MODELLING ASTEROID SHAPES USING BNAO ROZHEN AND AS VIDOJEVICA PHOTOMETRIC DATA IN COMBINATION WITH SPARSE DATA

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THE IMPORTANCE OF STUDYING ASTEROIDS

- **Carriers of primordial information**
- **Prevention of possible future collisions**
- **Containing elements that are deficit on the Earth**
- **Understanding the dynamic of the Solar System**

- **Collecting information about the history, evolution and future of our planetary system**

THE SHAPE OF THE ASTEROID

- **Basic representation of the shape: Triaxial ellipsoid shape with axis a, b, and c**
- **a>b>c**
- **Rotation about the smallest axis**

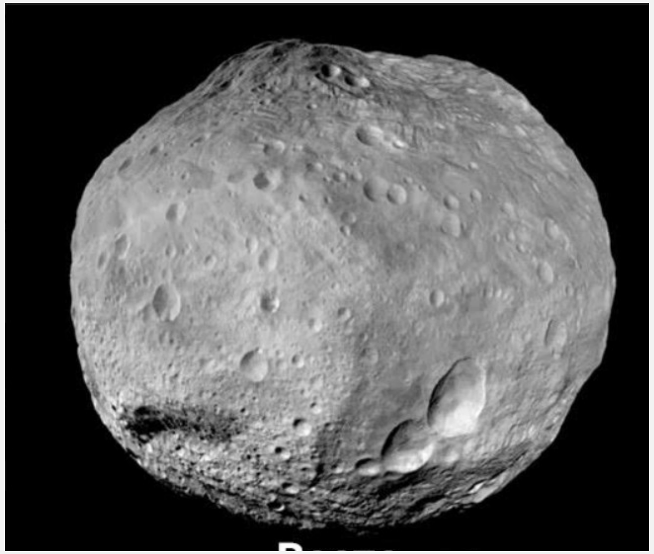


Fig.1 4 Vesta

- **Smaller objects have more elongated shapes than the large ones**
- **The shape can depend from the type of the asteroid: S-type are more elongated than C- and D-type (Torppa J., 2008)**
- **The period of rotation influence on the shape**
- **Lack of data for asteroids smaller than 30 km in diameter**

Fig.2 433 Eros

LIGHTCURVE INVERSION METHOD

- **Described by Kaasalainen and Torppa in 2001 (Kaasalainen M. & Torppa J., 2001)**
- **Uses the shape of tens of lightcurves, obtained at different oppositions, in order to determine the shape of the asteroid**
- **Shape of a triaxial polyhedron**
- **Condition:**

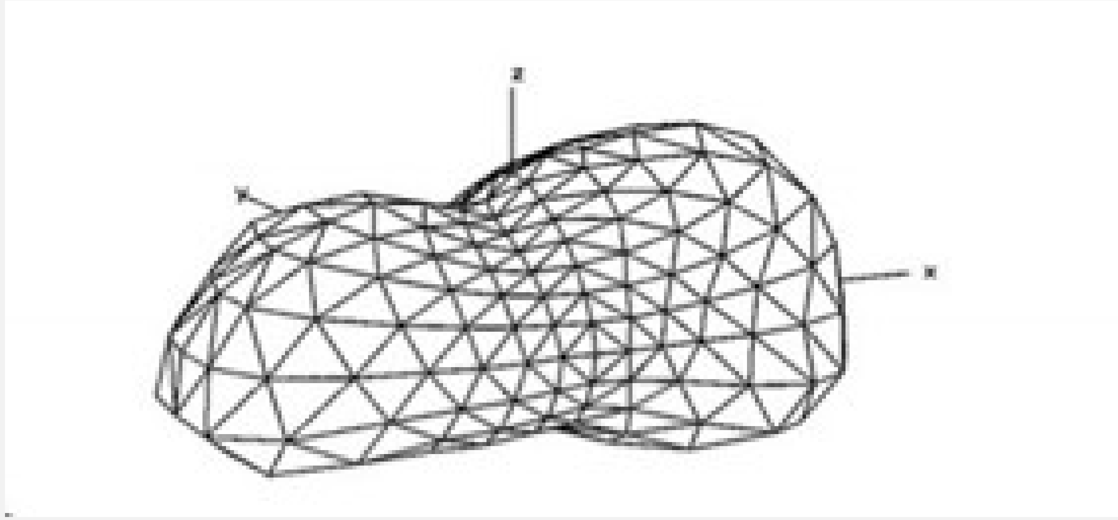


Fig. 3 Model of an asteroid using the lightcurve inversion method

THE MODEL OF THE ASTEROID

- Determining the model of the asteroid implies solving the problem about its
- shape,
- sense of rotation,
- calculating the coordinates of the asteroid's pole.

