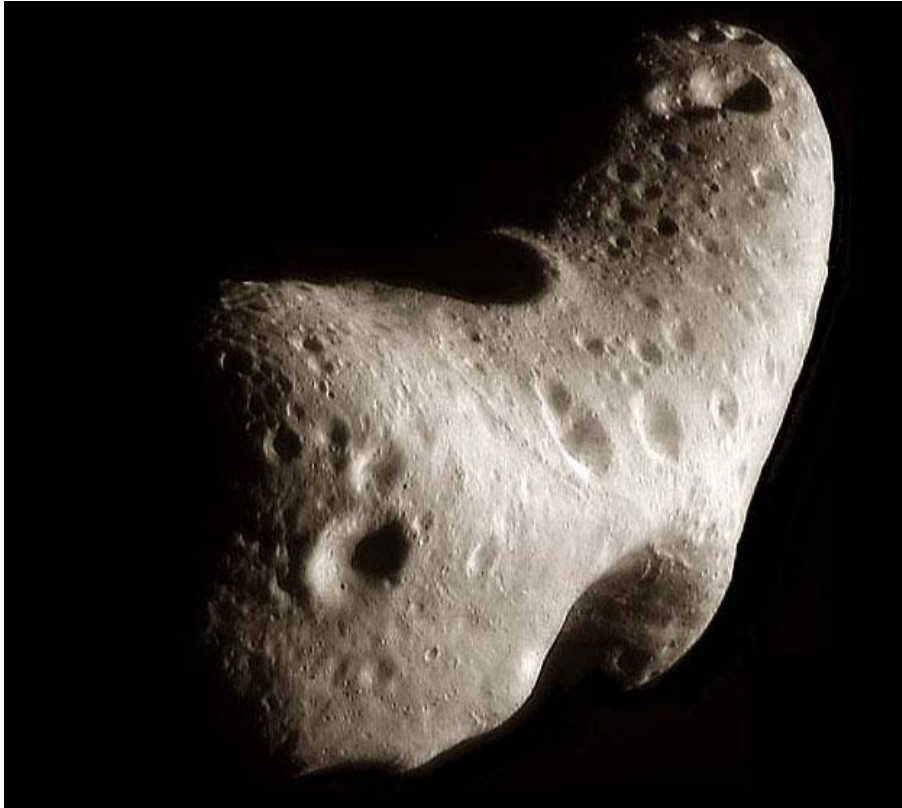


# Astrometric Observations of (1665) Gaby, and (1565) Lemaître Asteroids at TUBITAK National Observatory (TUG)



(433)Eros

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# Outline

- **Orbital Parameters of (1565)Lemaitre and (1665) Gaby**
- **Observation Facilities and Equipment at TUBITAK National Observatory (TUG)**
- **Observation Statistics**
- **Reduction Method**
- **Statistic Analysis**
- **Conclusion**

# Orbital Parameters of (1565) Lemaître

Orbital Elements at Epoch 2456200.5 (2012-Sep-30.0) TDB  
Reference: **MPO236399** (heliocentric ecliptic J2000)

Element	Value	Uncertainty (1-sigma)	Units
e	0.3484017	n/a	
a	2.3922312	n/a	AU
q	1.5587738	n/a	AU
i	21.46589	n/a	deg
node	261.36711	n/a	deg
peri	115.96511	n/a	deg
M	117.41328	n/a	deg
$t_p$	2455759.7240849 (2011-Jul-17.22408490)	n/a	JED
period	1351.4598131	n/a	d
	3.70	n/a	yr
n	0.26637862	n/a	deg/d
Q	3.2256886	n/a	AU

## Orbit Determination Parameters

# obs. used (total)	729
first obs. used	1948-??-??
last obs. used	2012-01-27
# oppositions	23
planetary ephem.	DE403
condition code	0
fit RMS	0.47
data source	MPC:mpn
producer	MPCLINUX

## Additional Information

$T_{jup} = 3.358$

# Orbital Parameters of (1665) Gaby

Orbital Elements at Epoch 2456200.5 (2012-Sep-30.0) TDB  
 Reference: **MPO226128** (heliocentric ecliptic J2000)

Element	Value	Uncertainty (1-sigma)	Units
e	0.2068371	n/a	
a	2.4139321	n/a	AU
q	1.9146414	n/a	AU
i	10.83292	n/a	deg
node	91.60121	n/a	deg
peri	5.75981	n/a	deg
M	53.13908	n/a	deg
$t_p$	2455998.2923751 (2012-Mar-11.79237510)	n/a	JED
period	1369.8909536 3.75	n/a	d yr
n	0.26279464	n/a	deg/d
Q	2.9132228	n/a	AU

