Occultation Newsletter

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FROM THE PUBLISHER

This is the third issue of 1989. It is the thirteenth issue of Volume 4.

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

Asteroidal occultation supplements will be available at extra cost: for South America through Ignacio Ferrin (Apartado 700; Merida 5101-A; Venezuela), for Europe through Roland Boninsegna (Rue de Mariembourg, 33; B-5381 DOURBES; Belgium) or IOTA/ES (see below), for southern Africa through M. D. Overbeek (Box 212; Edenvale 1610; Republic of South Africa), for Australia and New Zealand through Graham Blow (P.O. Box 2241; Wellington, New Zealand), and for Japan through Toshio Hirose (1-13 Shimomaruko 1-chome; Ota-ku, Tokyo 146, Japan). Supplements for all ather areas will be available from Jim Stamm (11781 N. Joi Drive; Tucson, AZ 85737; U.S.A.) by surface mail at the low price of 1.18 or by air (AO) mail at 1.96

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

[1] Single issue at ¼ of price shown
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[5] Area "B" includes the rest of South America, Mediterranean Africa, and Europe (except Estonia, Latvia, Lithuania, and U.S.S.R.).

IOTA NEWS

David W. Dunham

The next meeting of IOTA will be held on Saturday, Decemer 16th, at the Lunar and Planetary Institute; 3303 NASA Road 1; Houston, Texas (just east of the Johnson Spaceflight Center and about 35 miles southeast of downtown Houston). The meeting will start at 9 a.m. and is expected to last all day, as previous meetings have. More information can be obtained from Paul Maley; 15807 Brookvilla; Houston, TX 77059; phone 713,488-6871. The agenda will include election of officers (a ballot and a self-addressed envelope are enclosed in the initial mailing of this issue for each current IOTA member; please mark and return the ballot to Gary Nealis so we can meet our quorum requirement); status reports of IOTA's many observational, analysis, and software projects; and plans for future occultations and eclipses.

If you have occasion to phone any of the following, all in the suburbs of Chicago, note that their area code changes from 312 to 708 on November 11: Astro-Alert, DaBoll, Hays, Heil, Pedelty, and Stevens.

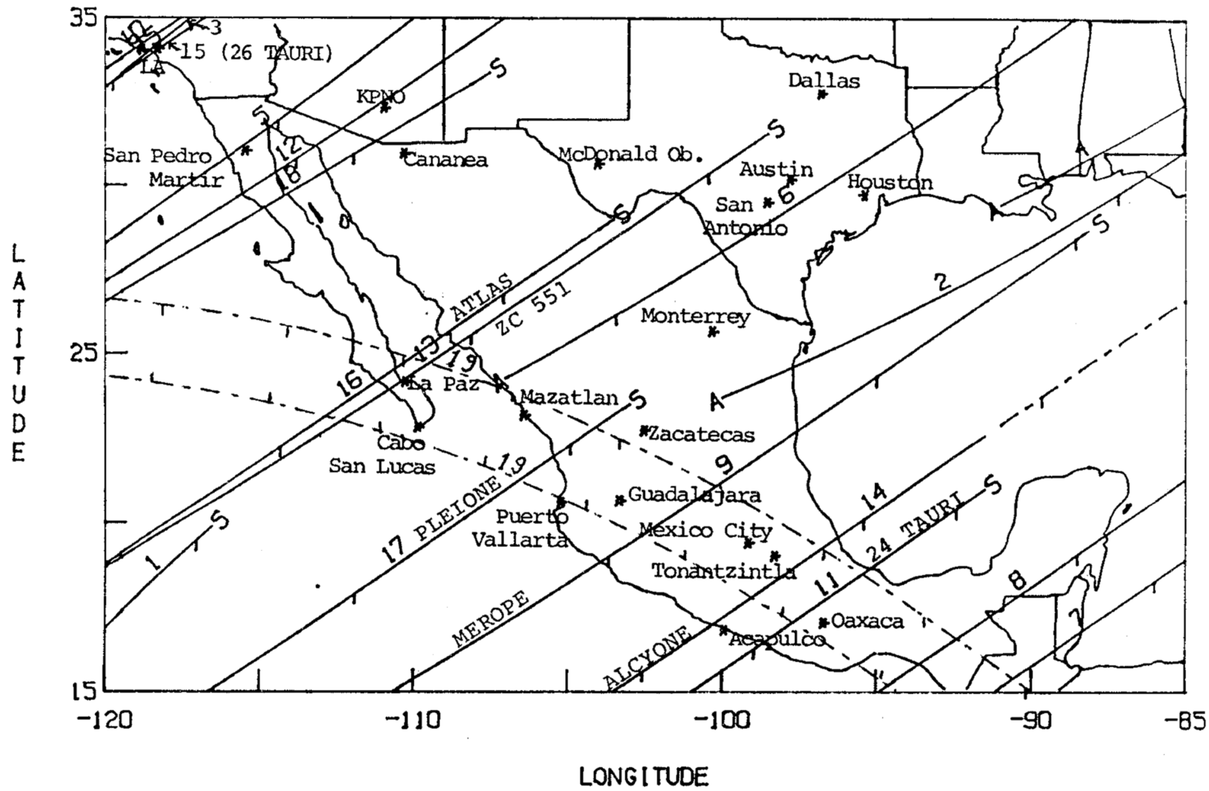
We finally completed the paper on the 1983 Pallas occultation and are going to submit it to the *Astronomical Journal* the third week of November.

Unfortunately, time did not permit preparation of the article about the Praesepe passage, which is only favorably visible from Hawaii, anyway, and in strong twilight on the West Coast.

On the next page is a map showing many northern limits of grazes during the very good Pleiades passage that occurs three days before the total solar eclipse in Mexico in 1991. It is like our other graze maps, with an associated table in the same format. More Pleiades stars will be occulted farther southeast in Mexico. None of the bright Pleiades stars will be occulted north of the Atlas northern limit just north of La Paz. Depending on weather advice, a good strategy might be to observe the Alcyone graze near Acapulco, then go to Puerto Vallarta, where we plan to hold a large international meeting on occultations and eclipses, then observe the eclipse from the Pacific coast in the Mazatlan-Puerto Vallarta area. Various options will be discussed at the IOTA meeting in December, and more about it will be in the next issue.

Unfortunately, I have run out of time; I have to catch a plane to Moscow, so I can write very little more for this issue. I had to spend my time getting out the 1990 planetary occultations article for *Sky and Telescope* (I was even late with it, so it will be in the February issue, with finder charts for 3 January asteroidal occultations in the January Calendar Notes section — watch for that in case our next issue of *O.N.* is late). Many things that I wanted to write about will have to wait until the next issue, which will include early 1990 asteroidal occultation information, and which we hope to distribute before the new year.

1991 EARLY JULY GRAZES



NO.	YEAR	MO	DAY		USNO	SAO D	MAG	%SNL	L	W.U.T.	LONG	LAT	STAR NAME
1	1991	JUL	2		3320	146210C	5.3	75-	N	12 51.0	-118	19	SITULA (KAPPA AQUARII)
2	1991	JUL	6		251	92588	7.6	37-	N	7 30.1	-93	27	
3	1991	JUL	6	X	2532	92645	7.9	35-	N	10 44.4	-119	34	
4	1991	JUL	7	X	3528	930310	8.1	26-	N	7 33.5	-88	31	
5	1991	JUL	7	X	3684	75558	8.0	25-	N	10 52.6	-115	32	
6	1991	JUL	8	X	4786	76103V	8.1	16-	N	9 38.5	-98	29	
7	1991	JUL	8	X	4836	76145	8.1	16-	N	10 23.1	-88	17	
8	1991	JUL	8	X	4856	76158	8.0	16-	N	10 31.5	-90	18	
9	1991	JUL	8		545	76172	4.2	15-	N	10 34.9	-100	22	MEROPE (23 TAURI)
10	1991	JUL	8	X	4897	76189	8.0	15-	N	11 9.1	-119	34	
11	1991	JUL	8		549	76192U	6.3	15-	N	11 7.5	-96	18	24 TAURI
12	1991	JUL	8		550	76193	6.8	15-	N	11 5.0	-114	31	
13	1991	JUL	8		551	76197W	7.1	15-	N	11 0.7	-109	25	
14	1991	JUL	8		552	76199K	3.0	15-	N	11 8.9	-95	21	ALCYONE (ETA TAURI)
15	1991	JUL	8		559	76225U	6.6	15-	N	11 49.8	-118	34	26 TAURI
16	1991	JUL	8		560	76228U	3.8	15-	N	11 44.2	-112	24	ATLAS (27 TAURI)
17	1991	JUL	8		561	76229V	5.2	15-	N	11 44.9	-110	19	PLEIONE (28 TAURI)
18	1991	JUL	9		733	76811H	7.2	8-	N	11 35.8	-114	30	
19	1991	JUL	11		4000	0	-26.	0E	N	18 25.7	-109	25	THE SUN
19	1991	JUL	11		4000	0	-26.	0E	S	18 26.3	-106	21	THE SUN

