GAIA AND SOLAR SYSTEM DATA

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GRANADA

SUMARY

- Stellar occultations by TNOs using Gaia DR2 data
- Astrometry of SS objects
- Photometry

- The future in DR3: Spectra, mass, more photometry and astrometry.

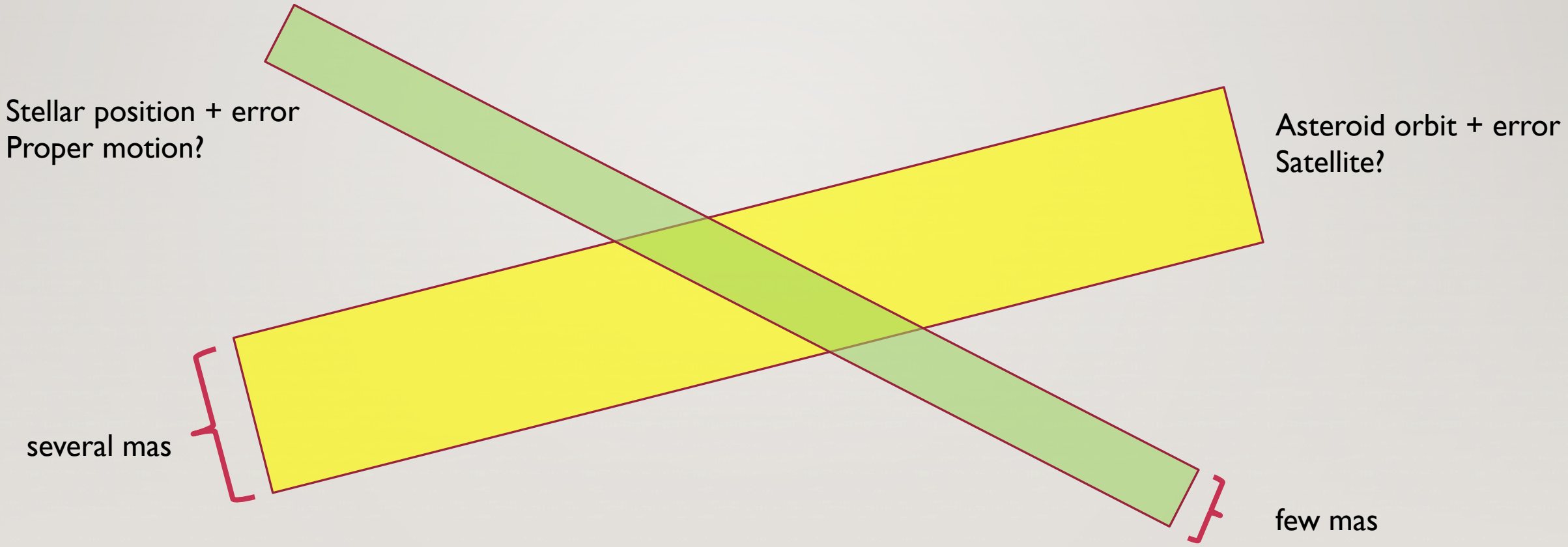
GAIA DR2

FLUXES FROM ASTEROIDS (2014 – 2017)

