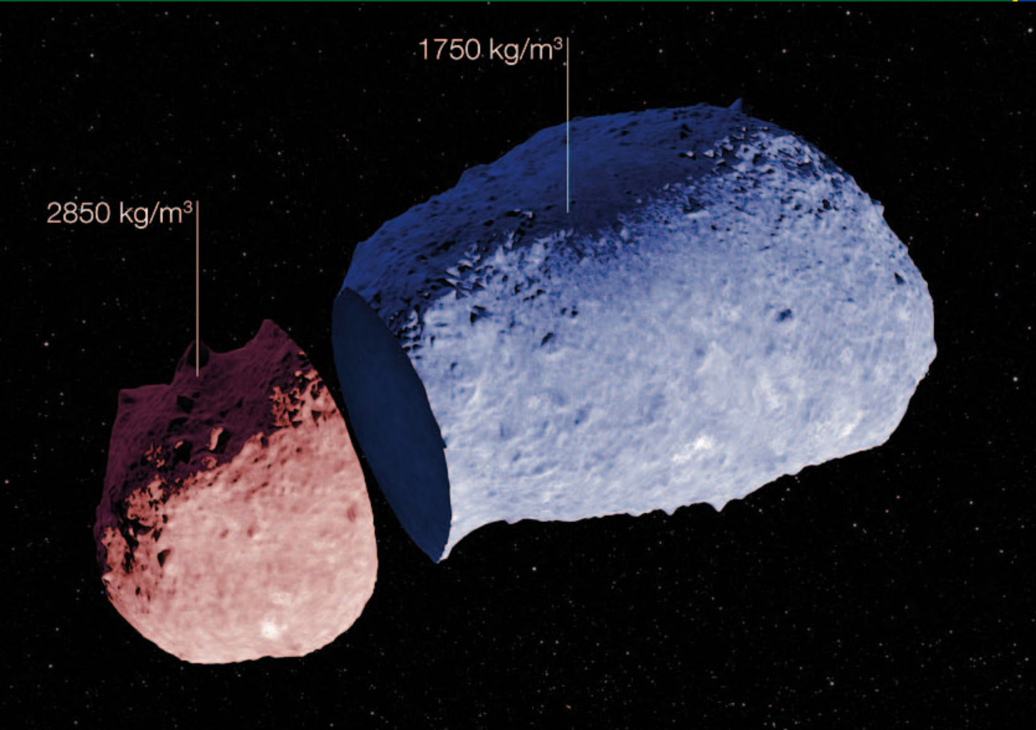
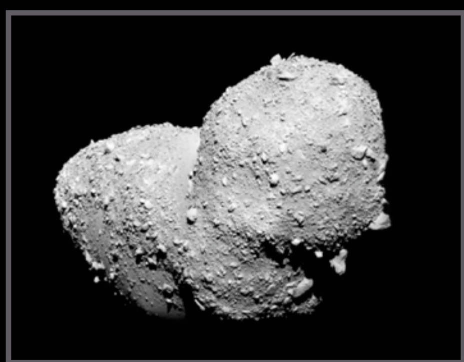
Journal for Occultation Astronomy

2014–01

FORMERLY OCCULTATION NEWSLETTER



The Anatomy of an Asteroid



ESO's New Technology Telescope (NTT) has been used to find the first evidence that asteroids can have a highly varied internal structure. By making exquisitely precise measurements astronomers have found that different parts of the asteroid Itokawa have different densities. As well as revealing secrets about the asteroid's formation, finding out what lies below the surface of asteroids may also shed light on what happens when bodies collide in the Solar System, and provide clues about how planets form.

Using very precise ground-based observations, Stephen Lowry (University of Kent, UK) and colleagues have measured the speed at which the near-Earth asteroid (25143) Itokawa spins and how that spin rate is changing over time. They have combined these delicate observations with new theoretical work on how asteroids radiate heat.

This small asteroid is an intriguing subject as it has a strange peanut shape, as revealed by the Japanese spacecraft Hayabusa in 2005. To probe its internal structure, Lowry's team used images gathered from 2001 to 2013, by ESO's New Technology Telescope (NTT) at the La Silla Observatory in Chile among others [1], to measure its brightness variation as it rotates. This timing data was then used to deduce the asteroid's spin period very accurately and determine how it is changing over time. When combined with knowledge of the asteroid's shape this allowed them to explore its interior — revealing the complexity within its core for the first time [2].

The spin of an asteroid and other small bodies in space can be affected by sunlight. This phenomenon, known as the Yarkovsky-O'Keefe-Radzievskii-Paddack (YORP) effect, occurs when absorbed light from the Sun is re-emitted from the surface of the object in the form of heat. When the shape of the asteroid is very irregular the heat is not radiated evenly and this creates a tiny, but continuous, torque on the body and changes its spin rate [3], [4].

Lowry's team measured that the YORP effect was slowly accelerating the rate at which Itokawa spins. The change in rotation period is tiny — a mere 0.045 seconds per year. But this was very different from what was expected and can only be explained if the two parts of the asteroid's peanut shape have different densities.

This is the first time that astronomers have found evidence for the highly varied internal structure of asteroids. Up until now, the properties of asteroid interiors could only be inferred using rough overall density measurements. This rare glimpse into the diverse innards of Itokawa has led to much speculation regarding its formation. One possibility is that it formed from the two components of a double asteroid after they bumped together and merged.

This new ability to probe the interior of an asteroid is a significant step forward, and may help to unlock many secrets of these mysterious objects.

http://www.eso.org/public/news/eso1405/

Dear reader,

"Why is Astronomy Important?"

I read this in November (see below) and remembered February 1980 when we were in Kenya to record Baily's beads during a total solar eclipse. A few days later the Moon was back again and we tried to observe a stellar occultion. Some of the African fellows who helped us and build up the pier for the C8, arrived wanting to know what we were doing, for the eclipse was over!

So we showed them the moon giving them some explanations concerning the mountains, valleys and maria resulting in their question: What about rain on the Moon?

(Submitted on 3 Nov 2013)

For a long time astronomers and other scientists believed that the importance of their work was evident to society. But in these difficult days of financial austerity, even the most obvious benefits of science have to undergo careful scrutiny. Eradicating poverty and hunger is a worldwide priority, and activities that do not directly attempt to resolve these issues can be hard to justify and support. However, several studies have told us that investing in science education, research and technology provides a great return (not only economically, but culturally and indirectly for the population in general and has helped countries to face and overcome crises. The scientific and technological developing country or region is closely linked to its human development index) a statistic that is a measure of life expectancy, education and income.

By courtesy of: Marissa Rosenberg, Pedro Russo (EU-UNAWE, Leiden Observatory/Leiden University, The Netherlands), Georgia Bladon, Lars Lindberg Christensen (ESO, Germany)

What are you doing with your old scope you do not need any longer? If it is still working you could donate it to a school or University in a development-country – have you ever thought about that possibility?

Hans-J. Bode (Editor in chief)

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In this issue:

Writing articles for JOA:

The rules below should be regarded while writing an article; using them will greatly facilitate the production and layout of ON!

If your article does not conform to these rules, please correct it.

There are 3 different possibilities for submitting articles:

- pdf-articles (must be editable – these can be converted)
- unformatted Word *.doc-files containing pictures/graphs or their names (marked red: <figure_01>) at the desired position(s)
- *.txt-files must contain at the desired position the name of each graph/picture

The simplest way to write an article is just use Word as usual and after you have finished writing it, delete all your format-commands by selecting within the push-down-list "STYLE" (in general it's to the left of FONT & FONTSIZE) the command "CLEAR FORMATTING". After having done this you can insert your pictures/graphs or mark the positions of them (marked red: <figure_01>) within the text.

txt-files: Details, that should be regarded

- Format-commands are forbidden
- In case of pictures, mark them within the text like <picture001> where they should be positioned

Name of the author should be written in the 2nd line of the article, right after the title of the article; a contact e-mail address (even if just of the national coordinator) should be given after the author's name.

IMPORTANT:Use only the end-of-line command (press ENTER) if it's really necessary (new paragraph, etc.) and not when you see it's the end of the line!

Sending articles to JOA:

Each country / state has a coordinator who will translate your article to English – if necessary.

In case there is no one (new country) please send a mail to the editorial staff at: **info@occultations.info**

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Bright Star Occultations by TNOs in 2014

Hans-J. Bode / credit: RIO-Team (Felipe Braga Ribas), B. Sicardy

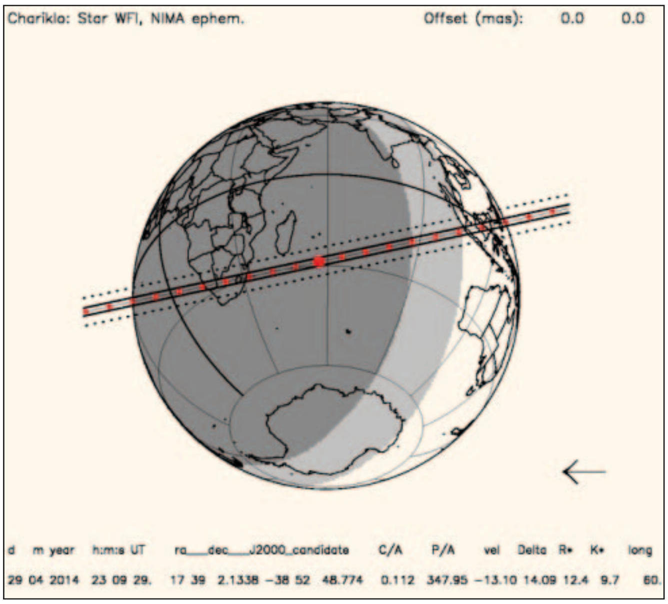
There are 3 relatively "bright" stars within the reach of European and African observers that will be occulted in 2014. These data are all preliminary and might be changed before the event due to last-minute-astrometry. Anyway it should be important to keep in mind the dates and areas in your schedule of events for 2014.

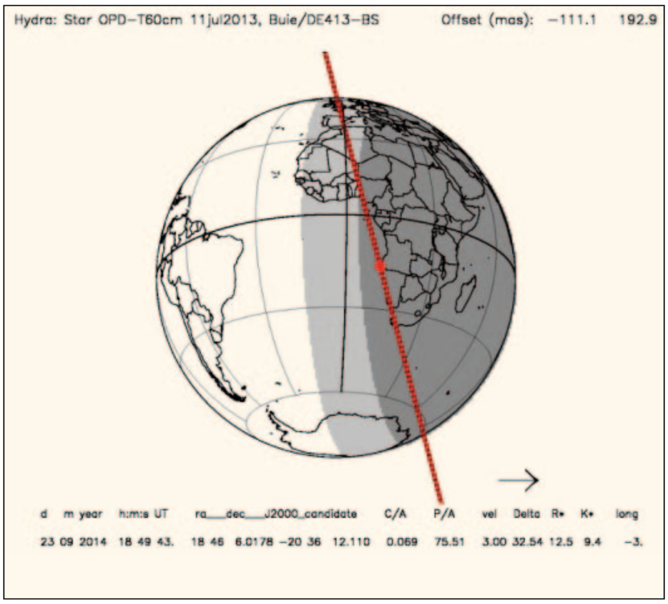
Object	Date	Time (UT)	RA	Dec (J2000)	Mag. (R)
Chariklo	Apr 29	23h09m29	17h39m02.1338s	-38°52'48.774"	12.4
Hydra	Sep 23	18h49m43	18h46m06.0178s	-20°36'12.110"	12.5
Bienor	Dec 30	22h23m01	01h32m39.0946s	29°22'13.440"	11.4

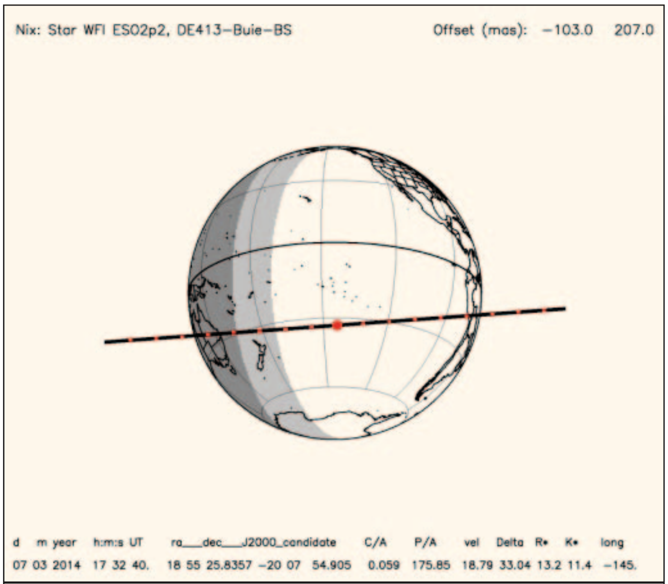
The Pluto-System will occult a R 16.2 star in Gambia & Kenya (Pluto) and Namibia (Charon) on May 24. Somehow the same will happen on July 7 in Morocco for Pluto & P4 (R 15.9) and Quaoar (R 17.6 (!)) whereas Charon will occult this star in Namibia.

