# Occultation Newsletter

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## FROM THE PUBLISHER

This is the second issue of 1989. It is the twelfth issue of Volume 4.

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

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|---|---|
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| Graze limit and profile prediction (each graze) | 1.50 |
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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.

[1] Single issue at ½ of price shown
[2] Price includes any supplements for North American observers.
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[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

*Annual Meeting*. The 1989 annual meeting of IOTA, an election meeting, will be held in November (probably 2nd half) or early December, probably during a Saturday and probably at the Lunar and Planetary Institute near the Johnson Space Center southeast of Houston, TX. The date will be established by the end of September and will be put on the IOTA occultation line message at 301,474-4945 when it is known. It will also be given in the next issue of *O.N.*, which we plan to distribute in October in time for the good lunar Praesepe passage on the 22nd, visible from New England and eastern Canada. Nominations are open for election of officers, whose duties are described in the bylaws; contact me at 7006 Megan Lane; Greenbelt, MD 20770; U.S.A.; telephone 301,474-4722 if you want to make a nomonation. Fortunately, we have a volunteer for the most important Secretary-Treasurer position: Craig and Terri McManus of Topeka, Kansas. They are an enthusiastic young couple who were recruited into IOTA by Richard Wilds. Richard has worked with occultations for twenty years and can give good advice to Craig and Terri about unusual requests and correspondence. Most of the other offices will probably be filled with incumbents.

*ESOP VIII*. The Eighth European Symposium of Occultation Projects will be held in Freiburg, German Federal Republic, on September 1-6, according to an announcement distributed July 5th by IOTA/ES. The symposium, in English with German translation, will be held at the Hotel Deutscher Kaiser; the Sternfreunde Breisgau e.V. will help with the arrangements. There will be the annual general assembly of IOTA/ES at 20:00 on the 1st. The sessions of ESOP VIII will start at 9:30 on Saturday, the 2nd, and end at about 13:00 on Sunday, the 3rd. The rest of the time can be spent with organized tours to nearby observatories, to Strasbourg, Freiburg, and the Black Forest. For more information, contact Dr. Eberhard Bredner; Astrag VHS Hamm; Postfach 2449; 4700 Hamm 1; German Federal Republic; phone 02381-172534.

*SPAN Electronic Mail Address*: Wayne Warren recently obtained an account for me on a VAX computer at the National Space Science Data Center, which includes an electronic mail address on the SPAN network. My SPAN address is: nsscda::dunham. This should improve my communications with the astronomical community. If you have a SPAN or BITNET address, please let me know the next time you communicate with me. I can not access my VAX and SPAN account from my office yet (that should be possible at a later date), so now I check my SPAN mail only every 2 or 3 days in the evenings at home. I apparently no longer have a nasamail account, but I still have my telemail-based gsfcmail address (dunhamd). But the SPAN network should be easier to use for communication with BITNET or other SPAN users.

*Future Tavel*: I may need to visit the European Space Research and Technology Centre (ESTEC) in the Netherlands in September or possibly October. But more certain, I will be giving a paper on spacecraft missions to Comet Honda-Mrkos-Pajdusakova during the 40th International Astronautical Federation Congress being held October 9-13. The IAF Congress originally planned to meet in Beijing, China, but after the political developments there in June, the IAF executive council has moved the meeting location to Malaga, Spain. In late October or early November, I may return to Moscow for more discussions at the Space Research Institute (see p. 295). Closer to home, I hope to attend part of the American Astronomical Society's Division on Planetary Science meeting in Providence, RI, October 31-November 3, but only for one or two days, if it does not interfere with the possible trip to the USSR. Farther in the future, I plan to attend the 17th ISTS meeting in Tokyo in May, 1990. While there, I will visit ILOC, for discussion of further cooperation with IOTA and to see how work is progressing following the retirement of A. Senda last March. Since Senda's departure, Kiyofumi Tomii has been answering my letters to ILOC. Also during this trip, I will see how Mitsuru Sôma is doing with his work at the National Observatory on analysis of lunar occultation observations and construction of software to replace critical parts of the U.S. Naval Observatory's OCC program. I sent him a copy of the 80J version of the XZ catalog, as well as other catalogs, in May of this year for his work, which may be of pressing concern for us next year. [Note: I have promised a few others copies of the XZ catalog on magnetic tape, which I hope to distribute in late August, after finalization of the L-catalog, which will also be included in the tapes]. That is because our current file of lunar and solar ephemeris information used by the OCC program, upon which all of our detailed graze and solar eclipse predictions (as well as USNO total lunar occultation predictions) depend, ends at the beginning of 1991. Van Flandern's programs that generate the ephemeris file information include some possibly unusable binary subroutines, for which the Fortran source code may be hard to locate, so generation of an accurate ephemeris file for 1991 detailed predictions and analysis may be difficult. We do have a file of j=2 lunar ephemeris data in the OCC format that goes well into the next century, which can be used, if necessary, for the USNO total occultation predictions.

*Distribution of this Issue*: In the last issue, I said that this issue would be sent in time for the July 27th Pleiades passage, but that event was covered quite well by my article in the July issue of *Sky and Telescope*. So instead, we were going to try to use the August 17th lunar eclipse as the main feature of this issue. However, it took longer than expected to prepare the other articles for this issue, so a separate supplement was prepared for the lunar eclipse and enclosed with USNO total occultation predictions that were computed and sent from USNO for most IOTA members in the region of visibility (members and *O.N.* subscribers in the visibility region not receiving the USNO predictions were also sent the supplement.

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## GRAZING OCCULTATION PREDICTION CORRECTION AND INTENSIFIED VIDEO GRAZE OBSERVATIONS

David W. Dunham

*Correction to Profiles by Walter Morgan:* A change was made to the profile program for 1989 graze predictions, as noted in *O.N. 4* (10), 241. However, in the predictions for 1989 generated by Walter Morgan, this change was not made, for the regions for which he computes grazes: B, D (only first half of 1989), F, O, Q, and XQ. The uncorrected profiles state at the top of each profile, "IOTA ACLPPP, 86 DEC. VERSION," while the correct ones say "88 NOV. VERSION." The correction only affects northern-limit waning-phase dark-limb grazes. If you have "86 DEC." profiles, the Watts angle of central graze is between 330 and 360 degrees, and VPC is not equal to -HEIGHT, then the correctly predicted path will be north of the predicted one by an amount -0.043 times the latitude libration. The result is in arc seconds (scale on left side of profile), which can be converted to miles or km by dividing by the VPS (vertical profile scale). For example, for a prediction for the graze of X7703 On 1989 July 29, the 86 DEC. VERSION profile gives VPS = 0".69/mile, VPC = -0.718 and HEIGHT = 0.490 with Watts angle of central graze 353.93 and LIBRATIONS - LAT = -5.30. Hence, the northward correction is $-0.043 \times -5.30 = +0''.228$. Dividing this by VPS gives a north shift of 0.33 miles. Morgan has corrected this error, but not before all of the late 1989 graze predictions were distributed. Another error that he has not corrected is the version, which should be 80J instead of 80H for all 1989 grazes.

*Graze Videorecordings:* On April 11, I used my image intensifier, RCA Ultricon camera, and 20-cm Schmidt-Cassegrain telescope to videorecord 11 events during a graze of 5.6-mag. Z.C. 885, with a cusp angle of 14N and a 30% waxing Moon. I had to drive 5 hours to western Pennsylvania to reach clear sky. After deploying 3 other visual observers, I quickly started to set up my equipment, only to be asked by a policeman, "Did you get permission to use township property?", etc., only 10 minutes before the graze. Fortunately, I was able to mollify him and get my equipment running with less than 1 minute before the first disappearance. The star appears very bright and the dark side of the Moon is plainly visible with earthshine. Coincidentally, I videorecorded a graze of the same star under virtually identical conditions in August, 1986, while the Moon was 30% sunlit waning, but that time without the intensifier. It is interesting to compare with the April event, since in the 1986 record, the star appears much fainter (though plainly visible), while the dark side of the Moon is hardly noticeable at all.

On March 12, again using the intensifier, I was able to videorecord most of a graze of 8.9-mag. SAO 75722 at a cusp angle of 6N with a 24% sunlit Moon; 3 others were able to visually time the graze with 20-cm and larger telescopes. We observed near Conowingo Dam, MD, in the same area where the first videorecording of multiple events during a graze was made in 1981.

# NEW VIDEO AND PHOTOELECTRIC EQUIPMENT ALLOW MORE OBSERVERS TO RECORD OCCULTATIONS AUTOMATICALLY

David W. Dunham and Peter Manly

*CCD Cameras:* For most of this decade, the RCA Ultricon surveillance camera has been the best camera available for occultation work, using the most sensitive vidicon detector. But several low-light-level CCD cameras have come on the market in the last couple of years. One of the first of these is the CCD monochrome imaging module by Philips, which has offices in virtually every non-communist country with IOTA members. Andrew Elliott, Reading, England, writes: "I have been researching video cameras for use in astronomy for 3-4 years now and was close to buying an Ultricon when I saw the article on the Philips CCD module. Having now obtained one, I really think it outweighs the Ultricon on nearly all points: price, sensitivity, weight, size, image distortion and lag, power consumption, and portability." The fact that he was able to record occultations of 7th-magnitude stars during a Pleiades passage when the Moon was 95% sunlit shows that the Philips camera can overcome glare from the highly gibbous Moon much better than the Ultricon. The minimum sensor illumination is quoted as 0.02 lux for "limit of picture acceptability" and 0.05 lux for "6 dB output voltage." A different rating for the Ultricon tube is "0.3 lux (f/1.6 lens)." Different manufacturers have different ways of measuring lux level, so a better comparison is to tell what magnitude the camera can see with a given telescope aperture. Under the best conditions, the RCA Ultricon camera can see 8th mag. with a 20-cm Schmidt-Cass., and a mag.-8.2 occultation has actually been recorded that way. But usually, 7th mag. is marginal for Ultricon recording with a 20-cm scope. A Philips camera at an observatory near Phoenix was able to see 9th-mag., and sometimes even 10th-mag., stars when used with a 35-cm telescope. Elliott notes that his unit fits into a small Tandy plastic box, suitably modified, that measures 95 by 52 by 42 mm. The total weight, including cable, is about 8 oz. (225 gm). The power consumption is only 165 mA at 12 V. The sensor size is 4.5 by 6 mm, smaller than standard vidicons. For a focal length of 200 cm, this translates into a field size of 7!7 by 10!3, about half the size of the Ultricon field. Prices may vary slightly with different dealers, but in general, the Philips camera (complete) costs about $800, while its cost without a housing and some connectors is about $500. If ten or more make a group buy, the price can be as low as $300 apiece. Any residents of the USA interested in joining an IOTA group purchase to get this "10 off" discount should contact Dunham at the address or phone given in IOTA NEWS on page 289. The Western Research Company (Tucson, AZ, phone 602,325-4505) sells the Philips camera in a housing about the size of 2 35-mm film boxes for $825; this includes a separate controller about the size of a cigarette pack that attaches to the camera with a 1-meter cable. The controller has gain and auto-gain. The unit can see 9th-mag. stars with a 28-cm telescope. They also sell a frame-grabbing board for PC use for about $1500.

During this year, several Japanese low-light-level CCD cameras have come on the market with prices similar to the Philips camera. Steve Hutcheon tells us that Mintron is selling a similar camera (CCD Camera MTV-1801CA) in Australia; its lux specs and stellar performance are the same as the Philips unit. We have not seen any ads for it in the USA. Norman Butler, San Diego, CA, informs us that the Panasonic 200 CCD camera is rated at "0.5 lux," but tests show that it can see 9th-mag. stars with a 20-cm Schmidt-Cass. telescope. It is sold for $505 by Saveon Video in Hollywood, CA. Panasonic also has a model 400, rated at "0.05 lux," that has higher resolution as well as sensitivity, with 800 horizontal pixels and 590 vertical pixels in an array with a diagonal measuring 1.7 cm; it is sold for $900 by Saveon Video. With the performances claimed for the Panasonic 200 and 400, there would be few occultations that would need an image intensifier. Butler considers these Panasonic units as the best buy for cameras currently on the market. Another popular sensitive Panasonic camera is model 5000-D, which is described in an article that will appear in the September issue of *Astronomy*. Roger Tuthill tells us that the Amateur Astronomers, Inc. recently obtained a CCD surveillance camera by Hitachi that has a higher lux rating than the other cameras mentioned above. However, it did very well for recording the occultation of 28 Sag. by Saturn with a 60-cm telescope. Considering the future, Andrew Elliott notes, "I am keeping an eye open for even better versions with larger sensor sizes, the ability to cool the sensor for greater sensitivity and gain, and variable integration times which include normal video rates." Dr. Eric Crane at Western Research Company is working on some of these ideas, to produce a cooled version of their Philips camera that will have some integrating capacity to increase sensitivity.

*Video Time Inserter:* We have surveyed commercially available video time inserters, and have found all of them wanting for the highest timing accuracy. Most of them depend on the recording frame rate for VCRs, which can vary with battery voltage, etc. So Manly has designed a video time inserter based on a quartz clock. A prototype model has proven to be extremely accurate, within the NTSC frame spacing of 0.03 second after running for several days. It has been designed with an active filter and phase-locked loop which detects the 100 Hz and 1200 Hz shortwave timesignal minute markers for triggering the timer. It should be possible to use between a source and a copying VCR to insert time on old tapes with a relatively clear timesignal on the audio. Two passes should be made to trigger the time inserter with minute markers before and after the observed event, to get the actual VCR rate at the time of observation. This will obviate the need to use studio equipment that is needed to isolate the individual frames where audio minute marks occur. Our estimate of the price is about $500.

*Compact Portable VCR:* The portable battery-powered video cassette recorders commonly available at the beginning of this decade can no longer be purchased, except rarely as used equipment. Dunham was able to purchase a portable VCR in April, 1987, but it was a relatively expensive stereo unit that had more features than he needed. When he recently tried to replace a damaged part for it, he found that the unit is no longer manufactured and that the part can not now be replaced, unless a used version of the machine can be found for cannibalization. He was able to bypass the broken part with a $12 special test adaptor. The technology for VCRs has "improved" to the point where all general commercially available recorders are incorporated into camcorders, many of which have non-removable lens and are all less sensitive than the CCD cameras described above. Camcorders with dubbing capability can be used as portable VCRs, but these seem to cost more than $1500. If you intend to use your camera at a fixed-site observatory, you can use a relatively inexpensive AC-powered VCR, and many did this for the occultation of 28 Sagittarii by Saturn. This could also be done for portable use for asteroidal occultations, where you can get AC power at a motel or gas station, but you would need to bring extension cords to try to get far enough away from local sources of light pollution. But for lunar grazes, sites with AC power are rarely available, unless you have time to contact those living in nearby houses at a reasonable hour.

This bleak situation has improved recently with three compact VCR units manufactured by Sony, although they are more expensive than less-portable AC-powered units. Each of these use the small 8-mm video cartidges with a capacity of about 20 minutes, but they all have connectors for copying to other VCRs that use full-size cassettes. The first unit is a GV-8 Video Walkman that has a 3-inch LCD display; it is $5^1/_{16}$ by $8^3/_8$ by $2^5/_8$ inches and weighs only 2 lbs. 14 oz. The second unit, EV-DT1, uses a 5-inch Trinitron screen, measures 6½ by 9 by 12½ inches, and weighs 11 lbs. 7 oz. without battery. Manly notes that the displays on both of these machines seem to show everything that can be seen with a good-quality small TV. The third unit, EV-S1, is a recorder only, that is, it has no monitor. It could be connected to a cheap monitor like the 5 by 5 by 5-inch sets available for $50 or less from Radio Shack. Unfortunately, the EV-DT1 has several features that are not needed for occultations, such as a tuner and 3-week programming capability, that increases the price. You can probably purchase these units in local stores that sell Sony products. Mr. Telescope, in Phoenix, AZ, phone 602,955-5521, sells the GV-8 and EV-S1 for $995, while the EV-DT1 costs $1395. A battery-powered VCR that uses full-size VHS cassettes, includes a 5-inch monitor, and weighs 22 lbs. is available for $1365 from Video Maker; P.O. Box 4591; Chino, CA 95927.

*Important Note on Copying:* For copying videotapes, it is better to connect the VCRs with video and audio lines rather than RF connectors, which lose some resolution relative to the former.

*Image Intensifiers:* Image intensifiers with housing and transfer optics are available for $2270 or more from Astrolink, which advertises in most issues of *Sky and Telescope*. Used 2nd-generation image intensifiers can be purchased for $675 from Stano Components; P.O. Box 6274; San Bernardino, CA 92412; phone 714,882-5789. If you want to purchase one, contact Stano by phone to discuss the units that are available; most have minor defects such as dark spots near the edge which are not much of a problem. But you should not get one with bright spots (look like stars), and you probably would not want one with a superimposed grid. If you get one of these intensifiers, you need to build a housing to attach it to your telescope and camera, and a transfer lens needs to be mounted between the intensifier output and the camera, a non-trivial job. Astrolink sells their "HAL 19," a relay lens video assembly to couple the back end of an intensifier to a standard "C" mounted video camera, for $275. The front of the HAL 19 is designed to fit their HAL 6 first-generation image intensifier housing, but Astrolink tells us that they can make some modifications to accommodate some other housings.

*Optec SSP-5 Photometer:* With the explosion of developments in video, we should not be blind to improvements that are also being made for photometers. Acquisition and tracking of stars to be occulted, especially for lunar grazes and reappearances, are much easier with video, but photometers permit higher timing and photometric accuracies which allow resolving diffraction patterns that can seldom be noticed with video. Thus, photometers can resolve angular diameters and double stars with angular dimensions too small for video occultation techniques. Also, the shallow light drops that occur during some asteroidal occultations can be recorded with photometers but usually not with video.

Optec, Inc., which advertises in most issues of *Sky and Telescope*, is marketing a new photometer, SSP-5, which uses a miniature photomultiplier tube with the same characteristics as the 1P21 and is significantly more sensitive than their SSP-3, while retaining most of the features and ease of use of the earlier model. The SSP-5 costs $1595. Either the SSP-3 or SSP-5 can have a $59 analog output connector modification to use, for example, with a chart recorder for occultations. The SSP-5 has a 10 ms rise time, as opposed to the 50 ms rise time for the SSP-3, so the newer unit should be able to record diffraction patterns for lunar occultations much better than the SSP-3. For $395, an SSP3CARD can be obtained to interface either the SSP-3 or the SSP-5 with an IBM PC, which should provide a better way to record occultation data; also, IBM PCs are more common than chart recorders. Using the SSP3CARD with an SSP-5, it should be possible to record occultations with integrations significantly shorter than 10 ms; tests are needed to see what is really possible. Since the SSP-5 is new, Gerald Persha tells us that Optec will work with their first customers to fix boards and make other modifications at no cost. He is especially interested in helping anyone wanting to record occultations.

*Prices and Call for Evaluations:* Note that the prices quoted above are subject to change; they were provided to us in July. So much new equipment has come on the market in a short time that it is hard to keep up with the most recent developments. Please tell us your experience with video or photoelectric equipment that you have purchased for occultations, so that we can pass it on to readers.

## GRAZING OCCULTATIONS

Don Stockbauer

My goals as coordinator of IOTA's lunar grazing occultation section are:

1. To provide a forum for the exchange of information through these articles;
2. To quality check the reports received and to request any needed clarifications;
3. To publish tabular summaries of each expedition's results; and
4. To maintain an independent repository of the reports.

In order to help IOTA accomplish these goals, please send a copy of your graze report to me at 2846 Mayflower Landing; Webster, TX 77598; USA. (Make a copy for yourself, of course). Sending a copy to ILOC in addition is very helpful; their address is: International Lunar Occultation Centre; Geodesy and Geophysics Division; Hydrographic Department; Tsukiji-5, Chuo-ku; Tokyo, 104 Japan. Data on diskette should be sent to ILOC; if you prefer this medium, please send me a printout of your data file only. Total occultation data in any format should only be sent to ILOC, as I do not need it to produce this article.

The Regulus graze of 1988 November 30 seen across the southwestern U.S. has set records for both the number of stations (110) and the number of timings (663) when totaled for all expeditions. [Ed: This does not include about a dozen timings made from 3 stations in a small expedition led by Richard Nolthenius.] These records should stand until another superbly spectacular graze occurs near several major metropolitan areas containing enthusiastic expedition leaders and observers. Congratulations to all who made it possible.

| Date | V/P | Star # | Mag | % Snl | CA | Location | # Sta | # Tm | S S | Ap Cm | Organizer | C | St | WA | b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | | | | | | | | | | | | | | | |
| 1109 | | 0948 | 4.4 | 84- | 4N | Keith, S.Austrl. | 1 | 1 | 2 | 15 | Jim Blanksby | 2 | 1N | 350 | -74 |
| 1228 | | 0166 | 6.9 | 61+ | 14S | Patchwllk,Austrl | 1 | 4 | 1 | 15 | Jim Blanksby | 3 | S | 166 | -33 |
| 1988 | | | | | | | | | | | | | | | |
| 0214 | | 187672 | 7.2 | 12- | 12S | Benalla,Australia | 1 | 3 | 1 | 15 | Jim Blanksby | | | 187 | 59 |
| 0425 | | 1392 | 7.3 | 61+ | 16N | Elkhorn, WI | 6 | 37 | 2 | 25 | P. Borchardt | 0 | | 19 | -34 |
| 0531 | | 2366 | 1.2 | 100+ | -86S | Hobart, Tasmania | 5 | 26 | 2 | 11 | Martin George | 2 | S | 190 | 58 |
| 0815 | | 118918 | 7.9 | 7+ | 10N | Mangalore,Austrl. | 2 | 9 | 1 | 15 | Jim Blanksby | 3 | S | 13 | 8 |
| 0905 | | 078483 | 7.6 | 29- | 7N | Castellar, Spain | 1 | 3 | 2 | 11 | Carles Schnabel | | | 353 | -60 |
| 0915 | | 2039 | 5.6 | 15+ | 0S | Eden Park,Austrl. | 1 | 6 | 1 | 15 | Jim Blanksby | 2 | S | 185 | 54 |
| 1021 | | 3379 | 6.4 | 86+ | 12S | Leeheim, G. F. R. | 1 | 4 | 1 | 10 | Reinhold Buchner | 5 | S | 166 | 5 |
| 1029 | | 0890 | 4.5 | 81- | 11S | Prenzlau, D. D. R. | 2 | 3 | | | Reddemann/Eichler | | | | |
| 1129 | | 1418 | 5.9 | 64- | 16S | Swanpool,Austrl. | 1 | 4 | 1 | 15 | Jim Blanksby | 1 | S | 197 | -28 |
| 1130 | V | 1487 | 1.3 | 58- | 8S | Fremont, CA | 35 | 212 | 2 | 15 | Baldridge/Morgan | 1 | N | 189 | -10 |
| 1130 | V | 1487 | 1.3 | 58- | 19S | Bastrop, TX | 36 | 229 | | | Frankenber./Dawes | | | 200 | -10 |
| 1205 | | 2003 | 8.5 | 12- | 13S | Cathkin, Austrl. | 1 | 4 | 2 | 15 | Jim Blanksby | 3 | N | 191 | 46 |
| 1215 | | 3431 | 6.6 | 46+ | 8S | Diedenbergen,GFR | 1 | 6 | 2 | 10 | Reinhold Buchner | 6 | N | 168 | -8 |
| 1220 | | 0541 | 4.0 | 93+ | 18S | Navas, Spain | 2 | 10 | 2 | 13 | Carles Schnabel | | | 170 | -62 |
| 1989 | | | | | | | | | | | | | | | |
| 0114 | | 0124 | 8.0 | 43+ | 10S | Cary, NC | 3 | 6 | 2 | 15 | Mark Lang | | | | |
| 0124 | | 1487 | 1.3 | 95- | -4N | Indian River, MI | 1 | 3 | 2 | 25 | Richard A. Walker | | | 5 | |
| 0131 | | 183594 | 7.3 | 36- | 11S | Hartford, CT | 1 | 14 | 1 | 15 | Richard Benton | | | 190 | 76 |
| 0201 | | 2383 | 2.9 | 26- | 15S | Hodge, CA | 3 | 14 | 1 | 9 | David Werner | 2 | N | 191 | 74 |
| 0215 | | 078191 | 7.4 | 80+ | 9N | Santiago,Portugal | 2 | 4 | 2 | 15 | Joaquim Garcia | 1 | S | 13 | -57 |
| 0228 | | 2300 | 7.8 | 55- | 14S | Wildwood, FL | 1 | 8 | 2 | 20 | Tom Campbell | 0 | | 194 | -62 |
| 0311 | | 0311 | 6.5 | 15+ | 4N | Pocahontas, MS | 1 | 4 | 1 | 33 | Benny Roberts | 5 | N | 359 | -59 |
| 0312 | | 076303 | 8.5 | 32+ | 5N | Calhau, Portugal | 3 | 6 | 1 | 15 | Joaquim Garcia | 0 | | 3 | -66 |
| 0313 | | 0616 | 5.6 | 35+ | 10N | Magnet, GA | 2 | 12 | 1 | 20 | Mike Kazmierczak | 2 | S | 9 | -66 |
| 0314 | | 0768 | 7.0 | 46+ | 9N | Wildwood, FL | 1 | 10 | 1 | 20 | Tom Campbell | 0 | | 9 | -66 |
| 0316 | | 1089 | 6.8 | 67+ | 12N | Purcell, KS | 4 | 14 | 1 | 6 | Richard P. Wilds | 3 | S | 14 | -48 |
| 0316 | | 1089 | 6.8 | 67+ | 12N | Nashua, MO | 6 | 18 | 1 | 15 | Robert Sandy | 0 | | 15 | -48 |
| 0316 | | 1089 | 6.8 | 67+ | 15N | Kellytown, GA | 2 | 11 | 1 | 20 | Mike Kazmierczak | 4 | S | 17 | -48 |
| 0318 | | 1329 | 6.8 | 84+ | 12N | Parrish, FL | 2 | 5 | 1 | 20 | Tom Campbell | 5 | S | 16 | -28 |
| 0411 | | 0885 | 5.6 | 30+ | 13N | Bellevue, WI | 2 | 4 | 1 | 20 | Daniel Klos | 2 | S | 12 | -57 |
| 0411 | | 0885 | 5.6 | 30+ | 14N | East Liverpool,OH | 1 | 2 | 1 | 17 | Francis Graham | | | 13 | -57 |
| 0411 | | 0885 | 5.6 | 30+ | 14N | Hookstown, PA | 2 | 22 | 1 | 15 | John Holtz | 2 | S | 13 | -57 |
| 0412 | | 1042 | 6.6 | 40+ | 14N | Canton, MS | 2 | 5 | 1 | 15 | Benny Roberts | 3 | S | 14 | -52 |
| 0413 | | 1180 | 7.1 | 51+ | | Tucson Mtn Pk, AZ | 1 | 4 | 1 | 20 | Michael Smith | | | | |
| 0501 | | 3353 | 3.8 | 25- | -7S | Brejos, Portugal | 4 | 34 | 2 | 15 | Joaquim Garcia | 5 | N | 172 | -1 |
| 0513 | | 1476 | 7.0 | 56+ | 12N | Bee Ridge, FL | 3 | 23 | 1 | 20 | Tom Campbell | 0 | | 14 | 4 |
| 0529 | | 3474 | 6.0 | 37- | 9N | Carroll County,MD | 3 | 8 | 2 | 11 | Curtis W. Roelle | | | | |
| 0529 | | 3474 | 6.0 | 37- | 9N | Coatesville, PA | 1 | 5 | 1 | 20 | Clifford Bader | | | | |

Any method of reducing tapes which uses interpolation by timing the WWV minute marks and the called events is subject to two sources of error; non-linear tape speeds and non-uniform reaction times introduced during the reduction process. Linearity may be checked by ensuring that the minute marks fall at equal intervals; if not, a function may be fitted to the minute marks to allow for this. An example of this would be discharging batteries that still record a signal; the function in this case would be a logarithmic decay. Non-uniform reaction times may be minimized by making an initial pass through the tape and logging the approximate times of all called phenomena. When the tape is replayed for the detailed reduction runs (several passes ensure a higher confidence and accuracy), the occultation events may then be fully anticipated. It is the surprise of an unanticipated called event that can lead to a slightly longer reaction time than that of the minute marks, which are usually fully anticipated. This biases the interpolation and can add several tenths of a second to the true time. One can practice reacting in a uniform way to both the minute marks and the occultation events; when used properly, this method gives excellent results.