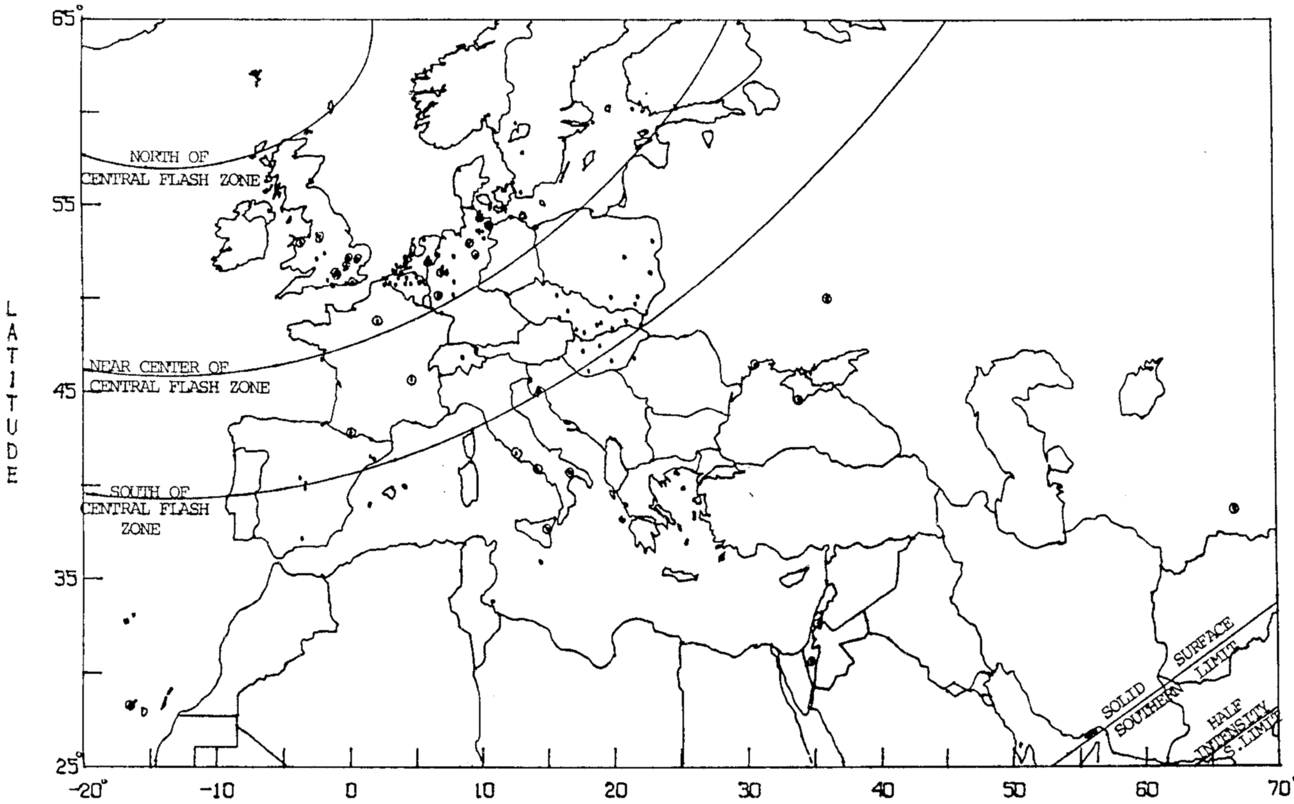
OBSERVATIONAL COVERAGE OF THE JULY 3RD OCCULTATION OF 28 SAGITTARII BY TITAN

David W. Dunham, Hans-Joachim Bode, Roland Boninsegna, and Andrew Elliott

We have learned of photoelectric, video, and visual observations of the Titan occultation from a variety of sources. The event was observed from many European countries, from Malta to Norway, the Soviet Union to Spain and the Canary Islands, and Northern Ireland to Israel. It was remarkable that skies were clear over such a large area that is, in general, not known for excellent astronomical observing sites. So far, we know of photoelectric or video recordings of the event made at 31 different locations (a few at multiple wavelengths using different nearby telescopes), and visual observers timed the occultation at 108 separate places. These 139 places are shown as dots on the map; circled dots mark locations where photoelectric and video recordings were made. At many locations, more than one observer timed the phenomena.

As noted on pages 300-301 of the last issue, the central flash was seen over a wide area. On the map, the northern curve is too far north, and the southern curve is too far south, since the central

1989 JULY 3. 28 SAGITTARII AND TITAN



flash was recorded at Pic du Midi, but was not seen by observers near Barcelona and Madrid. Due to the wavelength dependence of visibility of the central flash, we are not certain where the center of the central flash zone was located. Similarly, the southern limits shown are only approximate, but it is clear that the southernmost chord was obtained at Majdanak Observatory just north of Afghanistan, as reported in International Astronomical Union Circular 4825. The diameter of the "half-intensity" Titan, where the star's light was dimmed to half its unocculted level by differential refraction in Titan's upper atmosphere, was over 6000 km; the layer where this point was reached was about 450 km above Titan's solid surface. Hence, the event lasted much longer than indicated by the diameter used in most of the distributed predictions, which was too small even for the solid surface inferred from Voyager data.

Some preliminary reductions are already being published, such as the one by W. Beisker, *et al.*, starting on p. 324 of this issue. The excellent data obtained at Pic du Midi are portrayed well in the October issue of *Sky and Telescope*. Bruce Sicardy, Paris Observatory, gave me a preprint of a good article based on recordings made at observatories near Paris, Catania (Italy), and Pic du Midi; it has been submitted to *Nature*, along with another article about Wise Observatory and University of Arizona data obtained in Israel and at the Vatican Observatory near Rome. The analyses have concentrated on the video and photoelectric data, since the visual information is less accurate and in most cases difficult to interpret.

During the next few months, we will attempt to collect all of the data and share them with those who want to analyze them, including Paris Observatory, University of Arizona, IOTA/ES in northern Germany, and perhaps others. This will be necessary to quantify well what happened in the central flash and trace the various atmospheric layers around the large satellite, to lay the groundwork for a comprehensive paper about this remarkable occultation. During my visit to Moscow in early November, I will try to obtain the Soviet observations. I understand that several observers timed the event in the German Democratic Republic, and there are probably other reports as well that have not yet come to our attention. If you have some unreported data, please contact one of the authors of this note, who will be sure that your data are distributed to those who need them.

In a future issue I plan to publish a similar map showing the coverage for the Saturn occultation in the United States.

NOVEMBER 24TH LUNAR OCCULTATION OF BRIGHT COMET WILL NOT BE SEEN

Roger W. Sinnott
Associate Editor, *Sky and Telescope*

I hope nobody's bought a plane ticket yet! The new orbital elements for Comet Okazaki-Levy-Rudenko on MPC 15215 shift the favorable location for seeing the lunar occultation in a dark sky south and west, into the Pacific Ocean (near 120° west, 50° south). Not only is there no land there, but the Moon is very low when the Sun is far enough below the horizon at these far-south latitudes.

This is doubly embarassing because the November issue of *S & T* does mention the occultation as being visible in Peru and Ecuador. It may also be too late to fix the chart of the comet's path going in our December issue. But at least the ephemeris listing in December will be generated from the newer elements.

THE OCCULTATION OF 28 SGR BY TITAN – FIRST RESULTS

Beisker, W.; Bittner, C.; Bode, H.-J.; Buechner, R.; Denzau, H.; Dunham, D.: Nezel, M.; and Riedel, E.

Summary:

The occultation of 28 Sgr by Titan on 1989 July 3 was observed by many observatories in northern Germany. In this preliminary report we present an overview of the results of four photoelectric and video-equipped stations near the central line of the occultation. At all four stations a central flash was observed. We present some evidence that a layered structure as well as a turbulent structure in Titan's atmosphere causes the spikes on the immersion and emersion parts of the occultation tracks. We also give a rough idea as to what additional data are available from other stations throughout central Europe, and in what direction the upcoming analysis will be directed.

Observations and Data Analysis:

The occultation of 28 Sgr (5.8 mag.) by Titan on 1989 July 3 was observed at a large number of small observatories throughout northern and central Europe. In the following we present the first results of four stations in northern Germany with different distances with respect to the central line (projected on Titan's disk). All of the four stations were able to observe the so-called 'central flash'. Therefore, they have to be relatively close to the central line. The stations were equipped with different photoelectric and video systems:

Station 1, in Hannover, was equipped with a 16-inch Cassegrainian telescope, an image intensifier system, and a standard video camera with video recorder.

Station 2, in Essen, was equipped with a 14-inch telescope, a solid-state photometer, and a computerized analog/digital data acquisition system.

Station 3, in Langwedl, was equipped with a 12-inch Newtonian telescope and a photomultiplier photometric system (UNIPHOS, Hannover F+RG).

Station 4, near Kiel, was equipped with a 6-inch refractor and a UNIPHOS system.

Time signals recorded simultaneously with the photoelectric data were received from the German DCF 77 time-signal station. The following distances between the four stations projected on Titan referenced to station 1, which was the southernmost station, have been determined from first astrometric calculations as follows:

Station 1	0 km	Station 2	4 km
Station 3	21 km	Station 4	43 km

All data recorded at the four stations have been digitized where necessary, and have been transferred to a main computer system. Data have been reduced to the same time scale (0.25 seconds per sample) and have been adjusted to each other with respect to the central flash, which was recorded at all four stations. All data have been plotted and analyzed using the DAS software package Version 2.1 of IOTA/ES.

At the moment, the exact spectral sensitivity of the image intensifier used at station 1 is not known, but is presumably more in the red spectral range as compared with the V spectral range of all other stations. Therefore, we will not speculate on the relative intensities of the central flash at the moment.

Figures 1 and 2 represent total overviews of the occultation track from stations 1 and 2, with a time resolution of 0.5 second per sample.

