# Occultation Newsletter

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## FROM THE PUBLISHER

For subscription purposes, this is the fourth and final issue of 1988.

If you wish, you may use your VISA or MasterCard for payments to IOTA; include account number, expiration date, and signature, or phone order to 312,584-1162; if no answer, try 906,477-6957.

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| IOTA membership dues, including *O.N.* and any supplements | |
| for U.S.A., Canada, and Mexico | $17.00 |
| for all others to cover higher postal rates | 22.00 |
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| by surface mail | |
| for U.S.A., Canada, and Mexico[2] | 14.00 |
| for all others | 14.00 |
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| for area "A"[4] | 16.00 |
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There are sixteen issues per volume, all still available.

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

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

Asteroidal occultation supplements will be available at extra cost: for South America through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand through Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all ather areas will be available from Jim Stamm (11781 N. Joi Drive; Tucson, AZ 85737; U.S.A.) by surface mail at the low price of 1.18 or by air (AO) mail at 1.96

Observers from Europe and the British Isles should join IOTA/ES, sending DM 40.-- to the account IOTA/ES; Bartold-Knaust Strasse 8; 3000 Hannover 91; Postgiro Hannover 555 829 - 303; bank-code-number (Bankleitzahl) 250 100 30. Full membership in IOTA/ES includes the supplement for European observers (total and grazing occultations) and minor planet occultation data, including last-minute predictions, when available.

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

## IOTA NEWS

David W. Dunham

The 1988 annual meeting of IOTA was held at the Lunar and Planetary Institute on November 12th, as planned and as announced on p. 215 of the last issue. The executive secretary's report of the meeting is given on p. 248.

*Dues Increase.* The main business item was discussion of another dues increase, made necessary by the increase in size of *O.N.* issues and postal rates during the past year. When each of the last four issues was paid for, the secretary-treasurer had to give IOTA a loan to prevent a negative bank balance, as documented in his report presented to the meeting. The new rates, designed to reflect the current and anticipated cost of producing *O.N.* (under the old rate schedule, IOTA members were subsidizing non-members who subscribed to *O.N.*), were unanimously approved, and are given in "From the Publisher" in the left-hand column on this page. These rates will also be given in my lunar occultation highlights article in the January issue of *Sky and Telescope*. We apologize for any inconvenience to readers of the 1989 R.A.S.C. Observer's Handbook, which again gives the old rates since their deadline was in August, before we had decided on the new rates. As of the date of the IOTA meeting, they will have to pay the new rates quoted here.

*Next IOTA Meeting; Secretary-Treasurer Needed.* The date for the next IOTA meeting has not been set, but it will probably be held sometime during the last three months of 1989. It will be special, since it will be an election meeting. Some change is in store, since the secretary-treasurer does not plan to run for re-election. We need a volunteer for this important position, which serves as the main public contact point for IOTA. Some flexibility in the arrangements are possible (such as, there could be a secretary and a treasurer), and an interim appointment (for 1 year) could be made, although we would prefer someone willing to commit to the usual 3-year term. At the moment, the job is partly split up, with Derald Nye (Tucson, AZ) maintaining IOTA's computer records and Joseph Senne (Rolla, MO) calculating graze predictions for special requests and for new members. Nye and Senne are willing to continue with their current jobs, but others who have PCs and interest in doing this work are welcome. The main job of the secretary-treasurer then is to answer letters (mainly, sending introductory information to new and prospective members, and sending

IOTA publications, including back issues of *O.N.*, to those who send payment for them), maintain IOTA's bank account (depositing checks and paying bills, mainly for *O.N.* and for reimbursing graze computors' mailing expenses), periodically send lists of updates to Nye and Senne, and communicate special graze prediction requests to Senne. The secretary-treasurer should reside in the U.S.A. A secretary in Arizona could interact more easily with Nye, but this is hardly a requirement, since the current arrangement with the secretary-treasurer in Illinois has worked quite well. Someone with an IBM-compatible PC could combine the secretary's work with either Nye's and/or Senne's job, which would result in some efficiencies. If you have any interest or willingness to do any part of this work, please contact me at 7006 Megan Lane; Greenbelt, MD 20770; telephone 301,474-4722. H. F. DaBoll plans to continue as *Occultation Newsletter* editor for the indefinite future, and we are all indebted to him for this and for his superb work as secretary-treasurer.

*U.S. Naval Observatory Predictions for 1989 Total Lunar Eclipses.* Occultations of numerous faint stars can be timed during the total lunar eclipses that will occur next year, the first being on February 20th visible from Asia, Australia, and the Pacific, the second being on August 17th, visible from the Americas, Europe, Africa, and Antarctica. In early January, I will prepare a special star catalog, called the L catalog, consisting of stars in these eclipse fields to about 12th magnitude derived from Astrographic Catalog (A.C.) data, as well as about 20,000 stars from the Lick Voyager catalogs down to 11th magnitude that are not in the XZ catalog. David Herald has provided me with southern A.C. data covering the August eclipse field. If you want to receive L-catalog predictions, contact me at the address or phone given above, giving either your USNO address and station codes, and desired observability-code limit, or equivalently, your accurate geographical coordinates and the largest telescope that you plan to use. We plan to include a chart of the February 20th star field in the next issue of *O.N.*, which will probably be mailed very early that month. In addition to the L catalog predictions, I will also compute C catalog predictions, since the C catalog includes Praesepe stars down to mag. 11.5.

*IOTA/ES Meeting and Plans.* Dr. Eberhard Bredner, secretary of IOTA/ES, distributed a short report of a meeting they held in Hannover, also on November 12th. Cooperation with the European Asteroidal Observation network was discussed (also see p. 237).

The 1989 European grazing occultation supplement is being distributed along with this issue, and will also be distributed by IOTA/ES. Europeans who do not already have a copy can obtain one from IOTA/ES. Others can request copies from IOTA, at the address given in the masthead, free for IOTA members (although a SASE with 2-ounce postage from members in the U.S.A. would be appreciated, and costing $1.25 for others.

The following IOTA/ES meetings and trips are planned:

1989 late Feb., a small meeting perhaps near Darmstadt, where a Giotto Science Working Team meeting that I will attend will be held (exact date not known).

1989 May 5, Hannover, training meeting on solar eclipse observations.

1989 July 3, U.S.A. (perhaps California), to record the occultation of a 5.8-mag. star by Saturn.

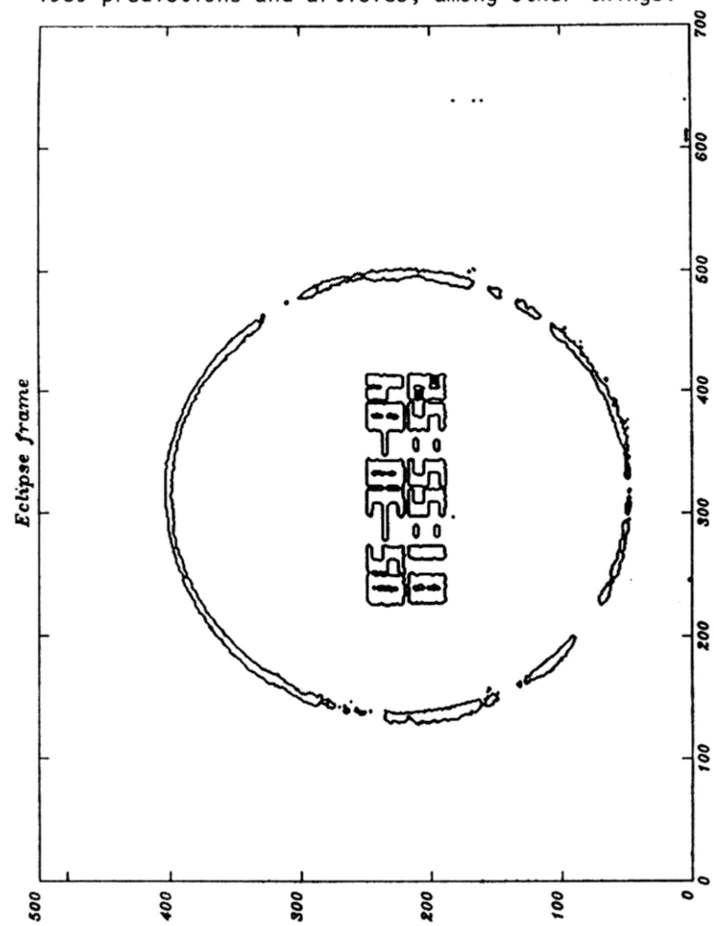
1989 Sept. 2/3, Freiburg (Black Forest), 8th European Symposium on Occultation Projects (ESOP VIII), with General Assembly on Sept. 1.

1990 July, Finland, total solar eclipse.

1991 July, Mexico, total solar eclipse.

*Business Trips to Germany, U.S.S.R., and Japan.* My next overseas trip, to the German Federal Republic in late February, is noted above. During early April, Dr. R. Farquhar and I will spend two weeks in Moscow as guests of the Space Research Institute; it will be my first trip to the Soviet Union. I hope to be able to arrange brief side trips to Kiev University Observatory and to the Institute of Theoretical Astronomy in Leningrad, to see the occultation work that is being conducted there. My next trip to Japan, to the Institute of Space and Astronautical Sciences near Tokyo for a meeting about the Geotail spacecraft, is now scheduled for early June. I am not happy with that, since on June 7th, I want to observe the very favorable lunar Praesepe passage from either Sicily or southern Greece.

*Pallas Paper Schedule and Other Analyses.* Unfortunately, work on the 1983 Pallas occultation paper noted on p. 217 was delayed by the need to prepare 1989 predictions and articles, among other things.



Most of the prediction work will be finished by mid-December, and I have completed the main new analysis and gathered the necessary information needed to finish the manuscript, which I will try to accomplish by the end of the year. Other analyses and papers will follow after the next issue of *o.n.* and L-catalog prediction distribution noted above, with completion of the 1987 Sept. eclipse analysis and paper first (Isao Sato, who photographed Baily's beads during that eclipse near Okinawa, is working on that analysis, also, and wants to join the publication with IOTA and Shanghai Observatory astronomers). Later, we need to complete analyses and prepare papers about the lunar polar diameter from the 1985 May lunar eclipse grazes of Zubenelgenubi; other asteroid occultations and summary article; and, eventually, complete analysis of the 1984 May 30th eclipse. Concerning the 1984 eclipse, the figure is a digitization of a frame from Alan Fiala's videorecording of that eclipse, using equipment on loan as a demonstration to USNO and run by Richard Schmidt. Hardcopy figures like this facilitate measurement of position angles and identification of beads caused by Watts features that may be present in other video records.

## 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. This is a new address, and it is different from some that I have supplied recently. The problem is that the post office box is only open during working hours, and I seem to be working at those times. Consequently, the only way to be sure that I receive reports in a timely fashion (assuming that you send them to me in time for these semi-annual summaries) is to use our home address, and that is what I will use for all IOTA purposes. Names and addresses of regional coordinators are given in "From the Publisher" on *Occultation Newsletter's* front page.

I have summarized all of the reports that I have received for the second half of 1987 in the following two tables and section of notes. Table 1 lists the 1987 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 which included positive observations, or other significant information which could not be reported in the tables. I am not including notes on those observations which 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.

Roland Boninsegna reports that the GEOS section has ceased to exist. The group decided to close the section at a Paris meeting last April. The network of observers will remain intact, however; only the name will be changed. Charts and information still will be sent to those involved in the occultation work.

Table 1. Asteroidal appulses and occultations - July through December 1987.

| 1987 | ASTEROID | STAR | OBSERVERS | REF |
|---|---|---|---|---|
| Jul 7 | 1175 MARGO | AGK3 +09° 3071 | Sc | |
| Jul 18 | 2893 1975qd | SAO 189192 | StGiGkPi | |
| Jul 21 | 628 CHRISTINE | SAO 186544 | PaBiLiLl | |
| Jul 23 | 739 MANDEVILLE | SAO 165095 | BeFcSuLb | |
| Jul 26 | 74 GALATEA | SAO 145932 | CjScAnBm | |
| Jul 28 | 313 CHALDAEA | SAO 93872 | Fm | |
| Jul 29 | 696 LEONORA | SAO 209002 | Sc | |
| Jul 31 | 2797 TEUCER | AGK3 +13° 0320 | Gi | |
| Jul 31 | 1263 VARSAVIA | AGK3 +02° 2704 | Ln | |
| Jul 31 | 302 CLARISSA | AGK3 +01° 0061 | BkGkHoMtPiSn TfWh | |
| Aug 5 | 203 POMPEJA | SAO 188689 | MqBoKeHuHcHk AnBiScBmBy | |
| Aug 7 | 535 MONTAGUE | SAO 188754 | HtSc | |
| Aug 7 | 524 FIDELIO | SAO 189514 | Lo | |
| Aug 8 | 481 EMITA | AGK3 +22° 0521 | SnSw | |
| Aug 8 | 56 MELETE | SAO 92414 | Ht | |
| Aug 15 | 68 LETO | SAO 210421 | FlBb | |
| Aug 18 | 267 SILESIA | SAO 146881 | LoHt | |
| Aug 24 | 472 ROMA | AGK3 -00° 0360 | Sc | |
| Aug 30 | 247 EUKRATE | SAO 213992 | Hl | * |
| Aug 31 | 8 FLORA | SAO 190239 | SqMcTd | |
| Sep 6 | 1701 OKAVANGO | SAO 229435 | CpErKnDkSpGd | |
| Sep 8 | 74 GALATEA | SAO 145609 | 14 Observers | 1 |
| Sep 10 | 284 AMALIA | SAO 161203 | CpOvDkSpGySm GdMd | |
| Sep 12 | 1679 NEVANLINNA | AGK3 +01° 0080 | Vn | |
| Sep 13 | 585 BILKIS | SAO 146144 | WdScAn | |
| Sep 16 | 45 EUGENIA | SAO 159661 | Gd | |
| Sep 19 | 585 BILKIS | SAO 146105 | SiHtAn | |
| Sep 19 | 554 PERAGA | SAO 187198 | SiHtAn | |
| Sep 20 | 171 OPHELIA | 12.1 mag. | Sv | |
| Sep 24 | 347 PARANIA | SAO 159553 | ChCpKnSh | |
| Sep 27 | 393 LAMPETIA | AGK3 +13° 0488 | StFhHaLlAv | |
| Sep 27 | 505 CAVA | AGK3 +20° 0989 | St | |
| Sep 28 | 489 COMACINA | AGK3 +06° 0418 | BnBuDbGiGsMl | |
| Sep 28 | 53 KALYPSO | SAO 164633 | An | |
| Sep 29 | 442 EICHSFELDIA | AGK3 +10° 0359 | Ln | |
| Sep 29 | 1796 RIGA | AGK3 +02° 0275 | Gy | |
| Oct 4 | 1870 GLAUKOS | SAO 164486 | StLn | |
| Oct 8 | 2180 MARJALEENA | AGK3 +04° 3065 | Lo | |
| Oct 8 | 441 BATHILDE | AGK3 +22° 0198 | KlMe | |
| Oct 16 | 57 MNEMOSYNE | SAO 143337 | BmBr | |
| Oct 18 | 78 DIANA | SAO 186957 | St | |
| Oct 19 | 472 ROMA | SAO 130628 | Ss | |
| Oct 21 | 187 LAMBERTA | SAO 189898 | Ss | |
| Oct 25 | 8 FLORA | SAO 190319 | Ss | |
| Oct 26 | 1331 SOLVEJG | SAO 185831 | Gg | |
| Nov 1 | 49 PALES | SAO 163450 | ScAn | |
| Nov 1 | 586 THEKLA | SAO 186591 | ScAn | |
| Nov 2 | 51 NEMAUSA | AGK3 +02° 0221 | StBh | |
| Nov 5 | 1 CERES | C28 14856 | Lo | |
| Nov 6 | 683 LANZIA | AGK3 +24° 0014 | StBhBzGuMe | |
| Nov 8 | 202 CHRYSEIS | SAO 129017 | CpOvSm | |
| Nov 13 | 1459 MAGNYA | SAO 191428 | St | |
| Nov 13 | 503 EVELYN | AGK3 +18° 0298 | GuMeMiVd | |
| Nov 13 | 313 CHALDAEA | AGK3 +04° 0777 | StGvVn | |
| Nov 15 | 74 GALATEA | SAO 164852 | StLn | |
| Nov 17 | 55 PANDORA | AGK3 +33° 0689 | Bo?? | |
| Nov 24 | 325 HEIDELBERGIA | SAO 56709 | CpGb | |
| Nov 25 | 1546 IZSAK | AGK3 +00° 0917 | StFmLn | |
| Nov 25 | 2060 CHIRON | 12.2 mag. | Ln | |
| Dec 2 | 387 AQUITANIA | AGK3 +00° 0483 | Vn | |
| Dec 2 | 675 LUDMILLA | AGK3 +21° 0722 | Ht | |
| Dec 5 | 234 BAMBERGA | AGK3 +05° 1109 | HtAn | |
| Dec 6 | 487 VENETIA | AGK3 +05° 1716 | IcSn | |
| Dec 8 | 324 BAMBERGA | AGK3 +40° 0783 | MpMv | * |
| Dec 11 | 160 UNA | AGK3 +29° 0563 | 17 Observers | 2 |
| Dec 16 | 250 BETTINA | SAO 61705 | Vn | |
| Dec 17 | 130 ELEKTRA | BD 0 2065 | Lo | |
| Dec 18 | 679 PAX | AGK3 +21° 1117 | Ln | |
| Dec 19 | 26 EMITA | SAO 59964 | 19 Observers | 3 |
| Dec 21 | 152 ATALA | AGK3 +37° 0887 | Sn | |
| Dec 22 | 32 POMONA | AGK3 +06° 0106 | Ly | |
| Dec 27 | 375 URSULA | AGK3 +11° 2968 | Ma | |