For American-, Australian- and Pacific-observers there will be the following interesting events:

Object	Date	Time (UT)	RA	Dec (J2000)	Mag. (R)
Nix	Mar 07	17h32m40s	18h55m25.8357s	-20°07'54.905"	13.2
Amycus	Apr 10	10h46m27s	17h49m45.7474s	-34°01'52.321"	12.9
Quaoar	Apr 11	14h19m35s	17h45m53.3232s	-15°32'51.869"	14.1 (!)
Chariklo	Apr 14	08h11m10s	17h40m50.5446s	-38°45'09.225"	12.3
2002TC302	Dec 24	07H14m58s	02h12m10.2932s	25°29'38.012"	12.2



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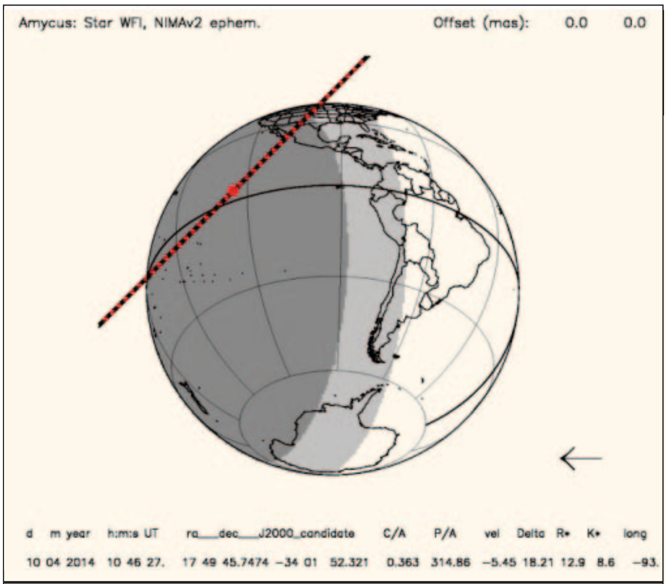
07 03 2014 17 32 40. 18 55 25.8357 –20 07 54.905 0.059 175.85 18.79 33.04 13.2 11.4 –145.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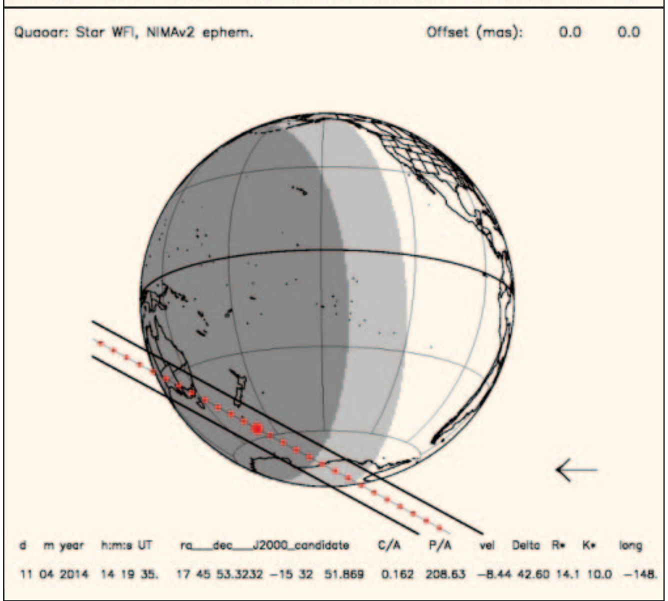
10 04 2014 10 46 27. 17 49 45.7474 –34 01 52.321 0.363 314.86 –5.45 18.21 12.9 8.6 –93.


Quaoar: Star WFI, NIMAv2 ephem.
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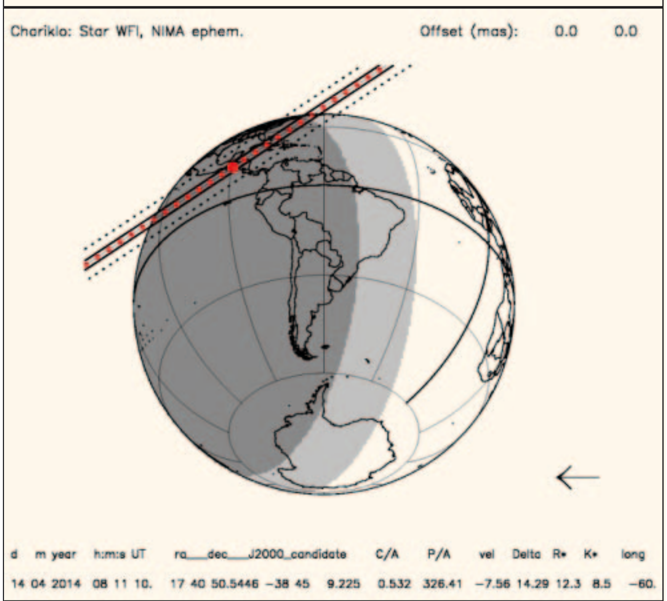
11 04 2014 14 19 35. 17 45 53.3232 –15 32 51.869 0.162 208.63 –8.44 42.60 14.1 10.0 –148.


Chariklo: Star WFI, NIMA ephem.
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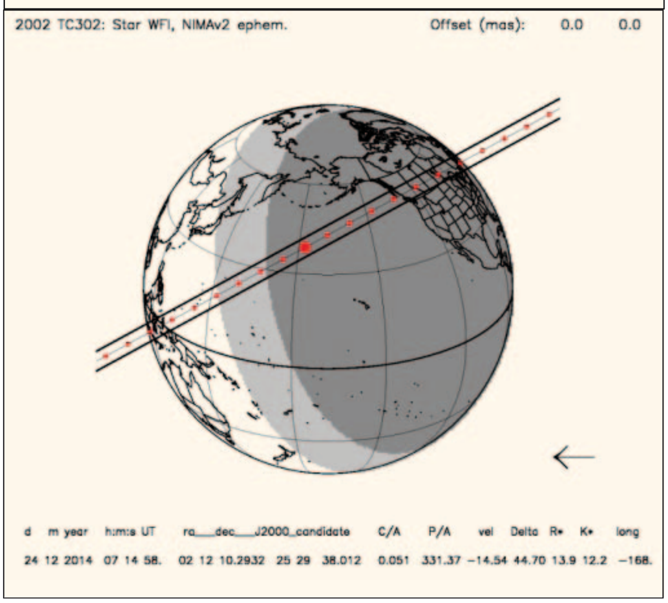
14 04 2014 08 11 10. 17 40 50.5446 –38 45 9.225 0.532 326.41 –7.56 14.29 12.3 8.5 –60.


2002 TC302: Star WFI, NIMAv2 ephem.
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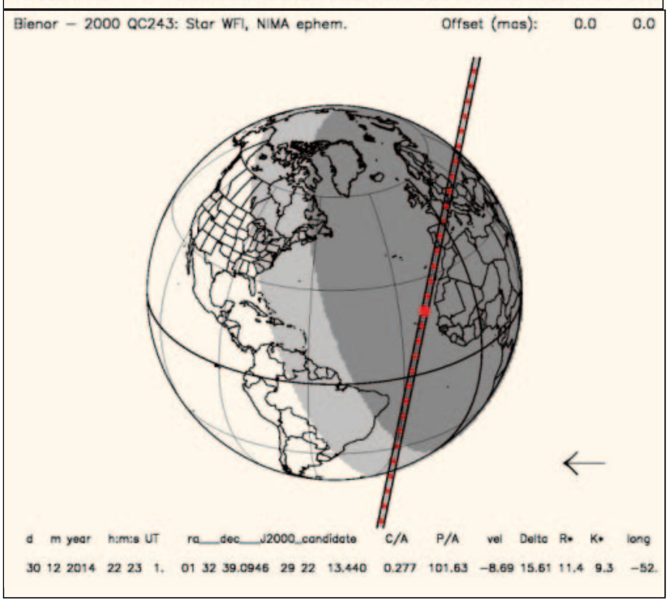
24 12 2014 07 14 58. 02 12 10.2932 25 29 38.012 0.051 331.37 –14.54 44.70 13.9 12.2 –168.


Bienor – 2000 QC243: Star WFI, NIMA ephem.
Offset (mas): 0.0 0.0
d m year h:m:s UT ra__dec__J2000_candidate C/A P/A vel Delta R• K• long
30 12 2014 22 23 1. 01 32 39.0946 29 22 13.440 0.277 101.63 –8.69 15.61 11.4 9.3 –52.

Journal for Occultation Astronomy

Mutual Events of the Jovian Satellitesin 2014/2015

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During a mutual eclipse or occultation one Jovian satellite eclipses or occults another. Depending on the geometry of the Jovian satellite orbits with respect to the Sun and to the Earth such events take place during a span of several months about every six years. That is twice during a Jupiter year.

The next series of mutual eclipses and occultations of Jupiter's satellites will occur during the 2014/2015 apparition of Jupiter.

Predictions for these events are calculated by the Institut de Mecanique Celeste et de Calcul des Ephemerides (IMCCE) which is linked to the Paris Observatory. The predictions can be found at [1]. A total of 534 events is predicted for the period from 2014 August 17 to 2015 August 22.

The series in 2014/2015 is especially favourable for northern hemisphere observers due to Jupiter's high positive declination of +19° to +11° during that period. Jupiter's opposition takes place on 2015 February 6.

A number of Technical Notes describing various aspects (presentation, observation, results, …) can be read and downloaded at [2].

An up to date article named 'Astrometry through photometry' by J.E. Arlot of the IMCCE can be found at [3]. It describes in detail the application of photometric observations to the astrometry of solar system bodies (especially minor planets and planetary satellites).

Observations by amateur and professional observers have been organised in the PHEMU campaigns by the IMCCE in the past. The analysis of the observations is done at the IMCCE too.

Observations of mutual events can be made at the highest precision with video or CCD devices. However, even careful visual observations may be of use. Independent from their scientific value, visual observations are especially exciting as they provide a live insight into the high dynamic in the distant world of Jupiter's satellite system.

There is a very powerful interactive tool at the IMCCE website [4]. It is named MULTI-SAT and enables the calculation of ephemerides for the natural satellites of the giant planets. Part of this is the search for eclipses by the parent planet and / or for mutual eclipses. The user can choose between various theories for the motion of the planets and their satellites (such as DE200, DE405, E-5, G-5, …). Furthermore, the data can be customized for a chosen place on the Earth. A detailed description of MULTI-SAT can be found in [5].

Mutual events of Jovian satellite can be recorded even with small instruments. An example of the eclipse of satellite J2 by satellite J3 is given in Fig. 1. The event was recorded with a 0.28m instrument and the Iota Occultation Camera (IOC) from Munich, Germany, and is published in [6].

References:

[1]: www.imcce.fr/hosted_sites/saimirror/nsszph515he.htm

[2]: www.imcce.fr/en/observateur/campagnes_obs/phemu15/

[3]: www.imcce.fr/en/observateur/campagnes_obs/phemu15/arlot-cours-astrometry-photometry-sat-v10-fp7.pdf

[4]: www.imcce.fr/hosted_sites/saimirror/nssephe.php

[5]: N. V. Emel'yanov and Arlot, J.-E.: 2008, Astronomy & Astrophysics, Vol. 487, 759-765

[6]: Arlot, J.-E. et. al.: 2006, Astronomy & Astrophysics, Vol. 451, 733-737

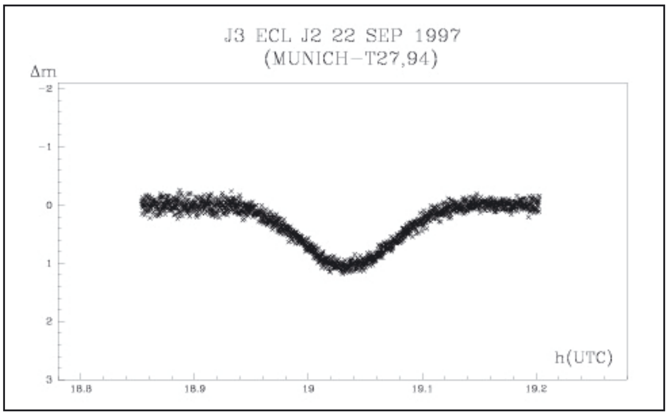

Fig. 1:

Jupiter satellite J3 eclipses J2 on 22nd of September 1997. Data recorded in Munich with a 0.28m Schmidt-Cassegrain telescope and the Iota Occultation Camera. Observer: W. Beisker, IOTA-ES

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Grazing Occultations 2014

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The following lists and maps show all bright star grazing occultation events down to a stellar magnitude of 6.0. A black line in the map indicates a graze at the dark lunar limb at night. Yellow lines are nighttime events on the bright lunar limb, whereas all daytime events are shown with a blue line.

Further precise information on the local circumstances of all grazing occultations is provided by the GRAZPREP-software which is offered on the member pages of the IOTA/ES site. The software assists in finding and listing individually favorable occultation events and in figuring out the best observing site in advance or even under way by graphically showing the expected apparent stellar path through the lunar limb terrain.