## Orbit Determination Parameters

# obs. used (total)	809
first obs. used	1930-??-??
last obs. used	2012-03-25
# oppositions	22
planetary ephem.	DE403
condition code	0
fit RMS	0.53
data source	MPC:mpn
producer	MPCLINUX

## Additional Information

**T<sub>jup</sub> = 3.465**

# TUBITAK National Observatory (TUG)

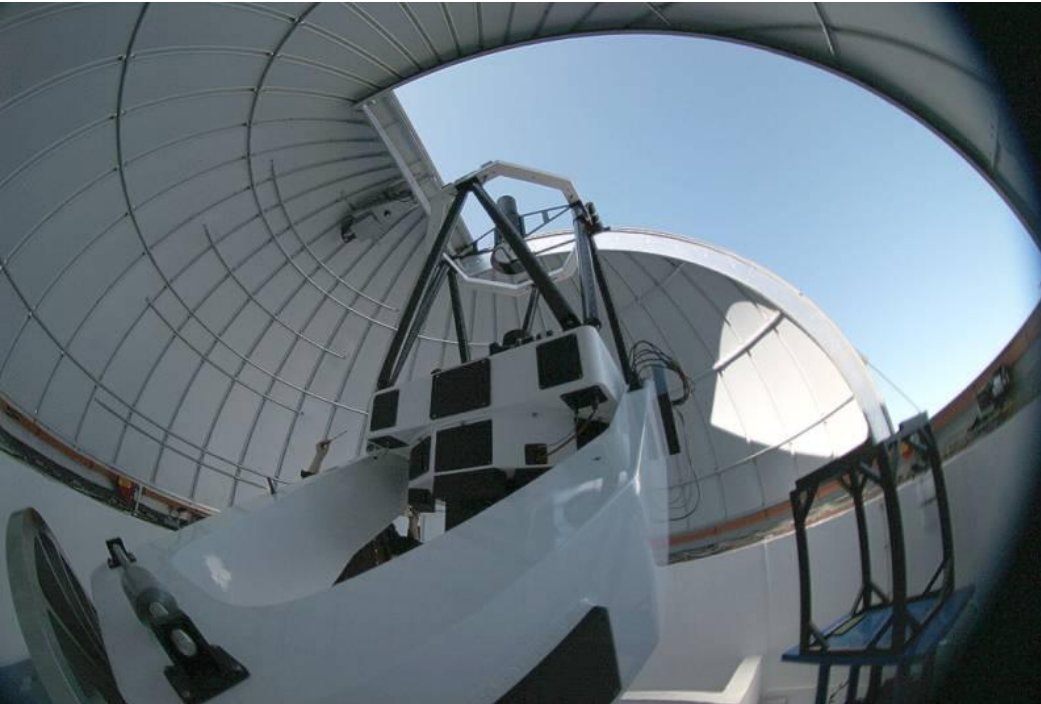


Lat :  $36^{\circ} 49' 27''$  N  
Lon:  $30^{\circ} 20' 08''$  E  
Alt : 2500 m

Location  
Bakırlitepe, Antalya  
Open Sky  $\approx 260$  nights  
Median Seeing =  $0''.81$

# T100 Telescope

## Technical Specifications



### SI 1100 CCD Camera

Model:	SI 1100 Cryo, UV, AR, BI
Chip Type:	Fairchild 486 BI, 4 Readin Chanal
Format	4096 x 4037 pixel
Pixel Size:	15 x 15 micron
Chip Size:	61.44 x 61.44 mm
Gain	0.55 e-/ADU (100KHz, Ch:A)
Noise (RMS):	4.19 e- (100 kHz, Ch:A)
"Bias" Level	500 (count)
Dark Current:	0.0002 e-/pixel/sn
Binning:	1x1, 2x2, 3x3, 4x4
Exposure Time	1 - 300 sn
Cooling	Cryo-tiger, -100 C
PC interface:	Gigabit F/O kart (PCI)
Transfer rate:	45 sn (1x1), 13 sn (2x2)
Pixel Scale:	0.31"/pixel
FOV :	21.5' x 21.5'
Software:	Maxim DL 5.12
Filter whell:	76x76 mm, 8 hole, 2 pair
Filters:	Bessel UBVRI, SDSS, H $\alpha$ , H $\beta$ , SII, OII, Call K, ND0.5, ND1.0, ND2.0

- Mirror : Ritchey-Chrétien
- Aperture : 1000 mm
- Focal Length : 10000 mm
- Focal Ratio : f/10