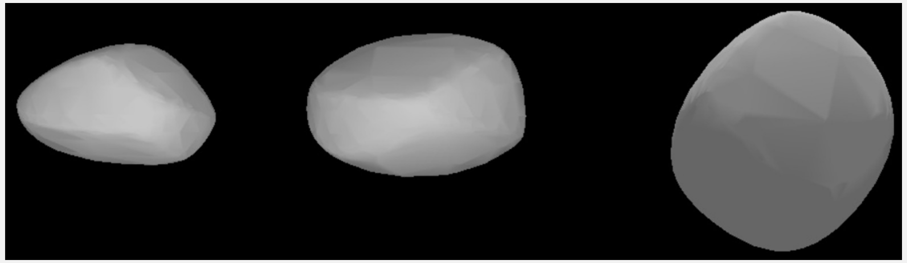


Fig. 4 Model of an asteroid using the lightcurve inversion method

To obtain the model of the asteroid:

- We, check 312 possible positions of the rotational axis and the period. In this search the positions for the axis are fixed, while the value for the sidereal period floats around the previously determined value for the synodical period.
- Usually, we get two mirrored solutions, due to the unambiguity in the problem.
- With the solution for the spin axis and the sidereal period we also get the answer for the axis ratio
- Comparation between the model lightcurve and the obtained lightcurve from the observations

SPARSE DATA

- The photometric sparse data are side product from astronomical data bases or space mission
- Sparse data are rare in time (only one or max 5 photometric points during one observational night
- These data increase the distribution of the PAB longitude and latitude, and gives as information from parts of the asteroid we have never observed
- In our work we used sparse data from AstDys database

