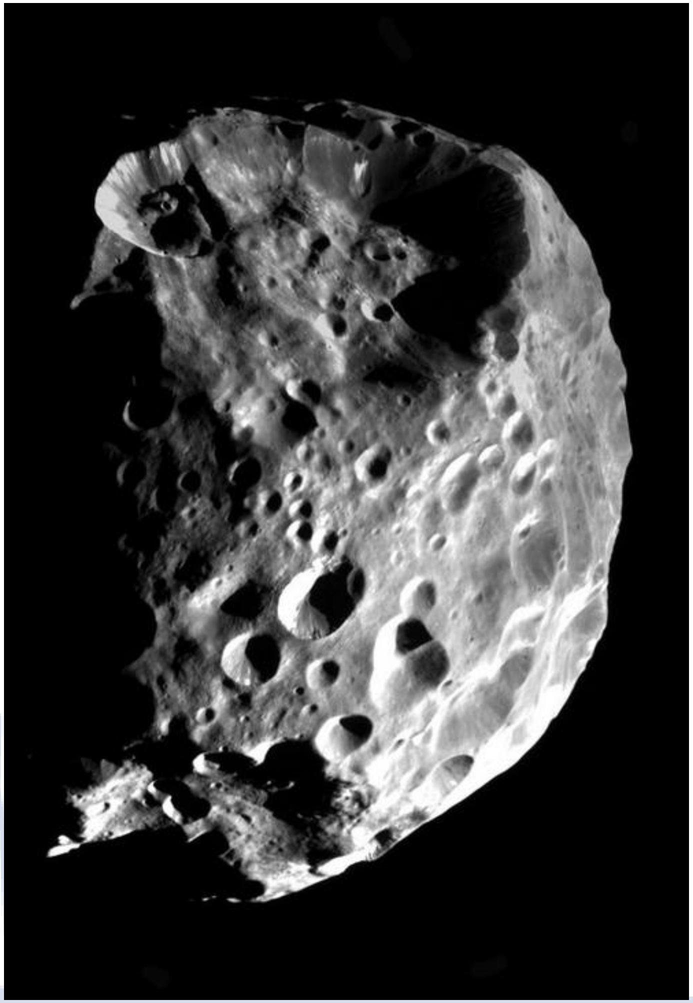
Predictions of Stellar Occultations by Irregular Satellites up to 2020



Phoebe
Source: *Cassini*

Altair Ramos Gomes-Júnior[1,3]
M. Assafin[1]
L. Beauvalet[2,3]
J. Desmars[3]
R. Vieira-Martins[1,2,4]
J. I. B Camargo[2,4]
B. E. Morgado[1,2]
F. Braga-Ribas[5]

(1) Observatório do Valongo
(2) Observatório Nacional
(3) Observatoire de Paris/IMCCE
(4) Laboratório interinstitucional de e-Astronomia
(5) Universidade Tecnológica Federal do Paraná

