Occultation Newsletter

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FROM THE PUBLISHER

For subscription purposes, this is the third issue of 1992. It is the ninth issue of Volume 5. IOTA annual membership dues, including ON and supplements for

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

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

Asteroidal occultation supplements will be available at extra cost: for South America via Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe via Roland Boninsegna (Rue de Mariembourg, 33; B-6381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa via M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand via Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan via Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all other areas will be available from Jim Stamm (117891 N. Joi Drive; Tucson, AZ 85737; USA) for $2.50.

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

IOTA NEWS

David W. Dunham

Very Time-Critical Events are described in the articles about occultations during the December 9-10 total lunar eclipse (p. 227) and the close (4179) Toutatis flyby (p. 233); you should read these articles first, since events may happen in your area tonight!

IOTA/ES and Dutch Business Meetings: The annual business meeting of the European Section of IOTA, organized by Hans Bode, will meet on Saturday, November 21st, in Hannover, Germany. Also, the same day, members of the two occultation organizations in the Netherlands are meeting to find ways to cooperate better on various projects. Unfortunately, most readers will receive this after these meetings, whose main purposes are, however, not scientific. They have been announced beforehand to those most likely to attend by other means.

North American Asteroidal Occultation Supplement for 1993: Predictions of asteroidal occultations visible from North America during 1993, generated by Edwin Goffin with events selected by Jim Stamm and charts annotated by David Werner, are being distributed with this issue.

Timekubes Discontinued: Unfortunately, the convenient "Realistic Weatheradio-Timekube", model 12-148, is being phased out by Radio Shack (Tandy Corp.) and is not listed in their latest catalog. Stores in the U.S.A. are selling them for $14.95 to get rid of remaining stock, a real bargain considering their normal retail price is nearly $40. Most stores no longer have them, but it is worthwhile to go through the Yellow Pages phoning the Radio Shacks in your area to see if you can take advantage of this bargain.

For those who can't get Timekubes, it will be necessary to use more expensive short-wave receivers (those with digital tuning are recommended since it is easy to mistune, or lose, a signal with dial tuning); call 900-410-8463 via AT&T to get Naval Observatory master clock signals by land lines; or have someone record a master tape of WWV and a preselected strong local AM standard-broadcast station for special events, so that others can use car and other small radios to record the AM station as a time base. There is hope; one Radio Shack clerk I spoke to recently said that there was such demand for the remaining Weatheradio-Timekubes that Tandy is considering marketing them again.

Electronic Mail Addresses: My main E-mail address, on Internet, is now:
dunhamdw@space2.spacenet.jhuapl.edu
I access it at least once each day that I am in my office. Although I still have two other E-mail addresses, nssdca::dunham on Decnet (Internet equivalent address is dunham@nssdca.gsfc.nasa.gov) and ddunham on GSFCMAIL, I access those addresses less frequently. Nevertheless, it is better to use them on weekends and holidays. Also, I noticed once that Internet messages were not delivered for 3 days, then were sent to me all at once, possibly due to local computer maintenance. For critical items, send to both Internet and one of the other addresses, or telephone during the day or evening: 1-301-474-4722 (with answering machine when we can't answer).

Express and other rapid mail: Please do not send express mail or Federal Express mail to our Greenbelt address given in the masthead, unless you live in the U.S.A. and sign the box waiving the need to obtain the addressee's (our) signature; never send registered or certified mail there. These slow down delivery, since often nobody is home to sign the receipt, and then we need to make a special trip to the Post Office or Federal Express office to collect the item, a nuisance for us. If you have to use these rapid forms of mail requiring a signature, please send them to my office address: Bldg. 23, Room 376; Applied Physics Laboratory; 11100 Johns Hopkins Road; Laurel, Maryland 20723-6099; telephone 1-301-953-5000, x3916. Such items for Joan should be sent to her at: Room 4A; Computer Sciences Corp.; 10110 Aerospace Road; Lanham, Maryland 20706; telephone 1-301-794-1791. Expensive items should be sent to one of the office addresses.

Ceres Occultation on October 30: The title of the article on p. 204 of the last **ON** should have ended with "OCTOBER 30" rather than "OCTOBER 307". In the first sentence of the last paragraph on p. 205, "Pallas" should have been "Ceres". But more serious problems in the October 30th event were found by Australian astronomers, who found that SAO 189263's V-magnitude was actually 9.3, indicating that the magnitude drop would be only about 0.6, difficult for visual observers; and whose astrometry on Oct. 27 at Siding Spring (by McNaught) indicated that the path shifted far to the south, completely off Australia to New Zealand, where the altitude would be relatively low. Graham Blow, trying to monitor the star at Mt. John Observatory, reported some problems with cirrus that prevented an unambiguous observation at the low altitude. In any case, nobody from the USA attempted this event, due to the great uncertainty in the event's location from preliminary astrometry by Peter Birch at Perth. I hope that some of the other events listed on p. 206 of the last **ON** will be better.

Next Issue: The main purpose of this issue is to provide information about occultations during the favorable total lunar eclipse of 1992 December 9-10. Adding predictions of occultations and appulses by (4179) Toutatis, also mainly during early December, caused some additional delay in this issue. Asteroidal and planetary occultations for 1993 will be the main emphasis for the next issue. Also, I plan to include a report of the interesting European Symposium on Occultation Projects (ESOP-XI) meeting held in Castel Gandolfo, Italy, in August; I did not have time to complete the report for this issue. Henk Bulder's report of the μ Geminorum graze observed before the meeting will follow the ESOP-XI report. Also in the next issue will be an article, "Organizing a Safe Expedition", giving IOTA guidelines for setting up grazing and asteroidal occultation expeditions. We expect to complete the issue and distribute it before the holidays at the end of 1992. If you plan to submit an article for that issue, we should have it by the time of the December lunar eclipse (December 9-10).

REPORT OF 10th ANNUAL IOTA MEETING

Rocky Harper, Executive Secretary

The 1992 annual meeting of the International Occultation Timing Association was held on October 3 at the Lunar and Planetary Institute, Houston, Texas. The meeting began at 9:00am with the call to order by president David Dunham. Twelve members were present, including the Dunhams from Greenbelt, Maryland.; the McManuses from Topeka, Kansas; Dan Falla from San Diego, California; and Rick Frankenberger and Todd Schell from San Antonio, Texas. The others were all from the Houston, Texas area. Visitors from the Houston Astronomical Society and the JSC Astronomical Society also attended.

The first order of business was the election of officers. As of this writing, a total of 93 ballots have been received by mail. Eight members present who had not mailed a ballot voted at the meeting. The slate of officers was unanimously elected, with enough ballots to constitute a valid election. The officers for the next three years are:

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

The election was followed by a discussion concerning the newsletter by Joan Dunham. She has been collecting newsletters from various groups to see what ideas others may have. At present she uses WordPerfect 5.1 with a Panasonic 24-pin dot matrix printer. She plans on purchasing a laser printer sometime in the future. The Dunhams' and Wayne Warren's IOTA Observer's Manual (first edition) was passed around for members to see. The handsome book is a vast improvement over the old Preliminary Occultation Manual. The final version will be released after review by David and others.

Next, Terri McManus gave the financial report that showed IOTA to be good shape. The newsletter and mailing were the most significant cost.

David Dunham gave a talk on the status of IOTA software. On October 1 at 6:00pm EDT the USNO mainframe computer was shut down as scheduled. David had it to himself the last two nights, however, and generated the 1993 totals as well the BEFILE (Besselian elements) for 1994 using the USNO OCC program. He also talked about Mitsuro Sôma and his OCCRED program, which is similar to OCC. The PC version of the Evans program, written by Claudio Costa of Italy, was also discussed. Hopefully, this program will be distributed to the national coordinators sometime in 1993. The program requires 80 Mb of disk space to run. Craig McManus gave a short talk about his testing of Gordon Taylor's IBM PC program LOP (Lunar Occultation Package). Craig reports that the program is accurate but very slow and doesn't have any rejection routines. It calculates every disappearance and reappearance regardless. For example, it will calculate the reappearance of an 8.7-magnitude star on the bright edge even though the Moon is 30° below the horizon.

The next topic was the October 30, 1992 occultation of SAO 189263 by Ceres. The preliminary path shows it to cross Australia. Several expeditions are planned, including one from the USA led by Paul Maley. At the time of the meeting everyone was waiting for better astrometry to determine exactly where to go. It was pointed out by David that southern SAO star positions are not very accurate, especially below -30° in declination.

David showed a video of occultations he took during the June 14/15 partial lunar eclipse. A lunch break was taken after the video showing.

After lunch, the meeting resumed with discussion about eclipses and grazes for the remainder of 1992. First on the agenda was the December 9 total lunar eclipse. Many occultations should be observed because the field has more than 4000 stars. Next was the description of the two 1993 lunar eclipses that occur on June 4 and November 29. There was also mention of the November 6, 1993 transit of Mercury. A look at the 1993 graze prospects showed some interesting events. It was proposed by David that the next annual IOTA meeting be held on September 13 at the LPI. The meeting will coincide with a spectacular graze of α Cancri in the Houston area.

The asteroid events were next on the agenda. David talked about 1992 asteroidal occultations. One in particular was the September 12 occultation by (344)

Desiderata of the 8.5-magnitude star SAO 147843. The preliminary path crossed the northern USA, but last-minute astrometry obtained at Lowell Observatory showed a shift to south Texas, where Rick Frankenberger observed the occultation. It was pointed out that the December 17th occultation of a double star by (36) Atalante should be interesting. Next, the 1993 asteroid events were discussed. There will be several interesting occultations toward the end of the year. Also, on January 8 at 10.7 UT, Jupiter will occult an 11.7 magnitude star.

A break was taken from 2:00pm until 3:45pm to go watch a local air show a few miles away. The U.S. Navy's Blue Angles performed their incredible skills at flying jets; the show was certainly a treat.

The next item of the IOTA meeting concerned video developments. Craig McManus gave a talk on the HART team's video setup and its unique time insertion technique. He then described software to be used to manipulate video images. He also passed around a copy of the "Zodiacal Sky Atlas 2000.0" for members to view. See **ON** 5 (7), p. 182 for a description.

David gave details of the ESOP-XI meeting held August 28-30 near Rome, Italy. He showed photographs of the area and also talked about the μ Geminorum graze that was observed preceding the meeting. It sounded like a great time was had by all and some excellent ideas shared.

The last item was a general discussion about educating the public more about the value of occultation work. Joan had some excellent transparencies showing how the occultation process works. They were produced by the company where she works for a public exposition for employees and local high school students. Paul Maley suggested that a video be made showing how to lead a grazing expedition, survey sites, etc. It was pointed out that with the completion of the manual things should improve.

The idea of an e-mail network was also discussed. Members are encouraged to send the McManuses an e-mail address if you have one. The advantage would be for David to alert people in the case of shifted asteroid paths. David also mentioned the possibility of IOTA getting information broadcast on the cable Weather Channel based in Atlanta. Perhaps they could provide occultation information in a 5-minute slot on a weekly late-night basis, with shorter weather updates for important events more frequently. They have done something like this before on the visibility of comets.

The meeting adjourned at 6:00pm, but most members continued discussion over dinner at a local restaurant. Later in the evening several IOTA meeting attendees went to a star party at Challenger 7 Memorial Park hosted by the Johnson Space Center Astronomical Society. Tim Lawrence, of the JSCAS, graciously let David attach his image intensifier and camera to his telescope. Many people were treated to their first look at a lunar occultation as they watched the TV monitor.

ERRONEOUS PREDICTIONS OF LICK2 STARS FOR 1993

Edwin Goffin

In their article on p. 218 of the last issue of **ON**, David Dunham and David Werner issued a warning that some of my predictions of occultations of stars from the Lick 2 catalogue are in error. I was unaware of this, but had figured out the cause before I finished reading the article. Contrary to what the authors wrote, I don't attribute it to a "programme bug", but rather to a "booby trap" incorporated in the catalogue itself.

The handwritten explanation to the catalogue stated that the declinations are given in the format ±DDMMSSSS, i.e. with the sign explicitly given and in a fixed position. As I found out after reading the article, the + sign is never given, which is not a problem. However, only the significant digits of the declinations are given with the - sign preceding the first significant digit, thus making it "wander" for all declinations less than 10° (absolute value).

I adapted the programme to cope with this dangerous practice, redid the transformation to J2000, recalculated the occultations for the Lick Saturn catalogue and sent the new results to David Dunham.

[Note added by D. Dunham: This error affected only stars with declinations between 0° and -10°; charts and data for Lick2 stars outside this range are all right. As the author of merged Lick-Voyager catalogs, and their handwritten explanation, I must accept blame for this problem, and apologize for the misunderstandings I created. The new results have been included in the 1993 North American Asteroidal

Occultation Supplement, and have also been sent to Jim Stamm for distribution to regional coordinators.]

BRIGHT STARS MISSING FROM PPM CHARTS

David W. Dunham

Edwin Goffin used the new PPM catalog for the predictions and finder charts for many of his asteroidal occultations for 1993. Unfortunately, several hundred of the brightest stars are missing from this catalog, so those annotating the charts for further distribution should check especially the small 15° charts with an Atlas such as Norton's or Tirion's and add the missing stars. The bright stars have been added in the final version of the southern part of PPM, which was completed in October. There are still some missing bright stars in the northern PPM, but these can be found with the ACRS catalog (which I provided to E. Goffin in August) and/or the FK5 and its extensions.

OCCULTATIONS DURING THE TOTAL LUNAR ECLIPSE OF 1992 DECEMBER 9-10

David W. Dunham

This eclipse, visible from Europe and Africa, the eastern parts of North and South America, and western and central Asia, may be even darker than the 1963 December and 1982 December eclipses, due to material still in the atmosphere from the eruptions of Mt. Pinatubo last year. The extreme darkness of the umbra during last June's partial eclipse was described on page 208 of the last issue. During totality this December, the Moon will probably disappear from naked-eye visibility. This coupled with the dense Milky Way star field in Taurus will make this eclipse perhaps the best in our lifetimes for observing occultations of numerous faint stars. The eclipses next year may not be so dark, since the Pinatubo dust in the upper atmosphere is decreasing and those eclipse star fields are not as dense as this December's. This December's eclipse deserves a maximum observational effort.

You should resist the urge by other amateur astronomers to use this as only a public relations event, or at best one suitable only for timing the passage of the edge of the umbra across craters during the partial phases, or of using the brief darkness of totality to look for Toutatis or other special objects far from the Moon, all of which can be accomplished with relatively small telescopes. Try to gain access to the largest telescope possible and concentrate on timing occultations around the entire Moon's limb; especially pay attention to reappearances, which are often under-observed during eclipses. Such timings have special value for accurately connecting the Moon's eastern and western hemispheres, specifically, for obtaining corrections to Watts' lunar profile reference system. Observations of grazing and near-grazing occultations during lunar eclipses are particularly useful for refining information about the lunar profile that causes Bailey's bead phenomena during solar eclipses. Such data permit the refining of analyses of solar eclipse data for determination of small variations of the solar diameter. More information about the value of eclipse lunar occultation timings, and methods of observation, were given in my articles for the 1982 eclipses in **ON 2** (16), pp 214-219 and **ON** 3 (2), pp 29-33, and in **Sky and Telescope 63** (6), p. 604 and **64** (6), pp 574-576. Good general information about the eclipse, and much information on various mainly educational projects, such as determining yet again that the radius of the apparent umbra is 2% larger that its geometrically calculated value, is given in separate articles starting on pages 670, 687, and 704 of the 1992 December issue of **Sky and Telescope**. Unfortunately, none of these articles mentions occultations, not even a reference back to last January's issue, which contains a map showing two eclipse graze paths on p. 68 and a discussion of occultations during both 1992 eclipses on p. 71. With the prediction problems and changes produced by USNO's computer loss and my new job, I did not have time to hound the editors at **S&T**, or prepare an article about the eclipse, this summer when they would have needed it for the December issue. This does not mean that the eclipse occultations are less important.

If you have a portable telescope, make plans to travel, if necessary, to view the eclipse; December has the worst cloud-cover statistics for most parts of Europe and North America, so mobility could mean the difference between seeing or not seeing this rare event. Since it occurs in the middle of the week, on a Wednesday night, you might plan to take vacation much or all of Wednesday, and perhaps Thursday morning, to give yourself maximum flexibility to observe this eclipse.

The Star Field: The eclipse star field, shown in two charts, is just north of Iota and 105 Tauri; the brightest star in the field is 5.5-mag. 103 Tauri = ZC 767, which will be occulted during totality in southern Africa. The northern limit of the 103 Tauri occultation across South Africa is shown in the Eastern Hemisphere Grazing Occultation Supplement for 1992, distributed a year ago. At first umbral contact, as seen from much of Africa, the still very bright Moon will be covering the large galactic cluster NGC 1746, and the two smaller clusters imbedded within it, NGC 1750 and NGC 1758, but reappearances of cluster members will be on parts of the Moon still outside the umbra and, hence, will not be observable. As seen from parts of the Indian Ocean, such as Mauritius and Diego Garcia, occultations of some of these cluster members will be seen in the umbra. However, the rest of the eclipse field is quite rich and promises much action without these objects.

One plot shows only the stars, down to magnitude 14.0 from the Q-catalog based on the XZ and the Space Telescope Guide Star (GS) Catalog mentioned on p. 208 of the last issue. The equinox 1950 chart boundaries were determined by David Herald; he supplied the equivalent equinox J2000 boundaries as 5h 2.0m to 5h 15.9m in right ascension and +21° 59′ to +24° 28′ in declination.