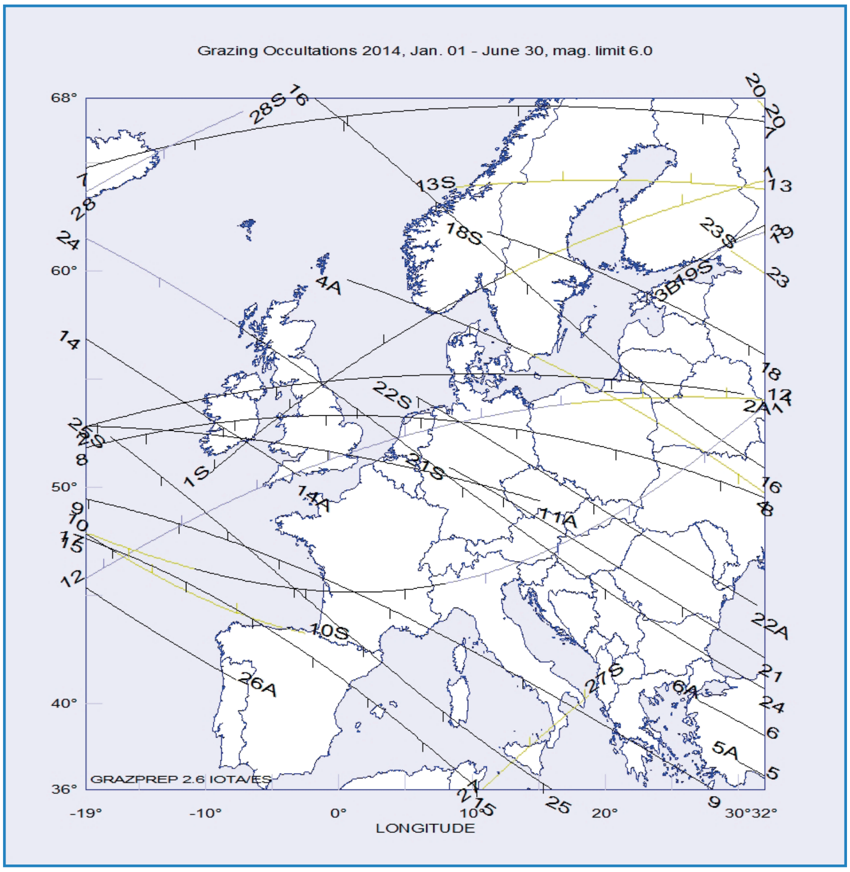
The main idea of the program is to easily visualize the complete list of all grazing occultation events in an area plus the complete line data for any selected event and (simultaneously on the same screen) both the geographic circumstances on earth and the enlarged topographic situation at the lunar limb including a fairly realistic display of the sunlit lunar portion as well as the approximate sky brightness due to the sun's altitude. Thus a judgment about the entire graze circumstances is easily possible at a few glances and a selection of the best events quick and easy. Any graze line for any selected favorable offset to the predicted limit can be displayed in Google Earth.

Besides that the software assists in creating one or several individual observing stations with any center and radius, that way filtering out the most suitable events according to a variety of personal preferences. Also an output similar to the former GRAZEREG-output was included.

The most recent feature is the 'navigation' to the location promising the most dis- and reappearances of the star or the desired apparent stellar path through the lunar limb terrain. This is possible with a USB-GPS-device being attached to a portable PC while approaching the observing area. The lunar limb situation is constantly shown saving much calculation time.

2014 — Grazing Occultations 2014, mag. limit 7.0 — GRAZPREP 2.6, IOTA/ES

No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG	LAT	STAR NAME	MAG1	MAG2
1	Jan 06	ZC 3508	128401 V	5.8	35+	S	16 59.7	-9	51	21 Psc	6.6	6.6
2	Jan 07	ZC 98	109461	6.0	46+	N	21 19.3	-19	53	60 Psc		
3	Jan 12	ZC 730	94164	5.1	90+	N	15 33.0	25	60	97 i V480 Tau	5.1	5.1
4	Jan 23	ZC 1886	139175 K	5.6	61-	N	0 38.8	0	60	439 B. g Vir	6.5	6.5
5	Jan 24	ZC 2117	158836 K	5.2	40-	S	23 47.7	30	37	8 alpha1 Lib	6.1	6.1
6	Jan 24	ZC 2118	158840 V	2.8	40-	S	23 55.1	27	40	9 alpha Lib (Zuben Elg.)	3.4	3.8
7	Feb 07	ZC 577	93650	6.0	60+	N	18 52.1	-19	65	148 B. Tau		
8	Feb 08	ZC 718	94112	6.0	69+	N	19 43.1	-19	52	302 B. Tau		
9	Feb 08	ZC 730	94164	5.1	70+	N	23 0.1	-19	49	97 i V480 Tau	5.1	5.1
10	Feb 23	ZC 2401	160052	5.5	44-	S	6 23.3	-19	48	131 B. (Sco)/Oph		
11	Mar 04	ZC 272	92659 X	5.9	15+	N	20 10.9	-19	53	54 (Cet)/Ari	6.7	6.7
12	Mar 07	ZC 648	93897 L	3.8	42+	S	15 27.8	-19	46	61 delta Tau (Hyadum II)	3.9	9.5
13	Mar 07	ZC 653	93907 X	4.8	42+	S	17 1.5	8	64	64 Tau	5.6	5.6
14	Mar 09	ZC 832	94628	4.3	54+	N	1 45.2	-19	57	119 CE Tau	4.3	4.5
15	Mar 12	ZC 1309	98069 V	5.6	87+	N	21 46.8	-19	48	45 A1 Cnc	6.4	6.4
16	Mar 13	ZC 1318	98117	5.9	87+	N	0 27.3	-2	68	50 A2 Cnc		
17	Mar 26	ZC 2969	163481 I	3.0	26-	N	4 58.9	-19	48	9 beta Cap (Dabih major)	3.5	4.8
18	Apr 06	ZC 1029	96015 V	5.2	44+	N	18 25.5	11	62	26 Gem	5.9	5.9
19	Apr 07	ZC 1106	96746 Y	3.6	52+	N	10 31.5	27	61	54 lambda Gem	4.0	5.0
20	Apr 08	ZC 1265	97819	5.6	64+	S	22 28.0	31	68	27 BP Cnc	5.6	5.8
21	May 02	ZC 832	94628	4.3	12+	N	18 46.2	8	51	119 CE Tau	4.3	4.5
22	May 02	ZC 836	94649	5.7	12+	N	19 20.2	6	54	120 Tau		
23	May 04	ZC 1096	96638M	5.0	28+	S	18 14.2	29	61	51 BQ Gem	5.7	5.8
24	May 04	ZC 1106	96746 Y	3.6	28+	N	20 3.0	-19	62	54 lambda Gem	4.0	5.0
25	May 06	ZC 1332	98235 K	5.4	47+	N	20 52.9	-17	52	60 Cnc	6.5	6.5
26	May 31	ZC 1073	96409	5.9	9+	S	21 25.3	-19	45	41 H1. Gem		
27	Jul 18	ZC 104	109471	5.7	60-	S	3 1.2	10	36	147 B. Psc		
28	Jul 22	ZC 648	93897 L	3.8	19-	N	5 44.2	-19	64	61 delta Tau (Hyadum II)	3.9	9.5
29	Aug 20	ZC 878	94858 K	5.5	24-	S	2 14.5	-19	56	130 Tau	5.6	9.0
30	Aug 22	ZC 1147	97016 V	5.3	10-	S	4 40.0	-19	40	68 Gem	5.4	7.0
31	Sep 11			5.7	94-	S	0 57.8	-19	52	Uranus		
32	Sep 16	ZC 836	94649	5.7	49-	N	3 16.2	26	36	120 Tau		
33	Sep 16	ZC 944	95419M	5.9	41-	N	21 29.6	30	52	124 H1. Ori	6.7	6.7
34	Sep 18	ZC 1096	96638M	5.0	30-	S	1 36.4	-19	55	51 BQ Gem	5.7	5.8
35	Sep 18	ZC 1106	96746 Y	3.6	30-	N	3 58.5	-19	60	54 lambda Gem	4.0	5.0
36	Sep 20	ZC 1332	98235 K	5.4	14-	S	4 26.6	-19	45	60 Cnc	6.5	6.5
37	Sep 20	ZC 1341	98267 Y	4.3	14-	N	5 55.5	-19	56	65 alpha Cnc (Acubens)	5.1	5.1
38	Oct 01	ZC 2680	161540 K	5.6	49+	N	17 36.7	2	52	95 B. Sgr	6.6	6.6
39	Oct 02	ZC 2826	162512 X	3.9	60+	S	13 42.8	20	38	44 rho1 Sgr	4.2	6.7
40	Oct 05	ZC 3285	146062 X	5.9	90+	S	17 47.0	30	36	170 B. Aqr	6.9	6.9
41	Oct 12	ZC 650	93900 J	5.6	83-	S	5 34.5	5	53	63 Tau	5.9	7.9
42	Oct 15	ZC 1073	96409	5.9	56-	S	4 16.2	-19	45	41 H1. Gem		
43	Oct 17	ZC 1309	98069 V	5.6	36-	N	5 45.2	-19	59	45 A1 Cnc	6.4	6.4
44	Oct 25			0.7	3+	S	17 2.6	4	36	Saturn		
45	Oct 29	ZC 2826	162512 X	3.9	35+	S	21 3.7	-19	50	44 rho1 Sgr	4.2	6.7
46	Nov 09	ZC 814	94554 T	5.4	90-	N	17 41.0	13	60	115 Tau	5.7	6.6
47	Nov 11	ZC 1106	96746 Y	3.6	75-	N	19 52.5	12	53	54 lambda Gem	4.0	5.0
48	Nov 12	ZC 1147	97016 V	5.3	73-	S	3 51.0	-19	40	68 Gem	5.4	7.0
49	Nov 13	ZC 1341	98267 Y	4.3	56-	N	21 6.0	23	55	65 alpha Cnc (Acubens)	5.1	5.1
50	Nov 14	ZC 1359	98378 L	5.2	54-	S	2 44.1	10	68	76 kappa Cnc	5.8	7.8
51	Dec 02	ZC 104	109471	5.7	77+	N	1 35.6	-19	57	147 B. Psc		
52	Dec 09	ZC 1106	96746 Y	3.6	93-	N	6 9.4	10	68	54 lambda Gem	4.0	5.0
53	Dec 14	ZC 1611	118668M	5.6	54-	S	0 57.2	-13	67	65 p4 Leo	5.6	9.7
54	Dec 27	ZC 3474	146780	5.9	39+	N	21 2.2	-19	60	14 Psc		
55	Dec 29	ZC 184	109753	6.0	61+	N	17 15.8	-11	46	88 Psc		


Grazing Occultations 2014, Jan. 01 - June 30, mag. limit 6.0
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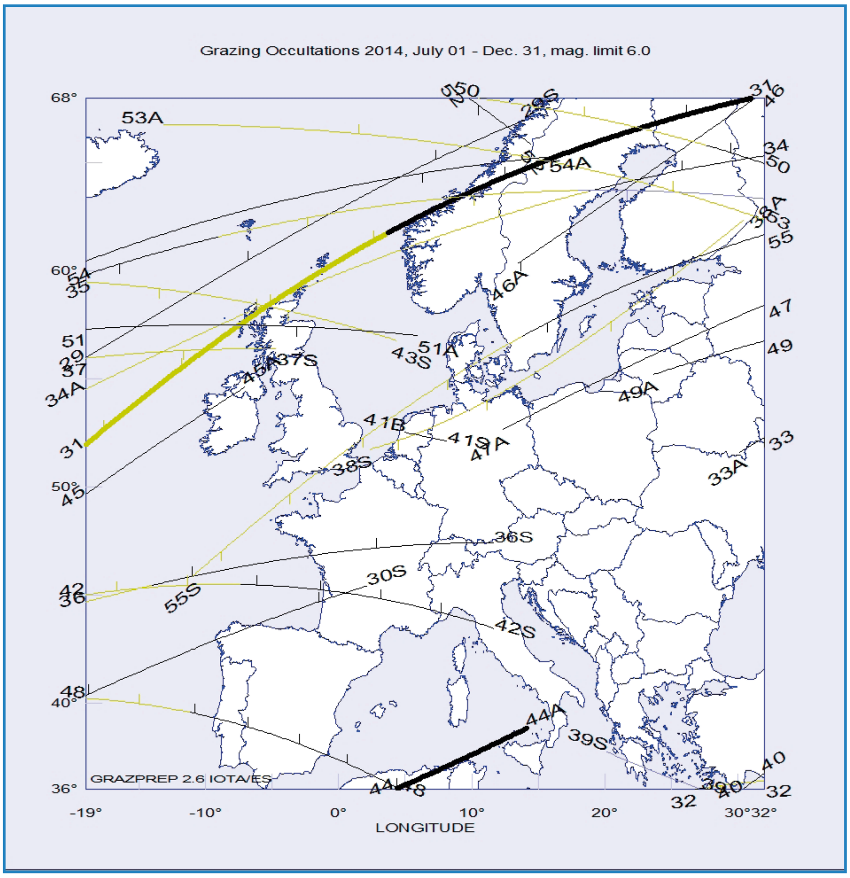
LONGITUDE
GRAZPREP 2.6 IOTA/ES