Table 2. Observers and locations of reported events: July - December 1987.

| ID | OBSERVER | TOWN | COUNTRY | GROUP | No. |
|---|---|---|---|---|---|
| ?? | ?? | CHARTERS TOWERS | QUEENSLAND - AUS | RASNZ | 1 |
| Av | ALVARADO, F. | VINA | CHILE | LIADA | 1 |
| An | ANDERSON, PETER | MELBOURNE | QUEENSLAND - AUS | RASNZ | 9 |
| Bl | BALL, LINDSAY | BRISBANE | QUEENSLAND - AUS | RASNZ | 1 |
| Bh | BARTHES, J. | CASTRES | FRANCE | GEOS | 3 |
| Bo | BARTHOLOMEW, J. | ROCKHAMPTON | QUEENSLAND - AUS | RASNZ | 2 |
| Bb | BEGBIE, R. | HARARE | SOUTH AFRICA | ASSA | 1 |
| Bm | BEMBRICK, COL | SYDNEY | N.S.W. - AUS | RASNZ | 3 |
| Bk | BERTOLI, O. | TORINO | ITALY | GEOS | 3 |
| Bp | BIANCHI, M. | MASSA | ITALY | GEOS | 1 |
| Bn | BONINSEGNA, R. | DOURBES | BELGIUM | GEOS | 1 |
| Bx | BORRAS, V. | BENICARLO | SPAIN | GEOS | 1 |
| Bu | BOURGEOIS, J. | CINEY | BELGIUM | GEOS | 1 |
| Bz | BOURGEOIS, J. | PIC-DU-MIDI | FRANCE | GEOS | 1 |
| Br | BRADFORD, GREG | SYDNEY | N.S.W. - AUS | RASNZ | 1 |
| Bi | BRARDA, SUSANA | CALAMUCHITA | ARGENTINA | LIADA | 1 |
| Be | BRETONES, PAULO | CAMPINAS | BRAZIL | LIADA | 1 |
| By | BYRON, JEFF | SYDNEY | N.S.W. - AUS | RASNZ | 1 |
| Cs | CASAS, R. | SABADELL | SPAIN | GEOS | 2 |
| Ch | CHURMS, JOE | CAPE TOWN | SOUTH AFRICA | ASSA | 1 |
| Cj | CLARK, MIKE | LAKE TEKAPO | NEW ZEALAND | RASNZ | 1 |
| Cy | CLUYSE, L. | TIELT | BELGIUM | GEOS | 1 |
| Cp | COOPER, TIM | EAST RAND | SOUTH AFRICA | ASSA | 5 |
| Dk | DE KLERK, J. | POTCHESFSTROOM | SOUTH AFRICA | ASSA | 2 |
| Dt | DENTEL, M. | BERLIN | EAST GERMANY | GEOS | 1 |
| Db | DERBORD, T. | PARTHENAY | FRANCE | GEOS | 1 |
| Er | EARLE, G. | EAST RAND | SOUTH AFRICA | ASSA | 1 |
| Ew | EWALD, D. | BIESENTHAL | EAST GERMANY | GEOS | 1 |
| Fh | FILHO, ANTONIO | RIO DE JANEIRO | BRAZIL | LIADA | 1 |
| Fl | FLEET, R. | HARARE | SOUTH AFRICA | ASSA | 1 |
| Fc | FRANCA, C. | CAMPINAS | BRAZIL | LIADA | 1 |
| Fm | FREEMAN, TONY | BERKELEY | CALIFORNIA - USA | ARP | 2 |
| Fs | FRISONI, C. | BOLOGNA | ITALY | GEOS | 1 |
| Go | GALLO, V. | SALERNO | ITALY | GEOS | 1 |
| Gb | GARBENI, G. | JOHANNESBURG | SOUTH AFRICA | ASSA | 1 |
| Gi | GARCIA, J. | LISBOA | PORTUGAL | GEOS | 6 |
| Gd | GARDE, T. | SHURUGWE | SOUTH AFRICA | ASSA | 3 |
| Gn | GENOVESE, M. | TORINO | ITALY | GEOS | 1 |
| Gg | GEORGE, DOUG | OTTAWA | ONTARIO - CAN | ARP | 1 |
| Gy | GEYSER, M. | PRETORIA | SOUTH AFRICA | ASSA | 2 |
| Gl | GIGLI, P. | PISTOIA | ITALY | GEOS | 2 |
| Gk | GONCALVES, R. | LISBON | PORTUGAL | GEOS | 3 |
| Gv | GRAHAM, F. | PITTSBURG ? | PENN. - USA | ARP | 1 |
| Gr | GRENESE, A. | ALGHERO | ITALY | GEOS | 1 |
| Gs | GROS, C. | BESANCON | FRANCE | GEOS | 2 |
| Gt | GRUNNET, C. | COPENHAGEN | DENMARK | GEOS | 1 |
| Gu | GUESSE, M. | NOUAKCHOTT | MAURITANIA | GEOS | 4 |
| Ha | HARRIS, LUIS | PANAMA | PANAMA | LIADA | 1 |
| Hn | HENSHAW, COLLIN | INDIAN OCEAN | SOUTH AFRICA | ASSA | 1 |
| Hc | HICKEY, TERRY | WOODFORD | QUEENSLAND - AUS | RASNZ | 1 |
| Hk | HICKEY, DAVID | REDCLIFFE | QUEENSLAND - AUS | RASNZ | 1 |
| Ho | HOLLER, G. | GRAZ | AUSTRIA | GEOS | 2 |
| Hl | HOLM, RICHARD | PAHOA | HAWAII - USA | APR | 1 |
| Ht | HUTCHEON, STEVE | SHELDON | QUEENSLAND - AUS | RASNZ | 7 |
| Hu | HUTCHEON, STEVE | GUNALDA | QUEENSLAND - AUS | RASNZ | 1 |
| Ic | IACOVONE, N. | TORINO | ITALY | GEOS | 1 |
| Ke | KEARNEY, P. | BUNDABERG | QUEENSLAND - AUS | RASNZ | 1 |
| Kn | KNIGHT, J. | EAST RAND | SOUTH AFRICA | ASSA | 2 |
| Kl | KOHL, M. | USTER | SWITZERLAND | GEOS | 1 |
| Ln | LANGHANS, T. | SAN BRUNO | CALIFORNIA - USA | ARP | 7 |
| Li | LICANDRO, JAVIER | MONTEVIDEO | URAGUAY | LIADA | 1 |
| Ll | LILLER, WILLIAM | VINA | CHILE | LIADA | 2 |
| Lo | LOADER, BRIAN | CHRISTCHURCH | NEW ZEALAND | RASNZ | 5 |
| Lb | LOBO, JULIO | CAMPINAS | BRAZIL | LIADA | 1 |
| Ly | LYZENGA, GREG | ALTADENA | CALIFORNIA - USA | ARP | 1 |
| Mq | MACDONALD, A. | TOWNSVILLE | QUEENSLAND - AUS | RASNZ | 1 |
| Ms | MAKSYMOWICZ, S. | MEZIERES | FRANCE | GEOS | 1 |
| Mp | MANLY, PETE | CENTRAL | ARIZONA - USA | ARP | 1 |
| Mv | MANLY, PATRICK | CENTRAL | ARIZONA - USA | ARP | 1 |
| Mr | MARCH, M. | MATARO | SPAIN | GEOS | 1 |
| Mt | MARTI, J. | MATARO | SPAIN | GEOS | 2 |
| Ma | MARTINEZ, P. | TOULOUSE | FRANCE | GEOS | 1 |
| Me | MEUDON OBSERV. | MEUDON | FRANCE | GEOS | 3 |
| Mc | MICHON, J.-P. | HERMENT | FRANCE | GEOS | 2 |
| Mi | MIDDLETON, R.W. | COLCHESTER | UNITED KINGDOM | GEOS | 1 |
| Ml | MORILLON, E. | POITIERS | FRANCE | GEOS | 2 |
| Md | MULDER, R. | THABAZIMBI | SOUTH AFRICA | ASSA | 1 |
| Mz | MUNOZ, P. | SABADELL | FRANCE | GEOS | 1 |
| Mu | MURRAY, TONY | GEORGETOWN | GEORGIA - USA | ARP | 1 |
| Nz | NEZEL, MICHAEL | BREMEN | WEST GERMANY | GEOS | 1 |
| Ov | OVERBEEK, DANIE | EAST RAND | SOUTH AFRICA | ASSA | 2 |
| Pa | PAOLANTONIO, S. | SANTE FE | ARGENTINA | LIADA | 1 |
| Pu | PINEAU, F. | TOURS | FRANCE | GEOS | 1 |
| Pi | PIRITI, J. | NAGYKANIZSA | HUNGARY | GEOS | 4 |
| Rc | RICCABONE, G. | TORINO | ITALY | GEOS | 1 |
| Sh | SCHILLER, D. | EAST RAND | SOUTH AFRICA | ASSA | 1 |
| Sn | SCHNABEL, C. | BARCELONA | SPAIN | GEOS | 6 |
| Sv | SCHNABEL, C. | MURA | SPAIN | GEOS | 1 |
| Sk | SCHOENMAKER, A. | RODEN | NETHERLANDS | GEOS | 1 |
| Sw | SCHWAENEN, J. | MARCINELLE | BELGIUM | GEOS | 1 |
| Sm | SMIT, J. | PRETORIA | SOUTH AFRICA | ASSA | 2 |
| Sc | SMITH, CHARLIE | WOODRIDGE | QUEENSLAND - AUS | RASNZ | 9 |
| Si | SMITH, CHARLIE | MT. TAMBOURINE | QUEENSLAND - AUS | RASNZ | 2 |
| Su | SOUZA, M. | CAMPINAS | BRAZIL | LIADA | 1 |
| Sp | SPOELSTRA, J. | POTCHEFSTROOM | SOUTH AFRICA | ASSA | 2 |
| Sq | STAMM, JIM | OLD LYME | CONN. - USA | ARP | 1 |
| Ss | STAMM, JIM | LEXINGTON | KENTUCKY - USA | ARP | 3 |
| St | STAMM, JIM | LONDON | KENTUCKY - USA | ARP | 11 |
| Sz | SZABO, S. | SZOMBATHELY | HUNGARY | GEOS | 2 |
| Ts | TESI, L. | PISTOIA | ITALY | GEOS | 1 |
| Td | TODONI, P. | ORVIETO | ITALY | GEOS | 1 |
| Tf | TOFOL, T. | BARCELONA | SPAIN | GEOS | 1 |
| Tp | TULIPANI, F. | BOLOGNA | ITALY | GEOS | 1 |
| Vs | VAISSIERE, F. | ST GENEST-L | FRANCE | GEOS | 1 |
| Vd | VIDAL, J. | MONEGRILLO | SPAIN | GEOS | 2 |
| Vg | VIGIL, E. | SABADELL | SPAIN | GEOS | 1 |
| Vn | VINSON, ED | DUNCAN | OKLAHOMA - USA | ARP | 4 |
| Wh | WIESENHOFER, W. | GRAZ | AUSTRIA | GEOS | 2 |
| Wd | WILDS, RICHARD | MAYETTA | KANSAS - USA | ARP | 1 |
| Zp | ZAPATA, P. | SABADELL | SPAIN | GEOS | 1 |

Notes:

1. Observers were MuNzCsCyGiGnGrMrMtMcRcSnSkVs. Michon recorded a disappearance at 01:14:15.4 (lasting 2-3 seconds), and a reappearance at 01:14:42.1, under good observing conditions.
2. Observers were BhBkDtEwFsGoGiGlTsGkGtGuHoPiSzTp Wh.
3. Observers were HnBkBpBxCsGiGlGsGuMsMlMzVgPuPiSn SzVdZp.

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## GRAZING OCCULTATIONS

Don Stockbauer

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

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; U.S.A. (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.

Ron Dawes and Rick Frankenburger of San Antonio, Texas, have written a program which allowed them to reduce their graze tapes and produce a plot of the El Nath graze (Oct. 12, 1987 near Tilden, Texas) using a home computer (*O.N. 4* (6), 143-146). Both they and Allen Gilchrist and I plan to modify the program to prompt for the remaining data that are requested on the IOTA/ILOC report form and automatically produce the machine-readable file which is equivalent to it (*O.N. 4* (5), 92-97). Capturing the timings for later inclusion in the report file eliminates a major portion of the drudgery associated with being an expedition leader. The last major manual operation which has resisted automation is the scaling of coordinates, and even this could be accomplished if one has access to a high-resolution mouse system. Dawes and Frankenburger are also working on software to use the output of their software and the USNO OCC program to automate the production of reduction profiles such as those periodically done in *O.N.* by Robert Sandy (*O.N. 4* (8),192), Robert Bolster (*O.N. 4* (5), 109), Toshio Hirose (*O.N. 4* (9), 223), and others. Quality assurance becomes easy with the automated reduction of all graze observations, and David Dunham could then update the prediction databases (especially the Watts lunar limb data) with all well-observed graze profiles instead of the infrequent correction of glaring discrepancies as is now the case. I will continue to report on the progress of these highly significant projects.

| Date | V/P | Star # | Mag | % Snl | CA | Location | # Sta | # Tm | S S | Ap Cm | Organizer | C | St | WA | b |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | | | | | | | | | | | | | | | |
| 0527 | | 1925 | 1.2 | 86+ | 21N | Itupeva,SP;Brazil | 2 | 17 | 1 | 11 | R. Lourencon | 2 | S | 19 | 32 |
| 0621 | | 1618 | 8.5 | 38+ | 9N | Elmont, KS | 1 | 0 | 1 | 33 | Richard P. Wilds | >5 | S | 11 | 6 |
| 0622 | | 1708 | 6.2 | 47+ | 15N | Lincolnville, KS | 1 | 0 | 1 | 33 | Richard P. Wilds | >2 | S | 16 | 18 |
| 0803 | | 0233 | 6.2 | 62- | 14N | Lk Ellesmere,N.Z. | 1 | 2 | 1 | 20 | Brian Loader | 4 | N | 344 | -51 |
| 0805 | | 0438 | 6.7 | 45- | 15N | Albergaria, Port. | 3 | 14 | 2 | 5 | Joaquim Garcia | 2 | N | 345 | -56 |
| 0806 | | X05019 | 9.7 | 36- | 13N | Pic du Midi,Frnce | 2 | 4 | 1 | 25 | H. J. J. Bulder | | | 348 | -60 |
| 0807 | | 0756 | 6.5 | 23- | 11N | Lockport,Manitoba | 1 | 1 | 1 | 20 | Patrick O'Connor | 1 | N | 348 | -61 |
| 0903 | | 0731 | 5.9 | 47- | 8N | Gower, MO | 3 | 17 | 1 | 15 | Robert Sandy | 0 | | 352 | -66 |
| 0903 | | 0731 | 5.9 | 47- | 8N | Elmont, KS | 5 | 32 | 1 | 6 | Richard P. Wilds | 0 | | 352 | -66 |
| 0905 | | 078483 | 7.6 | 29- | 9N | Palma, Portugal | 3 | 10 | 1 | 14 | Joaquim Garcia | 2 | N | 353 | -60 |
| 0907 | | 080239 | 8.9 | 12- | 8N | Jackson, MS | 1 | 2 | 1 | 33 | Benny Roberts | | | 358 | -41 |
| 0930 | | 0756 | 6.5 | 67- | 6N | Moordrecht, Neth. | 1 | 0 | 1 | 6 | Henk Bulder | 3 | S | 353 | -61 |
| 0930 | | 0756 | 6.5 | 68- | 6N | Gorredigk, Neth. | 1 | 4 | 1 | 11 | Adri A. Gerritsen | | | 353 | -61 |
| 1001 | | 0771 | 6.1 | 66- | 9N | Arraiolos,Portgl. | 3 | 20 | 2 | 14 | Joaquim Garcia | 2 | N | 345 | -64 |
| 1001 | | 0797 | 6.3 | 65- | 6N | Warren, Manitoba | 2 | 13 | 1 | 20 | Patrick O'Connor | 2 | N | 353 | -61 |
| 1001 | | 0810 | 1.8 | 64- | 9N | Estero, FL | 2 | 15 | 1 | 20 | Tom Campbell | 4 | N | 349 | -67 |
| 1002 | | 0996 | 6.8 | 52- | 3N | Chilocco, OK | 1 | 4 | 1 | 33 | Richard P. Wilds | 0 | | 358 | -61 |
| 1006 | | 098832 | 7.7 | 17- | 1N | Pickens, MS | 1 | 2 | 1 | 33 | Benny Roberts | 0 | | 4 | -20 |
| 1016 | | 185279 | 8.4 | 24+ | 12S | Webster, TX | 1 | 0 | 1 | 20 | Don Stockbauer | >3 | N | 172 | 74 |
| 1021 | | 3268 | 5.6 | 77+ | 17S | Shiro, TX | 11 | 35 | 1 | 11 | Don Stockbauer | 3 | S | 161 | 20 |
| 1106 | | 1792 | 7.1 | 9- | 13S | Rye, FL | 1 | 2 | 1 | 20 | Tom Campbell | 6 | N | 191 | 31 |

Dunham will ask each graze computor to send him his run's observer scan cards so that he or I might more easily notify expedition leaders of any recently observed shifts. The only system in place currently is the publication of the shift in *O.N.*; the lag here is 3 to 6 months, and this new system would get the word out much more quickly. This was agreed upon at the IOTA meeting and was inspired by Henk Bulder and Adri Gerritsen's request that their observed shift of Z.C. 756 (9 Sep 88, 0."3 S due to star position error) be disseminated to others.