Topocentric Paths: The other chart shows the same star field, but also includes numbers of the brighter stars, a figure of the Moon generated by Bob Bolster with John Westfall's Moonview program, and topocentric tracks for the Moon's center for 29 locations. Apparent place coordinates (with precession, nutation, and aberration applied to 1992 December 10) are used. The Moon's figure is drawn for the right size and orientation during the eclipse. The position angle of the Moon's North Pole (0° of Watts Angle, or WA on IOTA-USNO predictions) will be 354°, to help locate reappearing stars with lunar features. In many cases, the pattern of the star field will give a better idea of the point of emersion.

A copy of the Moon figure can be moved with its center along the path, keeping its orientation the same as shown on the chart, to estimate the times and locations of disappearing and reappearing stars. The name of the location, for which a topocentric curve of the Moon's center is plotted, is given at the right (west, or start) end of the path. The actual start of the path is at the lower left corner of the 9th character in the name of the location. So if the name of the location is less than 8 characters, there will be a blank space between the end of the name and the start of the curve (that is, the name will be entirely to the left, or east of, the start of the curve). In case of possible ambiguities, I have manually written the name of the location along the track. A list of the coordinates used for calculation of the paths is given below:

Location	Latitude	E.Longitude
TOMSK, Russia	56°468	84°950
NAINI TAL, India	29.361	79.457
KODAIKANAL, India	10.231	77.469
MOSCOW, Russia	55.755	37.570
NAIROBI, Kenya	-1.283	36.833
MITZPE RAMON, Israel	30.597	34.763
HARARE, Zimbabwe	-17.759	31.116
JOHANNESBURG, South Africa	-26.182	28.075
ATHENS, Greece	37.972	23.725
CAPE, South Africa	-33.933	18.475
ROME, Italy	41.924	12.453
HERSTMONCEUX, England	50.871	0.338
SAN FERNANDO, Spain	36.462	-6.200
RECIFE, Brazil	-8.051	-34.958
RIO DE JANEIRO, Brazil	-22.897	-43.186
ST. JOHN'S, Newfoundland	47.537	-52.753
BUENOS AIRES, Argentina	-34.605	-58.434
CARACAS, Venezuela	10.507	-66.928
SANTIAGO, Chile	-33.418	-70.630
MONTREAL, Quebec	45.500	-73.600
BOGOTA, Colombia	4.599	-74.081
LIMA, Peru	-12.100	-77.050
MIAMI, Florida	25.750	-80.250
KANSAS CITY, Missouri	38.964	-94.497
MEXICO CITY, Mexico	19.250	-99.100
LOS ANGELES, California	34.113	-118.302
VANCOUVER, British Columbia	49.500	-123.100
ANCHORAGE, Alaska	61.210	-149.870
NORTH POLE	90.0	----

Time increases from right to left (the Moon's R.A. is always increasing) along the curves. If the Moon is above the horizon both times, the paths start just before 22h 00m UT of December 9 (labelled "-2" for -2h of December 10) and end at 2h 00m UT of December 10. Besides the 1-hour tick marks labelled with the December 10th UT hour, unlabelled tick marks along the curves mark the Universal Times given at the top of the next page:

UT h m	
21 59.4	First umbral contact (First Contact)
23 06.8	Start of totality (Second Contact)
0 21.5	End of totality (Third Contact)
1 28.8	Last umbral contact (Fourth Contact)

In the list above, UT's greater than 12h are for December 9 and others are for December 10. Not shown is mid-eclipse, which occurs on December 9 at 23h 44.1m UT; it can be estimated as halfway between the start and end of totality.

Most of the paths include all of the tick marks mentioned above, from right to left. The first contact tick mark is so close to that for -2h that they form a distinctive double-tick mark at the start (right side) of most curves. But the path is not plotted when the Moon is below the horizon. Hence, the last parts of the paths for some Asian stations are not shown. Only the ends of the paths for Santiago, Lima, Mexico City, Los Angeles, Vancouver, and Anchorage are shown; also, the start of the paths for Bogota, Caracas, Miami, and Kansas City occur before moonrise and are not shown. For locations not shown on the chart, interpolate. I produced the chart just before my job change in September and I lost the data set used to create it, so I can not calculate paths for other locations. Detailed predictions are more important, and I may be able to provide them, as noted below.

The Stars and their Numbers: Apparent positions were plotted so that the RA and Dec. given in the detailed IOTA-USNO predictions could be used to locate stars whose occultations are listed. The RA bound was increased by 3m due to the increase in RA since 1950; stars with equinox 1950 RA's less than 5h 00m are not shown on the apparent-place chart. Also not shown are a few stars at the bottom of the equinox 1950 chart, since the southern boundary of the apparent-place chart had to be increased by 0°1.

A star's number is given just to the right of the star. A number in the 700's is a ZC number. A number in the 6000's is a USNO XZ (or X) number. Numbers between 1428 and 5511 are usually Q-catalog numbers, for stars not in the XZ. Other numbers are variants or modifications of the last 5 digits of the GS catalog number, given in the "DM REF NO" column of the Q-catalog predictions for many of the fainter stars, and were given by program logic for the old L-catalog that I did not have time to modify for this eclipse (it would have been better just to give Q-numbers for these).

Variable Star?: 10.1-mag. RT Tauri is marked on both charts; it is in NGC 1750 near the start of the path for Nairobi. The original reports of its variability have not been confirmed.

Double Stars: Known double stars are underlined on the charts. Data about them are listed below:

USNO#	D	SAO/BD	Desig.	Mag1	Mag2	Sep.	P.A.	N
X06437	K	076909	SI73407	9.2	9.2	0"25	90°	1
Q02016	(M)		J1816	10.3	10.4	5.4	110	2
X06488	C	076942	AG	8.3	?	19.5	187	3
ZC 761	M	076954	RS74302	7.2	8.2	0.51	158	4
X06541	M	076966	Cou155	9.3	9.4	0.17	318	
Q02864	(M)	+22°830	ADS3700	9.4	10.0	1.0	195	
ZC 767	W	076974	ADS3709	5.6	8.6	35.3	197	5
X06677	M	077035	Cou468	8.4	9.5	0.63	60	
ZC 784	C	077057	Cou158	6.3	12.5	1.93	349	

Mag1 is the magnitude of the primary, Mag2 is that of the secondary, Sep. is the separation in arc seconds, and P.A. is the position angle. The star's double-star code is given after the USNO#, under D; if it is in parentheses, the double code is not in the current Q-catalog file and is not in the IOTA/USNO predictions. Under SAO/BD, 6-digit numbers are SAO numbers; one of the stars is a BD star that is not in the SAO. Under Desig. (designation), ADS is Aitken's Double Star and Cou stands for Couteau, who has discovered many doubles at Nice Observatory with direct visual observation. Other designations are explained in the notes for individual stars below. The companions of none of these stars has a separate entry in the Q-catalog.

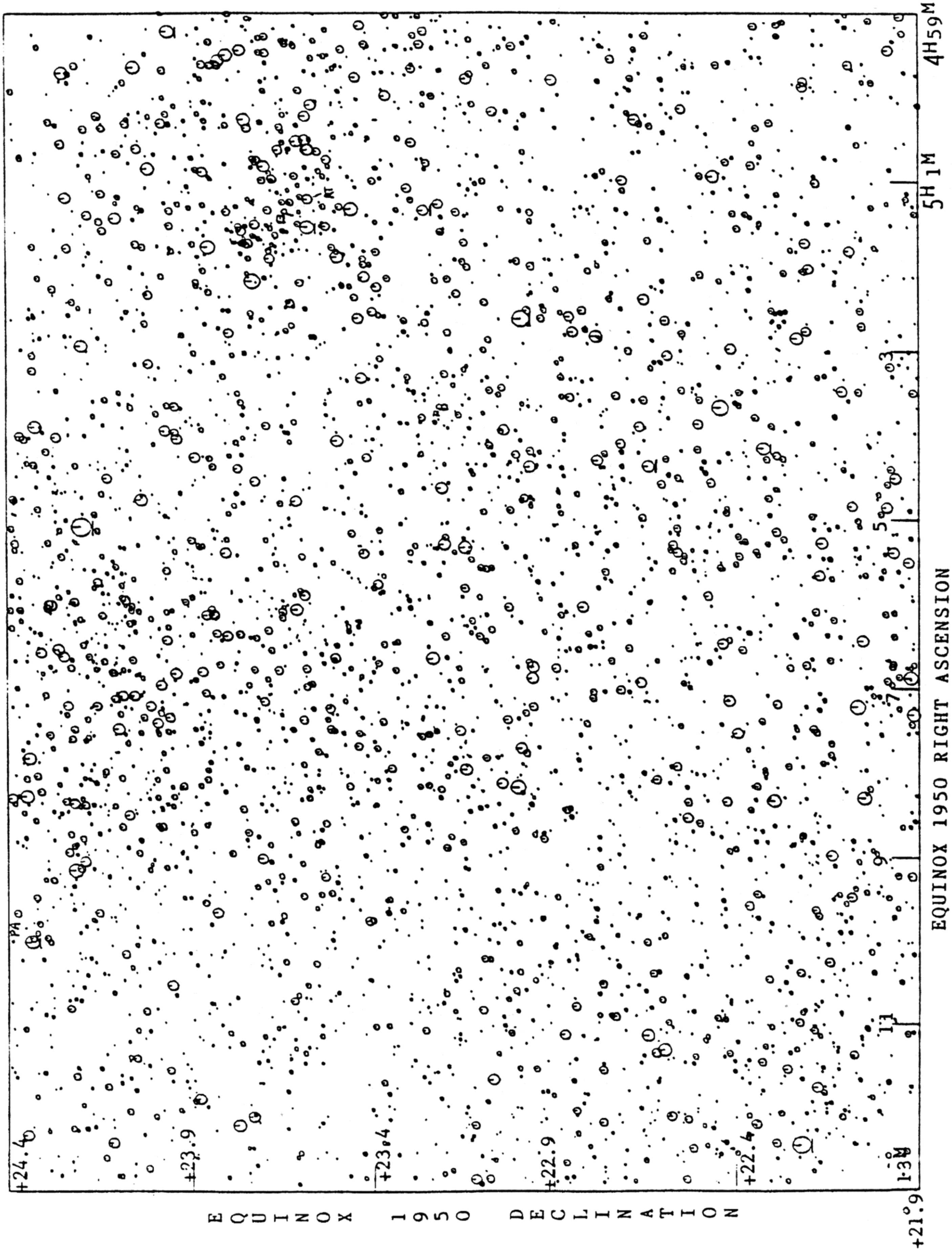
1. Possible duplicity suspected from a gradual occultation seen by B. Sincheskul, Poltava, Ukraine, on 1973 April 7, reported in **ON 1** (10), p. 110.

2. J is Jonckheere, another French visual double star observer. The Paris **Astrographic Catalog** gives the pair as +24° 4h 56m #315-318.

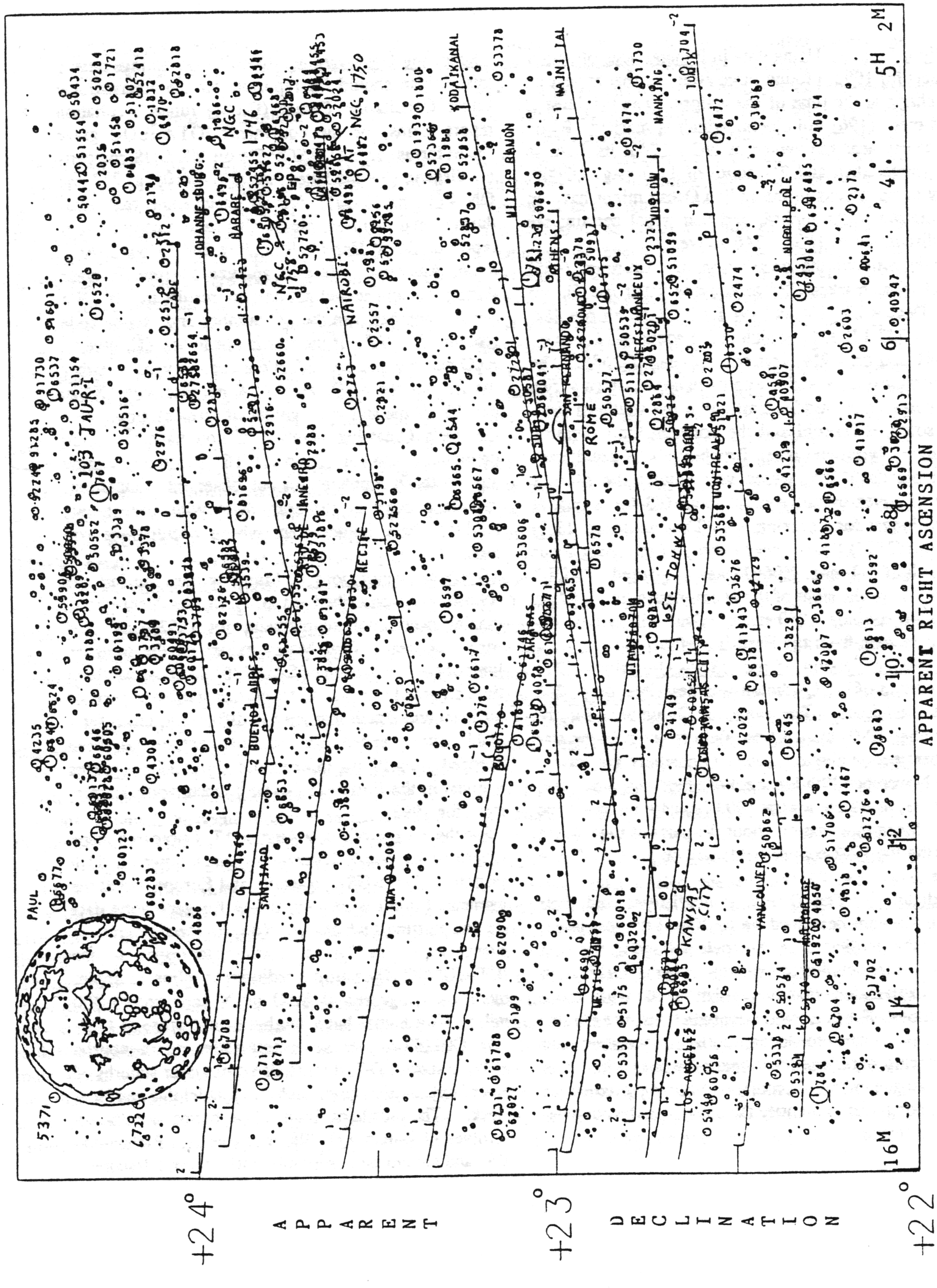
3. The secondary star's magnitude is not given in the double star catalog.

4. Discovered by Robert Sandy during an occultation observed in 1974 March 2 and confirmed in a photoelectric recording made at McDonald Observatory, as described in **ON 1** (1), p. 5.

5. The primary of ZC 767 (103 Tauri) is a single-line spectroscopic binary. The data given in the table are for AC; 12.5-mag. B is 16" from A in P.A. 155°.



EQUINOX 1950 RIGHT ASCENSION
4H59M
5H 1M
3
5
7
9
11
13M
EQUINOX 1950 DECLINATION
+24.4
+23.9
+23.4
+22.9
+22.4
+21.9
PA


APPARENT RIGHT ASCENSION
APPARENT DECLINATION
+24°
+23°
+22°
103 TAURI
NGC 1746
NGC 1750
PAUL
JOHANNESBURG
HARARE
CAPE
NAIROBI
RECIFE
BUENOS AIRES
SANTIAGO
LIMA
BOGOTA
CARACAS
MEXICO CITY
KANSAS CITY
LOS ANGELES
VANCOUVER
ANCHORAGE
ST. JOHN'S
MONTREAL
ROME
ATHENS
SAN FERNANDO
HERSTMONCEUX
URANIENBORG
MOSCOW
NANKING
TOKYO
NORTH POLE
KODAIKANAL
NAINI TAL
MIZPE RAMON
16M
2M
5H
4
6
8
10
12
14

Minor Planets: Using data in Ephemerides of Minor Planets for 1992, I found three asteroids that appear on the charts at the time of the eclipse. The brightest is 10.8-mag. (196) Philomela, which is marked "P" on the charts near the center of NGC 1746; its R.A. is 3ˢ.4 greater than and 2′.1 south of 11.0-mag. Q2009. Only some islands in the Indian Ocean might have an occultation in the umbra, and that is not certain; see the discussion of NGC 1746 above.

Better will be the occultation of 11.6-mag. (455) Bruchsalia, marked "B" at equinox 1950 RA 5h 3m 46s, Dec. +23° 13′ 34″ (= J2000 R.A. 5h 6m 48s, Dec. +23° 17′ 31″), which is 2′.4 south of 11.4-mag. Q2681 and only 2ˢ.4 west of 13.8-mag. Q2688. The occultation occurs during totality in northeastern Africa and part of the Middle East, with the southern limit just south of Nairobi and the northern limit crossing Lebanon, Syria, and Iraq. Bruchsalia's 87-km diameter subtends 0″.085, which will require the Moon's edge to cover or uncover in about 0ˢ.3 for a central event, longer for a grazing one. The faint (mag. 15.7) asteroid (3525) Paul is near the top of the chart about 3′ north of 8.2-mag. X06677 and is marked "PAUL" above and to the right of the Moon figure, or "PA" on the plain equinox 1950 chart. Paul will not be occulted as seen from the Earth's surface.