Grazing Occultations 2014, July 01 - Dec. 31, mag. limit 6.0
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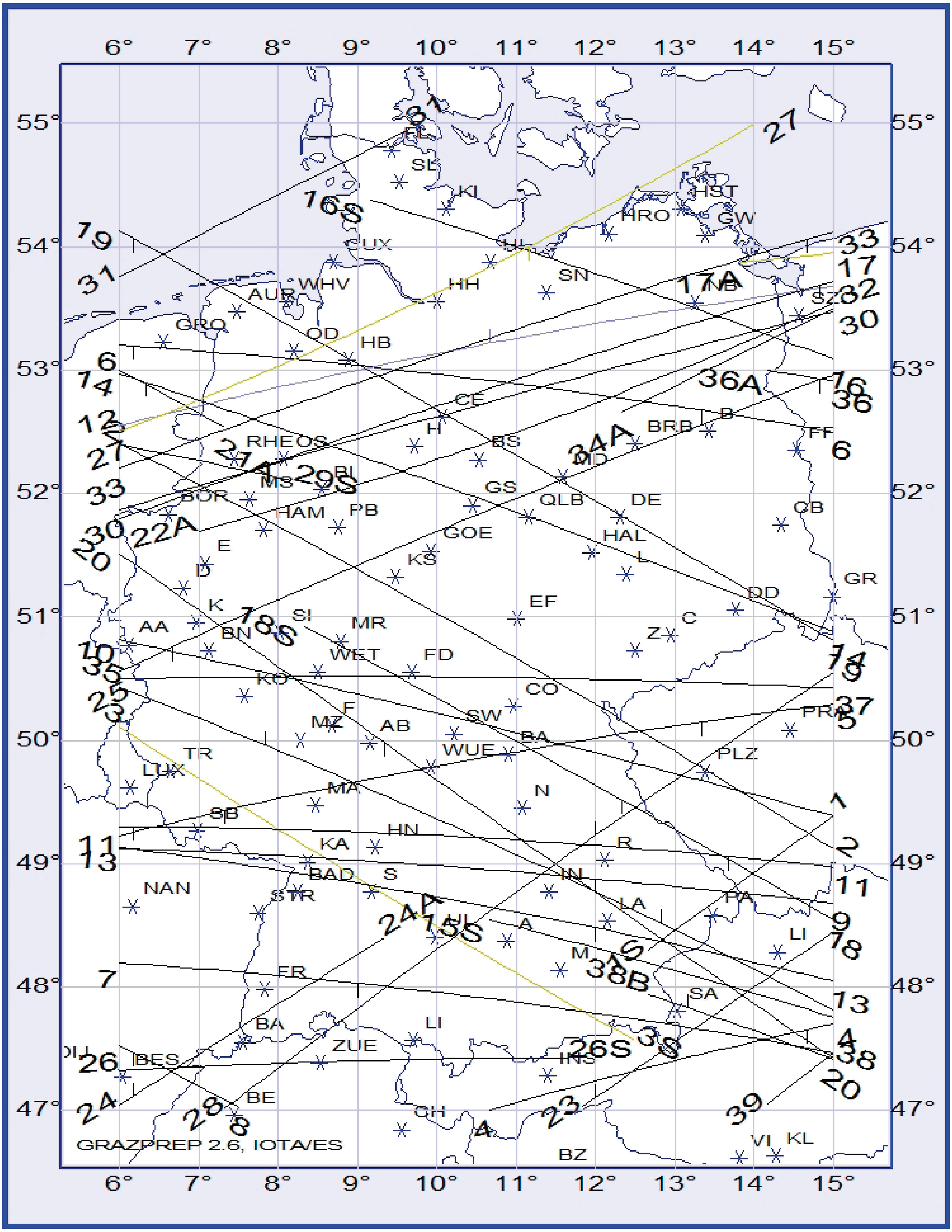
LONGITUDE
GRAZPREP 2.6 IOTA/ES

Europe

Grazing Occultations in Germany 2014

The following list and map show all grazing occultation events down to a stellar magnitude of 7.5. A black line in the map indicates a graze at the dark lunar limb at night. Yellow lines are nighttime events on the bright lunar limb.

2014			Grazing Occultations 2014, mag. limit 7.5							GRAZPREP 2.6, IOTA/ES	
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	CUSP-A T	STAR NAME	MAG1	MAG2
1	**Jan 04**	ZC 3216	145768	6.8	15+	S	15 43.6	1.5 D C			
2	**Jan 23**	ZC 1887	139183	6.3	61 -	S	1 22.3	0.9 T B			
3	**Jan 27**	ZC 2446	184922 C	7.4	18 -	S	6 16.4	1.4 B C			
4	**Feb 07**	X 4997	93630	7.5	60+	N	17 43.1	0.8 T B			
5	**Feb 08**	ZC 710	94078	7.1	69+	N	18 8.0	1.8 D B			
6	**Feb 08**	ZC 718	94112	6.0	69+	N	20 20.0	6.4 D A	302 B. Tau		
7	**Feb 08**	X 6119	94110	7.5	69+	N	20 15.4	6.3 D B			
8	**Feb 09**	ZC 862	94787	7.3	78+	N	23 30.7	12.4 D B			
9	**Mar 04**	ZC 264	92628	7.0	14+	N	18 36.4	5.2 D A	300 B. (Psc)/Ari		
10	**Mar 04**	ZC 272	92659 X	5.9	15+	N	20 22.1	7.3 D A	54 (Cet)/Ari	6.7	6.7
11	**Mar 06**	X 4565	93484 K	7.0	32+	N	18 10.3	3.6 D A		7.0	10.5
12	**Mar 07**	ZC 648	93897 L	3.8	42+	S	16 12.0	0.0 T A	61 delta Tau (Hyadum II)	3.9	9.5
13	**Mar 07**	ZC 663	93942 A	6.9	42+	N	19 1.7	5.4 D A		6.9	8.7
14	**Apr 02**	ZC 469	93350	7.2	10+	N	19 29.9	5.4 D A			
15	**Apr 03**	ZC 600	93749	6.6	17+	N	18 2.2	4.9 D B	173 B. Tau		
16	**Apr 05**	ZC 886	94920 X	6.8	35+	N	18 21.6	5.0 D B		7.7	7.7
17	**Apr 25**	ZC 3344	146315 D	7.3	19 -	N	2 46.6	1.1 B C	231 B. Aqr	7.3	7.6
18	**May 02**	ZC 832	94628	4.3	12+	N	18 46.2	3.1 D B	119 CE Tau	4.3	4.5
19	**May 02**	ZC 836	94649	5.7	12+	N	19 20.3	2.6 D B	120 Tau		
20	**May 04**	ZC 1106	96746 Y	3.6	28+	N	20 36.1	4.1 D A	54 lambda Gem	4.0	5.0
21	**May 05**	ZC 1237	97647	6.5	38+	N	23 26.4	1.4 D C			
22	**May 24**	ZC 40	109146	7.5	22 -	S	2 12.0	2.7 D C			
23	**Sep 04**	ZC 2755	162001	6.6	76+	S	21 50.9	9.4 D B			
24	**Sep 04**	ZC 2764	162050 X	6.4	76+	S	23 20.2	9.8 D C		7.1	7.1
25	**Sep 16**	ZC 829	94617	6.8	49 -	N	1 49.2	3.1 D A			
26	**Sep 20**	ZC 1332	98235 K	5.4	14 -	S	4 43.1	2.4 D A	60 Cnc	6.5	6.5
27	**Oct 01**	ZC 2680	161540 K	5.6	49+	N	17 42.5	3.0 B C	95 B. Sgr	6.6	6.6
28	**Oct 05**	ZC 3308	146135	6.2	91+	S	21 53.3	7.4 D B	186 B. Aqr		
29	**Oct 12**	ZC 650	93900 J	5.6	83 -	S	5 35.7	2.1 D A	63 Tau	5.9	7.9
30	**Oct 17**	ZC 1281	97913 X	6.3	37 -	N	0 26.7	4.1 D B	84 B. Cnc	7.2	7.2
31	**Nov 01**	X 30466	145938 M	7.2	69+	S	21 44.6	3.4 D C		7.3	10.2
32	**Nov 10**	ZC 1003	95795 Y	6.3	82 -	N	22 41.3	8.4 D B	21 Gem	8.0	8.0
33	**Nov 10**	ZC 1002	95794 S	6.9	82 -	N	22 41.5	8.3 D B	20 Gem		
34	**Nov 11**	ZC 1106	96746 Y	3.6	75 -	N	19 52.5	8.2 D B	54 lambda Gem	4.0	5.0
35	**Nov 12**	ZC 1145	97012	6.6	73 -	S	4 36.6	1.8 D A	67 Gem		
36	**Nov 18**	X 18172	138647 C	7.4	18 -	N	2 27.6	1.3 D C			
37	**Dec 12**	X 15514	118241 T	7.4	63 -	N	23 35.5	5.2 D C		8.0	8.4
38	**Dec 13**	ZC 1519	118271 C	6.5	63 -	S	1 49.3	0.0 T A	155 B. (Leo)/Sex	6.5	9.0
39	**Dec 30**	X 2889	110328 M	7.0	71+	S	15 41.5	1.0 T B		7.4	8.4


6° 7° 8° 9° 10° 11° 12° 13° 14° 15°
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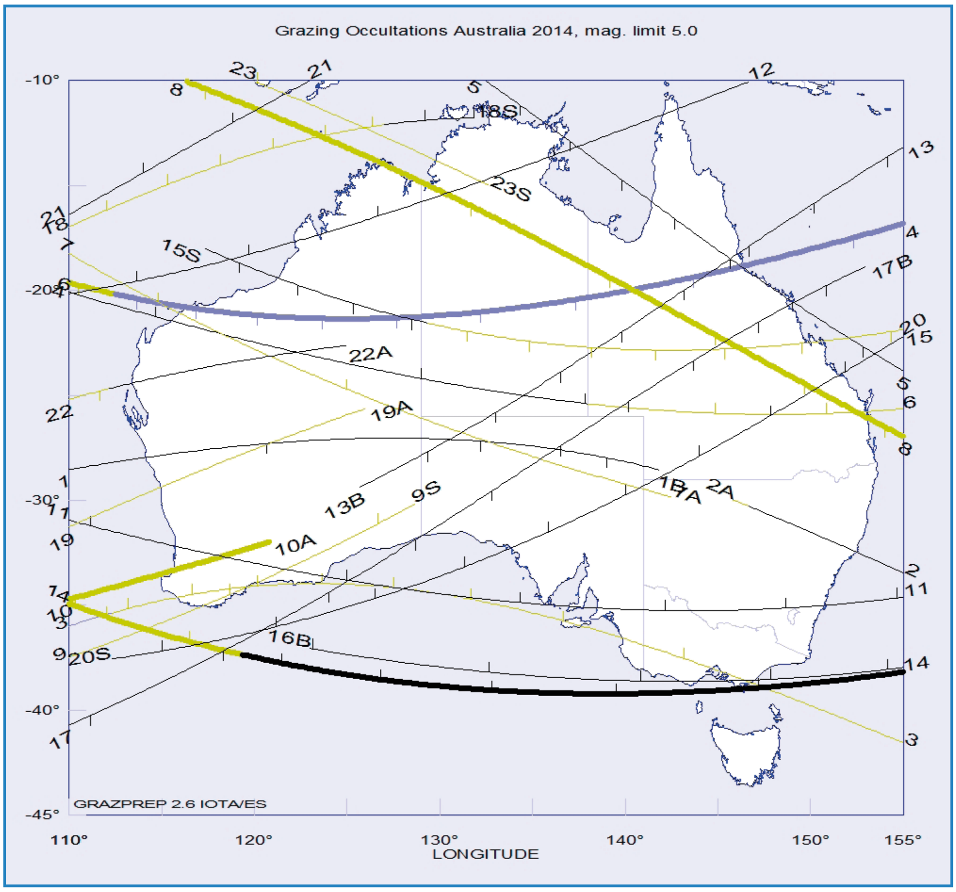
GRAZPREP 2.6, IOTA/ES