The Tau Sagittarii graze expedition held in conjunction with the 1988 IOTA meeting obtained some data, but was mostly clouded out. 150 sites were spaced 30 feet apart over 4500 feet of road by expedition leader Paul Maley; only a few of the stations were not occupied. We hope better for our graze of Regulus November 30th, 50 miles south of Houston.

It is gratifying to learn that Harold Povenmire benefitted greatly from our El Nath graze at Genoa airport, Texas (Oct. 12, 1987) by applying the results to his Oct. 1, 1988 El Nath graze in Florida (Tom Campbell also observed from Florida's west coast). Using our prior results, he was able to favorably position all sites and obtain almost 200 timings. He chose the equivalent of Barbara Wilson's 24-event chord for himself (our best one), and got 19 timings (fewer due to the slightly different geometry), the most he has ever had in his long occultation career.

People often ask me what graze data are used for in order to justify the effort they put into them. There are standard answers, such as discovering stellar duplicity, studying variations in the solar radius, measuring possible changes in the gravitational constant "G," etc. Dennis di Cicco discusses some of these in his occultation article in the November issue of *Sky and Telescope*. I would be quite interested in hearing from anyone who is currently using grazing occultation data as a part of his research in order that I might write a paper on the utilization of the data by the astronomical community.

Thanks for the reports.

Errors and corrections:

Robert Sandy notes that his name was misspelled as leader of the Z.C. 1609 expedition at Sycamore, KS, on 1987 July 2 (*O.N. 4* (9), 222).

Also, in the same list, the graze of SAO 76345 on 1988 April 19 at Blue Ridge, MO should not appear, as it had been listed previously (*O.N. 4* (8), 191).

## MORE ON REPORTING OCCULTATIONS ON DISKETTE

David W. Dunham

The format and procedures for reporting occultation observations as ASCII files on IBM-PC-compatible floppy disks was given in my article in *O.N. 4* (5), pp.92-97, with some more comments given in *O.N. 4* (7), p. 164. The latter gives addresses of Peter Nelson in Australia and McPherson Morgan in New Mexico, who are willing to serve as regional coordinators of occultation times; that is, they will create files on floppy disks from ILOC report forms that others send them. They then will send copies of these to ILOC. Two more regional (national) coordinators are:

For Belgium: P. Vingerhoets; Chairman Occultations VVS; 20 Blokmakerstraat; B-2758 HAASDONK.

For German Federal Republic and IOTA/ES: Reinhold Büchner; Kiefweg 2; D-6370 Oberurfel 6. Besides creating the files, Mr. Büchner also has developed software to calculate accurate residuals of occultation timings, which he can also provide.

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## 1988 IOTA ANNUAL MEETING

Gary Nealis

The annual meeting of IOTA was held November 12, 1988, at the Lunar and Planetary Institute, Houston, Texas. Seventeen people attended.

David Dunham presented the organizational status. The treasurer's report indicated we had a negative net balance this year. A vote approved the following increases:

| | US,Canada,Mexico | Others |
|---|---|---|
| IOTA dues | from \$15 to \$17 | from \$20 to \$22 |
| *o.N.* subscription | from \$10 to \$14 | from \$9.84 to \$14 |

Of special interest to European observers were the suggestions that the European Section (ES) copy and distribute all appropriate forms since Don Stockbauer has significant mailing costs sending them to Europe. Also, it was recommended that Europeans join the ES to get predictions more reliably; see p. 243

The Internal Revenue Service has issued another ruling which apparently says that, if there is any sightseeing during an international trip, we can't deduct any expenses. They are publishing a 600-page "clarification."

It was strongly recommended that we document all expeditions, international and local, by any method, technical journals, astronomical magazines, society newsletters, local papers, and of course, *o.N.* Any of this documentation should include the name IOTA to help our tax status.

Paul Maley discussed planning for the November 13 Tau Sagittarii graze in Texas City. 150 sites were staked out and a good turnout and good weather were expected. Maps and site numbers were given out to attendees. Paul then left to give a training course to novices planning to join the graze. The graze was extremely well attended, but was partially clouded out.

Derald Nye and David Dunham gave short descriptions of the total.eclipse of March 1988 in Indonesia. The Bangka Island group got good northern limit data but was unlucky with the southern limit due to transportation problems; see *o.N.* 4 (8), 200. The Kalimantan (IOTA/ES) group got good southern limit data. Derald Nye took centerline video from the ship Golden Odyssey in the Celebes Sea. He showed some fantastic video later in the afternoon. What was surprising was the stability of the image taken from a ship at sea, although not stable enough to obtain very many bead timings other than 2nd and 3rd contacts.

Ron Dawes and Rick Frankenburger described their data reduction techniques on home computers. In 1½ years the San Antonio group has obtained 230 events in 6 grazes (or attempts). This includes 143 events during the El Nath graze in October 1987. They realized how time consuming manual reduction of graze tapes would be and each developed a similar program to let the computer do it; see *o.N.* 4 (16), 143. Basically, they synchronize the computer clock to WWV at the start and finish of a tape run, then press a D or R key when they hear the appropriate event. They can't do dimming, flashes, or clouds yet, and have delay from the person calling the event, and a delay in hitting the key. The program currently plots the resulting profile. The next addition will print the times. There was a group discussion comparing the computer and stopwatch methods and concerning potential improvements and inaccuracies. Ron and Rick would like to make comparisons with previous reductions to find biases.

Joan Dunham discussed IOTA computer software. Joan distributes software and takes predictions and corrects for specific locations. There is a slow response due to massive numbers of data requests. She is looking into data compression schemes and occasionally runs into incompatibilities. She has a major problem converting from mainframe tapes to PC floppies. She has the 1989 floppy almanac. The USNO is having problems with the 10-year almanac due to compression problems. An entry format needs to be developed for ILOC and USNO data reduction.

David Dunham discussed 1988 and 1989 asteroid occultations. 1989 predictions will be in the January issue of *Sky and Telescope*. There have been 41 observed events between February 1958 and September 1983, worldwide, and 38 more between 1983 and January 1988. About 90% occurred after 1978. He showed the prediction charts from *o.N.* The only remaining one for 1988 in Texas is Klymene/Alpha 1 Librae on December 21. It may be too close to the Sun for astrometry (this was confirmed later by A. Klemola) and may shift south to Corpus Christi or Brownsville based on the 1985 January graze observations. 1989 occultations are discussed in Dunham's article on p. 244.

David Dunham discussed 1988 and 1989 grazes. 1989 predictions for the brighter stars will be in the January issue of *Sky and Telescope*. There was a discussion on how to disseminate real time star shifts. Bulletin boards and WWV are not practical; answerphone messages might be; see p. 237. 1989 grazes include: Pleiades, southern Canada and Northern U.S.A.; Regulus, January 24 and April 15; Tau Scorpii, February 1, southern limit in California, again on September 8, southern limit in northeastern U.S.A., Oklahoma, and Texas.

There are lunar occultations of M45 (Pleiades) from mid-1986 to early 1992 and of M44 (Praesepe) from 1989 to mid-1990. During the 1987 August 17th total lunar eclipse, there are two possible polar-diameter expeditions, England-Egypt and Egypt-Kenya.

On August 11 there was a meeting at the Space Telescope Science Institute concerning asteroid observing; see p. 218 of the last issue. David Dunham is included as a co-investigator in a large HST General Observer proposal as a professional astronomer and member of IOTA. Paul Maley is submitting an amateur astronomer proposal for asteroid imaging. Deadlines were October 1 (first round) for the professional proposals and STS-26 launch for the amateur proposals.

Paul Maley discussed the 1990 USSR solar eclipse expedition plans. IOTA can go in if they join a Soviet expedition. We may be able to use a Soviet GPS system for location. The Museum of Natural Science in Houston may be able to organize an expedition to the USSR. Another possibility is Finland, despite poor expected viewing angle and conditions. The Finns plan to observe.

Paul also mentioned the 1991 solar eclipse through New Zealand. It hits both North and South islands.

Paul discussed 3 potential expeditions for the 1991 Mexico solar eclipse. Hawaii is basically a centerline eclipse, but good weather is expected. Baja California will have a northern limit and centerline eclipse, and good weather is expected. The Pacific coast of Mexico is expecting a 25% chance of cloud cover. Northern limit is north of Mazatlán, southern limit is near Puerto Vallarta.

There was a discussion on data reduction and publication. Those in work include the 1983 Pallas and Nemausa occultations, the 1985 Sudan/South Africa polar diameter expedition, and graze profiles. Pete Manly is writing a paper on video techniques. A joint paper is in work concerning the China eclipse. Two astronomers from Shanghai Observatory were at the USNO to analyze their data for two weeks. They got good video and about 150 good timings. David Dunham worked with them to reduce their data, and has started on the IOTA timings. After we left China, the Chinese, at IOTA's request and expense, resurveyed the IOTA sites to provide common baseline location data.

The meeting then adjourned to another room to view video tapes of occultations, grazes, and eclipses. these included several lunar grazes and occultations, a lunar occultation of Jupiter, and video of the China eclipse and Derald Nye's video of the March eclipse from the ship Golden Odyssey.

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## ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

*Computing the Julian Date.* The Julian date is a numbering scheme used in astronomy which measures time as the number of days since noon, January 1, 4713 BC. Julian dates are used in several ways in astronomy. They can be the independent variable in equations for time or position. They are used to specify the epoch for elements of comets, asteroids, binary stars, etc. Some of the occultation software computes and uses Julian dates in equations for the mean equinox and the Greenwich hour angle. The principal value of Julian dates lies in the fact that they do not repeat.

The Julian dates can be obtained from the Astronomical Almanac, Observer's Handbook, some astronomy textbooks, and some calendars. They can also be computed.

If the Julian date is known for any given date, any other Julian date can be computed by counting from the first date. For example, the JD for December 31, 1987 is 2447160.5. The Julian date for any date in January is the January date + 2447160.5, in February it is 31 + the January date + 2447160.5, in March it is 31 + 29 (remember, this is a leap year) + 2447160.5, and so on. This technique is the one suggested by the Astronomical Almanac, and works quite well if a source of "reference" Julian dates is readily available. In a computer program which will be used within a small range of dates (only for 1988,,for example), the Julian date computation can be done quite easily with this method.

Sometimes, however, we would want to be independent of a source for a reference Julian date, or we want to allow a very wide range of dates as input. Several astronomers have developed equations for the computation of Julian dates from calendar dates, which are valid for any time. Jean Meeus has published one, and Tom Van Flandern has published two variations of an equation relating calendar and Julian dates.

The Meeus method (from *Astronomical Formulae for Calculators*, Willmann-Bell, 1982) is as follows: Given a year, month, day, and hour, then

If the date is after October 15, 1582, compute B = 2 - int(year/100) + int[int(year/100)/4]. Here, int( ) means "the integer part of the quantity inside the ( )," so int(2.2) = 2, and int (3/2) = int(1.5) = 1. If the date is before October 15, 1582, B = 0.

```
JD = int(365.25*year) + int[30.600(month + 1)] + day
     + hour/24 + 1720994.5 + B
```

The first Van Flandern method is a FORTRAN algorithm (published in Communications of the ACM, Vol. II, No. 10, Oct 1986, p. 10)

```
JD = day - 32075 +
     1461*[year + 4800 + (month-14)/12]/4
   + 367*[month - 2 - (month - 14)/12*12]/12
   - 3*¼[year + 4900 + (month - 14)/12]/100¶/4
```

The arithmetic in this equation is integer, which means that results of each division are truncated, and only the integer parts kept. The equation produces the Julian date at noon of the Gregorian date. The full Julian date is then

TJD = JD - 0.5 + hours/24

The computation of TJD is done in floating point arithmetic.

The second Van Flandern method was published in Astrophy. Journal Suppl, vol 41, Nov 1979, pp 391-411, and is

```
JD = 367*year - 7*[year + (month + 9)/12]/4
   - 3*¼[year + (month - 9)/7]/100 + 1¶/4
   + 275*month/9 + day + 1721029
```

where the arithmetic is integer, as above. For the JD at the correct time,

TJD = JD - 0.5 + t

A shorter form of this second equation for dates since March, 1900 is

JD = 367*year
   - 7*[year + (month + 9)/12]/4 + 275*month/9
   + day + 1721014

In many implementations of languages on PCs, and in particular, BASIC, integers are restricted to values between -32768 and 32767. This is not enough to accommodate the "full" Julian date, which, for noon on November 1, 1988 is 2447467. I find that, in Microsoft GW-BASIC, the computations can be done in integer as long as JD is a real (single-precision floating point). However, if the fractional part of a day is also wanted, as shown in TJD above, the single-precision floating point is also too small, and it must be declared a double precision.

*Using the PC as a Timer.* Part of the discussion at the 1988 IOTA business meeting in Houston was on the program Ron Dawes and Rick Frankenburger have written to reduce graze tapes. This program is discussed further in Don Stockbauer's article.

We wanted to know how accurately events could be timed with a PC. The Dawes and Frankenburger occultation timing software is written in BASIC, a good choice of language for this program, since many machines have it and it is usually the least expensive computer language on any given PC, often provided at no extra charge. The BASIC provided as a default, or as the least expensive option, is usually interpreted BASIC, which can be slow, but has the advantage that statements can be changed easily. The disadvantage is that interpreted BASIC software is the slowest. The question is whether or not it is too slow to use as a timer to record events to the nearest 0.1 second. Interpreted BASIC runs a certain amount slower for each statement it must process. I created a test to see what is the effect of adding one print statement in a loop that uses the timer. In a loop that executed 20 times, this execution time on my machine was increased by 0.49 sec.

I was more interested to see that the timer function reports times to 0.01 second, but does not appear to measure them more accurately than 0.05 seconds. The GW BASIC manual states that "Fractional seconds are calculated to the nearest degree possible." I tested this by storing results from successive calls to the timer function and printing them after 20 iterations. The time incremented in steps of 0.05 to 0.06 seconds, with successive values identical and then jumping by the increment. For example, the test with a print statement has values for timer calls of 0.05, 0.05, 0.1, 0.1, 0.16, 0.16, etc. Assuming no other delays, this coarseness of timing is satisfactory for reducing visual observations of grazing occultations, but is not very useful in situations where accuracy to less than 0.05 second is desired.

My conclusion was that, for my machine, a "turbo" PC XT clone that runs at roughly twice the speed of a standard IBM PC XT, the interpreted BASIC is too slow when both the coarseness of time measurement and the effects of executing statements are considered. I did try compiling the small test programs I ran and found that the timer function could not measure the time it took to execute 20 print statements.

*Computing Planetary Occultations with Newcomb.* Rocky Harper of LaPorte, Texas has some comments on the Newcomb and Gnewcomb software that Willmann-Bell sells to accompany Brentagnon and Simon *Planetary Programs and Tables from -4000 to +2800*. The software is in BASIC, and the source is provided, so purchasers can customize it for their needs. The program Newcomb has a subroutine to calculate an occultation of a star by a planet. Rocky did some tests using the April 7, 1976 occultation of Epsilon Geminorum by Mars, noting that, if he does not precess the 2000 epoch star coordinates to the occultation epoch of 1976.269, the occultation is not predicted. He modified the Newcomb source to work with QuickBASIC 4.0, and comments that compiling the Newcomb programs makes them run much faster. He writes "Playing with this program is a lot of fun and thought provoking."

*New Celestial Mechanics Book.* J. M. A. Danby has produced a second edition of his classic text, *Fundamentals of Celestial Mechanics*, revised to include, among other things, example software in BASIC for the IBM-PC. The publisher, Willmann-Bell, is selling both the book and diskettes of the software at very reasonable prices ($20 for the book and $16 for the software plus $1 for handling). They can be contacted at 804,320-7016, or at P.O. Box 35025; Richmond, VA 23235. Note that Virginia residents must pay 4.5% tax.

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## NEW XZ STAR CATALOG AND PROFILE PROGRAM CHANGE WILL IMPROVE 1989 GRAZING OCCULTATION PREDICTION ACCURACY

David W. Dunham

The recent star catalog and computer program changes mean that observers will not need to apply any corrections to their 1989 grazing occultation predictions, although in some cases, some improvement in the prediction accuracy can be obtained from reductions of observations of a previous graze of the same star (that is, by use of previous observed graze shifts). The U. S. Naval Observatory's (USNO's) XZ star catalog, used for computing their comprehensive lunar total occultation predictions, and IOTA's graze predictions, contains 32,221 stars within 6° 40' of the ecliptic, the maximum range that the edge of the Moon can reach as seen from anywhere on the Earth. I have updated the positions and proper motions of 22,814, or 71%, of the XZ stars, which should virtually eliminate the need to contact me for individual graze star position shift updates. In addition, I have modified the ACLPPP used to compute predicted profiles for grazes, to automatically apply the correction for waning-phase northern-limit grazes that have been described in previous issues. The changes should be indicated at the top of your predicted profiles with the statement, IOTA ACLPPP, 88 NOV. VERSION, and at the bottom with PREPARED BY VERSION 80J. 80J is the current version of USNO's OCC program; it is the same as the 80H version that has been used for the past couple of years, but uses the new "80J" version of the XZ catalog, and contains a few program changes to properly identify the source for the positional data. The basic data used to compute the graze limit predictions for 1989 used the "80I" version of the XZ catalog, which is the same as the 80J version, except for about 100 close double stars. In these cases, the new photographic catalogs used for the 80I positional data may have degraded accuracy due to the duplicity. This was fixed by using earlier data for these stars for the 80J version, so when the profiles are calculated, you automatically get corrected to 80J. The differences between the 80I and 80J versions are small, and I will try to document them in a future issue. Implementing these changes took longer than I expected, so that I was not able to send graze data for 1989 to the computors until late November. I apologize if you miss any events during early January; blame me, not the computor for your region.