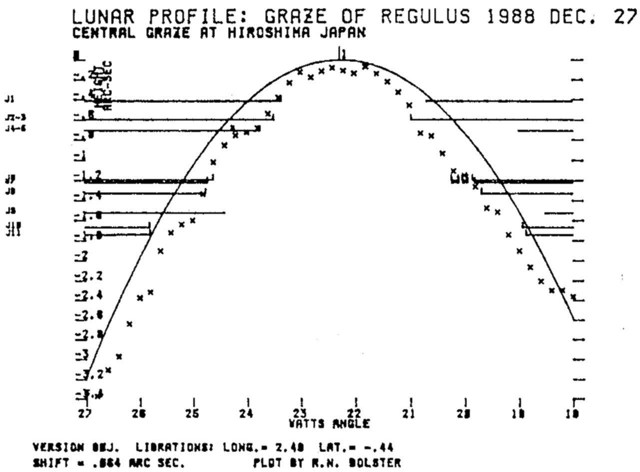
The magnitude listed for SAO 78483 (1988 September 5) in the graze table is from the USNO data base (7.6). Carles Schnabel found the star to be 8.1 magnitude based on observations made in October, 1988.

Dave Osborn wrote on the back of his report of the 1989 February 1 graze of ZC 2383, "Due to the presence of high thin clouds, the lateness of the hour, and an unfamiliar telescope, my personal equation and accuracy values are relatively high and uncertain. I would not recommend revising the gravitational constant "G" based on my data." Such forthright honesty is greatly appreciated; as per his request, Dave's observations will be kept from Stephen Hawking, lest they form the basis of yet another model of our universe.

It is to be hoped that others were more successful with the 28 Sagittarii occultation by Saturn than I. I was disabled with a back injury and could only glimpse Saturn (but not the star) naked-eye through my bedroom window.

I led an expedition to observe the graze of 1 Scorpii on 1989 June 17 UT date near Lufkin, Texas. It was rated marginal, but at 4.8 magnitude, 95% sunlit and a 24° dark northern cusp angle it was actually quite easy. So beware of bright star - bright moon - large dark cusp angle combinations rated marginal; many are actually favorable. Our Timekubes picked up what sounded like touch-tone signals during the graze, which were either from passing car phones or from a telephone trunk line; this was a first for us. David Dunham had a small south shift during a previous graze of 1 Sco, but we had a small north shift, doubtless due to inaccuracy in our predicted profile.

Thanks for all the reports received; keep up the good work.




× = Watts data points
Based on preliminary data supplied by M. Sôma

REDUCTION PROFILE - 1989 MARCH 16 GRAZE OF Z.C. 1089

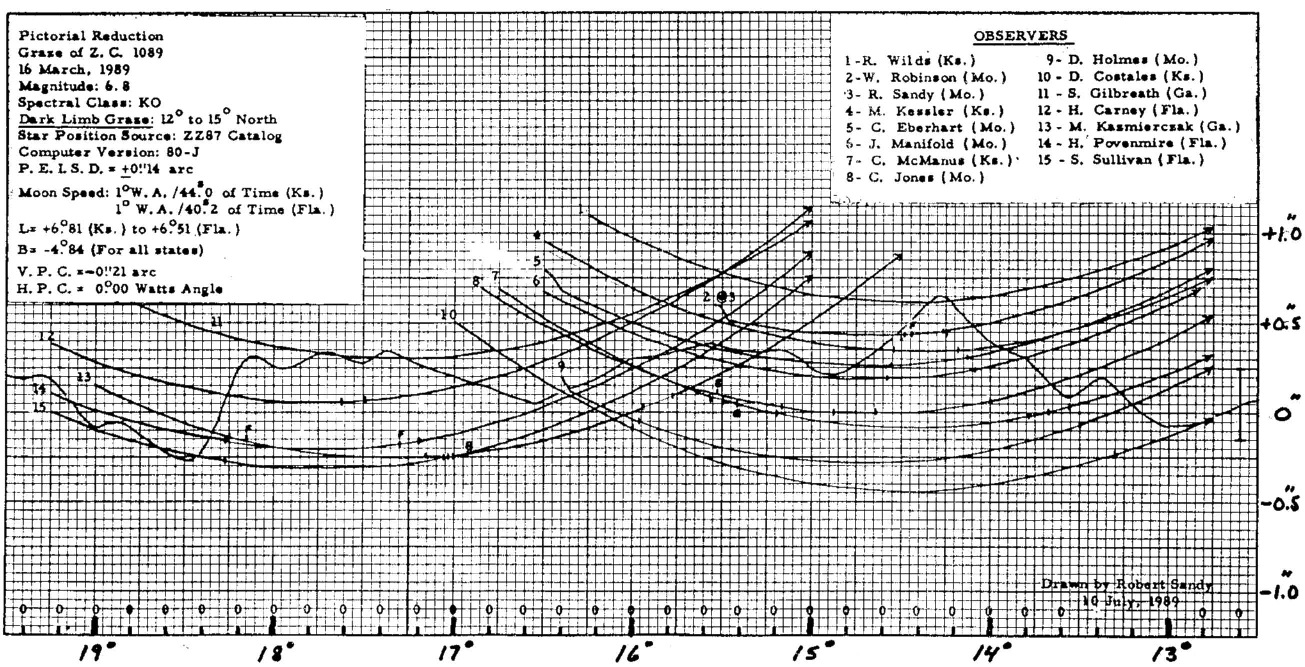
Robert L. Sandy

In *O.N.* *4* (11), 258, the record-setting graze of Z.C. 1089 on 1966 September 10 was mentioned. While we did not approach the 96 timings of that expedition in the latest expeditions for a graze of the same star, our Kansas, Missouri, Georgia, and Florida expeditions amassed a respectable total of 56 timings in addition to two miss observations.

Points in the predicted profile were all of code 0, the best possible current prediction accuracy, ±0ʺ2. Star position source for the prediction was the ZZ87 catalog, whose typical errors are 0ʺ2 to 0ʺ3. Probable error in the star's declination was listed as ±0ʺ14. The reduction indicates a south shift of about 0ʺ2 from the nominal prediction.

Overall, observations agree very well with the Watts profile, verifying the plateaus centered at 17°6 and 15°6, the valleys centered at 16°5 and 14ʺ8, and especially the mountain peaking at 14°3. But especially interesting is an obvious horizontal shift of some of the predicted features in the order of 0°2. This shift can be readily seen with the predicted valley at WA 14°9 observed to be shifted 0°2 to the right; the large predicted mountain at WA 14°3 was observed to be shifted left, the small valley predicted at 13°5, but observed at 13°75 for a left shift, and the small mountain at 13°4 also shifted left to 13°6. Wasn't this Watts horizontal profile error supposed to have been corrected several years ago, and incorporated into the ACLPPP?

If you would like a full-size copy of this reduction profile, essentially free from reduction and reproduction losses, send me $1.00 and a #10 SASE, at 4901 S. Valley View Road; Blue Springs, MO 64015.



## AN INTERESTING VISIT TO THE SOVIET UNION

David W. Dunham

In late March and early April, I visited the U.S.S.R. for the first time. It was primarily a business trip, the main purpose being to exchange ideas about spacecraft orbits with spacecraft mission designers at the Space Research Institute in Moscow. But I also obtained invitations from Dr. Victor Abalakin at Pulkovo Observatory near Leningrad, from Dr. Yaroslav Yatskiv at the Main Astronomical Observatory of the Ukrainian Academy of Sciences, and from Dr. Vladimir of Kiev University Observatory. All were excellent hosts, entertaining me in their apartments and taking me sightseeing, as well as conducting interesting discussions on occultations, eclipses, and astrometry. It was an exciting time since I arrived just a day after the March elections; seeing glasnost in action was very interesting. Before the trip, I got a videotape of occultation and eclipse observations translated into the Russian SECAM format, and showed the most interesting parts of the tape during talks that I gave in Leningrad and Kiev.

At Pulkovo, some restoration work was underway for the Observatory's 150th anniversary and IAU Symposium 141, Inertial Coordinate Systems on the Sky. Dmitri Polozhentsev, Jr. gave me a tour of the observatory, which includes the starting point for the Soviet geodetic system. It had to be relocated from survey markers in Leningrad after the observatory's destruction in World War II. Abalakin wanted to start a program of photoelectric occultation observations at Pulkovo, but has not been able to hire someone with the knowledge of electronics for setting up a working system. Before the trip, I had written to Dr. Kiselev, the director of the Institute of Astrophysics of the Academy of Sciences of the Tadjik S.S.R. asking to visit him in Dushanbe, to answer some questions that remain about two 1979 asteroidal occultations observed there. However, I found out that the connecting flight times to Dushanbe were too long for my limited stay in the USSR, so I did not try to go there. But Abalakin showed me a message that he received from Kiselev inviting me to go there. Abalakin said that he would be seeing Dr. Kiselev in a few weeks, and would pass my questions on to him.

I also visited the Institute of Theoretical Astronomy (ITA) in Leningrad. The institute's new director, Prof. Andrej Sokolsky, was interested in my spacecraft orbit work as well as occultations. I gave Abalakin and ITA's Victor Shor a magnetic tape containing the 80J version of the XZ catalog, as well as some other catalogs.

In Kiev, Yakskiv and Tel'nuk-Adamchuk showed me the astrometric telescopes and measuring engines at their observatories. One of their specialties has been measuring the positions of lunar features for libration studies. I had long discussions with Dr. Alexander Osipov, the coordinator for occultation work in the USSR who has been sending me their annual publications of observations for many years. He described how they would set up camp in the field for grazing occultations, and survey their sites relative to prominent landmarks so that accurate geographical could be determined later after good maps became available. He noted that they had a very successful expedition for a graze of Regulus in June 1988, but that a snowstorm prevented observations of the Regulus graze on November 3rd. The Main Astronomical Observatory has telex, which provides me with a way for sending critical information to Osipov via Yakskiv. I have already used this to send Osipov information about two grazes near Kiev in May, and about the occultation by Titan. We also discussed plans for next year's solar eclipse, which the Kiev University Observatory hopes to record with photometers near the path edges in Siberia. IOTA hopes to join this effort; see p. 320.

In Moscow, most of my time was spent at the Space Research Institute. They were using very out-of-date physical information on asteroids for planning possible future missions, so after I returned, I sent them recent data, including a summary of diameters from occultations. I was able to meet with honorary IOTA member and amateur astronomer Alexander Kovall, who showed me a very interesting collection of slides he has taken throughout the USSR. I gave him a Timekube and some books, in return for a piece of the Sikote-Alin meteorite. At Dr. Tel'nuk-Adamchuk's suggestion, I visited Nickolai Kuznetsov of the Foreign Relations Department of the Astronomical Council one afternoon to discuss logistics for next year's eclipse; see p. 320. I am looking forward to the possibility of a return trip to Moscow in October or November.

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## GALATEA EVENT OF 1987 SEPTEMBER 8

Roland Boninsegna

13 observers distributed in 12 stations reported on the occultation of SAO 145609 by 74 Galatea. Jean-Pol Michon, Herment (F), reported a positive reappearance at $01^h\ 14^m\ 42^s.1$ U.T. The disappearance was gradual (2-3s), the sky was clear, and the star image stability was good.

Two Spanish observers (R. Casas and C. Schnabel) made position measurements of Galatea relative to the star. The error band for this kind of measures is generally great (~3-5"), but the observers agreed quite well on the time of closest approach, ~$01^h\ 10^m$ with ~7-11 minutes of possible error.

The table below presents the distances differences in km of the observers' positions with respect to Jean-Pol's, perpendicular to 74 Galatea's motion in the fundamental plane. The sign represents an upper (+) or lower(-) difference relative to the direction of motion.

| | | | |
|---|---|---|---|
| Schoenmaker, A. A. | (NL | Roden) | + 484.4 |
| Cluyse, L. | (B | Tielt) | + 405.9 |
| Nezel, M. | (D | Bremen) | + 399.4 |
| Michon, J.-P. | (F | Herment) | 0 |
| Garcia, J. | (P | Lisboa) | - 92.2 |
| Vaissière, F. | (F | St. Genest-Lerp) | - 146.1 |
| Genovese, M. | (I | Torino) | - 254.3 |
| Riccabone, G. | (I | Torino) | - 255.0 |
| Casas, R. | (E | Sabadell) | - 351.8 |
| Grenese, A. | (I | Alghero) | - 357.3 |
| March, M. | (E | Mataró) | - 365.9 |
| Marti, J. | (E | Mataró) | - 365.9 |
| Schnabel, C. | (E | Barcelona) | - 367.5 |

The long occultation recorded by J.-P. Michon, $26^s.4$, suggests a diameter of at least 178 km for 74 Galatea, a little less than 50% larger than predicted (123 km). No other observer could have seen the event; J. Garcia was not far from the limit.

Of course, no conclusion can be drawn.

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## 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 289.

**Table 1. Asteroidal appulses and occultations: January - June 1988.**

| 1988 | MINOR PLANET | | STAR | OBSERVERS | REF |
|---|---|---|---|---|---|
| Jan 02 | 615 | ROSWITHA | AGK3 +07° 0113 | ChOvWlMd | |
| Jan 08 | 139 | JUEWA | L 2 1321 | AnSc | |
| Jan 10 | 479 | CAPRERA | AGK3 +09° 1334 | Ov | |
| Jan 10 | 16 | PSYCHE | SAO 158872 | RrRzFnAlGe | |
| Jan 12 | 690 | WRATISLAVIA | SAO 128290 | MuFm | |
| Jan 13 | 675 | LUDMILLA | AGK3 +18° 0561 | StBvLpQtSsDsHzArRz | |
| | | | | RrGaMzFrGzDuCbHn | |
| Jan 15 | 12 | VICTORIA | SAO 137799 | St | |
| Jan 25 | 87 | SYLVIA | 11.7 mag. | FmFn | |
| Jan 31 | 980 | ANACOSTIA | SAO 205248 | ChGy | |
| Feb 01 | 1317 | SILVRETTA | AGK3 +34° 1081 | BcLxMyMeTtVl | |
| Feb 02 | 242 | GERMANIA | AGK3 +03° 1379 | ChOvWlSm | |
| Feb 03 | 59 | ELPIS | SAO 139502 | GzBa | |
| Feb 04 | 125 | LIBERATRIX | AGK3 +15° 0888 | HoMtSnWh | |
| Feb 06 | 506 | MARION | SAO 137920 | LyGg | |
| Feb 07 | 80 | SAPPHO | AGK3 +07° 1092 | Ly | |
| Feb 12 | 393 | LAMPETIA | AGK3 +08° 0507 | Vn | |
| Feb 12 | 75 | EURYDIKE | SAO 183535 | FbMt | |
| Feb 12 | 426 | HIPPO | AGK3 +24° 0899 | HdBw | |
| Feb 13 | 654 | ZELINDA | AGK3 +15° 0511 | Mu | |
| Feb 13 | 1628 | STROBEL | AGK3 -02° 0313 | Mu | |
| Feb 19 | 721 | TABORA | AGK3 +06° 1509 | Sc | |
| Feb 22 | 10 | HYGIEA | SAO 118291 | VnFyRd | |
| Feb 22 | 335 | ROBERTA | AGK3 +09° 1336 | Sc | |
| Feb 23 | 856 | BACKLUNDA | AGK3 +22° 1141 | SjGvRb | |
| Feb 23 | 230 | ATHAMANTIS | SAO 184515 | Vn | |
| Feb 24 | 211 | ISOLDA | SAO 183657 | VnMrMo | |
| Feb 27 | 209 | DIDO | AGK3 +11° 1262 | SjMuBjCzMtMiNbPcSn | |
| Mar 01 | 4 | VESTA | AGK3 +26° 0863 | Gu | |
| Mar 03 | 152 | ATALA | AGK3 +37° 0814 | Ly | |
| Mar 08 | 10 | HYGIEA | BD +06° 2274 | GgBtBzBkBlBdBjCgGi | |
| | | | | GrGkGsGuHkJjNbPc | |
| | | | | RoSlSeSzVcVlWhWb | 1 |
| Mar 08 | 121 | HERMIONE | SAO 186959 | HtAnScGqGmMnPyGdBm | 2 |
| Mar 15 | 114 | KASANDRA | SAO 139205 | VnLn | |
| Mar 21 | 71 | NIOBE | SAO 202846 | Ov | |
| Mar 24 | 14 | IRENE | AGK3 +19° 1171 | BkDlGnMeNpSzSx | 3 |
| Apr 03 | 466 | TISIPHONE | SAO 137000 | SnLrLuCpOvSm | 4 |
| Apr 14 | 772 | TANETE | AGK3 +02° 1837 | BtBhBkBcBnBdCnDt | |
| | | | | EwGuGlHfKcLzMePs | |
| | | | | RtSaTzTtTpWnZk | * |
| Apr 16 | 735 | MARGHANNA | SAO 210378 | Ov | |
| Apr 20 | 93 | MINERVA | AGK3 +30° 0666 | SjGv | * |
| Apr 21 | 139 | JUEWA | SAO 157598 | CpWk | 5 |
| Apr 26 | 105 | ARTEMIS | AGK3 +05° 2232 | OvBdGuKcMePwPsSb | |
| May 01 | 52 | EUROPA | 11.4 mag. | Fm | |
| May 01 | 1200 | IMPERATRIX | AGK3 +01° 1379 | SjFm | |
| May 08 | 1146 | BIARMIA | AGK3 +01° 2499 | LlLc | |
| May 14 | 10 | HYGIEA | 11.1 mag. | Vn | |
| May 14 | 1143 | ODESSEUS | AGK3 +20° 0741 | OvWkSm | |
| May 20 | 570 | KYTHERA | AGK3 -00° 2979 | VrSj | |
| May 24 | 138 | TOLOSA | AGK3 +16° 1043 | Ly | |
| May 29 | 521 | BRIXIA | B 2166613 | Ov | |
| May 30 | 145 | ADEONA | SAO 190841 | Cr | |
| May 31 | 712 | BOLIVIANA | AGK3 +04° 3022 | Ad | |
| Jun 02 | 81 | TERPSICHORE | SAO 207185 | Sg | |
| Jun 07 | 152 | ATALA | AGK3 +28° 0933 | Sm | |
| Jun 08 | 360 | CARLOVA | SAO 141501 | DrKl | |
| Jun 09 | 426 | HIPPO | AGK3 +11° 1052 | Sj | |
| Jun 23 | 508 | PRINCETONIA | SAO 208706 | VbFdOvShDkSpWk | |
| Jun 25 | 115 | THYRA | SAO 208420 | Ch | |
| Jun 30 | 276 | ADELHEID | AGK3 +06° 2377 | ClDlGoGuHoTpWh | |

Two reports that came in after the second half of 1987 summary was published:

(325) Heidelberga and SAO 56709, 1987 Nov. 26; Arun Shankar reports no definite occultation.

(26) Emita and SAO 59964, 1987 Dec. 19; [*O.N.* *4* (10) 235]. Novice observer, Krishan Aggarwal (New Delhi, India) reports a disappearance at 22:16:41 ±2 sec., while experienced observers Chandra Bhushan Devgun and Ajay Talwar reported a miss from 5.25 km away.

I have summarized all of the reports that I have received for the first half of 1988 in the following two tables and section of notes. Table 1 lists the 1988 date, minor planet, occulted star, IDs of successful observers, and references to any notes. Table 2 lists the observer's ID, name, nearest town to location of observation, country (includes state or province for North America and Australia), organization through which the report came, and the total number of observations made in the period. The notes section details those events that included positive observations, or other significant informa-

**Table 2. Observers and locations of reported events: January - June 1988.**

| ID | OBSERVER | CITY | COUNTRY | GROUP | No. |
|---|---|---|---|---|---|
| Ad | ADIB, CARLOS | PORTO ALEGRE | BRAZIL | LIADA | 1 |
| An | ANDERSON, PETER | MELBOURNE | QUEENSLAND - AUS | RASNZ | 2 |
| Ar | ARIAS, TOBIAS | CARACAS | VENEZUELA | LIADA | 1 |
| Al | AVILA, ERNESTO | MERIDA | VENEZUELA | LIADA | 1 |
| Ba | BALLESTEROS, ANTONIO | CARACAS | VENEZUELA | LIADA | 1 |
| Bt | BALTASAR, V. | BARCELONA | SPAIN | GEOS | 2 |
| Bz | BARRUEZO, JOSE | GRANADA | SPAIN | GEOS | 1 |
| Bh | BARTHES, J. | CASTRES | FRANCE | GEOS | 1 |
| Bm | BEMBRICK, COL | SYDNEY | N.S.W. - AUS | RASNZ | 1 |
| Bv | BENAVIDES, ALFONSO | CARACAS | VENEZUELA | LIADA | 1 |
| Bk | BERTOLI, O. | TORINO | ITALY | GEOS | 3 |
| Bc | BLANCHART, C. | BRUSSELS | BELGIUM | GEOS | 2 |
| Bl | BLOMMERS, L. | LEIDEN | NETHERLANDS | GEOS | 1 |
| Bw | BLOW, GRAHAM | WELLINGTON | NEW ZEALAND | RASNZ | 1 |
| Bn | BONINSEGNA, R. | DOURBES | BELGIUM | GEOS | 1 |
| Bd | BULDER, H. | ZOETERMEER | NETHERLANDS | GEOS | 3 |
| Bj | BULLON, J.M. | VALENCIA | SPAIN | GEOS | 2 |
| Cg | CANONACO, G. | GENK | BELGIUM | GEOS | 1 |
| Cn | CARPENTER, H.J.T. | WELLING | UNITED KINGDOM | GEOS | 1 |
| Cz | CAZAUX, C. | AVIGNON | FRANCE | GEOS | 1 |
| Cr | CERRUTTI, NORBERTO | DOLORES | URAGUAY | LIADA | 1 |
| Cb | CHALBAUD, PEDRO | PICO AGUILA | VENEZUELA | LIADA | 1 |
| Ch | CHURMS, JOE | CAPE TOWN | SOUTH AFRICA | ASSA | 4 |
| Cl | COLOMBA, A. | REGGIO CALABRIA | ITALY | GEOS | 1 |
| Cp | COOPER, TIM | EAST RAND | SOUTH AFRICA | ASSA | 2 |
| Dk | DE KLERK, J. | POTCHEFSTROOM | SOUTH AFRICA | ASSA | 1 |
| Ds | DE SALAS, ROMELIA | CARACAS | VENEZUELA | LIADA | 1 |
| Dt | DENTEL, M. | BERLIN | EAST GERMANY | GEOS | 1 |
| Dl | DI LUCA, R. | BOLOGNA | ITALY | GEOS | 2 |
| Dr | DREDGE, A. | JOHANNESBURG | SOUTH AFRICA | ASSA | 1 |
| Du | DURAN, LEONIDES | PICO AGUILA | VENEZUELA | LIADA | 1 |
| Ew | EWALD, D. | BIESENTHAL | EAST GERMANY | GEOS | 1 |
| Fb | FABREGAT, JUAN | VALENCIA | SPAIN | GEOS | 1 |
| Fy | FERNANDEZ, YAMANDU | MONTIVIDEO | URAGUAY | LIADA | 1 |
| Fn | FERRIN, IGNACIO | MERIDA | VENEZUELA | LIADA | 2 |
| Fr | FERRIN, IGNACIO | LLANO HATO | VENEZUELA | LIADA | 1 |
| Fd | FIELD, R. | DURBAN | SOUTH AFRICA | ASSA | 1 |
| Fm | FREEMAN, TONY | BERKELEY | CALIFORNIA - USA | ARP | 4 |
| Ga | GALDIS, CHRISTOS | VALENCIA | VENEZUELA | LIADA | 1 |
| Go | GALLO, V. | SALERNO | ITALY | GEOS | 1 |
| Gi | GARCIA, J. | LISBOA | PORTUGAL | GEOS | 1 |
| Gd | GARRADD, G. | TAMWORTH | N.S.W. - AUS | RASNZ | 1 |
| Gn | GENOVESE, M. | TORINO | ITALY | GEOS | 1 |
| Gg | GEORGE, DOUG | KANATA | ONTARIO - CAN | ARP | 2 |
| Gm | GEORGE, MARTIN | HOBART | TASMANIA | RASNZ | 1 |
| Gr | GERRITSEN, A.A. | AMSTELVEEN | NETHERLANDS | GEOS | 1 |
| Gy | GEYSER, M. | PRETORIA | SOUTH AFRICA | ASSA | 1 |
| Gq | GILMORE, ALAN | MT. JOHN OBSERV. | NEW ZEALAND | RASNZ | 1 |
| Gk | GONCALVES, R. | LISBOA | PORTUGAL | GEOS | 1 |
| Gz | GONZALEZ, JAVIER | LLANO HATO | VENEZUELA | LIADA | 2 |
| Gv | GRAHAM, FRANCIS | EAST LIVERPOOL | OHIO - USA | ARP | 2 |
| Gs | GRUPPO, ASTR. SAVO. | SAVONA | ITALY | GEOS | 1 |
| Ge | GUERRERO, JESUS | BARQUISIMETO | VENEZUELA | LIADA | 1 |
| Gu | GUESSE, M. | NOUAKCHOTT | MAURITANIA | GEOS | 5 |
| Gl | GUHL, K. | BERLIN | EAST GERMANY | GEOS | 1 |
| Hd | HERALD, DAVID | CANBERRA | A.C.T. - AUS | RASNZ | 1 |
| Hz | HERNANDEZ, FERNANDO | CARACAS | VENEZUELA | LIADA | 1 |
| Hn | HERNANDEZ, HECTOR | PICO AGUILA | VENEZUELA | LIADA | 1 |
| Hf | HOFFMAN, M. | SCHALKENMEHREN | WEST GERMANY | GEOS | 1 |
| Ho | HOLLER, G. | GRAZ | AUSTRIA | GEOS | 2 |
| Hk | HOLLER, K. | GRAZ | AUSTRIA | GEOS | 1 |
| Ht | HUTCHEON, STEVE | SHELDON | QUEENSLAND - AUS | RASNZ | 1 |

tion that could not be reported in the tables. I am not including notes on those observations that may have been spurious unless there is some sort of confirmation, or the fact that something may have happened is relevant to another observation. Instead, I will place an asterisk (*) in the REF column to indicate that I have received a report with more than a "no event" in it.