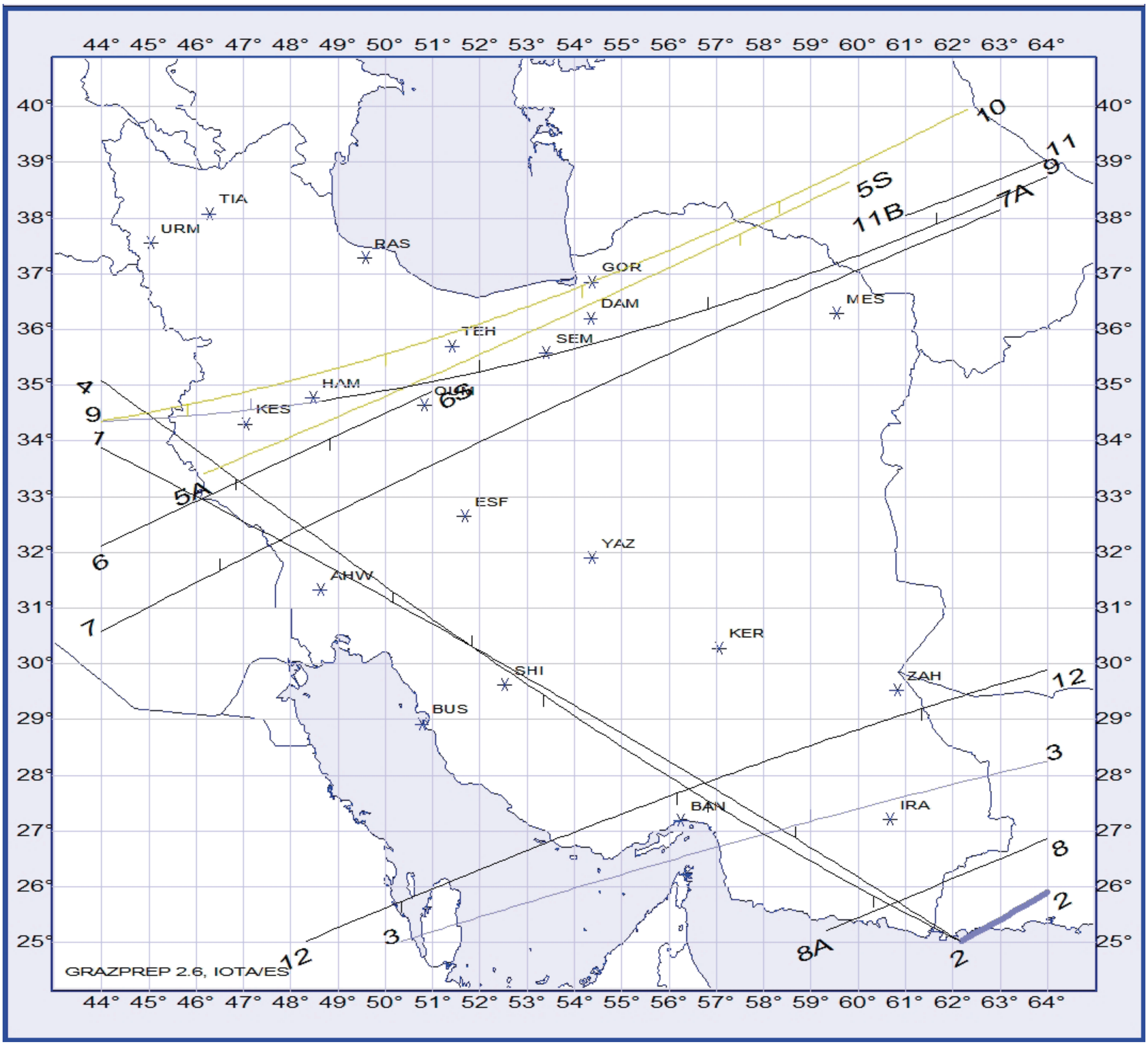
Australia

No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
2014									Grazing Occultations Australia 2014, mag. limit 5.0		GRAZPREP 2.6, IOTA/ES
1	Jan 18	ZC 1428	98709W	3.5	95 -	N	13 6.8	110 -29	14 omicron Leo (Subra)	4.4	4.6
2	Jan 26	ZC 2361	159918	4.2	24 -	S	15 51.4	146 -30	7 chi Oph	4.2	5.0
3	Feb 08	ZC 668	93954	3.5	67+	S	11 21.4	110 -36	74 epsilon Tau (Ain)		
4	Feb 21			0.7	58 -	N	22 18.4	110 -20	Saturn		
5	Mar 14	ZC 1468	118044	4.7	96+	N	13 13.6	132 -10	29 pi Leo (Yu Neu)		
6	Mar 25	ZC 2913	163141	5.0	30 -	S	18 48.3	110 -20	61 g Sgr		
7	Apr 09	ZC 1341	98267 Y	4.3	71+	S	15 12.6	110 -18	65 alpha Cnc (Acubens)	5.1	5.1
8	May 14			0.3	100+	N	10 29.7	116 -10	Saturn		
9	May 24	ZC 146	109627 K	4.3	15 -	S	21 53.2	110 -37	71 epsilon Psc	5.2	5.2
10	Jun 10			0.4	93+	N	20 9.9	110 -35	Saturn		
11	Jun 15	ZC 2913	163141	5.0	91 -	S	13 49.5	110 -31	61 g Sgr		
12	Jul 09	ZC 2361	159918	4.2	89+	S	16 13.1	110 -20	7 chi Oph	4.2	5.0
13	Jul 15	ZC 3320	146210 T	5.0	84 -	N	17 40.7	125 -29	63 kappa Aqr (Situla)	6.1	6.1
14	Aug 04			0.7	55+	S	10 35.7	110 -35	Saturn		
15	Aug 05	ZC 2271	159563 X	4.1	66+	N	9 54.6	117 -18	46 theta Lib	5.1	5.1
16	Aug 09	ZC 2913	163141	5.0	97+	S	10 30.4	123 -37	61 g Sgr		
17	Aug 14	ZC 146	109627 K	4.3	78 -	N	17 28.8	110 -41	71 epsilon Psc	5.2	5.2
18	Sep 14	ZC 658	93923 T	4.3	62 -	S	19 54.6	110 -17	68 V776 Tau	4.3	8.4
19	Oct 02	ZC 2827	162518 V	4.5	60+	N	16 22.4	110 -31	46 ypsilon Sgr	4.8	5.8
20	Oct 04	ZC 3093	164182	4.5	80+	S	10 36.2	112 -38	13 nu Aqr		
21	Oct 30	ZC 2913	163141	5.0	44+	S	12 20.9	110 -16	61 g Sgr		
22	Nov 29	ZC 3320	146210 T	5.0	53+	N	15 28.8	110 -25	63 kappa Aqr (Situla)	6.1	6.1
23	Dec 19	ZC 2271	159563 X	4.1	6 -	S	20 30.1	120 -10	46 theta Lib	5.1	5.1



Iran

2014	Grazing Occultations Iran 2014, mag. limit 5.0										GRAZPREP 2.6, IOTA/ES
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	CUSP-A T	STAR NAME	MAG1	MAG2
1	Jan 25	ZC 2118	158840 V	2.8	40 -	S	0 2.3	4.1 D A	9 alpha Lib (Zuben Elg.)	3.4	3.8
2	Feb 26			-4.3	13 -	N	5 50.8	14.6 D A	Venus		
3	Apr 07	ZC 1106	96746 Y	3.6	52+	S	9 51.7	5.7 D C	54 lambda Gem	4.0	5.0
4	Jun 06	ZC 1685	138298 K	4.3	59+	N	16 31.6	7.0 D A	91 ypsilon Leo	4.5	9.0
5	Jun 25	ZC 658	93923 T	4.3	5 -	N	0 35.8	5.8 B C	68 V776 Tau	4.3	8.4
6	Jul 23	ZC 764	94332 O	4.9	13 -	N	1 34.3	0.5 T A	104 m Tau	5.6	5.6
7	Aug 08	ZC 2826	162512 X	3.9	95+	S	22 38.0	17.7 D A	44 rho1 Sgr	4.2	6.7
8	Sep 14	ZC 653	93907 X	4.8	62 -	N	18 36.4	4.3 D C	64 Tau	5.6	5.6
9	Oct 02	ZC 2826	162512 X	3.9	60+	S	14 14.1	1.3 D B	44 rho1 Sgr	4.2	6.7
10	Oct 03	ZC 2969	163481 I	3.0	71+	N	14 46.1	2.6 B A	9 beta Cap (Dabih major)	3.5	4.8
11	Oct 05	ZC 3269	145991	4.2	89+	S	14 42.1	4.0 D A	43 theta Aqr (Ancha)		
12	Nov 09	ZC 832	94628	4.3	90 -	N	19 26.9	12.7 D A	119 CE Tau	4.3	4.5



2014	Grazing Occultations USA 2014, mag. limit 5.0									GRAZPREP 2.6, IOTA/ES	
No.	M D	USNO	SAOPPM D	MAG	%SNL	L.	W.UT	LONG LAT	STAR NAME	MAG1	MAG2
1	Jan 03	ZC 2969	163481 I	3.0	4+	N	0 48.3	-125 49	9 beta Cap (Dabih major)	3.5	4.8
2	Jan 08	ZC 146	109627 K	4.3	50+	S	4 38.1	-125 25	71 epsilon Psc	5.2	5.2
3	Jan 26	ZC 2322	159764 Y	4.1	27 -	S	10 22.0	-96 51	14 nu Sco (Jabbah)	4.9	6.9
4	Jan 29	ZC 2826	162512 X	3.9	3 -	N	11 38.7	-72 53	44 rho1 Sgr	4.2	6.7
5	Feb 21	ZC 2118	158840 V	2.8	66 -	S	6 38.3	-72 55	9 alpha Lib (Zuben Elg.)	3.4	3.8
6	Mar 09	ZC 832	94628	4.3	54+	S	0 37.3	-99 33	119 CE Tau	4.3	4.5
7	Mar 11	ZC 1106	96746 Y	3.6	73+	S	3 24.8	-125 38	54 lambda Gem	4.0	5.0
8	Mar 13	ZC 1341	98267 Y	4.3	89+	N	5 42.9	-125 35	65 alpha Cnc (Acubens)	5.1	5.1
9	Mar 20	ZC 2118	158840 V	2.8	86 -	S	13 9.7	-125 54	9 alpha Lib (Zuben Elg.)	3.4	3.8
10	Mar 22	ZC 2361	159918	4.2	70 -	N	4 29.7	-77 26	7 chi Oph	4.2	5.0
11	Apr 04	ZC 648	93897 L	3.8	20+	S	1 58.5	-125 44	61 delta Tau (Hyadum II)	3.9	9.5
12	Apr 04	ZC 653	93907 X	4.8	20+	S	2 38.3	-120 52	64 Tau	5.6	5.6
13	Apr 04	ZC 658	93923 T	4.3	20+	N	3 23.0	-118 55	68 V776 Tau	4.3	8.4
14	Apr 21	ZC 2826	162512 X	3.9	61 -	S	9 48.0	-125 32	44 rho1 Sgr	4.2	6.7
15	Apr 22	ZC 2969	163481 I	3.0	49 -	N	10 59.9	-125 54	9 beta Cap (Dabih major)	3.5	4.8
16	May 30	ZC 832	94628	4.3	2+	N	2 58.0	-109 47	119 CE Tau	4.3	4.5
17	Jun 01	ZC 1106	96746 Y	3.6	11+	N	4 26.4	-109 55	54 lambda Gem	4.0	5.0
18	Jun 26			2.4	1 -	N	10 35.0	-88 34	Mercury		
19	Jul 04	ZC 1685	138298 K	4.3	35+	N	0 31.8	-68 48	91 ypsilon Leo	4.5	9.0
20	Jul 06			0.3	55+	N	0 10.5	-125 35	Mars		
21	Aug 06	ZC 2361	159918	4.2	70+	N	0 13.6	-81 30	7 chi Oph	4.2	5.0
22	Aug 18	ZC 648	93897 L	3.8	41 -	N	11 13.4	-125 42	61 delta Tau (Hyadum II)	3.9	9.5
23	Aug 18	ZC 653	93907 X	4.8	41 -	S	12 8.3	-100 25	64 Tau	5.6	5.6
24	Aug 18	ZC 658	93923 T	4.3	40 -	N	12 33.0	-124 25	68 V776 Tau	4.3	8.4
25	Aug 31			0.8	32+	N	17 43.1	-88 48	Saturn		
26	Sep 05	ZC 2826	162512 X	3.9	80+	S	8 12.8	-125 43	44 rho1 Sgr	4.2	6.7
27	Sep 21	ZC 1468	118044	4.7	7 -	N	13 12.8	-125 28	29 pi Leo (Yu Neu)		
28	Oct 12	ZC 653	93907 X	4.8	83 -	N	3 43.3	-91 25	64 Tau	5.6	5.6
29	Oct 13	ZC 832	94628	4.3	73 -	N	10 40.4	-125 27	119 CE Tau	4.3	4.5
30	Oct 15	ZC 1106	96746 Y	3.6	54 -	N	12 39.4	-85 55	54 lambda Gem	4.0	5.0
31	Oct 17	ZC 1341	98267 Y	4.3	34 -	N	13 30.4	-125 52	65 alpha Cnc (Acubens)	5.1	5.1
32	Oct 30	ZC 2969	163481 I	3.0	47+	N	20 8.8	-96 34	9 beta Cap (Dabih major)	3.5	4.8
33	Nov 01	ZC 3269	145991	4.2	70+	S	22 4.6	-76 37	43 theta Aqr (Ancha)		
34	Nov 26	ZC 2826	162512 X	3.9	15+	S	3 4.0	-125 41	44 rho1 Sgr	4.2	6.7
35	Nov 27	ZC 2969	163481 I	3.0	25+	N	3 51.4	-125 43	9 beta Cap (Dabih major)	3.5	4.8
36	Nov 29	ZC 3269	145991	4.2	47+	S	5 7.8	-125 51	43 theta Aqr (Ancha)		
37	Dec 30	ZC 257	110110	4.3	67+	S	9 0.8	-125 33	110 omicr.Psc (Torcular)		