*Profile Change.* For northern-limit profiles, we have been applying a correction equal to 0".043 times the latitude libration expressed in degrees. A linear dependence was noticed by me in the early 1970s, and quantified by L. V. Morrison and Appleby during their analyses of graze observations performed at the Royal Greenwich Observatory in the late 1970s. Examination of graze shifts observed during the past couple of years showed that the correction only applied to grazes with Watts angles (W.A.) between 0 and 30 degrees (that is, east of the lunar north pole, in regions that are dark during the waxing phases), and was zero for grazes with W.A. between 330 and 360 degrees (west of the north pole, dark during the waning phases). This was not noticed from 1981 to 1986, when the 80F and 80G versions of OCC used a version of the XZ catalog with the accuracy of many of the bright northern-declination stars degraded with Perth 70 data (that catalog is one of the best for southern stars, but was shown to be poor in the north, where the observations were made at low altitude). So in those days, star position errors masked the smaller lunar signature. The 88 November version of the ACLPPP corrects the problem, so that you no longer need to apply the corrections mentioned in previous issues of *o.N.*

*New XZ Catalog.* The 80J version of the XZ catalog includes the following new positional sources that are given in the heading of IOTA's graze limit predictions:

ZZ87 (21,189 stars): This is R. Harrington's 1987 (so far only) version of the Zodiacal Zone (ZZ) catalog described in *o.N. 4* (6), 140. It is generally preferred, since in addition to good recent (1979-1980) positions, proper motions were also derived by remeasuring the original Yale catalog plates and reducing them with improved reference star data. Since it is a photographic catalog, its accuracy is worse for stars brighter than 6th magnitude. Since the recent plates were taken in Washington, DC, the positions of stars in the -20s declination range are also not as accurate; indeed, there are few ZZ stars south of declination -25°. The brighter stars usually have better fundamental positional data from meridian circle observations from FK4, FK4S, Perth 70, and AGK3R. At the current epoch, typical errors of the ZZ stars are 0".2 to 0".3. Since the images were measured automatically, double stars with separations from about 0".5 to 15" and magnitude differences from about 0.3 to 3 can have large errors, and about 500 ZZ matches with the XZ were rejected on this account. A new version of ZZ is expected in 1989, when the SRS (Southern Reference Star) catalog proper motions will be finalized and can be used to rereduce the southern ZZ stars.

LICK (1345 stars): These are from Klemola's Voyager catalogs. The positions at their epochs, ranging from 1978 to 1984, are better than ZZ, but with few exceptions, new proper motions were not derived, so that their current errors are comparable to ZZ. The Lick Uranus catalog was especially useful for replacing XZ data in the area between $17^h$ and $19^h$ of R.A. south of the ZZ coverage (which the Moon is now traversing), and many AGK3 non-SAO stars in the north had data replaced from the Jupiter catalog.

P70 (245 stars): XZ data for southern stars, usually originally from the old, inaccurate G.C. catalog, were replaced with Perth 70 data. This is in addition to the 485 ZP70 southern stars whose data had been determined earlier for the XZ by combining existing XZ data at the old XZ epoch with Perth 70 to try to improve the proper motions.

YALE (35 stars): Original Yale catalog data were used to replace G.C. data for southern stars, when data from the other catalogs noted above were not available. Although the accuracy of Yale data at current epochs is poor, it is better than G.C. data.

XZGC (129 stars): These stars were not changed, but they were not previously distinguished. They are northern stars where G.C. data were used for an early epoch, and other catalog data (usually AGK3) were used for a more recent epoch to derive proper motions. Their accuracy is not very good, but it is better than GC alone or YALE data.

SAO now refers to southern stars whose data are from the SAO catalog, which in turn used YALE, with systematic corrections applied. XZ-source stars are also unchanged; they are northern stars where SAO (Yale) data were combined with recent data (usually AGK3). FK4, FK4S, and N30 stars are now properly identified. FK4 positions (195 stars) remain the best available, while FK4S (122 stars) data are almost as good. N30 (43 stars) data are not as good, and are also behind P70 and ZP70, but are better than SAO, Yale, or G.C. The position source for two stars has been changed to FK4, since extraordinary measures (including special recent observations) were taken to reduce these objects to the FK4 system in support of asteroid occultation prediction improvement. The stars are Z.C. 2577 [63 Ophiuchi, actually in Sagittarius, to be occulted by (4) Vesta on 1989 August 19 in northern South America] and Z.C. 3474 [14 Piscium, was occulted by (51) Nemausa on 1983 September 11].

In a related XZ modification, the double star codes of a few hundred stars, which were previously A or C, have been changed to M (mean position) or, in the case of triple stars, to H (A and B components form close pair). These are close pairs with significant secondaries, such that the astrometric positions of the separate components can not be measured directly. Consequently, the catalog position almost certainly is a mean position (center of light) rather than the position of the A-component, which is the way the ACLPPP treats stars with codes A or C.

*Shifts.* The only time now when shifts might be requested would be for double stars with separations from 0".5 to 15" (less for fainter stars) and component magnitude differences from 0.3 to 3.0. The positions of these stars from photographic catalogs are likely to be poor, so data from another catalog would at least give another "vote." During the past several months when I have calculated shifts from the old XZ using ZZ data, and the shift was very large, the actual shift virtually always favored ZZ, but was usually a little less than ZZ indicated.

If I get a chance, I will calculate the 80J - old XZ differences and print the largest ones in a form that might be published in a future issue.

Another problem is with shifts from previously observed grazes. Since most of the star positions have now been changed, you can't use shifts for grazes observed before 1989 to predict shifts for future grazes based on an 80J prediction. You CAN do this for FK4, FK4S, ZP70, PLDS, (these cover most of the bright stars) and any other stars whose data have not been changed for the 80J version of XZ. We can calculate the 80J - old XZ difference to adjust a previously observed shift to the new 80J basis. So in the case where there are previous graze observations, you can get some improvement by requesting such an adjustment for stars whose source is one of the new catalogs (ZZ87, LICK, P70, or YALE).

*Catalog Requests.* Now that the XZ catalog has been improved to my satisfaction, I will start sending magnetic tapes with the new XZ to several who have requested them during the last few years, as my time permits. I apologize for the long delay in doing this, but I felt that the improved accuracy was needed. Some want the catalog on floppies, but its size (nearly 4 million bytes) poses a problem. I am open to suggestions for compressing the catalog (removing unwanted information), such as by making a Z.C. subset (about 11% of the XZ).

*Future Improvements.* I will soon send Mitsuru Sôma a copy, so that he can redo his lunar occultation analysis. During my trip to Japan in October, I gave Sôma the input and output formats for USNO's OCC program, so that he might be able to use the results of his new analysis to generate corrections and limb data for graze profiles, and for detailed solar eclipse predictions and analysis. If tests are satisfactory, the goal will be to replace these functions, now performed with OCC, with Sôma's software, since he can improve the analyses and produce updates, as needed. In the meantime, Alan Fiala has begun work on trying to create a new ephemeris tape for OCC that could serve us through th 1990s (see p. 218 of the last issue). He did find an ephemeris tape with data through 1990, which he has already used to calculate some data for the 1990 July solar eclipse, but we need to make some more calculations to see if the 1990 ephemeris data are compatible with those for 1988 and 1989 that we are now using.

Also, new catalog data will become available in 1989 that would justify creating an "80K" version of the XZ. The final version of the ZZ has been mentioned above. The final version of the Heidelberg PPM catalog should also become available, giving improved data for most AGK3 stars. In the mid-1990s, I hope to get much-improved data from the Hipparcos satellite. Over 90% of the stars in my proposal for the Z.C., and about 40% of those for the XZ, have been accepted for the Hipparcos input catalog.

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## SPECTACULAR GRAZES OF REGULUS OBSERVED IN NOVEMBER

David W. Dunham

On November 3rd, a dark-limb graze of Regulus by the 34% sunlit Moon was observed near the southern limit in Scotland and Denmark. I heard that two Belgian observers went to Scotland, but I do not know their results. Twelve stations were set up by IOTA/ES in Denmark, manned about equally by Danish and West German observers. On November 28th, I received a fax from Dr. Eberhard Bredner giving a report and preliminary plot (by Reinhold Büchner) of 3 of their stations. Video records were obtained at two stations, including an impressive one by Hans Bode with 20 events! Comparing Büchner's observed profile with a profile computed by ACLPPP showed an overall north shift, but the amount was different for different features, as follows: The shift was 0".6 north for the top of the mountain at Watts angle (W.A.) 184°, but it averaged 0".4 north over the range 184° to 185°. From W.A. 185° to 189°, the shift was 0".2 north, while the top of the mountain at 190° had no (0".0) shift. Central graze W.A. was 186°. The librations were -1°.0 in latitude and +3°.9 in longitude, similar to those for the graze on November 30th. On the evening of the 28th, I telephoned the expedition leaders for the event on the 30th to give them these results, but in the U.S.A., events ranged from W.A. 190° to over 200°. Since the size of the Nov. 3rd north shift decreased with increasing W.A., I told expedition leaders to expect a small north shift, between 0".0 and 0".2. Jim Van Nuland reported a north shift of about 0".25 for the November 27th graze of the FK4 star Kappa Geminorum (Z.C. 1170) observed in California, further strengthening the idea of a small north shift for Regulus. On November 27th, the W.A. was 196° and the latitude libration was -4°.4.

There were no suitable sites on San Francisco Peninsula, so the first 3 expeditions listed on p. 528 of the November issue of *Sky and Telescope* combined forces in Fremont on the east side of the bay. They manned 34 stations, seven with video systems. They planned on a slight north shift, and none of them had a miss. Their preliminary impression was that a 0".1 north shift occurred. Van Nuland had only four stations at Patterson, since a forecast of heavy fog in the area discouraged many. But the fog stayed low, and they obtained 20 timings. Harold Povenmire had planned to join two Texans to observe near Brady, Texas, where the southern limit of Regulus crossed that of its distant 7.6-mag. companion, whose graze occurred 8 minutes before Regulus'. Unfortunately, the Texan who had the maps was called out of town at the last moment, and the other became too sick to go out, so Povenmire and his wife set up 2 stations near Austin where they could be sure of their positions; each got six events. I have not heard the results of other attempts near Manteca, CA; north of Las Vegas, NV; near Cameron, AZ; and south of Albuquerque, NM. Rick Frankenburger reports that 35 observers timed the graze at Bastrop, near Austin, TX, with at least 3 videorecordings, one of which contained many contacts. Don Stockbauer observed at the top of the highest mountain on their profile near W.A. 200° at Wharton, TX, and had no occultation. The other 26 stations in his expedition were north of him, and the next one, 200 feet away, had a 2-second occultation, indicating a near-zero shift. Overall, the separate expeditions may add up to set a record for total number of stations, but perhaps not for total number of timings, even though many observers saw more events than were expected from the predicted profile. Many saw slow, gradual or partial events lasting a full second or more, undoubtedly due to Fresnel diffraction. With such a bright star far on the dark side of a 58% sunlit Moon, it was possible to see much farther down the "toe" of the diffraction curve than normal (that is, see the star faintly when it was geometrically tens of meters below the lunar surface). High-quality photoelectric records of previous occultations have been used to derive Regulus' small angular diameter, and conclusively show the star to be single. A discussion of photoelectric light curves, including the diffraction pattern, is given in R. E. Nather and D. S. Evans' article in *Astron. J. 75* (5), 575 (June 1970).

I thank Walter Morgan and Don Oliver for providing me with maps and much prediction data for this graze. I originally planned to observe the graze myself either near Las Vegas or San Francisco, but decided against it due to a combination of my heavy workload at the time, the uncertainty in the profile for ensuring more than 4 contacts at any location, and the fact that others would try to videorecord the event at both locations. I timed the D and R of the nearly central occultation visually from my home in Greenbelt. The Sun alt. was -2' at R, which decreased contrast to hinder any video attempt. It clouded over less than an hour after the R.

During the two weeks following the graze, I will try to obtain preliminary reduction profile information from the expedition leaders, so that we can help Japanese observers the same way that the Europeans helped us. I will fax the information to Mitsuru Sôma at the National Observatory in Tokyo, so that he can inform the many Japanese observers who will attempt the southern-limit Regulus graze that will occur near Hiroshima on December 26th.

## ARE YOU RECEIVING THE GRAZE PREDICTIONS THAT YOU WANT?

David W. Dunham

If you are a member of IOTA, and you have requested graze prediction coverage but have received no data, please write to H. F. DaBoll (use the address in the masthead) giving your coordinates, desired travel radii, and the period for which you have not received requested data (only the latter is needed if we have an observer information form (o.i.f.) for you on file). We will try to make a reasonable adjustment (credit) to your dues if the prediction failure is our fault (for example, if you have an o.i.f. on file, and our computer data do not agree with it). If you do have any prediction, verify the coordinates for your station (given in the summary page, not in the limit predictions), and your travel radii. Sometimes, mistakes are made which can result in your position being outside the intended super standard station (S.S.S.) region, so that you would get few if any predictions. Derald Nye now has a program that calculates the distance of individual stations from the S.S.S. center, so that we can spot some of the bigger errors. Some observers specify small travel radii that can result in only one prediction during one, or two or more, years.

Some European observers have joined IOTA and not received predictions. We encourage European observers to join IOTA/ES instead, since graze predictions for Europe are calculated and distributed by IOTA/ES using data from the U. S. Naval Observatory like that wich IOTA uses. European observers who have paid to join IOTA, and provided us with station coordinates and travel distances, will receive their graze predictions from IOTA/ES, which will deduct their costs for this distribution from IOTA's bill to IOTA/ES for copies of *O.N.* that we provide them. In the past, IOTA/ES had some problems with the graze predictions, but these have been overcome and their calculations for 1988 were completed in good time. IOTA/ES also has a copy of our program for calculating local circumstance/appulse predictions for planetary and asteroidal occultations, and hopes to have this operational soon so that IOTA/ES members can be sent these predictions for 1989.

## VIDEO SYSTEMS NEEDED FOR OCCULTATION BY VESTA

David W. Dunham

If you have a video system capable of recording an occultation of a 6.2-magnitude star by a 6.6-magnitude asteroid, and would be willing to travel with it on 1989 August 19th, please contact me at the address and phone given on p. 234, or at 301,794-1392 on weekdays. Some information about this event will appear in the January issue of *Sky and Telescope*, and more about it will be in the next *O.N.* Using an 8-inch Schmidt-Cass, and RCA Ultricon camera, or other camera attached to an image intensifier, could probably make the observation, provided skies are clear. That's the problem; the path for this occultation of 63 Ophiuchi (Z.C. 2577 or SAO 185938) will cross the Galapagos Islands, Ecuador, northern Peru, and the Amazon, according to extensive astrometry that has already been completed. Ed Brooks' analysis indicates about 70% cloudcover over most of the area, with few places where the prospects are even 50-50. With these odds, many observers would need to be deployed to obtain even a few well-placed chords across this important asteroid, the largest whose diameter has not been measured by an occultation. Astronomers at Lowell Observatory and the University of Arizona, along with IOTA, are exploring the possibilities of obtaining a grant to fund travel for this event, the best occultation by Vesta that has yet been predicted. Although prospects for obtaining a grant may not be high, and even if one is obtained, it might not be large enough to fund travel for all potential video or photoelectric observers who would be interested, I still want to know what resources we have in IOTA that could be applied to the problem, if sufficient funds do become available. I believe that small video systems would provide the most cost-effective means for observing this occultation. But there are also difficult logistics and security problems that need to be solved for this event, in addition to the astronomical and weather problems.

## SOME REMARKS ON "OCCULTATIONS AND THE AMATEUR"

David W. Dunham

Dennis di Cicco's article with the above title on pages 480-481 of the November issue of *Sky and Telescope* contains a good discussion of the value of occultation observations. There are a few minor omissions and errors. One of the errors is in the address at the end of the article; the zip code should be 60175.

In the discussion about double stars, speckle interferometry is not mentioned, although this technique also fills the gap between visual and spectroscopic binaries. Speckle observations can resolve separations down to about 0".03, but rather smaller separations can be resolved with occultations, especially with high-speed photoelectric records. Since speckle resources are limited, they can only do limited surveys, and try to concentrate on known close doubles to obtain enough information to determine their orbits. Harold McAlister, a leader of speckle work, says that occultations are very useful for his selection of stars for effective speckle observations. So visual, video, and photoelectric observations of occultations are all valuable for discovering close doubles, and photoelectric records can give accurate binary component magnitudes. But speckle observations are best for obtaining a long string of separation and position angle measurements, not tied to specific periods when occultations of a given star occur, needed for orbital studies. Speckle observations have a 180° ambiguity in position angle, which can be resolved with occultation data.

The uses of lunar profile information derived from grazes is mentioned for solar eclipse analyses. It says that the eclipse studies have shown that "the Sun is neither expanding nor shrinking." This is true, but they have shown small variations that are probably roughly periodic, perhaps like the sunspot cycle. A longer discussion of solar eclipse Baily's bead timings for measuring the Sun's diameter is given in L. Robinson's article on p. 496. Neither mention that observations near the edges are needed due to librations: The latitude libration during an eclipse is always near zero, while the longitude libration can have a wide range of values. Therefore, the same mountains and valleys dominate the lunar polar profile during each eclipse, while the equatorial profile is constantly changing. Hence, errors of the profile information are much less severe at the edges than at the center; the same features keep repeating near the poles, which then can give a better mesurement of the solar diameter, and its variation from eclipse to eclipse. Another advantage of observing near the edge of a total eclipse path is the prolonged viewing of all limb phenomena, including the chromosphere and flash spectrum. Also, due to the circular geometry, observers near the edges can view the corona for a large fraction of the central eclipse duration.