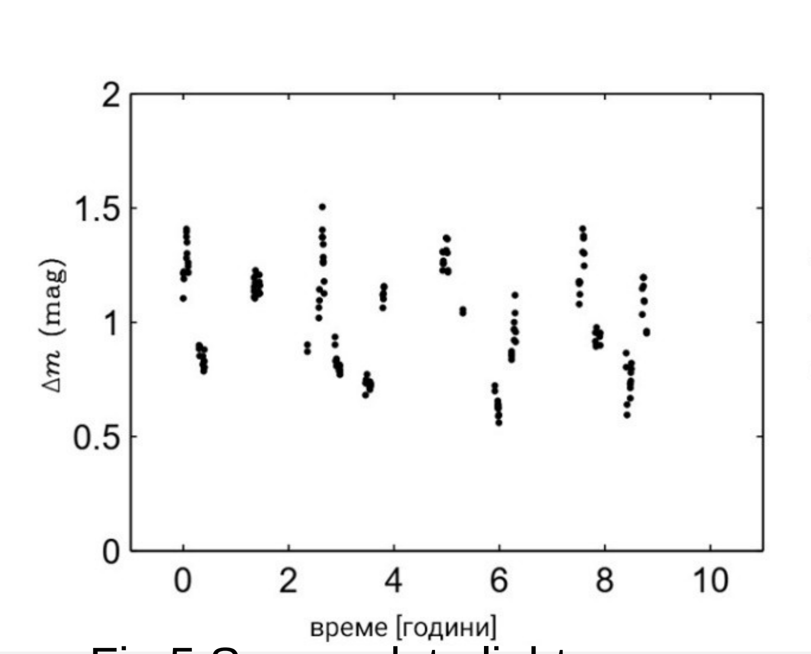


Fig.5 Sparse data lightcurve

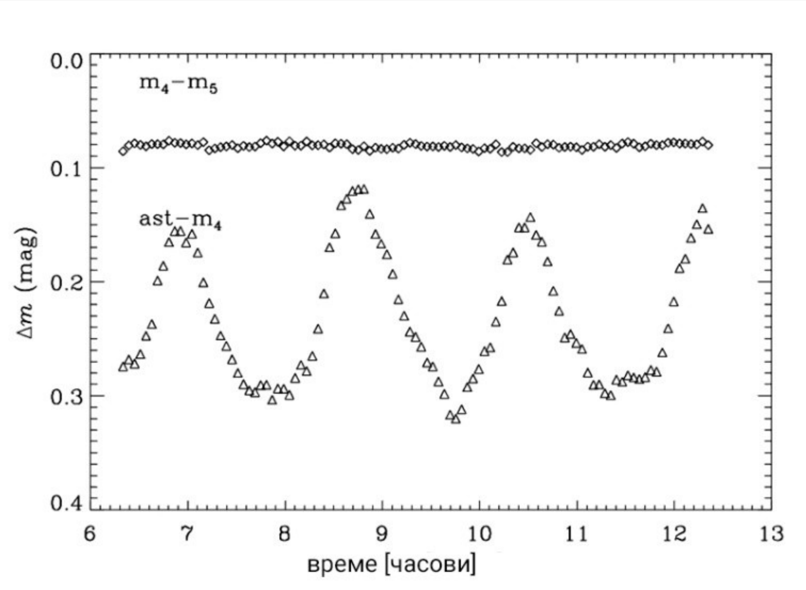


Fig. 6 Dense data lightcurve

THE MODEL OF 901 BRUNSIA

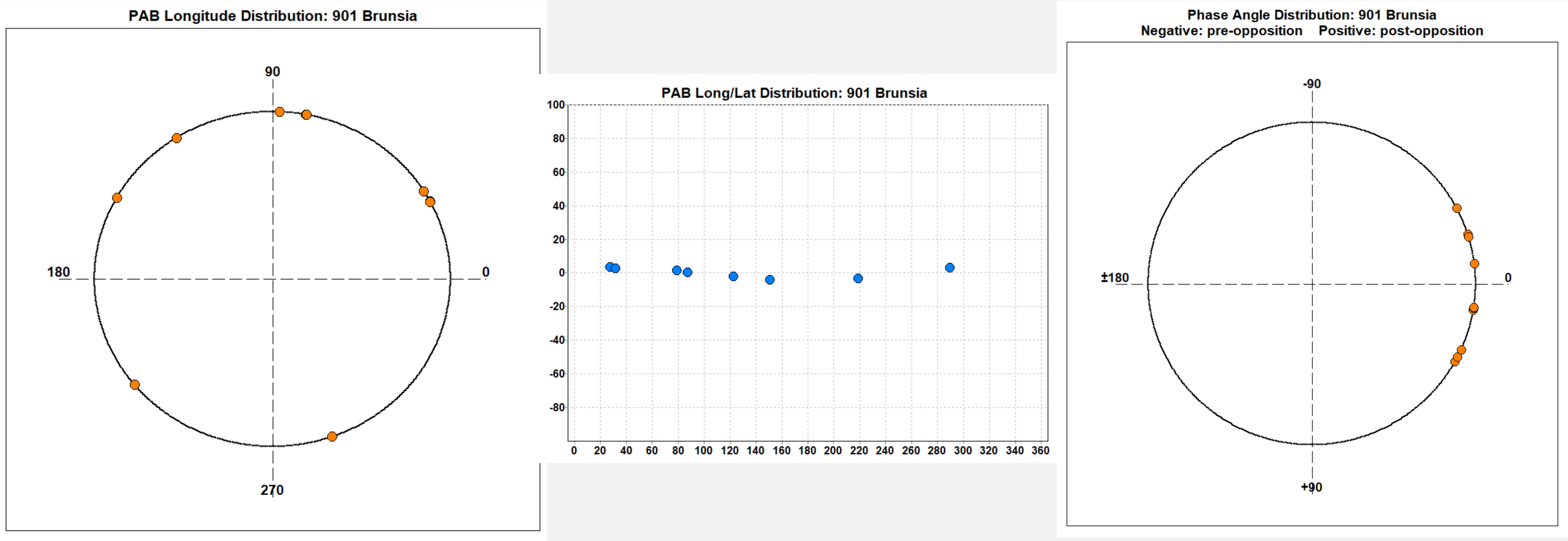
- Flora family member
- Discovered in 1918
- Period of rotation 3.1363 h
- S spectral type