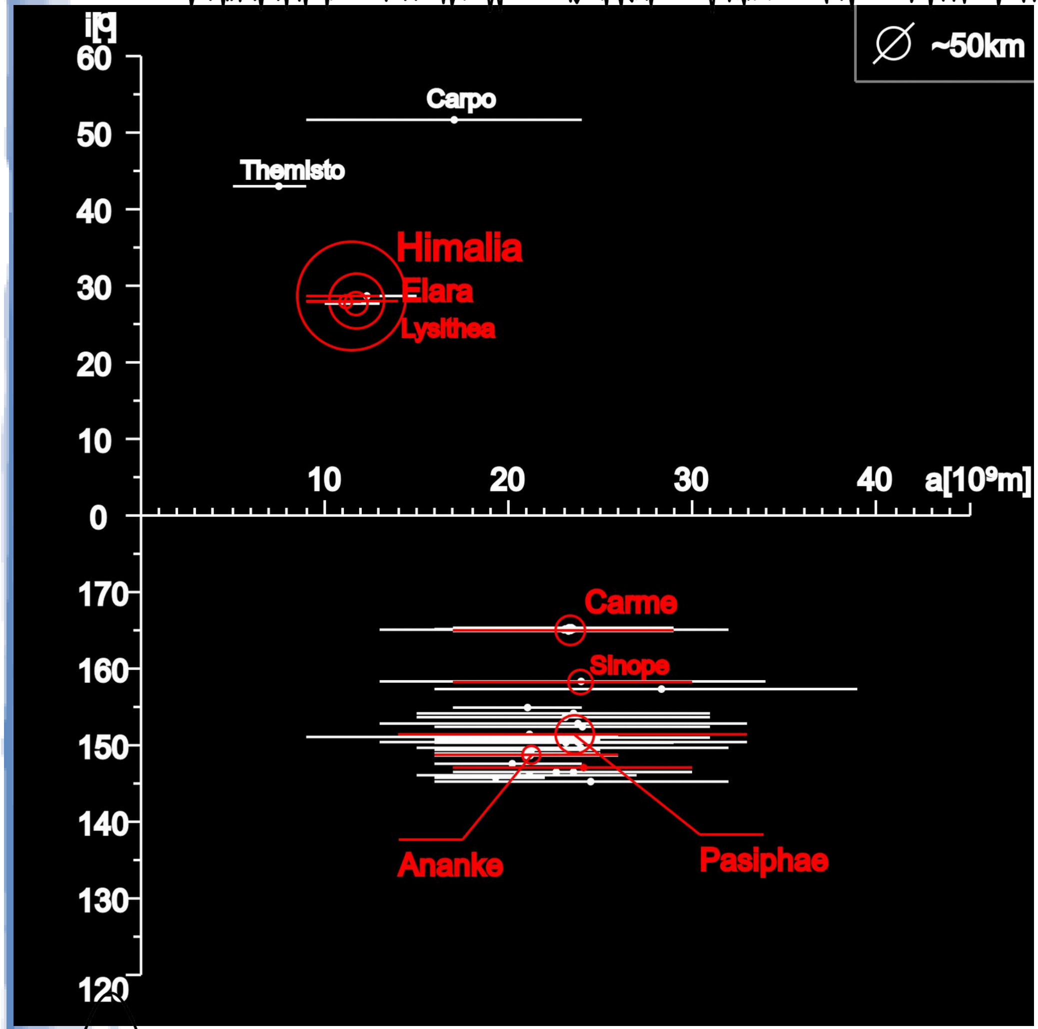
IAU Symposium 330 – April 26, 2017

Irregular Satellites

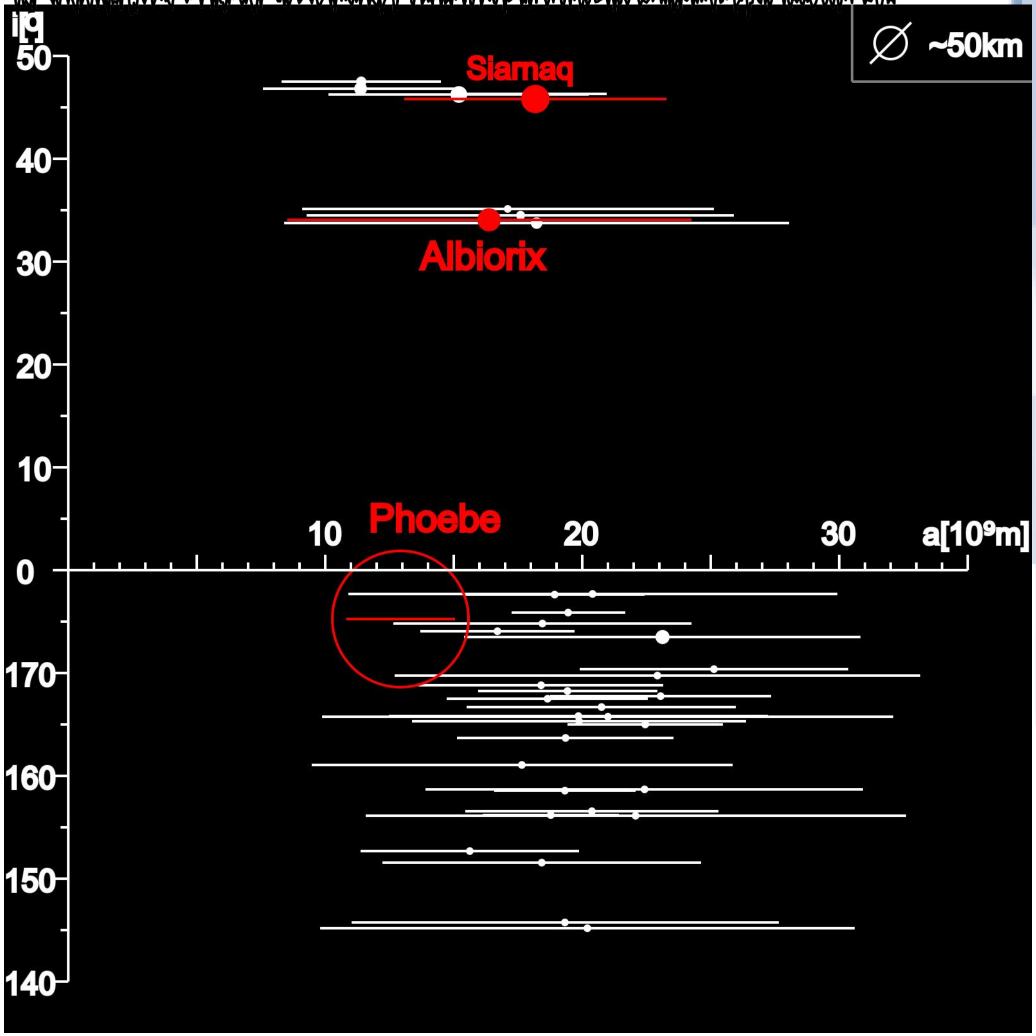
- Burns (1986): Satellites are irregular when their orbital planes precess primarily under the influence of torques from the Sun.

- Their orbits are eccentric, usually highly inclined and distant from