Accurate polar profile information may someday be valuable for lunar exploration. Some deep valleys and craters in the polar regions may be in perpetual darkness, so that ice may exist there. If so, it would be an extremely valuable resource for a lunar base.

It is true that space-based astrometry, such as with the Hipparcos satellite that is scheduled to be launched in 1989, should give more accurate measurements of stellar positions. But these will be relative measurements; occultation data will still be useful for linking them with an equatorial or ecliptic reference frame.

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## SOLAR SYSTEM OCCULTATIONS DURING 1989

David W. Dunham

The 1989 *Asteroidal Occultation Supplement for North American Observers*, prepared by Edwin Goffin with finder charts annotated by David Werner, is enclosed with this issue for IOTA members and *O.N.* subscribers in North America. Copies of Goffin's predictions and charts applicable to other parts of the world were sent by Jim Stamm a few months ago to regional coordinators for distribution to members and subscribers in their regions. Goffin's data cover all of 1989. But also, data for 4 events that actually occur during 1988 December, and which were included in the 1988 predictions distributed a year ago, were included with the 1989 data. They were not obvious at first since the data were sorted by month and day of month, but not by year, so they were mingled with 1989 December data. These events are not included in the North American Supplement, but were included in the material sent earlier to the regional coordinators and which have already been distributed. The four 1988 events occur on December 21st, involving (104) Klymene, (41) Daphne, and (781) Kartvelia, and on December 23, involving (200) Dynamene.

My predictions of occultations of stars by major and minor planets, and by Comet P/Schwassmann-Wachmann 1, during 1989 are given in two tables below, which are presented in the same format as those for 1988 published in *O.N. 4* (6), 150. A few changes from the tables for previous years, especially parameters for path computation, are described in that issue. The previous tables are described in detail in *O.N. 4* (1) (July, 1986). See also *O.N. 4* (3), pages 45-47 for star designations and new source codes. For the 1989 calculations, I updated the combined catalog to replace the positional data for many of the stars with improved positions from USNO's Zodiacal Zone catalog (source code U) described in *O.N. 4* (6), 140 and also discussed more on p. 240 of this issue. In addition to better positions for most occulted stars, many of the asteroid orbits have also been improved. Hence, unless old data had to be used (such as from catalog codes C, G, S, or Y; there has also been no improvement for most AGK3 stars, code A, which are not in the SAO; or for orbits updated before 1980 or with MPC numbers less than 8000), the nominal predictions should be more accurate than in the past, with path location errors generally under 300 km rather than over 1000 km. Like last time, no values are listed under $\Delta m$ for occultations by major planets, since the extent of the planet, and the fact that events can occur against its dark side, make it meaningless. Similarly, no value is listed under the Table 2 RSOI column, since this is always greater than 99999 km. Like the last few years, no information relating to the estimated angular diameters of the occulted stars is given. This information has been computed and is available upon request to me at 7006 Megan Lane; Greenbelt, MD 20770; they would be of use for analysis of high signal-to-noise photoelectric records. In the notes, I will include a remark about the stellar angular diameter if it is large enough for the edge of the asteroid to require more than 0.05 second to geometrically pass across the star during a central occultation. In this case, it might be noticed by visual observers, especially in the case of a nearly grazing event if the observer is near one of the edges of the occultation path.

*Local circumstances/appulse predictions.* Joseph E. Carroll; 4261 Queen's Way; Minnetonka, MN 55345, computes the IOTA appulse predictions for all IOTA members. Carroll's predictions are computed and listed in the same order as Tables 1 and 2 here. These predictions are in the same format as those for 1988 discussed in *O.N. 4* (6), 149.

*Coverage for early 1989.* Only my data for January, February, and March are given here, with the two tables on facing pages. Tables covering the rest of the year will be included as a continuation of this article in the next issue. Finder charts are included here only for North American and European events that are not included in Edwin Goffin's supplements. Detailed 1-degree charts based on Astrographic Catalog data are included for some of the fainter stars that are included in Goffin's supplements; they supplement Goffin's charts since 3-degree and larger fields are not included for them. I have mailed finder charts for other non-Goffin events through March to regional coordinators.

Since I was not able to send complete data for 1989 events to Mitsuru Sôma until about the same day that I had to transmit this to the editor, his maps will not appear in this issue. We will publish his maps for future events in the next issue. In the meantime, when possible, rely on the similar maps by Goffin. There is also not time to produce regional maps for individual events. Instead, three maps covering most of the world show my predicted paths for the first three months of 1989. These maps were described in *O.N. 4* (6), 149, except that the 1".0 north and 1".0 south shift lines are not included. Also, the time along the path is not given. The time can be inferred approximately from Table 1, but it is best to consult J. Carroll's appulse prediction, which gives the accurate predicted time of closest approach for your location.

*Occultations by major planets.* The most interesting event of 1989 will be an occultation of 5.8-magnitude 28 Sagittarii by Saturn around $7^h$ U.T. of July 3rd, visible from most of the Americas. This is the brightest star ever to be predicted to be occulted by Saturn; Gordon Taylor first noted it several years ago. Unfortunately, the brightness of Saturn will overwhelm most photometers. The event would be best recorded with a CCD, and probably can be recorded at high power with image-intensified video systems. But even visual observers can call out variations of the star's brightness to a tape recorder. Although the star's angular diameter will limit resolution to a few kilometers, not as accurate as the Voyager-2 photopolarimeter recording of Delta Scorpii, the multiple chords from widely spaced observers could give unprecedented two-dimensional details of Saturn's rings. More information about this unique opportunity will be given in future issues.

Predictions for the outer three planets are not included in my tables, but data about events through 1990 have been published by D. Mink and A. Klemola in *Astron. J. 90* (9), 1894 (1985 September). The brightest star listed by them to be occulted during 1989, by Uranus on May 21st visible from the central Pacific around $12^h$ U.T., is magnitude 12.5. All of the Uranus and Neptune events involve small magnitude drops, and are well beyond the capabilities of most *O.N.* readers. However, some of the star fields are very crowded, which posed some problems for the automatic plate scanning, so that some occultations may have been missed. Last July, observers near Houston claimed to have seen an unpredicted occultation of a star of nearly 10th magnitude by Neptune; this is being investigated. Occultations of many stars even fainter than those found by Mink and Klemola, but suitable for monitoring in the infrared, have been published by P. Nicholson *et al.* in *Astron. J. 95* (2), 562 (1988 February). The only 1989 occultation listed for Pluto, on June 14th, will not occur, according to astrometric updates carried out for the successfully observed June 9th occultation.

*Occultations by minor planets.* For the asteroids, I computed ephemerides for combined-catalog searches for all objects for which occultations during 1989 were listed by L. Wasserman *et al.* in *Astron. J. 94* (5), 1364 (1987 November). In addition, I have included all other asteroids with expected diameters greater than 200 km, and many down to 150 km. Also, several smaller asteroids were selected on the basis that they will occult relatively bright stars, according to Goffin's predictions. Searches were performed with Fresneau's Astrographic Catalog (F.A.C.) only for the larger or more important asteroids, including numbers 1-3 (Vesta will be entirely south of F.A.C. coverage in 1989, as will some other large asteroids that I have omitted), 6, 10, 12, 15, 16, 18, 24, 29, 31, 34, 45, 47, 48, 49, 51, 52, 65, 94, 121, 146, 216, 250, 275, 375, 423, 451, 511, 532, 617, 624, 690, 702, 704, 2060, 3123, and Comet P/Schwassmann-Wachmann 1. Combined catalog searches were performed for these and also for numbers 4, 5, 7-9, 11, 13, 14, 19, 23, 28, 30, 36, 39, 40, 41, 43, 44, 53-56, 63, 67, 69-71, 76, 78, 79, 87-89, 92, 93, 96, 106, 114, 117, 130, 139, 144, 150, 154, 165, 168, 171, 187, 192, 196, 200, 205, 238, 241, 264, 273, 304, 313, 324, 334, 346, 359, 369, 386, 405, 409, 410, 416, 449, 471, 481, 521, 602, 693, 694, 747, 751, 760, 790, 846, 852, 895, 911, 980, 1723, and 1867. Events were rejected if:

| angular diameter less than | and | star magnitude greater than |
|---|---|---|
| 0".080 | | 9.0 |
| 0.055 | | 8.5 |
| 0.045 | | 8.0 |
| 0.035 | | 7.0 |

These tests were not performed for relatively small objects, especially when Goffin predicted that they would occult relatively bright stars, including numbers 18, 36, 39, 43, 44, 49, 51, 55, 56, 67, 69, 71, 79, 106, 114, 144, 150, 171, 205, 216, 238, 250, 264, 273, 313, 359, 369, 410, 481, 532, 602, 617, 624, 690, 693, 694, 751, 760, 852, 911, 980, 1723, 1867, 2060, 3123, and Comet P/Schwassmann-Wachmann 1. I was able to generate all of the events for 1989 published by L. H. Wasserman, E. Bowell, and R. L. Millis in "Occultations of Stars by Solar System Objects. VII. Occultations of Catalog Stars by Asteroids in 1988 and 1989," *Astron. J. 94* (5), 1364 (November 1987). Since Goffin used different rejection criteria, he found many occultations of SAO and AGK3 stars not in my list.

Edwin Goffin has continued his valuable work improving many of the orbits of the larger asteroids useful for occultation work. Most of the orbits whose source is the Minor Planet Circulars (MPCs) with numbers greater than 10000 are from this work.

Some of the physical information for the minor planets has been updated using the Asteroids II database, assembled by Ed Tedesco at Jet Propulsion Laboratory in conjunction with the Asteroids II meeting held last March in Tucson; see *O.N. 4* (8), 190 and

204. The main improvement (and consequent differences in my predicted central durations from those published by Goffin and by Lowell Observatory) has been my use of diameters obtained by the IRAS satellite. In some cases, better diameters derived from previous occultations have been used. I have not used the new H and G magnitudes, using instead the B and B-V magnitudes published in the 1979 Asteroids book. I have not had time to update my computer programs to include the more complex H and G magnitude calculations, and my database of asteroid physical and orbital information. I have used the new

Table 1, Part A

| 1989 DATE | Universal Time | PLANET Name | PLANET $m_v$ | PLANET Δ,AU | STAR SAO No | STAR $m_v$ | STAR Sp | STAR R.A.(1950) | STAR Dec. | Occultation Δm | Occultation Dur | Occultation df | Occultation P | Possible Area | El Sun | MOON El | MOON %Snl | N Up | Ephem. Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 9 | 19h41m | Nuwa | 13.4 | 2.916 | | 10.9 | | 23h28m.9 | -2°49' | 2.6 | 5s | 10 | 27 | South Africa?n | 63° | 36° | 5+ | w 20°E | MPC11508 |
| Jan 10 | 13 50-65 | Wratislavia | 12.1 | 2.079 | | 10.1 | | 6 22.9 | 15 40 | 2.2 | 12 | 23 | 19 | India,seAsia,Luzon,HI | 164 | 128 | 10+ | w 95E | Goffin87 |
| Jan 12 | 6 44-50 | Diotima | 12.0 | 2.229 | | 12.1 | | 6 25.7 | 31 45 | 0.7 | 16 | 22 | 15 | Canada, AK, Kamchatka | 162 | 104 | 25+ | w130W | MPC12305 |
| Jan 13 | 2 12 | Kalypso | 11.1 | 1.133 | 97455 | 8.9 | KO | 7 57.4 | 16 7 | 2.3 | 15 | 26 | 14 | s. Chile, Patagonia | 173 | 116 | 33+ | w 55W | MPC12188 |
| Jan 13 | 3 29 | Venus | -3.9 | 1.568 | 186495 | 8.9 | MO | 18 10.7 | -23 7 | | 206 | 4 | 1 | Uganda to nw Iran | 20 | 91 | 34+ | none | NA0001 |
| Jan 14 | 16 39 | Vesta | 7.8 | 2.640 | 159716 | 8.7 | F5 | 16 4.8 | -15 30 | 0.4 | 13 | 8 | 8 | New Zealand?n | 52 | 142 | 51+ | none | Goffin86 |
| Jan 20 | 21 35-42 | Chiron | 15.9 | 11.104 | | 10.2 | | 6 8.7 | 16 37 | 5.7 | 22 | 36 | 40 | U.S.S.R., Scandinavia | 151 | 20 | 99+ | all | Marsden |
| Jan 24 | 14 15-27 | Sapientia | 12.0 | 1.516 | | 10.2 | MO | 7 24.6 | 19 33 | 2.0 | 10 | 24 | 21 | NZ?s, Queensland,Java | 166 | 44 | 93- | all | EMP 1981 |
| Jan 25 | 11 02 | Hermentaria | 13.0 | 3.594 | 160464 | 8.0 | F2 | 17 17.1 | -19 56 | 5.0 | 3 | 10 | 47 | eastern Canada?s | 45 | 95 | 88- | all | MPC13442 |
| Jan 26 | 12 30 | Agamemnon | 15.0 | 4.289 | 99160 | 8.9 | GO | 10 27.1 | 14 24 | 6.1 | 11 | 27 | 36 | (N.Z., e.Australia)?n | 152 | 25 | 81- | all | MPC13443 |
| Jan 28 | 8 25 | Melpomene | 10.1 | 1.969 | 129169 | 5.9 | KO | 1 9.2 | -2 31 | 4.2 | 4 | 8 | 19 | eastern Siberia | 67 | 167 | 66- | none | Goffin87 |
| Feb 1 | 1 51-69 | Sapientia | 12.1 | 1.536 | | 11.5 | | 7 18.4 | 20 3 | 1.1 | 12 | 27 | 22 | n.Africa,Iberia,Canada | 157 | 135 | 31- | e 10E | EMP 1981 |
| Feb 2 | 7 18-25 | Hebe | 9.0 | 1.518 | | 10.8 | | 8 14.3 | 14 41 | 0.2 | 14 | 19 | 12 | e. U.S.A., w. Canada | 168 | 137 | 20- | e 60W | Goffin86 |
| Feb 3 | 3 05 | Mars | 0.6 | 1.289 | 92912 | 8.9 | F5 | 2 20.5 | 15 7 | | 301 | 10 | 1 | e.AK,n.Canada,Greenland | 84 | 126 | 13- | none | NA0001 |
| Feb 3 | 4 27 | Lucina | 13.5 | 3.319 | 128977 | 8.9 | F8 | 0 47.9 | -5 24 | 4.7 | 4 | 11 | 34 | (Hawaii, California)?n | 56 | 96 | 13- | none | EMP 1981 |
| Feb 6 | 2 15-30 | Juno | 8.8 | 1.556 | 118247 | 9.1 | KO | 10 18.4 | 2 10 | 0.6 | 23 | 22 | 8 | S.Af.?n,n.S.&Cen.Amer. | 160 | 156 | 0- | none | Goffin86 |
| Feb 7 | 11 36 | Ophelia | 12.8 | 2.390 | 139755 | 9.4 | GO | 14 6.2 | -9 36 | 3.5 | 13 | 32 | 29 | New Zealand?s | 105 | 122 | 2+ | none | MPC13294 |
| Feb 10 | 10 45-52 | Lipperta | 15.2 | 2.371 | 93557 | 5.5 | B8 | 3 39.4 | 19 32 | 9.7 | 3 | 20 | 64 | Hainan,Taiwan,Hawaii?n | 96 | 39 | 23+ | w167E | MPC13443 |
| Feb 12 | 17 23-36 | Dione | 12.3 | 2.356 | | 10.2 | G5 | 10 26.8 | 16 46 | 2.2 | 10 | 21 | 23 | e.Med.,Mideast, China | 169 | 101 | 47+ | w105E | EMP 1982 |
| Feb 17 | 9 29 | Mars | 0.8 | 1.426 | 93195 | 5.6 | F5 | 2 53.6 | 17 49 | | 265 | 9 | 1 | e.Austrl.,NZ,Fiji,Samoa | 78 | 65 | 90+ | all | NA0001 |
| Feb 19 | 10 46 | Fortuna | 12.4 | 3.060 | 186069 | 7.5 | B5 | 17 57.0 | -22 33 | 5.0 | 5 | 11 | 26 | Mexico?n, Colombia | 61 | 132 | 99+ | w 79W | MPC13145 |
| Feb 21 | 3 54 | Atalante | 12.4 | 1.828 | | 10.7 | G5 | 11 1.7 | 17 46 | 1.9 | 8 | 18 | 21 | Patagonia, s. Chile | 167 | 11 | 100- | all | Herget78 |
| Feb 23 | 13 22 | Faina | 13.0 | 2.175 | 76355A | 8.0 | KO | 3 54.8 | 22 47 | 5.0 | 6 | 14 | 27 | Indonesia | 87 | 125 | 93- | e100E | MPC12433 |
| Feb 23 | 13 23 | Faina | 13.0 | 2.175 | 76355B | 9.7 | KO | 3 54.8 | 22 47 | 3.4 | 6 | 14 | 27 | n.India,China,s.Japan | 87 | 125 | 93- | e104E | MPC12433 |
| Feb 24 | 4 03-24 | Massinga | 11.9 | 1.705 | | 11.4 | GO | 8 22.8 | 25 21 | 1.0 | 9 | 30 | 33 | Germany, UK, N.America | 147 | 72 | 89- | e107W | EMP 1986 |
| Feb 25 | 15 46 | Martha | 14.6 | 3.078 | 160998 | 6.2 | K2 | 17 58.5 | -17 9 | 8.4 | 3 | 12 | 53 | (se Australia, NZ)?2"n | 67 | 60 | 79- | all | MPC13295 |
| Feb 25 | 19 20 | Hesperia | 11.7 | 2.099 | | 9.9 | G5 | 5 10.8 | 12 51 | 1.2 | 11 | 22 | 21 | South Africa?n | 101 | 132 | 78- | none | Herget77 |
| Feb 28 | 19 09-36 | Sylvia | 12.7 | 3.028 | | 11.7 | | 14 7.8 | -1 13 | 1.4 | 56 | 72 | 16 | Okinawa,China,Siberia | 129 | 42 | 50- | e107E | MPC11507 |
| Mar 5 | 7 15 | Chaldaea | 13.5 | 2.415 | 160730 | 9.1 | B9 | 17 37.0 | -12 43 | 4.5 | 5 | 14 | 35 | Cen.America, Venezuela | 80 | 47 | 9- | e 45W | MPC11621 |
| Mar 5 | 12 15 | Martha | 14.6 | 2.975 | 161155 | 8.1 | B3 | 18 8.3 | -16 43 | 6.5 | 3 | 13 | 51 | (nw USA, w. Canada)?s | 72 | 42 | 7- | e102W | MPC13295 |
| Mar 7 | 0 24-39 | Philomela | 11.2 | 2.235 | | 12.3 | | 13 9.1 | 2 45 | 0.3 | 15 | 31 | 22 | n.e.Brazil, Cape Town | 150 | 140 | 1- | none | Herget |
| Mar 7 | 1 41 | Vibilia | 12.4 | 2.770 | 110036 | 9.1 | KO | 1 37.0 | 7 57 | 3.4 | 3 | 7 | 28 | north-central Canada | 39 | 49 | 1- | none | Herget77 |
| Mar 12 | 12 06-18 | Nysa | 11.1 | 1.965 | 159702 | 8.1 | A2 | 16 4.0 | -16 1 | 3.1 | 11 | 40 | 39 | western U.S.A. | 109 | 169 | 30+ | none | MPC11982 |
| Mar 13 | 13 29 | Vibilia | 12.4 | 2.825 | 110190 | 8.9 | KO | 1 50.0 | 9 20 | 3.6 | 3 | 7 | 28 | India, Burma | 37 | 43 | 41+ | all | Herget77 |
| Mar 15 | 19 29 | Wratislavia | 13.2 | 2.849 | 95466 | 9.1 | K2 | 6 13.3 | 15 31 | 4.1 | 14 | 29 | 26 | South Africa | 99 | 15 | 64+ | all | Goffin87 |
| Mar 16 | 9 39-53 | Chiron | 16.0 | 11.733 | | 10.0 | | 6 3.4 | 16 59 | 6.0 | 71 | 119 | 43 | northern Pacific Ocean | 96 | 21 | 70+ | all | Marsden |
| Mar 16 | 22 38 | Pales | 12.6 | 2.551 | | 12.4 | | 5 17.8 | 23 17 | 0.9 | 7 | 15 | 24 | Greenland, Scandinavia | 85 | 35 | 75+ | all | Herget77 |
| Mar 17 | 1 23 | Pretoria | 13.4 | 2.764 | 185039 | 10.0 | G5 | 17 4.4 | -28 4 | 3.4 | 13 | 25 | 23 | South Africa?n | 98 | 141 | 76+ | w 5W | MPC11333 |
| Mar 18 | 4 57-67 | Bamberga | 11.9 | 2.516 | 138118 | 9.2 | F5 | 11 15.3 | -2 17 | 2.8 | 13 | 18 | 16 | n.w. Africa, U.S.A. | 171 | 41 | 84+ | w 5W | MPC11724 |
| Mar 19 | 5 40-45 | Flora | 9.7 | 1.439 | 99376 | 8.8 | F8 | 10 55.5 | 15 45 | 1.3 | 14 | 23 | 15 | southern Pacific Ocean | 159 | 17 | 91+ | all | MPC11234 |
| Mar 27 | 10 43 | Victoria | 11.3 | 2.013 | | 11.5 | | 19 57.8 | -16 15 | 0.6 | 3 | 8 | 25 | Mexico?n, Cen. America | 68 | 58 | 78- | all | MPC12187 |
| Mar 28 | 1 26 | Psyche | 11.5 | 3.177 | 163429 | 9.3 | A3 | 20 15.6 | -17 43 | 2.4 | 9 | 12 | 17 | Middle East | 65 | 54 | 73- | all | Goffin87 |
| Mar 31 | 7 57 | Kleopatra | 12.5 | 3.081 | 143946 | 8.2 | B9 | 19 55.1 | -9 21 | 4.3 | 5 | 12 | 33 | Chile,Argentina,s.Brazil | 71 | 17 | 40- | all | EMP 1986 |