Notes:

1) Canadian Doug George along with 23 European observers monitored this event: See Roland Boninsegna's article on page 298.
2) See *O.N. 4* (8), 194.
3) S. Szabo and A. Szauer (Szombathely, Hungary) reported a disappearance at 19:17:42.5 and 19:17:42.9 respectively, and a reappearance at 19:17:55 and 19:17:53 respectively. Five other European observers reported misses.
4) See *O.N. 4* (8), 194.
5) See the article by T. P. Cooper and M. D. Overbeek on this page.

| | | | | | |
|---|---|---|---|---|---|
| Ij | JONLET, J. | LIEGE | BELGIUM | GEOS | 1 |
| Kc | KOCSIS, A. | VESZPREM | HUNGARY | GEOS | 2 |
| Kl | KOHL, M. | USTER | SWITZERLAND | GEOS | 1 |
| Ln | LANGHANS, T. | SAN BRUNO | CALIFORNIA - USA | ARP | 1 |
| Lx | LECACHEUX, J. | MEUDON | FRANCE | GEOS | 1 |
| Ll | LILLER, WILLIAM | VINA DEL MAR | CHILE | LIADA | 1 |
| Lp | LOPEZ, RUBEN | SAN ANTONIO | VENEZUELA | LIADA | 1 |
| Lz | LORENZ, H. | BERLIN | EAST GERMANY | GEOS | 1 |
| Lc | LOURECON, ROMUALDO | JUNDAI | BRAZIL | LIADA | 1 |
| Lr | LURCOTT, EDWIN | WEST CHESTER | PENNSYLVANIA - USA | ARP | 1 |
| Ln | LURCOTT, STEVE | WEST CHESTER | PENNSYLVANIA - USA | ARP | 1 |
| Ly | LYZENGA, GREG | ALTADENA | CALIFORNIA - USA | ARP | 4 |
| Mt | MARTI, J. | MATARO | SPAIN | GEOS | 3 |
| My | MAZALREY, P. | VERNON | FRANCE | GEOS | 1 |
| Mn | MCNAUGHT, ROB | SIDING SPRING | N.S.W. - AUS | RASNZ | 1 |
| Mz | MENDEZ, ANTONIO | VALENCIA | VENEZUELA | LIADA | 1 |
| Me | MEUDON OBSERV. | MEUDON | FRANCE | GEOS | 4 |
| Mi | MIDDLETON, R.W. | COLCHESTER | UNITED KINGDOM | GEOS | 1 |
| Mr | MORALES, GERMAN | COCHABAMBA | BOLIVIA | LIADA | 1 |
| Mo | MOYANO, ROSARIO | COCHABAMBA | BOLIVIA | LIADA | 1 |
| Md | MULLER, M. | THABAZIMBI | SOUTH AFRICA | ASSA | 1 |
| Mu | MURRAY, TONY | GEORGETOWN | GEORGIA - USA | ARP | 4 |
| Np | NAPOLITANO, G. | S. MARIA D. MOLE | ITALY | GEOS | 1 |
| Nb | NOBEL, W. | AMSTERDAM | NETHERLANDS | GEOS | 2 |
| Ov | OVERBEEK, DANIE | EAST RAND | SOUTH AFRICA | ASSA | 10 |
| Pw | PALZER, W. | WIESBADEN | WEST GERMANY | GEOS | 1 |
| Ps | PARIS OBSERV. | PARIS | FRANCE | GEOS | 2 |
| Py | PAYNE, PAUL | SIDING SPRING | N.S.W. - AUS | RASNZ | 1 |
| Pc | PORCEL, A. | GRANADA | SPAIN | GEOS | 2 |
| Qt | QUINTANA, CARLOS | CARACAS | VENEZUELA | LIADA | 1 |
| Rt | RICHTER, S. | EBERSWALDE-F. | EAST GERMANY | GEOS | 1 |
| Rb | ROBERTS, BENNY | JACKSON | MISSISSIPPI - USA | ARP | 1 |
| Rz | RODRIGUEZ, FRANKLIN | CARACAS | VENEZUELA | LIADA | 2 |
| Rd | RODRIGUEZ, JOSE | MONTIVIDEO | URAGUAY | LIADA | 1 |
| Rr | RODRIGUEZ, VICTOR | CARACAS | VENEZUELA | LIADA | 2 |
| Ro | ROOS, M. | BENNEBROEK | NETHERLANDS | GEOS | 1 |
| Ss | SALAS, HENRY | CARACAS | VENEZUELA | LIADA | 1 |
| Sb | SCHIEB, D. | MULHOUSE | FRANCE | GEOS | 1 |
| Sh | SCHILLER, D. | EAST RAND | SOUTH AFRICA | ASSA | 1 |
| Sn | SCHNABEL, C. | BARCELONA | SPAIN | GEOS | 3 |
| Sl | SCHOLTEN, A. | EERBEEK | NETHERLANDS | GEOS | 1 |
| Se | SERNE, P. | AMSTERDAM | NETHERLANDS | GEOS | 1 |
| Sg | SINGH, JASJEET | JAIPUR | INDIA | ARP | 1 |
| Sm | SMIT, J. | PRETORIA | SOUTH AFRICA | ASSA | 4 |
| Sc | SMITH, CHARLIE | WOODRIDGE | QUEENSLAND - AUS | RASNZ | 4 |
| Sa | SPECOLA SOLARE TICI | LUCERNE | SWITZERLAND | GEOS | 1 |
| Sp | SPOELSTRA, J. | POTCHEFSTROOM | SOUTH AFRICA | ASSA | 1 |
| Sj | STAMM, JIM | LONDON | KENTUCKY - USA | ARP | 6 |
| St | STAMM, JIM | TUCSON | ARIZONA - USA | ARP | 2 |
| Sz | SZABO, S. | SZOMBATHELY | HUNGARY | GEOS | 2 |
| Sx | SZAUER, A. | SZOMBATHELY | HUNGARY | GEOS | 1 |
| Tz | TATYRZA, J. | OLSZTYN | POLAND | GEOS | 1 |
| Tt | THIRIONET, Y. | BRUSSELS | BELGIUM | GEOS | 2 |
| Tp | TULIPANI, F. | BOLOGNA | ITALY | GEOS | 2 |
| Vb | VAN BLOMMESTEIN, P. | CAPE TOWN | SOUTH AFRICA | ASSA | 1 |
| Vl | VAN LOO, F. | HASSELT | BELGIUM | GEOS | 2 |
| Vc | VELASCO, P. | MADRID | SPAIN | GEOS | 1 |
| Vr | VENABLE, ROGER | AUGUSTA | GEORGIA - USA | ARP | 1 |
| Vn | VINSON, ED | DUNCAN | OKLAHOMA - USA | ARP | 6 |
| Wk | WAKEFIELD, N. | WALKERVILLE | SOUTH AFRICA | ASSA | 3 |
| Wl | WALLACE, R. | JOHANNESBURG | SOUTH AFRICA | ASSA | 2 |
| Wh | WIESENHOFER, W. | GRAZ | AUSTRIA | GEOS | 3 |
| Wn | WIETH-KNUDSEN, N. | TISVILDELJE | DENMARK | GEOS | 1 |
| Wb | WUBBENA, E.K. | OOSTERHOUT | NETHERLANDS | GEOS | 1 |
| Zk | ZALEZSAK, T. | VESZPREM | HUNGARY | GEOS | 1 |

## TWO MINOR PLANET OCCULTATIONS OBSERVED FROM THE TRANSVAAL

T. P. Cooper and M. D. Overbeek

[Reprinted from *M.N.A.S.S.A.* (Feb. 1989, #'s 1 & 2]

*Summary:* Results of two positively observed minor planet occultations are presented. These events are the first two minor planet occultations observed from South Africa to be confirmed by more than one observer. Observations confirm the accepted diameter of 139 Juewa and indicate that 250 Bettina may be non-spherical.

*Occultation of SAO 157598 by 139 Juewa on 1988 April 21:* The path of central occultation as originally predicted crossed southeast Australia and just south of Cape Town. Johannesburg was just inside the 1" limit. Astrometry carried out at Siding Spring later indicated three possible tracks roughly 0".9, 1".0, and 1".1 north of the nominal track and thus in the vicinity of the PWV area. Attempts by S.A.A.O. to conduct 'last-minute' astrometry were clouded out. The Australians had cloud on the night of the occultation, but two positive results were obtained from the Transvaal. Further positive observations might have been obtained but for several observers being away at the Izinkhanyezi weekend.

*Conditions:* The magnitude of the occulted star was 8.4 and that of the minor planet 10.8. This resulted in a dimming during occultation rather than a disappearance, even in small telescopes. The altitude of the star was 53° and sky conditions were good with no haze or cloud on the Witwatersrand. The 30% Moon set one hour and twelve minutes after the event, and was thus low on the horizon, causing no interference.

*Observer details:* From a potential 23 observers within the occultation path, only two made positive timings, as follows:

| Name | Site | Lat. | Long. | Alt. | Instr. |
|---|---|---|---|---|---|
| Cooper | Benoni | 26°.1709S | 28°.3192E | 1662M | 20cm |
| Wakefield | Walkerville | 26.4221S | 27.9569E | 1670M | 31cm |

*Timings:* The results of the timings are as follows:

| Name | Dimming SAST | Brightening SAST |
|---|---|---|
| Cooper | $20^{h}\ 33^{m}\ 18^{s}.0 \pm 0.5$ | $20^{h}\ 33^{m}\ 33^{s}.9 \pm 0.2$ |
| Wakefield | 20 33 21.6 | 20 33 31.6 |

Cooper used a quartz watch synchronised to ZUO, recording all events on tape. Reference points were made before and after the event. Timings were measured afterwards by stopwatch accurate to $0^{s}.01$ and the average of the best five consecutive timings was taken. Personal errors were applied of $1^{s}.5$ for the dimming and $0^{s}.3$ for the brightening.

Wakefield used a quartz watch and tape in the same manner. Personal errors have been applied to the above times. Wakefield noted some variability in his tape drive rate which may have affected the accuracy of his timings.

*Discussion:* Figure 1 shows the reduced timings as plotted by Dunham. A slight discrepancy in the central occultation times of the two observers has been ignored. From the observed times and best fit of the two chords a diameter for 139 Juewa of 164km was derived. This compares well with the diameter of 165km accepted for this body.

For the diagram, the assumption has been made that the minor planet is spherical. However, Hirayama grouped 139 Juewa as a member of family number 39. There is some indication that members of asteroid families may have been formed as a result of breakup of discrete parent bodies. This would lead to the minor planets in question being irregularly shaped fragments rather than spherical bodies.

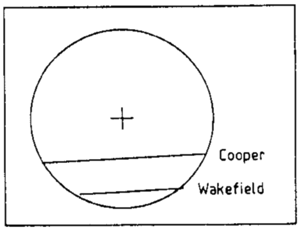


Fig. 1

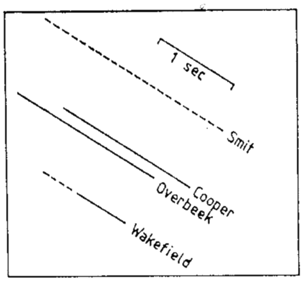


Fig. 2

*Occultation of AGK +17°1127 by 250 Bettina on 1988 July 9:* The path of central occultation as originally predicted crossed central U.S.A., northwestern Africa, Nigeria, Mozambique, and Madagascar. Cape Town was just outside the 1" limit, and the PWV area was approximately 0".6 from the predicted track.

*Conditions:* The magnitude of the occulted star was 8.6 and that of the minor planet 13.4. This resulted in a definite disappearance in the instruments used. Although sky conditions were clear and no Moon interfered, the event occurred before the end of evening twilight so that inexperienced observers and those with telescopes of small aperture were unsuccessful. The altitude of the star was 40°.

*Observer details:* Two observers timed both the disappearance and reappearance. One observer saw both disappearance and reappearance but made no timings. One observer reported a definite miss. The following positions and instruments relate to the timings:

| Name | Site | Lat. | Long. | Alt. | Instr. |
|---|---|---|---|---|---|
| Cooper | Benoni | 26°.1709 | 28°.3192 | 1662M | 20cm |
| Fraser | Johannesburg | 26.1820 | 28.0753 | 1808M | 15cm |
| Overbeek | Edenvale | 26.1542 | 28.1389 | 1602M | 31cm |
| Smit | Pretoria | 25.6993 | 28.2442 | 1300M | 20cm |
| Wakefield | Walkerville | | | | |

*Timings:* The following timings were made by the above observers:

| Name | Dimming SAST | Brightening SAST |
|---|---|---|
| Cooper | $18^h\ 20^m\ 36^s.1 \pm 0.2$ | $18^h\ 20^m\ 37^s.8 \pm 0.2$ |
| Overbeek | 18 20 35.6 ± 0.2 | 18 20 37.4 ± 0.2 |
| Wakefield | | 18 20 37.4 ± 0.5 |

Fraser observed both the disappearance and reappearance but did not time the events due to influence of daylight and the small aperture. Smit observed a definite 'miss'.

Both Cooper and Overbeek used tape recorders and made verbal comments against a common background transmission of Radio South Africa. Overbeek made a simultaneous recording of ZUO. Both tapes were later connected to a strip chart recorder and timings were determined against common reference points from the RSA transmission. Cooper applied personal errors of 0.8 and 0.3 seconds and Overbeek 0.0 and 0.3 second to the disappearance and reappearance timings. Overbeek reported a zero-second personal error for the disappearance since the disappearance coincided with the start of a routine comment made on the tape recording. Wakefield's times were also corrected for personal error. The latter used a tape recorder and quartz watch.

*Discussion:* Figure 2 shows the timings as chords plotted on the fundamental plane as derived by the authors.

A spherical profile cannot be fit to the chords. If there is no significant error in the timings then the observations would indicate that 250 Bettina is non-spherical. Note that 250 Bettina was grouped by Hirayama as a family member of family number 57. It should also be noted that the three observers were confident of the accuracy of their reappearance times and that two used a common reference transmission for the timings. The conclusion that 250 Bettina is definitely non-spherical based on only three observers' timings should however be made with caution. More accurate conclusions could have been made had more observers in the Transvaal network observed the event.

*Conclusions:* Astrometry conducted at Siding Spring was confirmed by the occultation observations of 139 Juewa from the Transvaal. It is suggested that further cooperation between South African and Australian observers be pursued.

Visual observations gave a diameter of 139 Juewa of 164km. The accepted diameter is 165km.

A spherical profile could not be fit to the timings of the 250 Bettina event. The body could possibly be non-spherical.

For generation of reliable observational data on future events, the timings of several observers, all using a common reference transmission, are required. A standard timing technique and method of reduction must be used.

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## HYGIEA EVENT OF 1988 MARCH 8

Roland Boninsegna

23 observers from 20 different stations have sent reports for the occultation of AGK3 +06°1290 by 10 Hygiea.

Many observers reported Hygiea to be 0.3 to 1.0 magnitude brighter than the star, instead of being 0.1 magnitude fainter as mentioned on the EAON's chart. However, in IOTA's prediction, Hygiea was 0.3 magnitude brighter than the star. If we assume a 0.5 magnitude difference (Hygiea brighter than the star) the magnitude drop during occultation would have been around 0.5 magnitude also. Let us keep in mind so little a drop in magnitude is perfectly visible under good conditions; many papers exist now, reporting visual observations on small amplitude (less than 0.5 magnitude) variable stars. See for example L. Cereda *et al*, 1988, *Astronomy and Astrophysics*

*Sup. Ser., 76,* 255. In that case, the duration of the magnitude drop, caused by an occultation, is commonly very short and thus easier to detect than small variations of variable stars over several hours. [Ed: Conclusion debatable]

Last-minute predictions were made from 2 observatories, Bordeaux and Lowell, the central path crossing Morocco and Gibraltar for Bordeaux, Spain and Portugal for Lowell. Both observatories agreed that the event would take place sooner (3 to 6 minutes), around $00^h$ $28^m$ U.T.

Joaquim Garcia and Rui Goncalves, observing from Lisboa (same station, with 2 telescopes), reported an occultation beginning at $00^h$ $37^m$ $17^s$ U.T. and lasting 23.0 seconds. The timings were difficult due to the small magnitude drop and the lack of experience. Meanwhile, a pair of Spanish observers, observing from Granada, reported no occultation at all. Perpendicular to the asteroid's path (pap), the difference between the two stations is 47 km only. Taking into account the Portuguese observation and ascribing to (10) Hygiea a 429 km circular diameter, a nearly 8-second occultation at least should have been seen from Granada. José Manuel Barruezo and Aniceto Porcel have also reported that they did not see Hygiea. That fact is very strange, because due to the magnitude difference, they should have seen the minor planet. Can we suppose that this is due to the small-diameter instruments they used (6 and 11.4 cm) and the little experience they have in asteroidal occultations, or that the wrong star was observed?

Finally, I think that we could credit the Portuguese observation supported also by two independent last-minute predictions. Joaquim Garcia and Rui Goncalves observed a northern chord (Spanish observers Joan Bullon and Pedro Velasco report no occultation). Unhappily, one chord does not permit us to draw an image of Hygiea's shape and diameter. We regret that the Portuguese observers were observing at the same place. However, more and more, EAON members should get organized in double stations; it is surely a great help.

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## PRELIMINARY REPORT OF THE JULY 3RD OCCULTATION OF 28 SAGITTARII BY SATURN AND BY TITAN

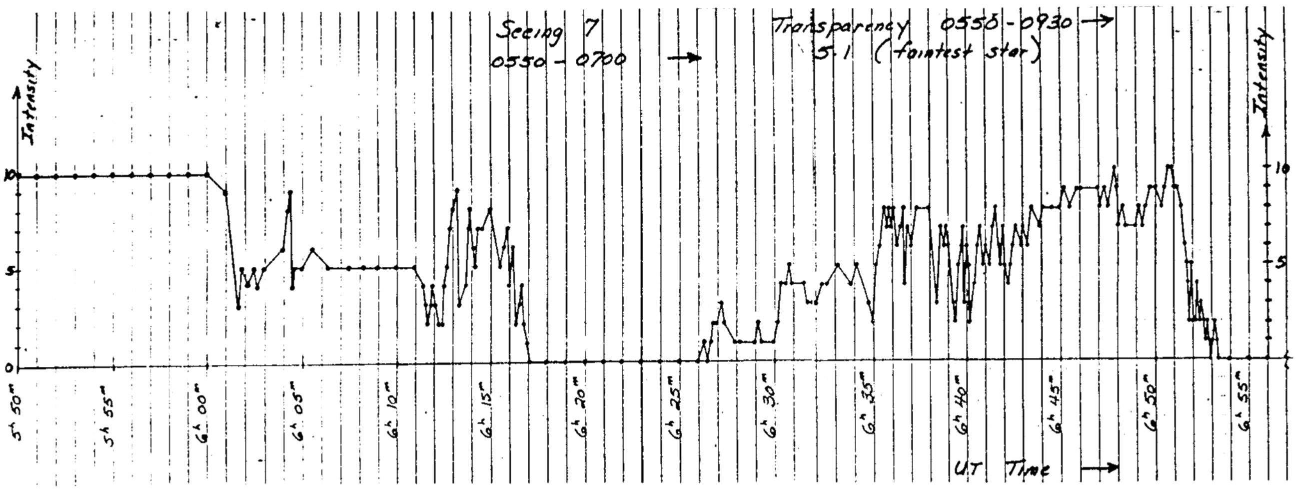
David W. Dunham

A prediction article about the 1989 July 3rd occultation of 28 Sagittarii by the Saturnian system by Carolyn Porco, Doug Mink, and me was published on pages 638-641 of the June issue of *Sky and Telescope*. Doug Mink computed detailed predictions of the occultation by Saturn and its rings for all IOTA members, using a copy of IOTA's station data provided by Derald Nye. Joseph Carroll mailed these predictions, as well as local circumstances for the Titan occultation/appulse. Eberhard Bredner and I also included a 1-page writeup about the Titan occultation, including Larry Wasserman's world map of the event with the latest Lick Observatory update prediction drawn on it, with mailings about the June 7th lunar Praesepe passage sent to IOTA and IOTA/ES members. A short note about observations of the occultations will appear in the September issue of *Sky and Telescope*, with a longer article in their October issue.

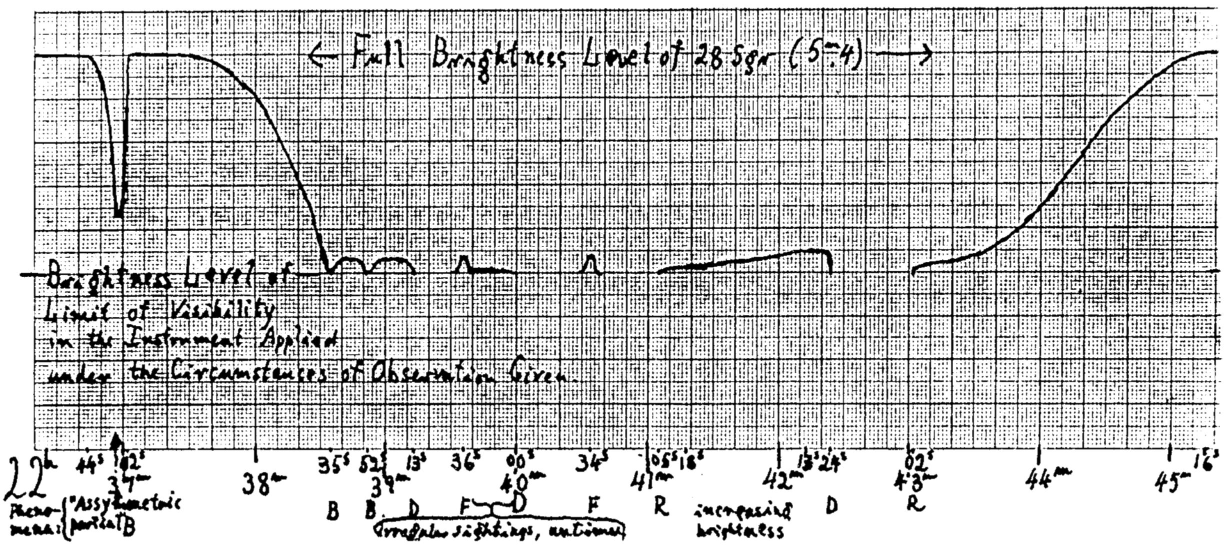
*Saturn:* By the end of July, I had received about 30 written reports of the Saturn occultation sent by observers from Maine to Hawaii and from California to Florida, and one from Australia (So far, no reports have been received from Latin America). Less than half of these were from IOTA members. In addition, a dozen observers left their preliminary impressions on the IOTA occultation line phone answering machine. In general, observers with larger telescopes and in locations with good atmospheric seeing saw more fluctuations, and timed dozens of fadings and brightenings, while those with small instruments where the seeing was mediocre or poor were lucky to even see the star in the Cassini Division. Most visual observers provided lists of times and their comments taken from tape recordings. Some provided more elaborate records, estimating the star's brightness during the passage and plotting the results like a photoelectric recording. Bob Talaga, using a 6-inch refractor at Tucson, Arizona, provided one of the more interesting records enclosed. Some observers attempted to analyze their timings, comparing them with Doug Mink's predictions. John Broughton, Cronulla, Australia, provided the radius distance from Saturn for his events.