their planets. The direction of their movements can be prograde or retrograde.

Irregular Satellites



Satellites of Jupiter



Satellites of Saturn

Irregular Satellites

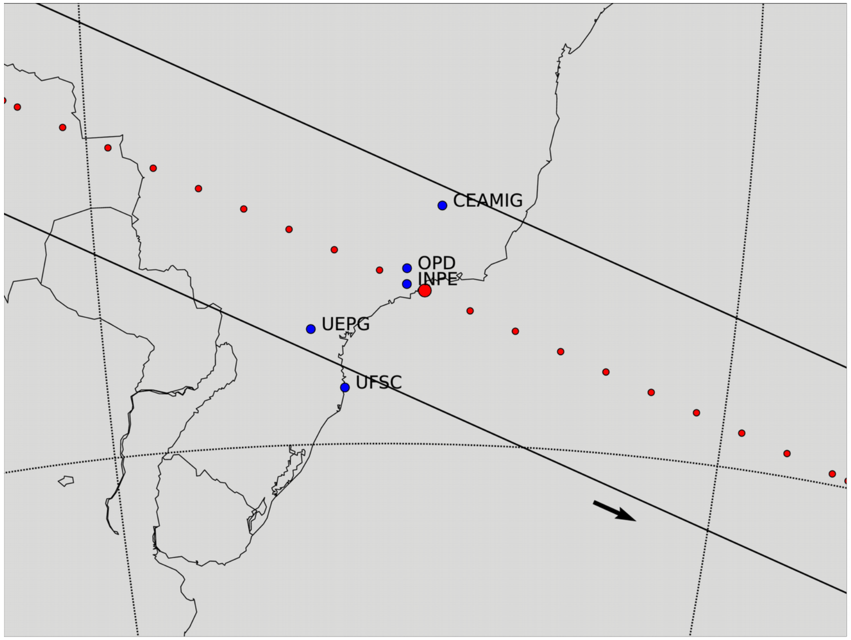
- Capture:
  - Gas Drag (Cuk & Burns, 2003);
  - 3-body interation (Nesvorný et al., 2007);
  - Collision (Sheppard, 2006).