September Version of the USNO Q-catalog: This first edition of the Q-catalog was described on p. 208 of the last issue. The range of Q-numbers for the December 1992 lunar eclipse field is given in the star number section above. Lower Q-numbers are for the 1993 November 29th lunar eclipse field and those with higher numbers are for the 1993 June 4th lunar eclipse field. More information about the parts of the catalog covering the 1993 eclipse fields will be given in future issues.

Predictions: The Q-catalog predictions and their distribution are described on p. 208 of the last issue, and in the prediction news article following the next article. More detailed information is in the verification form explanation that was distributed with those predictions. For those without predictions, use the star field charts here to locate both disappearing and reappearing stars, and try to mark the ones without an identifying number. Accurate Q-catalog predictions can be computed to identify the stars after the observations are made.

Reporting Observations: Occultation timings during this eclipse should be reported on the International Lunar Occultation Centre (ILOC) lunar occultation report forms, or the equivalent IOTA/ILOC graze report forms, or in an ASCII file on MS-DOS-compatible diskette (for the latter, see ON 4 (10), p. 237 and ON 4 (5), pp 92-97). For all occultations that occur during lunar eclipses, please also send a copy of your report to David Herald; P.O. Box 254; Woden, ACT 2606; Australia. He will analyze all timings made during the eclipse and publish his results in ON. For the star number, use the ZC number and catalog code (column 16) "R". If the star is not in the ZC, give its SAO number and put "S" in col. 16. If it is in neither the ZC nor the SAO, give its X number with "X" in col. 16. If the star is in neither of these catalogs, give the star's Q-catalog number, if you have Q-catalog predictions, and put "Q" in col. 16. If you don't know any of these numbers for an observed occultation, include a copy of the star chart with your report marking these fainter stars whose occultations you time.

Grazing Occultations: Major grazes during the eclipse were described on p. 3 of the hemispheric grazing occultation supplements for 1992 distributed early this year. Paul Maley examined the southern limit of the occultation of SAO 77019 (whose northern limit crosses Florida) and found that it crossed parts of Surinam and Brazil that are too difficult to reach for a viable graze expedition, so that option has been dropped. Additional information about eclipse grazes is given in the European Grazing Occultation Supplement for 1992.

For the eclipse of 1989 August 17, I prepared maps of grazes of non-XZ grazes of stars down to 11th magnitude in the USA, Canada, and Europe, but at the moment, I don't have a capability for generating data for and plotting such charts. You can learn about such events from the "graze nearby" messages in the IOTA/USNO Q-catalog predictions. For example, there are no grazes of SAO or X stars within 300 miles of our home, but a southern-limit graze of 11.9-mag. Q04287 crosses the western and northern suburbs of Washington, DC; it must also cross over suburbs of other Northeastern cities such as Philadelphia and New York. The northern limit of a better occultation involves 11.2-mag. Q04398; it passes near Richmond, VA, and should be observable with 20-cm telescopes.

OCCULTATIONS BY 4179 TOUTATIS DURING ITS CLOSE FLYBY IN DECEMBER

David W. Dunham

General information about the December near-Earth flyby of asteroid (4179) Toutatis is given in an article on pages 673-675 of the December issue of **Sky and Telescope**. I have calculated dozens of occultations that occur during this close approach. They are listed in two full-page tables like those for other planetary and asteroidal occultations described in **ON 5**, (2), p. 39 and **ON 5**, (6), p. 132. The type has been omitted from Table 2, since Toutatis' type is now unknown (it will almost certainly be determined from physical observations that will be made in December). Also, I changed the program to print the duration to 0.1 second, since most of the occultations will be very brief, less than 1 second. Except for the brightest stars, only events potentially visible by **ON** subscribers were selected; many events visible only from the ocean, or areas with no **ON** subscribers such as Siberia, Antarctica, and central Africa were omitted.

Maps: Get information (time, etc.) from the table for those paths that pass near your location shown on three maps depicting all of the listed events between latitudes +65° and -50°, like the quarterly maps showing all other planetary occultations that I have predicted. The longitude/latitude boundaries are the same as those used for the quarterly maps, and like the quarterly maps, both scales are linear, but no 10° labels or 5° tick marks are given. Another difference is that the maps show the uncertainty zone, about 200 km wide, in which the occultation is expected to occur; the actual path would be just a line on the map, only slightly larger than the 3.5-km diameter estimated for Toutatis. The uncertainty is based on the 100-km error that Jet Propulsion Laboratory's Don Yeomans provided with his orbit, based on observations made through July, 1992, which should be a little more accurate than the MPC 15061. Another difference from the quarterly maps is that these maps show time ticks at one-minute intervals, making most of the zones look like ladders. I had intended to use a larger time interval, but discovered after the files had been generated that the program usually overrode my input value when used in the mode needed to produce the map information. So in a few cases, the program did use a 10-minute interval, and for some other events, the one-minute interval filled the available time-point storage arrays, causing some minute lines to be deleted. Since Toutatis' motion is retrograde during the rest of 1992, the motion of the shadow on the ground is (that is, time increases along the path) always from east to west. In November, the events occur in the evening, with twilight at the west path end and low altitude above the horizon at the east path end. In December, the events occur in the morning, so the paths start at dawn at the east end, and end in low altitude at the west end. Moonrise or moonset lines cross some paths; they can be identified easily since they slant in a different direction from the time lines. I thank my co-worker Jack Hunt for using his software to read my files to produce the actual plots. Unfortunately, this software can not automatically label the paths, so the labels had to be handwritten. This was necessary anyway for these maps due to crowding in some areas. A minimum label is given to identify the event in Table 1, if possible, only a date, such as Dec. 20 or 12-20, is given. If more than one event occurs on a given date, the start U.T. hour is also given. If two events occur in the same hour, the date and star SAO numbers are given. One path, overlapping much of the path for Dec. 14, SAO 117987, was caused by an error, so it is labelled "ERROR"; its line has been removed from Tables 1 and 2.

Ephemeris Calculations: The very close approach taxes the accuracy of my two programs for generating Toutatis' ephemeris, the Schubart-Stumpff (SS) and Numin programs. I used a 0.1-day step size in the SS program to provide an accurate numerical integration of Toutatis' path by the Earth, but Numin is limited to a 5-day step size, too coarse to accurately model the Earth's gravitational influence. However, an accurate Earth-orbit model is also needed, and SS only uses Newcomb's theory developed a century ago (it is still quite accurate, but is not the best now available). Numin uses a slightly better Earth model, but can't model the orbit gravitationally to high accuracy so close to the Earth. When I compared the ephemerides calculated with the two programs, I was relieved to find that the paths agreed to within a few tenths of an arc second, with time differences of less than half a minute. Edwin Goffin also calculated the first event on my list (now already past) independently; his result was also in close agreement with my prediction. I

Table 1.

1992 Date	Universal Time	PLANET Name	PLANET Mv	PLANET Δ,AU	STAR SAO No	STAR Mv	STAR Sp	STAR R.A. (1950)	STAR Dec.	OCCULTATION Δm	OCCULTATION Dur	OCCULTATION DF	OCCULTATION P	Possible Path Lo1	Possible Path La1	Possible Path Lom	Possible Path Lam	Possible Path Loe	Possible Path Lae	El Sun	MOON El	MOON %Snl	MOON up	Ephem. Source
Nov 14	16h 1m-49m	Toutatis	14.2	0.158	187740	8.7	K2	19h 6m.2	-25°12'	5.5	5s.1	99	114	68°	7°	66°	6°	29°	19°	53°	175°	79-	none	YeomansA
Nov 23	17 38-45	Toutatis	13.6	0.098	187438	7.9	B8	18 51.5	-26 57	5.7	1.7	26	71	28	15	26	14	6	2	41	48	1-	none	YeomansA
Nov 24	11 48-51	Toutatis	13.5	0.094	187374	9.3	B5	18 48.8	-27 12	4.2	1.5	23	68	108	20	108	20	94	11	39	37	0+	none	YeomansA
Nov 26	0 22-26	Toutatis	13.4	0.084	187230	9.2	A0	18 42.1	-27 44	4.2	1.3	19	61	-54	-28	-60	-32	-69	-38	36	16	3+	w61°W	YeomansA
Nov 26	1 46-46	P/Swf-Tutl	9.7	1.307		10.9		18 42.9	9 40	0.3	1.7	4	2	-86	43	-87	42	-87	27	49	37	3+	none	MPC21081
Nov 27	2 21-23	Toutatis	13.3	0.077	187089	7.5	B9	18 36.1	-28 14	5.8	1.2	16	56	-115	24	-119	21	-128	16	34	7	8+	all	YeomansA
Nov 28	8 11-13	Toutatis	13.1	0.069	186892	7.6	A2	18 27.3	-28 50	5.6	1.1	14	75	165	4	162	2	151	-3	31	19	16+	all	YeomansA
Nov 30	21 54-55	P/Swf-Tutl	9.7	1.378		10.3		18 58.3	4 3	0.5	1.8	4	2	-38	61	-39	60	-34	6	45	42	37+	all	MPC21081
Dec 6	8 21-21	Toutatis	11.4	0.027	206445	4.9	F0	15 11.6	-31 20	6.4	0.4	3	59	-57	-32	-62	-29	-69	-24	24	154	86+	none	YeomansA
Dec 6	17 25-25	Toutatis	11.2	0.026	206035	6.3	G0	14 49.5	-30 22	4.9	0.4	3	57	159	-40	155	-37	145	-30	28	162	88+	none	YeomansA
Dec 6	19 29-30	Toutatis	11.1	0.026	205945	7.8	K0	14 44.4	-30 9	3.4	0.4	3	56	137	-20	136	-19	126	-13	29	164	89+	none	YeomansA
Dec 6	21 2- 3	Toutatis	11.1	0.026	182799	7.9	F5	14 40.5	-30 0	3.3	0.4	3	56	130	11	128	12	119	17	30	165	89+	none	YeomansA
Dec 7	4 50-50	Toutatis	10.9	0.025	182487	9.1	K0	14 20.3	-28 51	2.0	0.4	3	55	21	34	21	34	18	36	35	169	91+	none	YeomansA
Dec 7	18 5- 6	Toutatis	10.7	0.024		9.5	F0	13 45.6	-26 9	1.5	0.4	3	53	147	-35	137	-28	129	-23	43	163	94+	w136E	YeomansA
Dec 7	20 27-28	Toutatis	10.6	0.024	181875	9.1	F8	13 39.4	-25 43	1.8	0.4	3	53	138	15	124	24	119	27	45	160	95+	w122E	YeomansA
Dec 8	1 37-39	Toutatis	10.6	0.024	181684	9.4	F8	13 26.0	-24 25	1.5	0.4	3	53	42	-25	32	-19	17	-10	48	155	96+	w 29E	YeomansA
Dec 8	6 25-27	Toutatis	10.5	0.024	181502	8.7	K0	13 13.5	-23 17	2.0	0.4	3	53	-10	14	-21	20	-37	30	51	150	96+	w 22W	YeomansA
Dec 8	9 6- 8	Toutatis	10.4	0.024	181418	8.3	K2	13 6.7	-22 35	2.3	0.4	3	53	-50	14	-60	21	-78	31	53	147	97+	w 62W	YeomansA
Dec 8	12 42-45	Toutatis	10.4	0.024	181308	8.3	K2	12 57.8	-21 31	2.2	0.4	3	53	-135	-39	-139	-36	-163	-21	56	143	97+	w140W	YeomansA
Dec 8	15 9-11	Toutatis	10.4	0.024	181210	8.8	M0	12 51.8	-20 57	1.8	0.4	3	53	-141	14	-148	18	-173	33	57	140	98+	w149W	YeomansA
Dec 8	18 51-55	Toutatis	10.3	0.024	157492	7.5	A0	12 42.9	-19 52	2.9	0.4	3	53	151	-13	144	-8	111	9	60	135	98+	w144E	YeomansA
Dec 8	20 23-27	Toutatis	10.3	0.024	157451	6.0	F2	12 39.2	-19 29	4.3	0.4	3	53	141	11	134	15	100	34	61	134	98+	w132E	YeomansA
Dec 8	21 21-24	Toutatis	10.3	0.025	157425	8.9	K2	12 37.0	-19 14	1.6	0.4	3	53	126	18	121	22	91	38	61	133	99+	w121E	YeomansA
Dec 9	3 36-39	Toutatis	10.2	0.025	157273	9.4	F8	12 22.6	-17 28	1.2	0.4	3	54	37	27	35	28	3	48	65	125	99+	w 35E	YeomansA
Dec 9	6 36-41	Toutatis	10.2	0.025	157203	8.7	K0	12 16.2	-16 33	1.7	0.4	3	55	-22	-7	-24	-6	-67	16	67	122	99+	w 24W	YeomansA
Dec 9	6 52-52	Toutatis	10.2	0.025	157195	9.2	K2	12 15.4	-16 33	1.4	0.4	3	55	5	54	3	56	-2	63	67	122	99+	all	YeomansA
Dec 9	7 7-11	Toutatis	10.2	0.025	157189	9.3	K2	12 15.1	-16 24	1.3	0.4	3	55	-31	-8	-33	-7	-76	15	68	121	99+	all	YeomansA
Dec 9	7 18-21	Toutatis	10.2	0.025	157184	6.0	A2	12 14.5	-16 25	4.2	0.4	3	55	-8	37	-14	41	-44	61	68	121	99+	w 11W	YeomansA
Dec 9	21 1- 7	Toutatis	10.1	0.026	156912	8.7	A5	11 46.9	-12 32	1.7	0.4	3	57	125	3	125	3	71	30	76	106	100+	all	YeomansA
Dec 9	23 54-57	Toutatis	10.1	0.027	156859	9.4	F5	11 41.4	-11 48	1.2	0.4	3	58	99	41	97	42	64	63	77	103	0E	all	YeomansA
Dec 10	10 28-35	Toutatis	10.1	0.028	138200	9.4	G5	11 23.2	-9 2	1.2	0.4	3	61	-73	10	-73	10	-135	40	83	91	100-	all	YeomansA
Dec 10	12 26-32	Toutatis	10.1	0.028	138166	6.8	A2	11 19.9	-8 34	3.4	0.4	3	62	-90	31	-93	33	-149	62	84	89	100-	all	YeomansA
Dec 10	18 1-10	Toutatis	10.1	0.029	138075	9.4	G5	11 11.4	-7 9	1.2	0.4	4	63	156	-24	156	-24	97	3	87	84	99-	all	YeomansA
Dec 10	18 40-48	Toutatis	10.1	0.029	138067	9.2	K5	11 10.5	-6 59	1.3	0.4	4	63	140	-33	138	-32	85	-6	87	83	99-	all	YeomansA
Dec 11	4 4-14	Toutatis	10.1	0.031	137929	8.9	K2	10 57.2	-4 55	1.5	0.5	4	56	7	-21	7	-21	-58	8	91	74	98-	all	YeomansA
Dec 11	6 17-22	Toutatis	10.1	0.031	137899	9.0	F0	10 54.1	-4 32	1.4	0.5	4	56	4	42	3	43	-47	72	92	71	98-	all	YeomansA
Dec 11	8 37-45	Toutatis	10.1	0.031	137869	9.2	A5	10 51.2	-4 2	1.3	0.5	4	57	-40	25	-40	25	-110	57	93	69	98-	all	YeomansA
Dec 11	8 47-56	Toutatis	10.1	0.031	137865	9.0	G1	10 50.9	-4 0	1.4	0.5	4	57	-41	23	-41	23	-113	57	93	69	98-	all	YeomansA
Dec 11	19 33-45	Toutatis	10.1	0.033	137719	9.4	G5	10 38.1	-1 56	1.2	0.5	4	61	150	11	150	11	69	45	98	59	96-	all	YeomansA
Dec 11	21 41-51	Toutatis	10.2	0.034		9.8	K0	10 35.7	-1 34	1.0	0.5	5	61	125	28	125	28	47	62	98	57	95-	all	YeomansA
Dec 13	0 32-48	Toutatis	10.3	0.039		9.2	K0	10 10.4	2 36	1.5	0.6	6	57	57	-29	57	-29	-20	3	107	34	88-	all	YeomansA
Dec 13	3 45-58	Toutatis	10.3	0.040		9.0	K0	10 7.7	2 57	1.6	0.6	6	58	36	29	34	30	-60	66	108	31	87-	all	YeomansA
Dec 14	0 4-24	Toutatis	10.4	0.044	117995	9.7	F5	9 53.1	5 17	1.2	0.7	7	64	83	11	83	11	-18	47	113	14	80-	all	YeomansA
Dec 14	1 25-46	Toutatis	10.4	0.045	117987	9.0	M2	9 52.3	5 26	1.7	0.7	7	65	59	3	59	3	-42	39	113	13	80-	all	YeomansA
Dec 14	1 39-55	Toutatis	10.4	0.045		10.5		9 52.1	5 26	0.7	0.7	7	65	64	28	64	28	-36	64	113	13	80-	all	YeomansA
Dec 14	5 34-56	Toutatis	10.5	0.045		9.9	M0	9 49.7	5 51	1.0	0.7	7	66	-5	-3	-5	-3	-105	31	114	10	78-	all	YeomansA
Dec 14	8 15-37	Toutatis	10.5	0.046		9.7	G5	9 48.0	6 6	1.2	0.7	7	67	-39	11	-39	11	-144	48	115	8	77-	all	YeomansA
Dec 14	9 32-50	Toutatis	10.5	0.046		9.8		9 47.3	6 12	1.1	0.7	7	67	-52	25	-52	25	-162	63	115	7	76-	all	YeomansA
Dec 14	23 1-19	Toutatis	10.6	0.049	117865	9.1	A5	9 39.9	7 25	1.7	0.7	8	72	64	-44	63	-43	-6	-14	118	4	71-	all	YeomansA
Dec 16	1 10-10	Toutatis	10.7	0.056		11.0		9 27.6	9 14	0.6	0.8	9	61	-26	62	-29	62	-37	62	122	22	59-	e 29W	YeomansA
Dec 16	5 1-32	Toutatis	10.8	0.057	117720	9.1	A5	9 25.9	9 31	1.8	0.8	10	62	6	2	-92	40	-110	40	123	25	57-	e 92W	YeomansA
Dec 16	19 0-30	Toutatis	10.8	0.060	98538	9.0	K0	9 20.5	10 20	2.0	0.9	11	65	137	-29	67	1	42	3	125	35	50-	e 66E	YeomansA
Dec 16	20 3-37	Toutatis	10.8	0.060	98536	9.1	F8	9 20.1	10 23	1.9	0.9	11	66	139	-2	53	33	20	34	125	36	50-	e 50E	YeomansA
Dec 16	22 40-66	Toutatis	10.9	0.061		9.7	K5	9 19.2	10 33	1.5	0.9	11	66	73	-40	13	-12	-9	-10	126	37	48-	e 13E	YeomansA
Dec 17	7 8-33	Toutatis	10.9	0.063	98487	8.3	K0	9 16.2	10 56	2.7	0.9	11	69	-11	31	-87	67	-152	71	127	43	44-	e 95W	YeomansA
Dec 17	11 6-41	Toutatis	10.9	0.064		9.1		9 14.9	11 8	2.0	0.9	12	70	-84	3	-163	38	151	41	127	46	42-	e163W	YeomansA
Dec 18	14 57-98	Toutatis	11.1	0.071		9.3		9 6.5	12 21	2.0	1.0	13	77	-146	-3	154	24	89	32	131	65	30-	e154E	YeomansA
Dec 19	0 2-31	Toutatis	11.1	0.073		10.0		9 4.1	12 40	1.5	1.0	14	80	93	32	47	58	-52	71	132	70	26-	e 44E	YeomansA
Dec 20	2 37-78	Toutatis	11.3	0.080		10.1		8 57.7	13 34	1.5	1.1	15	58	46	14	9	34	-92	52	135	87	16-	e 9E	YeomansA
Dec 21	1 56-99	Toutatis	11.4	0.086		10.7		8 52.9	14 15	1.1	1.2	17	62	30	-32	12	-22	-73	0	137	102	9-	e 11E	YeomansA
Dec 21	8 7-57	Toutatis	11.4	0.088	98218	9.6	G5	8 51.7	14 24	2.0	1.2	17	64	-48	-13	-69	-1	-176	22	138	106	8-	e 69W	YeomansA
Dec 22	9 17-53	Toutatis	11.5	0.094	98149	8.2	F	8 47.2	15 1	3.4	1.2	19	68	-95	-50	-99	-47	178	-20	140	120	3-	e 99W	YeomansA
Dec 22	9 23-58	Toutatis	11.5	0.094	98148	7.2	F0	8 47.1	15 1	4.4	1.2	19	68	-97	-52	-103	-47	175	-21	140	120	3-	e101W	YeomansA
Dec 23	13 29-72	Toutatis	11.7	0.102		10.0	F8	8 42.6	15 34	1.9	1.3	21	74	-109	29	-109	29	86	68	142	137	0-	none	YeomansA
Dec 25	6 35-78	Toutatis	11.8	0.113	98007	7.8	K2	8 36.8	16 19	4.1	1.4	23	82	-53	-49	-56	-47	-149	-18	146	160	2+	none	YeomansA
Dec 26	14 1-30	Toutatis	12.0	0.121		11.0		8 32.9	16 45	1.3	1.5	25	88	-107	47	-107	47	23	83	148	177	7+	none	YeomansA
Dec 26	22 55-98	Toutatis	12.0	0.124	97923	9.1	K0	8 31.9	16 54	3.0	1.5	25	90	57	-49	56	-48	-33	-20	149	177	8+	none	YeomansA
Dec 29	12 18-48	Toutatis	12.2	0.140		9.0		8 25.5	17 39	3.3	1.6	29	102	-163	-57	141	-34	131	-34	153	146	26+	w141E	YeomansA
Dec 29	17 9-17	Toutatis	12.2	0.142		11.4		8 25.1	17 41	1.2	1.6	29	103	78	-3	76	-3	53	-5	153	143	28+	w 74E	YeomansA
Dec 30	19 45-98	Toutatis	12.3	0.150	97803	9.2	F8	8 22.6	17 57	3.2	1.6	30	108	158	30	49	72	-30	68	155	129	38+	w 44E	YeomansA
Dec 31	7 28-95	Toutatis	12.4	0.153		8.5	K0	8 21.6	18 3	3.9	1.6	31	111	-21	16	-124	57	156	54	156	123	42+	w128W	YeomansA
Dec 31	13 21-99	Toutatis	12.4	0.155		10.5		8 21.1	18 7	2.1	1.6	31	112	-125	-7	140	29	80	28	156	120	45+	w140E	YeomansA
Dec 31	21 37-98	Toutatis	12.4	0.157		11.0		8 20.4	18 11	1.7	1.6	32	114	125	25	33	61	-53	61	157	116	48+	w 33E	YeomansA