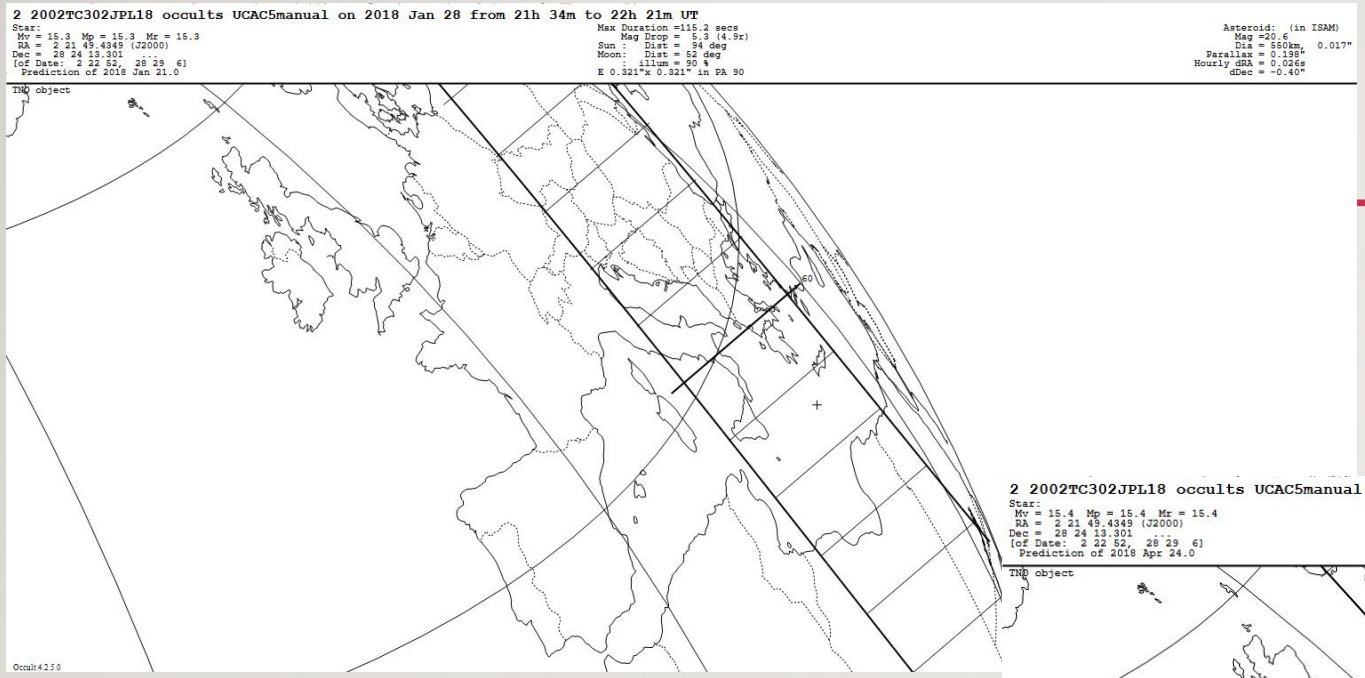
ASTROMETRY

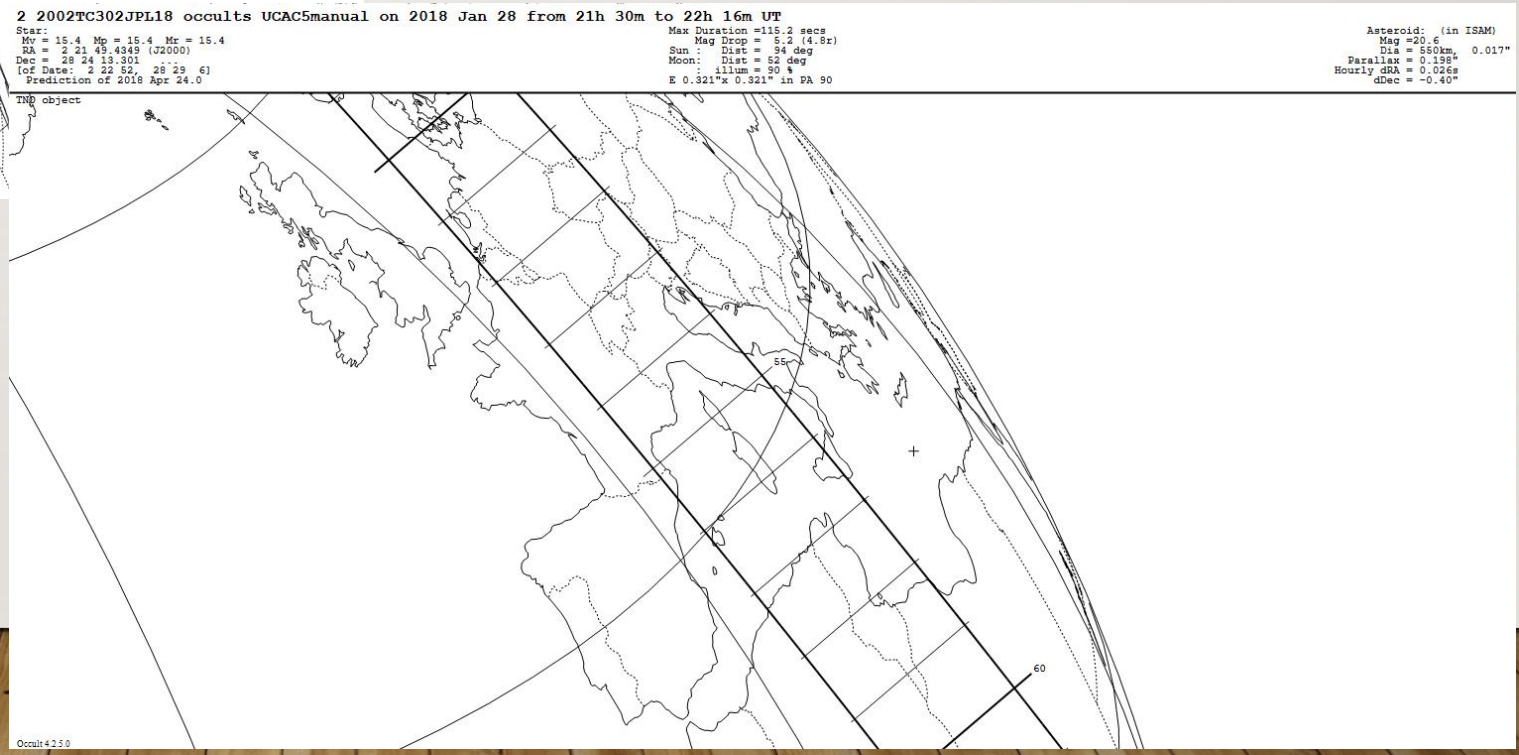
WHAT CAN WE DO WITH THESE DATA ?