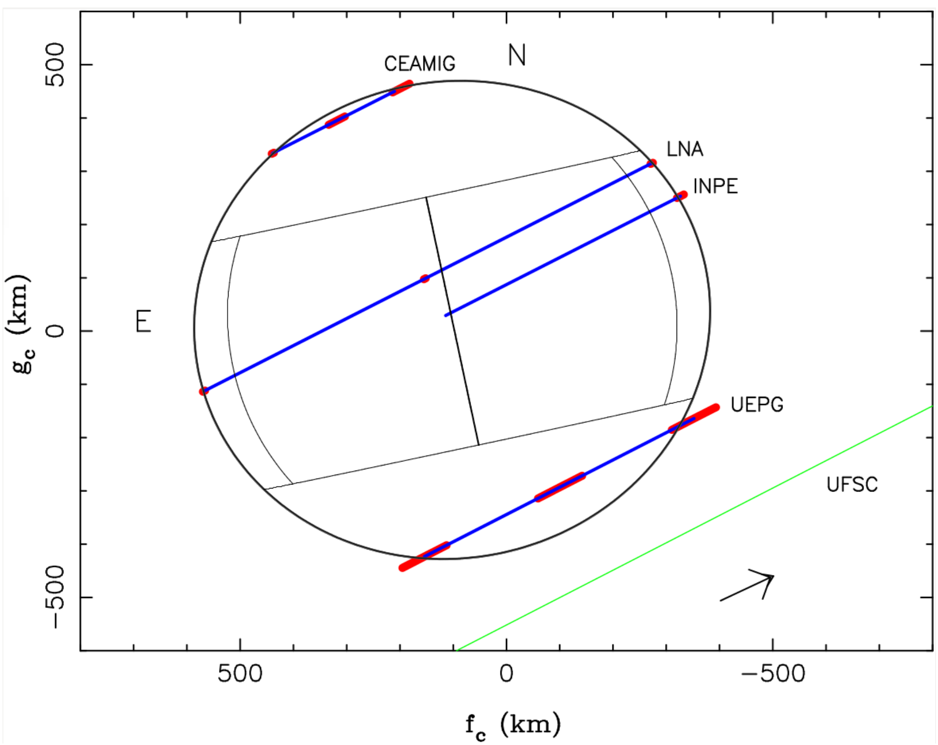
- Orbital Evolution:
  - Origin of the orbital family of satellites (Nesvorný et al., 2004);