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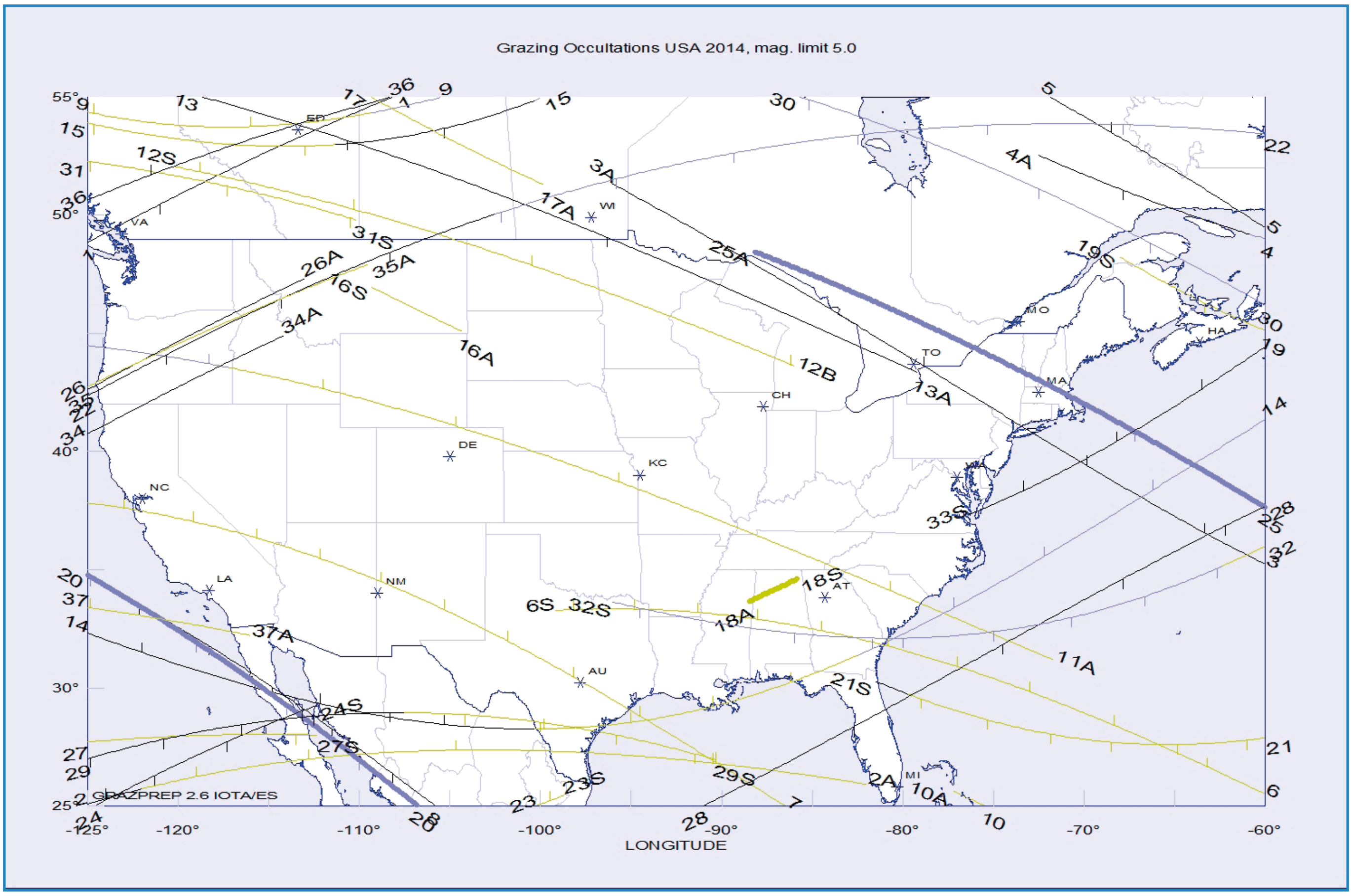
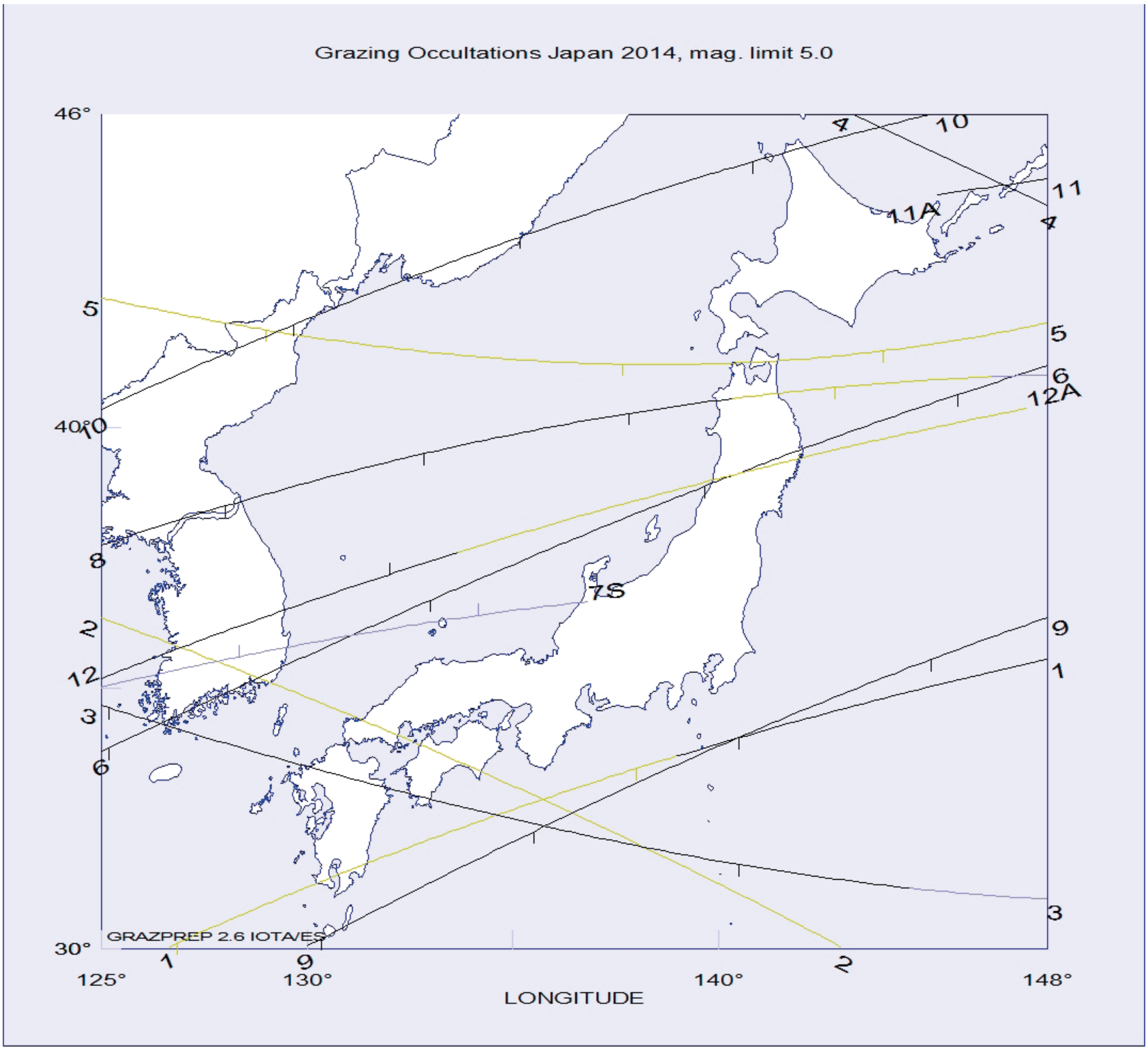
USA



Japan

2014	Grazing Occultations Japan 2014, mag. limit 5.0								GRAZPREP 2.6, IOTA/ES		
No.	**M D**	**USNO**	**SAOPPM D**	**MAG**	**%SNL**	**L.**	**W.UT**	**LONG LAT**	**STAR NAME**	**MAG1**	**MAG2**
1	**Jan 05**	ZC 3320	146210 T	5.0	22+	N	10 10.1	126 30	63 kappa Aqr (Situla)	6.1	6.1
2	**Feb 20**	ZC 2053	158489 U	4.5	71 -	N	15 11.8	125 36	100 lambda Vir	4.9	6.3
3	**Feb 26**	ZC 2969	163481 I	3.0	9 -	N	20 40.6	125 35	9 beta Cap (Dabih major)	3.5	4.8
4	**Mar 08**	ZC 764	94332 O	4.9	51+	N	14 24.5	143 46	104 m Tau	5.6	5.6
5	**May 19**	ZC 2969	163481 I	3.0	71 -	N	16 17.0	125 42	9 beta Cap (Dabih major)	3.5	4.8
6	**Aug 19**	ZC 832	94628	4.3	28 -	N	18 50.0	125 34	119 CE Tau	4.3	4.5
7	**Aug 21**	ZC 1106	96746 Y	3.6	12 -	S	21 14.9	125 35	54 lambda Gem	4.0	5.0
8	**Sep 14**	ZC 648	93897 L	3.8	62 -	N	19 13.7	125 38	61 delta Tau (Hyadum II)	3.9	9.5
9	**Nov 08**	ZC 648	93897 L	3.8	96 -	N	13 29.6	130 30	61 delta Tau (Hyadum II)	3.9	9.5
10	**Nov 08**	ZC 653	93907 X	4.8	96 -	N	14 12.0	125 40	64 Tau	5.6	5.6
11	**Dec 12**	ZC 1468	118044	4.7	68 -	N	12 43.9	145 44	29 pi Leo (Yu Neu)		
12	**Dec 26**	ZC 3269	145991	4.2	25+	S	11 15.0	125 35	43 theta Aqr (Ancha)		



Journal for Occultation Astronomy

The occultation of Arcturus in the Vatican

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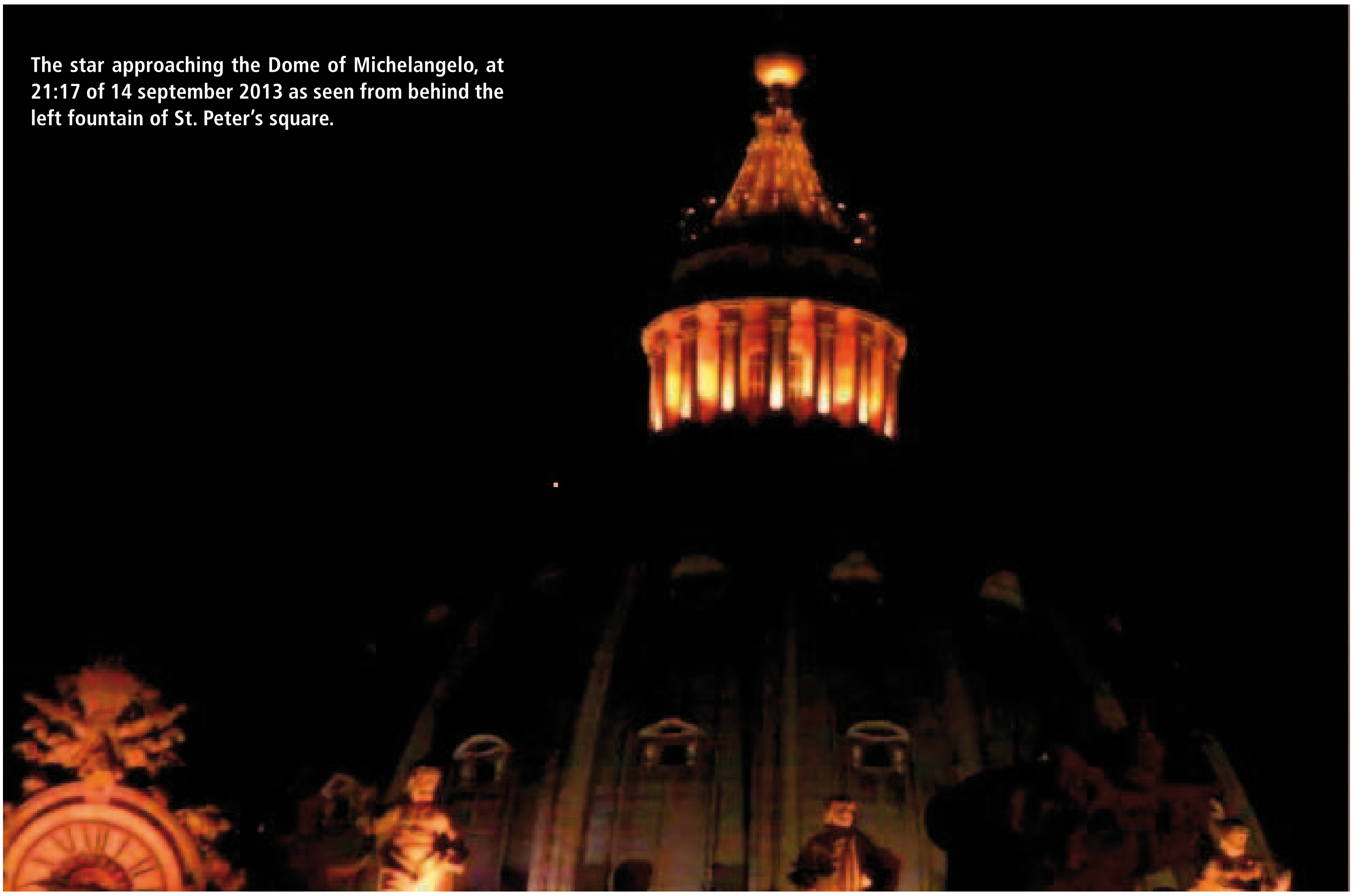

The star approaching the Dome of Michelangelo, at 21:17 of 14 september 2013 as seen from behind the left fountain of St. Peter's square.