Spectacular videorecordings were made, mainly with the new CCD surveillance cameras (see p. 291) attached to telescopes with apertures ranging from 12 to 60 inches. I know of videotapes made by Dennis DiCicco, Peter Manly, and Leif Robinson, Mt. Wilson, California (did anyone make a recording of the CBS news broadcast on the 4th that showed about 30 seconds of their recording?); Jeff Smith, San Diego, California; at Palo Verde Observatory, Phoenix, Arizona; by Richard Wilds, Topeka, Kansas (their VCR didn't work during the immersion phase, so Wilds made "visual" timings with an audio tape recorder as he watched on the TV monitor); reported by Robert Sandy, Kansas City, Missouri; by Albert Kelly, Friendswood, Texas (emersion phase clouded out); Chuck Cole, Minneapolis, Minnesota; and Roger Tuthill, Union College Observatory, Cranford, New Jersey.

Some observers travelled long distances to escape widespread cloudcover in the Southeast caused mainly by the remnants of tropical storm Allison. Michael Crist travelled 400 miles west from his home in Burns, Tennessee, to catch glimpses of the occultation through gaps in the clouds in Arkansas. More successful were Harold Povenmire and Harold Carney, who travelled from Florida to western Arkansas, where they had a good view of most of the occultation and made perhaps a hundred timings. At one time in the F-ring region, the star disappeared abruptly and completely for 4 seconds, possibly an occultation by a satellite? However, they did not need to travel so far just to see the occultation, since Wallace Baldwin in Jacksonville and Tom Campbell near Tampa, Florida were able to time several events under good seeing conditions. It was completely overcast in Maryland, so four other observers and I drove to West Willington, a crossroads 25 miles east of Hartford, Connecticut, to observe the occultation with 8-inch telescopes. Although the sky was very clear, the seeing was rather poor, and we were able to time very few events. But at Glastonbury, Connecticut, Phil Dombrowski was able to time 57 events using an 11-inch telescope. Conditions were also better near New York City, where good seeing made up for the thick haze present.




Ingress visual lightcurve, occultation of 28 Sagittarii by Saturn, 6" refractor, 350X, Bob Talaga, Tucson, AZ




Visual lightcurve of occultation of 28 Sgr by Titan, 1989 Jul 3 by N.P. Wieth-Knudsen, Tisvildeleje, Denmark

Carolyn Porco also reported that all of the major professional observatories that she had contacted beforehand successfully recorded the occultation. So many data were collected that it will take years to properly analyze it. A practical means of converting videorecordings to a timed photometric record needed for analysis has not yet been worked out. However, Peter Manly may get some help from the University of Arizona to upgrade his box digitizer (see *O.N. 4* (8), p. 193) to do this job. In many cases where atmospheric conditions were not perfect, it may be difficult or impossible to separate seeing variations from Saturnian ring events.

*Titan:* The occultation by Titan was observed from Sweden to the Canary Islands, from Northern Ireland to Israel, and from Oslo to Malta. I have received about 15 written reports, but know of many others from telephone conversations and *IAU Circulars* 4801, 4803, and 4809. Fortunately, skies were very clear in Great Britain, Holland, Belgium, and southern Scandinavia, as well as in much of France and northern Germany, where the occultation turned out to be central. The event was easy to observe with even small telescopes since the star was much brighter than Titan; in fact, some observers were not able to see Titan due to twilight and low altitude. But the star's variations were clear, with immersion and emersion in Titan's atmosphere each taking many seconds to a full minute and more, with much structure (brightenings and dimmings). The observed total duration for many was significantly longer than the calculated central duration since Titan's atmosphere began to refract and dim the star's light at very large distances from the satellite. Moreover, the immersion and emersion lightcurves were not symmetric. An example is the visual lightcurve by Dr. N. P. Wieth-Knudsen, observing with only a 60mm refractor from Tisvildeleje, Denmark.

Perhaps most interesting were reports of the central flash, seen by many observers in Sweden, England, France, and Germany. Andrew Elliott, Reading, England, used an image intensifier to record a 15-second central flash, peaking at about half the unocculted star's brightness. The 15-second duration multiplied by Titan's relative velocity gives a distance of about 300 km on the skyplane. However, because of Titan's relatively low altitude in Europe, the central flash skyplane area projected onto a much larger area on the Earth's surface, a path about 900 km wide. This circumstance, and the clear weather over a region densely populated with astronomers, allowed the central flash to be widely observed. Elliott knows of 4 other videorecordings of the occultation made in England. Hans-Joachim Bode used my image intensifier with his video system on his 40-cm telescope in Hannover, West Germany*. He was fortunate, for a large patch of clouds cleared away only ten minutes before the Titan occultation. His central flash reached $^3/_4$ of the star's full unocculted brilliance, the brightest central flash of which I am aware. Another German, Wolfgang Beisker, travelled to the south end of the Italian peninsula in hopes of seeing the central flash (the final prediction called for the center line to cross Italy) and to escape cloudcover, which hampered observers from Rome to Frankfurt and in much of eastern Europe. He photoelectrically recorded the occultation, but had no central flash. Bode reports that at least seven others in northern Germany recorded the event automatically, most with photometers. At Luebeck and Kiel in the northernmost part of Germany, the central flash was much fainter than at Hannover. Some observers reported a double central flash, which may indicate that Titan's atmosphere is oblate. Hakon Dahle, observing with a 20-cm telescope near Oslo, was the northernmost known observer, and he saw no central flash. The sky was clear and the seeing was reasonably stable, in spite of the 7 degree altitude. Only a little farther south, Christer Jansson observed at Orums, Sweden (long. 12° 48!5 E, lat. +59° 26!3, h 50 m) with a 25-cm telescope and saw no central flash. Five other observers farther to the southeast in Sweden reported central flashes, according to Paul Schlyter's report. I do not yet have reports bounding the central flash so well on the south. Marco Cavagna and Carlo Gualdoni said skies were overcast at their main observatory near Milan, Italy, so they drove to Schattdorf, Switzerland (long. 8° 38' 17" E., lat. +46° 51' 38", h 450 m), where they observed the occultation with 25-cm and 10-cm telescopes; they saw no central flash. University of Arizona teams made photoelectric recordings of the main occultation with portable equipment in northern Israel and at the Vatican Observatory. The Vatican data were obtained through clouds.

*Hans Bode had used my complete video system with his 20-cm portable telescope to videorecord about 30 occultations of stars as faint as mag. 10.6 during the Praesepe passage on June 7, with help from Joseph Caminiti, at Furci Siculo, Sicily. I had sent the equipment earlier by air cargo, with instructions for its use, which turned out to be much less expensive than if I had gone there myself, in spite of a few intercontinental telephone calls to clarify the instructions. During the Praesepe passage, he fortuitously recorded a bright meteor that passed close to the Moon.

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## PAPER ON THE 1983 MAY 29TH PALLAS OCCULTATION

David W. Dunham

Joan and I are still working on the paper on analysis of the May 1983 occultation of 1 Vulpeculae by (2) Pallas, and this issue of *O.N.* was delayed somewhat to further this important, overdue work. We have reanalyzed the observations following several corrections that were reported following distribution of the first draft last August (the new solution changed very little from the previous ones). One of the most important corrections was Don Stotz' refinement of the longitude and latitude of the observer of the occultation who timed the northernmost chord. Stotz also reported his own miss observation of the occultation, and he turns out to have been closer to the northern limit than any of the others who watched 1 Vulpeculae and saw no occultation. I have written a section on the 3-dimensional shape of Pallas. We still have relatively minor changes to make before submitting the paper, including incorporation of information about the star and calculations of Pallas' albedo. We still have not received a couple of photoelectric traces that we requested. Sometime late in August, after the lunar eclipse on the 17th, we will complete the paper and submit it, and also send copies of the preprint to coauthors.

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## THE 1989 FEBRUARY 20 LUNAR ECLIPSE STAR FIELD

Steven J. Hutcheon

While waiting up for the February 12th appulse of (106) Dione I checked the star field in the *O.N. Supplement* for the February 20th lunar eclipse (89 FES). The notes below follow in order of the list of discrepancies (89FES-1, 2, 3).

1. Two stars shown as small pluses near R.A. $10^h$ $17^m$ Dec. +11°.0. Nothing seen at either position (limit 14.5m).
2. The third star shown as a small plus just south of ZC 1506 was visible at 12m.
3. The star marked as V? was seen at 14m.
4. The star listed as 3.3m in the AC was seen at 13m, the value that was used in the L-catalog.
5. The possible large proper motion star southwest of V?. There was a 13m star at both the TVMA and AC positions.
6. The possible large proper motion star just east of X15268. There was a 13m star only at the AC position.
7. The BD +12° 2192 problem. Both the 10.5m and 12.3m stars were present in the positions plotted.

These corrections indicate that a few minor modifications should be made to the charts in the 89FES, but the only changes that need to be made to the L-catalog are that the "spectral types" MNW and MNE indicating possible large proper motion should be removed from L07779 and L07963, respectively.

[Ed: The 89FES was sent only to those in the region of visibility of the eclipse.]

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## ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

*Sorting:* Sorting is a function with almost universal application for all users of computers. In astronomy, sorting is done to organize data about stars. We can sort by declination, by constellation name, by right ascension, or, like the SAO catalog, by right ascension within zones of declination. Providing users with orderly lists or tables of data is a function computers do very well. A number of different algorithms are available to ease the computational burden of sorting. Some of these are better when the set of data to be sorted is very large, others work better when the data set is somewhat smaller, but still larger than something we would want to do by hand.

Straight insertion: This is the simplest method, and should be familiar to anyone who ever organized a hand of bridge or placed a month's worth of canceled checks in order by check number. The algorithm is to take each item one at a time and move it into the right place with respect to all the others which have been sorted. That is, the second is placed before or after the first, the third where it fits relative to the first and second, and so forth. If there are N objects to sort, this method requires N*N comparisons. This becomes cumbersome very quickly, and is not recommended for sorts of more than 50 objects.

Shell's method: The Shell sorting technique is to divide the data to be sorted into smaller groups, sort the smaller data sets by insertion, then combine the small groups into larger groups and sort, and continue combining and sorting until the final sorted group is the entire data set. For example, if there are N objects, the first step could be to divide the data into N/2 groups of 2, order them, divide the data into groups of 4 by combining adjacent pairs, sort them, and so on. These first preliminary sorts allow the final sort to proceed more efficiently, since the subsets of data are all in order. The Shell technique requires fewer comparisons than the straight insertion. In theory, the worst case Shell sort takes N to the power $^{2}/_{3}$ comparisons.

Heapsort: The heapsort is a more complicated method to explain, but is a favorite technique of several texts on numerical analysis. This technique organizes the data into a heap, or a binary tree. This is a hierarchy that can be diagrammed like an organization chart or a pyramid. The highest data point is on top (the company president), with connections to points on the next lower levels (the vice presidents), which are themselves connected to the next level lower, and so on. A data point (or person) in the middle has an upward path by traveling along those connections. If the top point is removed, the organization is shuffled following strict rules of promotion so that the next highest point is now on top. The sorting is done by first creating the heap and then pulling off the top points one at a time, promoting members of the heap so that the highest is always on top. More bookkeeping is required for a heapsort than for the simpler sorts, but the total number of comparisons required is fewer, of the order on N logN for the worst case analysis.

Quicksort: The quicksort algorithm is somewhat of a reverse Shell sort method. The data are split into the half above the middle and the half below. New middle values are determined for each half, and then each is again split into those above and below their midpoints. This repeats until the entire set of data is sorted. This technique is also a favorite of many. For N data points, the quicksort technique performs 2N logN comparisons on average. However, the number of comparisons in the worst case is N*N, the same as the simple straight insertion method.

Bucket sort: In bucket sorts, data are first sorted into bins and then each bin is sorted. One example of bucket-sorted data is a star catalog organized by declination zones. In preparing such a catalog, the star data are first sorted in the buckets representing the declination zones. Then, each zone is sorted by right ascension. The Smithsonian Astrophysical catalog, for example, presents the stars in declination zones of 10 degrees. This is a good way to handle voluminous data, particularly when it is not necessary to recombine the buckets into one gigantic data set at the end. It works best if the bucket design distributes the data evenly among the bins. An example of a bucket sort would be one of sorting a year's worth of observations taken by time using the month as a bucket. If the observations are evenly spaced, this produces 12 bins each approximately a twelfth the size of the original data set. If all the data were taken in October, this would produce 11 empty bins, and one with all the data.

Further information on sorting is available in many numerical analysis textbooks. Two which present computer algorithms are *Numerical Recipes*, Whilliam H. Press *et. al.*, Cambridge University Press, 1986 (diskettes of FORTRAN or Pascal source for the examples are sold separately), and *Computer Algorithms*, Sara Baase, Addison-Wesley, 1978.

*Sources for Software*: On Astronomy Day last spring, I demonstrated the use of a half-dozen pieces of software which generate star fields or plots of solar system objects for viewing at a given time and location. All but one of these programs are noncommercial, user-distributed software. (The commercial package is not on the market yet.) These programs have been gathered through BBSs, user groups, friends, or direct purchases from the author. The following lists places where I have found astronomy software, and where you might start.

- Bulletin Board Systems (BBSs). Names and numbers for BBSs are available from user groups and BBSs themselves. Listings that give the purposes for the BBSs are best; recent lists I have received tend to state just their names and the bulletin board software they use.
- Distributors of shareware, user-supported software, etc. My favorite is PC SIG, 1030D East Duane Avenue, Sunnyvale, CA 94086. This is a membership organization ($39/yr) which has more than 1000 diskettes of software distributed at $6/diskette. Deep Space is on diskettes 866 and 867, Starmap on diskette 83, Planets on diskette 298, Starfind on 447. Individual diskettes are sold to those who do not want the membership.
- *Sky and Telescope* and *Astronomy* both publish small program listings, and have many ads for computer software.

*Computer Languages:* Computer programmers commanded the first computers in machine code, strings of numbers (in binary or octal) that directed the machines to perform computations, retrieve input, and store results. Machine code is hard to read and difficult to write. Every step of the computations must be specified - fetch a value from memory, store it in an arithmetic register, operate on the register, store the result to memory. Computer languages were developed to ease the chore of software writing, as well as to make the programs hardware independent. The following are some of the languages available for personal computers today.

Assembly languages were the first computer languages, developed to assemble machine code that could then be linked into executable programs. While current assemblers are tremendously improved over their predecessors, they are still difficult to use and are very hardware-specific. These languages are still used today for times when processing speed or computer memory limitations are such that absolutely nothing else will do.

BASIC is the most widely used computer language today. It suffers from lack of standardization, so that software written for one vendor's BASIC may not run under another's. It also lacks the glamor of the "real" computer languages. This is usually the language of choice for the occasional programmer. It is easy to use, virtually every PC can run some version of BASIC, and there are hundreds of books on "how-to."

Pascal is a language originally developed by Wirth for teaching good programming practices. It has been extended and modified from the original, and is the favorite language of many programmers for scientific applications. There are many books on how to program in Pascal, but not the hundreds we find for BASIC.

FORTRAN was developed (by IBM) to translate scientific formulae into computer code. It is very widely used, and has been standardized to reduce the problems for moving programs from one machine and vendor to another. There are a few books on programming in FORTRAN. It is considered a difficult language to learn.

C is midway between assembler and Pascal. It allows more control over the computer hardware than Pascal, but is not as difficult to use as assembler. Using C can be tricky, but it is quite popular for microcomputers. There are almost as many books on C as there are on Pascal.

In addition to these languages, the major ones available for the PC, there are also programming capabilities offered within many major programs. DBase is one of the best known examples. It has its own set of commands that form a language that can be used to manipulate data and prepare reports. Spreadsheet programs, such as Lotus 1-2-3, also have these capabilities.

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## SOLAR SYSTEM OCCULTATIONS DURING 1989

David W. Dunham

This is a continuation of the article with the same title starting in *O.N. 4* (10), p. 244 and continued on from p. 288 of the last issue.

*Report on Priority Events; March 12th Bamberga and May 26th Emita Events Observed.* A list of priority events for astrometric improvement and concerted observational improvement was given on p. 276 of the last issue. In that list, the only event before July for which "last-minute" astrometry was obtained, were William Penhallow's observations for the March 18th Bamberga occultation. Referring to the map on p. 278 of the last issue, the updated path shift was 0ʺ.2 south, with an uncertainty of ±0ʺ.2. If a star position, provided by Arnold Klemola measured from a plate taken at Lick Observatory a few years ago, was used with Penhallow's asteroid position, the new path would have been another 0ʺ.2 south. I telephoned many regional and local coordinators in the uncertainty zone, but cloudy skies, especially along both coasts, prevented many observations. The occultation was recorded photoelectrically at Lowell Observatory, and two IOTA members, Ernest Koppl and Leo Wellner, timed short chords visually in Albuquerque, NM. Those are the only known positive reports, which show that the northern limit was just north of Albuquerque with the path center at about 0ʺ.42 south. I videorecorded the appulse from Greenbelt, MD, and received several other negative reports. More details will be given in J. Stamm's report for early 1989 in a later issue. A preliminary report of the July 3rd occultation of 28 Sagittarii by Saturn and Titan is on page 299.

No updates were obtained for the occultation of SAO 119809 by (481) Emita on May 26th, but my nominal path shown on the regional map on p. 280 of the last issue turned out to be very accurate. Peter Manly videorecorded a miss from Tempe, AZ, a southeastern suburb of Phoenix, but he reports that a short occultation was videorecorded at Palo Verde Observatory on the north side of town. This fixes the southern limit at about 0ʺ.08 S, so the northern limit should have been only 0ʺ.01 S of the nominal (0) line. At least one other observer farther north in Arizona visually timed the occultation, so a diameter estimate should be possible. The northern limit should have crossed San Diego, CA; Ottawa, Ont.; and Montreal, Que.; while Kansas City and Detroit were crossed by the southern limit; the event should have been nearly central in Topeka, KS; Chicago, IL; and Toronto, Ont., but the only positive reports of which I am aware are those from Arizona.

*Updates for August Occultations by (216) Kleopatra and (4) Vesta.* [Note: Since this issue will probably be distributed after these events, a copy of this section was enclosed with the mailing for the August 17th lunar eclipse noted on p. 290.] Astrometric plates were taken at Lick Observatory on July 8th and July 29th, and were measured by Arnold Klemola to improve the predictions for the Kleopatra and Vesta occultations on the 14th and 19th. The updated paths for these events, amounting to 1ʺ.4 north for Kleopatra and 0ʺ.3 north for Vesta, are shown on Sôma's updated world maps on p. 309. The unusually large shift for Kleopatra was mainly due to error in the AGK3 star position; unfortunately, the star is too far from the ecliptic to be in either the ZZ87 or Lick Voyager catalogs. The correction to the orbit was also significant, so Edwin Goffin will try to improve it. The Vesta event was discussed on p. 271 of the last issue; see p. 277 for a note about Kleopatra. Finder charts for the events are on pages 21 and 22 of the *O.N. 1989 Asteroidal Occultation Supplement*. Call the IOTA occultation line at (301) 474-4945 to learn about the astrometry and updated observing plans.

The new path for Kleopatra passes over Juneau, AK, and between White Horse, Yukon, and Fort Nelson in the northeast corner of British Columbia. This path is rather far from any IOTA members; as far as I know, nobody is planning to observe it. I have performed a search for future Kleopatra events, and found good possibilities for the USA on 1990 Sept.

27 (CA to KY) and 1991 Jan. 19 (WA to MD), and on 1990 Dec. 12 and 25 in the Atcama Desert just north of Cerro Tololo Interamerican Obs., Chile. But these predictions are based on relatively poor AGK3 and AC data, so I have asked Arnold Klemola to improve the stellar data with existing Lick plates.

The new path for Vesta straddles the Colombia-Ecuador border and crosses the northern Amazon basin. High elevations in western Ecuador seem to have rel-