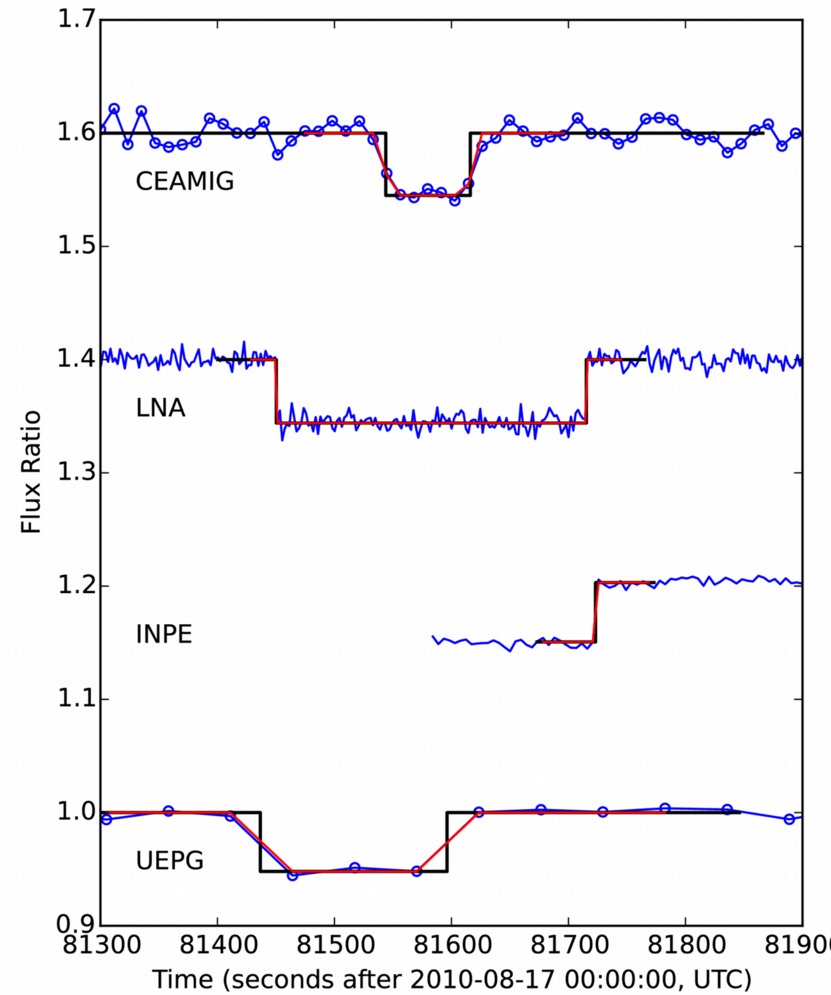
Goal

- Predict stellar occultation by irregular satellites to determine:
  - Size;
  - Shape;
  - Albedo;
  - Density, if mass known;
  - Characterize family of satellites.

Example: Ceres (2010)







Gomes-Júnior et al. (2015, MNRAS)

Irregular Satellites

Table 1. Estimated diameter of the satellites and correspondent apparent diameter.

Satellite	Diameter of the satellites mas[a]	km	Ref.
Ananke	8	29	1
Carme	13	46	1
Elara	24	86	1
Himalia	41	$(150 \times 120) \pm 20^b$	2
Leda	5	20	1
Lysithea	10	36	1
Pasiphae	17	62	1
Sinope	10	37	1
Phoebe	32	212 ± 1.4^b	3

References: 1 – Rettig, Walsh & Consolmagno (2001); 2 – Porco et al. (2003); 3 – Thomas (2010).

Notes. [a]Using a mean distance from Jupiter of 5 au, from Saturn of 9 au and from Neptune of 30 au.

[b]From Cassini observations.

Gomes-Júnior et al. (2016)

Opportunity for Irregular Satellites

- Successful experience in stellar occultations by TNOs/Centaurs in an international collaboration;
- Saturn and Jupiter will cross the central side of the Galactic Plane in 2018 and 2019-2020, respectivelly;
- Gaia;
- Improvement of ephemeris using our positions (Gomes-Júnior, 2015).

Ephemeris

- Phoebe:
  - Update the ephemeris of Desmars et al. (2013) with +75% in the number of observations.
- Jupiter Satellites:
  - Special Tailored Ephemeris;
  - Ephemeris for the 8 major irregular satellites of Jupiter;
  - Only using the positions of Gomes-Júnior et al. (2015, A&A)
  - JUP340 (Brozovic & Jacobson, 2017)