Table 2.

1992 Date	No.	MINOR PLANET Name	km-Diam.	-//	RSOI	Motion °/day	P.A.	STAR SAO No	DM/Id No	D	Min. Geocentric U. T.	Sep.	S	Comparison Data AGK3 No	Shift	Time	APPARENT R.A.	Dec.
Nov 14	4179	Toutatis	4	0.03	1	0.165	224°5	187740	C25 13774		17h53m1	29"50S	XS		-0"01	0m0	19h 8m8	-25° 8'
Nov 23	4179	Toutatis	4	0.06	1	0.808	247.4	187438	C2713348		18 22.1	0.02S	7P		0.16	0.5	18 54.2	-26 54
Nov 24	4179	Toutatis	4	0.06	1	0.916	248.3	187374	C2713296		12 27.9	11.46N	HX		0.28	0.2	18 51.5	-27 9
Nov 26	4179	Toutatis	4	0.07	1	1.188	249.9	187230	C2713160		0 45.6	76.81S	HX		0.44	0.1	18 44.8	-27 41
Nov 26		P/Swf-Tutl	100	0.11	129	1.477	145.3				1 45.8	6.53N	C				18 44.9	9 43
Nov 27	4179	Toutatis	4	0.07	1	1.440	251.1	187089	C2814821		2 51.6	27.17N	HY		-0.28	-0.1	18 38.8	-28 11
Nov 28	4179	Toutatis	4	0.08	1	1.819	252.6	186892	C2814648		8 38.4	16.59S	ZY		-0.39	0.1	18 30.1	-28 48
Nov 30		P/Swf-Tutl	100	0.10	126	1.327	145.8				21 54.4	5.54N	C				19 0.4	4 7
Dec 6	4179	Toutatis	4	0.20	1	12.235	279.7	206445	C3111813		8 12.7	182.10S	F				15 14.2	-31 30
Dec 6	4179	Toutatis	4	0.21	1	13.206	282.6	206035	C3011780		17 18.2	231.57S	PY		-0.41	0.0	14 52.1	-30 33
Dec 6	4179	Toutatis	4	0.21	1	13.408	283.2	205945	C2911309		19 20.5	132.69S	PS		-0.61	-0.0	14 47.0	-30 19
Dec 6	4179	Toutatis	4	0.21	1	13.554	283.7	182799	C2911263		20 52.8	71.86N	YG		-0.06	0.0	14 43.0	-30 11
Dec 7	4179	Toutatis	4	0.22	1	14.252	286.2	182487	C2810638		4 42.6	203.41N	S				14 22.8	-29 2
Dec 7	4179	Toutatis	4	0.23	1	15.096	290.3		C2510003		17 59.2	233.91S	Y				13 48.1	-26 22
Dec 7	4179	Toutatis	4	0.23	1	15.175	291.0	181875	C25 9950		20 19.0	99.97N	S				13 41.8	-25 56
Dec 8	4179	Toutatis	4	0.23	1	15.308	292.4	181684	C2410930		1 30.7	172.35S	S				13 28.3	-24 39
Dec 8	4179	Toutatis	4	0.23	1	15.325	293.7	181502	C22 9830		6 18.4	95.34N	PS		0.17	0.0	13 15.9	-23 31
Dec 8	4179	Toutatis	4	0.23	1	15.301	294.4	181418	C22 9778		8 59.4	99.54N	US		0.28	0.0	13 9.1	-22 49
Dec 8	4179	Toutatis	4	0.23	1	15.236	295.2	181308	-21 3643		12 38.2	256.57S	US		0.48	0.0	13 0.1	-21 45
Dec 8	4179	Toutatis	4	0.23	1	15.148	295.8	181210	-20 3737		15 2.4	97.94N	S				12 54.1	-21 11
Dec 8	4179	Toutatis	4	0.23	1	14.995	296.6	157492	-19 3560		18 45.8	85.02S	UP		0.13	0.0	12 45.2	-20 6
Dec 8	4179	Toutatis	4	0.23	1	14.910	296.9	157451	-18 3442		20 17.7	87.99N	UY		-0.29	-0.0	12 41.5	-19 43
Dec 8	4179	Toutatis	4	0.22	1	14.856	297.1	157425	-18 3436		21 14.6	122.11N	US		-0.23	0.0	12 39.2	-19 28
Dec 9	4179	Toutatis	4	0.22	1	14.439	298.2	157273	-16 3456		3 30.4	175.67N	US		0.22	0.0	12 24.9	-17 42
Dec 9	4179	Toutatis	4	0.22	1	14.210	298.7	157203	-16 3439		6 31.1	46.13S	S				12 18.4	-16 47
Dec 9	4179	Toutatis	4	0.22	1	14.175	298.8	157195	-16 3435		6 47.2	293.74N	S				12 17.6	-16 48
Dec 9	4179	Toutatis	4	0.22	1	14.168	298.8	157189	-15 3444		7 1.8	57.29S	S				12 17.3	-16 38
Dec 9	4179	Toutatis	4	0.22	1	14.140	298.8	157184	-15 3442		7 13.6	236.35N	PY		-0.22	0.0	12 16.7	-16 39
Dec 9	4179	Toutatis	4	0.21	1	12.829	300.6	156912	-12 3499		20 56.5	26.21N	US		-0.61	0.0	11 49.1	-12 46
Dec 9	4179	Toutatis	4	0.21	1	12.513	300.9	156859	-11 3168		23 49.5	227.33N	US		-0.48	-0.0	11 43.6	-12 2
Dec 10	4179	Toutatis	4	0.20	1	11.358	301.7	138200	- 8 3169		10 24.8	63.53N	US		0.09	-0.0	11 25.4	-9 16
Dec 10	4179	Toutatis	4	0.19	1	11.135	301.9	138166	- 8 3154		12 22.8	181.56N	UY		0.01	-0.0	11 22.1	-8 48
Dec 10	4179	Toutatis	4	0.19	1	10.536	302.2	138075	- 6 3331		17 59.8	134.82S	US		0.47	0.0	11 13.6	-7 23
Dec 10	4179	Toutatis	4	0.19	1	10.467	302.2	138067	- 6 3328		18 39.2	180.40S	UP		-0.20	0.0	11 12.7	-7 13
Dec 11	4179	Toutatis	4	0.18	1	9.475	302.5	137929	- 4 2993		4 3.1	109.11S	US		0.85	0.0	10 59.4	-5 9
Dec 11	4179	Toutatis	4	0.18	1	9.240	302.6	137899	- 4 2977		6 13.9	202.91N	US		0.69	0.0	10 56.3	-4 46
Dec 11	4179	Toutatis	4	0.18	1	9.011	302.7	137869	- 3 3013		8 34.6	129.90N	UR		0.22	0.0	10 53.4	-4 16
Dec 11	4179	Toutatis	4	0.18	1	8.993	302.7	137865	- 3 3012		8 45.6	128.96N	US		0.51	0.0	10 53.1	-4 14
Dec 11	4179	Toutatis	4	0.17	1	7.991	302.9	137719	- 1 2422		19 32.5	65.18N	UX	S 1° 1516	0.24	-0.0	10 40.3	-2 9
Dec 11	4179	Toutatis	4	0.16	1	7.802	302.9		- 1 2416		21 39.9	137.40N	A	S 1 1512			10 37.9	-1 47
Dec 13	4179	Toutatis	4	0.14	1	5.830	302.8		+ 3 2332		0 34.9	110.97S	A	N 2 1358			10 12.6	2 23
Dec 13	4179	Toutatis	4	0.14	1	5.627	302.8		+ 3 2325		3 45.6	122.98N	A	N 2 1348			10 9.9	2 45
Dec 14	4179	Toutatis	4	0.12	1	4.569	302.5	117995	+ 5 2253		0 7.6	51.09N	UA	N 5 1465	0.03	0.0	9 55.4	5 5
Dec 14	4179	Toutatis	4	0.12	1	4.509	302.5	117987	+ 5 2249		1 29.0	22.38N	UA	N 5 1462	0.77	0.1	9 54.6	5 14
Dec 14	4179	Toutatis	4	0.12	1	4.497	302.5				1 40.8	103.41N	C				9 54.4	5 14
Dec 14	4179	Toutatis	4	0.12	1	4.330	302.4		+ 6 2220		5 38.8	3.75S	A	N 5 1458			9 52.0	5 39
Dec 14	4179	Toutatis	4	0.12	1	4.216	302.4		+ 6 2219		8 19.5	50.52N	A	N 6 1254			9 50.3	5 53
Dec 14	4179	Toutatis	4	0.12	1	4.164	302.3				9 34.5	95.64N	C				9 49.5	6 0
Dec 14	4179	Toutatis	4	0.11	1	3.675	302.1	117865	+ 7 2169		23 6.4	131.29S	UX	N 7 1359	0.05	0.0	9 42.2	7 14
Dec 16	4179	Toutatis	4	0.10	1	2.929	301.6				0 52.3	77.77N	C				9 30.0	9 2
Dec 16	4179	Toutatis	4	0.10	1	2.829	301.5	117720	+ 9 2189		5 10.3	20.71N	UX	N 9 1211	0.25	0.0	9 28.2	9 19
Dec 16	4179	Toutatis	4	0.09	1	2.534	301.2	98538	+10 1987	A	19 10.3	71.12S	UX	N10 1205	-0.06	0.0	9 22.9	10 9
Dec 16	4179	Toutatis	4	0.09	1	2.511	301.2	98536	+10 1986		20 14.2	7.06N	UX	N10 1204	0.11	0.0	9 22.4	10 12
Dec 16	4179	Toutatis	4	0.09	1	2.465	301.2		+10 1981		22 49.2	97.76S	XA	N10 1202	0.31	0.1	9 21.6	10 21
Dec 17	4179	Toutatis	4	0.09	1	2.309	301.0	98487	+11 2008		7 15.1	88.02N	UR	N10 1198	-0.04	0.0	9 18.5	10 45
Dec 17	4179	Toutatis	4	0.09	1	2.243	300.9				11 17.5	22.29N	C				9 17.2	10 57
Dec 18	4179	Toutatis	4	0.08	1	1.852	300.3				15 11.4	2.34N	C				9 8.9	12 10
Dec 19	4179	Toutatis	4	0.08	1	1.747	300.2				0 10.3	76.66N	C				9 6.5	12 29
Dec 20	4179	Toutatis	4	0.07	1	1.490	299.6				2 51.2	40.16N	C				9 0.1	13 24
Dec 21	4179	Toutatis	4	0.06	1	1.313	299.2		L 1 4875		2 13.3	53.07S	H				8 55.3	14 5
Dec 21	4179	Toutatis	4	0.06	1	1.271	299.1	98218	+14 1992	B	8 26.7	13.78S	XA	N14 960	0.31	0.2	8 54.1	14 14
Dec 22	4179	Toutatis	4	0.06	1	1.125	298.6	98149	+15 1912	B	9 32.6	72.83S	XA	N15 985	0.34	0.2	8 49.6	14 51
Dec 22	4179	Toutatis	4	0.06	1	1.125	298.6	98148	+15 1912	A	9 38.6	74.14S	RX	N15 984			8 49.6	14 51
Dec 23	4179	Toutatis	4	0.05	1	0.990	298.0		+15 1892		13 45.4	54.48N	XA	N15 977	0.21	0.1	8 45.0	15 25
Dec 25	4179	Toutatis	4	0.05	1	0.842	297.2	98007	+16 1789	X	6 54.4	58.97S	UR	N16 920	-0.08	0.0	8 39.3	16 10
Dec 26	4179	Toutatis	4	0.05	1	0.752	296.6				14 11.4	61.78N	C				8 35.4	16 36
Dec 26	4179	Toutatis	4	0.04	1	0.731	296.5	97923	+17 1876		23 14.2	55.25S	UX	N16 912	0.30	-0.1	8 34.4	16 45
Dec 29	4179	Toutatis	4	0.04	1	0.605	295.4				12 31.7	56.52S	C				8 28.0	17 30
Dec 29	4179	Toutatis	4	0.04	1	0.598	295.3				16 43.8	34.52S	C				8 27.6	17 32
Dec 30	4179	Toutatis	4	0.04	1	0.555	294.9	97803	+18 1937		20 8.3	40.25N	UX	N17 897	0.22	0.1	8 25.1	17 48
Dec 31	4179	Toutatis	4	0.04	1	0.538	294.7		+18 1934		7 58.9	28.36N	XA	N18 860	0.32	0.4	8 24.1	17 55
Dec 31	4179	Toutatis	4	0.04	1	0.530	294.6				13 57.0	1.61N	C				8 23.6	17 59
Dec 31	4179	Toutatis	4	0.04	1	0.519	294.4				22 3.9	32.56N	C				8 22.9	18 3