Table 1, Part D

| 1989 DATE | Universal Time | PLANET Name | PLANET mv | PLANET Δ,AU | STAR SAO No | STAR mv | STAR Sp | STAR R.A. (1950) | STAR Dec. | Occultation Δm | Occultation Dur | Occultation df | P | Possible Area | El Sun | MOON El | MOON %Snl | MOON Up | Ephem. Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oct 8 | 7h44m | Diana | 12.7 | 2.040 | 60237 | 9.4 | A2 | 7h35m.1 | 30°27' | 3.3 | 5s | 12 | 24 | Alaska | 84° | 174° | 53+ | all | MPC12189 |
| Oct 11 | 18 45 | Circe | 12.4 | 1.876 | 109711 | 9.1 | K0 | 1 7.7 | 5 4 | 3.4 | 9 | 21 | 23 | Tasmania | 178 | 43 | 87+ | w134E | MPC13294 |
| Oct 12 | 19 45-55 | Ceres | 8.4 | 2.266 | | 11.6 | | 6 14.2 | 21 44 | .05 | 104 | 33 | 3 | s.Russia,w.&n.Siberia | 106 | 103 | 94+ | w117E | MPC12187 |
| Oct 13 | 11 44-61 | Anacostia | 11.3 | 1.552 | 126524 | 9.3 | F2 | 21 2.4 | 3 20 | 2.1 | 16 | 44 | 25 | Java,Torres Str.,Fiji | 118 | 43 | 97+ | all | EMP 1986 |
| Oct 13 | 16 53 | Fortuna | 11.7 | 2.289 | | 11.5 | | 18 49.1 | -21 21 | 0.8 | 8 | 14 | 19 | southern Sweden | 82 | 82 | 98+ | all | MPC13145 |
| Oct 15 | 9 33-42 | Patroclus | 14.8 | 3.695 | 110597 | 9.4 | F5 | 2 29.6 | 9 55 | 5.3 | 9 | 24 | 36 | sCanada,Aleut.,Hokkaido | 163 | 13 | 99- | all | Goffin88 |
| Oct 16 | 17 55-60 | Georgia | 13.2 | 1.982 | 189062 | 9.6 | A5 | 20 12.0 | -25 19 | 3.7 | 3 | 17 | 60 | cen.Africa,Arabia,Iran | 97 | 110 | 94- | e 20E | MPC13442 |
| Oct 17 | 17 55-61 | Circe | 12.5 | 1.878 | | 12.3 | | 1 2.9 | 4 24 | 0.9 | 9 | 21 | 23 | Russia,Hungary, Italy | 172 | 49 | 88- | e 10E | MPC13294 |
| Oct 18 | 19 42-59 | Ceres | 8.3 | 2.186 | | 11.1 | | 6 17.1 | 21 57 | .08 | 139 | 43 | 3 | Sumatra,Luzon,Japan?n | 111 | 15 | 78- | all | MPC12187 |
| Oct 19 | 22 08 | Venus | -4.3 | 0.817 | 184567 | 9.5 | A2 | 16 39.9 | -25 8 | | 453 | 7 | 1 | ME,NB,Bermuda,neBrazil | 46 | 156 | 67- | none | NA0001 |
| Oct 19 | 22 12-36 | Urania | 9.7 | 1.088 | 109497 | 9.1 | F5 | 0 48.0 | 9 18 | 1.1 | 14 | 28 | 15 | Siberia,sEurope,Trinidad | 168 | 81 | 67- | e15W | MPC12680 |
| Oct 22 | 19 58 | Asia | 12.5 | 2.522 | 160317 | 8.6 | A2 | 17 6.2 | -18 12 | 4.0 | 1 | 8 | 61 | Azores?n,Canaries,Moroc. | 48 | 123 | 37- | none | Herget78 |
| Oct 23 | 2 15-36 | Brixia | 10.5 | 1.078 | 147658 | 7.4 | G0 | 1 9.0 | -13 7 | 3.1 | 19 | 33 | 13 | swEurope,neUSA,c.Canada | 154 | 125 | 34- | e25E | MPC13145 |
| Oct 23 | 23 28-70 | Lucina | 12.8 | 2.298 | | 11.8 | | 6 18.1 | 21 9 | 1.4 | 36 | 77 | 24 | s.&e. Africa, sw Asia | 116 | 54 | 26- | e 35E | EMP 1981 |
| Oct 26 | 19 14-26 | Anacostia | 11.5 | 1.683 | 126630 | 9.0 | F8 | 21 11.1 | 3 13 | 2.6 | 8 | 24 | 27 | n. Africa, Yemen,Aden | 107 | 137 | 7- | none | EMP 1986 |
| Nov 2 | 11 33 | Cybele | 12.7 | 3.486 | | 11.1 | K4 | 18 42.8 | -21 4 | 1.8 | 7 | 11 | 22 | Mongolia | 61 | 19 | 13+ | w101E | MPC12302 |
| Nov 3 | 9 40 | Venus | -4.4 | 0.707 | | 9.5 | B9 | 17 48.2 | -26 51 | | 554 | 8 | 1 | e. Australia, N. Z. | 47 | 6 | 20+ | all | NA0001 |
| Nov 3 | 11 36 | Venus | -4.4 | 0.706 | 185849 | 8.7 | K5 | 17 48.6 | -26 52 | | 555 | 8 | 1 | se Asia, most Australia | 47 | 7 | 20+ | all | NA0001 |
| Nov 6 | 22 01 | Hygiea | 10.9 | 3.413 | | 10.8 | K8 | 18 14.3 | -23 6 | 0.8 | 11 | 10 | 12 | eastern Brazil | 49 | 45 | 54+ | all | Goffin86 |
| Nov 8 | 21 12 | Psyche | 10.9 | 2.495 | 164047 | 8.9 | A5 | 20 57.2 | -17 29 | 2.2 | 13 | 16 | 14 | e. Brazil, cen. Africa | 86 | 33 | 74+ | all | Goffin87 |
| Nov 11 | 0 30-36 | Ariadne | 11.7 | 1.600 | | 10.5 | | 5 15.3 | 24 36 | 1.5 | 7 | 27 | 36 | Mauritius?n; S.Africa | 148 | 63 | 93+ | w 40E | MPC11507 |
| Nov 11 | 10 45-79 | Ceres | 7.8 | 1.903 | | 10.5 | | 6 19.2 | 23 7 | .08 | 199 | 57 | 3 | Galapagos,CA,eSiberia | 134 | 71 | 95+ | w100W | MPC12187 |
| Nov 14 | 11 16 | Loreley | 13.2 | 3.083 | 98387 | 8.8 | K0 | 9 6.1 | 17 53 | 4.4 | 15 | 33 | 28 | Greenland?s | 98 | 65 | 98- | all | Herget78 |
| Nov 15 | 11 11 | Pretoria | 13.7 | 3.552 | 161234 | 8.2 | B2 | 18 13.1 | -13 36 | 5.5 | 4 | 9 | 29 | w.& central Australia | 42 | 163 | 93- | e141E | MPC11333 |
| Nov 15 | 20 45 | Ursula | 13.5 | 3.496 | | 10.7 | | 10 31.0 | 14 50 | 2.8 | 11 | 19 | 24 | sw Siberia, Manchuria | 79 | 65 | 90- | all | EMP 1981 |
| Nov 17 | 23 50-71 | Lucina | 12.4 | 2.021 | | 12.0 | | 6 13.6 | 22 28 | 1.0 | 17 | 34 | 21 | swAsia,sEurope,Nfld.?n | 142 | 26 | 72- | e 49W | EMP 1981 |
| Nov 18 | 14 57-63 | Ariadne | 11.5 | 1.563 | 77021 | 8.5 | M0 | 5 8.3 | 24 21 | 3.1 | 6 | 22 | 35 | North Is., Tasmania | 157 | 49 | 66- | e128E | MPC11507 |
| Nov 19 | 9 53 | Interamnia | 12.1 | 3.770 | | 12.1 | G9 | 18 3.3 | -23 10 | 0.8 | 8 | 9 | 16 | New South Wales | 34 | 133 | 58- | none | Schmadel |
| Nov 21 | 17 05-22 | Aeria | 11.8 | 1.511 | 111457 | 8.7 | K0 | 3 48.2 | 7 1 | 3.1 | 5 | 21 | 35 | Fiji,Indonesia,cen.Afr. | 167 | 108 | 35- | e119E | EMP 1981 |
| Nov 22 | 22 55-61 | Eunomia | 9.6 | 1.905 | 127300 | 7.2 | F8 | 22 4.0 | 1 37 | 2.5 | 16 | 16 | 10 | Amazon, n.Guinea coast | 93 | 152 | 25- | none | Goffin87 |
| Nov 23 | 3 08 | Venus | -4.5 | 0.558 | 187898 | 7.1 | K0 | 19 13.1 | -25 45 | | 823 | 10 | 1 | s. Chile, s. Argentina | 46 | 103 | 23- | none | NA0001 |
| Nov 26 | 5 22-35 | Lucina | 12.2 | 1.956 | | 11.8 | | 6 8.4 | 23 0 | 1.0 | 13 | 26 | 20 | Tunisia,Spain,nCanada,AK | 151 | 127 | 4- | e 0 | EMP 1981 |
| Nov 26 | 8 17 | Saturn | 0.6 | 10.794 | 187347 | 9.1 | G0 | 18 47.9 | -22 39 | | 3481 | 19 | 2 | D-HI; R-China,Australia | 38 | 60 | 4- | none | NA0001 |
| Nov 27 | 3 00-19 | Nausikaa | 9.4 | 1.028 | 57505 | 9.5 | G5 | 4 52.5 | 35 54 | 0.7 | 14 | 26 | 14 | Namibia, Amazon, Peru | 162 | 153 | 2- | e 18E | MPC12432 |
| Nov 30 | 10 38-41 | Venus | -4.6 | 0.504 | 188473 | 7.8 | F0 | 19 39.6 | -24 30 | | 1015 | 12 | 1 | Australia,S.I.,Bali,PNG | 45 | 22 | 4+ | w145E | NA0001 |
| Dec 2 | 2 27-34 | Ursula | 13.3 | 3.256 | | 12.8 | | 10 40.2 | 13 39 | 1.0 | 17 | 29 | 22 | Mecca, north Africa | 93 | 135 | 13+ | none | EMP 1981 |
| Dec 2 | 6 47-61 | Helio | 12.6 | 1.809 | | 10.9 | | 6 28.6 | 21 6 | 1.9 | 11 | 20 | 18 | Norway,N.Amer.,Tahiti | 153 | 162 | 14+ | w145W | EMP 1986 |
| Dec 3 | 5 54 | Thia | 12.6 | 2.306 | 157205 | 7.7 | A2 | 12 16.4 | -13 16 | 4.9 | 4 | 8 | 26 | n.e. Brazil?s | 62 | 116 | 22+ | none | MPC13443 |
| Dec 3 | 20 48-61 | Lucina | 12.1 | 1.910 | | 12.0 | | 6 2.1 | 23 31 | 0.8 | 11 | 22 | 20 | China,USSR,Europe,UK | 161 | 136 | 27+ | w 1W | EMP 1981 |
| Dec 4 | 0 08 | Hygiea | 11.0 | 3.677 | 187591 | 8.8 | A2 | 18 59.0 | -22 10 | 2.4 | 10 | 9 | 12 | Buenos Aires?n | 32 | 32 | 29+ | all | Goffin86 |
| Dec 4 | 11 03-11 | Ceres | 7.2 | 1.722 | | 10.9 | | 6 5.9 | 24 39 | .04 | 86 | 24 | 3 | Hawaii, Japan?n | 160 | 129 | 33+ | w168E | MPC12187 |
| Dec 4 | 23 34 | Mars | 1.6 | 2.451 | 159122 | 6.2 | B9 | 15 11.7 | -17 35 | | 133 | 6 | 1 | cen.China,Mongolia,Chita | 22 | 99 | 38+ | none | NA0001 |
| Dec 8 | 19 29 | Thalia | 10.7 | 1.987 | 99946 | 8.0 | G5 | 12 4.7 | 10 49 | 2.8 | 4 | 11 | 26 | s.e. Siberia | 80 | 150 | 80+ | w117E | EMP 1983 |
| Dec 8 | 23 15-29 | Lucina | 12.0 | 1.888 | | 12.1 | | 5 57.3 | 23 52 | 0.7 | 10 | 20 | 20 | sAsia,nEurope,eCanada | 167 | 64 | 81+ | w 57E | EMP 1981 |
| Dec 9 | 0 30-48 | Hamburga | 12.8 | 1.506 | 93075 | 8.0 | K0 | 2 41.0 | 13 5 | 4.8 | 74 | 37 | 25 | RSA?n,Argentina,Chile | 145 | 18 | 82+ | w 16E | EMP 1986 |
| Dec 9 | 16 18-34 | Sibylla | 12.9 | 2.427 | 96055 | 9.3 | K5 | 6 41.6 | 17 14 | 3.7 | 13 | 26 | 23 | HI?n, Luzon, s.e.Asia | 156 | 65 | 87+ | w163E | EMP 1986 |
| Dec 13 | 9 56-68 | Jupiter | -2.7 | 4.192 | 78505 | 9.0 | G5 | 6 31.0 | 23 5 | | 8962 | 25 | 2 | N.Amer.,Pacific,Japan | 164 | 7 | 99- | all | NA0001 |
| Dec 13 | 19 59-73 | Aeria | 12.1 | 1.607 | 111234 | 8.7 | K5 | 3 28.2 | 8 12 | 3.4 | 7 | 27 | 38 | Madagascar, s. Africa | 149 | 47 | 98- | e 19W | EMP 1981 |
| Dec 15 | 11 27 | Victoria | 11.3 | 1.906 | | 9.0 | M2 | 23 11.8 | 0 57 | 2.5 | 5 | 12 | 24 | s. Tasmania | 86 | 130 | 90- | e158E | MPC12187 |
| Dec 15 | 16 34-39 | Venus | -4.7 | 0.398 | 189216 | 9.3 | F8 | 20 20.1 | -21 0 | | 2053 | 21 | 1 | part of Europe,e.Africa | 39 | 180 | 89- | none | NA0001 |

atively good chances for clear skies, but that may cover only half the path. IOTA members Paul Maley and Peter Manly will go to Ecuador to videorecord the occultation, as part of a University of Arizona expedition funded by the National Geographic Society. Lowell Observatory astronomers will also participate, using new CCD recorders with two 20-cm telescopes. Altogether, four stations are planned for Ecuador and two for French Guiana. I encourage anyone travelling to observe the Vesta event to also record occultations during the total lunar eclipse and try the Hypatia appulse (occultation more probable in northern Chile) the night before.

Stephen O'Meara (*Sky and Telescope*) contacted the Earthwatch Society about organizing volunteers to go

Table 2, Part D

| 1988 | MINOR PLANET | | | | | | Motion | | STAR | | | Min. Geocentric | | | COMPARISON DATA | | | APPARENT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | No. | Name | km-diam. | -// | RSOI | Type | °/Day | P.A. | SAO No | DM/ID No | D | U. T. | Sep. | S | AGK3 No | Shift | Time | R.A. | Dec. |
| Oct 8 | 78 | Diana | 125 | 0.08 | 392 | C | 0.374 | 95°.0 | 60237 | +30 1537 | | 7h 45m.8 | 3".98N | UA | N30° 825 | 0".19 | -0m.3 | 7h 37m.6 | 30°22' |
| Oct 11 | 34 | Circe | 118 | 0.09 | 474 | C | 0.231 | 240.8 | 109711 | + 4 198 | | 18 48.4 | 4.38S | UX | N 5 138 | -0.34 | -0.4 | 1 9.7 | 5 17 |
| Oct 12 | 1 | Ceres | 946 | 0.58 | 10161 | G | 0.133 | 74.6 | | | | 19 52.6 | 2.96N | C | | | | 6 16.6 | 21 43 |
| Oct 13 | 980 | Anacostia | 89 | 0.08 | 238 | SU | 0.119 | 98.9 | 126524 | + 2 4299 | | 11 50.5 | 1.02S | AS | N 3 2754 | 0.32 | 5.5 | 21 4.4 | 3 30 |
| Oct 13 | 19 | Fortuna | 171 | 0.10 | 680 | G | 0.307 | 86.7 | | B2175651 | | 16 52.8 | 3.76N | C | | | | 18 51.5 | -21 18 |
| Oct 15 | 617 | Patroclus | 149 | 0.06 | 1091 | P | 0.144 | 269.0 | 110597 | + 9 331 | | 9 37.4 | 1.68N | XA | N 9 236 | -0.13 | -0.0 | 2 31.7 | 10 6 |
| Oct 16 | 359 | Georgia | 48 | 0.03 | 99 | CX | 0.266 | 63.6 | 189062 | C2514636 | | 17 54.1 | 1.75N | UX | | -0.31 | 0.2 | 20 14.4 | -25 12 |
| Oct 17 | 34 | Circe | 118 | 0.09 | 474 | C | 0.227 | 241.1 | | | | 17 58.1 | 4.19N | C | | | | 1 4.9 | 4 37 |
| Oct 18 | 1 | Ceres | 946 | 0.60 | 10143 | G | 0.103 | 67.6 | | | | 19 53.9 | 0.08S | C | | | | 6 19.5 | 21 56 |
| Oct 19 | | Venus | 12220 | 20.63 | | | 1.092 | 100.1 | 184567 | C2412780 | | 22 6.6 | 11.76N | XS | | | | 16 42.4 | -25 13 |
| Oct 19 | 30 | Urania | 104 | 0.13 | 283 | S | 0.227 | 246.9 | 109497 | + 8 116 | | 22 24.2 | 3.74N | UX | N 9 65 | 0.20 | 0.2 | 50.1 | 9 31 |
| Oct 22 | 67 | Asia | 60 | 0.03 | 120 | S | 0.533 | 96.0 | 160317 | -18 4427 | A | 19 56.1 | 2.42N | UX | | -0.42 | -0.2 | 17 8.5 | -18 15 |
| Oct 23 | 521 | Brixia | 121 | 0.15 | 346 | C | 0.193 | 276.3 | 147658 | -13 217 | | 2 24.0 | 6.07N | S | | | | 1 11.1 | -12 54 |
| Oct 23 | 146 | Lucina | 140 | 0.08 | 613 | C | 0.056 | 41.9 | | | | 23 53.6 | 0.56N | C | | | | 6 20.5 | 21 8 |
| Oct 26 | 980 | Anacostia | 89 | 0.07 | 238 | SU | 0.207 | 89.4 | 126630 | + 2 4324 | | 19 16.5 | 1.27N | AS | N 3 2769 | 0.53 | 0.6 | 21 13.1 | 3 23 |
| Nov 2 | 65 | Cybele | 230 | 0.09 | 1402 | P | 0.307 | 88.3 | | L 3 9693 | | 11 31.9 | 2.21N | HC | | -0.73 | -0.2 | 18 45.2 | -21 1 |
| Nov 3 | | Venus | 12220 | 23.83 | | | 1.033 | 92.1 | | C2612434 | | 9 37.1 | 12.91S | Y | | | | 17 50.7 | -26 52 |
| Nov 3 | | Venus | 12220 | 23.85 | | | 1.032 | 92.1 | 185849 | C2612444 | | 11 33.0 | 2.79S | HX | | -0.02 | -0.1 | 17 51.0 | -26 53 |
| Nov 6 | 10 | Hygiea | 429 | 0.17 | 3283 | C | 0.367 | 86.6 | | L 3 5100 | | 21 58.6 | 0.31S | H | | | | 18 16.8 | -23 5 |
| Nov 8 | 16 | Psyche | 264 | 0.15 | 1446 | M | 0.263 | 76.4 | 164047 | -17 6144 | | 21 9.1 | 0.05S | UX | | 0.16 | 0.7 | 20 59.4 | -17 20 |
| Nov 11 | 43 | Ariadne | 65 | 0.06 | 169 | S | 0.189 | 261.4 | | A25 1450 | | 34.4 | 4.43S | C | | | | 5 17.8 | 24 39 |
| Nov 11 | 1 | Ceres | 946 | 0.69 | 10074 | G | 0.083 | 316.2 | | L 1 631 | | 10 57.0 | 0.44N | H | | | | 6 21.7 | 23 6 |
| Nov 14 | 165 | Loreley | 160 | 0.07 | 877 | CD | 0.113 | 120.7 | 98387 | +18 2128 | | 11 18.6 | 3.05N | UX | N17 993 | 0.19 | 0.3 | 9 8.3 | 17 43 |
| Nov 15 | 790 | Pretoria | 176 | 0.07 | 869 | P | 0.376 | 84.5 | 161234 | -13 4897 | | 11 8.4 | 1.01S | UP | | 0.95 | 0.4 | 18 15.3 | -13 35 |
| Nov 15 | 375 | Ursula | 214 | 0.08 | 1390 | C | 0.183 | 116.7 | | | | 20 48.9 | 0.82N | C | | | | 10 33.2 | 14 38 |
| Nov 18 | 146 | Lucina | 140 | 0.10 | 611 | C | 0.137 | 297.4 | | | | 0 -0.7 | 0.84N | C | | | | 6 16.1 | 22 27 |
| Nov 18 | 43 | Ariadne | 65 | 0.06 | 169 | S | 0.235 | 260.9 | 77021 | +24 776 | | 14 58.5 | 4.94S | UX | N24 469 | 0.14 | -0.1 | 5 10.7 | 24 24 |
| Nov 19 | 704 | Interamnia | 333 | 0.12 | 2353 | F | 0.360 | 82.4 | | L 3 2784 | | 9 51.2 | 1.31S | H | | | | 18 5.7 | -23 10 |
| Nov 21 | 369 | Aeria | 62 | 0.06 | 156 | M | 0.254 | 276.6 | 111457 | + 6 592 | | 17 13.5 | 0.93S | UR | N 7 405 | 0.16 | -0.4 | 3 50.4 | 7 8 |
| Nov 22 | 15 | Eunomia | 272 | 0.20 | 1270 | S | 0.295 | 78.4 | 127300 | + 1 4583 | | 22 54.6 | 0.55S | UA | N 1 2691 | 0.02 | -0.8 | 22 6.0 | 1 49 |
| Nov 23 | | Venus | 12220 | 30.20 | | | 0.881 | 80.3 | | C2513875 | | 3 4.2 | 14.70S | 7P | | 0.09 | -0.3 | 19 15.6 | -25 41 |
| Nov 26 | 146 | Lucina | 140 | 0.10 | 611 | C | 0.183 | 291.7 | | | | 5 27.7 | 2.80N | C | | | | 6 10.9 | 22 59 |
| Nov 26 | | Saturn | 115644 | 14.78 | | | 0.102 | 85.9 | 187347 | C2213341 | | 8 15.4 | 7.63N | X | | | | 18 50.3 | -22 36 |
| Nov 27 | 192 | Nausikaa | 107 | 0.14 | 284 | S | 0.248 | 267.1 | 57505 | +35 929 | | 3 10.5 | 5.22S | UA | N35 478 | 0.14 | 0.5 | 4 55.2 | 35 58 |
| Nov 30 | | Venus | 12220 | 33.43 | | | 0.790 | 75.4 | 188473 | C2415532 | | 10 33.0 | 18.10S | U7 | | -0.10 | 0.1 | 19 42.0 | -24 24 |
| Dec 2 | 375 | Ursula | 214 | 0.09 | 1391 | C | 0.124 | 120.6 | | | | 2 35.1 | 0.08N | C | | | | 10 42.3 | 13 26 |
| Dec 2 | 895 | Helio | 147 | 0.11 | 625 | FCB | 0.243 | 231.0 | | L 1 1028 | | 6 54.2 | 1.58N | H | | | | 6 31.0 | 21 4 |
| Dec 3 | 405 | Thia | 129 | 0.08 | 385 | C | 0.519 | 118.6 | 157205 | -12 3603 | | 5 56.7 | 1.22S | PS | | -0.53 | -0.6 | 12 18.5 | -13 29 |
| Dec 3 | 146 | Lucina | 140 | 0.10 | 610 | C | 0.217 | 288.6 | | | | 20 53.6 | 1.91N | C | | | | 6 4.6 | 23 31 |
| Dec 4 | 10 | Hygiea | 429 | 0.16 | 3312 | C | 0.394 | 82.6 | 187591 | C2213536 | | 6.2 | 1.86S | UX | | -0.62 | 0.1 | 19 1.4 | -22 7 |
| Dec 4 | 1 | Ceres | 946 | 0.76 | 10009 | G | 0.210 | 289.9 | | | | 11 2.0 | 0.65S | C | | | | 6 8.4 | 24 39 |
| Dec 4 | | Mars | 6782 | 3.81 | | | 0.687 | 106.1 | 159122 | -17 4285 | | 23 35.4 | 3.03N | 7P | | -0.05 | -0.0 | 15 14.0 | -17 44 |
| Dec 8 | 23 | Thalia | 111 | 0.08 | 309 | S | 0.416 | 104.6 | 99946 | +11 2429 | | 19 31.4 | 2.40N | UA | N10 1505 | 0.06 | -0.1 | 12 6.8 | 10 35 |
| Dec 8 | 146 | Lucina | 140 | 0.10 | 610 | C | 0.234 | 287.1 | | | | 23 21.9 | 2.19N | C | | | | 5 59.8 | 23 52 |
| Dec 9 | 449 | Hamburga | 89 | 0.08 | 258 | C | 0.144 | 264.9 | 93075 | +12 381 | | 41.6 | 4.33S | UX | N13 222 | 0.07 | 0.3 | 2 43.2 | 13 15 |
| Dec 9 | 168 | Sibylla | 154 | 0.09 | 825 | C | 0.162 | 267.2 | 96055 | +17 1373 | | 16 26.1 | 0.00S | UH | N17 686 | -0.34 | 0.8 | 6 43.9 | 17 12 |
| Dec 13 | | Jupiter | 140904 | 46.34 | | | 0.126 | 274.3 | 78505 | +23 1403 | | 10 1.6 | 1.80S | UR | N23 685 | -0.01 | -0.2 | 6 33.5 | 23 4 |
| Dec 13 | 369 | Aeria | 62 | 0.05 | 157 | M | 0.191 | 294.1 | 111234 | + 7 514 | | 20 4.7 | 1.75S | UR | N 8 362 | 0.08 | -0.2 | 3 30.4 | 8 20 |
| Dec 15 | 12 | Victoria | 117 | 0.08 | 341 | S | 0.403 | 77.9 | | + 0 4980 | | 11 24.9 | 3.75S | XA | N 0 2884 | -0.03 | -0.1 | 23 13.8 | 1 10 |
| Dec 15 | | Venus | 12220 | 42.28 | | | 0.494 | 59.5 | 189216 | -21 5699 | | 16 21.7 | 3.34S | UH | | 0.62 | -0.3 | 20 22.5 | -20 53 |

to the Galapagos Islands to observe the Vesta occultation, as well as the lunar eclipse 2 days before. He was encouraged to propose, with the possibility for funding from them for two organizers to go to the Galapagos. O'Meara worked out the logistics while I wrote the scientific justification and observing techniques; our detailed proposal was submitted in early June. But then there were delays in reviewing the proposal at Earthwatch. In early July, they said they really liked the proposal, and would like to fund something like this in the future, but that there just wasn't time for them to implement it. In the meantime, Edwin Goffin has found a rather good occultation of a 7th-mag. star by Vesta on 1991 Jan. 3, and I calculated the path with ZZ87 star data, giving a nearly north-south pass over Minnesota and Florida. I also found an occultation of a 6th-mag. star visible from the Seychelles in March 2000, but with a solar elongation of 72°, not ideal for astrometry.

Table 1, Part E

| 1989 Universal DATE | Time | PLANET Name | mv | Δ,AU | STAR SAO No | mv | Sp | R.A.(1950) | Dec. | Occultation Δm | Dur | df | P | Possible Area | El Sun | MOON El | %Snl | Up | Ephem. Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec 16 | 1h31m | Aegle | 11.9 | 2.029 | 39960 | 9.0 | B0 | 4h58m.6 | 43°47' | 3.0 | 13s | 21 | 17 | south Atlantic?n | 158° | 52° | 86- | all | EMP 1984 |
| Dec 16 | 13 48-55 | Aegle | 11.9 | 2.029 | | 11.6 | G | 4 58.0 | 43 45 | 0.9 | 13 | 21 | 17 | Fiji, Australia | 158 | 59 | 82- | all | EMP 1984 |
| Dec 20 | 11 35 | P/SM-WM-1 | 13.3 | 5.727 | | 11.9 | | 23 32.2 | 5 18 | 1.7 | 7 | 34 | 83 | e.Asia; Australia?s | 88 | 172 | 45- | none | MPC11510 |
| Dec 20 | 13 01 | Laetitia | 12.0 | 3.199 | | 11.2 | | 12 56.4 | -2 25 | 1.3 | 7 | 15 | 29 | (Alaska, n.Canada)?s | 74 | 12 | 45- | all | MPC12686 |
| Dec 20 | 15 43-59 | Ceres | 6.9 | 1.675 | | 10.5 | | 5 49.9 | 25 45 | 0.0 | 76 | 20 | 3 | Samoa, Luzon, s.Asia | 178 | 98 | 44- | e129E | MPC12187 |
| Dec 21 | 22 59-71 | Helio | 12.4 | 1.745 | | 10.5 | | 6 9.8 | 18 0 | 2.1 | 10 | 17 | 17 | sSib,seEur,nwAf,Brazil | 174 | 108 | 32- | e 49E | EMP 1986 |
| Dec 22 | 16 52 | Siegena | 12.9 | 3.765 | 143026 | 9.0 | A0 | 19 3.7 | -9 53 | 3.9 | 4 | 8 | 32 | France,Switz.,nw Italy | 20 | 78 | 26- | none | Landgraf |
| Dec 24 | 9 41 | Psyche | 11.2 | 3.015 | 164807 | 9.0 | F8 | 21 57.8 | -13 11 | 2.3 | 7 | 10 | 17 | Japan?n; Papua?s | 55 | 97 | 13- | none | Goffin87 |
| Dec 24 | 18 55-68 | Lamberta | 12.5 | 2.037 | | 9.9 | B8 | 5 57.6 | 38 6 | 2.6 | 9 | 20 | 22 | s. Asia, n.w. Africa | 165 | 144 | 11- | e134E | MPC11620 |
| Dec 26 | 4 05-12 | Nuwa | 12.3 | 1.959 | | 10.5 | | 5 51.6 | 20 29 | 2.0 | 12 | 22 | 18 | Brazil, Peru | 174 | 162 | 4- | none | MPC11508 |
| Dec 26 | 4 07-14 | Ceres | 7.0 | 1.677 | | 11.1 | | 5 44.1 | 26 5 | .02 | 77 | 21 | 3 | Scandinavia,Arctic O. | 172 | 165 | 4- | none | MPC12187 |
| Dec 27 | 1 40 | Hebe | 11.3 | 3.164 | | 12.0 | | 14 2.7 | -0 56 | 0.5 | 7 | 13 | 25 | southern Africa | 66 | 55 | 1- | e 41E | Goffin86 |
| Dec 28 | 1 03-19 | Nuwa | 12.4 | 1.964 | | 10.2 | | 5 49.9 | 20 28 | 2.3 | 13 | 22 | 18 | Arabia,Med.,GA,FL,Mex. | 171 | 170 | 0- | none | MPC11508 |
| Dec 30 | 13 26 | Thia | 12.3 | 1.998 | 157757 | 7.2 | A0 | 13 6.8 | -19 51 | 5.1 | 4 | 10 | 22 | w.N.America?n;Hawaii?s | 76 | 103 | 6+ | none | MPC13443 |

*Predictions for October through December.* Data for these months are listed in two tables like those given for the middle 6 months of 1989 in the last issue. Sôma'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 on Sôma's map.

*Notes about Individual Events.*

Oct. 13: A new orbit for (19) Fortuna has been used; see pages 273-275 of the last issue.

Oct. 15: Patroclus is a Trojan asteroid.

Oct. 19, Venus and SAO 184567: Venus will be 59% sunlit. The disappearance will be on the dark side, as will be the case for all other Venus occultations during the rest of 1989.

Oct. 22: The star is Aitken's Double Star (ADS) 10359. The 10.6-mag. companion, 15".3 away in position angle (P.A.) 151°, will not be occulted.

Oct. 23: A new orbit for (521) Brixia has been used; see pages 273-275 of the last issue. The old orbit gave a more southerly path, shown on p. 70 of the January issue of *Sky and Telescope*.

Nov. 3 (both): Venus will be 52% sunlit.

Nov. 18, (43) Ariadne and SAO 77021: The star has an angular diameter of 0".0048, requiring 0.5 second for a central occultation.

