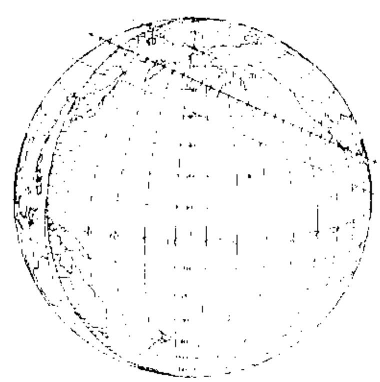
Alan Fiala, USNO, hopes to observe near the northern limit on Maui. One prediction shows that the northern limit may miss the island; refined calculations will be performed in the next month or two at USNO to establish whether some totality will be

PLANETARY OCCULTATIONS. 1990 JAN. - MAR.





SAO 162858 by Venus 1990 Feb 21



Anonymous by Gaspra 1990 Mar 1

visible from the south coast. If you are interested in joining this effort, contact Dr. Fiala at the U.S. Naval Observatory; Washington, DC 20390.

IOTA and IOTA/ES plans to have their main effort at Puerto Vallarta, where there is a virtually inexhaustible supply of accommodations. Details will be announced at least in issue #16. I'm seeking volunteers to lead expeditions for some of the Pleiades grazes shown on p. 322 of the last issue. Guillermo Mallen warns me that skies are very cloudy, in general, in central and southern Mexico in July, and that Baja may be best for the Pleiades. But most of the action is farther southeast, and the cloudiness is mostly convective daytime buildup, which tends to dissipate by the early morning hours of the Pleiades passage. We need more weather statistics before making detailed plans.

SOLAR ECLIPSE — FINLAND 1990 JULY 22

Anyone planning to go to Finland for the total solar eclipse of 1990 July 22 is again reminded to write for information to: Ursa Astronomical Association; Laivanvarustajankatu 3; SF-00140 Helsinki; Finland. Literature is available in both Finnish and English.