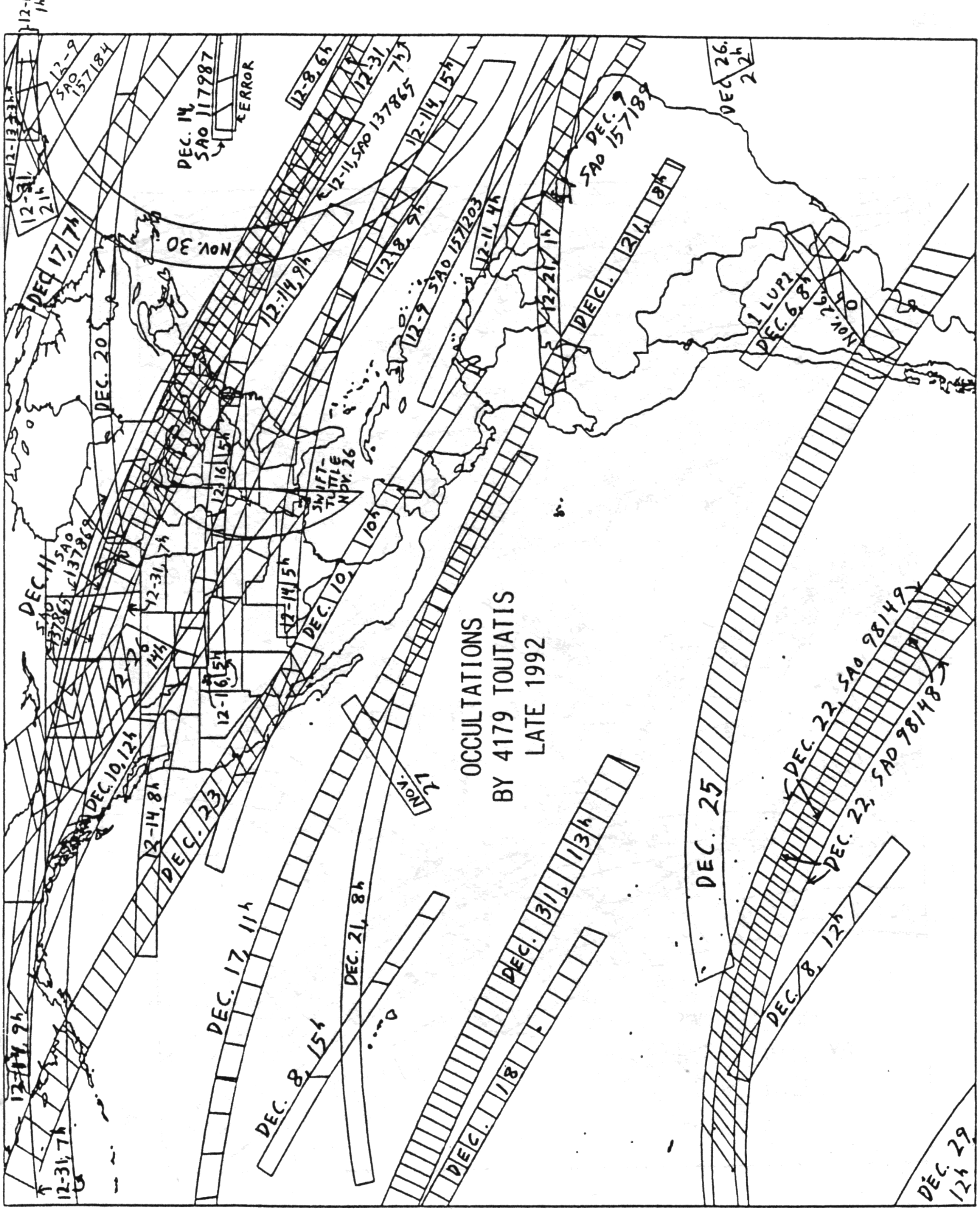
telephoned the basic prediction information about that event to Dannie Overbeek in South Africa.

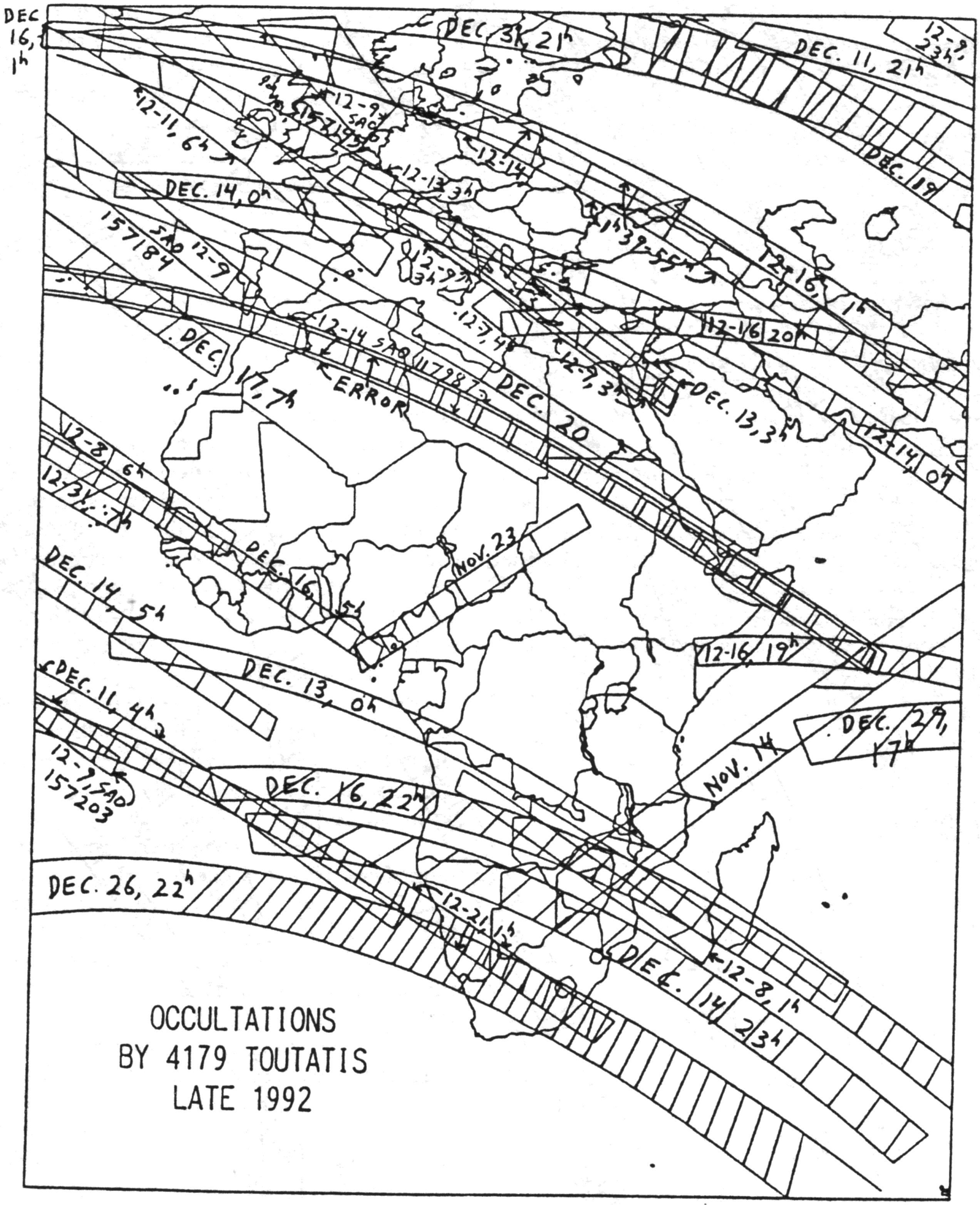
Since this is the first orbit that I have received for Toutatis from Yeomans, I have called it "YeomansA". By the end of November, Toutatis will be observed by radar, and Yeomans will quickly update the orbit. This should provide an ephemeris accurate to a few kilometers. To take advantage of it, I will need to closely duplicate Yeomans' Earth model. This will take some effort, but since I need to do it in any case for my work at APL on the Near Earth Asteroid Rendezvous project, I hope to accomplish it in time for the December occultations.

Value: The predictions are mainly to allow observers to watch for close appulses to stars about as bright as, or brighter than, Toutatis, to help locate the asteroid (near the time of an appulse or occultation, Toutatis will appear as a close "double star" with the target star). Observing an actual occultation will be much more difficult; even video timings of many of the occultations will give size and shape information to only about 10% of Toutatis' expected diameter, not nearly as good as can be expected from the planned radar measurements. Since I can't produce finder charts at the moment, you will need to use atlases such as **Atlas Eclipticalis** to locate the occulting stars, except for events that occur December 10-19, when the detailed charts on p. 674 of the **S&T** article can be used. Note that Toutatis' horizontal parallax will at times be larger than 6′, meaning that it can be a significant distance from the **S&T** path. The editors of **S&T** have promised to provide more detailed charts covering the path beyond December 19th in their 1993 January issue, which should be received by many subscribers before December 19th.

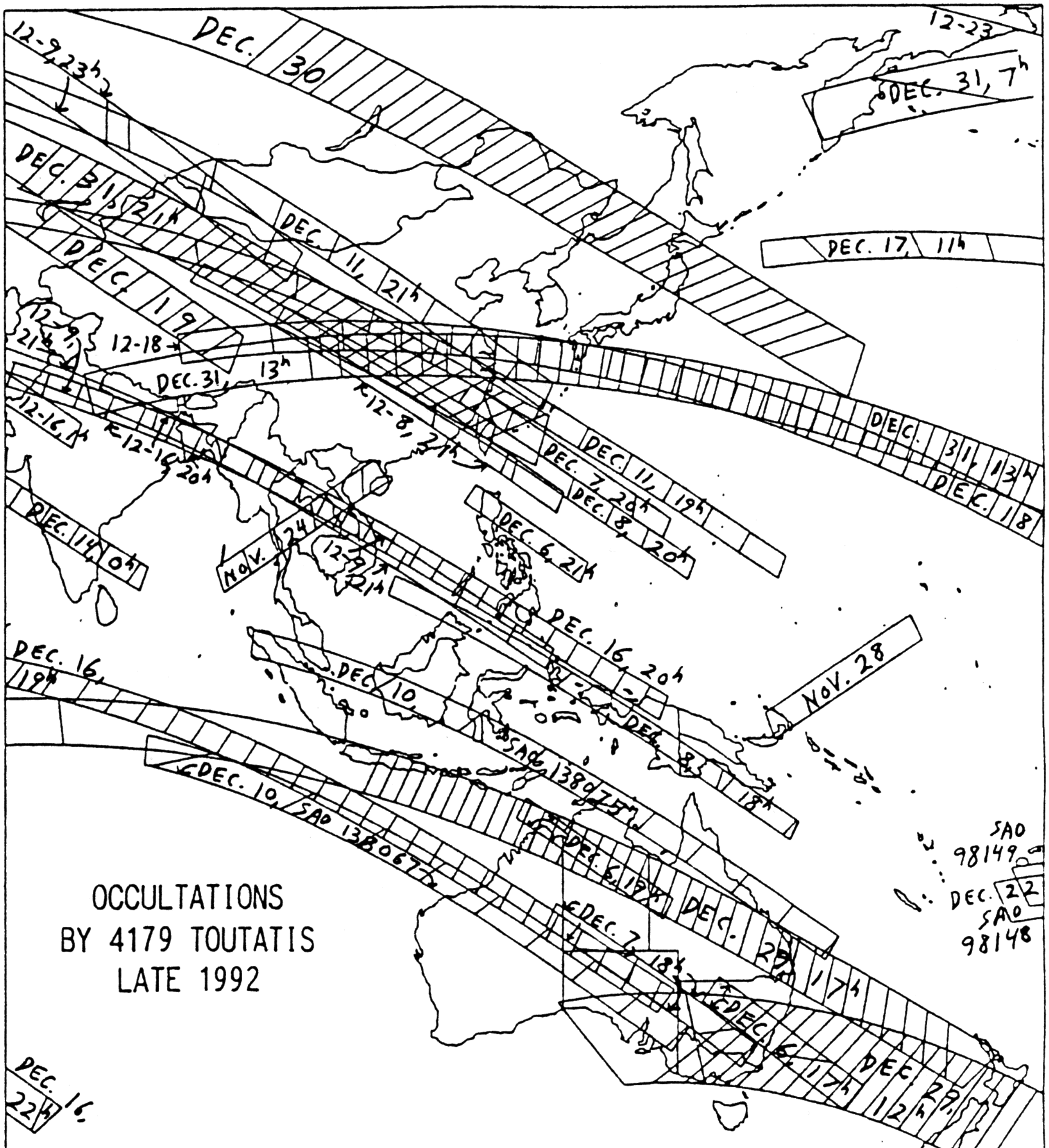
Comet Swift-Tuttle: I also searched for occultations by the recently-recovered periodic comet Swift-Tuttle. The only events I found during the rest of 1992 involve two tenth-magnitude Astrographic Catalog stars that should be quite difficult to observe due to the comet's brightness. I have tried to use a nuclear magnitude for the comet, but it could be significantly in error. Edwin Goffin has also searched for occultations by this comet, and found only one event visible from southern Africa and part of South America in January 1994 (I mistakenly told D. Overbeek by phone that the event was in 1993 when I informed him about the first Toutatis occultation possibility). Goffin also searched the PPM, ACRS, and FAC catalogs for occultations by Pholus, the new Chiron-type object, and found no events during the rest of 1992 or all of 1993. Since my ephemeris programs are based on B1950/FK4, I wrote and tested a small program that converts the J2000/FK5 orbital elements to B1950/FK4 using a variation of formulae supplied by the International Astronomical Union's Commission 20.

Toutatis Updates: When an improved orbit for Toutatis becomes available from the planned radar observations, I will give this information on the IOTA occultation line at 1-301-474-4945, in the form of the updated line's location within the uncertainty zone, and a time correction. It may be possible with this new orbit to calculate the path to an accuracy smaller than Toutatis' diameter, but the actual path will then be limited to star position errors, which in the case of ZZ87 (source U) stars is about $\pm 0\overset{''}{.}3$, meaning that the actual path could be located to within less than 3 times its width. This would make possible accurate targeted expeditions to catch the event; these would be more like graze expeditions, covering a width of only about 10 km, rather than the much wider spread of most asteroidal occultation attempts. But it would take some effort to do this, for little practical gain; although it might be done, more effort should and will be concentrated on predictions for and observations of the more valuable occultations during the December 9-10 total lunar eclipse discussed in the previous article.


OCCULTATIONS
BY 4179 TOUTATIS
LATE 1992
NOV. 30
DEC. 17, 7h
DEC. 20
DEC. 14, SAO 117987
ERROR
12-8, 6h
12-11, SAO 137865
12-31, 7h
12-14, 5h
DEC. 9 SAO 157189
DEC. 26, 2h
12-14, 9h
12-8, 9h
12-9 SAO 157203
12-11, 4h
12/21, 1h
DEC. 21, 8h
1 LUPI
DEC. 6, 8h
NOV. 26
SWIFT-TUTTLE NOV. 26
12-16, 5h
DEC. 11 SAO 137869
12-31, 7h
12-14, 5h
DEC. 10
10h
DEC. 10, 12h
12-14, 8h
DEC. 23
NOV. 27
DEC. 25
DEC. 22, SAO 98149
DEC. 22, SAO 98148
DEC. 31, 13h
DEC. 17, 11h
DEC. 21, 8h
DEC. 8, 15h
DEC. 18
DEC. 8, 12h
DEC. 29, 12h
12-14, 9h
12-31, 7h



OCCULTATIONS
BY 4179 TOUTATIS
LATE 1992



OCCULTATIONS
BY 4179 TOUTATIS
LATE 1992

Notes on Individual Events:
Nov. 26, 1h: Periodic comet Swift-Tuttle is abbreviated "P/Swf-Tutl". The eastern side of the probability zone stretching from upper Michigan to Mobile, Alabama, marks where the comet is too low (11°) in the west for effective observation.
Nov. 28: The star is ZC 2681.
Nov. 30: This curved path crossing the southern tip of Greenland and Newfoundland both starts and ends at low altitude (10°) above the horizon.
Dec. 6, 8h: The star is 1 Lupi, the brightest star that will be occulted by Toutatis during the rest of 1992.
Dec. 9, 23h: The occultation of SAO 156859 occurs during the total lunar eclipse, which is more important to observe; see the previous article.
Dec. 16, 19h: SAO 117720 is the close double ADS 7337; the components are both mag. 9.8, with current separation 0".7 and position angle 44°.
Dec. 21, 8h: SAO 98218 is the B-component of a wide double. The primary is 8.0-mag. SAO 98219, 113" away in PA 9°, which is not occulted, its shadow missing the Earth by 1300 km.
Dec. 22, 9h: SAO 98148 and 98149 are the components of ADS 7031, separated by 16".4 in 123°.
Dec. 25: SAO 98007 has component magnitudes of 8.1 and 9.2 separated by 0".132 in direction 243°, according to a lunar occultation recorded photoelectrically at McDonald Observatory on 1973 March 15. However, the duplicity was not confirmed during another McDonald lunar occultation recording made on 1980 March 26.