Nov. 23: Venus will be 41% sunlit.

Nov. 26, Saturn: The duration calculation used the equatorial diameter of Saturn, and does not include the rings.

Nov. 27: The star has an angular diameter of 0".0006, requiring 0.6 second for the edge of the asteroid to cover for a central occultation.

Nov. 30: Venus will be 37% sunlit.

Dec. 2: Helio's orbit has not been updated recently, so the path is quite uncertain.

Dec. 4, Mars and SAO 159122: The star is 26 Librae = ZC 2182. Mars will be 99% sunlit and will have no significant defect of illumination.

Dec. 9, (449) Hamburga and SAO 93075: The star has an angular diameter of 0".0005, requiring 0.09 second for the edge of the asteroid to cover for a central occultation. Hamburga may be observed by the CRAF spacecraft on its way to Comet Kopff.

Dec. 9, (168) Sibylla and SAO 96055: The star has an angular diameter of 0".0005, requiring 0.07 second for the edge of the asteroid to cover for a central occultation.

Dec. 13: Dimming by Jupiter's ring might be seen near the central line.

Dec. 13, (369) Aerea and SAO 111234: The star has an angular diameter of 0".0006, requiring 0.08 second for the edge of the asteroid to cover for a central occultation.

Table 2, Part E

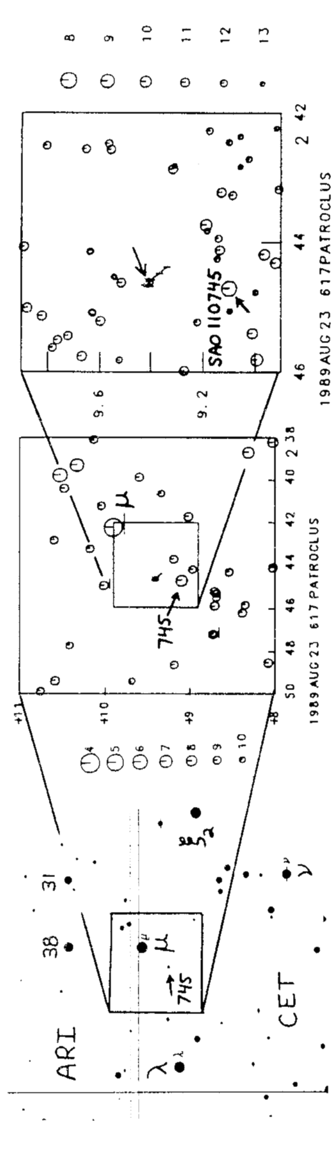
| 1988 DATE | MINOR PLANET No. | Name | km-diam. | -// | RSOI | Type | Motion °/Day | P.A. | STAR SAO No | DM/ID No | D | Min. Geocentric U.T. | Sep. | S | COMPARISON DATA AGK3 No | Shift | Time | APPARENT R.A. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec 16 | 96 | Aegle | 174 | 0.12 | 877 | T | 0.216 | 251°.5 | 39960 | +43 1168 | | 1h 31m.3 | 5".27S | A | N43° 554 | | | 5h 1m.5 | 43° 51' |
| Dec 16 | 96 | Aegle | 174 | 0.12 | 877 | T | 0.216 | 250.9 | | +43 1164 | | 13 50.6 | 3.81S | A | N43 550 | | | 5 0.9 | 43 49 |
| Dec 20 | | P/SM-WM-1 | 100 | 0.02 | 744 | | 0.081 | 76.8 | | | | 11 31.6 | 0.21N | C | | | | 23 34.3 | 5 31 |
| Dec 20 | 39 | Laetitia | 159 | 0.07 | 795 | S | 0.243 | 102.6 | | L 2 631 | | 13 2.9 | 3.43N | H | | | | 12 58.4 | -2 38 |
| Dec 20 | 1 | Ceres | 946 | 0.78 | 9964 | G | 0.246 | 285.0 | | A2641396 | | 15 51.1 | 0.52S | C | | | | 5 52.4 | 25 46 |
| Dec 21 | 895 | Helio | 147 | 0.12 | 626 | FCB | 0.292 | 237.6 | | A1847116 | | 23 6.1 | 1.54N | HC | | -0".34 | -1m.0 | 6 12.2 | 18 0 |
| Dec 22 | 386 | Siegena | 173 | 0.06 | 839 | C | 0.407 | 89.7 | 143026 | -10 4949 | | 16 50.7 | 1.76N | UP | | 0.50 | 0.4 | 19 5.9 | -9 49 |
| Dec 24 | 16 | Psyche | 264 | 0.12 | 1426 | M | 0.391 | 71.1 | 164807 | -13 6071 | | 9 38.6 | 0.57N | UX | | -1.24 | 0.1 | 22 0.0 | -12 59 |
| Dec 24 | 187 | Lamberta | 135 | 0.09 | 606 | C | 0.234 | 274.0 | | +38 1353 | | 19 1.2 | 0.26S | A | N38 655 | | | 6 0.4 | 38 6 |
| Dec 26 | 150 | Nuwa | 157 | 0.11 | 745 | CX | 0.214 | 268.8 | | A2045073 | | 4 9.8 | 2.07S | C | | | | 5 54.0 | 20 30 |
| Dec 26 | 1 | Ceres | 946 | 0.78 | 9950 | G | 0.242 | 284.1 | | | | 4 10.8 | 4.78N | C | | | | 5 46.6 | 26 6 |
| Dec 27 | 6 | Hebe | 186 | 0.08 | 951 | S | 0.291 | 96.3 | | L 2 4263 | | 1 42.9 | 1.06S | H | | | | 14 4.7 | -1 8 |
| Dec 28 | 150 | Nuwa | 157 | 0.11 | 745 | CX | 0.211 | 268.9 | | A2044436 | | 1 11.1 | 1.43N | C | | | | 5 52.3 | 20 29 |
| Dec 30 | 405 | Thia | 129 | 0.09 | 376 | C | 0.483 | 118.4 | 157757 | -19 3641 | | 13 28.1 | 1.70N | UP | | 0.24 | -0.1 | 13 9.0 | -20 4 |

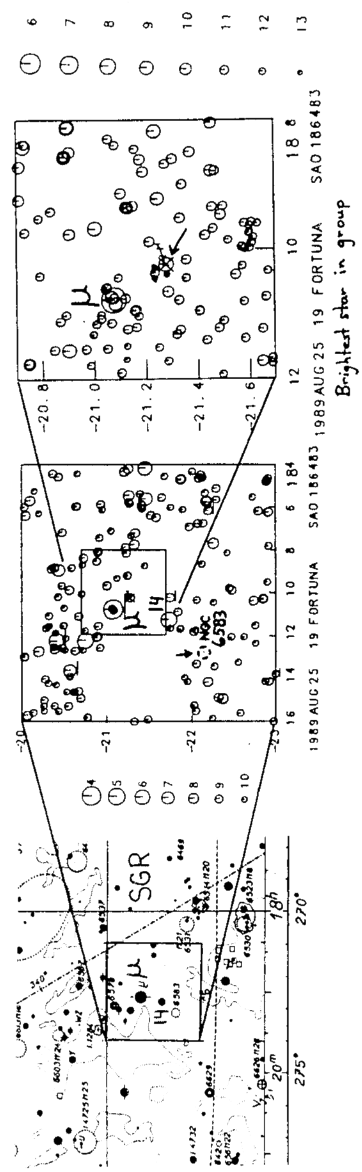
Dec. 15, (12) Victoria and B.D. +0° 4890: The AGK3 catalog gives a photographic magnitude of 10.7, which was used for the local circumstance predictions. But with a spectral type of M2, the star is quite red, so that the visual magnitude must be much brighter, which is confirmed by the fact that the star is in the B.D. Consequently, for the table, I have used mag. 9.0.

Dec. 15, Venus: Venus will be 25% sunlit.

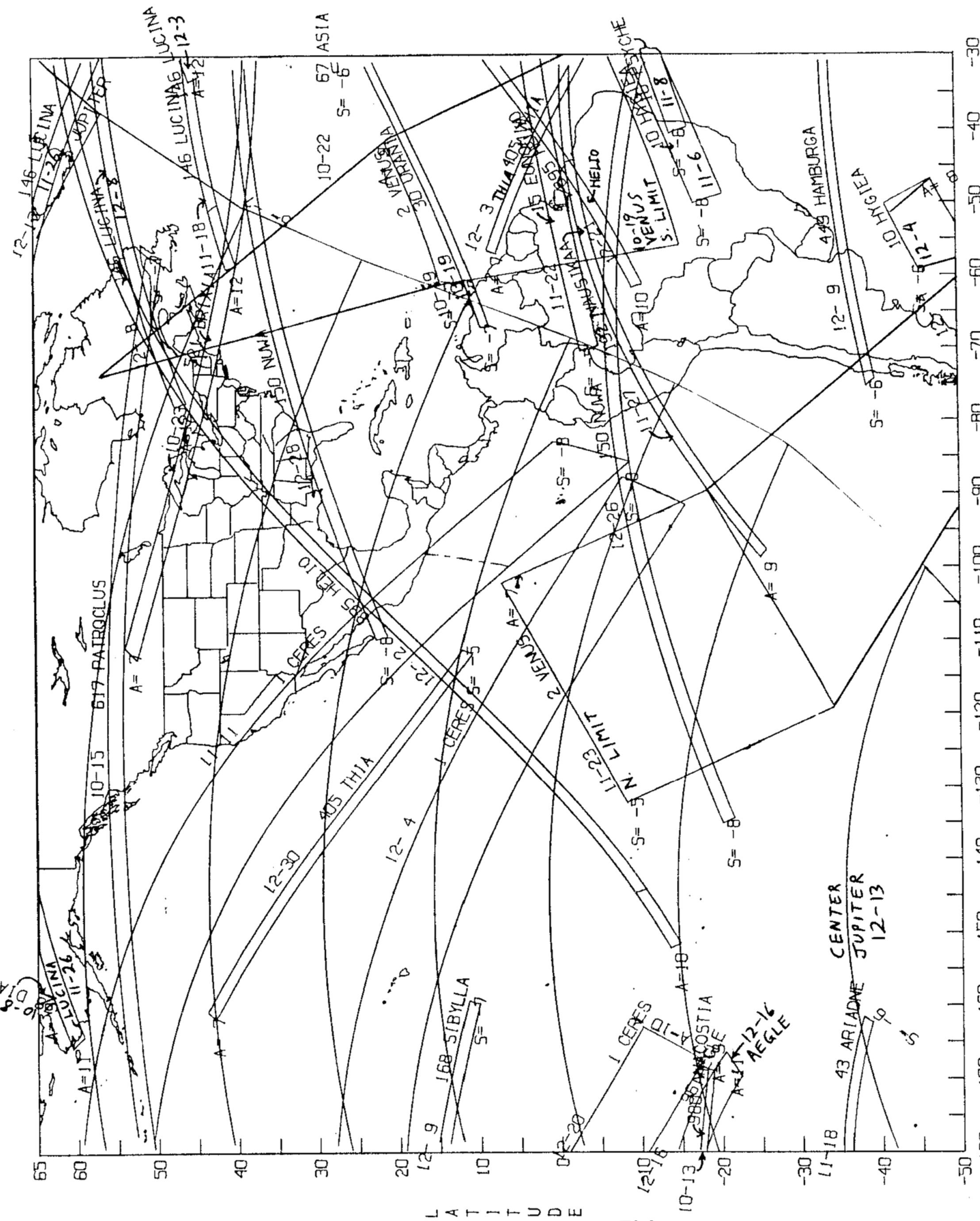
Dec. 20, P/SM-WM-1: The occulting object is the massive periodic comet Schwassmann-Wachmann-1; its diameter is unknown.

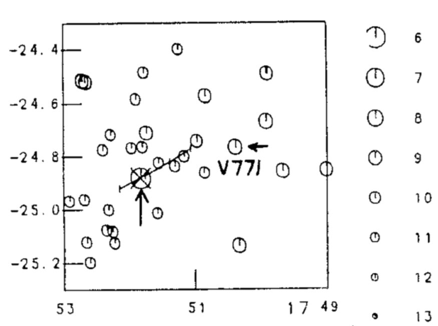
Dec. 21: Arnold Klemola has supplied an improved position for the star measured from a 1979 Lick plate, which indicates a 0".34 north shift from the data used for the local circumstance calculations, with a time correction of 1.0 minute late. The new position has been used for the table and for the path shown on the map of Europe and Africa for December events. However, see the note for the Dec. 2nd occultation.



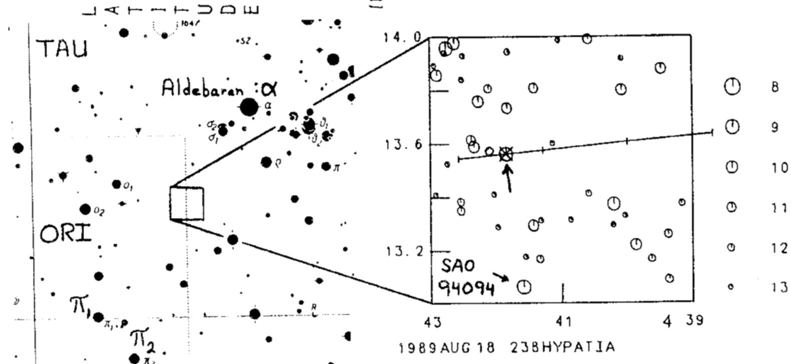



PLANETARY OCCULTATIONS. 1989 OCT. - DEC.



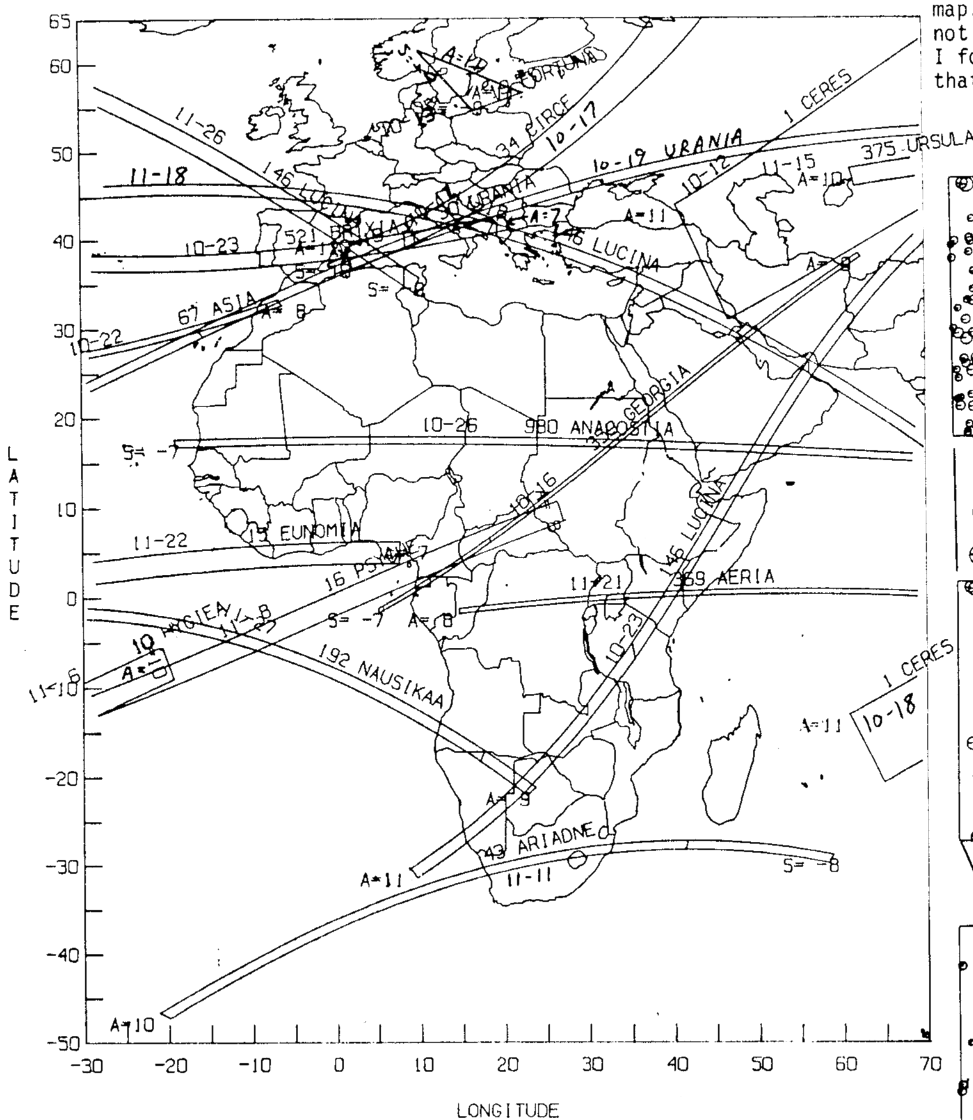

1989AUG19 4 VESTA SAO 185928

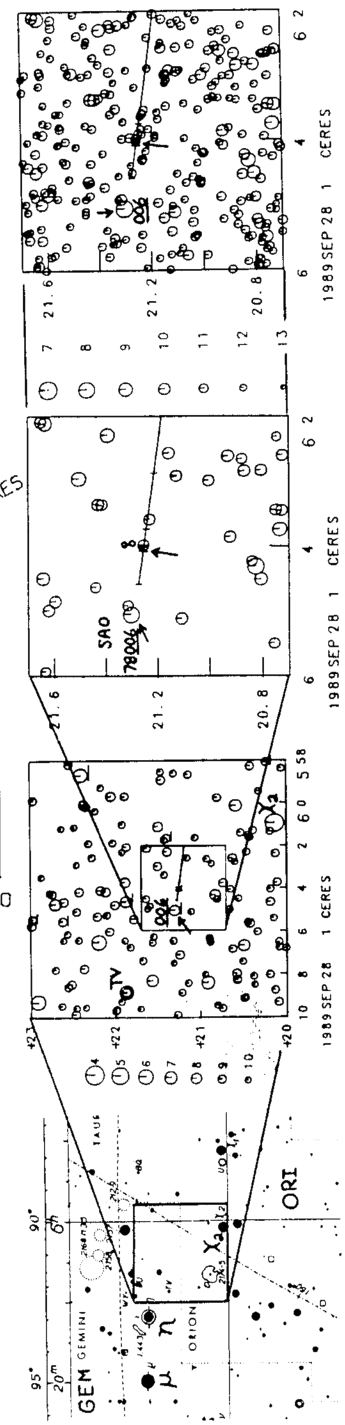


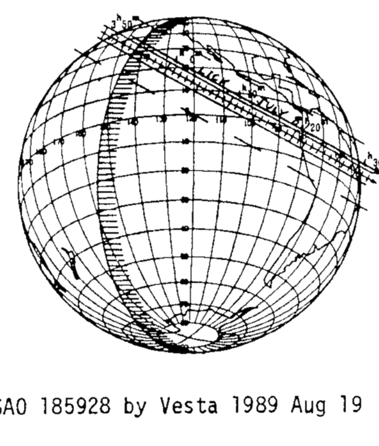

1989AUG18 238HYPATIA

PLANETARY OCCULTATIONS. 1989 OCT. - NOV.

[Ed: Apologies for not including the Kleopatra world map. Deleted because it would not reach observers in time, I forgot, until proofreading, that it should have appeared.]



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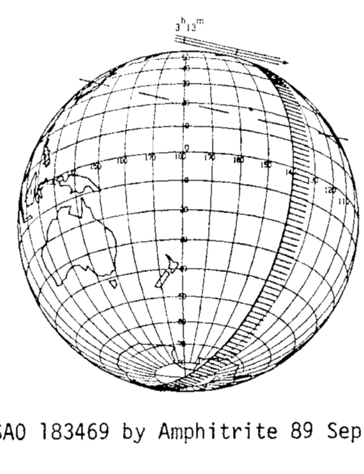
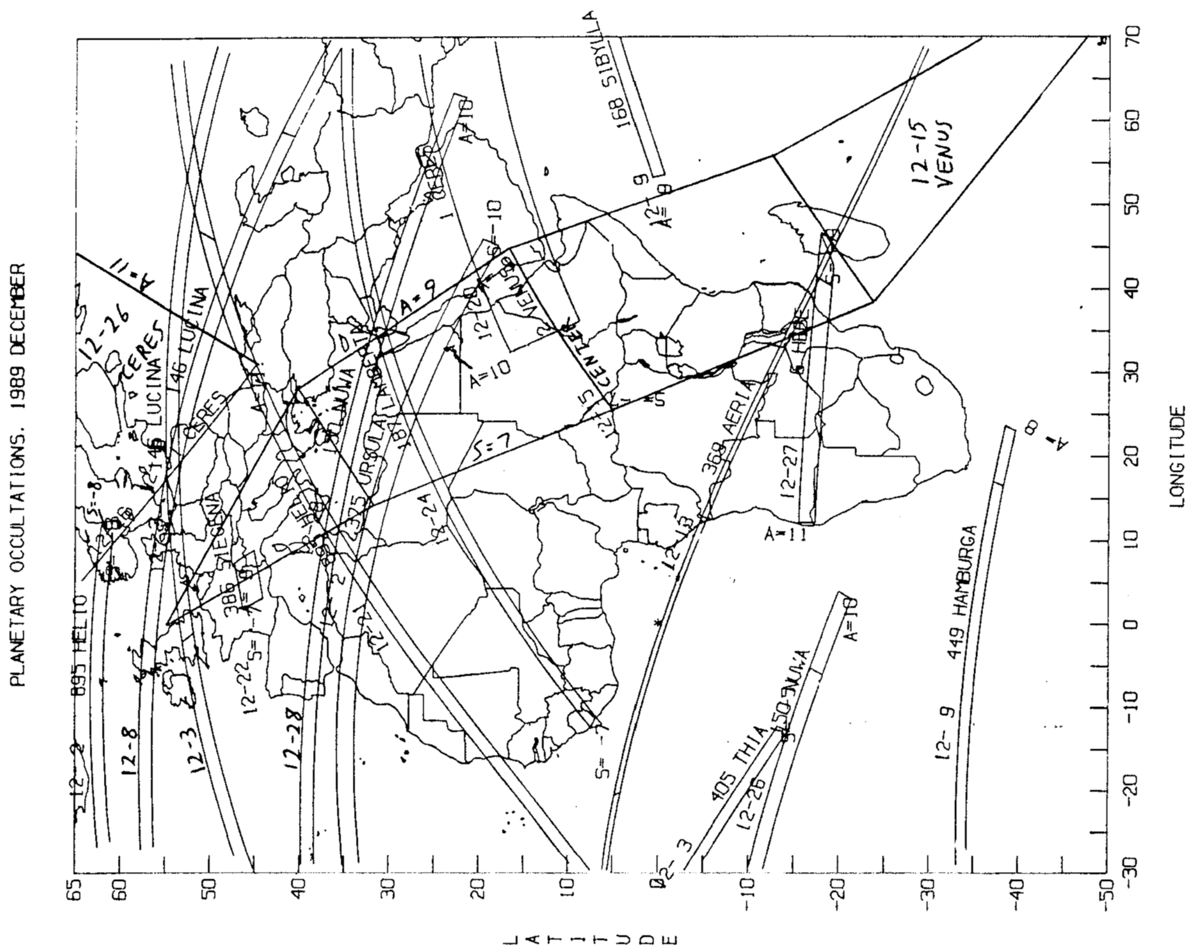