# Observation Data Table of (1565) Lemaître

NIGHTS	NUMBER OF FRAME	ALTITUDE OF OBJECT	FILTER
20110826	19	52-58	V
20110827	20	20-25	E-V-R
20110828	19	30-37	E-V-R
20110829	12	27-37	E-V-R
20110830	19	40-45	E-V-R
20110925	18	64-70	E-V-R-ND0.5
20110926	50	45-56	E
20110927	21	47-53	ND0.5-V-R
20110928	21	45-50	ND0.5-V-R
20110929	21	53-59	ND0.5-V-R
20111021	15	73-81	ND0.5-V-R
20111022	30	66-70	E-V-R
20111023	7	67-74	E-V
20111024	60	74-79	E-V-R
20111025	20	78-80	E-V-R
20111123	34	58-67	E-V-R
20111124	30	70-73	E-V-R
20111125	40	70-72	E-V-R
20111126	27	67-80	E-V-R
20111127	20	65-67	V-R
20111214	15	65-66	E
20111225	40	53-45	E-V-R
20120122	20	28-33	E
20120123	17	48-52	E
20120211	19	48-52	E
20120224	32	48-58	V-R
20120319	8	20-27	V-R
<b>27 Nights</b>	<b>654 Frames</b>		

# Observation Data Table of (1665) Gaby

NIGHTS	NUMBER OF FRAME	ALTITUDE OF OBJECT	FILTER
20111021	24	56-58	NDO.5-V-R
20111022	47	53-58	E-V-R
20111023	40	41-55	E-V
20111024	61	49-56	E-V-R
20111025	40	47-55	E-V-R
20111123	15	32-37	E-V-R
20111124	36	41-53	E-V-R
20111125	34	49-55	E-V-R
20111126	36	49-55	E-V-R
20111127	33	42-52	E-V-R
20111214	16	31-34	E
20111225	20	27-32	V-R
20120211	40	51-64	E-V-R
20120212	25	29-43	E-V-R
20120223	41	43-50	V-R
20120224	28	56-66	V-R
20120318	36	28-44	V-R
20120319	22	39-41	V-R
<b>19 Nights</b>	<b>594 Frames</b>		



# Reduction Method

The screenshot displays the Astrometrica software interface. The main window shows a star field with several stars highlighted in green and yellow. A red circle highlights a specific star. A verification window titled "Verify Object 1/2 (0.83"/min, PA 215.1°)" is open, showing a zoomed-in view of the star and its profile. The verification window includes the following information:

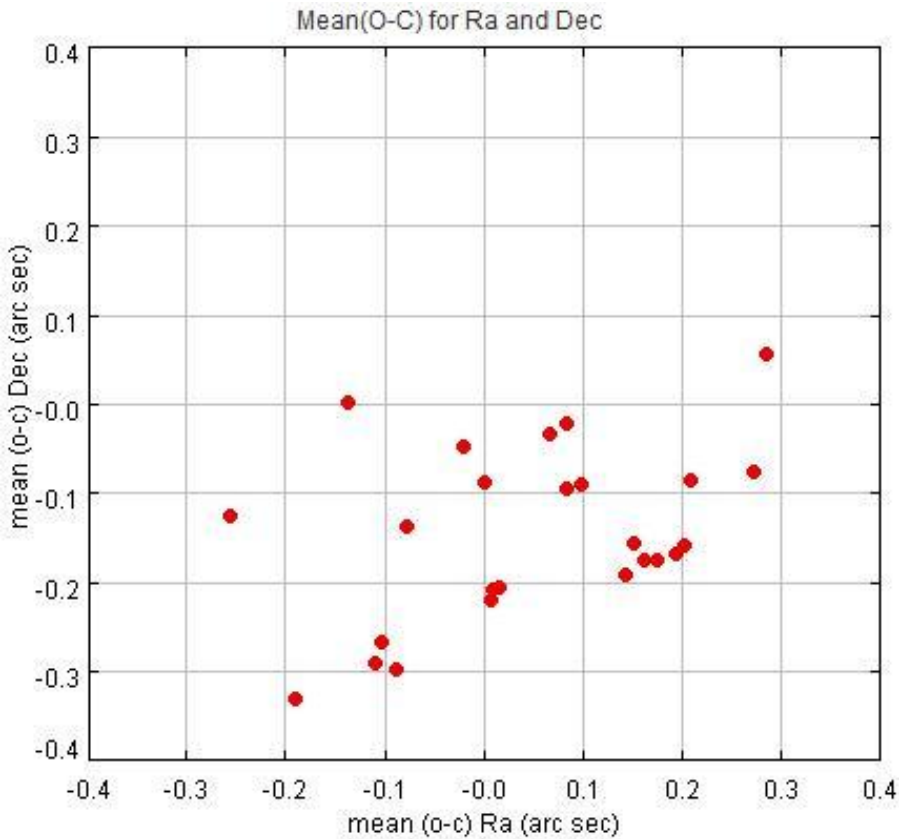
- Display: Zoom 2x, Center Pos. 2, Freq. 2
- Information: 1565001.fit, 2011 11 27.07523 (1:48:20 UT), RA = 07 10 31.959, De = +19 15 18.40, V = 14.62
- Object Designation: (1565) Lemaître, 01565
- Note: (empty)
- PSF-Fit: x = 2387.05, y = 2068.18, SNR = 115.2, Flux = 343409, FWHM = 1.4", Fit RMS = 0.021