Abstract

The dome of Saint Peter's Basilica plays the role of the Moon during a stellar occultation and Arcturus is the target star. This occultation-like phenomenon is useful for introducing to occultation astronomy a class of student up to university level. It can be organized very easily at the convenience of the audience.

Techical and didactical aspects are discussed; the video is available at http://www.youtube.com/watch?v=hIfsj7t-u-c and has been realized with an ordinary camcorder.

Introduction

Arcturus is not in the Zodiacal Catalogue and a lunar occultation is impossible.

The possibility of a TNO or asteroidal occultation is remote, but the observation of an occultation with a special landmark can be easily organized for presenting to an astronomy class the concept of stellar occultations.

The observation of the occultation of Arcturus recorded with an ordinary camcorder in Saint Peter's Square in the Vatican is here presented for its multiple didactical issues.

The large diffusion of mobile telephone camera allows nowadays to permit this kind of experience to all students, being the limit only in their will of learning more and more about astronomy and astronomical observations.

Scintillation and electronic noise

The use of a small camera in the observations of stars, when the video option is used, implies to know the scintillation effects in more detail.

With objective lenses of 2 cm this phenomenon is rather big, as shown e.g. in the occasion of the Venus occultation of 1 december 2008. [1]

The scintillation effect can be considered as the effect of the variation of the number of photons arriving at the objective. Their average value for unit time is N, the Poisson statistics implies a variation of +/-√(N) during the same unit time interval.

If N is relatively small this variation is percentually significant.

The electronic noise also produces a similar effect,[2] and the combination of the two is the actual appearance of the star in the different frames of the video.

According to calculation for a zero magnitude star like Arcturus and a 2 cm diameter objective, [see e.g. Ref. 3] as the one of the SANYO CG9 camcorder, the Poissonian variations of detected luminosity of this star are much less important than the ones observed.

So we can deduce that the main responsible is the elecronic noise.

Parallax effect

The Moon, for the effect that it produces for the stellar occultation, can be considered at infinite distance with respect to our amateur telescopes diameters.

The occultation is nearly instantaneous, excepted for the stellar diameter effect.

The idea of this measurement came on the evening of prevoius 7 of september while I was participating to the universal prayer for peace convocated by pope Francis in the St. Peter square, because from my position that occultation was visible.

When the occultation occurs with a finite distance target the parallax effect can be calculated from the angle formed by the objective at the distance with the target.

The procedure is described in the case of a similar Venus occultation at the Locarno Film Festival inauguration on http://www.astroticino.ch/fileadmin/groups/astroticino/documenti/Meridiana209bassa.pdf. [4]

With a 2 cm camera, at about 400 m from the dome of St. Peter's Basilica we have a parallax effect of 1/20000 radians or 10 arsec, which correspond to 0.7 s of disappearance time of the star from the detector.

In this time interval, progressively, the light of the star decreases, while it goes behind the dome as seen from the various point of the objective lens.

We can easily imagine the profile of the dome moving in the opposite direction of the star, which determines the instant of disparition on each point of the lens.

This effect produces a progressive diminution of the star light, combined with the electronic noise and scintillation, and this diminution starts 0.7 s before the complete occultation.

As an example, for a 40 m telescope as the forthcoming ELT, we would expect an effect proportional to 40/400*10^6 which is about 10^(-7) radians or 0.02 arcsec, which in the case of a lunar occultation it would last 0.04s = 1/25 s.

Stellar diameter effect

In the case of Arcturus the angular diameter is 0.02 arcsec,[5] i.e. a duration of the disparition of the stellar light of 0.02/15 s or 1.3 ms, well below the 1/30 s of maximum duration of a single frame, which is the video sampling time.

In the case of the Moon the relative velocity with the stars is about 0.5 arcsec/s, while in the case of landmarks the speed is the one of the daily motion: 15 arcsec/s.

So 0.02 arcsec would be covered in 0.04 s, i.e. 1/25 s, and visibile with an ordinary commercial camcorder.

The SANYO CG9 camera used for the video gets up to 1/60s of frame rate. Another model gets 1/300 s enough to appreciate this effect, there are other camera like CASIO Exilim capable of 1/1200 s on limitate period of time (10 s) and the possibility to film a stellar diameter becomes interesting.

Using photomultipliers the acquisition time is much faster, and this is the traditional way used for measuring stellar diameters.

Video analysis

It is possible to apply the same softwares of video analysis used in occultation astronomy to verify the parallactic effect.[1].

For a rapid analysis we can use simply Quicktime 7 which allows to inspect the single photogram.

In this case the last 10 photograms before the disparition are show the parallactic effect at 30fps it corresponds to 0.33 s, half of the expected value.

Conclusions

The didactic interest of this experiment is in the possibility to adapt it to other landmarks and other celestial objects, namely bright stars and planets, where their diameter's effect is much bigger, and its deconvolution from the parallactic effect becomes an interesting application of signal theory.

The observation can be easily organized at convenience of the audience.

This kind of angular measurement of planets is also very much stimulating for introducing students in positional astronomy and astrometry issues.

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Journal for
Occultation Astronomy

Recruiting and Deploying a High-Density Public Observing Network

for the 2014 Occultation of Regulus by (163) Erigone

Ted Blank · International Occultation Timing Association

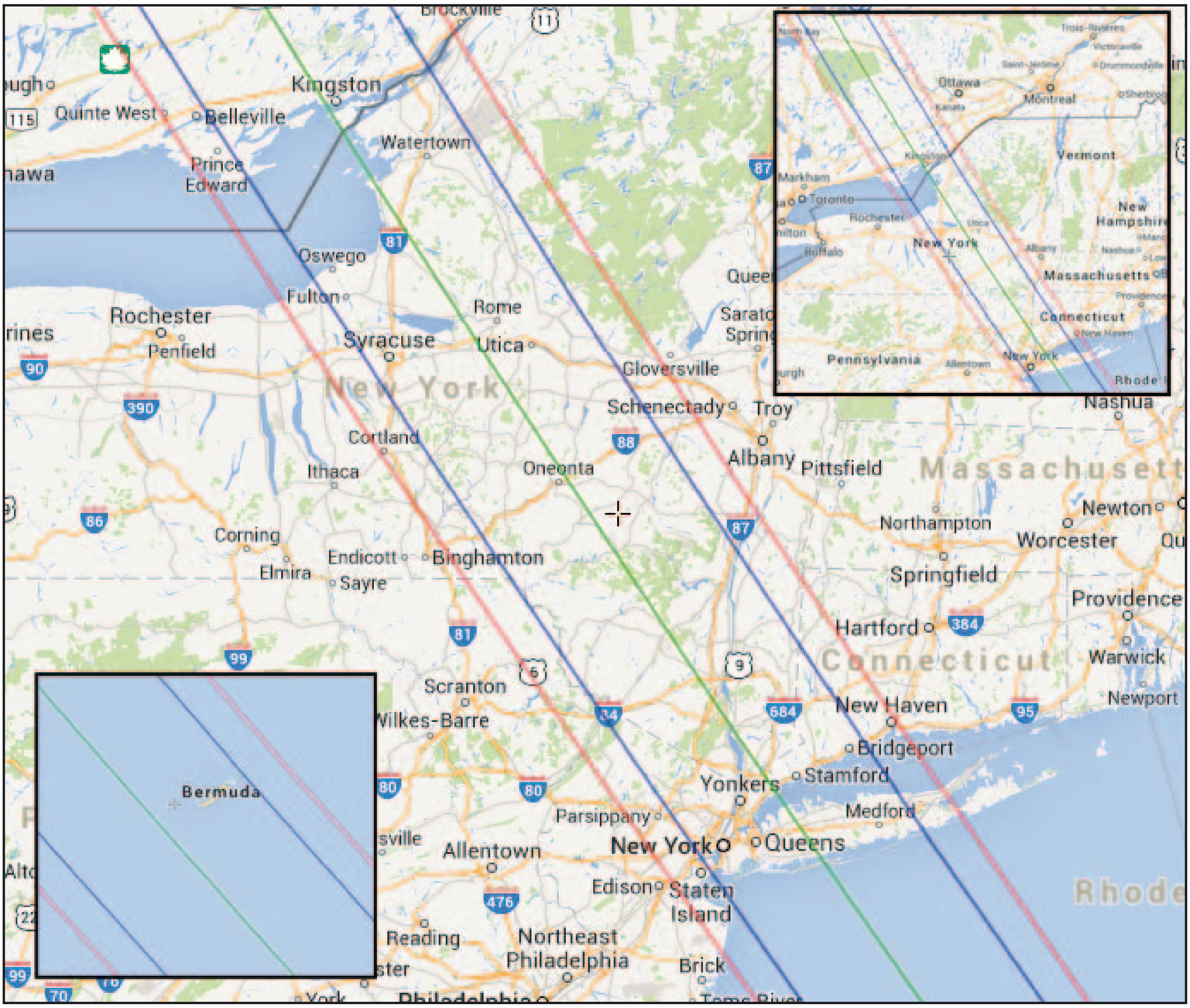

Figure 1. The predicted shadow path for the Regulus-Erigone occultation. Predicted center line in green, path edges (for a path exactly following the center line) in blue, 1-Sigma uncertainty limits for path edges in red. Prediction as of 26 Jan 2014. For the most up-to-date path predictions see http://www.poyntsource.com/New/Google/20140320_32317.htm .

Abstract

When the asteroid (163) Erigone passes in front of the first magnitude star Regulus on March 20, 2014 the shadow of the asteroid will pass over one of the most densely populated areas of the United States and Canada as well as parts of Bermuda. As the number of observers of an asteroid occultation increases, several things happen: The network of observing locations becomes more dense; the spacing of the "picket fence" of observers decreases; the chance of obtaining positive occultation timings improves; and likelihood of having "miss" observations close to positive observations increases. This event will be visible for up to 14 seconds to millions of people without optical aid, and if properly recruited and trained they have the potential to form the densest network of observers of any asteroid occultation in history. Challenges include: informing the public of

LAST MINUTE PATH UPDATE

I recently posted an updated path prediction for the March 20, 2014 occultation of Regulus by (163) Erigone. This new path has shifted about 0.15 pathwidths to the Southwest (less than one sigma). I am not surprised to see this much change in the orbit fit because there was a lack of astrometry between Dec 2012 and the end of 2013. Now that we are gaining some good current astrometry for Erigone the orbit should be more stable and I expect only small changes with future updates

Unfortunately… this most recent path prediction decreases the chances of seeing the event from Bermuda. Bermuda is still inside the predicted path. But a shift of about 1.5 sigma to the south could push the path beyond the southern edge of Bermuda.

Steve Preston

the event, explaining its background, providing training so inexperienced observers can obtain useful timing data with the best resolution possible, disseminating real-time weather updates in the days leading up to the event, and managing the collection of large numbers of observations at greatly varying levels of accuracy.

The asteroid (163) Erigone will occult Regulus (alpha Leonis, V=1.35) on 2014 Mar 20, along a path crossing Bermuda, NY, CT, NJ, ON, and QC (Figure 1). Sigismondi has described three important attributes of this occultation, namely: the rarity and beauty of the phenomenon, the importance of absolute timing of the event, and the utility of relative timing of the event. The International Occultation Timing Association (IOTA) is making a major effort to deploy the largest number of experienced observers possible to capture high-resolution GPS-linked video timings of the event through portable telescopes, with coverage organized by means of the standard OccultWatcher software network. However the number of observers with this level of experience and equipment numbers is only in the hundreds worldwide. The fact that this event will be visible without optical aid to a potential audience of millions means that a dense network of observers may be engaged simply by inviting the general public to observe from wherever they are. Any resultant gaps in coverage will be minimized by the sheer number of participants.

For outreach and education of the public at large, IOTA is adopting a philosophy of explaining the increasing scientific value of more accurate timings but then letting each member of the public choose the level of sophistication, accuracy and observing equipment with which they are comfortable. All are encouraged to attempt to time the event but it is also important for everyone who observes a miss to report that fact as well, since a miss observation close to a positive greatly improves the knowledge of the shape of the asteroid. Making it easy to report a miss is a high priority for this event, since there will rarely be this many people who can report where they were standing when they did not see the star disappear near the predicted time.

It is an unfortunate fact that familiarity with the night sky and astronomical activity in general has become rare among the general public. IOTA has developed a comprehensive set of answers to Frequently Asked Questions on one of their websites to convey basic as well as advanced information to those who wish to participate. This information also forms a core of communication with the mainstream media. It includes general information about asteroids and occultations, the expected shadow path for this event, how to find the right star, suggestions for how to time and observe the event with various types of equipment, how and where to report results of observations, etc. A recent 3-page article was also published in Sky & Telescope which explains the event, invites people to observe and points them to the FAQ web page for more information.

Since the observer does need to be looking at the proper star, a series of webpages and maps is being developed to assist even those completely unfamiliar with the night sky to successfully find Regulus. Astronomy clubs all along the path have also been contacted and are planning to assist in outreach efforts for the public.