STELLAR OCCULTATIONS



PREDICTION MAP



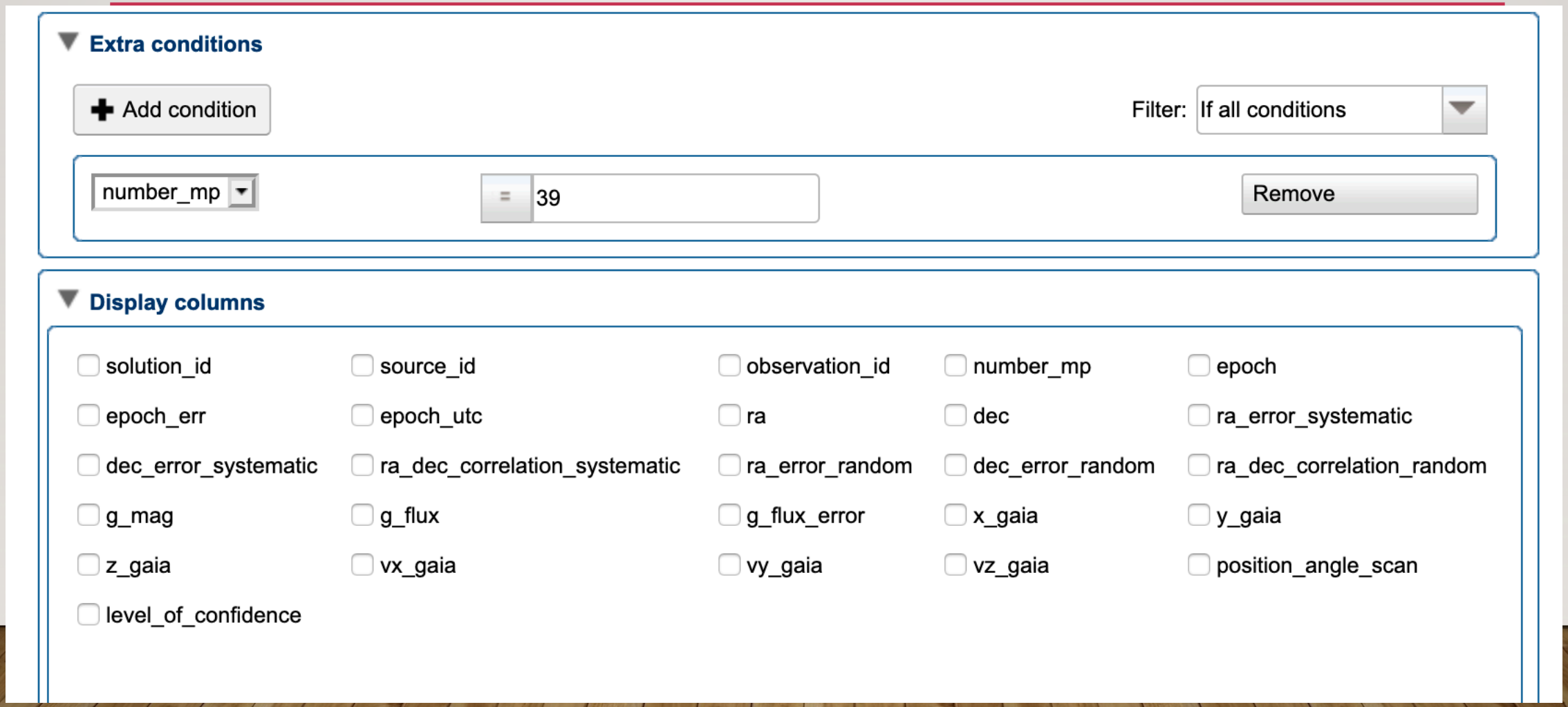


RESULTS

- Better predictions
- Less negatives observations