At the bottom right, a "Data Reduction Results" table is visible:

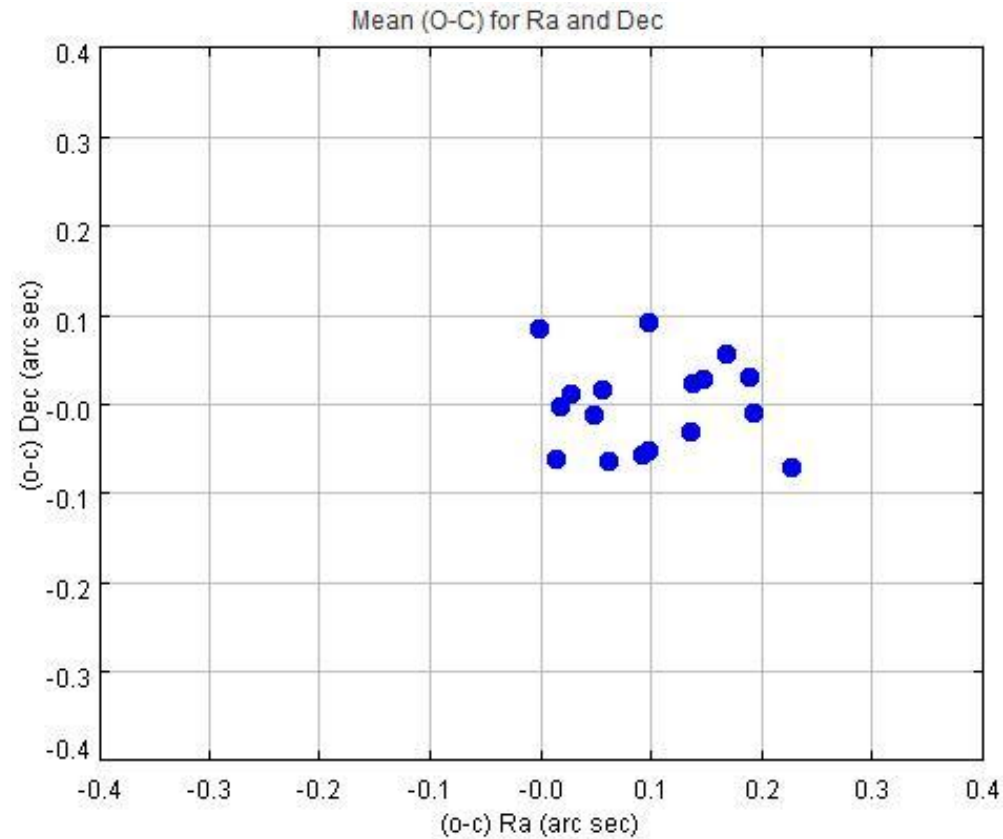
Image	Stars	Ref. Stars	Ref./Ast.	Fit Order	dRA	dDe	Ref./Phot.	dmag
1565001.fit	1397	195	187	4	0.08"	0.08"	177	0.12ma
1565002.fit	1463	195	183	4	0.08"	0.07"	171	0.12ma
1565003.fit	1558	186	172	4	0.07"	0.07"	165	0.13ma
1565004.fit	1514	188	174	4	0.08"	0.06"	171	0.14ma

The bottom status bar shows "UCAC-2", "Fit Order: 4", "V mag", "Astrometrica.cfg", "TR", and the time "01:32 17.09.2012".