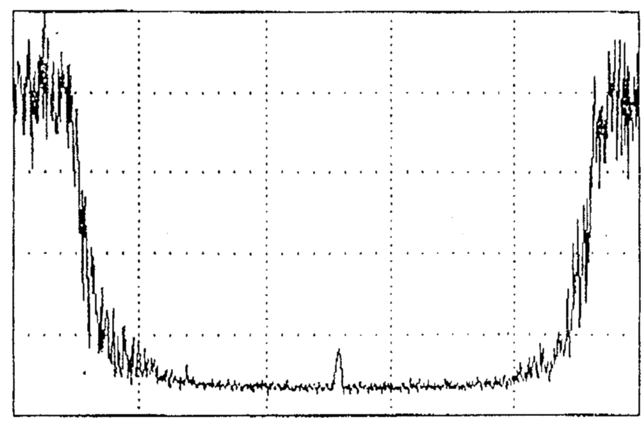


Figure 1

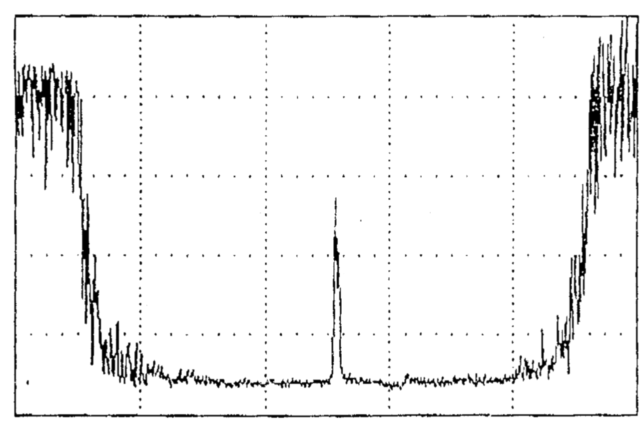


Figure 2

In order to show the spiking during immersion and emersion, a low-frequency filtered curve (frequencies less than 0.05 Hz) has been subtracted from the light curves. All curves have been adjusted with respect to the middle of the central flash. The residuals for all four stations are plotted in fig. 3 for immersion, and in fig. 4 for emersion. In order to compare the immersion and emersion curves, the time scale on the plots for emersion has been in-

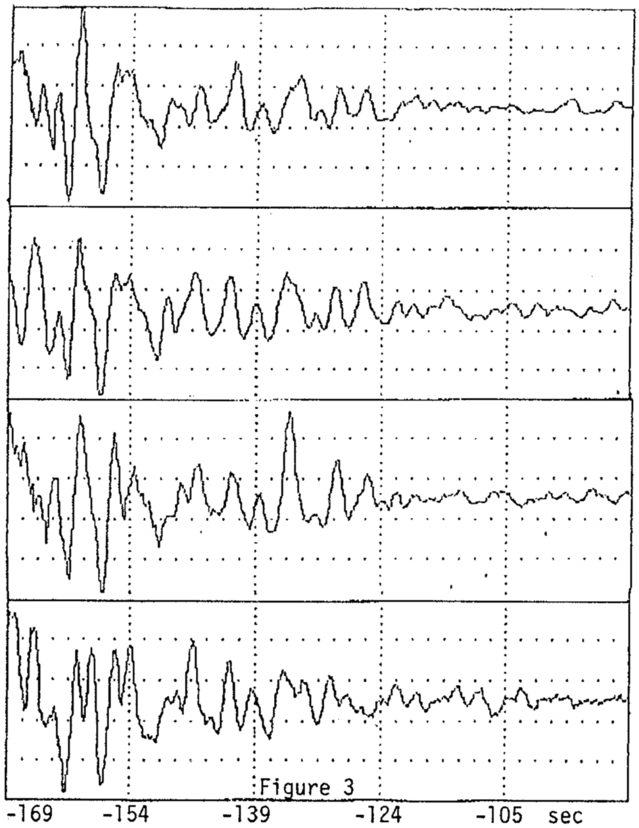


Figure 3

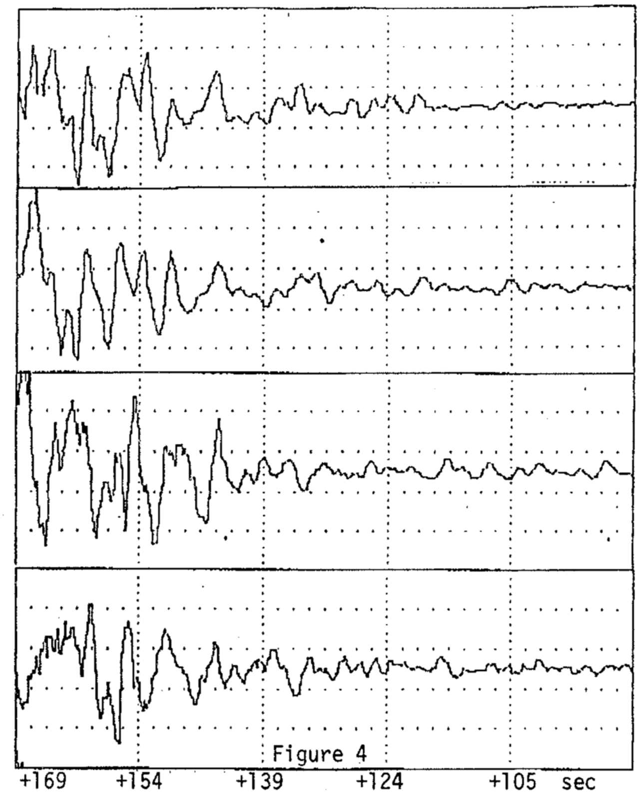


Figure 4

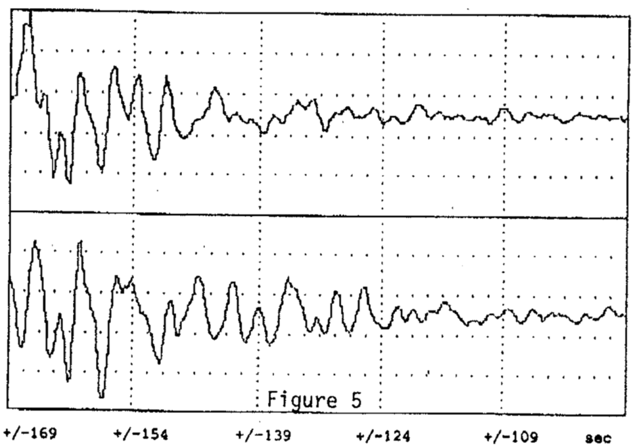


Figure 5

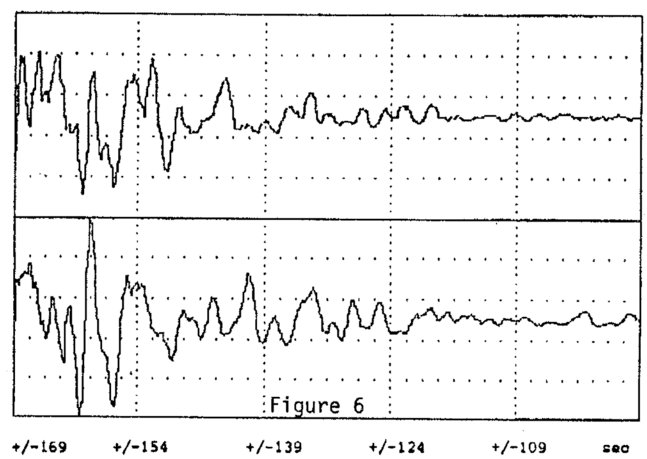


Figure 6

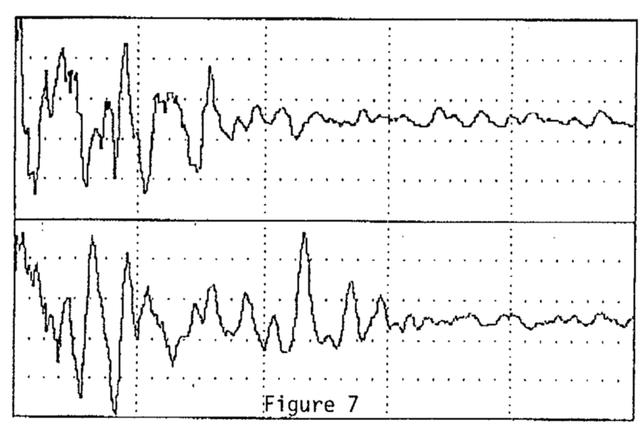


Figure 7

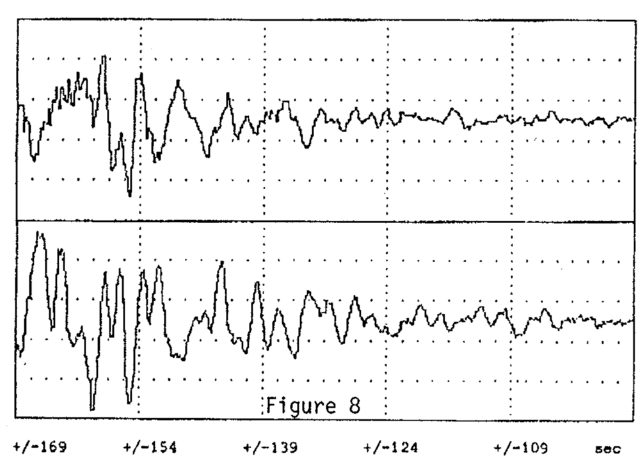


Figure 8

verted.

Figures 5 to 8 show the immersion and emersion curves for each single station with inverted time scale for the emersion.

The time resolution of figures 3 to 8 is 0.25 second per sample, and the plots cover 75 seconds. Time scales are referenced to the position of the central flash.