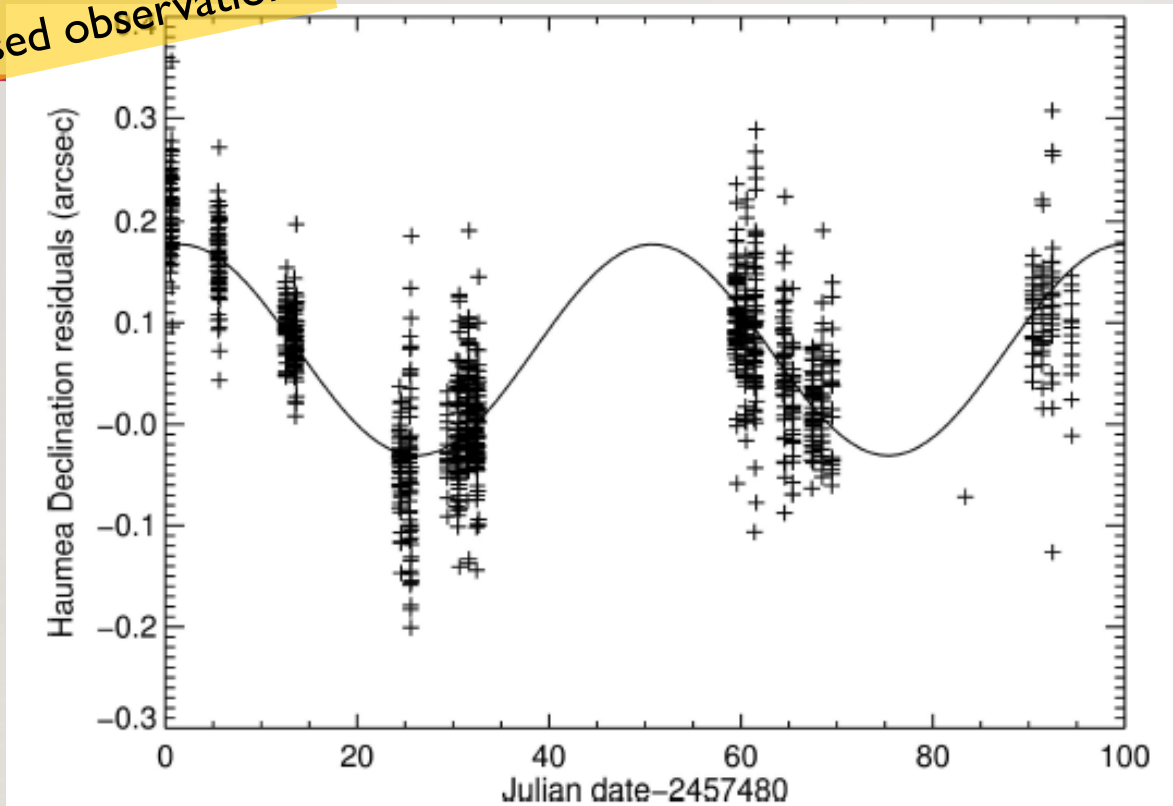
- Determination of Shape, Diameter and Albedo with <5% error
- Atmospheres
- Rings