# Distribution of Mean (O-C ) for Ra and Dec

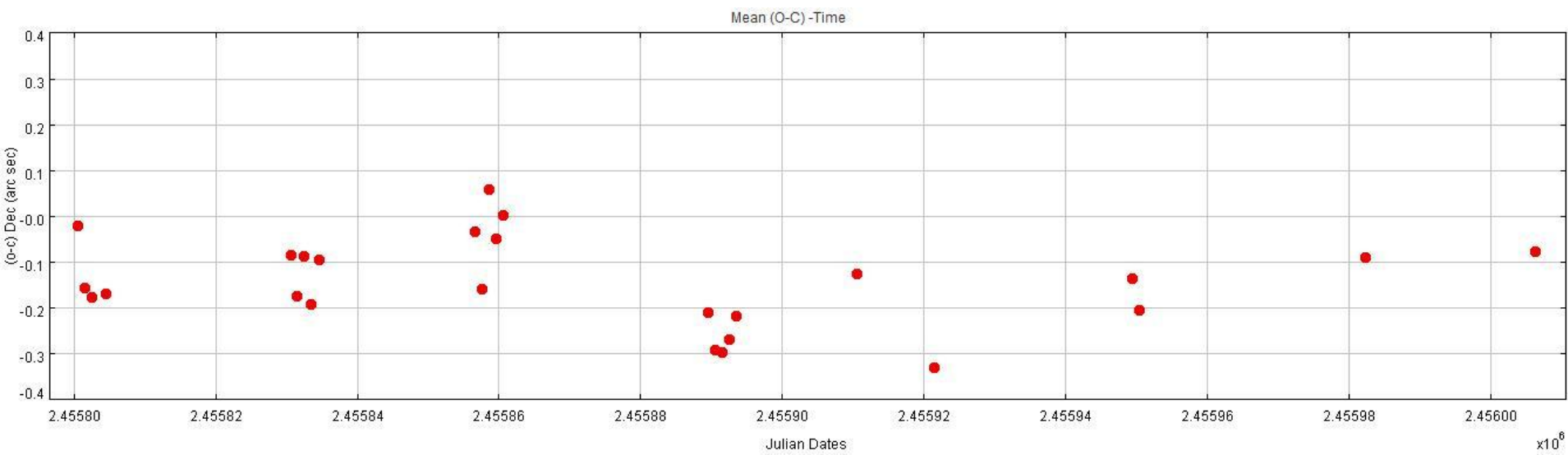
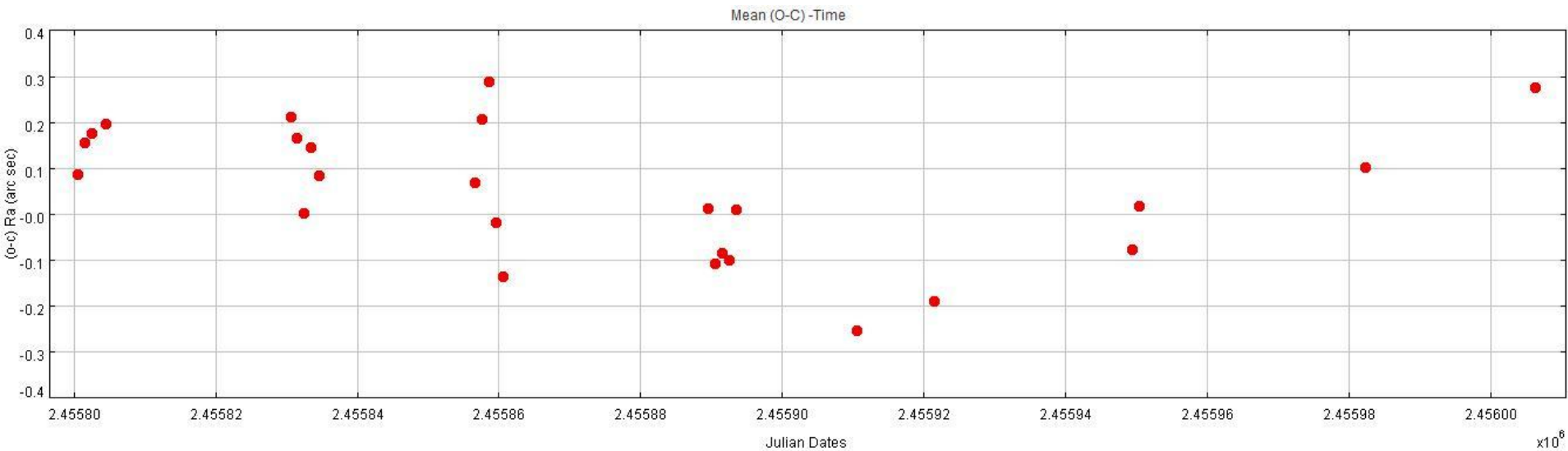


1565 (Lemaitre)