Table 1. Aspect data for 901 Brunsia

Asteroid	Date (UT)	*r* (AU)	*Δ* (AU)	Phase angle (°)	*λ* (°)	*β* (°)
901 Brunsia	2011 Dec 01,79	1,9415	1,1878	24,16	15,62	4,03
	2011 Dec 16,77	1,9780	1,3641	27,08	18,28	3,22
	2013 March 10,96	2,7156	1,7787	8,58	146,92	-4,95
	2013 March 13,0	2,7158	1,7901	9,41	146,47	-4,93
	2014 Aug 26,85	1,7715	1,0175	29,02	275,34	3,77
	2015 Dec 14,96	2,5552	1,7964	16,84	131,32	-2,38
	2017 March 21,06	2,4070	1,6223	17,87	228,34	-4,19
	2018 Oct 03,02	2,1300	1,7705	27,83	93,26	1,42
	2018 Dec 07,94	2,2980	1,3330	6,589	91,22	0,07

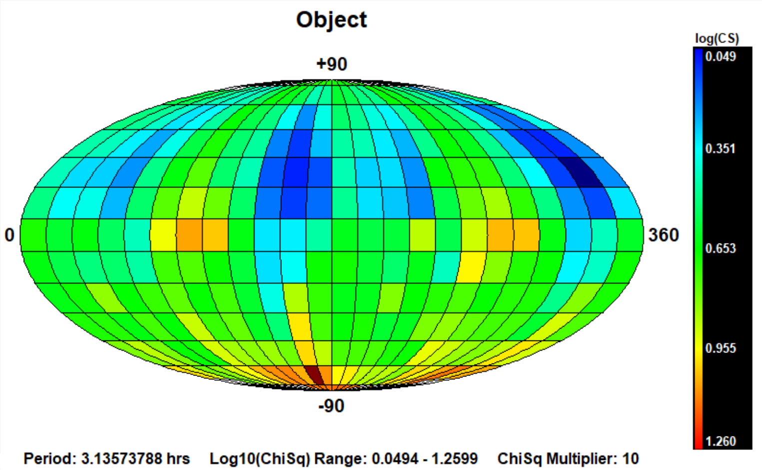
THE MODEL OF 901 BRUNSIA

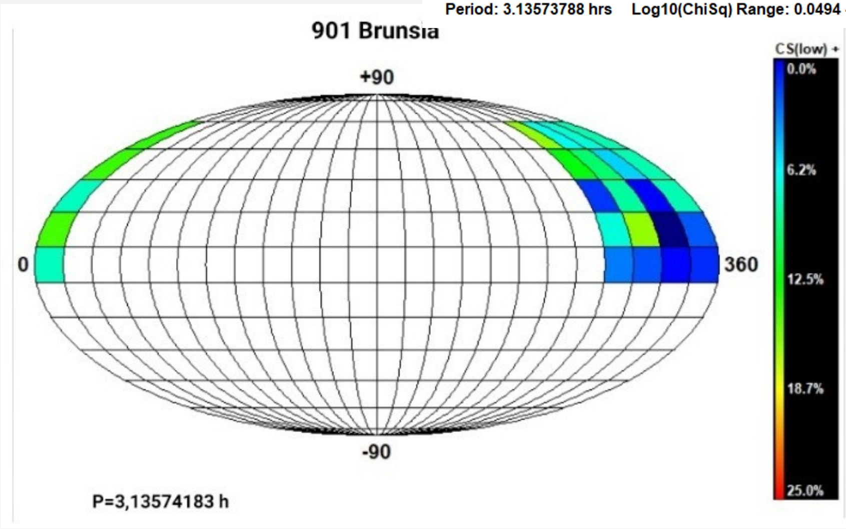
Fig. 7 Distribution of the phase angle and PAB longitude and latitude at the time of the observations