DR2 DATA


Extra conditions
Add condition
Filter:
If all conditions
number_mp
=
39
Remove
Display columns
solution_id
source_id
observation_id
number_mp
epoch
epoch_err
epoch_utc
ra
dec
ra_error_systematic
dec_error_systematic
ra_dec_correlation_systematic
ra_error_random
dec_error_random
ra_dec_correlation_random
g_mag
g_flux
g_flux_error
x_gaia
y_gaia
z_gaia
vx_gaia
vy_gaia
vz_gaia
position_angle_scan
level_of_confidence

ASTROMETRY

Ground based observations



- Observations – JPL#81 ephem.
- Sinusoidal fit to the residuals
- Period = Hi'iaka

Photocenter is moving

Haumea is one of the few TNOs observed by GAIA

Ortiz et al. 2017. The size, shape, density and ring of Haumea. Nature, october 2017

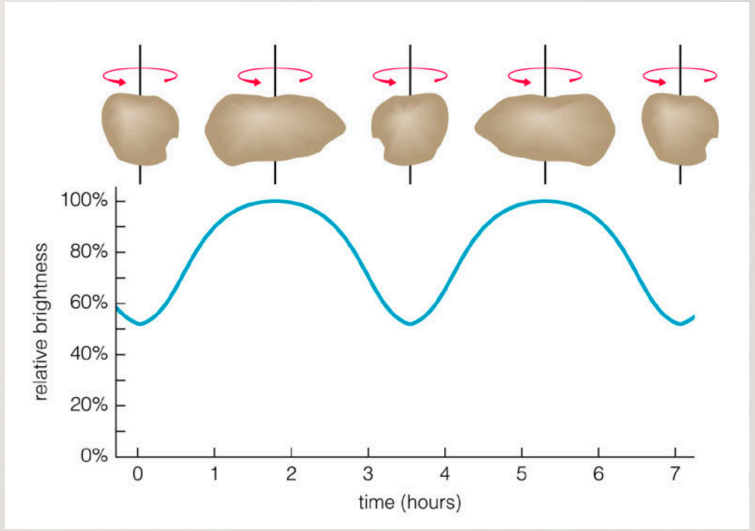
ASTROMETRY

- Can we determine the presence of a satellite using only DR2 astrometry?

- The larger satellite of Haumea is NOT detected using DR2 data
- The satellite of Patroclus is NOT detected using DR2 data