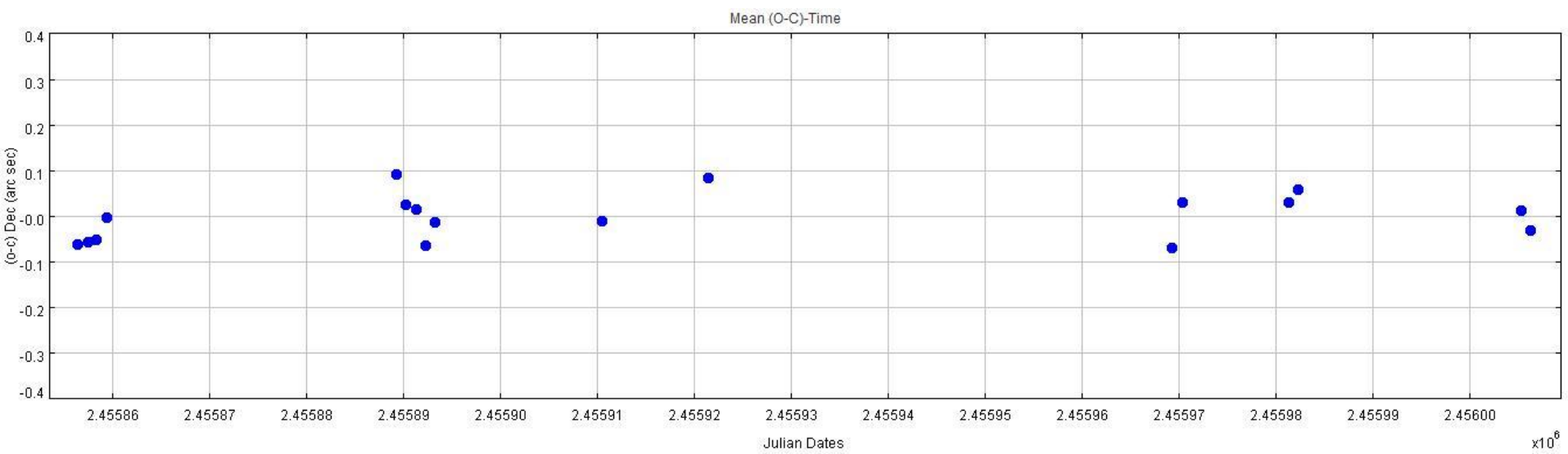
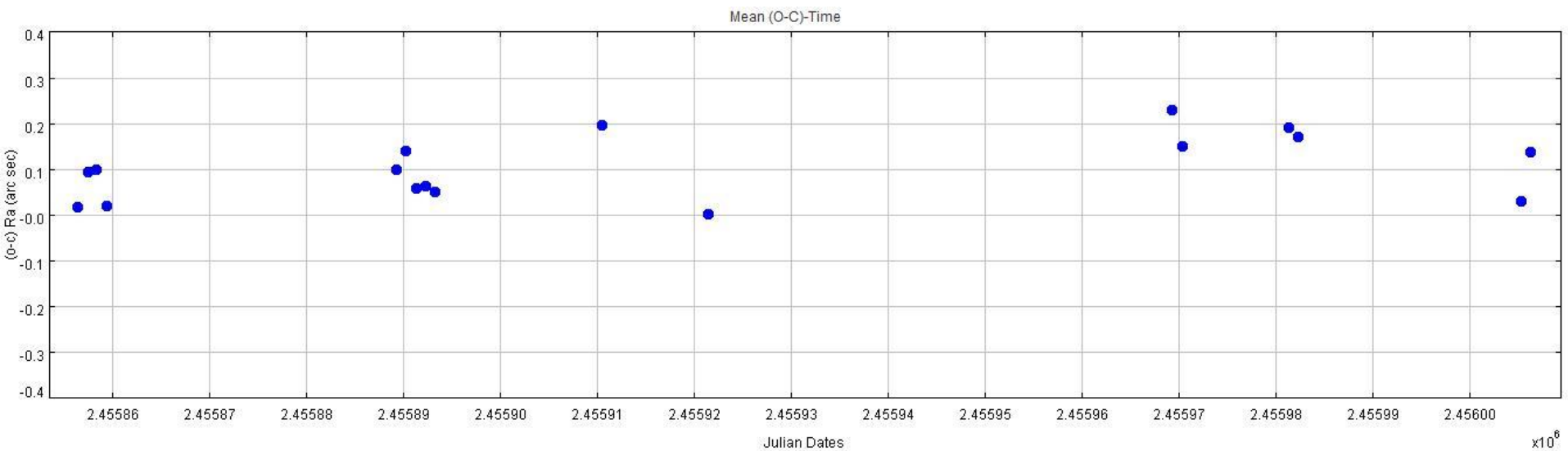


1665 (Gabby)