LUNAR OCCULTATION PREDICTION AND SOFTWARE NEWS

David W. Dunham and Walter I. Nissen, Jr.

Some additional information about these topics is given in Rocky Harper's account of the IOTA meeting; in the article about occultations during the December lunar eclipse; and in the IOTA Workshop Report by Kretlow and Zimmermann elsewhere in this issue.

Detailed Total Occultation Predictions: The Q-catalog predictions of lunar occultations of faint stars during the 1992 December and 1993 lunar eclipses, along with a revised explanation, were sent to the European national coordinators in late October, so they have probably distributed all of the information by now. The predictions for North American observers are being mailed this month. In early October, David discovered a mistake; he had not computed the Q-catalog predictions for non-European and non-North American observers at USNO before their computer was shut down on October 1st. Fortunately, he gained access to another computer that has the CMS operating system, like USNO's, so he was able to install the EVANS program and run the needed predictions. At the time, David was unable to load the large Watts limb correction data set (that problem was solved recently), so those Q-catalog predictions were computed without Watts data, leading to errors of a few seconds. In any case, we sent a magnetic tape with both the Q-catalog and main 1993 predictions for non-European, non-North American observers to the International Lunar Occultation Center (ILOC) in late October. In a letter dated November 10, ILOC's Yumiko Watanabe informed me that they printed the predictions from our tape and mailed the Q-catalog predictions (at least for the 1992 December eclipse) by air mail by October 30th, and that all the other predictions would be sent by surface mail by mid-November. Only predictions for active observers in the IOTA-USNO system, that is, those who returned verification forms for the 1993 predictions, have been computed and sent.

Predictions of Lunar Occultations of Asteroids: Predictions for these events were included in the detailed USNO total occultation predictions for 1978 - 1992. However, lack of time prevented us from taking the several steps needed to include lunar occultations of asteroids in the 1993 predictions (occultations of major planets are included). Fortunately, B. Stecklum has filled this void with his article, "Occultations of Asteroids by the Moon in 1992 and 1993" starting on p. 1623 of the October 1992 issue of **Astronomical Journal.** He includes a good general description of these very difficult events. None of these events in 1993 is favorable enough for effective observation with apertures smaller than 60 cm. Stecklum has also provided us with his PC-based software for calculating lunar occultation predictions of stars. Its operation is similar to Taylor's LOP discussed in Harper's article and in **ON** 5 (7), p. 174, but is somewhat slower due to calculation of lunar ephemerides from analytical formulae rather than from files (this does give it an advantage of being valid for a much longer period of time).

Software Developments: Claudio Costa has completed debugging of his PC version of the EVANS detailed lunar occultation prediction program, but it did not produce all of the events in predictions computed at USNO. As mentioned in the last issue, the MAGLIM free parameter affecting the observability calculation was adjusted with new information as late as August 10, and Costa apparently did not have these final updates. David sent the latest updates to Costa by e-mail in early November, and these should solve this problem. Costa is writing a short user's guide for use of the PC version. So distribution of the PC EVANS program should be possible soon. In late October, Costa received the formatted BEFILEs needed to calculate Q-catalog predictions during the total lunar eclipses in 1992 and 1993.

In their November 10th letter, ILOC basically agreed to IOTA's plan for a prediction system based on use of the PC version of EVANS by national coordinators. Details of this will be worked out early in 1993; the desire to get rid of our current worldwide prediction burden gives us strong motivation for accomplishing this. In cases where prediction mailing cost is a problem for national organizations (such as for those in the country who are not paid members of the organization), ILOC has agreed to supply the predictions, so they are also anxious to receive the PC EVANS software.

VISUAL OBSERVATIONS OF DOUBLE STAR OCCULTATIONS

Dietmar Büttner

My stimulus to write this article comes from the resumption of discussions on double star observations in the **ON** by Tony Murray. It may be that some of my statements in this article are controversial. However, this may encourage other observers to deal with this matter.

Many observers find themselves in doubt about the reliability of results derived from visual observations of lunar occultations of double stars. This uncertainty originates in the nature of such occultation events, as the phenomena occur within a few tenths of a second and are sometimes hard to notice due to the small magnitude drop or due to bad seeing. In this article, the author presents his experience in order to help other observers in estimating their own results. The conclusions are derived from 330 total occultation observations made by the author with a 63mm refractor since 1978. All observations that seemed not to occur instantaneously were considered. This is 36 observations, 12% of all of them.

First, the non-instantaneous observations were divided into step-wise and gradual events, giving two classes with 8 and 28 occultations, respectively.

As there is a considerable divergence in the certainty of the observed phenomena, all observations were given a certainty code from 1 to 3. It is similar to the certainty code in the ILOC report forms, however, it refers to the certainty of the seen manner of light drop. The certainty code was given either directly at the telescope or was assigned later from the comments written in the observing book.

Within the particular groups, the observations were distributed as follows:

Certainty	Stepwise	Gradual	Sum
1 (certain)	5	9	14
2 (somewhat uncertain)	1	9	10
3 (very uncertain)	2	10	12
Sum	8	28	36

Of these events, 29 were disappearances and 7 reappearances.

The certainty of gradual events was especially good when two or more observers saw the same occultation at the same place and all rated it as gradual. There was one special case, where even a gradual reappearance was seen by the author and confirmed by another observer nearby. Five further reappearances, however, were somewhat or very uncertain. One stepwise reappearance was quite certain. Gradual events were especially uncertain if the duration was short (0.1-0.2 s). The confidence with gradual events improved with longer durations. In many cases the duration of the gradual stage could be determined rather well because the observer used the eye-and-ear timing method and heard a time signal while seeing the fade.

All of the stepwise occultations concerned stars with double star codes in the USNO predictions (K, M, O, V, Z). In the case of the nine certain gradual events, five stars did not have a double star code in the USNO predictions.

From the distribution of observations, the following conclusions may be derived:

1. There are several certain gradual or stepwise events, but there is also a considerable number of somewhat or very uncertain observations, especially in the case of gradual events.
2. The certainty of stepwise events seems to be higher than that of gradual ones.

Based on his own experience, the author suggests the following in doing double-star observations and in handling their results:

1. Observe as carefully as possible.
2. For stepwise events, try to measure or estimate the time difference between the two steps (use two stopwatches or a memory stopwatch) and estimate the size of the magnitude drop. For gradual events, try to estimate the duration of the gradual phase. Quantified results may be better compared with data from other observers.
3. Try to assign a certainty note to your observations.
4. Record all circumstances that may be important for the visibility of a non instant phase:
   - Stability of the star image (seeing)
   - Your ability to see the unocculted star, especially for faint stars
   - Averted vision, etc.

   Remember that nobody else knows the conditions and circumstances of your observation better than you.
5. Try to consider your results as realistically as possible. Do not overestimate your ability and results on the one hand. However, on the other hand, do not discard all observations which you felt to be gradual or stepwise with the argument "it cannot be".
6. Try to compare your results with those of other observers. However, do not change your opinion about what you think you have seen if another observer did not see the same thing.

If you look into a double star catalog before the observation in order to see what to expect or after the observation in order to see what you should have seen, be careful. Many data in the catalog will be correct, but there may also be questionable entries. This is especially possible for double stars discovered during previous occultations. The position angle of such double stars may be derived from one occultation and is therefore not necessarily the position angle of the greatest distance. Also, the magnitude data from such discoveries may be weak because it is difficult to estimate two different magnitudes within a fraction of a second.

The author hopes to have shown that visual detection of double star occultations is worthwhile, but the observations should be handled carefully.

DOUBLE STARS

Tony Murray

Since the last article on new double stars appeared in **ON 5** (7), we have received reports from six observers, all in the USA. In addition, we have finished work on the 200 reports received in 1991, mostly from J. Bourgeois and H. Bulder. After the table that accompanies this article was completed, a report was received from D. Büttner. It will be checked and reported in the next article on new double stars.

The table contains 61 additions to the IOTA Catalog of Double Stars of the Moon's Occultation Zone.

J. Bourgeois' reported observation of June 27, 1989 confirms the previously known duplicity of SAO 75531. This observation is interesting because this star is ADS 2072. Its magnitudes are 8.0 and 12.0. Bourgeois timed the reappearance of the secondary 0.9 second before the reappearance of the primary. This star has no double star code in the XZ catalog, since such a faint secondary star is normally not observable. Bourgeois observed the reappearance of the faint secondary using the 105 cm (41 inch) reflector at Pic du Midi Observatory in France. No doubt this extraordinary observation was possible because of the telescope's aperture.

On March 14, 1992, R. Sandy and D. Brewer observed disappearances of SAO 79375 and SAO 79376 from stations 30 miles apart, east and west. Both observers saw 79375 fade over a period of 0.2 second, strongly indicating that 79375 is a double star. The occultation occurred at PA 106°. These two stars together are ADS 6060. The observations by Sandy and Brewer show that the primary of ADS 6060, SAO 79375, is itself a double star. For its purposes, the IOTA catalog will now have 79395 with Mag1 = 8.0 and mag2 = 8.0, and 79376 will have its own listing, with magnitude = 8.3.

In addition to the observers already mentioned, reports were received from R. Hays, Jr., C. McManus, R. Wilds, and D. Costales. Wilds observed the graze of SAO 78919 at Pedonia, Kansas on May 7, 1992.

Notes:

The magnitude, separation, and PA given for ZC 2524 in **ON 5** (7), p. 186 are incorrect. This is the double star discovered by H. Povenmire on September 16, 1991. The correct data are: Mag1 = 6.9, mag2 = 8.6, sep. = 0."5 and PA of secondary is 160°. The catalog has been corrected.

The Table of New Double Stars on page 118 of **ON V** (5) contains inaccurate magnitudes for six stars. The correct magnitudes for the components of the stars are: 75773 = 8.6, 75990 = 8.4, 76216 = 7.4, 79615 = 8.5, 80524 = 8.4, and 93884 = 9.8. SAO 76225 should read 76225. The catalog has been corrected.

In addition, the following 11 stars were reported as double whose duplicity had previously been discovered:

75715 R. Hays, Jr. observed a fade lasting 0."3 on Jan 15, 1992. J. Bourgeois observed this star as a fading event Sept. 28, 1988. The code is now $.

77647	C. McManus, 92 May 06
77767	C. McManus, 92 May 06
78852	R. Hays, Jr., 92 May 07
92207	R. Hays, Jr., 92 Feb 09
94385	J. Bourgeois, 78 Sep 23
98674	J. Bourgeois, 83 Feb 22
161540	J. Bourgeois, 78 Oct 08
+16° 0640	J. Bourgeois, 80 Sep 29
+19° 2078	J. Bourgeois, 82 Mch 06
P 339	J. Bulder, 88 Aug 06

Table of Double Stars

SAO	M	N	Mag1	Mag2	PA	Date	Discoverer	Notes
	T	X	10.0	10.0	92.0	90Jan03	Bourgeois	+04° 0016
	T	X	8.4	8.4	133.0	83Feb18	Bourgeois	+08° 0364
	T	X	11.0	11.0	134.0	82May26	Bourgeois	+21° 1712
	T	X	10.2	10.2	296.0	90Nov09	Bourgeois	+16° 1854
	T	X	9.8	9.8	314.0	88Dec28	Bourgeois	+11° 2205
	T	X	10.7	10.7	122.0	90May30	Bourgeois	+08° 2343
075804	T	K	9.3	9.3	119.0	89Dec10	Bourgeois	
075882	T	X	9.4	9.4	63.0	89Dec10	Bourgeois	
075990	T	K	8.4	8.4	85.0	89Dec11	Bourgeois	
076119	T	X	9.3	9.3	139.0	90Feb03	Bulder	
076770	T	K	8.4	8.4	324.0	89Sep20	Bourgeois	
076924	T	X	9.3	9.3	225.0	90Oct08	Bourgeois	
077608	T	X	10.0	10.0	69.0	90Feb05	Bourgeois	
077654	T	X	9.0	9.0	79.0	82Feb04	Bourgeois	
077688	T	X	10.1	10.1	0.0	92May06	McManus	
077874	T	X	9.8	9.8	264.0	89Sep22	Bourgeois	
078365	T	X	9.3	9.3	321.0	90Sep13	Bourgeois	
078413	T	X	9.6	9.6	210.0	90Sep13	Bourgeois	
078443	T	X	9.6	9.6	225.0	90Sep13	Bourgeois	
078890	T	X	9.9	9.9	0.0	92May07	McManus	
078919	G	K	9.2	9.2	17.7	92May07	Wilds	Graze
078920	T	X	9.7	9.7	0.0	92May07	Costales	
079111	T	X	9.8	9.8	271.0	90Oct10	Bourgeois	
079211	T	X	9.3	9.3	244.0	90Oct11	Bourgeois	
079375	T	$	8.0	8.0	106.0	92Mch14	Sandy,	Brewer
079381	T	X	9.8	9.8	120.0	82Apr01	Bourgeois	
079499	T	X	10.0	10.0	324.0	90Sep14	Bourgeois	
079504	T	X	9.2	9.2	124.0	82Apr01	Bourgeois	
079871	T	X	9.6	9.6	318.0	90Nov08	Bourgeois	
079912	T	X	9.3	9.3	301.0	90Nov08	Bourgeois	
080046	T	K	8.8	8.8	175.0	90Apr03	Bourgeois	Nearly grazing
093236	T	X	9.8	9.8	52.0	82Feb01	Bourgeois	
093252	T	X	9.9	9.9	57.0	82Feb01	Bourgeois	
093301	T	X	7.9	7.9	263.0	78Jul28	Bourgeois	
093551	T	X	9.6	9.6	249.0	80Sep28	Bourgeois	
093901	T	X	8.6	8.6	205.0	77Sep05	Bourgeois	
094374	T	X	10.2	10.2	316.0	78Sep23	Bourgeois	
094976	T	X	9.8	9.8	241.0	80Sep03	Bourgeois	
095013	T	X	9.8	9.8	77.0	81Apr09	Bourgeois	
095426	T	X	9.4	9.4	236.0	80Oct28	Bourgeois	
096142	T	X	9.8	9.8	236.0	78Sep25	Bourgeois	
097665	T	X	9.2	9.2	272.0	90Oct12	Bourgeois	
097889	T	X	9.8	9.8	123.0	82Apr02	Bourgeois	
097970	T	X	9.8	9.8	262.0	80Nov26	Bourgeois	
097996	T	X	9.3	9.3	44.0	90May28	Bourgeois	
098064	T	X	9.9	9.9	131.0	82Mch06	Bourgeois	
098193	T	X	9.9	9.9	331.0	90Nov09	Bourgeois	
098376	T	X	10.0	10.0	222.0	81Sep24	Bourgeois	
098396	T	K	9.3	9.3	345.0	90Oct13	Bourgeois	
098549	T	X	8.9	8.9	321.0	77Dec02	Bourgeois	
098823	T	X	10.1	10.1	136.0	82May28	Bourgeois	
098879	T	X	9.7	9.7	137.0	90Apr05	Bourgeois	
110123	T	X	10.2	10.2	273.0	81Jul24	Bourgeois	
110447	T	X	9.5	9.5	293.0	78Jul27	Bourgeois	
117869	T	X	9.5	9.5	270.0	77Nov05	Bourgeois	
139224	T	X	9.9	9.9	141.0	82Jun01	Bourgeois	
158781	T	X	9.5	9.5	12.0	82Jan18	Bourgeois	Graze
184208	T	X	8.9	8.9	63.0	89Jul14	Bourgeois	
186314	T	X	9.9	9.9	77.0	82Aug28	Bourgeois	
186322	T	X	9.7	9.7	93.0	82Aug28	Bourgeois	
188245	T	X	9.4	9.4	72.0	82Sep26	Bourgeois	

TREASURER'S REPORT

Craig and Terri McManus

As of September 30, 1992, IOTA had assets of $3881.53 in cash and bank accounts.

Receipts for the period July 1, 1991 to September 30, 1992 were:

Contributions - Gifts from members	87.50
Interest earned on checking	164.44
Membership renewal	
- full memberships	8,337.90
Misc. Income - Sale of IOTA Items .	14.18
POM - Preliminary Occultation Manual	17.50
Predictions	
- Non-member prediction sales . .	16.50
Subscriptions	
- ON Subscriptions only	1,105.00
USNO Total Occultation Payment .	1,000.00
TOTAL INCOME	10,743.02

Expenditures during this same period were:

Bank Card Costs - Credit Card Costs	41.99
Misc. Debits - other expenses . . .	149.73
ON Printing - Newsletter only . .	3,374.70
Office expenses	260.01
Postage - All mailings	3,769.74
Asteroid and Graze Supplements . .	516.56
USNO Total Occ Run and Mailing . .	764.63
TOTAL EXPENDITURES	8,877.36
OVERALL TOTAL	1,865.66

PUBLISHER'S REPORT

Joan Bixby Dunham

This is a updated version of the report I presented at the annual meeting in Houston. We have, since the meeting, acquired a new laser printer, which should make a significant improvement in the **ON** quality.