PHOTOMETRY

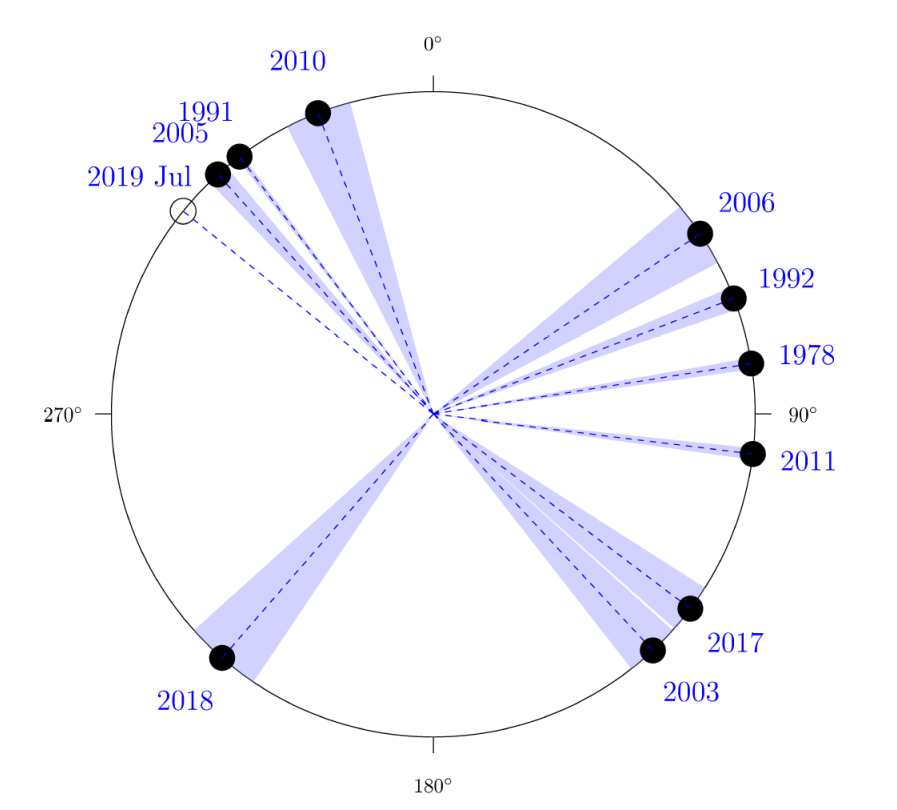
Real life



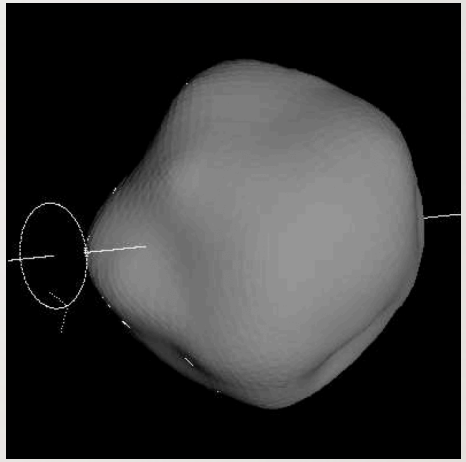
AFTER SEVERAL APPARITIONS

Shape
Rotation Pole direction

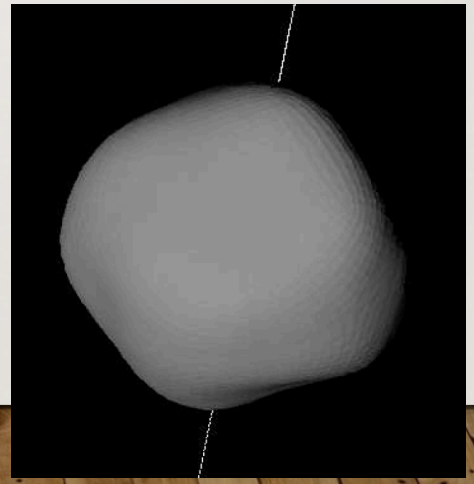
Diameter
Albedo } **problem**



Good detail in shape



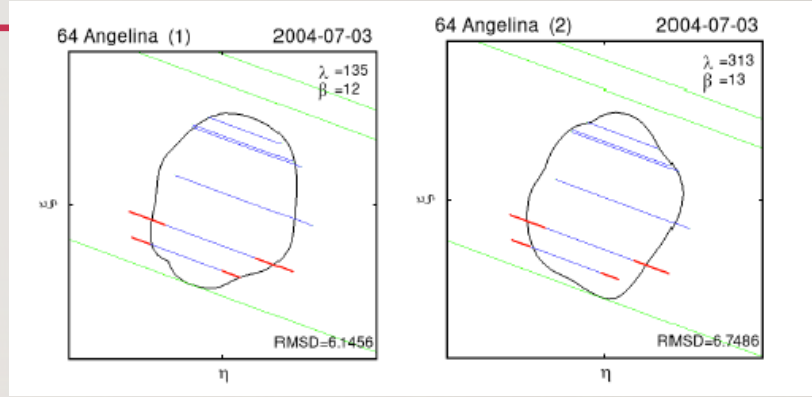
14 Irene



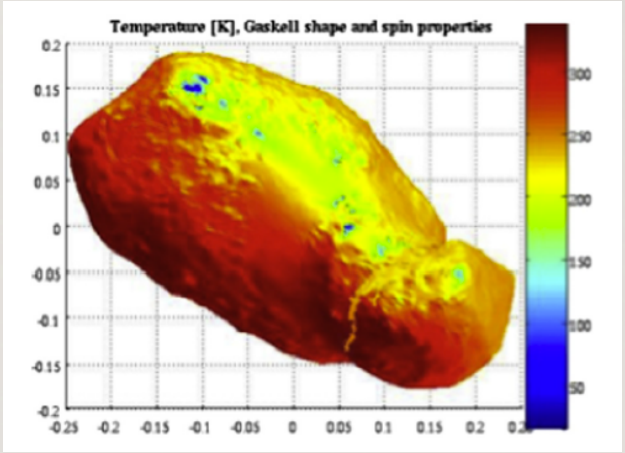
68 Leto