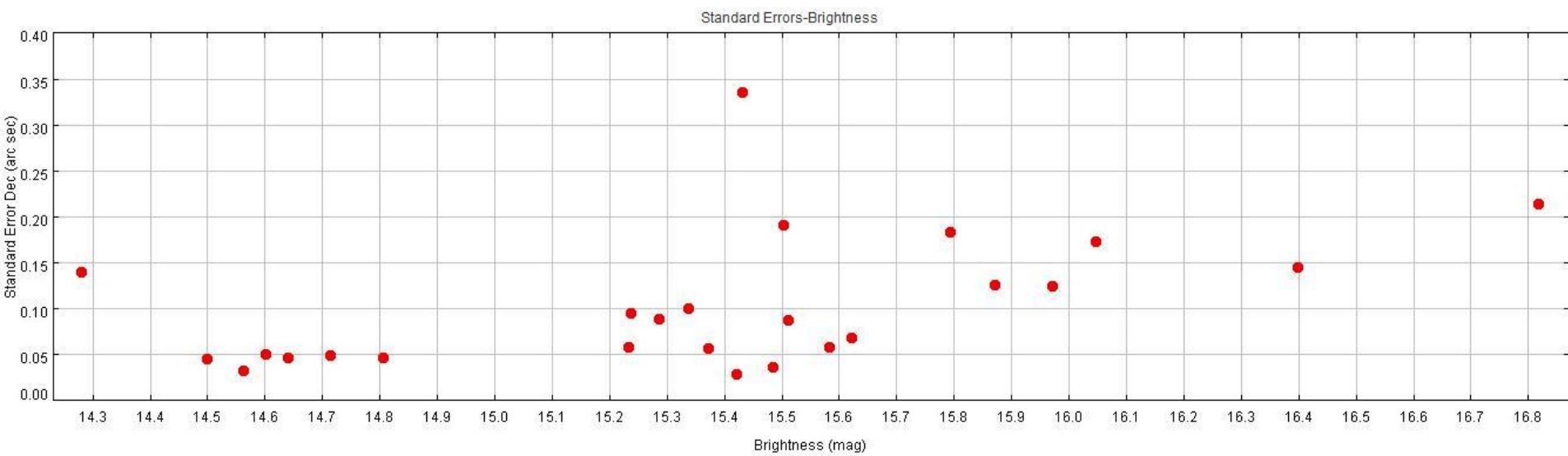
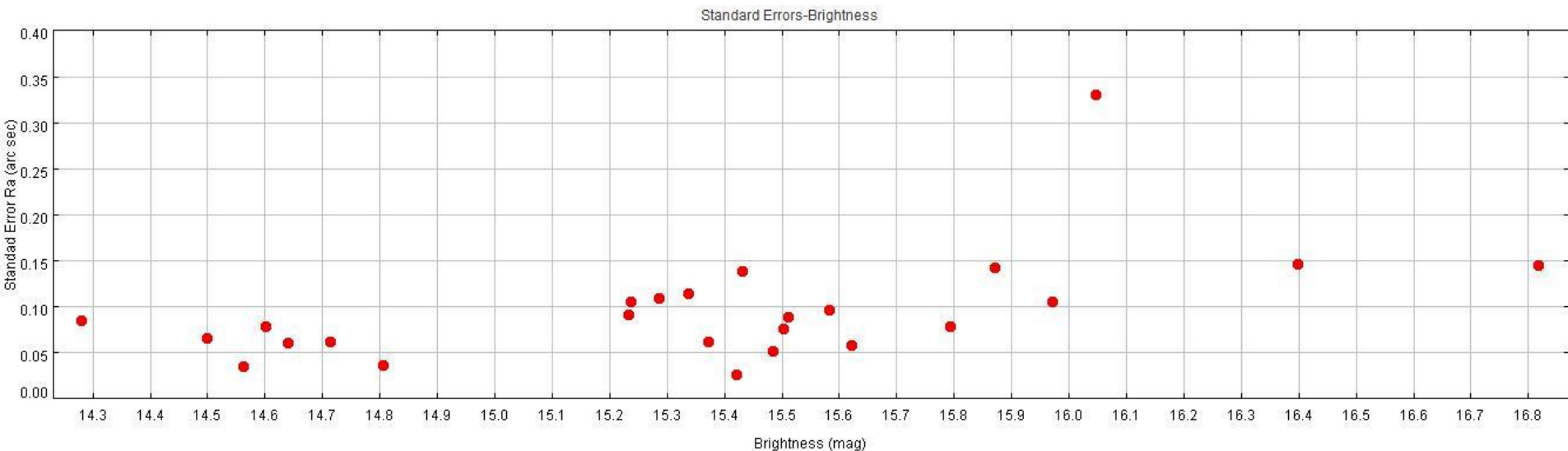
# Distribution of Mean (o-c) - Time for 1565 (Lemaitre)