Gaia

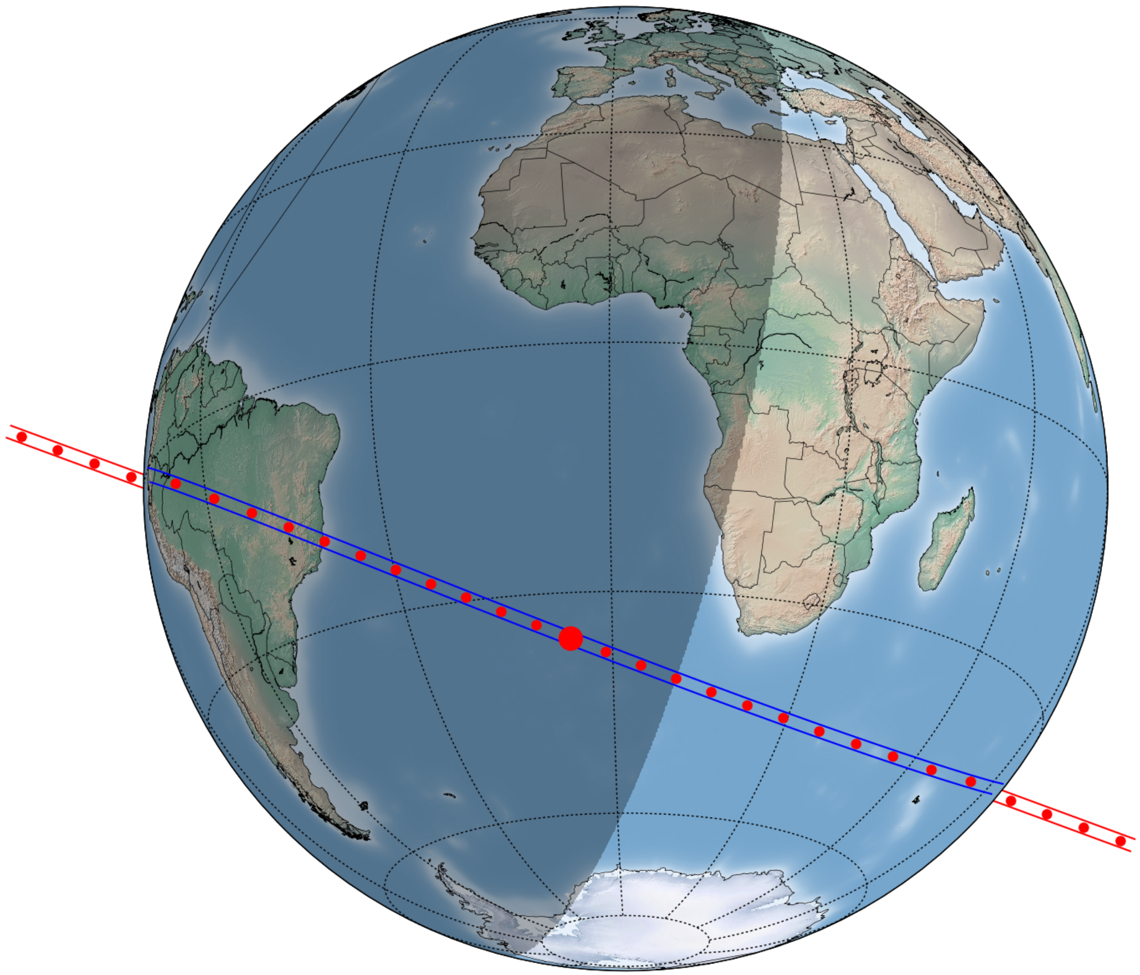
- Stars brighter than G=16.5;
- Proper Motion from TGAS;
- Number of occultations: 6230 from January 1st, 2017 up to December 31, 2020;
- 10% with stars brighter than R=14. Potentially observable by amateurs.
- 25% with stars brighter than R=15.

Occultations

Satellite	2017	2018	2019	2020	Total
Ananke	16	44	359	187	606
Carme	16	33	369	235	653
Elara	17	39	305	193	554
Himalia	13	55	380	222	670
Leda	24	51	536	207	818
Lysithea	10	35	414	221	680
Pasiphae	20	44	522	226	812
Sinope	21	45	491	279	836
Phoebe	234	274	78	15	601