REPORTS OF ASTEROIDAL APPULSES AND OCCULTATIONS

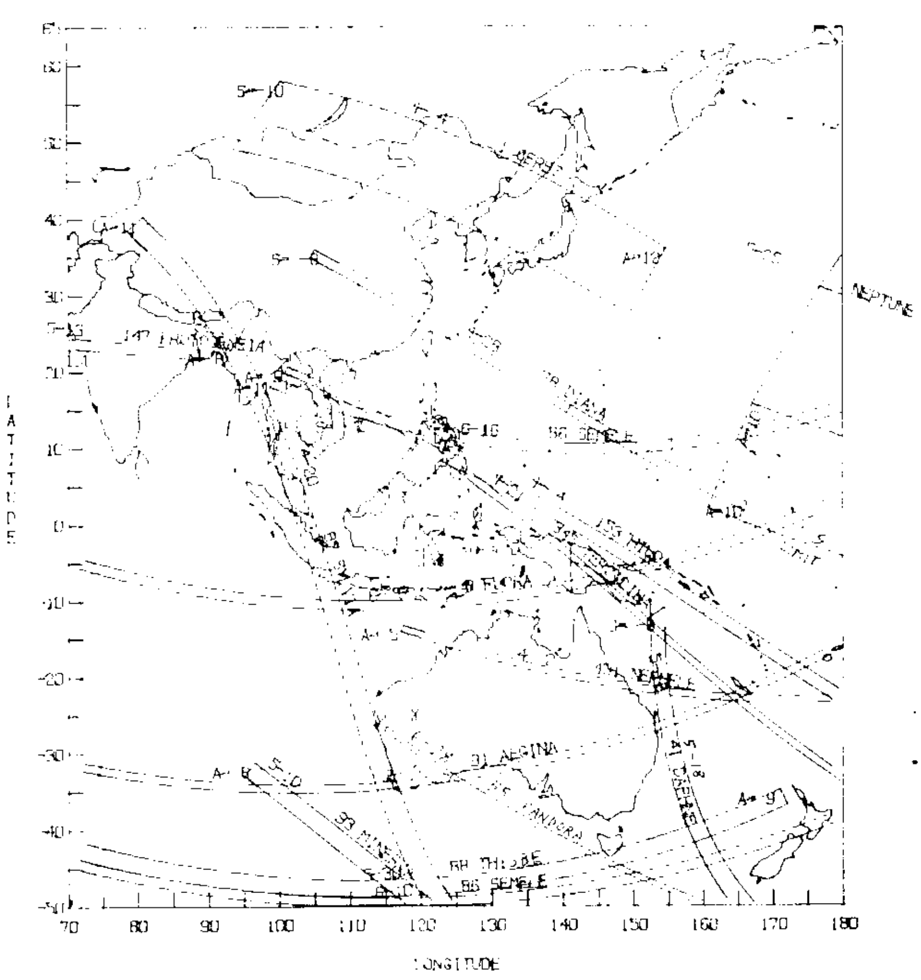
Jim Stamm

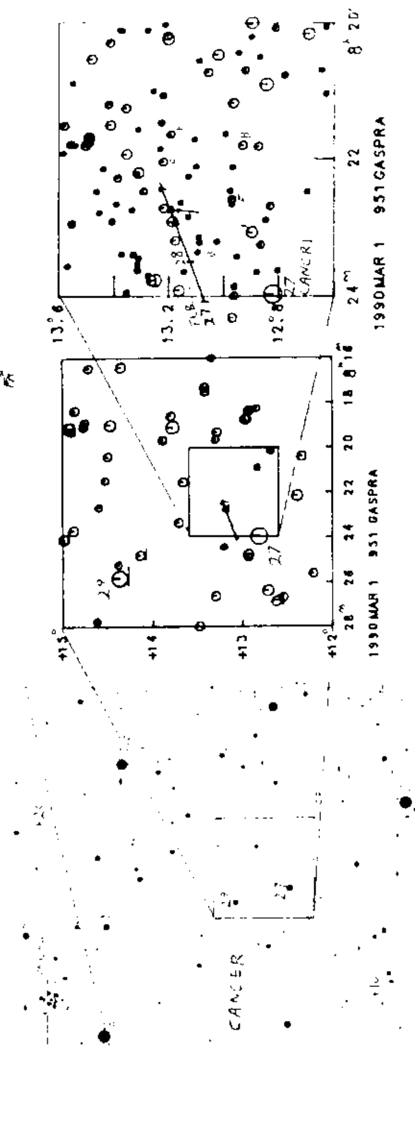
If you do not have a regional coordinator who forwards your reports, they should be sent to me at: 11781 N. Joi Dr.; Tucson, AZ 85737; U.S.A. Names and addresses of regional coordinators are given in "From the Publisher" on page 335.

[illegible] So far I have received three reports of this event. Tony Murray reported a negative observation at Georgetown, Georgia, as did G. Samolyk at West Allis, Wisconsin. Paul and Susan Pavlakis, who were in the predicted path at Waterbury, Connecticut also reported "no event." However, Christof Sauter who observed north of the predicted path at St. Margarethan, Switzerland timed a 11.1-second disappearance beginning at 02:17:44.0. There are several regular observers who live in or near the path of the occultation, so more data are likely to follow.

I am also awaiting some promised reports for the second half of 1988, so that summary will be delayed until the next issue.

PLANETARY OCCULTATIONS. 1990 APR. - JUNE





CAMERA GROUP PURCHASE ALMOST READY; OTHER VIDEO NEWS

David W. Dunham

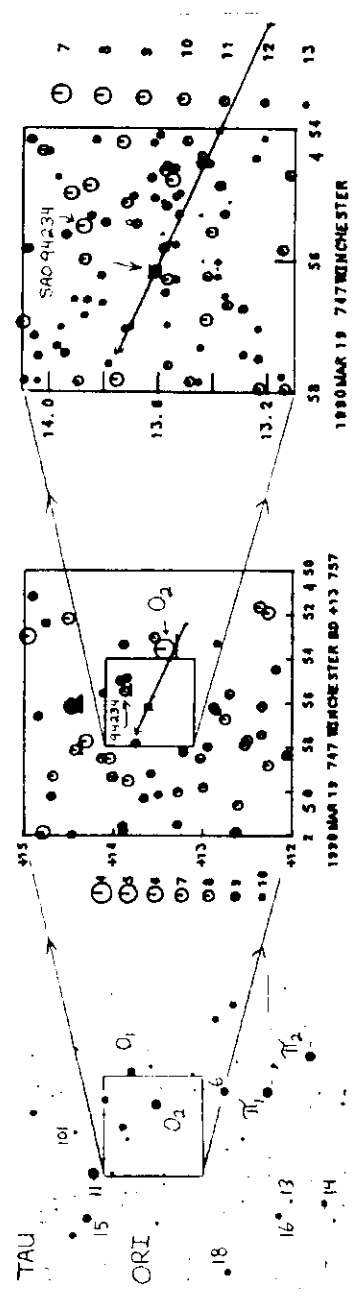
P. Manly and I mentioned a group purchase for the Philips low light level CCD video camera in O.N. 4 (12), p. 291 (1989 Aug.). Eight subscribers have expressed an interest in a group purchase, so we need only two more to get the discount price. But some of the information in the August article is not correct, so some of the eight may want to change their minds. The price is closer to $400 than $300; we have heard different prices quoted, so we will shop around for the lowest one as soon as we have ten interested purchasers. Also, the camera in the group purchase comes without the housing and a few connectors. These cost only a few dollars, and we will provide a list of the Radio Shack part numbers and basic information that might be needed for final assembly of the camera. The eight prospective purchasers at the moment are: C. Bader, T. Hockey, G. Lucas, P. Manly, J. Miller, J. Thrush, W. Warren, and E. Wells. If your name should be added to, or subtracted from, this list, please telephone me at 301-474-4722. After the first ten are purchased, we will accumulate names for a second group of ten.