spectral-and-albedo classification scheme (taxonomy) given in the Asteroids II database, using the types given by David Tholen in his 1984 Ph.D. dissertation and amended by him in Asteroids II. Most of the old classes mentioned in *O.N. 4* (1), 7 have been retained, but several new classes are defined. A brief description of most classes is given below:

B C subclass, mainly members of Themis family
C carbonaceous, low albedo, most common outer belt
D dark (very low albedo), common for Trojans
E enstatite achondrites, high albedo
F flat spectrum
G C subclass, includes Ceres
I inconsistent data, can't classify
M metallic, moderate albedo
P pseudo-M, low albedo, spectra like M
Q Apollo (almost unique spectrum)

Table 2, Part A

| 1988 DATE | MINOR PLANET No. | Name | km-diam. | -// | RSOI | Type | Motion °/Day | P.A. | STAR SAO No | DM/ID No | D | Min. U. T. | Geocentric Sep. | S | COMPARISON DATA AGK3 No | Shift | Time | APPARENT R.A. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 9 | 150 | Nuwa | 157 | 0.07 | 663 | CX | 0.367 | 68°3 | | B2332185 | | 19h39m2 | 2"85S | C | | | | 23h30m9 | -2°36' |
| Jan 10 | 690 | Wratislavia | 156 | 0.10 | 762 | CPF | 0.200 | 263.2 | | | | 13 57.3 | 0.40N | C | | | | 6 25.2 | 15 39 |
| Jan 12 | 423 | Diotima | 217 | 0.13 | 1309 | C | 0.195 | 280.4 | | | | 6 46.0 | 2.03N | C | | | | 6 28.3 | 31 43 |
| Jan 13 | 53 | Kalypso | 119 | 0.14 | 353 | XC | 0.236 | 293.3 | 97455 | +16 1604 | | 2 10.8 | 7.25S | UH | N16° 836 | 0"38 | 0m4 | 7 59.6 | 16 0 |
| Jan 13 | | Venus | 12220 | 10.75 | | | 1.252 | 90.7 | 186495 | C2314092 | | 3 31.0 | 5.98N | HU | | 0.21 | -0.0 | 18 13.0 | -23 6 |
| Jan 14 | 4 | Vesta | 501 | 0.26 | 3143 | V | 0.484 | 100.6 | 159716 | -15 4250 | | 16 40.8 | 3.10S | UX | | 0.10 | -0.5 | 16 7.0 | -15 37 |
| Jan 20 | 2060 | Chiron | 400 | 0.05 | 12340 | B | 0.055 | 274.8 | | | | 21 39.3 | 0.60N | C | | | | 6 10.9 | 16 36 |
| Jan 24 | 275 | Sapientia | 103 | 0.09 | 334 | X | 0.222 | 288.3 | | L 4 1093 | | 14 22.6 | 3.07S | H | | | | 7 27.0 | 19 28 |
| Jan 25 | 346 | Hermentaria | 110 | 0.04 | 443 | S | 0.348 | 96.1 | 160464 | -19 4602 | A | 11 3.1 | 3.06N | UY | | -1.20 | -0.3 | 17 19.4 | -19 58 |
| Jan 26 | 911 | Agamemnon | 175 | 0.06 | 1545 | D | 0.118 | 277.0 | 99160 | +14 2252 | | 12 26.9 | 2.10S | UX | N14 1122 | 0.20 | -0.6 | 10 29.2 | 14 12 |
| Jan 28 | 18 | Melpomene | 148 | 0.10 | 425 | S | 0.559 | 65.1 | 129169 | - 3 161 | | 8 23.6 | 3.83N | UY | | -0.12 | 0.3 | 1 11.2 | -2 19 |
| Feb 1 | 275 | Sapientia | 103 | 0.09 | 333 | X | 0.192 | 290.0 | | | | 2 0.3 | 3.10N | C | | | | 7 20.7 | 19 58 |
| Feb 2 | 6 | Hebe | 186 | 0.17 | 814 | S | 0.281 | 305.9 | | | | 7 20.2 | 3.88N | C | | | | 8 16.6 | 14 33 |
| Feb 3 | | Mars | 6782 | 7.25 | | | 0.579 | 70.1 | 92912 | +14 388 | | 3 3.2 | 7.68N | UX | N15 203 | 0.02 | 0.1 | 2 22.7 | 15 18 |
| Feb 3 | 146 | Lucina | 140 | 0.06 | 615 | C | 0.338 | 57.6 | 128977 | - 5 134 | | 4 24.7 | 0.75S | US | | -0.22 | -0.4 | 49.8 | -5 11 |
| Feb 6 | 3 | Juno | 267 | 0.24 | 1407 | S | 0.242 | 307.3 | 118247 | + 2 2316 | | 2 21.7 | 2.17S | US | | 0.18 | 0.4 | 10 20.4 | 1 58 |
| Feb 7 | 171 | Ophelia | 121 | 0.07 | 483 | C | 0.130 | 102.7 | 139755 | - 9 3863 | | 11 43.3 | 2.24S | UX | | -0.52 | 0.3 | 14 8.3 | -9 47 |
| Feb 10 | 846 | Lipperta | 54 | 0.03 | 136 | CBU: | 0.216 | 77.3 | 93557 | +19 578 | V | 10 45.4 | 0.03N | 3P | N19 286 | 0.17 | -0.2 | 3 41.7 | 19 40 |
| Feb 12 | 106 | Dione | 147 | 0.09 | 765 | G | 0.200 | 293.4 | | +17 2232 | | 17 29.0 | 0.52N | XA | N16 1114 | 0.15 | 0.5 | 10 28.9 | 16 34 |
| Feb 17 | | Mars | 6782 | 6.56 | | | 0.594 | 72.7 | 93195 | +17 458 | | 9 27.5 | 5.09S | 3P | N17 257 | 0.15 | -0.1 | 2 55.8 | 17 59 |
| Feb 19 | 19 | Fortuna | 171 | 0.08 | 784 | G | 0.341 | 88.8 | 186069 | C2212401 | | 10 48.9 | 1.17N | UH | | -0.04 | 0.1 | 17 59.4 | -2[illegible] 33 |
| Feb 21 | 36 | Atalante | 124 | 0.09 | 498 | C | 0.268 | 274.9 | | +18 2445 | | 3 52.4 | 4.33S | A | N17 1186 | | | 11 3.8 | 17 33 |
| Feb 23 | 751 | Faina | 115 | 0.07 | 372 | C | 0.308 | 65.6 | 76355 | +22 608 | A | 13 19.7 | 2.14S | UX | N22 371 | -0.36 | 0.1 | 3 57.1 | 22 54 |
| Feb 23 | 751 | Faina | 115 | 0.07 | 372 | C | 0.308 | 65.6 | 76355 | +22 608 | B | 13 19.9 | 0.09S | U | N22 371 | | | 3 57.1 | 22 54 |
| Feb 24 | 760 | Massinga | 75 | 0.06 | 217 | SU | 0.165 | 245.5 | | +25 1918 | | 4 15.0 | 2.05N | XA | N25 979 | -0.24 | 1.8 | 8 25.1 | 25 13 |
| Feb 25 | 205 | Martha | 84 | 0.04 | 282 | C | 0.314 | 80.3 | 160998 | -17 4987 | | 15 48.9 | 3.12S | FU | | 0.07 | 0.2 | 18 0.8 | -17 10 |
| Feb 25 | 69 | Hesperia | 143 | 0.09 | 548 | M | 0.204 | 67.1 | | +12 748 | | 19 11.1 | 5.23S | A | N12 528 | | | 5 13.0 | 12 53 |
| Feb 28 | 87 | Sylvia | 271 | 0.12 | 2142 | P | 0.052 | 318.8 | | L 2 4415 | | 19 15.9 | 1.17N | H | | | | 14 9.9 | -1 24 |
| Mar 5 | 313 | Chaldaea | 101 | 0.06 | 320 | C | 0.303 | 77.1 | 160730 | -12 4799 | | 7 18.3 | 1.54N | US | | -0.73 | -0.9 | 17 39.2 | -12 44 |
| Mar 5 | 205 | Martha | 84 | 0.04 | 282 | C | 0.296 | 77.9 | 161155 | -16 4744 | | 12 16.1 | 3.66N | UH | | 0.18 | 0.4 | 18 10.6 | -16 43 |
| Mar 7 | 196 | Philomela | 146 | 0.09 | 712 | S | 0.141 | 299.6 | | L 2 1333 | | 29.8 | 2.23S | H | | | | 13 11.1 | 2 33 |
| Mar 7 | 144 | Vibilia | 146 | 0.07 | 478 | C | 0.538 | 66.3 | 110036 | + 7 253 | | 1 39.6 | 2.19N | XA | N 7 188 | -0.25 | -0.2 | 1 39.1 | 8 9 |
| Mar 12 | 44 | Nysa | 73 | 0.05 | 199 | E | 0.116 | 86.3 | 159702 | -15 4246 | | 12 13.6 | 3.75N | U7 | | -0.20 | 0.2 | 16 6.3 | -16 7 |
| Mar 13 | 144 | Vibilia | 146 | 0.07 | 480 | C | 0.539 | 67.0 | 110190 | + 8 288 | | 13 27.3 | 0.31S | XA | N 9 179 | -0.13 | 0.0 | 1 52.1 | 9 32 |
| Mar 15 | 690 | Wratislavia | 156 | 0.08 | 791 | CPF | 0.132 | 87.2 | 95466 | +15 1134 | | 19 25.5 | 2.11S | UA | N15 592 | 0.09 | 0.3 | 6 15.6 | 15 30 |
| Mar 16 | 2060 | Chiron | 400 | 0.05 | 12233 | B | 0.016 | 60.4 | | A1746194 | | 9 35.2 | 1.19N | C | | | | 6 5.7 | 16 59 |
| Mar 16 | 49 | Pales | 154 | 0.08 | 652 | CG | 0.280 | 89.1 | | | | 22 36.7 | 2.69N | C | | | | 5 20.2 | 23 19 |
| Mar 17 | 790 | Pretoria | 176 | 0.09 | 923 | P | 0.156 | 78.1 | 185039 | C2711467 | | 1 27.7 | 0.76S | G | | | | 17 6.9 | -28 7 |
| Mar 18 | 324 | Bamberga | 228 | 0.12 | 1553 | CP | 0.223 | 286.5 | 138118 | - 1 2506 | | 4 2.3 | 1.89N | UX | S 2 652 | 0.22 | 0.4 | 11 17.3 | -2 30 |
| Mar 19 | 8 | Flora | 141 | 0.14 | 517 | S | 0.233 | 292.4 | 99376 | +16 2193 | | 5 42.6 | 5.79S | UA | N15 1197 | 0.33 | 0.8 | 10 57.6 | 15 32 |
| Mar 27 | 12 | Victoria | 117 | 0.08 | 307 | S | 0.553 | 71.6 | | L 5 2162 | | 10 45.6 | 2.51N | H | | | | 20 0.0 | -16 9 |
| Mar 28 | 16 | Psyche | 264 | 0.11 | 1600 | M | 0.317s | 76.8 | 163429 | -18 5644 | | 1 28.2 | 2.29N | UH | | -0.15 | -0.2 | 20 17.8 | -17 36 |
| Mar 31 | 216 | Kleopatra | 137 | 0.06 | 603 | M | 0.298 | 66.2 | 143946 | - 9 5302 | | 8 0.2 | 0.36S | US | | 0.48 | -0.5 | 19 57.2 | -9 15 |

S silicate, moderate albedo, most common inner belt
T transition between S and D; not real subclass?
V Vesta (almost unique spectrum)
X E or M or P (current data can't distinguish; these have similar spectra, and differ only in albedo)

Tholen notes that his spectral/albedo "cluster analysis" defines 7 major classes: A (no special description), C, D, E, M, P, and S. In some cases, an asteroid's characteristics place it in an area between 2 or 3 of these classes, in which case, each of the applicable class letters is used. Besides the other subclass and special types given above, Tholen also uses the following suffixes:

| | |
|---|---|
| U | unusual spectrum, far from class cluster center |
| : | noisy data |
| :: | very noisy data |
| --- | data too noisy to permit classification. |

*Astrometric updates.* The main source for astrometric updates is my recorded message on the IOTA occultation line, telephone 301,474-4945. Information can also often be obtained from other recordings at 312 [changes to 708 on 11/11/89] 259-2376 (Chicago) or 713,488-6871 (Houston). Call 301,474-4722 if you want to talk to me, rather than just obtain a prediction update.