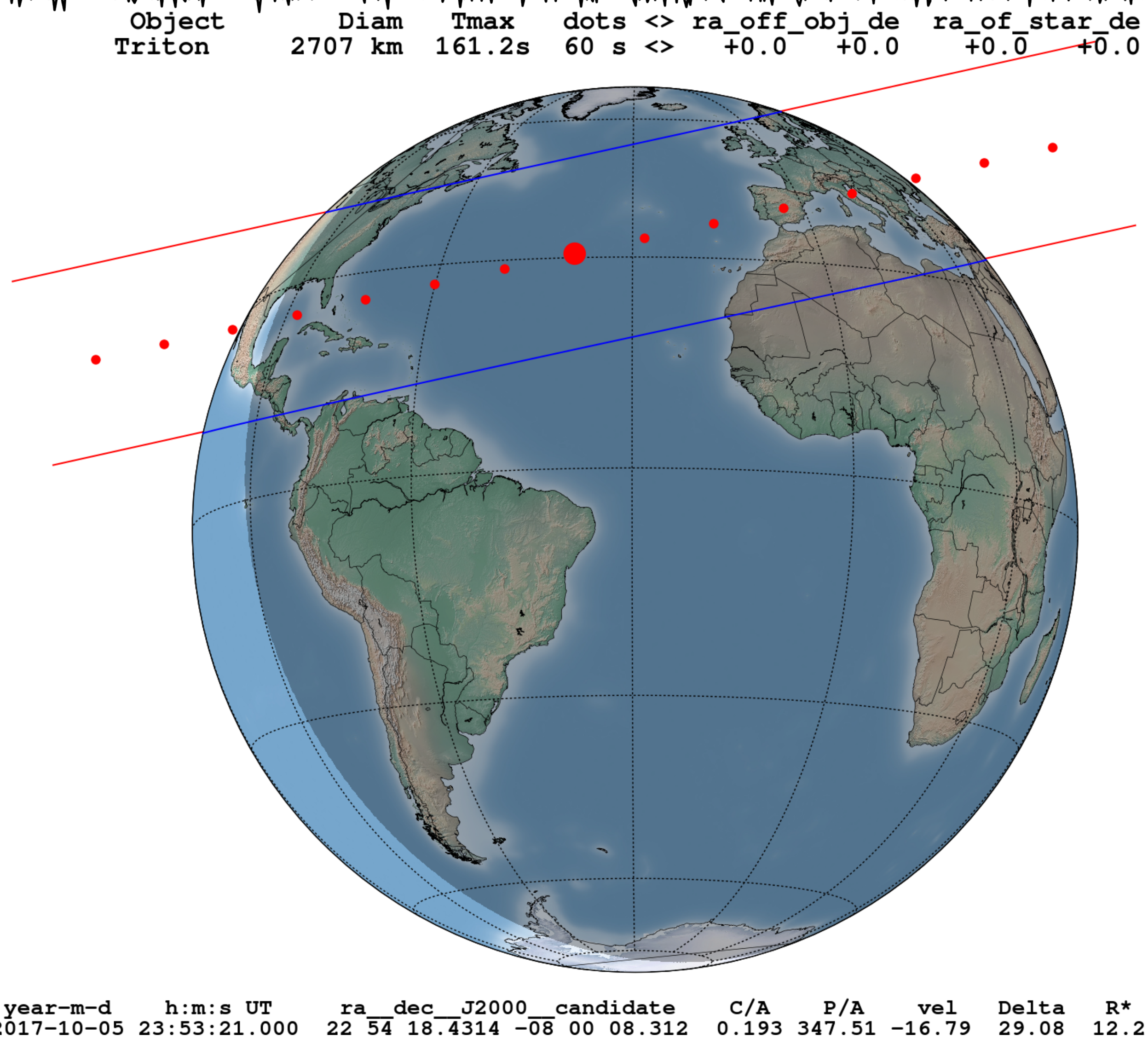
Himalia – February 24, 2018

Object	Diam	Tmax	dots	<>	ra_off_obj_de		ra_of_star_de	
Himalia	170 km	19.8s	60 s	<>	+0.0	+0.0	+0.0	+0.0



year-m-d	h:m:s UT	ra__dec__J2000__candidate	C/A	P/A	vel	Delta	R*	K*	long
2018-02-24	04:59:48.000	15 23 42.5273 -17 42 12.998	0.559	200.20	8.60	5.20	14.1	-0.9	2

Triton – October 10, 2017



Next Steps

- Re-reduce the observations with GAIA catalogue;
- Numerical Integration of the orbits of the Irregular Satellites using all positions available;
- Update occultation predictions using Gaia DR2;
- Observe stellar occultations by these objects.

Thank You