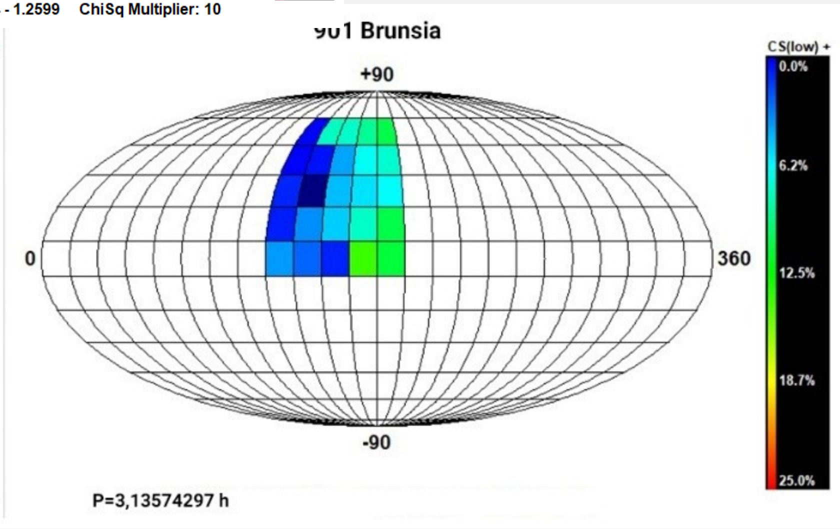


THE MODEL OF 901 BRUNSIA

The spheres with the possible solution. The blue regions indicates the solutions with the smallest χ^2





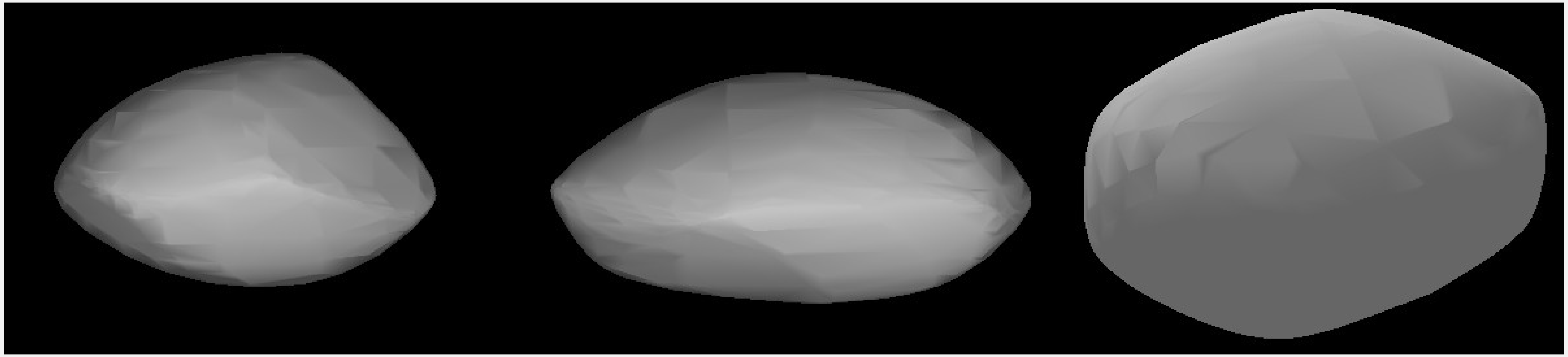


THE MODEL OF 901 BRUNSIA

Table 2 The values for the model of 901 Brunsia

Asteroid	Sidereal period (h)	Sense of rotation	Pole 1		Pole 2		a/b	b/c
			λ (°)	β(°)	λ (°)	β(°)		
901 Brunsia	3.13574	P	329,7	26,7	152,4	20,9	1,2 5	1,28

The shape



THE MODEL OF 339 DOROTHEA

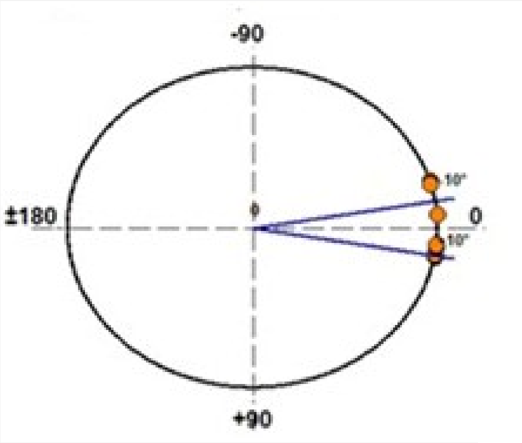
- EOS family member
- Discovered in 1892
- Rotational period 5.976 h
- K spectral type