This issue of **ON** is being produced with Wordperfect 5.1 and Fonts-on-the-Fly on a DOS machine, and printed with our recently acquired Hewlett Packard LaserJet IIIp printer. To save money, we have been reproducing the newsletter by Xerox, instead of photo-offset. Switching to Xerox halved the reproduction costs. Now that we are using a laser printer, the difference in reproduction quality between photo-offset and Xerox should be minor.

Homer DaBoll designed a two-column format for the **ON** using the IBM Selectric Letter Gothic type ball, which was then reduced by 77% in photo-offset reproduction. We were using a Brother daisywheel printer and following the same format. The daisywheel printer broke and we elected to save our money to buy a laser printer instead of getting the Brother repaired. We used a Panasonic 24-pin dot matrix printer, which, at first, was printing well enough to be almost indistinguishable from laser printing with the right font software. However, our attempts to do an entire newsletter with special fonts revealed some problems with that printer and aged it considerably.

The new laser printer is our sixth printer. That does seem to be the piece of computer hardware we wear out the fastest. Two of the six, Citizen and Apple dot matrix printers just became superfluous. The Citizen is used very occasionally; the ADM we gave away with the Apple II+. The Citizen was the least expensive of the printers, and the best value. It still performs as well as it did when new. It does have some quirks - for example, the pin feed cannot be brought close enough together to take 1-up pin feed mailing labels. (This is a tremendous annoyance, since it would seem to be the best use of that printer now.) The Panasonic 24-pin dot matrix printer was a disappointment. The carriage is much wider than its maximum line length of 8 inches. Even though it will take an 8"x11" sheet of paper sideways, it will only print 8 inches. We needed to buy the wide-carriage version to print a longer line. Also, as mentioned above, it is showing signs of overuse. One problem it has developed is that it can no longer be trusted to print a table in all fonts. In some fonts it will shift a line of the table by half a character, spoiling the appearance of the table.

We have done some experiments with the fonts we used to prepared the newsletter. The text for this issue is being prepared with CG Times at 11 points. CG Times is a proportional font with serifs. That means that thin letters, like l's and i's, take less room than wide ones, like m's and w's. Also, the letters have bumps at the tops and bottoms, which are supposed to make them easier to read. We have experimented in the past with producing an issue in a sans-serif font, but we received complaints that it was too hard to read. We are preparing the tables in non-proportional fonts (usually Courier) at various pitches, since the entries in tables in a proportional font often do not line up nicely. The original design of **ON** used Letter Gothic, a sans-serif font that is widely available for typewriters. The CG Times font at 11 points (smaller than 12 pitch) is unlikely to be available on a typewriter, so it does make it harder for others to type material that can be pasted directly into the newsletter.

Some notes on preparing tables for the **ON**:
I have been using a combination of PC-File, WordPerfect, and PC-Write to prepare tables. If I have a complicated table to prepare, or I am not quite sure how it would best be presented, I put the data into PC-File and try different output formats to see how it looks. If I am sent a table as a formatted file on a floppy and want to rearrange the data, I can import the data into PC-File and make them into a data base. Once I have the data as a data base, I can rearrange columns, insert or delete columns or rows, and delete blanks. I usually "print to disk" when I generate a PC-File report, and use PC-Write or WordPerfect to generate the final report.

We have ordered a ZEOS 486-66MHz computer to replace our VanFlandern PC-XT clone. (VanFlandern is no longer selling computers.) Once we have this machine, we should be able to read MS-DOS 5-1/4 and 3-1/2 diskettes in all densities. If you send me your text on a floppy, it prevents the typos that creep in when I type it myself. We can also receive files via modem with prior arrangement, or through David's Internet account. We canceled our Source membership, since we rarely had time to use it.

I apologize for the delays in the recent issues. David's job change, plus the additional work he has to do since USNO stopped providing occultation services, plus the demands on our time from family concerns (familiar I am sure to all working parents with small children!) have left us with very little free time in which to prepare the newsletter. I also wish to thank all of those who contribute articles to the **ON**.

Future Changes Tony Murray has offered to print the **ON** at a reduced cost, and to add a cover to give the newsletter a more polished appearance. The next issue will be our first attempt at doing this.

COMMENTS ON VIDEO TIMING ACCURACY

Cliff Bader

The September 1992 **ON** article on video timing accuracy by Bourgeois and Bousmar (**V** (8), pg 217) provides a basis for extracting the best possible accuracy from video timings. However, the article assumes a camera integration time equivalent to a full frame (33.3 msec EIA or 40 msec CCIR), whereas Campbell in his September article (pg 214) (and also Manly) points out that integration is on a field basis and occurs twice per frame, in 16.7 or 20 msec increments. The image accumulated during the first field is displayed as the second field, and that during the second field appears as the first field of the following frame. This fact would appear to modify the conclusions drawn by Bourgeois and Bousmar. Furthermore, when the VCR frame-freeze behavior noted in my September article is considered, interpretation of the recording becomes less straightforward.

It helps to draw a timing diagram similar to that presented by Bourgeois and Bousmar, but including the effects of individual-field integration and VCR frame-freeze format. I make a chart for each occultation and draw parallel diagrams for my two VCR's, which freeze different fields. Taken together, the two diagrams extract a maximum of information from the event.

The technique of using brightness changes to estimate the fraction of the integration time in which the star was present can by used only if the VCR displays the field in which the event occurred. Also, the effects of twinkling are difficult to separate from brightness changes due to partial-field integration; nevertheless, the technique is useful if the air is steady or the pattern of twinkling is regular.

With timing errors reduced to a few milliseconds, the telescope positional error becomes the dominant uncertainty in the data. The equivalent time error for a given position error can be calculated from the A and B factors in the prediction for a particular event. Typical map uncertainties on the order of ±30 meters often amount to a full video frame or more of equivalent time.

In addition to the map uncertainty for the nominal telescope position, additional error creeps in when the telescope is moved in order to access various portions of the sky. Even on my small suburban property, the added error due to dodging trees can approach the map uncertainty. This was not much of a concern with visual timing accuracies of tenths of a second.

Nothing can be done about the map uncertainty until better coordinate determination means are available, but coordinate corrections can be applied for local position shifts relative to the nominal position. This is practical if only two or three positions are used. However, if (as in my case) ten or twenty positions are needed, it is doubtful if the complication in reporting and reduction is worth the benefit gained.

A less legitimate but perhaps useful alternative is to use the A and B factors in reverse to refer timings back to the nominal position, and to report the corrected time. This approach is not rigorous; however the results should be significantly better than those obtained by ignoring the local position shifts. I would be interested in hearing opinions on this idea.

Note: There are several ways to determine how a VCR displays a frozen frame. One is to focus the camera on a rapidly moving or oscillating object and measure the amount of movement and blurring while stepping through the recorded frames. A more sophisticated approach is to record the image of a light-emitting diode pulsed in synchronization with or nearly at the frame rate. It is interesting to watch the light simply disappear when the flash occurs in the field missed by the VCR.

[Ed note: A few typos were made in Cliff Bader's article in the last **ON**:

The published sentence beginning with "While it is not possible to use radio time signals to —" should read "While it is possible —". In a letter on the subject, Bader writes "There is no inherent reason why voice/tic/tone radio signals cannot be used to modulate the carrier, but the linear modulation circuitry and level control means get a bit complicated. Nothing beyond simple ticks or tones yields intelligible information during frame freeze operation; this is the factor which restricts format complexity."

The appended discussion of VCR frame freeze operation is in error. In the sentence ending "to identify on which individual frame the event occurred" the word "frame" should be "field". The discussion was on the use of two recorders to pinpoint the event time to the nearest field (half frame).]

IOTA WORKSHOP REPORT

M. Kretlow and W. Zimmermann

This meeting was held in Hannover, Germany, last May. The participants were: Dr. W. Beisker (München), H.-J. Bode (Hannover), Dr. D. Böhme (Dresden), R. Bücjmer (Oberursel), A. Doppler (Berlin), A . Gnädig (Berlin). J. Jahn (Bodenteich), M. Kretlow (Siegen), D. E. Riedel (München), and W. Zimmermann (Hannover), all from Germany.

Three main topics were discussed:

(1) Asteroidal astrometry and last minute predictions (LMAN project).

(2) Questions concerning the software for the prediction and reduction of occultations.

(3) Questions which are affecting all parts of occultation work. The basic items were the switch to J2000.0 FK5 and the compilation of a single star catalog (based on J2000.0 FK5) for future work.

The first part of topic 3 was discussed by all participants. They agreed that a switch to the J2000.0/FK5 system is necessary from different points of view (replacement of software, creation of new software packages, physical and mathematical reasons, consistency with IAU recommendations, etc.) However, the problem which could arise is a probable disagreement with IOTA/US computations. [D. Dunham: The IOTA/US software uses the earlier less accurate B1950/FK4 system. Some of this software will be upgraded to the J2000.0/FK5 system, but much of it will be replaced with Sôma's J2000-based OCCRED program, and some of the IOTA/ES software described here, so these "disagreements" should disappear as these tasks are accomplished.]

W. Zimmermann gave some information about individual star catalogs, which should be considered for incorporation into one big star catalog for future predictions and reductions. Many questions are open about the "how" to do it and how to get information about the mean error of positions and proper motions of each catalog. A ranking list of the input catalogs in compiling the new catalog is needed. Another problem is that no (known) cross reference including all 13 catalogs exists and possibly has to be done by IOTA.

W. Zimmermann has written FORTRAN programs to read and convert all of these 13 catalogs. He also reported that his software for computing apparent places following the formulae given in the Astronomical Almanac for 1984 onwards (using Cartesian vectors) is now ready and that it works very well. Because he does not have the JPL lunar and planetary ephemerides on J2000.0, DE200/LE200, he extracted the barycentric coordinates from the USNO ICE (Interactive Computer Ephemeris). [He obtained the DE200/LE200 JPL ephemerides in September. DWD]

M. Kretlow has written a FORTRAN program for computing ephemerides of minor planets (an n-body integration program). But this program is far from ready and further investigation is necessary. A first working version is expected at the end of the year.

Topics (1) and (2) were discussed in separate groups.

Results of the discussion (1):

In this first meeting about the Last Minute Astrometry Network (LMAN), basic questions between the initiators M. Kretlow and Dr. D. Böhme were discussed. Some problems arising in high precision astrometry have been shown (e.g., magnitude equation). The mathematical model, which should be used in the reduction of the plates, has been extensively discussed. Concerning the film formats to be used by the observers and to get a sufficient overestimation of the equations of condition, it has been concluded that a six plate constant model should be used. The radial distortions will be estimated from reductions of measurements of exposures of the Pleiades cluster. The radial distortions will be computed by M. Kretlow and then have to be incorporated into the computation of the standard coordinates of the unknown objects by the astronomer. Because most of the observers have their own programs for the plate reduction, they only have to change this entry. Some changes will be made in the FORTRAN 77 program of M. Kretlow in response to suggestions made by some observers (e.g., online measurement input). It was also concluded that the plates have to be made of as many predicted events as possible for this year, even if the event has already happened or if the plates cannot be reduced in time for the event. If the plates are measured and reduced, and the positions of the star and the asteroid are forwarded to M, Kretlow, a mean error of the positions (or at least the residuals of the reference stars) also must be communicated.

In general, the data on all existing resources should be communicated to M. Kretlow and H.-J. Bode for a data base for later use.

Results of the discussion on topic 2:

Dr. Riedel reported about the development of his program for the prediction of grazing occultations. He coded the formulae from the **Astronomical Tables** by Jean Meeus and used the FK4/B1950.0 coordinate system in his first version. The star catalog he uses is the PPM for stars north of -2°.5 degrees and the SAO for the southern stars. He computes lunar coordinates with the aid of daily polynomials. The polynomials are obtained from ICE data. Output of his program is a path on the Earth where a graze can be seen.

His program detected all 1992 events for the U-region. All paths had an accuracy of better than 100 meters. In spite of many phone calls between München (Dr. Riedel) and Hannover (Mr. Zimmermann), the apparent places of the stars as found in the data set used as input for the OCC graze program could not be reproduced. Mr. Zimmermann found an undocumented subprogram in the OCC cycle performing empirical corrections. For this reason, they want to use the documented algorithms for the FK5/J2000.0 coordinates. Dr. Riedel will now change his program to use the FK5/J2000.0 system and compute lunar coordinates from barycentric coordinates (using ICE as long as no copy of LE200 is available for our use).

Dr. Riedel is not familiar with FORTRAN 77. He uses Pascal instead. Mr. Zimmermann will translate the Pascal into FORTRAN 77 later.

One requirement from David Dunham was to output the same data card formats as the USNO OCC programs, because they are required for other programs like the graze program, MEEUSMAP, and so on. There was no acceptance to fulfill it within Dr. Riedel's program. For compatibility the data cards should be generated for the graze paths by a separate program. But this requires a complete description of the 8 data cards of the USNO OCC programs. The first 5 cards are described in ANS (graze program subroutine), the other 3 cards contain values that ANS does not use. Also needed is an explanation of the USNO code for star catalogs. Mr. Zimmermann successfully guessed some codes by studying the minor planet program, LOCM88, but more documentation is required. The third problem is to recompute FK4/B1950.0 coordinates. Mr. Zimmermann will write a subroutine which will do this in accordance with the algorithm for computing FK5/J2000.0 coordinates from FK4/B1950.0 coordinates (Ref. **Astron. J. 97** (1), Jan. 1987, Smith, et. al., "Mean and Apparent Place Computations in the New IAU System. I. The Transformation of Astrometric Catalog Systems to the Equinox J2000.0). [Ed note: This will generate coordinates in accordance with the defined J2000.0 and B1950.0, but will not necessarily reproduce the apparent place computations of OCC with the empirical corrections. D. Dunham has provided some of the needed documentation, and will supply the rest as soon as this issue is completed.]

Mr. Zimmermann reported that he is going to write programs to manage stars from different catalogs. He stated that this is not an astronomical problem, but is a typical problem from commercial data processing: handling and organizing a large amount of data. The ideas on how to do so were discussed at the beginning. It was quite interesting that different persons came to comparable results independently. Mr. Zimmermann also stated that, for the executing programs, binary files should be used. For portability programs must be written which convert between these programs and ASCII files. This guarantees high speed for the computations and good packing for the files needed on one hand and portability between hardware of different architectures on the other hand.

The participants of the workshop decided to use the PPM catalog for further work (PPM South is announced for June [the final version became available in October]). In the **ON** of December 1991, the FAC (Fresneau's Astrographic Catalog) is mentioned. The participants wanted to know which is the better catalog for the purpose, FAC or PPM. IOTA/ES will use whichever is the better. [D. Dunham: PPM is certainly better, although USNO's Astrographic Catalog Reference Star catalog (ACRS) is better than PPM for many zodiacal stars, especially in the northern hemisphere. FAC is not nearly as accurate as either PPM or ACRS, but it gives much denser coverage, many more stars per square degree, for declinations between +4° and +32°.]

Addendum:

On June 4, Dr. Riedel and Mr. Zimmermann talked by phone. Dr. Riedel's program now uses FK5/J2000.0 coordinates and computes lunar coordinates from barycentric coordinates generated by ICE. The apparent place for the Moon is in agreement with the ICE computations and with Zimmermann's FORTRAN program to within $0^s.001$ in α and better than $0''.01$ in δ. Pascal has an accuracy of 10 digits, FORTRAN an accuracy of 14 digits. [Ed note: This must be compiler dependent. Mine (Lahey FORTRAN and Borland Turbo Pascal) have nearly the same accuracy for double precision, 15-16 digits.] This verifies Dr. Riedel's program as well as that of Mr. Zimmermann.

Mr. Zimmermann has written the subprogram to create FK4/B1950.0 coordinates from FK5/J2000.0 coordinates, and verified it with the 10 stars in the article referenced earlier.

GRAZING OCCULTATION OBSERVATIONS

Richard P. Wilds

We begin this quarter's graze list with two 1990 reports from Spain. Manuel Iglesia reported a graze in the area of the crater Amundsen, while his fellow countryman, Carles Schnabe, observed a graze near Boltzmann between the lofty southern peaks Alpha and Beta in the Doerfel Mountains.

Our 1992 grazes began down under in Australia with Phill Kearney leading a team in observing events between the Cassini craters Drygalski and Zeeman. Terri McManus, IOTA's Treasurer and member of our local Heartland Astronomical Research Team (HART), led her first graze with events observed around the crater Gioja. Roy Bishop's team observed their events north of the crater Pascal. They observed without printed predictions. They chose stations based on data provided by telephone from David Dunham. G. Samolyk and Robert Hays led expeditions to observe events between the craters Brianchon and Merril. G. Samolyk reports that this was the best effort in years for The Milwaukee Astronomical Society. Craig McManus led a beautiful sunrise expedition on 6/26. The events were near the crater Byrd. We had an interesting faint sunlit peak way out beyond the terminator. At first we thought we had an unpredicted graze of a faint star, but the star never moved. Mike Kazmierczak returns this time with a tough graze near the crater Le Gentil. The efforts on 8/22 produced more miss observations than usual. Guy Nason from Canada reported the only timings. Our HART team was forced to observe too shallow due to bad roads in Arkansas. However, we got revenge the next night on our way back to Kansas with a successful view of a

9.0 mag. star in the same area of the Moon. Craig McManus led two more grazes the following month near the crater Boltzmann, with both grazes observed from the same locations. John Holtz had a nice graze near the north pole. It was near the terminator. The grazes near the terminator, if videotaped, could be used in our search for lunar dust storms [see **ON V** (7), pp 177-178].