Discussion:

In this short report, we give only a preliminary overview and some ideas of the interpretation of the light curves. From figures 1 and 2, a pronounced asymetry of the light curves can be seen. During immersion, the spiking is much stronger than during emersion. This can also be observed in more detail from the extended light curves in figures 3 to 8. It has to be noticed, that the atmospheric conditions on Titan were different for immersion and emersion. Due to the fact that the Saturn system was close to opposition, immersion and emersion took place near the terminator. From the geometry of the event, it is clear that immersion was at the sunset side and emersion at the sunrise side of the terminator. Taking into account that Titan has a synchronous rotation (period 16 days), the atmosphere at the sunset side had been subjected to solar radiation for 8 days, whereas the atmosphere at the sunrise side had been in darkness for about 8 days. The atmosphere at emersion is probably much more homogeneous after 8 days of no energy absorption compared with the immersion side. This would result in the observed difference in spiking for immersion and emersion.

In the past, a lively discussion had been about the origin of these spikes. They can be caused by a layered atmosphere (3) or by the existence of a Kolmogorov-like turbulence in the atmosphere. Following Young (5), many authors (1,2) have shown that the spiking can be much better explained by a turbulent atmosphere. This could be shown in detail from an analysis of the 1985 stellar occultation by Neptune (1,2). Because we recorded many occultation tracks from stations spread out over relatively small distances with respect to the atmosphere, we will be able in the future to show a more-detailed picture of the kind of correlation between different tracks in the atmosphere. As can be seen from a comparison of the tracks in figures 3 and 4 with increasing distance the correlation of many spikes is lost. However, an important fact can be seen from the direct comparison of immersion and emersion tracks in figures 5 to 8: There is a sharp double spike at about ± 162 and ± 157 seconds away from the central flash. This can clearly be seen in figures 5 and 6, and to a lesser extent in figure 7. The fourth station shows such a correlation only very poorly, but this may be due to the large contribution of scintillation from the Earth's atmosphere for this station. The small size of the telescope (only 6" as compared to 12" to 16" diameter) may be the reason. Some other structures also seem to be comparable for immersion and emersion. However, all the spikes after about ± 145 seconds seem to be uncorrelated. Therefore, the existence of a layered structure, besides the existence of turbulence in the atmosphere, may be possible. A more-detailed analysis will be prepared in the future.

More video or photoelectric recordings of the event could be obtained from other stations in Great Britain as well as in France and The Netherlands. The analysis of the data of these stations will give further insight into the problems of Titan's upper atmosphere. Furthermore, extremely precise astrometry of the relative positions of Titan and 28 Sgr can be given based on these data. However, further analysis will take much more time; therefore, we intended to provide some early information through this report. Further results will be published elsewhere. At the moment, a basic study of the structure of Titan's upper atmosphere is in preparation, focusing on the importance of the results for the physics of planetary atmospheres.

References:

(1) Hubbard, W. B.; Lellouch, E.; Sicardy, B; Brahic, A.; Vilas, F.; Bouchet, P.; McLaren, R. A.; and Perrier, C.: Structure of Scintillation in Neptune's Occultation Shadow. *A. J. 325*, 490-502 (1988)

(2) Narayan, R. and Hubbard, W. B.: Theory of Anisotropic Refractive Scintillation: Application to Stellar Occultations by Neptune. *Astr. J. 325*, 503-518 (1988)

(3) Vapillon, L.; Combes, M.; and Lecacheux, J.: The β Scorpii Occultation by Jupiter. *Astron. & Astrophys 29*, 135-149 (1973)

(4) Wasserman, L. and Veverka, J.: On the Reduction of Occultation Light Curves. *Icarus 20*, 322-345 (1973)

(5) Young, A.: Scintillations During Occultations by Planets. I. An Approximate theory. *Icarus 27*, 335-357 (1976)

GRAZING OCCULTATIONS

Don Stockbauer

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

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

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

It is standard procedure to only report the closest miss to an actual occultation when there are more than one. Thus the graze of ZC 773 on 9/21/89 (6 stations altogether) and that of ZC 1013 on 8/26/89 (15 stations) were larger efforts than the table indicates. For ZC 1013 I moved observers 0".3 north of the nominal USNO XZ catalog prediction since the Zodiacal Zone (ZZ) catalog indicated this. The star is a known double (7.1- and 8.7-magnitude components at a separation of 0".62 in PA 314° at the epoch of observation of the graze). The automated measuring techniques used to produce the ZZ give a reduced accuracy for the irregular outlines of double stars; I figured that our actual shift of 0".3 south of the XZ was due to this. A total of 0".5 difference between what was expected and what was observed on a profile with fine northern features produced the large number of misses. However, David Dunham suspects that part of the south shift may be a general trend for all northern-limit waning-phase grazes. It would be very helpful to collect more observations of grazes fitting this description, biasing all stations several tenths of an arc second south of the nominal prediction when deploying observers. We cannot give a more-precise figure, as this is the number we are trying to determine. This applies <u>only</u> to northern-limit waning-phase grazes. If a sufficient quantity of observations is gathered and a definite figure is determined, it will be published in *O.N.* and applied automatically by the predictions in the future.

Date	V/P	Star #	Mag.	% Snl	CA	Location	# Sta	# Tm	S S	Ap Cm	Organizer	C	St	WA	b
1988															
0823		2609	4.3	75+	5S	Spring Hill, TX	6	28	1	10	Ed Vinson		0	171	74
1989															
0314		0768	7.0	46+	3N	Pennington, TX	2	13	1	25	Ken./Paula Drake		1N	4	-66
0617		2263	4.8	95+	24N	New Hope Ch, TX	5	29	1	20	Don Stockbauer		2N	12	73
0826		073309	7.8	23-	7N	Lakeville, CT	3	18	2	20	Chris Predom			356	-47
0826		1013	6.9	22-	7N	Fulshear, TX	6	28	1	20	Don Stockbauer		3S	357	-49
0908		2383	2.9	46+	5S	Coalgate, OK	2	11	1	6	Daniel Johnson			175	74
0910		186964	8.4	67+	13S	Juliff, TX	1	10	1	20	Don Stockbauer		0	165	58
0921		0773	7.1	58-	7N	Westmoreland, KS	1	0	1	6	Richard P. Wilds	>	7S	353	-57
0924		1222	7.2	27-	4N	Clintonville, WI	1	8	1	33	Daniel Klos		2N	359	-25

One can receive a fair amount of criticism as an expedition leader when a large number of people observe misses. To a general participant, it may seem that such a result would necessarily have to be a mistake on the part of the leader. It helps to write an article for one's club newsletter detailing the types of errors an expedition leader might make to cause a large shift, and the types over which he or she has no control, e.g., the accuracy of the prediction.

For which specific point in the limit is a profile generated? It is usually for the closest approach to one's home, but sometimes not exactly. Find the text "POS ANGLE XXX.XXX PROFILE FOR (YOUR NAME)" in the footer information of the profile. Then find the position angle XXX.XXX on the limit prediction; this is the longitude for which the profile was generated. If observed a substantial distance from this point, the PA difference may be calculated and a new line of central graze drawn on the profile using the Watts angle scale (Watts angle differs from position angle for a given graze by a constant; its scale and direction are the same).

Corrections

I believe that corrections from now on should be separated from the rest of the text under a title; there is less chance of a correction getting buried in the text this way.

The graze of ZC 2609 led by Ed Vinson on 8/23/88 at Spring Hill, TX was inadvertently omitted from *O.N. 4* (10), 237.

The graze of ZC 1089 led by Mike Kazmierczak on 3/16/89 at Kellytown, GA reported in *O.N. 4* (12), 293 had a shift of 0".2 S, not 0".4 S.

The USNO file of double star information (DSFILE) has incorrect information for Kappa Aquarii (SAO 146210). Its 1975 separation should be 90".0 at a PA of 249°.4; its separation rate ("/yr) should be -0.167, and the PA rate (°/yr) should equal 0°.04.

Thanks for the reports sent.

REPORTS OF ASTEROIDAL APPULSES AND OCCULTATIONS

Jim Stamm

If you do not have a regional coordinator who forwards your reports, they should be sent to me at: 11781 N. Joi Dr.; Tucson, AZ 85737; U.S.A. Names and addresses of regional coordinators are given in "From the Publisher" on *Occultation Newsletter's* front page. I will publish the results of the second half of 1988's observed events in the next issue of *O.N.* Please — everyone — send your reports in. These summaries are much enhanced when we use complete data, and I often hear of observations that aren't reported. If you don't want to fill out forms or bother with all of the details of your observation, just report the times that you observed, location, and whether you saw anything or not.

Regional coordinators should have received Edwin Goffin's 1990 asteroidal occultation predictions by now. They include 12 revisions that were sent to me by Goffin, presumably from improved orbital elements of the minor planets.

It is interesting to note some of the differences between the original and the newer predictions. The average predicted time difference was 3.8 minutes, with two new events being more than 10 minutes earlier. Also the shift in positions (or paths on the Earth's surface) averaged just under one arc second (a thousand kilometers or more), with one path being shifted southward by more than 6000 kilometers. Goffin is constantly improving his predictions, but our knowledge of the minor planets' orbits and the exact positions of the stars is incomplete. Consequently, the occultation paths of many events can be shifted great distances. Goffin's improved predictions confirm this.

The following are all reports of positive observations that I have received. A more-detailed report has been promised from the coordinator, or the principal observer, and will be published soon after I receive it. All times are U. T.