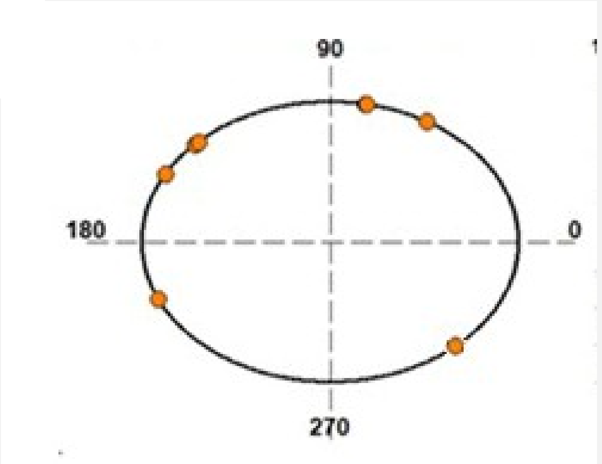
Table 3. Aspect data for 339 Dorothea

Asteroid	Date (UT)	*r* (AU)	*Δ* (AU)	Phase angle (°)	*λ* (°)	*β*(°)
339 Dorothea	2013 Dec 09,03	3,0519	2,0891	4,72	79,80	-14,53
	2014 Jan 03,81	3,0753	2,1943	9,64	74,72	-13,98
	2014 Jan 04,83	3,0762	2,2022	9,92	74,56	-13,93
	2014 Jan 06,88	3,0781	2,2187	10,49	74,27	-13,84
	2014 Dec 24,07	3,2936	2,7811	15,95	158,93	-6,08
	2018 Dec 02,89	2,9530	2,0041	6,30	57,06	-13,68
	2019 Nov 30,06	3,2522	2,8675	17,11	143,25	-8,41
	2019 Dec 01,07	3,2527	2,8539	17,03	143,33	-8,43
	2020 Feb 24,98	3,2888	2,3598	7,01	133,10	-7,82
	2021 May 10,93	3,1783	2,2749	9,63	199,63	8,10

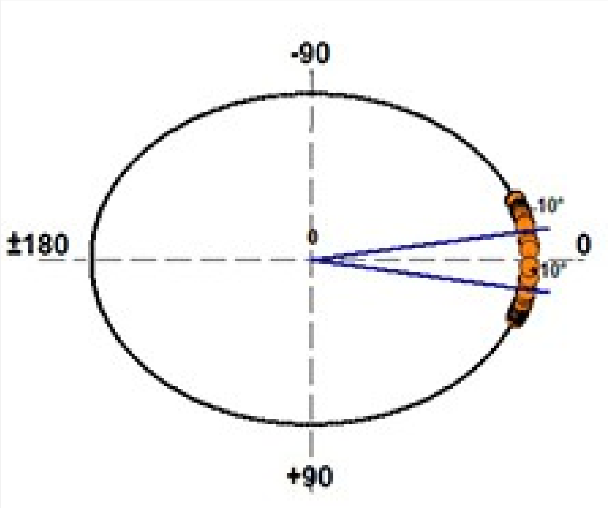
THE MODEL OF 339 DOROTHEA

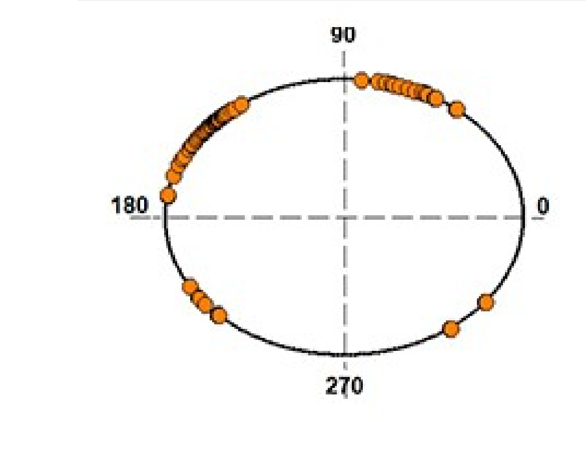
DISTRIBUTION OF THE PHASE ANGLE AND PAB LONGITUDE AND PHASE ANGLE FROM THE DENSE OBSERVATIONS