CAN WE SOLVE THE DETERMINATION OF DIAMETER AND ALBEDO ?

- 1) Observing a multichord occulation
- 2) Thermal modelling (data from Spitzer, Wise, Herschel)



- Determining absolute magnitude with Gaia



PHOTOMETRY

- Fluxes to magnitudes → g_{mag}

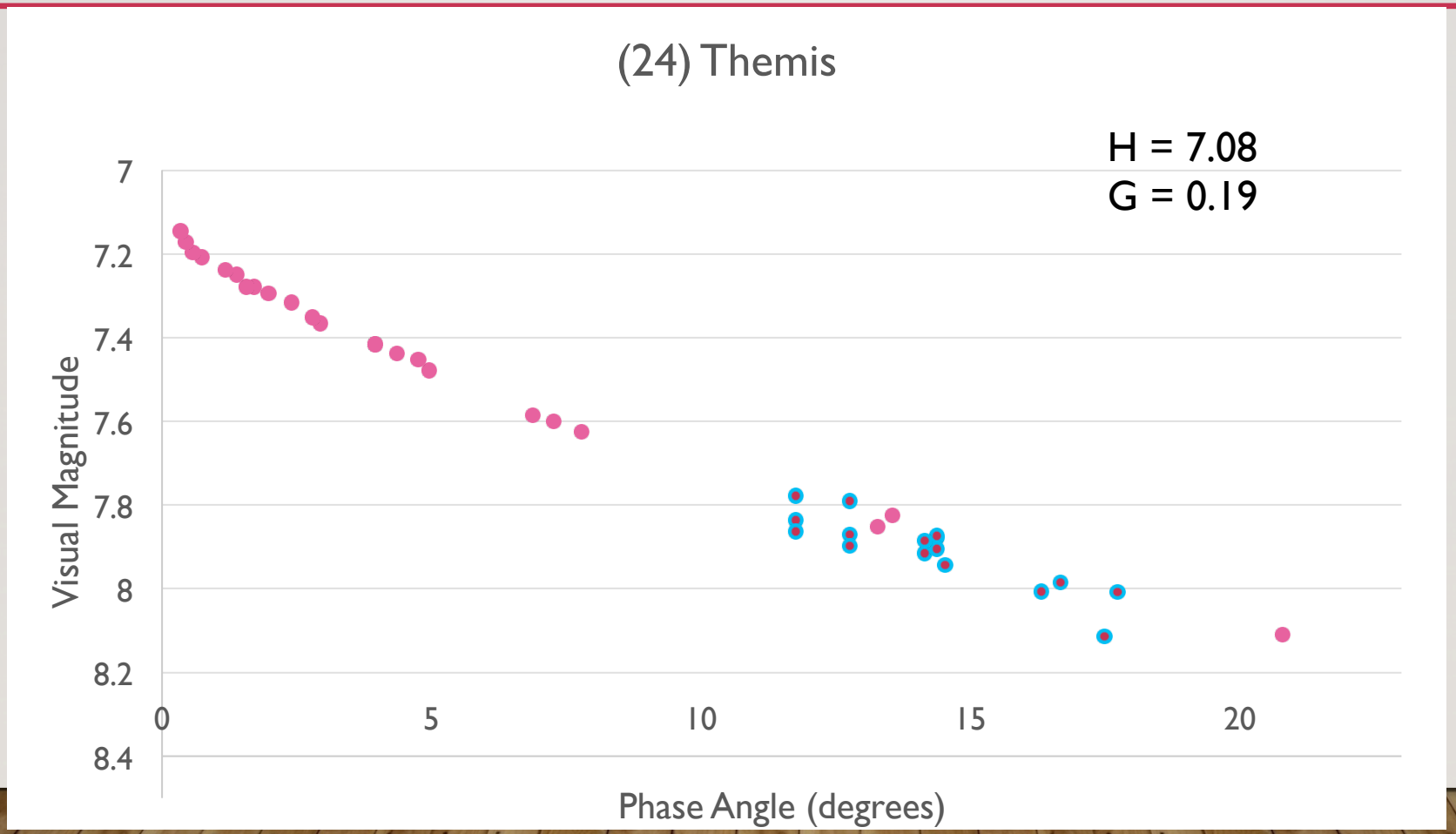
- Using JPL ephem → α, r, Δ, λ_{ast}, β_{ast}
- g_{mag} → $g(1,1,\alpha)$
- Using H,G system