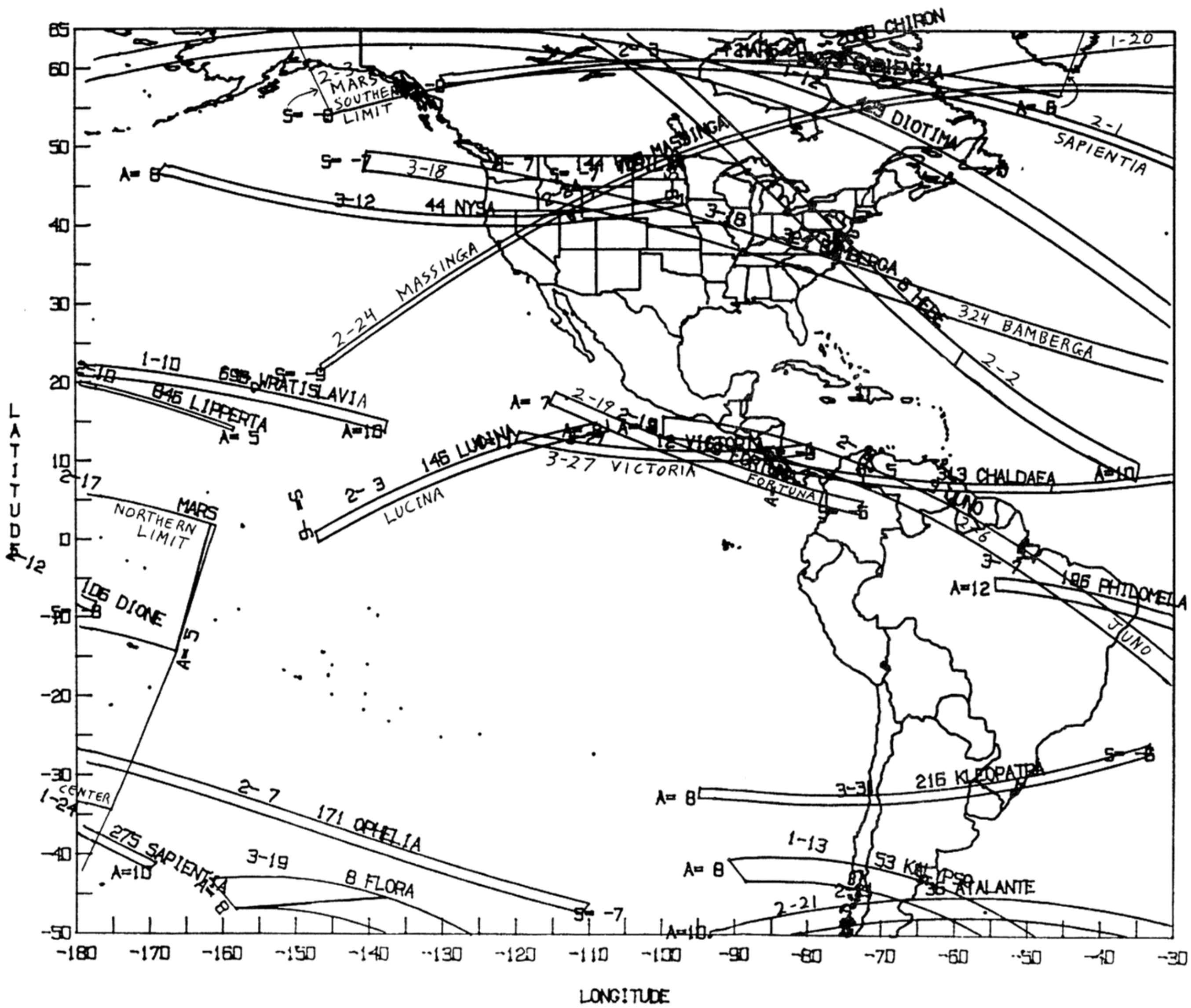
No lists of priority events for astrometry for 1989 are available as this goes to press. However, Bob Millis informs me that the next event that Lowell Observatory will try to improve with astrometry will be the March 18th occultation by Bamberga. Bill Penhallow will try to obtain astrometric updates for some earlier events. I plan to include a priority list in the next issue.

*Notes about individual events.* Wayne Warren supplied important information about some stars, especially doubles.

Jan. 13, Venus and SAO 186495: Venus will be 94% sunlit. The reappearance will be on the dark crescent, 0"6 wide at most.

Jan. 14: (4) Vesta is either the 2nd or 3rd largest asteroid, and the largest for which there are no previous occultations of stars observed. Conse-

PLANETARY OCCULTATIONS. 1989 JAN. - MAR.



quently, any observations of this occultation would be extremely valuable.

Jan. 20: The predicted path for this distant mysterious asteroid (large comet?) is very uncertain, so observers much farther south may see an occultation. The diameter is also poorly known. Observation will be hindered by the nearby full Moon.

Jan. 25: The star is Aitken's Double Star (ADS) 4602. The 13.2-mag. companion, 10".8 away in position angle (P.A.) 258°, will not be occulted.

Jan. 28: The star is 34 Ceti and has an angular diameter on 0".0021, requiring 0.09 second for the edge of the asteroid to cover for a central occultation. A secondary extinction recorded during an occultation by Melpomene in 1978 suggests that the asteroid may have a satellite.

Feb. 3, Mars and SAO 92912: Mars will be 89% sunlit. The disappearance will be on the dark crescent, 0".8 wide at most.

Feb. 3, (146) Lucina and SAO 128977: A secondary extinction recorded during an occultation in 1982 suggests a possible small satellite of Lucina.

Feb. 10: The star is 13 Tauri = Z.C. 531, a suspected spectroscopic binary. Duplicity was not evident during a spectacular lunar graze of the star that several observers (including me) timed in Quebec in 1966 April, during the first international graze expedition led by Tom Van Flandern.

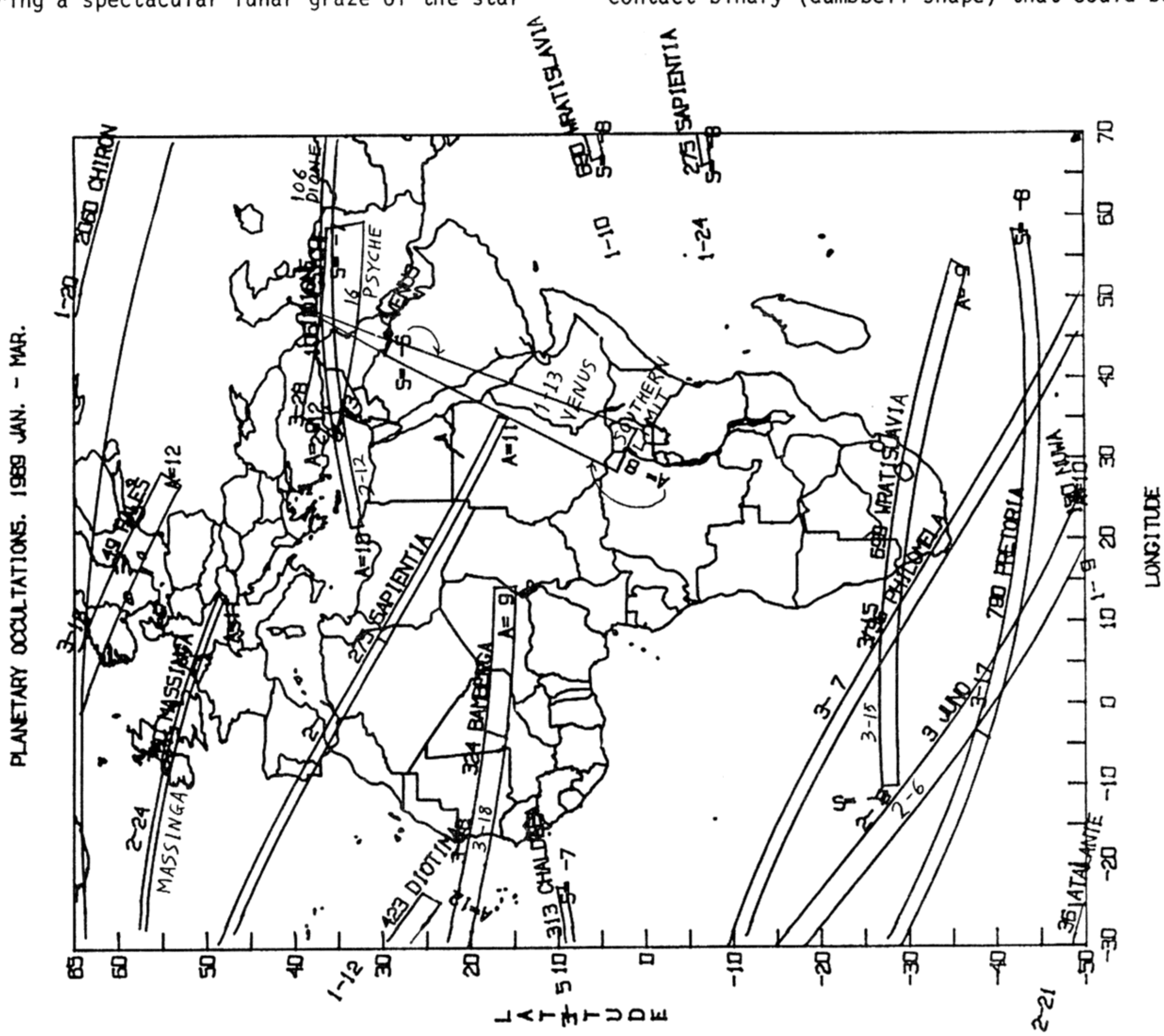
Feb. 17: The star is Rho Arietis = Z.C. 433. Mars will be 89% sunlit. The disappearance will be on the dark crescent, 0".7 wide at most. A central flash might be seen north of Sydney.

Feb. 23: Separate paths are calculated for the components of this double star, Couteau 364, with separation 2".05 in P.A. 150°. If the seeing is not good enough to resolve the stars, the apparent Δm will be 1.9 if component A is occulted, rather than the 5.0 given in the table that assumes that it is clearly resolved. In case of poor seeing and an occultation of component B, the apparent Δm will be only 0.21, not the tabular 3.4 for clear resolution.

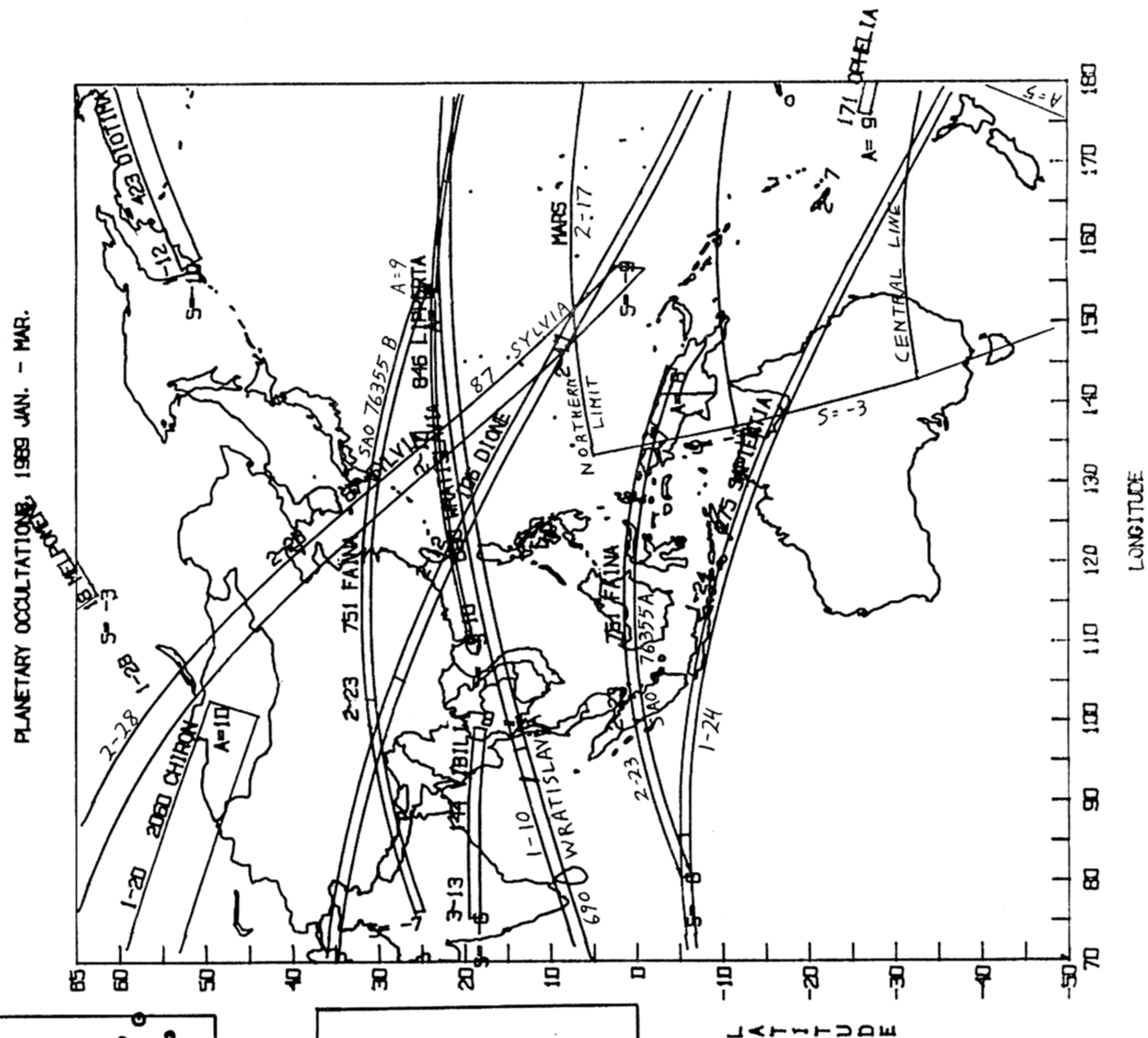
Feb. 25, (205) Martha and SAO 160998: The star, 6 Sagittarii = Z.C. 2594, has an angular diameter of 0".0012, requiring 0.09 second for the edge of the asteroid to cover for a central occultation.

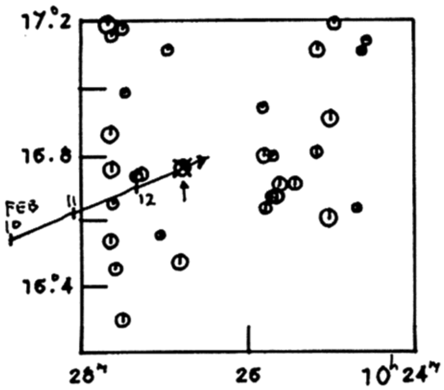
Mar. 15: The star has an angular diameter of 0".00031, requiring 0.06 second for the edge of the asteroid to cover for a central occultation.

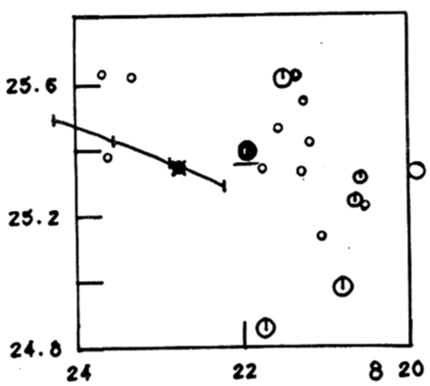
Mar. 31: Radar observations of (216) Kleopatra, and its large-amplitude light curve, indicate a probable contact binary (dumbbell shape) that could be con-

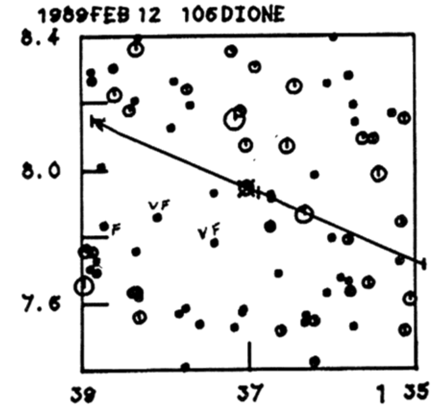


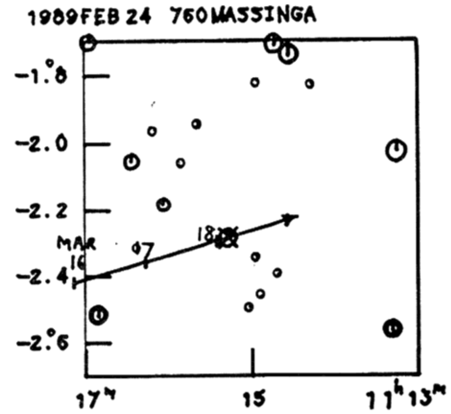
firmed with occultation observations. A confirmed secondary extinction during an occultation in 1980 October (it occurred at minimum light, when the "dumbbell" was probably end-on and not resolvable) suggests a possible small satellite.