DISTRIBUTION OF THE PHASE ANGLE AND PAB LONGITUDE AND PHASE ANGLE INCLUDING SPARSE DATA





THE MODEL OF 339 DOROTHEA

The results for the model of 339 Dorothea using only dense data

339 Dorothea	Sidereal period (h)	Coordinates of the pole		a/b	a/c	b/c	χ^2
		λ_p (°)	β_p (°)				
pole 1	5,968194±0,00001	195	45	/	/	/	0,122432
pole 2	5,968194±0,00001	30	30	/	/	/	0,124060
pole 1	5,968194±0,00001	200,80	46,98	1,11	1,48	1,34	0,117061
pole 2	5,968194±0,00001	36,00	31,94	1,10	1,38	1,26	0,116640

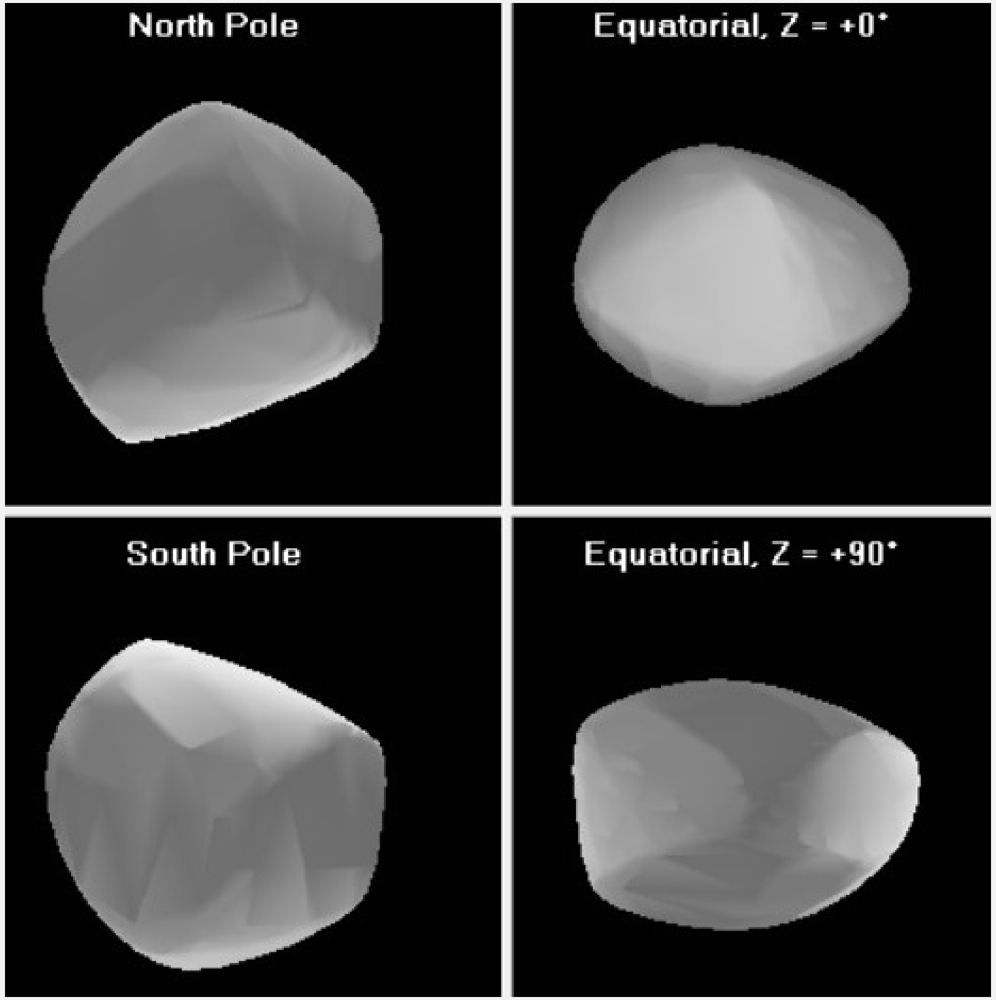
THE MODEL OF 339 DOROTHEA

The results for the model of 339 Dorothea using combination of sparse and dense data