SAO 183469 by Amphitrite 89 Sep 22


PLANETARY OCCULTATIONS. 1989 DECEMBER
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12-26 CERES
146 LUCINA
895 HELIO
369 AERIA
449 HAMBURGA
405 THIA
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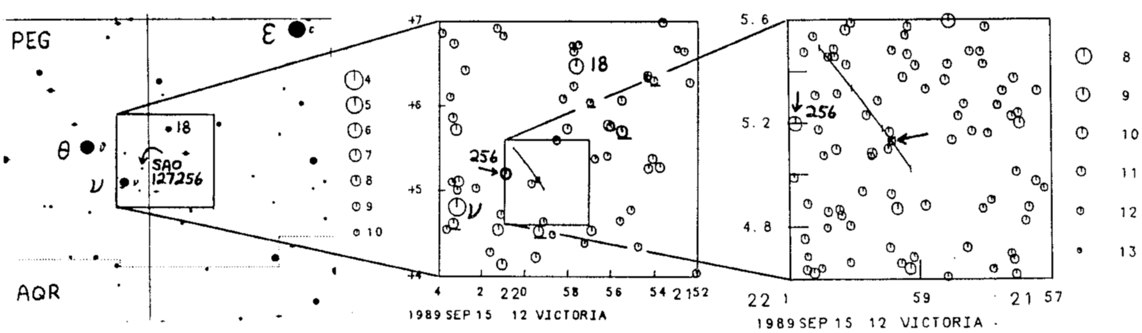
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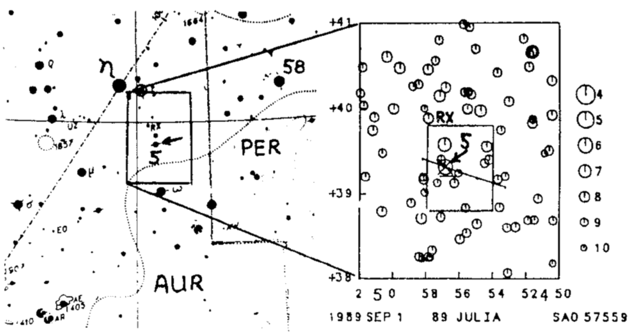
1989 SEP 15 12 VICTORIA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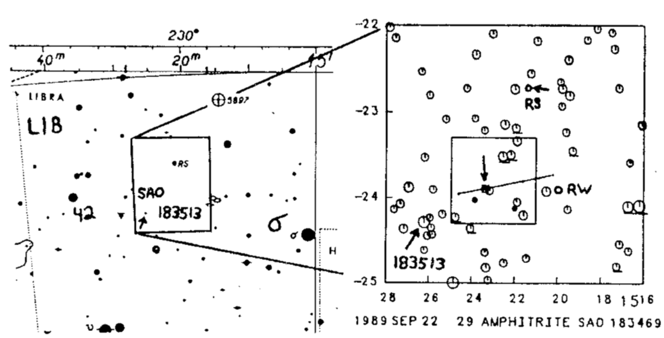
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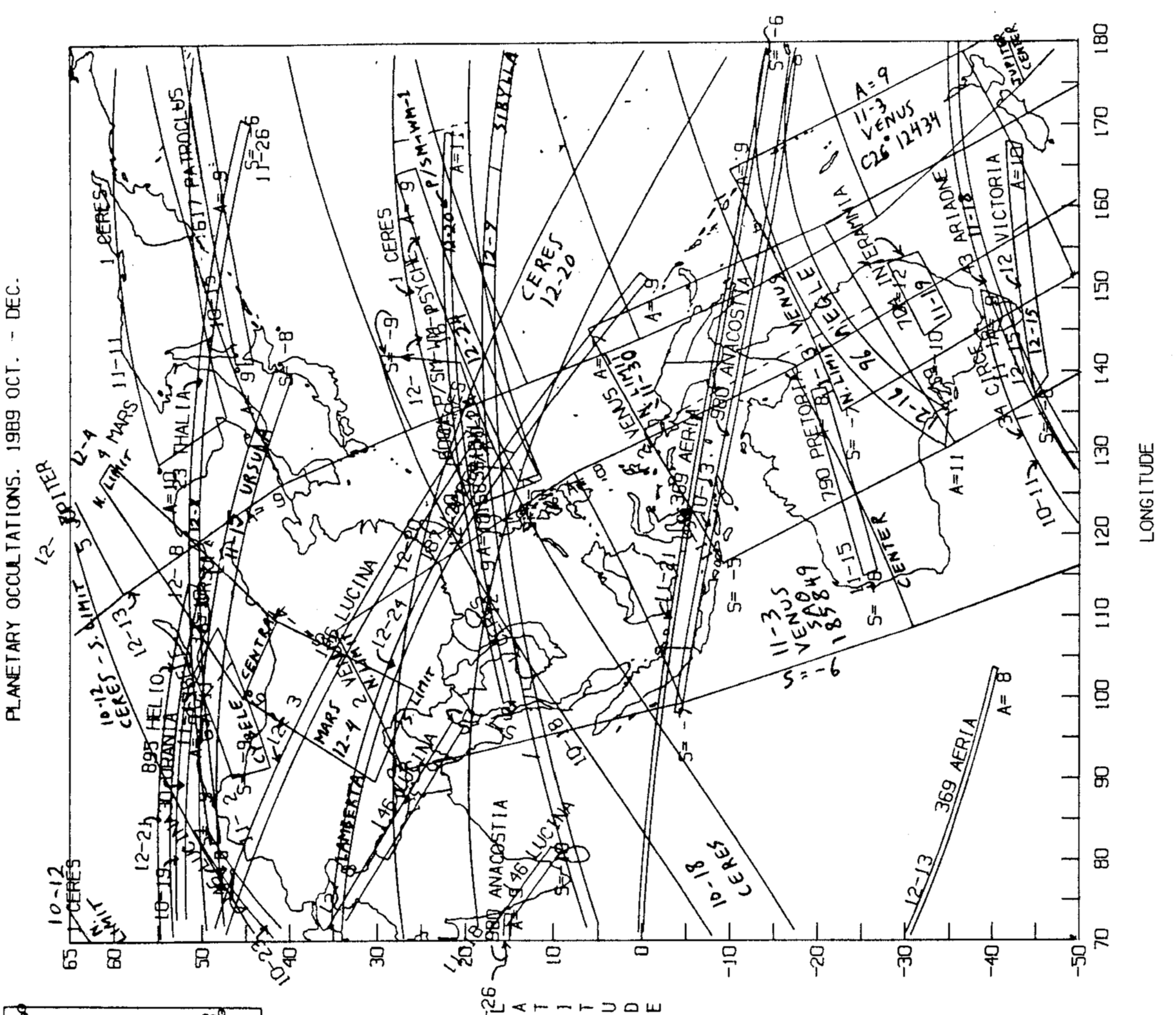
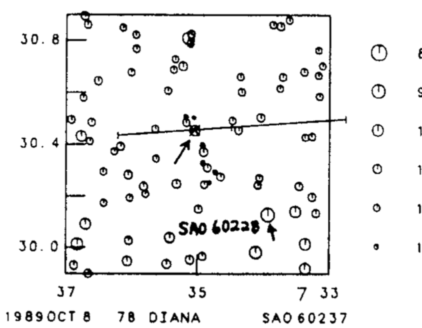
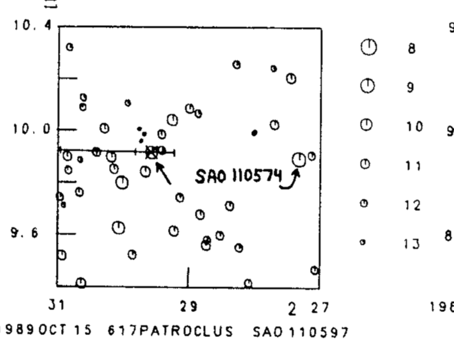
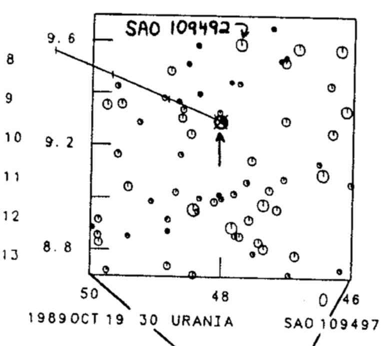
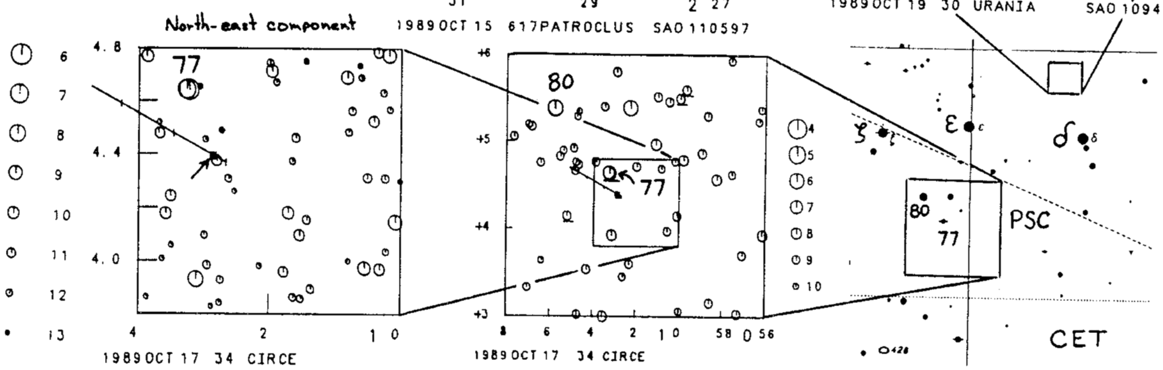
PLANETARY OCCULTATIONS. 1989 OCT. - DEC.

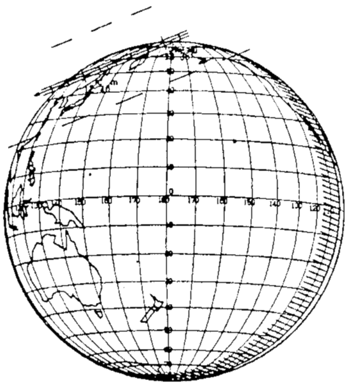




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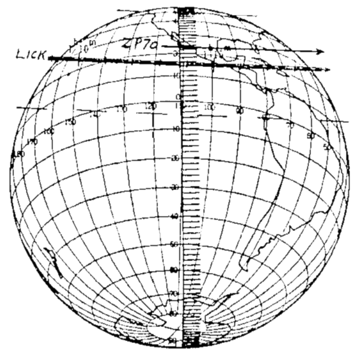

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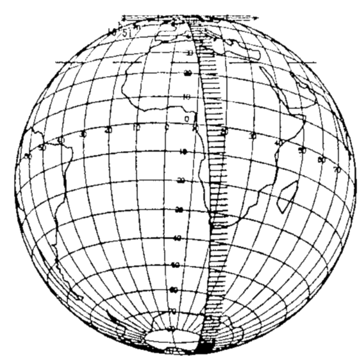
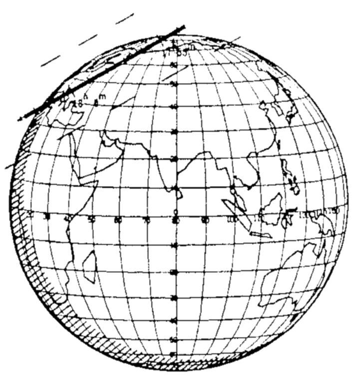
Anonymous by Ceres 1989 Sep 28

Anonymous by Ceres 1989 Oct 12

+2° 4299 by Anacostia 1989 Oct 13

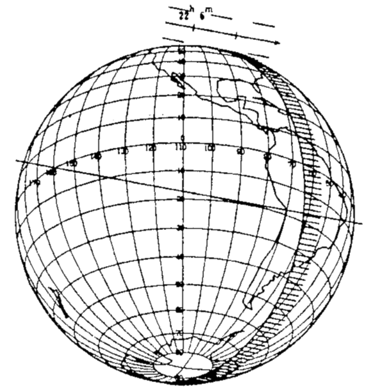


B2175651 by Fortuna 1989 Oct 13

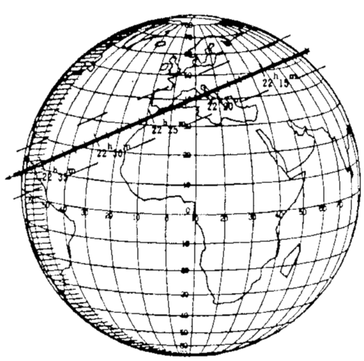


Anonymous by Circe 1989 Oct 17

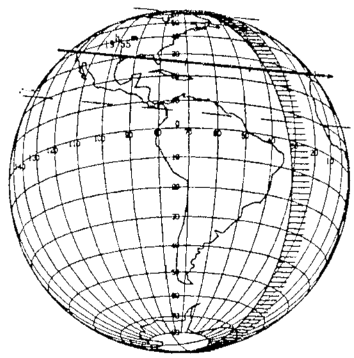
Anonymous by Ceres 1989 Oct 18



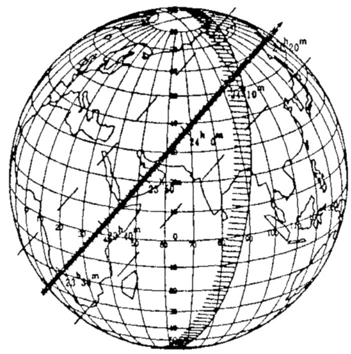
SAO 184567 by Venus 1989 Oct 19



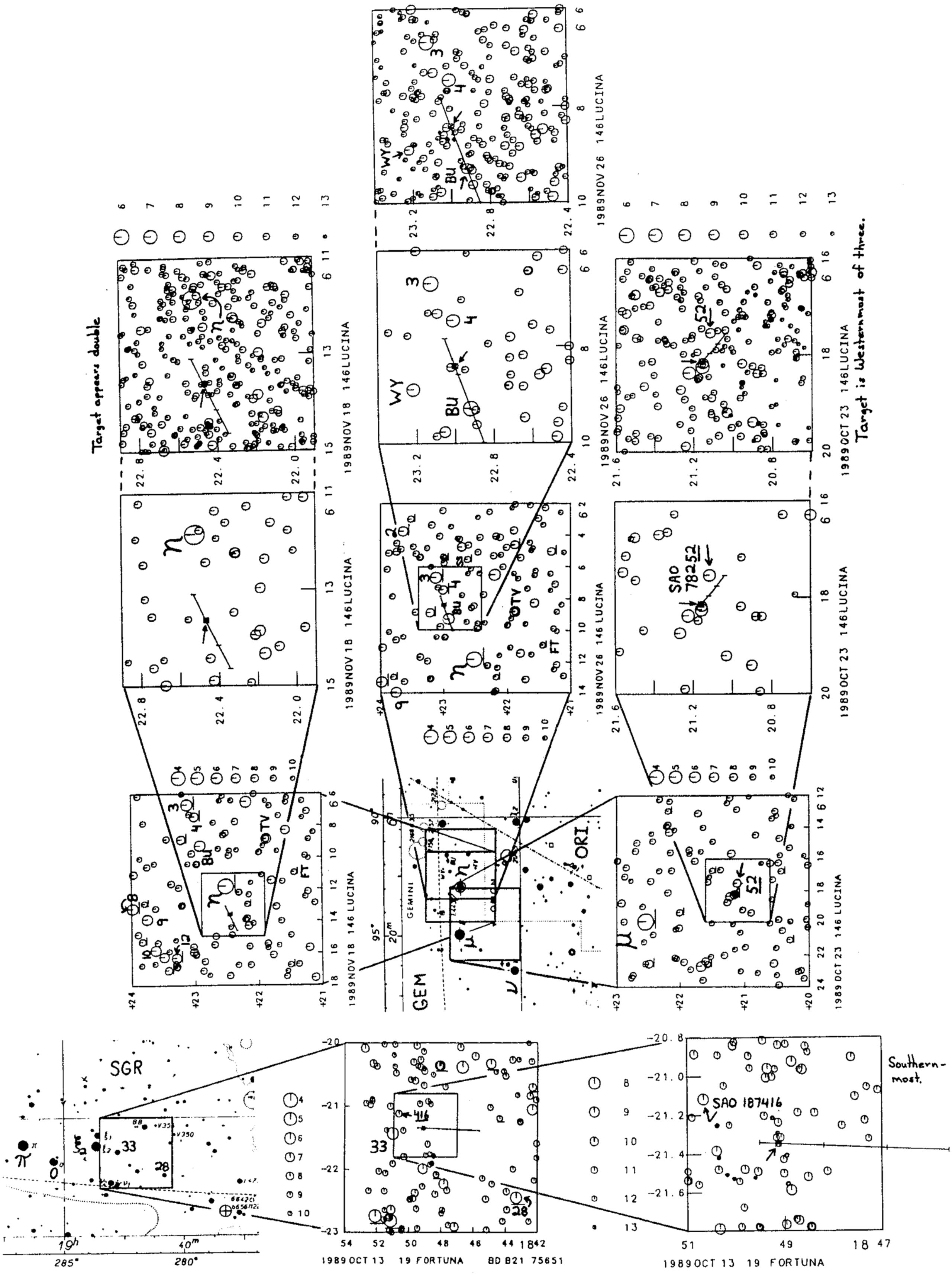
SAO 109497 by Urania 1989 Oct 19

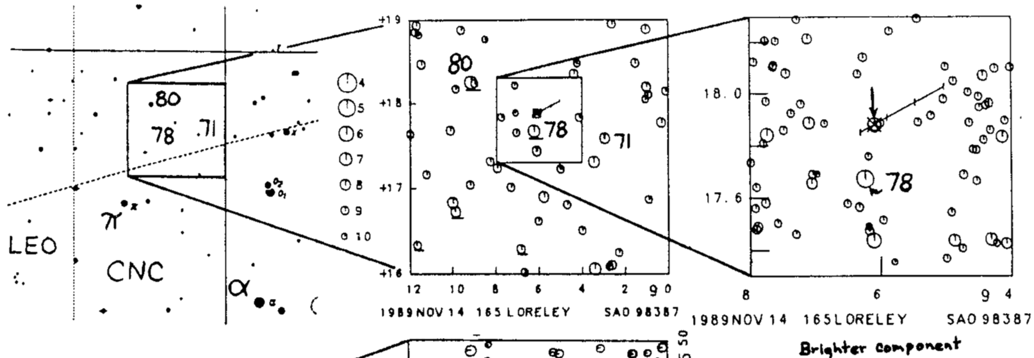


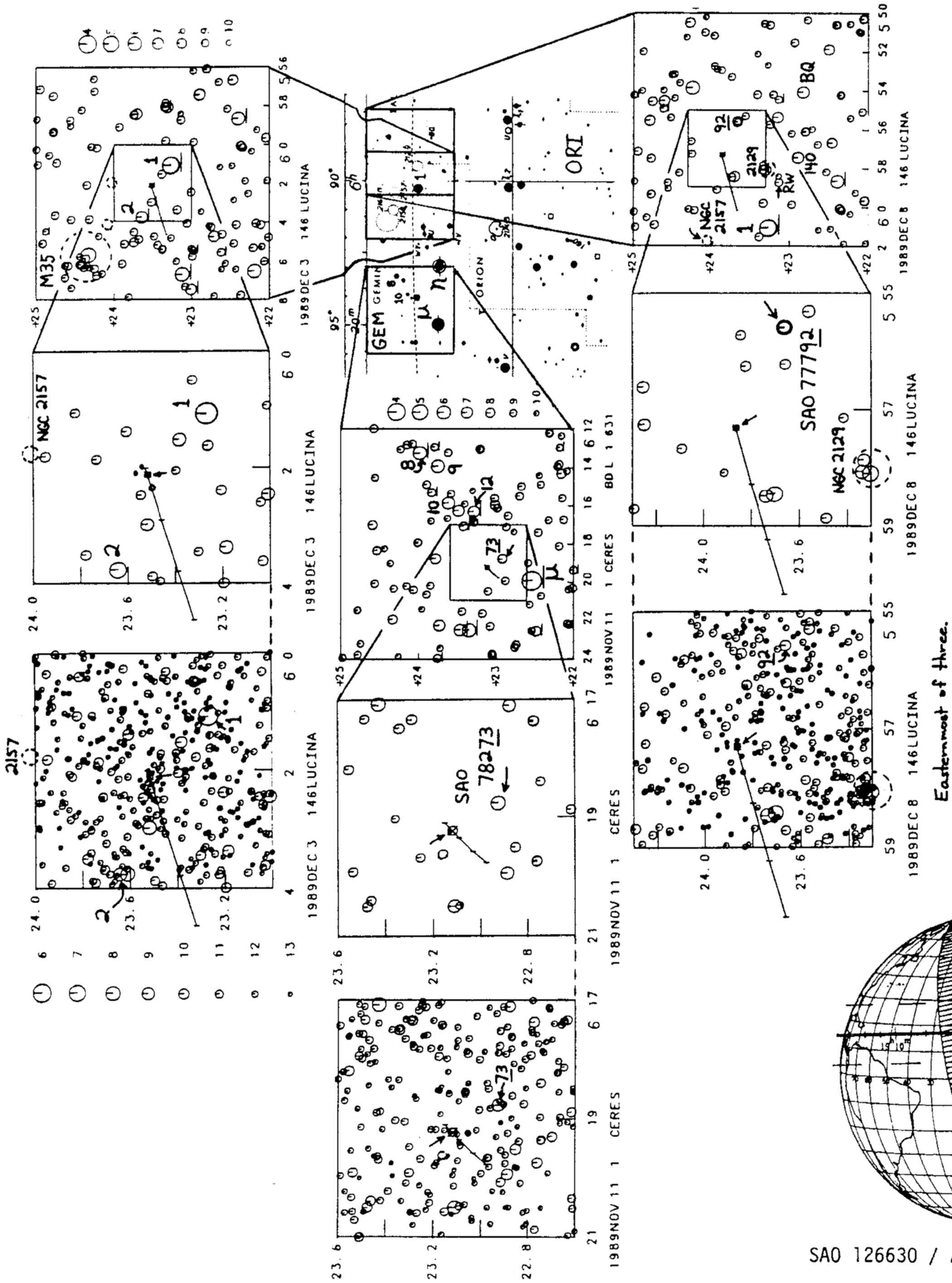
SAO 160317 by Asia 1989 Oct 22

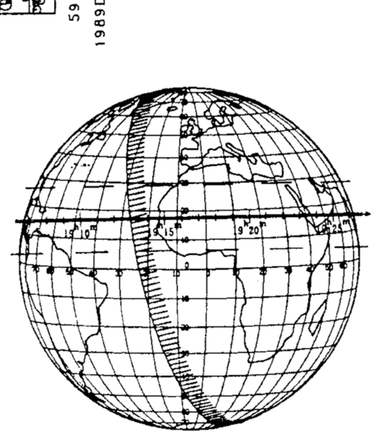


Anonymous by Lucina 1989 Oct 23

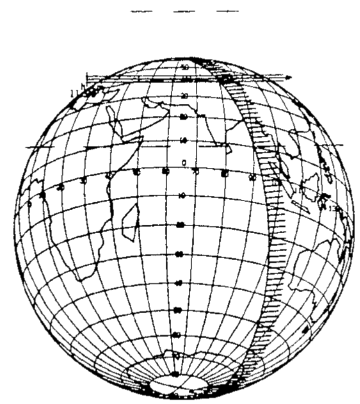

Target appears double
1989NOV18 146LUCINA
1989NOV26 146LUCINA
1989OCT23 146LUCINA
Target is Westernmost of three.
SAO 78252
GEM
ORI
GEMINI
SGR
1989OCT13 19 FORTUNA
BD B21 75651
SAO 187416
Southern-most.