In this day and age it is possible that the number of "smart phones" in the shadow path may actually exceed the number of observers. Unfortunately the video sensitivity of the camera in the typical smartphone is insufficient to record even as bright a star as Regulus. So members of the public who participate are being encouraged to time the event in any of several ways. For relative timings the traditional stopwatch (or stopwatch apps) are acceptable. An iPhone app called Emerald Timestamp (and a similar app called TimeTheSat for Android phones) use Network Time Protocal (NTP) to maintain an internal time close to UTC, usually within +/- 0.1 second, and can record these timestamps for later submission. (TimeTheSat will also report the location of the user). DDQ, a company in the Netherlands specializing in scientific applications, has developed an app for the iPhone which allows the user to tap the screen to record the time when they see the star disappear and tap it again when they see it reappear. (However, these times are not synchronized to GPS time). The user can then tap a "Submit" button and the D and R timings as well as their GPS-derived location will be transmitted automatically to a server for collection. One very useful feature of the DDQ app is that it has a "Report a Miss" button, allowing users to report a miss immediately from the field. This should greatly increase the density of good quality miss reports. A comprehensive set of instructions for recording the event on video with a DSLR camera has also been developed, as counting frames will provide a high-resolution measurement of the occultation's elapsed time. Recording WWV or other UTC-linked audio on the DSLR video while recording the event, or recording a few seconds of the display of one of the NTP-synchronized timing apps before and after the event (without stopping the video recording) would provide the most accuracy available from inexperienced observers. Achieving this should be well within the reach of a large number of the public.

Another benefit of the dense network of observers, especially those recording video on DSLR cameras, will be the possibility of obtaining improved information on the size and shape of Regulus itself. Regulus

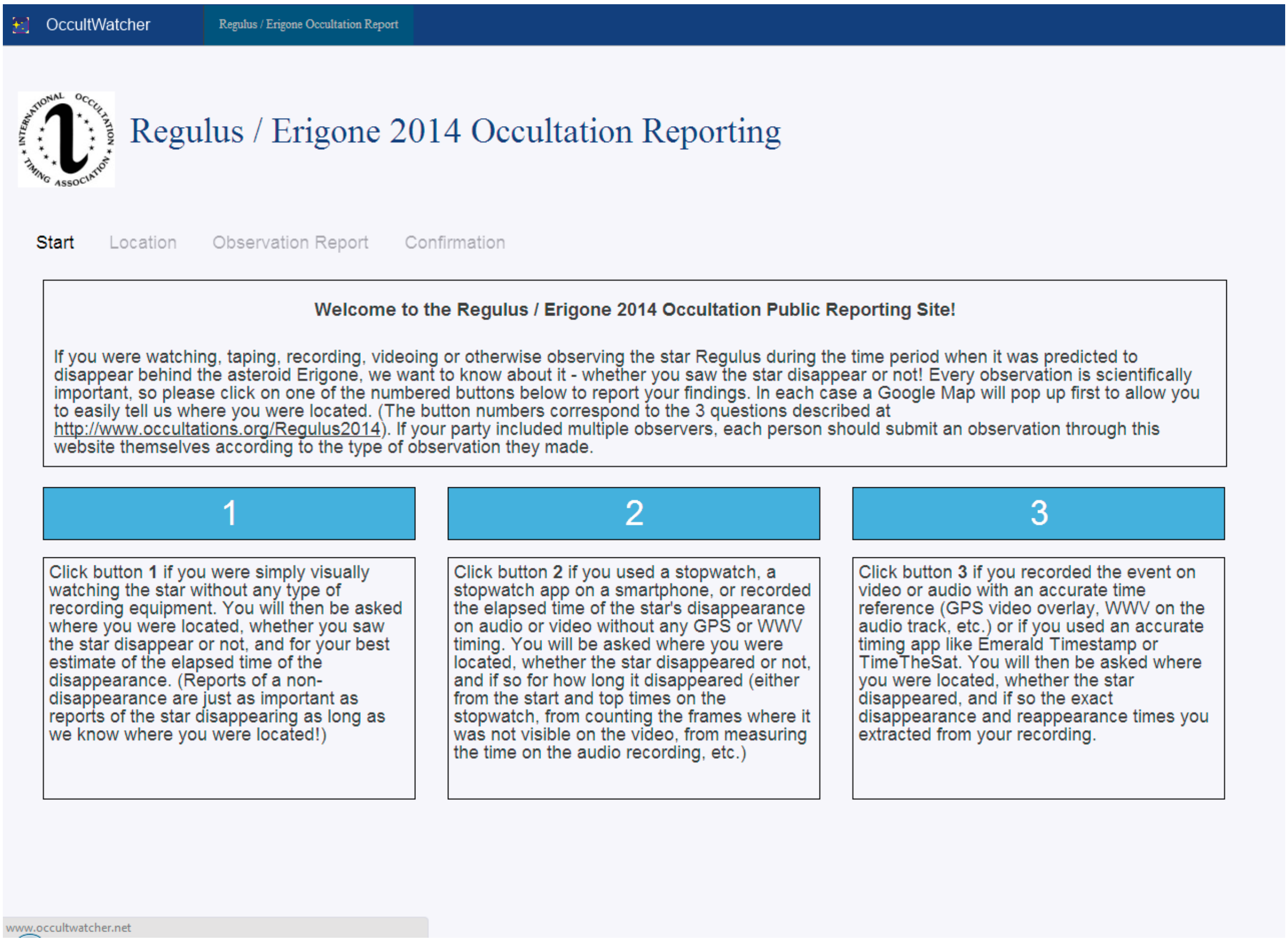

Figure 2. A version of the first page of the public reporting site. After making a choice of button on the first page, all respondents are asked to precisely identify their location on a Google map and are then invited to enter their observation data.

is known to be dramatically oblate- 32% wider at the equator than at the poles; http://www.skyandtelescope.com/community/skyblog/newsblog/22756444.html. Positive observations near the edges of the path ("near-hits") will be grazing events in which the time for the star to disappear or reappear will be elongated. Analysis of these light curves will allow derivation of improved knowledge about the size and shape of Regulus. The large number of observers who have DSLR cameras should provide many more of these events than would be expected for fainter stars where bigger telescopes would be required to record the occultation. However, to be most scientifically useful, video measurements should be carefully planned to minimize errors due to non-linear camera response such as saturation.

Observers outside the path are also encouraged to watch for occultations by small satellites of Erigone; although the chances are low (and that should be stressed to potential observers outside the 2-sigma zone) anyone within 10 path-widths of center has a chance to discover a satellite of Erigone; with such a bright star, this occultation provides a unique opportunity to scan densely a large volume around Erigone. Preferably they should observe in pairs 100m to 1000m apart, to obtain independent confirming observations, which was a pay-off for the discovery of a satellite of Kleopatra in 1980, confirmed by adaptive optics (AO) observations over 20 years later. For Erigone, especially with the relatively slow motion, the chances of obtaining good observations of an occultation by a satellite, one too small to be resolved by current AO observations with large telescopes, are improved.

Finally, to insure that the greatest possible number of observations are submitted, a public reporting website has been developed where people can easily submit their observations (Figure 2). The reporting site allows the user to easily pinpoint their observing location on a Google map. The user is then offered the option to submit simple miss reports, positive reports with estimates of the elapsed time, relative elapsed times obtained from stopwatches, timing apps or frame counting on DSLR video, as well as absolute times linked to GPS by means of audio recordings with WWV, video timings using video time inserters like the IOTA VTI, etc.

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- Dave Herald performed an analysis of the gradual disappearance of LQ Aquarii during the 2011 July 19 Antiope event, published in JOA 2013-3 (July-Sept 2012), pp. 3-9. http://www.iota-es.de/JOA/JOA2012_3.pdf .
In it, he extensively analyzes the effects of saturation on occultation timing and stellar diameter measurement. The recommendations in this paper are intended primarily for experienced observers using video cameras.

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Journal for Occultation Astronomy

2014 OCCULTATION OF REGULUS: OPPORTUNITIES & OUTREACH

Costantino Sigismondi[1,2,3,4]

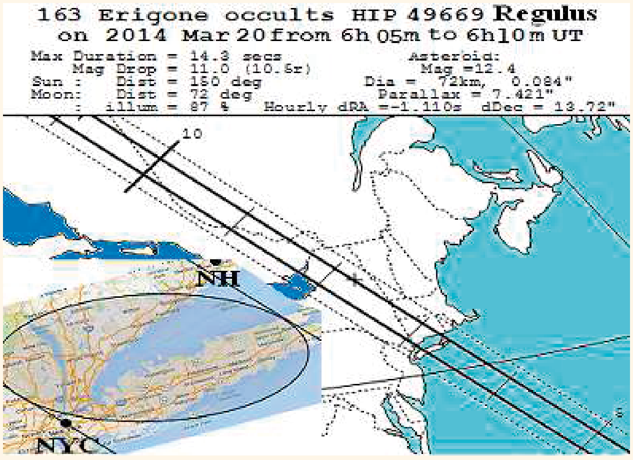
Abstract: Regulus will be occulted by the asteroid 163 Erigone on 20 March 2014 across North Eeastern United States and Canada. The outreach of this event can be potentially enormous, encouraging media and schools to consider how this aspect of astronomy works. An educational campaign on how to perform accurate timing, recording, upload and analysis of data has been started.

The asteroid & the star: The occulting asteroid diameter is 72 km: this is the width of the totality band on the Earth in the case of zenital occultation, the projection from the altitude of Regulus gives an ellipse of $\sim 144 \times 72$ km. The angular diameter is 84 milliarcsec. The stellar diameter of Regulus, a fast rotating star with an oblate profile [1] of 1.6×1.2 milliarcsec, produces two partial occultation bands of ~ 2 km on either sides of totality. Totality will last 14.3 s at the center.

Scientific opportunities: asteroidal occultations allow refining either the ephemerides of the asteroid, and its profile in the case of multiple observations. The case of Regulus in 2014 can be observed and recorded by many people as occurred for 472 Roma occultation of Delta Ophiuchi on 8 July 2010, unfortunately the 2.75 magnitude target star produced numerous saturated data and non-linear response of the sensors (anti-blooming effect, etc.) leading to larger than expected errors [2], moreover the stellar diameter was 35% of the asteroidal one, and because of wrong ephemerides most observers did not see this occultation. Good ephemerides of 163 Erigone can be obtained for better preparation of the observational campaign. Relativistic differential effects due to the solar gravitational field can also be observed with very accurate timings with single photon detectors (photomultipliers) [1].

Public outreach and educational campaign: On January 24, 1925 a total eclipse of the Sun was seen from New York City, and E. W. Brown [3] of Yale University organized the observational campaign with the help of local astronomy magazines. New Haven and New York city are again on the totality path of this occultation (box in figure).

[1]ICRA, Rome, Italy www.icra.it/solar sigismondi@icra.it
[2]Observatório Nacional, Rio de Janeiro, Brazil. [3]IOTA/ES
[4] Pope Sylvester II Astron. Observatory in Bukowiec, Poland.



The outreach campaign can be concentrated in three points. **1. The rarity and beauty of the phenomenon:** first magnitude stars' asteroidal occultations occurred on 19.10.2005 again for Regulus [1] in S. Europe, and for Betelgeuse on 2.1.2012 [4] with no positive observations, and again on 12.12.2023 in Southern Europe. **2. The importance of absolute timing of the event** for improving asteroidal ephemerides and to locate precisely its center of mass to± 3 millarcsec. It can be obtained by synchronization of clocks with an absolute timing reference. To do this there are NTP, radio and telephone services: these Institutions can be invited in a main media event. **3. The utility of relative timing of the event:** can be obtained with any digital SLR or camcorder, by the inspection of the video, frame by frame, at frame rates up to 1/30 or 1/60 second. As shown in the case of an Arcturus test observation [5] there is no need of a telescope to record a first magnitude star.

Conclusions: this event can be also followed and broadcast with a potential audience of several thousands of people. The organization of this event for media, astronomy and education is now starting.

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The IOTA-ES Depot

It was in 1989 when IOTA-ES bought several methane band filters that should be used by those observers willing to measure the occultation of sigma Sagittarii by Titan. That was the first time that different observers could record this event at different observatories using the methane band filters. Further use of these filters was made for other occultations, leading to the important event in 2003 when for a second time after 1989 a central flash by Titan could be recorded just about one year before the Huygens-Titan encounter!

In the following years additional astronomical instruments were bought for our IOTA-ES community, like filters for solar eclipses to record Baily's beads and 4 identical motor-driven 4", f/10 Maksutov telescopes, complete with tripods. Three new portable 70 mm Meade refractors with tripods and eyepieces were a good bargain too – each cost only 70 Euro. A C8 had been donated and our motor-driven portable 20" Dobsonian will be re-engineered to further reduce its 45 kg weight.

In addition there are a lot of lenses and electronic devices stored in our stock.

It took about a year to build up the IOTA-ES depot where all these items can now be stored – and can be lent to any member upon request..

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IOTA's Mission

The International Occultation Timing Association, Inc. 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.

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http://www.occultations.org
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This site contains information about the organization known as IOTA and provides information about joining

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