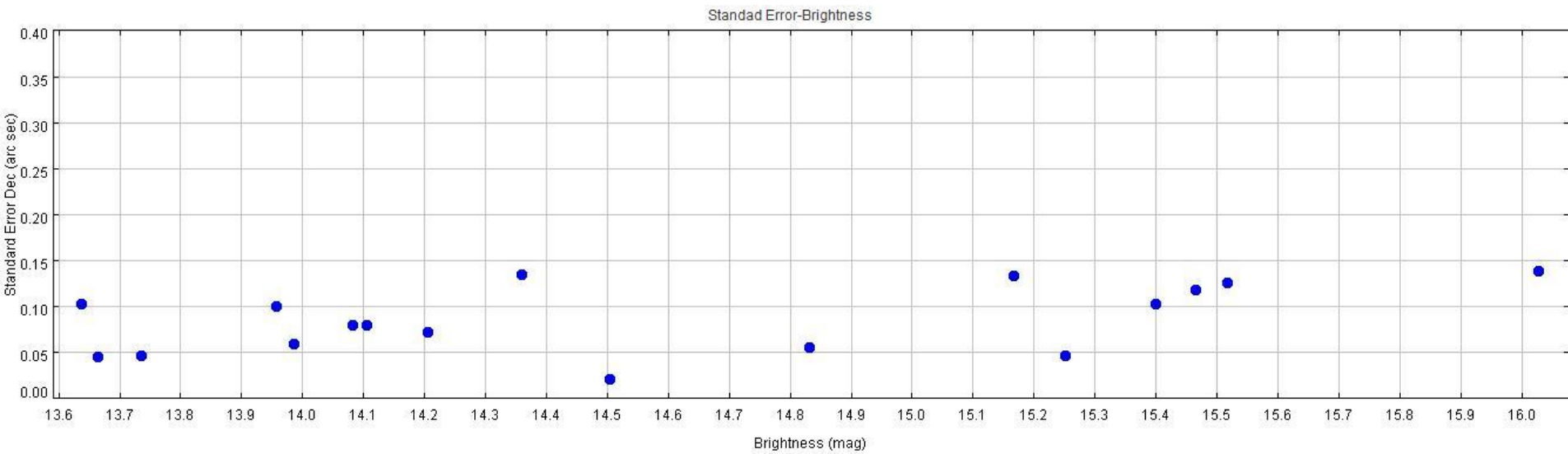
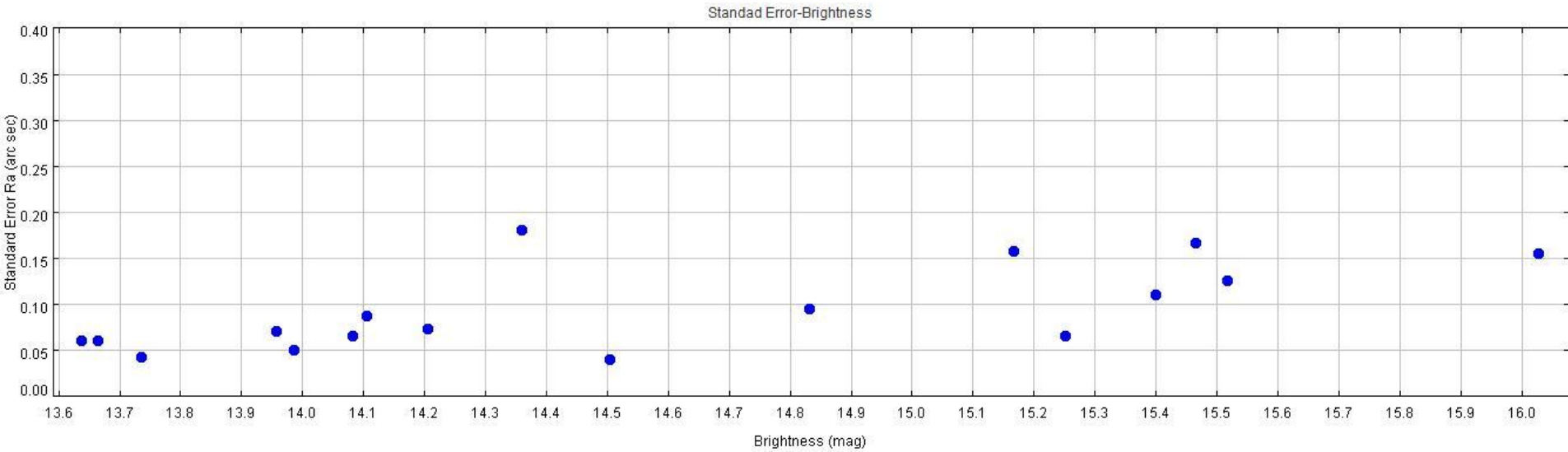
# Distribution of mean (o-c)-Time for 1665 (Gaby)



# Standard Errors For Ra and Dec of Lemaitre



# Standard Errors For Ra and Dec of Gaby



# Conclusion

- We obtained 654 observations in 27 nights for Lemaitre asteroid and 594 observations in 19 nights for Gaby asteroid
- Systematic error of the both asteroid is about  $0''.2$
- The available observations allow to improve the current orbit of the both asteroids (current orbit fit of the Lemaitre is  $0''.47$  and Gaby's is  $0''.53$ )

**Thank you for your  
attention**