(342) Endymion and SAO 158885, 1989 Apr. 23: John Priestley at Pukera Bay (Wellington), New Zealand recorded a disappearance at 17:14:13.5 lasting 3.9

seconds. This would indicate a shift southward, placing the path close to Melbourne, New South Wales, and indeed, Jim Blanksby at Wandin reported a 0.5-second event beginning at 17:17:53.2. However, he stated the event was "possibly spurious" due to its short duration. Weather conditions were good, but the quick extinction was not the blink this experienced observer was expecting. Furthermore, an observer at Stockport in South Australia reported a short event which was "probably atmospheric."

(15) Eunomia and SAO 164594, 1989 Apr. 26: Due to bad weather, only one astrometric update (Black Birch Astrometric Observatory) was obtained, indicating a northward shift and a time 5 minutes later than the nominal prediction. Steve Hutcheon organized an Australia-wide observing fence, but terrible storms, fog, and cloud cover thwarted most efforts. Steve travelled 119 km north of his normal observing site to Noosa, and recorded an 11.4-second extinction beginning at 17:18:13.8. He reports that both disappearance and reappearance were very quick, but not instant. About 60 km to the southwest (just north of Brisbane), Terry Hickey had a lot of bad luck with a foggy eyepiece, radio fades, and two stopwatches going blank, but he did manage to record a 6-9-second disappearance beginning at 17:18:13.3. Negative reports were made by Peter Anderson and others at Brisbane (120 km south of Noosa); Dennis Lowe at Bundaberg (190 km south); two observers at Hobart, Tasmania; Martin George 70 km from Launceston, Tasmania; and another observer in Launceston (who reported some fadings that are being analyzed further). Since the diameter of Eunomia is published at 261 km, a central event of 9.4 seconds is all that could be expected. Steve and Graham Blow are gathering more data, and will report on the noncircular shape of Eunomia in the future.

(9) Metis and SAO 190531, 1989 Aug. 6: Bob Hindsley at the Black Birch Astrometric Observatory (USNO) produced two astrometric updates indicating a path shift southward and off New Zealand. But he indicated problems with the measuring engine, and placed no degree of reliability on the updates. At Launceston, Tasmania Martin George reported a disappearance of about 13 seconds beginning at about 10:42:49. Seeing was poor and the magnitude drop was only 1.2 magnitudes. Peter Daalder to the southeast at the same town reports an 8.5-second disappearance beginning at 10:42:53 ± 2 seconds (due to his tape recorder chewing up his tape 15 seconds earlier, after running OK for 20 minutes). From New Zealand, John Priestley reported a 12.2-second disappearance beginning at 10:40:20.8 (Pukera Bay), Philip Rifey a 15-second event beginning at 10:40:19.3 (Wellington), and Bill Allen photoelectrically recorded a 15-second extinction beginning at 10:40:24 (Blenheim). N. Munford reported a negative observation although he stated the air to be very unsteady, so he couldn't be certain (Palmerston North). K. Hill and S. Dieters at Hobart, Tasmania saw nothing with their photometer. Graham Blow planned to plug a hole at Levin, but after coordinating other observers on the South Island, he only had time to make it to Otaki, and then got set up only a few seconds before the occultation actually began. The rush, plus poor seeing and haze prevented him from observing a positive event.

(4) Vesta and SAO 185928, 1989 Aug. 19: Larry Lebofsky from the University of Arizona led four teams to Ecuador under a National Geographic Society grant, and three teams obtained chords. However, the results of these observations should be published for the Society before the data are made available to IOTA. American observers G. Samolyk and Greg Lyzenga reported misses from Wisconsin and California, respectively. Samolyk used a filar micrometer to measure the passage of Vesta, and determined a closest approach separation of about 2 arc seconds at P.A. 212°.

There were several other reports of possible positive observations in the first half of 1989, but I am awaiting more information, and will report on those in the next issue of *O.N.*

BOOK REVIEW — ECLIPSE

Paul D. Maley

Eclipse, by D. and C. Allen is one of those very pleasantly written books by people who obviously are enthralled by the subject. The Allens point out that their mission is to describe the beauty, impressions, and scientific view of solar and lunar eclipses. Did they succeed? First, the good news. For the novice, the material is presented in a manner that can be read with ease; there are lots of excellent anecdotes about eclipses and related matters. It is told in a chronicled style of which I am personally fond. The photographs in the text, and the drawings, are of high quality. Conscious experiences that occur mainly during total solar eclipses are rendered in a stimulating fashion.

Now for the bad news. Experienced eclipse chasers will not find this text for them. It does not delve into the hard-core science that IOTA expeditions pursue; occultations are barely mentioned. Exploring the science behind measuring the Sun's polar diameter, using modern techniques to record data on the progress of the eclipse, and the current benefits of amateur/novice contributions to the discipline would have been welcome additions if present. There are far too many stories, many of which are repetitive, and very little on observational methods. I found such problems as: 1) the description of how to get good eclipse photos is lacking; 2) mixing of engineering units; 3) deficient information on lunar observations; 4) no information on Mercury transits; 5) the technical description of a saros is missing; 6) Baily's original beads observation is poorly handled; 7) highly exaggerated portrayal of shadow bands; and other minor technical errors that the novice would not recognize.

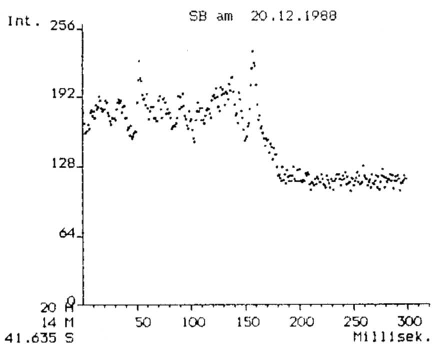
So, if you want a short, unencumbered text that makes pleasant reading, *Eclipse* may be for you. But if you crave information on how IOTA eclipse objectives are carried out, you had best look elsewhere.

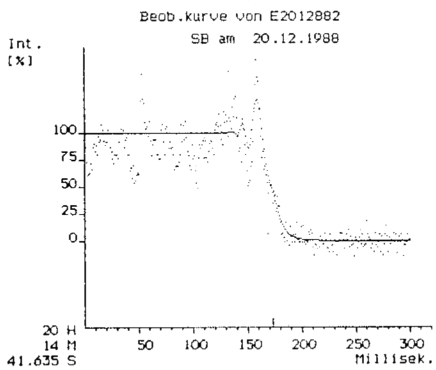
PHOTOELECTRIC OBSERVATIONS OF 3 SUSPECTED BINARIES

K. -G. Steinert, Technische Universität Dresden

In 1988 our certificated engineer G. Katerbaum employed the numerical analysis of photoelectric occultation observations by model fitting (see *Wiss. Ztschr. Techn. Univ. Dresden 38* (1989), 73-75 = Mitteilungen des Lohrmann-Observatoriums Nr. 56).

An occultation of the Pleiades took place at Dresden on 1988 December 20. Among others, the stars SAO 76140 (Taygeta) and SAO 76155 (Maia) were occulted, both considered as close double stars. Our analysis may confirm these assumptions. We don't think that





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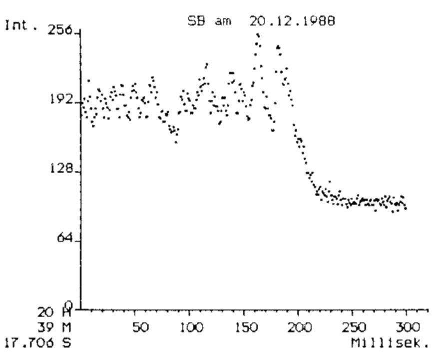

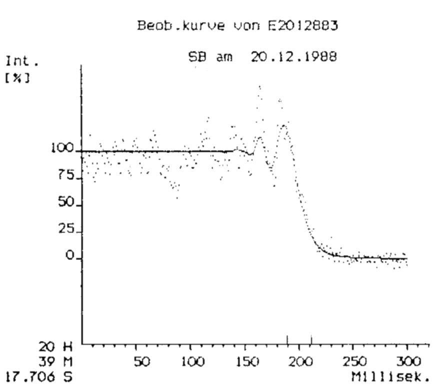

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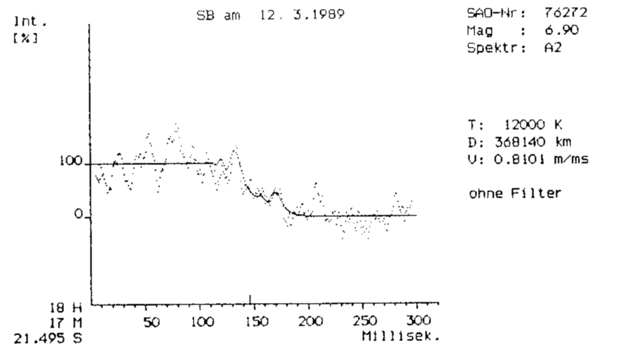


Rho= 0.0168" DeltMag= -0.82 1.Bedwert= 146 DeltZeit= 37 ms Gleimi= 9
1.Bedeckungszeitpunkt: 18 H 17 M 21.641 S UTC

the following results are affected by irregularities in the recording equipment.

SAO 76140: $\zeta = 0''.0059 \pm 0''.0005$ P.A.: $81^\circ.9$
$\Delta m = -1.65^m \pm 0.14^m$ (1st comp. brighter)

SAO 76155: $\zeta = 0''.0056 \pm 0''.0003$ P.A.: $116^\circ.7$
$\Delta m = 2.32^m \pm 0.10^m$ (2nd comp. brighter)

Besides this, we got a double star observation of SAO 76272 on 1989 March 12.