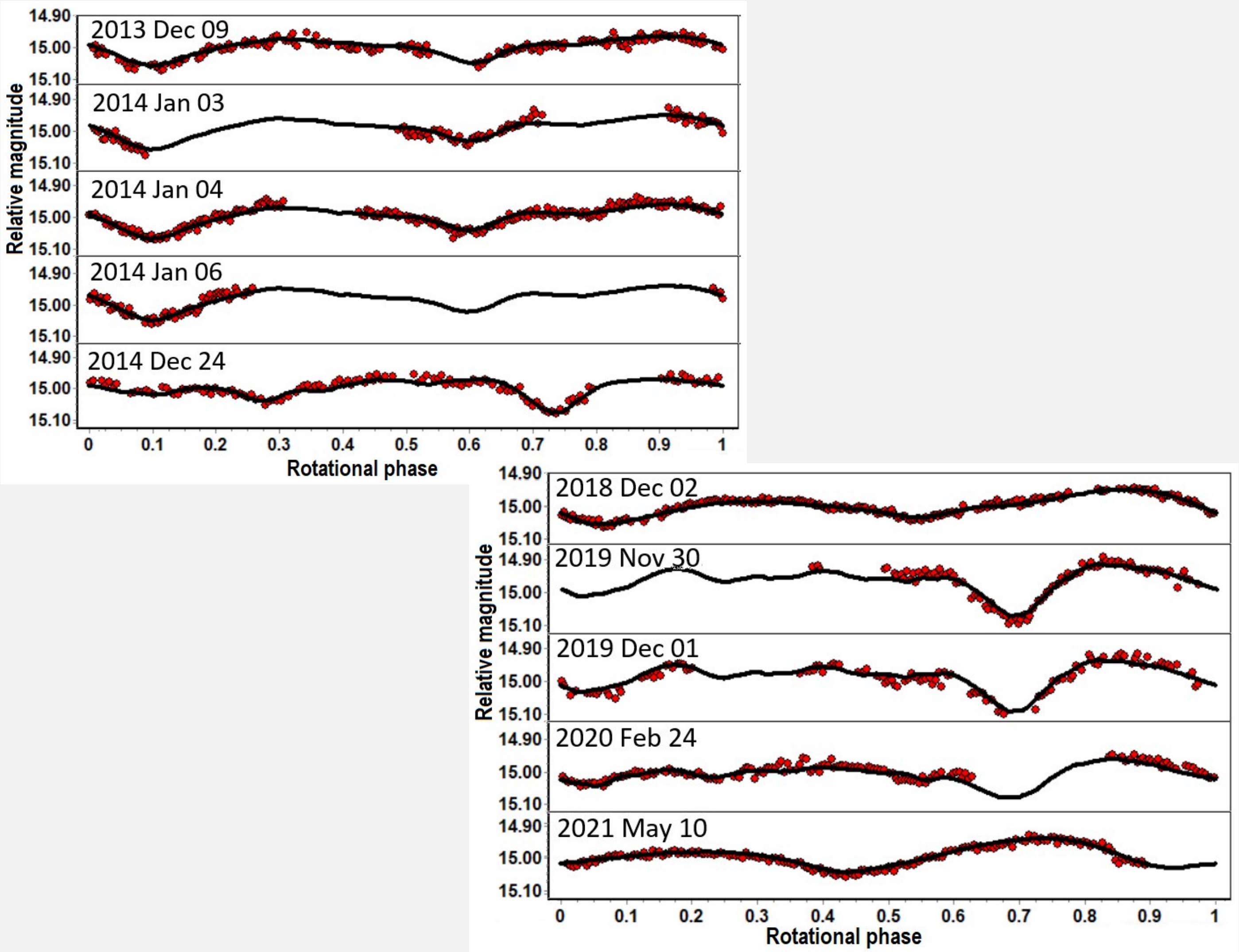
339 Dorothea	Sidereal period (h)	Coordinates of the pole		a/b	a/c	b/c	χ^2
		λ_p (°)	β_p (°)				
pole 1	5,968194±0,00001	195	45	/	/	/	0,149062
pole 2	5,968194±0,00001	30	30	/	/	/	0,152255
Pole 1	5,968194±0,00001	200,98	46,79	1,11	1,48	1,35	0,143065
Pole 2	5,968194±0,00001	35,87	31,53	1,10	1,31	1,20	0,143064

THE MODEL OF 339 DOROTHEA

The shape of 339 Dorothea



Comparation between the model lightcurve and the obtained lightcurves from the observations



CONCLUSION

- We derived model for few asteroids
- Only 0.6% of the known asteroids have known models
- More observations needed (known period and unknown period)
- Combining our results with results gained from different types of observations

THANK YOU FOR YOUR ATTENTION