Don Stotz observed a bright side graze on 10/4 near a well-defined crater with no name. Without the regular predictions he had to plot the graze path by using the straight-line formula from his total occultation predictions. On the same night your author led his first graze in two months. I had an operation in August, and though I still went on grazes, I had to have help setting up. I could not lead grazes in such a condition. The graze had an interesting path through the Doerfel Mountains. However, though I could follow the star, I could not see it well enough to get most of the timings. This star was much more difficult to see at 10 degrees altitude than the other 9th mag. stars we had seen this year - most around 10°. The problem seems to be in the spectral classes. This star was F0 and most of the other stars were M or K. The red stars will always show up better near the horizon than other types.

REMEMBER to apply a 0.3 second of arc south shift to your predicted path of northern limit, waxing-phase, dark-limb grazes. One should spread out, however, since star errors could increase this shift of reduce it to a 0 shift.

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

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

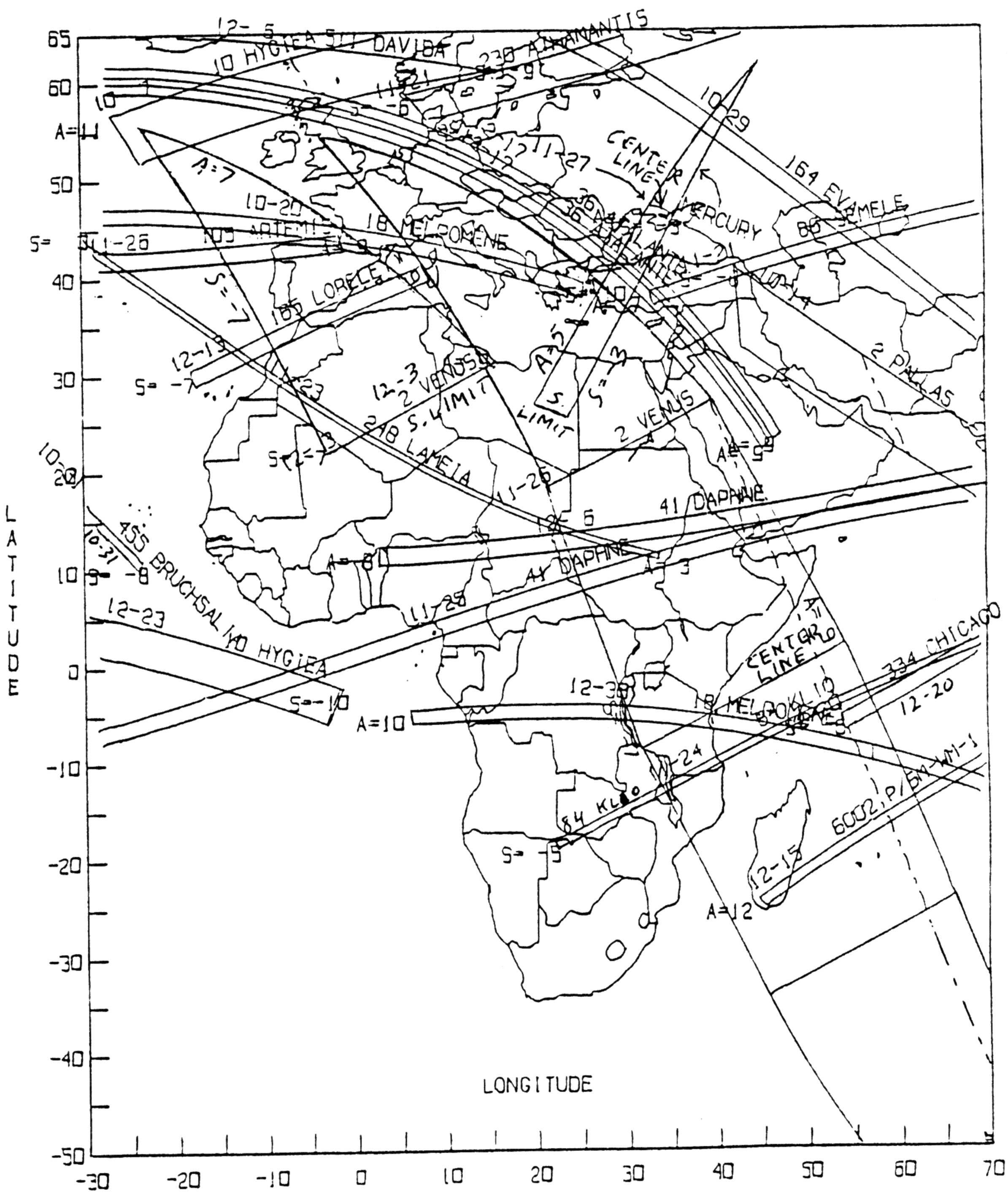
UTDate YYMMDD	V P	Star #	Mag	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	Sh	N S	WA	B
1990															
900916		79307	6.9	26-	3.6S	Ciudad, Spain	2	6	1	20	Manuel Iglesias	0.0		185	-1.6
901030		128336	4.6	88+	15.0S	Talamanca, Spain	3	8	1	20	Carles Schnabel	?		164	-4.9
1992															
920109		146067	5.8	16+	4.0S	Bunaberg, Queensland	3	15	1	20	Phill Kearney	0.3	N	171	-6.3
920210		92645	7.9	33+	5.1N	Allen, KS	3	4	1	20	H.A.R.T. T. McManus	0.7	S	4	-6.0
920211		75531	7.8	44+	7.0N	Silver Lake, KS	1	0	1	33	H.A.R.T. C. McManus	>0.8	S	8	-5.2
920211		93062	5.7	44+	11.0N	Elmsdale, Nova Scotia	4	10	1	6	Roy L. Bishop	?		13	-5.3
920508		97357	7.4	32+	11.5N	Raymond, WI	15	46	1	33	G. Samolyk	0.0		14	3.5
920508		97357	7.4	32+	12.0N	S. Beaver Dam, WI	1	2	1	13	Robert H. Hays, Jr.	0.4	S	14	3.5
920606		117751	5.3	30+	7.0N	Chebanse, IL	1	2	1	13	Robert H. Hays, Jr.	0.1	N	11	6.1
920626		93002	6.8	20-	7.9N	Barnes, KS	2	15	1	33	H.A.R.T. C. McManus	0.0		356	-4.5
920712		185320	3.2	94+	10.0S	Cassville, GA	1	5	1	25	Mike Kazmierczak	0.0		165	1.8
920822		76670	6.0	40-	3.6N	Venus, AR	1	0	1	33	H.A.R.T. C. McManus	>0.2	N	358	-1.5
920822		76670	6.0	40-	3.4N	Coburg, Ontario	1	4	1	15	Guy Nason	0.2	N	358	-1.5
920823		77400	9.0	29-	2.9N	Lyndon, KS	2	4	1	33	H.A.R.T. C. McManus	0.0		359	-0.1
920904		184636	9.1	51+	10.9S	Halls Summit, KS	2	2	1	33	H.A.R.T. C. McManus	0.0		168	2.4
920904		184679	8.9	52+	13.2S	Halls Summit, KS	2	4	1	33	H.A.R.T. C. McManus	0.0		165	2.3
920920		78135	3.2	45+	2.4N	Washington, PA	2	7	2	15	John Holtz	0.3	N	359	1.3
921004		187756	3.0	55+	-15.0N	St. Paul Church, TX	1	4	1	20	Donald J. Stotz	?		343	-1.7
921004		187852	8.9	55+	15.9S	Lane, KS	1	2	1	33	H.A.R.T. R. Wilds	0.0		163	-2.0

SOLAR SYSTEM OCCULTATIONS DURING 1992

David W. Dunham

This is a conclusion of the article with the same title begun in **ON 5** (6), p. 130 and continued in **ON 5** (7), p. 167. This issue contains only the three regional maps covering the world between latitudes +65° and -50° showing the paths of planetary and asteroidal occultations during October-December, 1992. In September, I lost access to the hardware needed to produce finder charts for asteroidal occultations, so I cannot provide these for events that I found that are

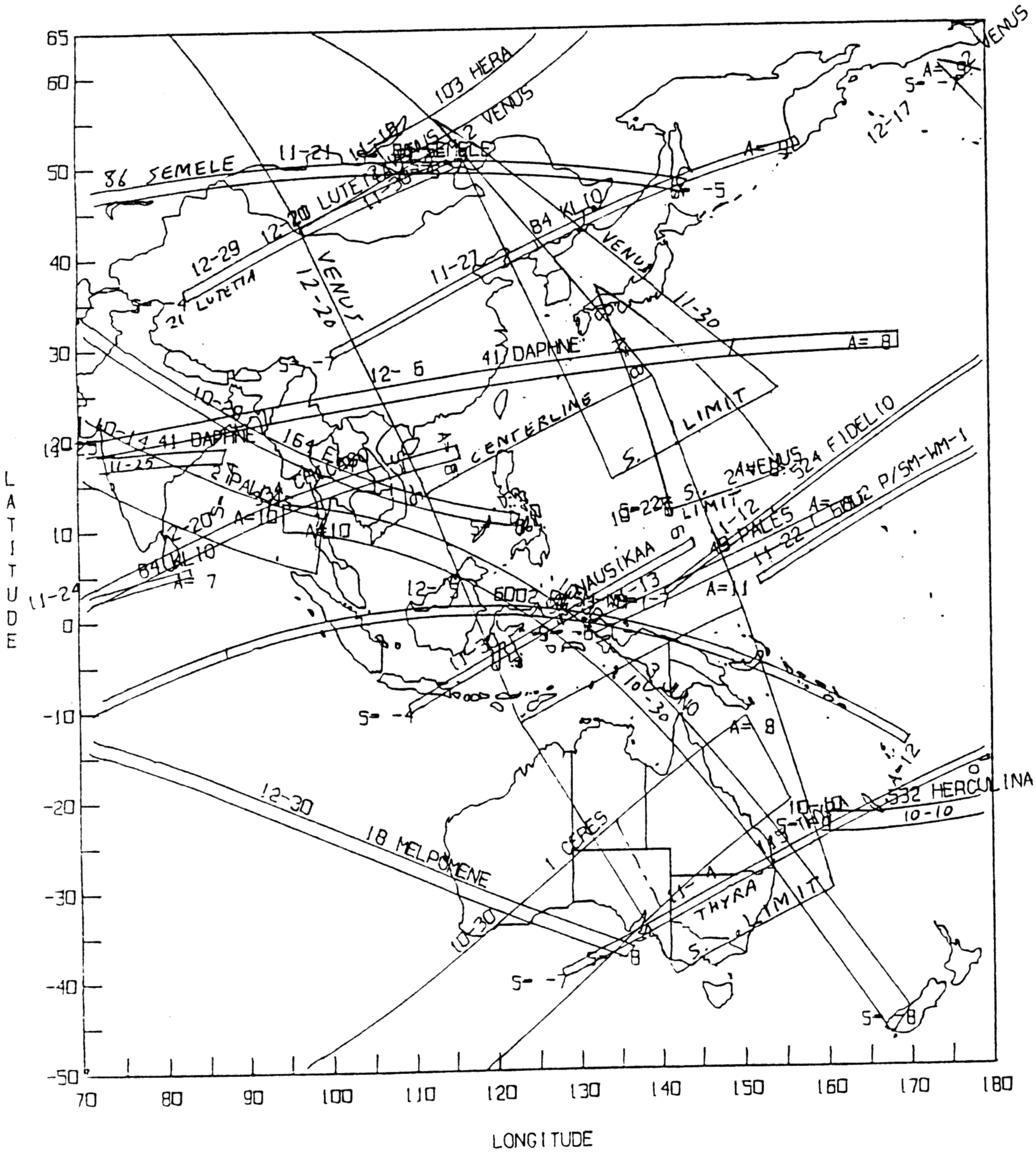
PLANETARY OCCULTATIONS. 1992 OCT.-DEC.



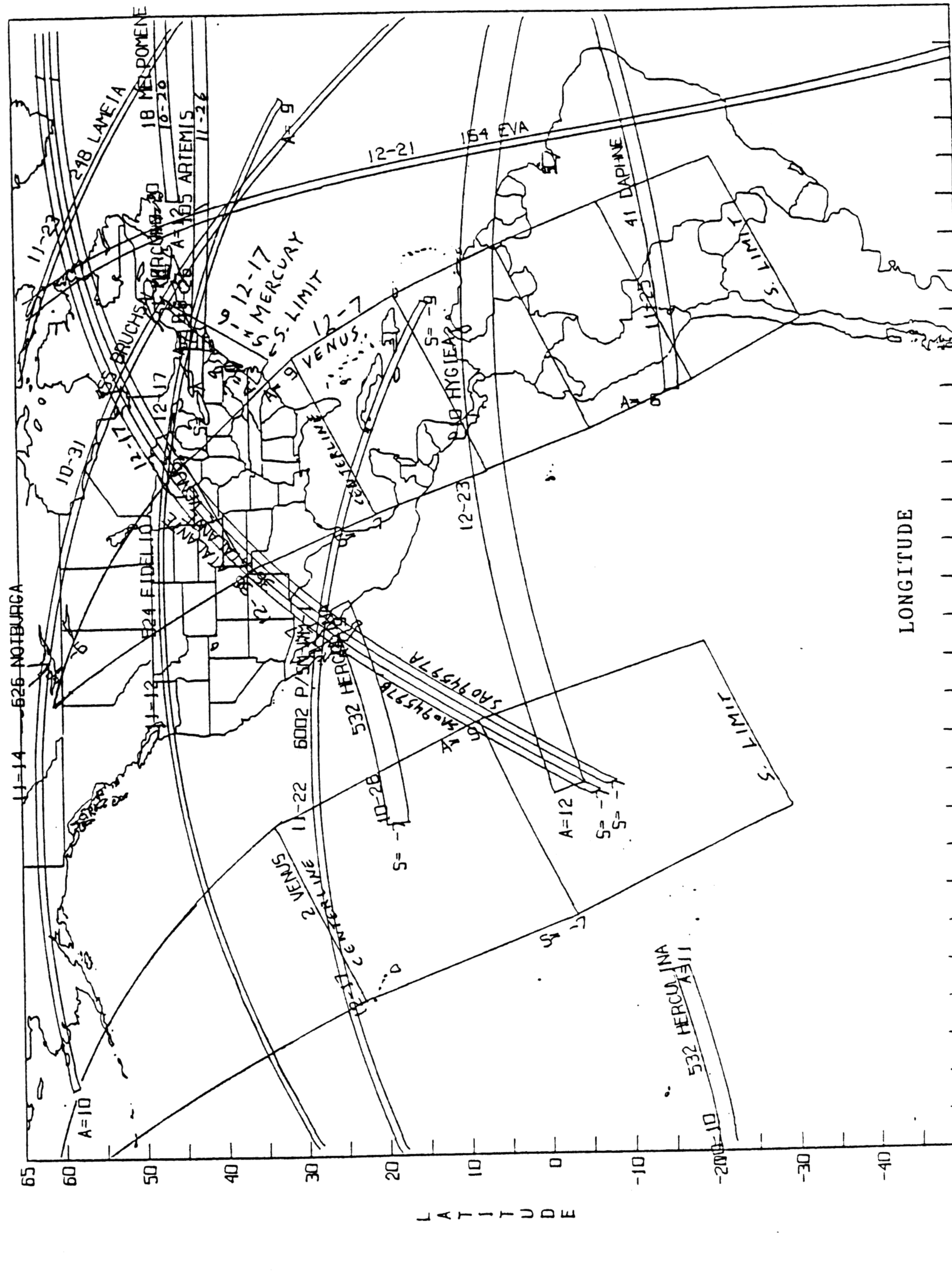
not in Edwin Goffin's coverage. Also, again lack of time prevents annotating and pasting up the world maps prepared by Mitsuru Sôma. A note about one event was left out of previous issues:

Nov. 27, Mercury: The star is 32 Librae = ZC 2209. Remarkably, this event occurs in the same region (Libya to Ukraine) where an occultation of 5.3-mag. μ Cancri by Mercury occurred on June 26. The chances of two 5th-magnitude stars being occulted by Mercury in the same area in the same year must be very small.

PLANETARY OCCULTATIONS. 1992 OCT.-DEC.



PLANETARY OCCULTATIONS. 1992 OCT.-DEC.



IOTA

The International Occultation Timing Association was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made. IOTA is a tax-exempt organization under section 509(a)(2) of the (USA) Internal Revenue Code, and is incorporated in the state of Texas.

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

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The Dunhams maintain the occultation information line at 301-474-4945. Messages may also be left at that number. When updates become available for asteroidal occultations in the central U.S.A., the information can also be obtained from either 708-259-2376 (Chicago) or 713-488-6871 (Houston); note that the area code given for the Chicago number on p. 77 of the January issue of Sky and Telescope is wrong.

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

The addresses for IOTA/ES are:

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

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

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