SAO 76272 $\zeta = 0''.0168 \pm 0''.0005$ P.A.: $73^\circ.1$
$\Delta m = -0.82^m \pm 0.15^m$

The traces of the three observations and the best-fitting results are shown here.

ESOP VIII

The Eighth European Symposium of Occultation Projects was held in Freiburg, German Federal Republic. The following papers were presented on September 2nd and 3rd, 1989:

Titan:

Overview of its Structure and Atmosphere
Stellar Occultations by Planetary Atmospheres
First Atmospheric Results
Preliminary Results of the Atmosphere
Photoelectric Observation and Results
Videodemonstration and First Results – I
Videodemonstration and First Results – II

Minor Planets:

Recent Results of Planetary Occultations
Calculation of Planetary Occultations
Planetary Occultations / General Overview
Relationship between Personal Equation and Star Magnitude Drops
Discussion and Videodemonstration – Saturn Occults 28 Sagittarii

Lunar Occultations:

Occultation Work in the CSSR
Occultation Work in the GDR
Occultation Work at Archenhold Observatory
Grazing Occultation of 44 Capricorni
Grazing Occultation of Alpha Leonis
IOTA/ES Reductions of Lunar Occultations

Technology and Communication:

A new CCD Imaging System
Automatic Drive Control
MINITEL
Image Intensifier for Occultation Work

Occultation Projects:

SAO 189216 by Venus
Finland 1990
Australia 1991
Mexico 1991
Report of ESOP VII

[Ed: You probably could obtain the abstracts of the papers by contacting Dr. Eberhard Bredner; Marderweg 17; D-4700 Hamm 1; German Federal Republic.]

ASTRONOMY AND PERSONAL COMPUTERS

Joan Bixby Dunham

Precession and Mean Place: The reference frames we use to define coordinate systems for celestial objects are based on the Earth's orbit about the Sun and the Earth's equator. These two planes, the ecliptic plane and the equatorial plane, are not fixed, but move as the Earth's orbit and pole of rotation are moved by gravitational perturbations from the Sun, Moon, and planets. As a result, star positions measured in a reference frame defined by the ecliptic and the equator appear to move. These motions are not large, but they can be observed in measurements repeated over many years. This phenomenon of precession was discovered by Hipparchus over 2000 years ago. The standard practice to accommodate this motion has been to define certain dates as the dates of mean epochs, to prepare star catalogs with positions as they would be on those dates, and, with very long-term observing programs, to determine formulae to compute the precession so that observations or predicted positions of celestial objects may be placed in the reference frames of those star catalogs.

When we recompute star catalogs, and move their epochs from time A to time B, we include the effects of the motions of the stars from time A to time B (their proper motions, or space motions). This is necessary to give us a representation of the sky at time B, our new mean epoch. This is different from how we use mean positions for asteroids, comets, planets, or artificial satellites. When we have an asteroid position given in mean of 1950 coordinates, we have its position as of today (or whenever we are observing) in the reference frame defined by the star catalog of 1950. That is, the mean position of the asteroid can be plotted on the star catalog of 1950 and show us the position of the asteroid relative to the stars. We very specifically do not want to move the asteroid to where it will actually be on the epoch date of 1950. We can also compute the asteroid's mean position in the new reference frame of 2000. It is still the same asteroid, and its 'real' position measured in some absolute reference frame has not changed. We have just redefined its position in a reference frame defined by the stars in 2000.

The current systems and catalogs are in a state of flux. The 'old' system is being replaced with a 'new' one. The epochs of the old system are 1950 or, sometimes, 1900; the new is 2000. It is possible to define mean epochs of whatever time we wish. To distinguish the old and new systems, epochs of the old are prefaced with a B, to give us B1900, B1950, B1975, and the new with a J, as in J2000. The B refers to the Besselian year used as a unit of time, while the J refers to the Julian year. The date and time of B1950 is December 31, 1949 at 22:09.8 UT, that of J2000 is January 1, 2000 at 12 noon. The current state of affairs can leave us with the problem of converting mean of 1950 elements (from an IAU circular, for example) to J2000 to use with a star catalog in J2000 (Uranometria 2000 is one).

If we are using orbital elements, the precession affects only the angles that orient the orbit within the reference frame, the inclination (i), longitude of ascending node (Ω), and argument of perigee (ω). The eccentricity, semimajor axis, and position on the orbit are unchanged. Equations are given in the *Astronomical Ephemeris* (p. B19 in the 1989 version) for the precession to/from the J2000 epoch of these orbital elements, valid for elements given in either the ecliptic or the equatorial frames. Equations are also given on the same page for precession of right ascension (α) and declination (δ), or latitude (β) and longitude (λ).

The page before gives the equations for more-precise computations. However, most cometary and asteroidal elements are not terribly accurate themselves, and the simpler equations may be sufficient. We do not need high precision for simply locating objects.

In the latter part of section B (page 42 and 43 of the *1989 AE*), equations are given for conversion of stellar positions between B1959 and J2000. The final matrix M of this section is only for computing stellar positions, and not for other objects, because the computations include adding in the space motions of the stars between 1950 and 2000.

This is only a discussion of the mean positions from considerations of the precession. There is also the computation of the true position, adding in the effects of nutation. The nutation of the Earth's pole is a wobble about its mean position. It is a much smaller effect, and is periodic, while the period for precession is so large it is considered a secular effect.

Communications: Communications with a computer using a MODEM is a subject that confuses many. There are so many ways of configuring MODEMs and communications software, and so many different communications 'standards' that are followed that many people do not even try. To add to the problems, just being able to send and receive intelligible information is only the first step in establishing good communications. Most of us use standard telephone lines, intended for voice transmission, when we send or receive data via MODEMs. The noise we can hear on the line can play havoc with data communications.

Communications checking: Cyclic redundancy checking (CRC) is a popular method of checking the integrity of transmitted data, and is used in the PC protocols XMODEM, YMODEM, and others like them. Basically, a CRC test involves dividing the data sent from point A to point B into blocks of set length (128 or 1024 bytes are frequently used), dividing each block by a prime number, generating the remainder (throwing away the quotient) and sending the remainder as well from A to B. Once received, the remainder is recomputed. If B finds the remainder to be the same as A, the data are judged to have been communicated correctly. If they are not the same, the process has detected a communications error.

The CRC checking process is based on the fact that the result of dividing an integer of M digits by a prime number is unique. A prime is a number that cannot be evenly divided except by itself or 1. Each integer of M digits divided by, for example, the prime number 7, has a unique remainder. If we know the prime number that is the divisor, the number of digits in the integer, and the remainder, we can determine what the integer was. The remainder will be smaller (have fewer digits) than the original number. If we keep only remainders, we then have a way of passing information about numbers with fewer digits than are in the numbers.

Every piece of information stored in a digital computer can be manipulated as a binary number. Rather than do the CRC computation in base 10 arithmetic, which could be time consuming, the computation is done in binary. Instead of a prime number, the divisor is a primitive polynomial, a polynomial which cannot be factored into two smaller polynomials. As it happens, since only the remainder, and not the quotient, is kept, the binary manipulation is fairly simple. Most PC communication software performs the computations for one or more protocols that use CRCs.

Communications checking protocol: Having the ability to check that data sent or received have been correctly transmitted is only one third of the battle. The rest, and sometimes the most difficult, is determining just exactly how the other end of the communications line is doing its checking. It is not at all uncommon to agree with a sender (or recipient) that a specific protocol will be used, and then discover that the recipient's computer insists that every transmission attempt fails. I frequently find that, even though the particular variant of XMODEM we have agreed to use has the same name on both ends of the communications link, they really are not the same. Most communications packages and most BBSs have several protocols, and some experimentation may be necessary to find one that is the same on both ends.

The procedures that might be used in communications checking, that are referred to as the protocol, include how many times a message is sent before quitting, how long to wait between sends, how big the data blocks are, who tells the receiver what the file name is, what happens if the program detects problems. The PROCOMM PLUS User's Guide lists 12 protocols it has, plus 2 extras they supply as external programs, and the option to send data with no checking at all.

Further information about CRCs can be found in some of the user's guides on communication software, textbooks of data communications, and occasional articles on data communications in magazines like *Byte* and *Computers in Physics*. Two articles I found are on page 88 of the Jul/Aug 89 *Computers in Physics*, page 115 of the September 86 *Byte*. There is also a discussion on pages 147-150 in the textbook *Data Communications*, by Kenneth Sherman, Reston Publishing, 1985.

Printers: The second-most troublesome component to most PC users is the printer (modems give the most trouble). We can spend many frustrating hours glaring at that beige plastic case trying to understand why a printer refuses to do what the manual plainly says it can do.

Printers receive their commands through a cable connected to the computer serial or parallel port. Serial and parallel ports refer to two different communications standards, one (the serial) in which the bits that make up each command are sent one after another, the other (the parallel) in which the bits of each word are sent at the same time on separate wires. Even the physical connection to the computer can be a problem in some cases. Connectors come in sexes, male and female (one look at the connectors should tell you why they are called that), and sometimes both the end of the printer cable and the PC outlet can be the same sex. Manufacturers may use a different type of connector than the standard, especially with a very small portable where small connectors may be used to save room. There are ways to overcome all printer connection incompatibilities, such as buying converters or special custom cables, but it is usually easier and cheaper to make sure a specific printer can work with a specific computer before buying the printer.

The commands to a printer are processed by what amounts to a small computer inside the printer. This interprets the data as they are received and separates what are controls to turn on or off features from what are characters that are to be printed. The printer's manual lists what these commands are. Many also give example BASIC programs on how to send these commands to the printer. Commands are usually distinguished from printable characters by starting with an escape control character, the ASCII character at 27, or by being one of the control characters that are below 32 in the ASCII table of characters. When learning how to use a printer, it is instructive to try some of the example programs in the manual.