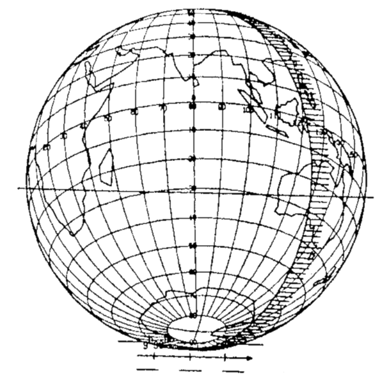



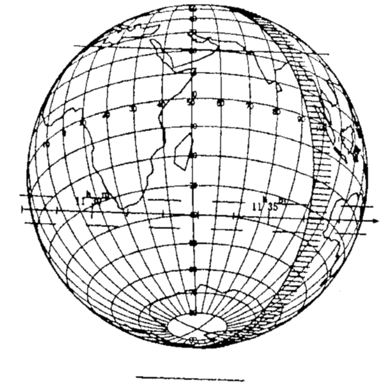
SAO 126630 / Anacostia 1989 Oct 26



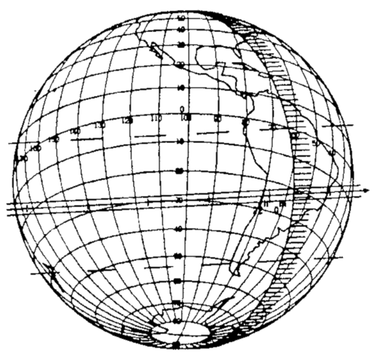
L 3 9693 by Cybele 1989 Nov 2



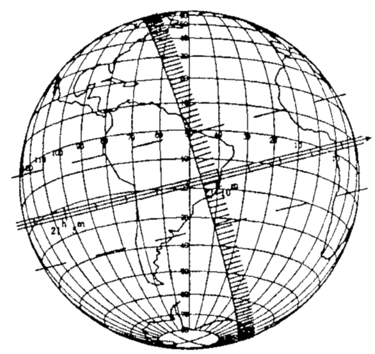
C2612434 by Venus 1989 Nov 3



SAO 185849 by Venus 1989 Nov 3

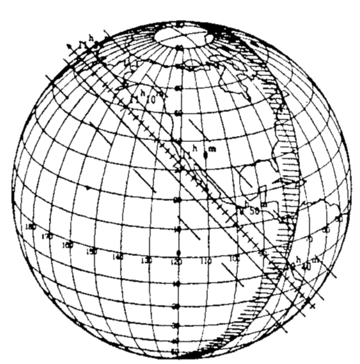


L 3 5100 by Hygiea 1989 Nov 6

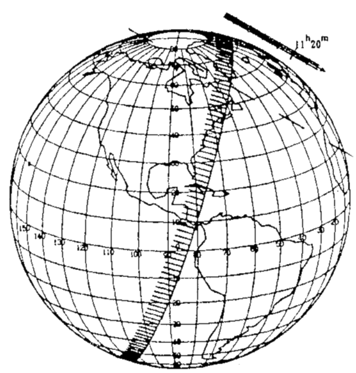


SAO 164047 by Psyche 1989 Nov 8

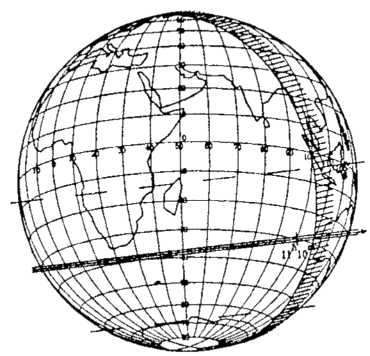
A25 1450 by Ariadne 1989 Nov 11



L 1 631 by Ceres 1989 Nov 11

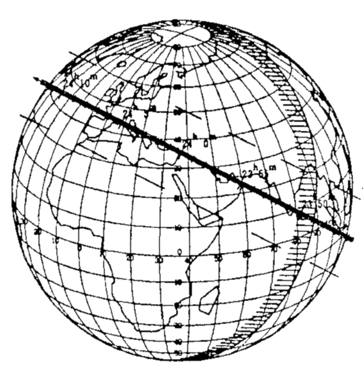


SAO 98387 by Loreley 1989 Nov 14

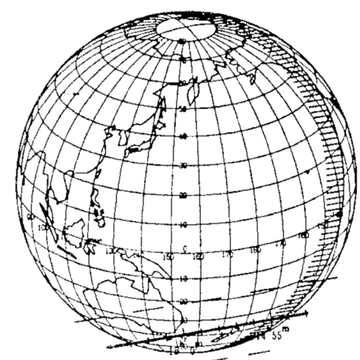


SAO 161234 by Pretoria 1989 Nov 15

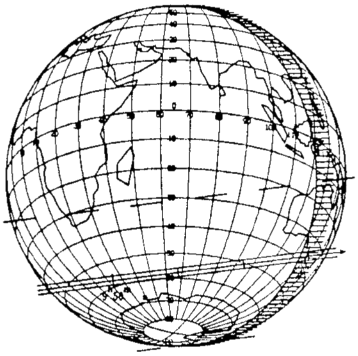
Anonymous by Ursula 1989 Nov 15



Anonymous by Lucina 1989 Nov 17

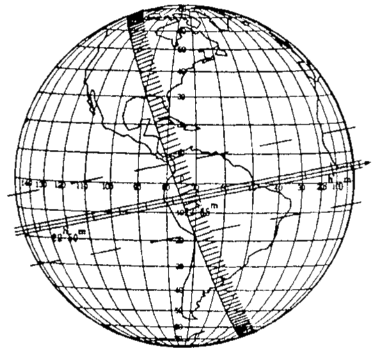


SAO 77021 by Ariadne 1989 Nov 18

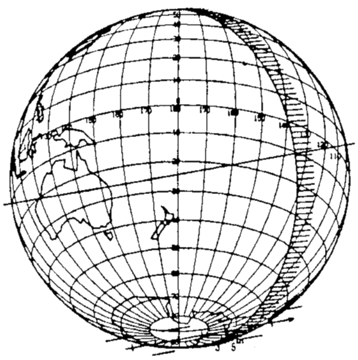


L 3 2784 by Interamnia 1989 Nov 19

SAO 111457 by Aeria 1989 Nov 21

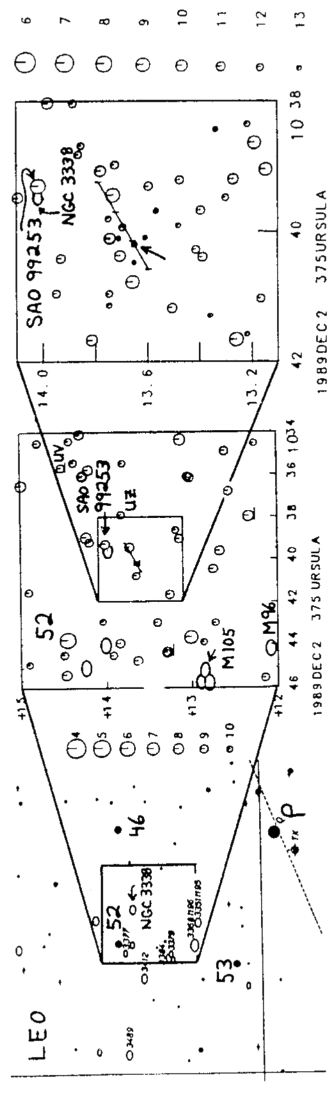


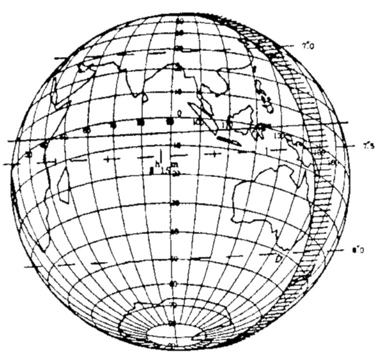
SAO 127300 by Eunomia 1989 Nov 22



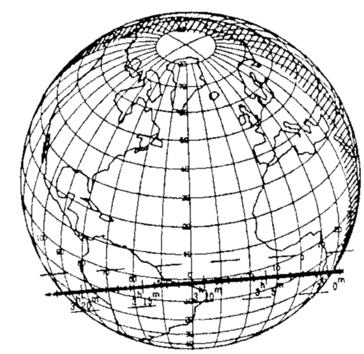
C2513875 by Venus 1989 Nov 23

Anonymous by Lucina 1989 Nov 26

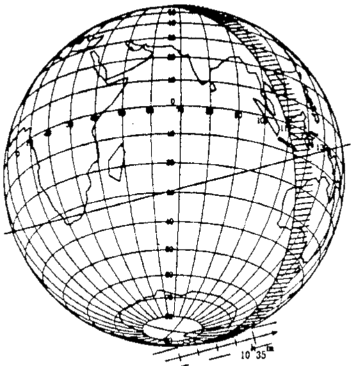


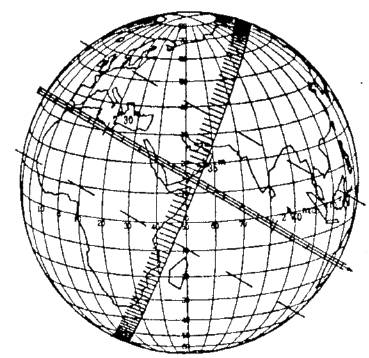
SAO 187347 by Saturn 1989 Nov 26



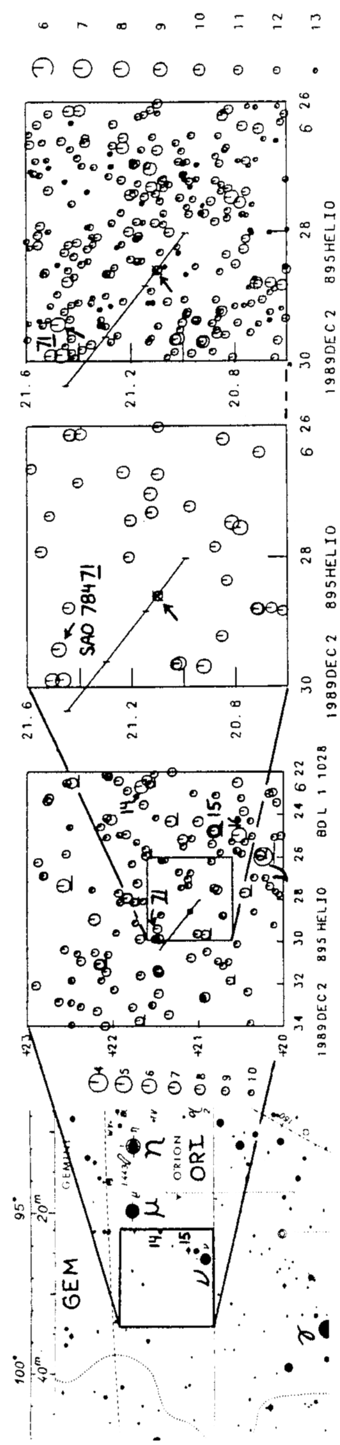
SAO 57505 by Nausikaa 1989 Nov 27

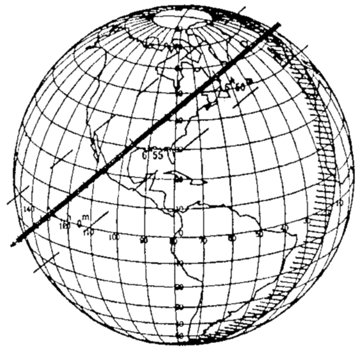


SAO 188473 by Venus 1989 Nov 30

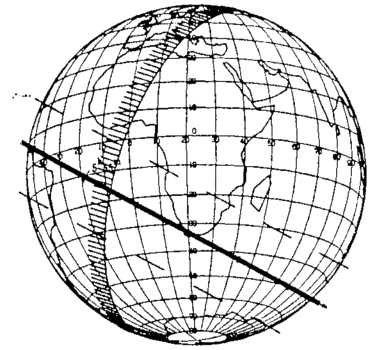


Anonymous by Ursula 1989 Dec 2

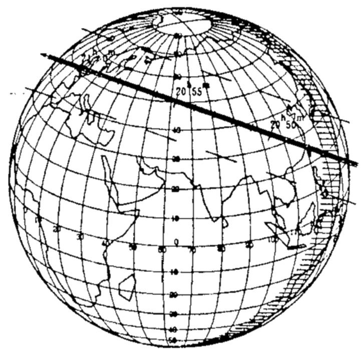




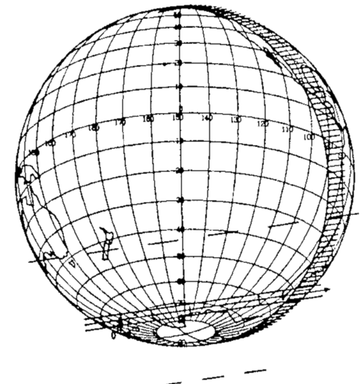
L 1 1028 by Helio 1989 Dec 2



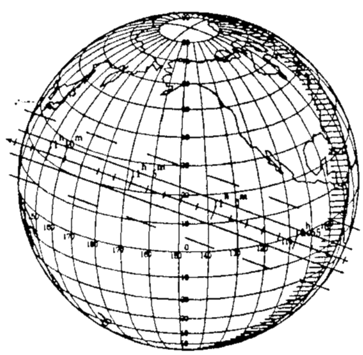
SAO 157205 by Thia 1989 Dec 3



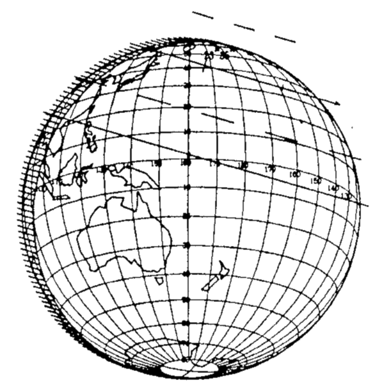
Anonymous by Lucina 1989 Dec 3



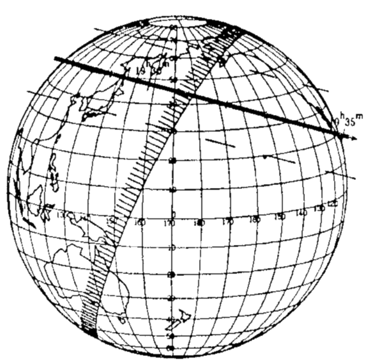
SAO 187591 by Hygiea 1989 Dec 4



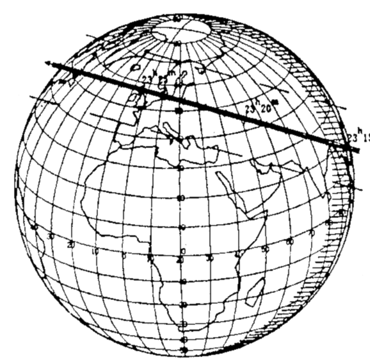
Anonymous by Ceres 1989 Dec 4



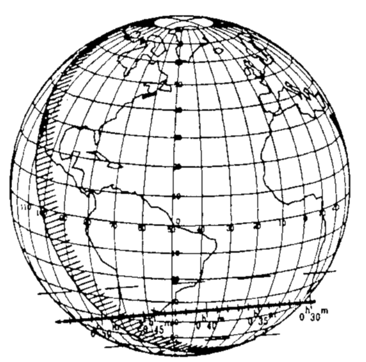
SAO 159122 by Mars 1989 Dec 4



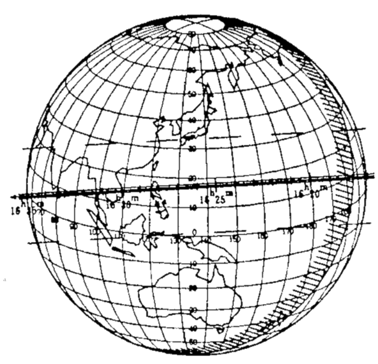
SAO 99946 by Thalia 1989 Dec 8



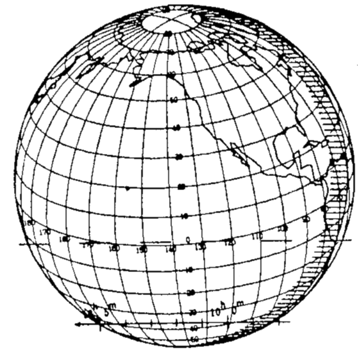
Anonymous by Lucina 1989 Dec 8



SAO 93075 by Hamburga 1989 Dec 9

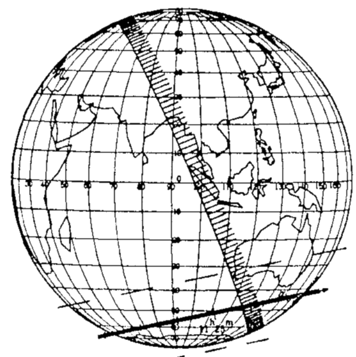


SAO 96055 by Sibylla 1989 Dec 9

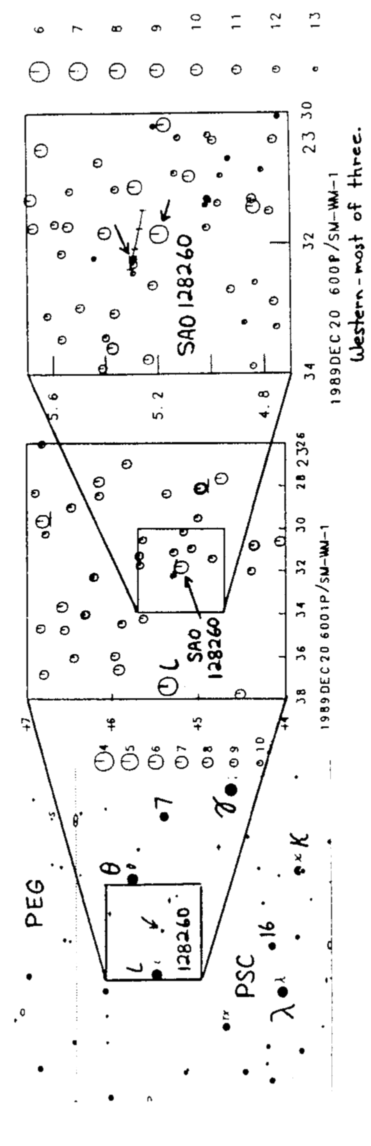


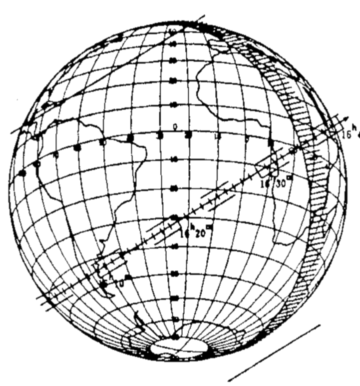
SAO 78505 by Jupiter 1989 Dec 13

SAO 111234 by Aeria 1989 Dec 13

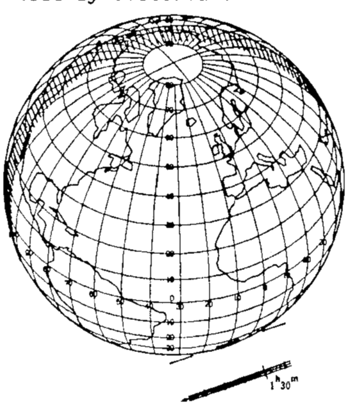


+0° 4980 by Victoria 1989 Dec 15

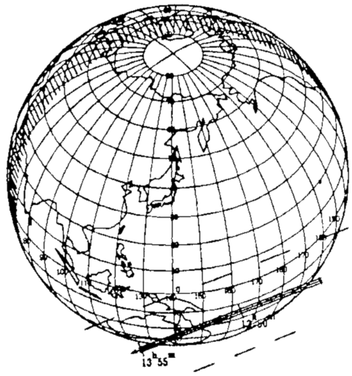


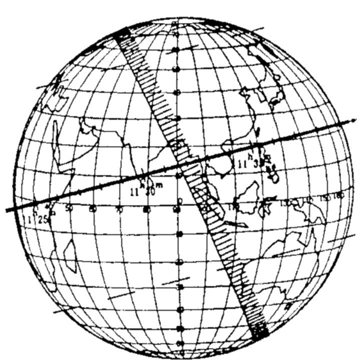
SAO 189216 by Venus 1989 Dec 15



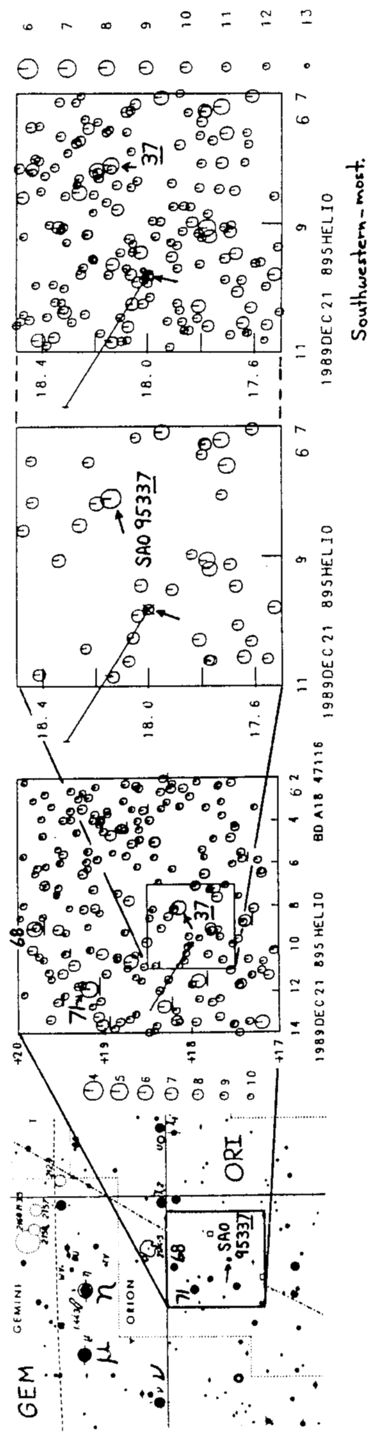
SAO 39960 by Aegle 1989 Dec 16

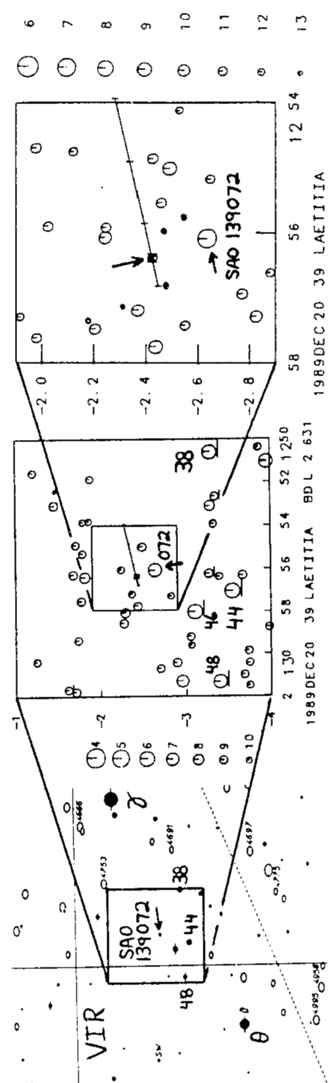


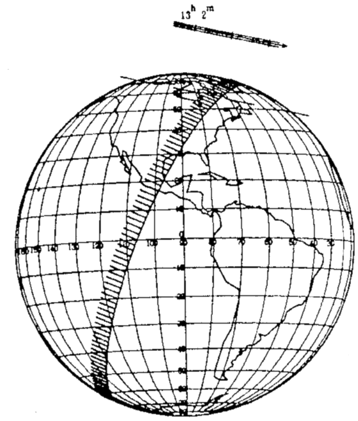
+43° 1164 by Aegle 1989 Dec 16

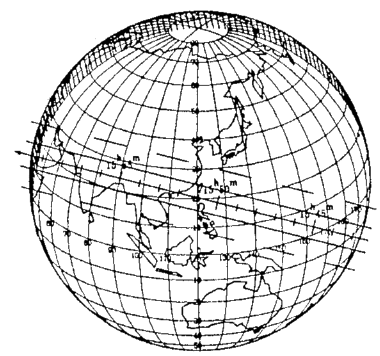


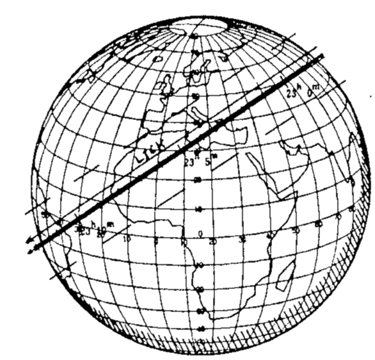
Anonymous by P/SM-WM-1 1989 Dec 20

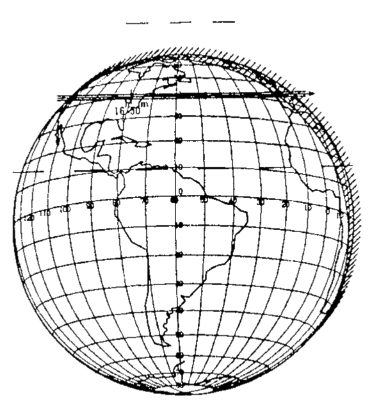


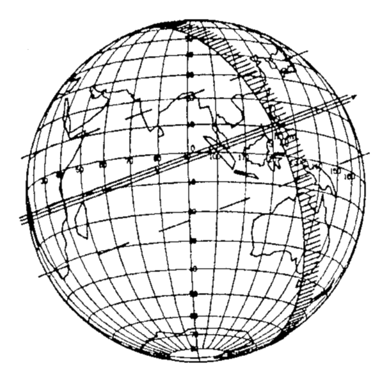





L 2 631 by Laetitia 1989 Dec 20


A2641396 by Ceres 1989 Dec 20


A1847116 by Helio 1989 Dec 21


SAO 143026 by Siegena 1989 Dec 22


SAO 164807 by Psyche 1989 Dec 24

## IOTA PLANS TO OBSERVE UPCOMING SOLAR ECLIPSES

David W. Dunham

*Total Eclipse, 1990 July 22:* Problems with this eclipse are described by Edward Brooks in his article on p. 138 of the 1988 August issue of *Sky and Telescope*. Two IOTA efforts are planned for this eclipse, one to southern Finland by IOTA/ES and the other to northern Siberia with Soviet astronomers. If you are interested in joining the IOTA/ES effort, contact Hans-Joachim Bode at the address on p. 289 or telephone him in Hannover, German Federal Republic, at 49-511-424696. The 1990 ESOP meeting will probably be held in Finland just before or after the eclipse.

The entire eclipse path in the Soviet Union is restricted for travel by foreigners. However, Nickolai Kuznetsov, Foreign Relations Department of the Astronomical Council of the Academy of Sciences of the U.S.S.R. (see p. 295), is coordinating all requests by foreign groups and individuals who want to observe the eclipse in the U.S.S.R., and so far, these requests have been reviewed favorably and none have yet been denied. I said that American IOTA members would work with the Kiev University Observatory expedition, which will also observe near the path edges to try to measure the solar diameter, perhaps in the Taymyr Peninsula area. But Kuznetsov indicated a region farther east, near Cherskiy, as a region likely for foreign observers. He said that the mosquitoes and other insects in northern Siberia in July are so fierce that netting and tents do not provide adequate shelter, so he is trying to locate buildings where observers could stay during the nights just before and/or just after the eclipse. Since there are not very many buildings, observers may need to be spread over a considerable distance in longitude. Kuznetsov is visiting the eclipse zone this summer to work out as much of the logistics as possible. He notes that the fare on Aeroflot from Moscow to Magadan and return is 500 rubles, and that a helicopter that holds about 10 people and their supplies rents for 750 rubles an hour. Americans could save considerable costs by flying from Alaska direct to Siberia. Alaskan Airlines is working on arrangements for this, with some flights from Nome to Provideniya, that may start this summer, and are expected to be operating semi-regularly next summer. If this can be arranged, Aeroflot has flights from Provideniya to Magadan and to Anadyr. Anadyr is quite close to the eclipse path.

If you are interested in taking a chance with the clouds for a most unusual eclipse outing to Siberia, send me your name and that of others who may accompany you, along with a list of equipment (with serial numbers) that you plan to bring (see start of IOTA NEWS for my address and phone). Try to do this within a month of the postmark of this issue, so that I can send (or hand-deliver in October) comprehensive information to Kuznetsov, who in turn needs it soon to work out the logistics and customs clearance.

*Annular Eclipse, 1991 January 15:* This eclipse will be visible just after sunrise in the southwestern corner of Australia. The altitude will be higher in Tasmania, and higher still in New Zealand. David Herald, Woden, A.C.T., will probably coordinate the activities in Australia, while Graham Blow will likely coordinate observations at both limits in New Zealand. Paul Maley is working on arrangements to observe from New Zealand; contact him at 15807 Brookvilla; Houston, TX 77059; phone 713,488-6871 if you are interested in participating. I notice that a very favorable occultation of a 9th-mag. star by (216) Kleopatra that should be visible from a large part of the U.S.A. will take place 3.2 days after the eclipse.

*Total Eclipse, 1991 July 11:* This eclipse has understandably generated much interest, with most observers heading for Hawaii and Baja California. I understand that all of the hotel rooms in Baja have already been reserved by various travel agencies, and accomodations in Hawaii are also going fast. I have not heard of anyone planning to attempt IOTA's path-edge observations of Baily's beads for solar diameter measurement from Hawaii, other than some Australian members, who will get as close to the limits as they can there. If you are intersted in joining that effort, contact me or David Herald, P.O. Box 254; Woden, A.C.T. 2606; Australia; telephone 61-62-319214. Steve Edberg is organizing an international amateur convention to be held in La Paz, Baja California, before the eclipse. If anyone going to Baja (joining one of the groups that have reserved all of the hotel rooms, or planning to camp out there) is interested in observing Baily's beads from locations near the northern limit, I would be interested in hearing from him. I have detailed maps of the areas crossed by the northern limit in Baja.

IOTA's main effort will be from the Mexican mainland Pacific coast, where weather prospects are still rather good (about 25% cloudcover, much of which is convective and would likely dissipate as the Sun is covered). This is the first area where the southern limit can be reached on land, near Puerto Vallarta. We will hold an international IOTA convention in Puerto Vallarta July 8 and 9; it might be joined by an ESOP meeting. Puerto Vallarta is a major resort with many hotels, so securing accommodations should not be as difficult as in Baja California. We have not yet contacted any travel agencies for airline connections, hotels, and rental cars, but will start working on these details soon, and will announce them when they are determined. The northern limit passes near Mazatlan, so northern-limit observers may want to stay there on July 10 and 11. A good Pleiades passage will be visible from Mexico the morning of July 8th, so travellers should plan to arrive no later than the 7th. I have not had time to calculate predictions or graze paths for the passage yet, which could affect just where we want to be during that event. If you are interested in joining IOTA's effort for this eclipse, contact Paul Maley, address and phone given above. We will also be working with Guillermo Mallen in Mexico City for this eclipse.