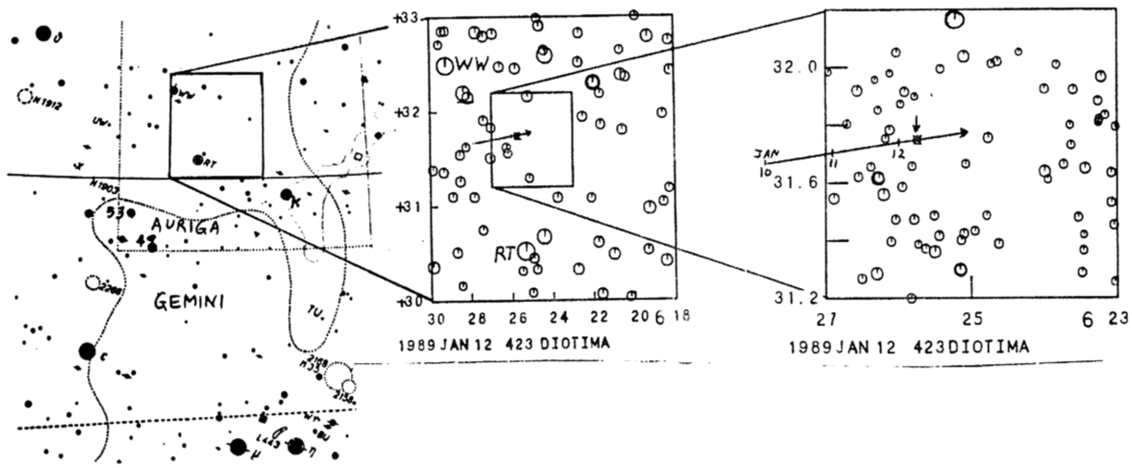


1989FEB 12 106DIONE

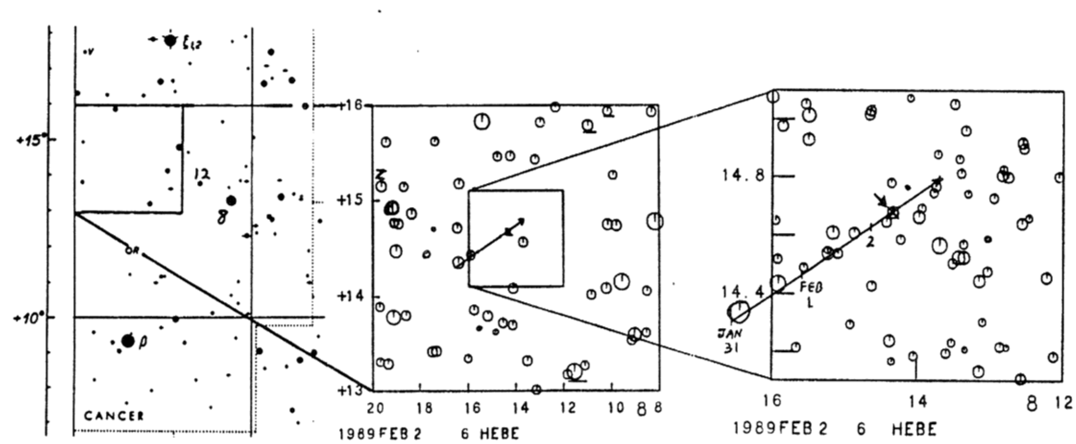

1989FEB 24 760MASSINGA

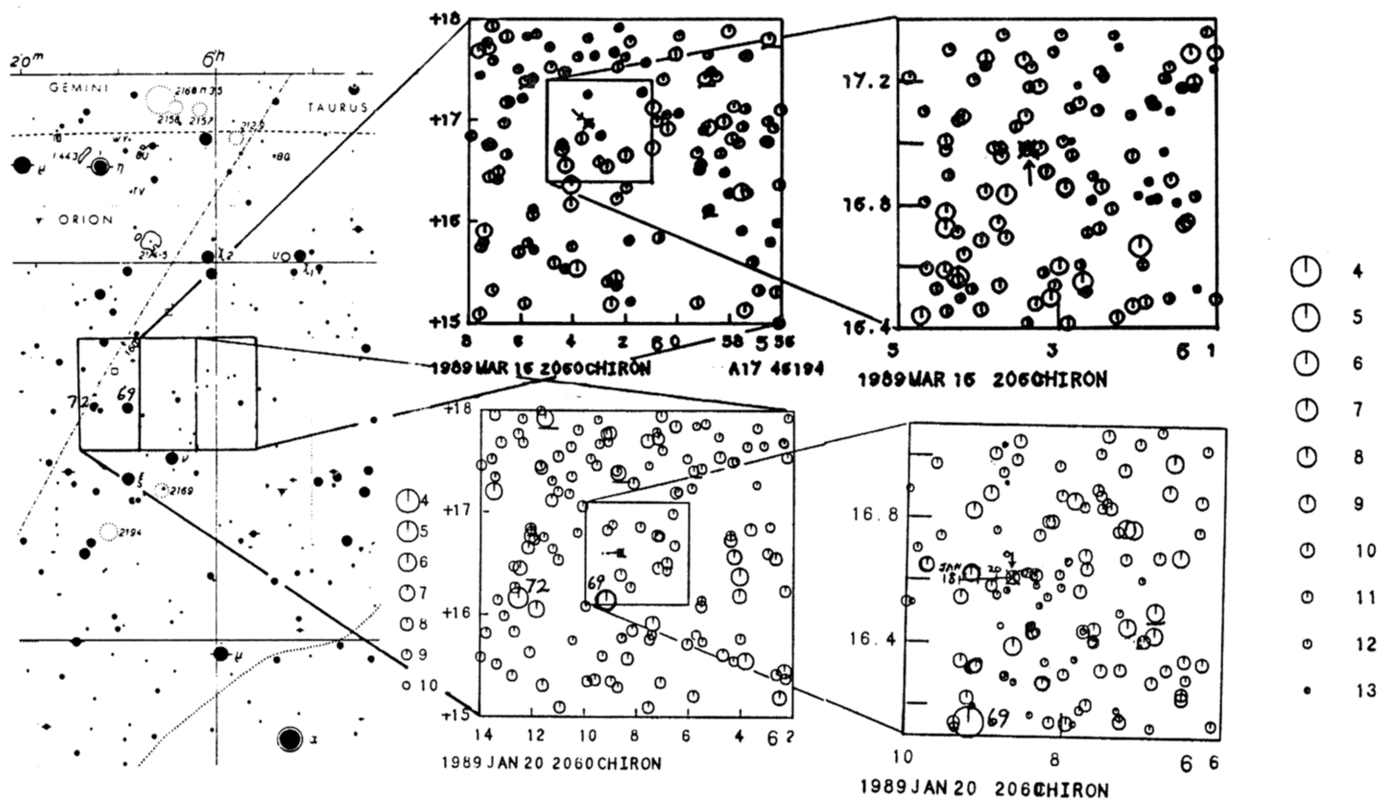

1989MAR 7 144VIBILIA SAO 110036

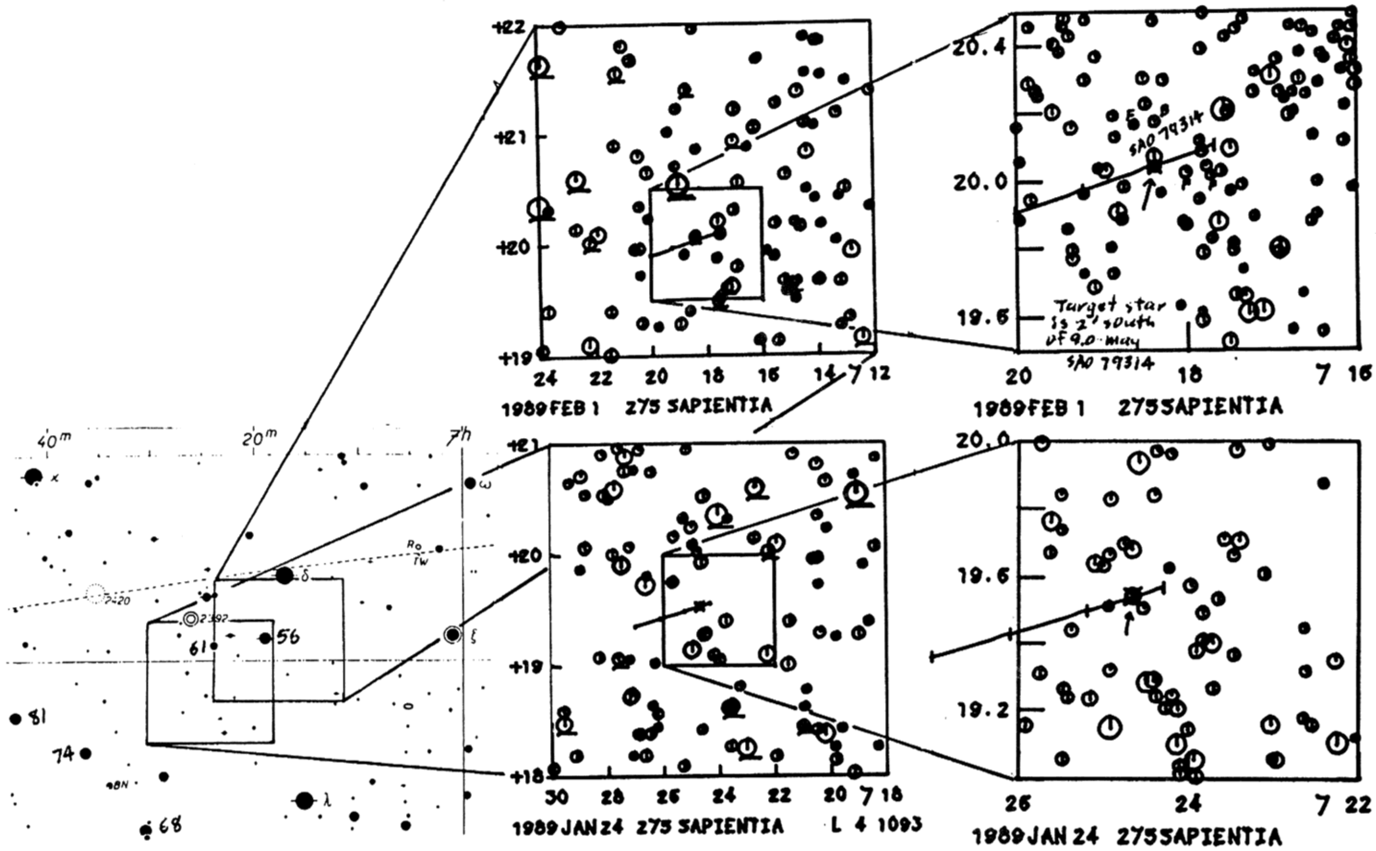

1989MAR 18 324BAMBERGA SAO 138118

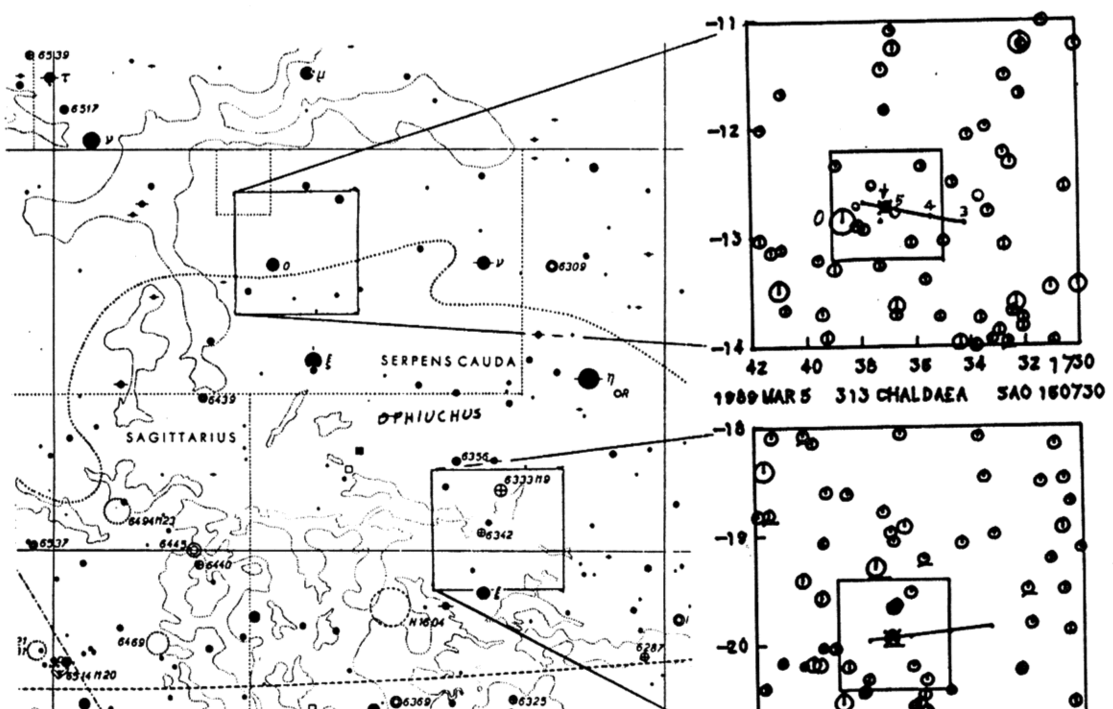
Edwin Goffin has produced finder charts for these events in his supplements, already distributed to observers. These 1° charts show fainter stars that are not on Goffin's charts.

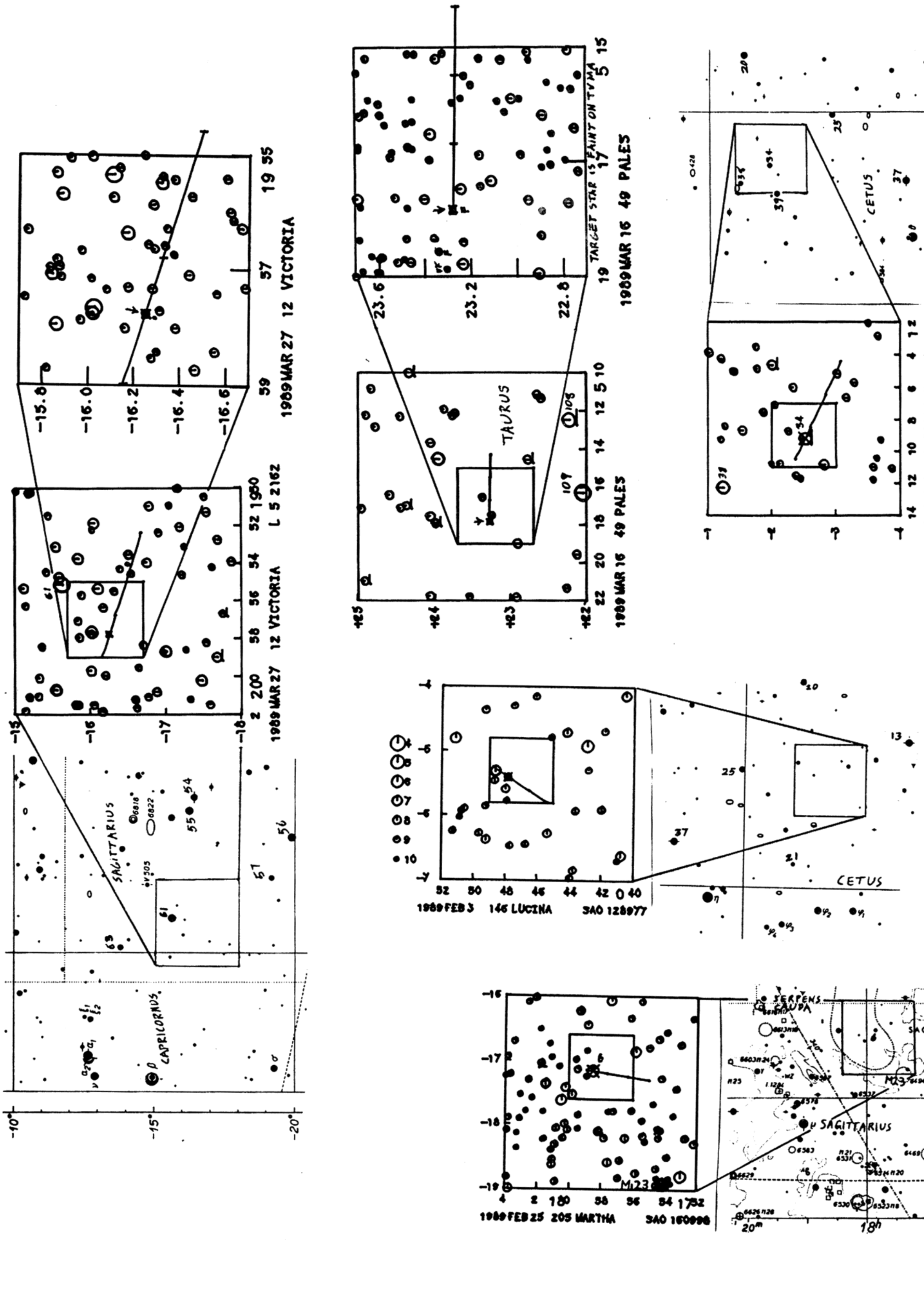

AURIGA
GEMINI
1989 JAN 12 423 DIOTIMA
1989 JAN 12 423 DIOTIMA


CANCER
1989 FEB 2 6 HEBE
1989 FEB 2 6 HEBE


GEMINI
TAURUS
ORION
1989 MAR 16 2060 CHIRON
A17 46194
1989 MAR 16 2060 CHIRON
1989 JAN 20 2060 CHIRON
1989 JAN 20 2060 CHIRON

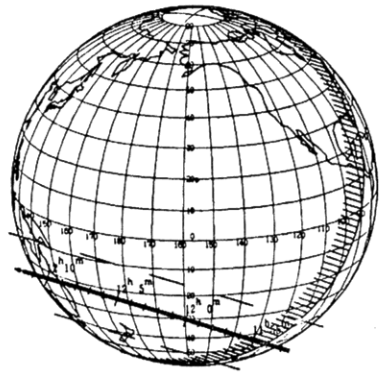

1989 FEB 1 275 SAPIENTIA
1989 FEB 1 275 SAPIENTIA
SAO 79314
Target star is 2' south of 9.0 mag SAO 79314
1989 JAN 24 275 SAPIENTIA L 4 1093
1989 JAN 24 275 SAPIENTIA


SERPENS CAUDA
OPHIUCHUS
SAGITTARIUS
1989 MAR 5 313 CHALDAEA SAO 160730
1989 JAN 25 346 HERMENTARI SAO 160464


1989 MAR 27 12 VICTORIA
1989 MAR 27 12 VICTORIA L 5 2162
SAGITTARIUS
CAPRICORNUS
TARGET STAR IS FAINT ON TV MA
1989 MAR 16 49 PALES
TAURUS
1989 MAR 16 49 PALES
CETUS
18 MELPOMENE
1989 FEB 3 146 LUCINA SAO 128977
CETUS
1989 FEB 25 205 MARTHA
SERPENS CAUDA
SAGITTARIUS

These are the remaining 1988 events not shown in Goffin's supplement.

+30°1347 by Diotima 1988 Dec 18



L 4 3045 by Sapientia 1988 Dec 25

L 1 4688 by Hebe 1988 Dec 29