In line with the venerable tradition in PCs that software does not keep up with hardware, most printers have more features than the software we use will support. Part of this is because every printer, and often different models made by the same manufacturer, has a different set of commands from every other. Also, modern printers have a wide range of features with more added with each new model. Software authors just can't keep up. Some of the features printers provide, though, may not be all that necessary. Word processors rarely use printer's commands for tabbing and margins, since it is more efficient to do it in code that will work for every printer than setting up hardware-dependent structures. But it still seems the software developers could do better. They tend to have too few options to support all the useful features of a printer and are reluctant to support the direct insertion in the text of the ASCII control characters to command the printer.

Portable Computers: Shrinkage of computers continues, with competitors vying to have the smallest and lightest portable computer, working towards a truly functional shirt-pocket PC. There are still some practical issues to consider. One is that the keyboard of today's shirt-pocket sized calculator is not suited to typing — and once you learn to type, holding a pad in one hand while poking keys with the index finger of the other hand is never satisfactory. Other major problems are the difficulty in reading small screens and problems in storing data, but both of these are likely to be solved before the keyboard problem. Part of the difficulty in developing a keyboard to fit into a very small computer is that we have rather definite ideas on how a keyboard should respond and how it should feel. We like the feedback of having the keys depress when we press them and click as we type. Or, for that matter, having the mouse button click when we press that. It is hard to imagine how a very small device can provide that same feel. Several innovations that might have worked just as well as a keyboard have not been well accepted. These were, for example, mouse-sized devices that were studded with buttons, to be manipulated with one hand. Depressing combinations of the buttons produced the letters of the alphabet, numerals, or control keys. An overachiever mouse announced last summer supposedly has 128 (!) buttons.

There are several more-or-less well-defined categories of portable computers. The luggable computer is the original portable design, with a CRT display built into its case, a weight of 25 pounds and up (to over 40 for some models), and a need to be near an electric outlet. The back pages of computer magazines still carry ads for these, but they are no longer made by large manufacturers. The lunch-box style is more portable, with a weight of 20-25 lbs, achieved by using a gas plasma, electroluminescent, or LCD display instead of a CRT. Some of the lunch-box computers can operate from battery power. These are not very popular, since they are a little clumsy in comparison with smaller portables. The laptop or clam-shell style portables are more portable, usually weighing in at 12-16 lbs. Most of these can operate with battery power for several hours, and they can be used on a lap. Recent models are smaller and more powerful than earlier ones. A new category, the notebook computer, is 6 lbs or less, and about the size of a notebook. Smaller yet are the palmtop or shirtpocket computers. Shirtpocket models presented to date are too large for pockets, although they do fit nicely into a purse or briefcase. And then there are, of course, programmable calculators, which really do fit into a shirt pocket.

The November 89 issue of *Smithsonian* has an ad that shows a new palm-top Atari computer in actual size. This one-pound marvel has a small keyboard which might take some practice to use, and no disks. Software comes on plug-in cards. It looks like it might be very useful for writing notes and memos, especially if the user can connect it to a 'real' PC for printing, storage, word processing, and so forth. We can expect to see other entries in this ultralight class before long. The Atari is a direct competitor to top-of-the-line programmable calculators. It costs about the same, or even less, it can do more, and it is not very much bigger. I would be very surprised if the high-priced programmable calculator market survives.

Physics Education Software: The American Institute of Physics has several reasonably priced education software programs of interest. One of them, Orbits, is a program that computes and plots the restricted three-body problem (a massless particle orbiting a binary star with components in circular orbits). You can obtain a catalog from Physics Academic Software, American Institute of Physics; 335 East 45th Street; New York, NY 10017, phone (800) AIP-PHYS. If you would like to submit software for publication, request submission guidelines from Dr. John S. Risley; Editor; Physics Academic Software; Department of Physics; North Carolina State University; Raleigh, NC 27695-8202. If you think you have written a prizewinning educational software program, you can submit it to the Computers in Physics Education Software Awards for consideration for the $500 grand prize. The contest deadline is February 1, 1990. Write Alison Drotman; Computers in Physics; 500 Sunnyside Blvd.; Woodbury, NY 11797 for more information.

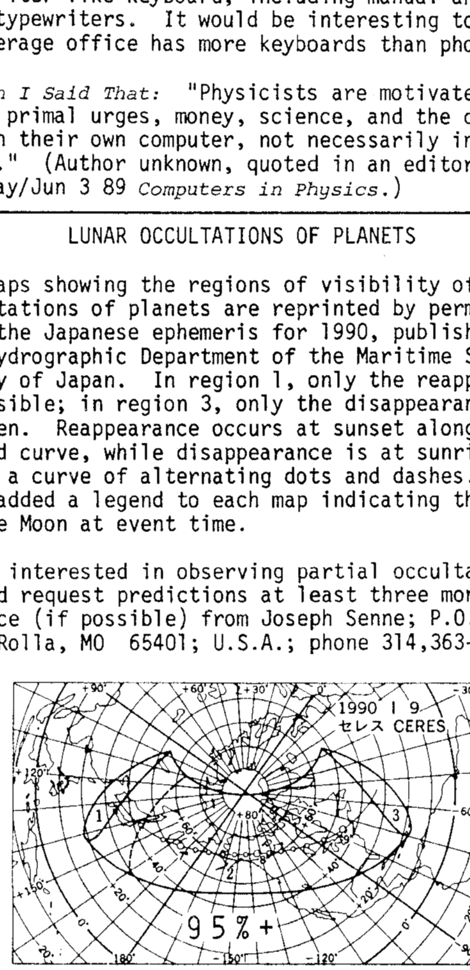
Keyboards: *PC Week* recently reported that there are now more keyboards than workers that use them. In 1984, 40% of desk workers had no keyboards; now there is more than one keyboard per desk worker. 'Keyboard' means just that — anything that has a typewriter-like keyboard, including manual and electric typewriters. It would be interesting to see if an average office has more keyboards than phones.

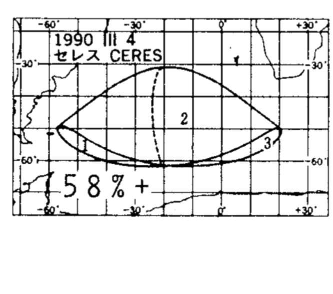
I Wish I Said That: "Physicists are motivated by three primal urges, money, science, and the desire to own their own computer, not necessarily in that order." (Author unknown, quoted in an editorial in the May/Jun 3 89 *Computers in Physics*.)

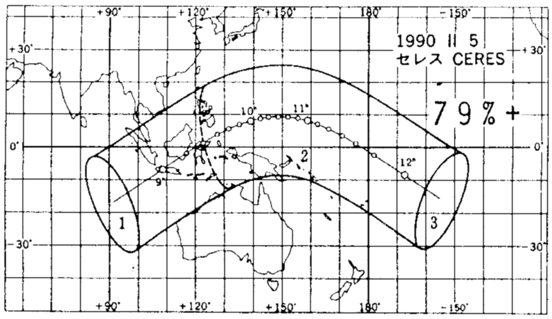
LUNAR OCCULTATIONS OF PLANETS

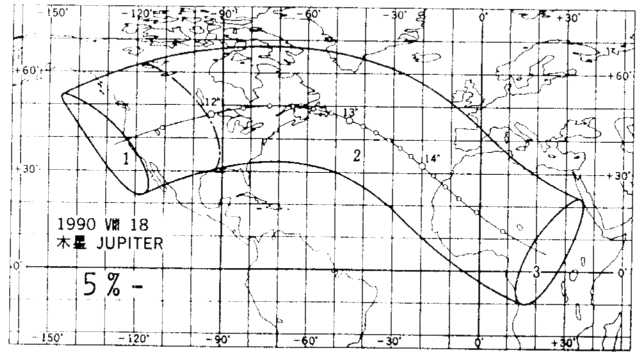
The maps showing the regions of visibility of lunar occultations of planets are reprinted by permission, from the Japanese ephemeris for 1990, published by the Hydrographic Department of the Maritime Safety Agency of Japan. In region 1, only the reappearance is visible; in region 3, only the disappearance may be seen. Reappearance occurs at sunset along a dashed curve, while disappearance is at sunrise along a curve of alternating dots and dashes. We have added a legend to each map indicating the phase of the Moon at event time.

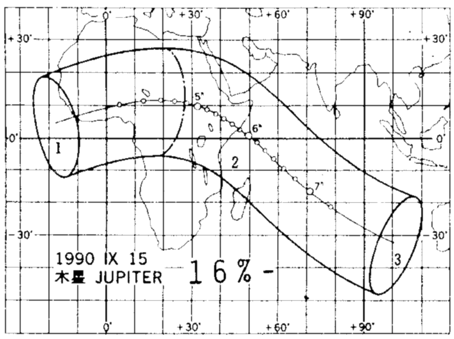
Those interested in observing partial occultations should request predictions at least three months in advance (if possible) from Joseph Senne; P.O. Box 643; Rolla, MO 65401; U.S.A.; phone 314,363-6233.