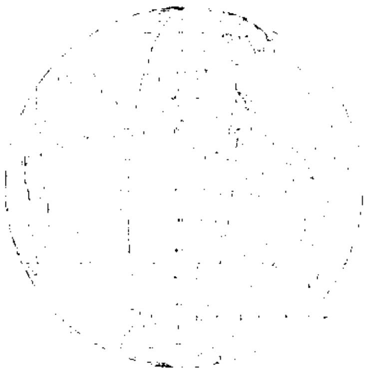
Another important development is the availability of a power inverter which can be used to power an inexpensive ordinary AC-power VCR, and other equipment, from a car battery. G. Hug uses one for his equipment; see p. 340. The device, the Model III Pocket Power Inverter by Statpower Technologies Corp. (STC), can be purchased by mail for $134 from Overton in NC, phone 800-334-6541. Other sources can be found by phoning STC in British Columbia at 604 420-1585. The continuous output is rated at 100 watts; I noticed that the specs for my AC-powered VCR is well under this at 19 watts. Other similar devices may be available.

Two articles on video astronomy have appeared recently, one good and the other bad (that is, for occultations). The good news is Peter Manly's article, "On the Application of Video Technology to Occultation Photometry", in I.A.P.P.P. Comm. #36, p. 15-21 (June 1989). Observation with and without an image intensifier is described. Sections include Prior Observation Techniques, System Operation, Observation Methods, and Data Reduction. In the same issue, Gerald Persha describes the Optec SSP-5 Photometer on pages 28-31.

The bad news is Alan MacFarlane's "A Primer for Video Astronomy" on pages 226-231 of this month's Sky and Telescope. The article concentrates on obtaining good images of the planets and the Moon, and even has a good view of the July 3rd occultation of 28 Sagittarii by Saturn. But the methods that he describes are the opposite of what is needed to obtain high time-resolution data of transient events involving faint objects. For the latter, you need a low-light-level black-and-white camera, not a color camera. A large-screen TV monitor is a nuisance, especially for portable use, where battery-powered equipment is desirable, if not essential. For occultations, you only need enough resolution to clearly record the star that you are trying to observe; this can usually be obtained with simple 4-inch or 5-inch monitors. MacFarlane gives a few useful hints, but keep in mind that what he's trying to do is almost diametrically opposite to the aims of videorecording occultations.

There are other corrections that need to be made to the August article, and I have some other new information, including some camera sky comparisons that we have made here in Greenbelt, MD, which I will describe in a longer article in the next issue.





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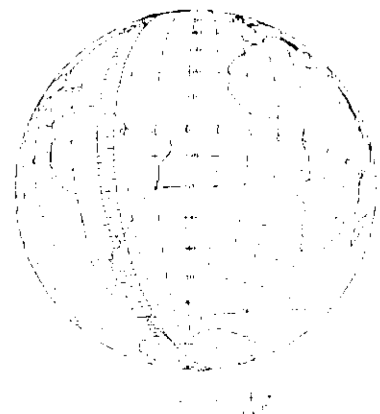
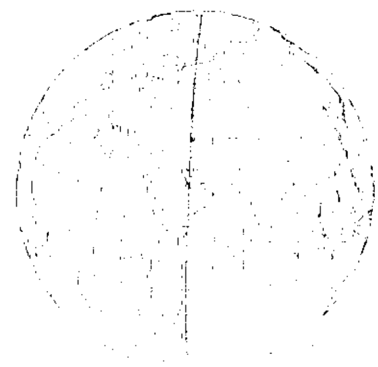


SAO 144068 by Titan 1990 Mar [illegible]



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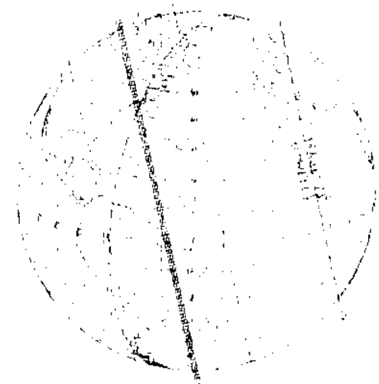
PLANETARY OCCULTATIONS 1990 APR [illegible]



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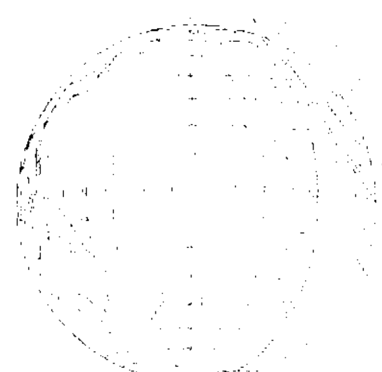

SAO 1[illegible] by [illegible] 1990 Mar [illegible]