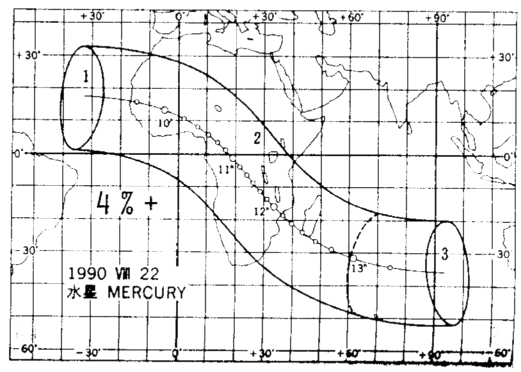


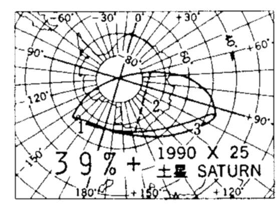


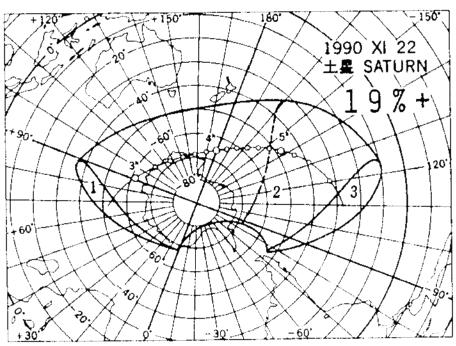


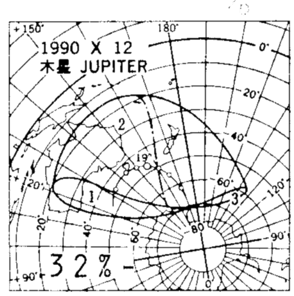


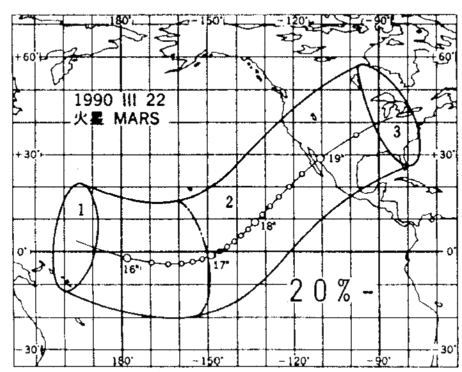


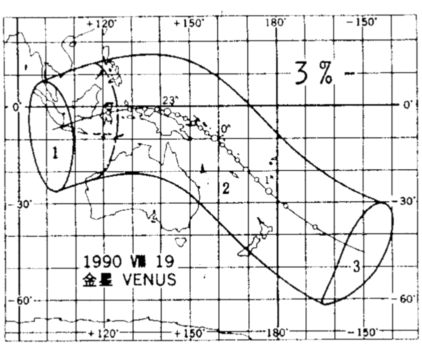


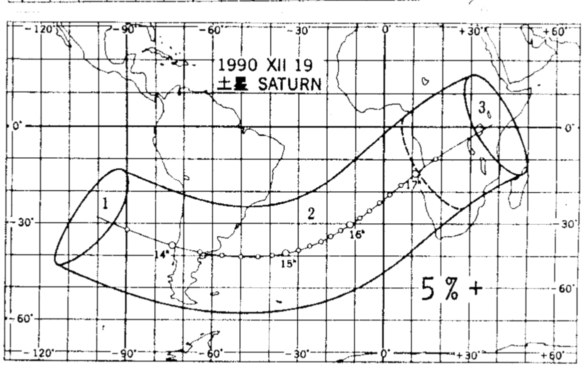


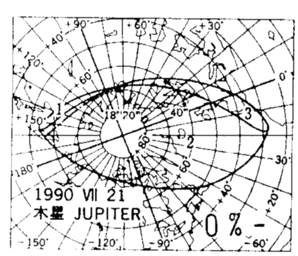


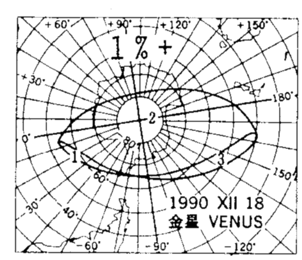








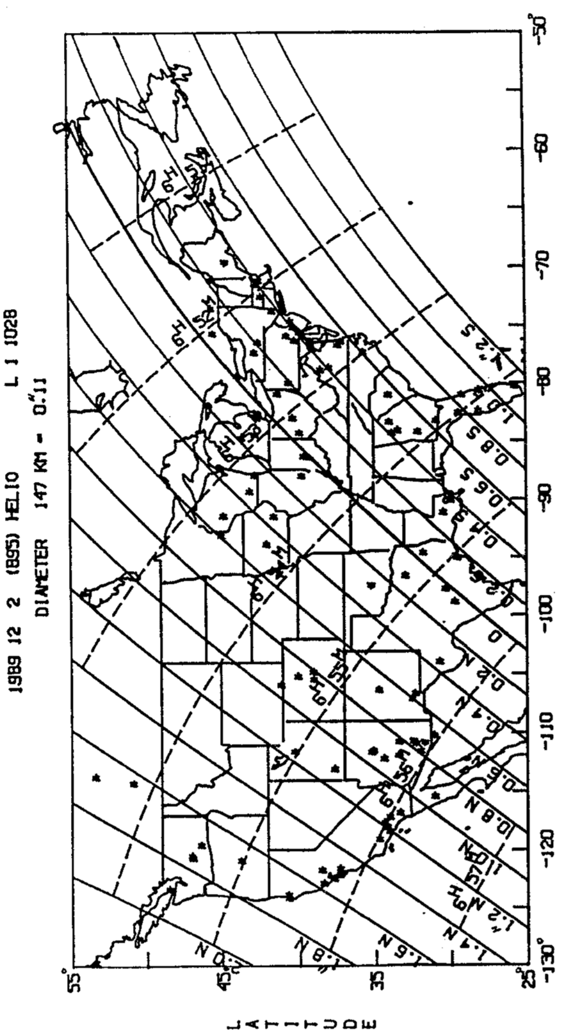


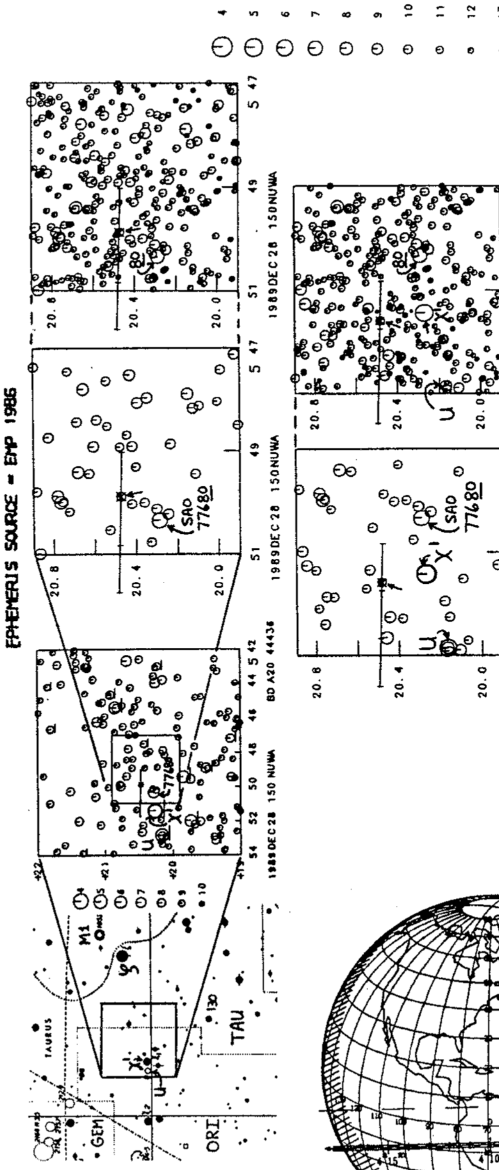


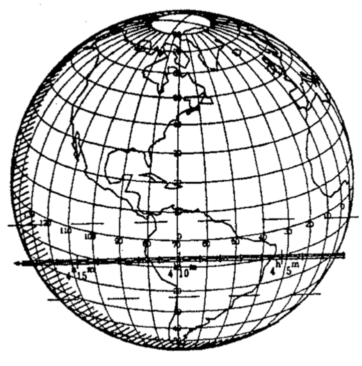
SOLAR SYSTEM OCCULTATIONS DURING 1989

David W. Dunham

This is a continuation of the article with the same title starting in *O.N.* *4* (10), p. 244 and continued on from p. 319 of the last issue.







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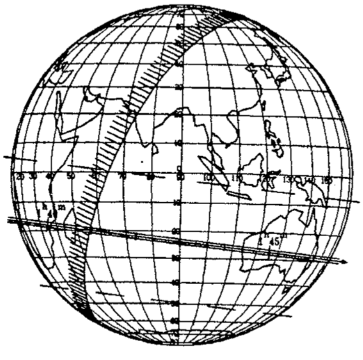

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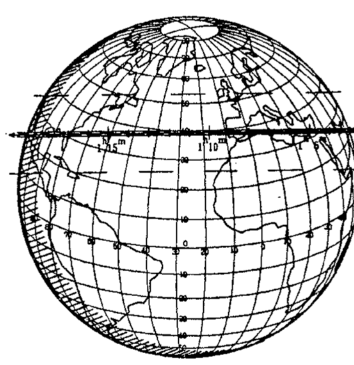

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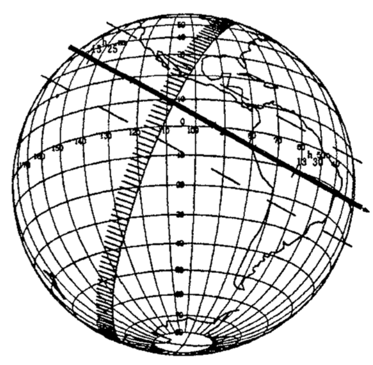

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