$$V(\alpha) = H - 2.5 \log_{10} [(1 - G)\, \phi_1(\alpha) + G\, \phi_2(\alpha)$$

- $V(\alpha) = g(1,1,\alpha)$
- Assuming G = 0.15 …… We can obtain H_g

$$V(\alpha) = H - 2.5 \log_{10} [(1 - G)\, \phi_1(\alpha) + G\, \phi_2(\alpha)$$

$V - G = 0.008 + 0.190*(V - R) + 0.575*(V - R)^2$
(Jordi et al 2010)



Ellipsoid $a > b > c$

Rotational pole oriented to (λ_p, β_p)

$\lambda_{se} = \lambda_a +/- 180$
$\beta_{se} = -\beta_a$

(λ_a , β_a) = asteroid
(λ_p , β_p) = pole

Aspect angle is given by

$$\psi = 90 - \arcsin[\sin\beta_{se}\sin\beta_p + \cos\beta_{se}\cos\beta_p\cos(\lambda_{se} - \lambda_p)].$$

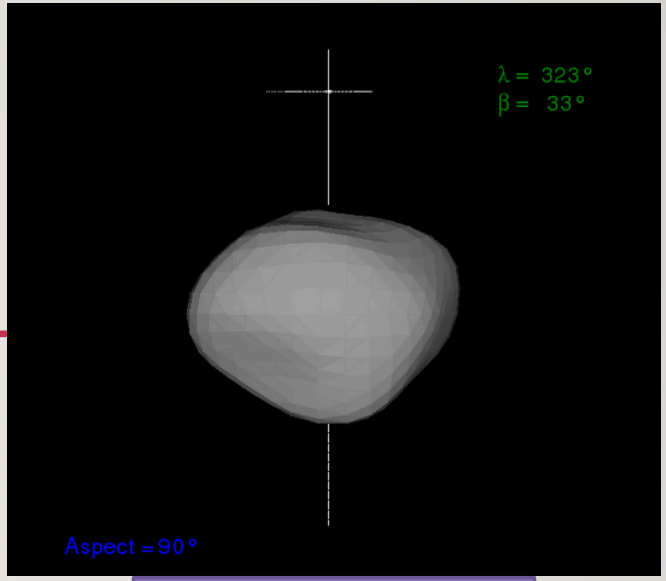
Lightcurve amplitude given by

$$\Delta m = 1.25\log\left[\frac{(\frac{b^2}{c^2})\cos^2\psi + \sin^2\psi}{(\frac{b^2}{c^2})\cos^2\psi + (\frac{b^2}{a^2})\sin^2\psi}\right],$$

Se = sub Earth point in the asteroid reference frame

Tegler et al 2005

DIFFERENT CASES

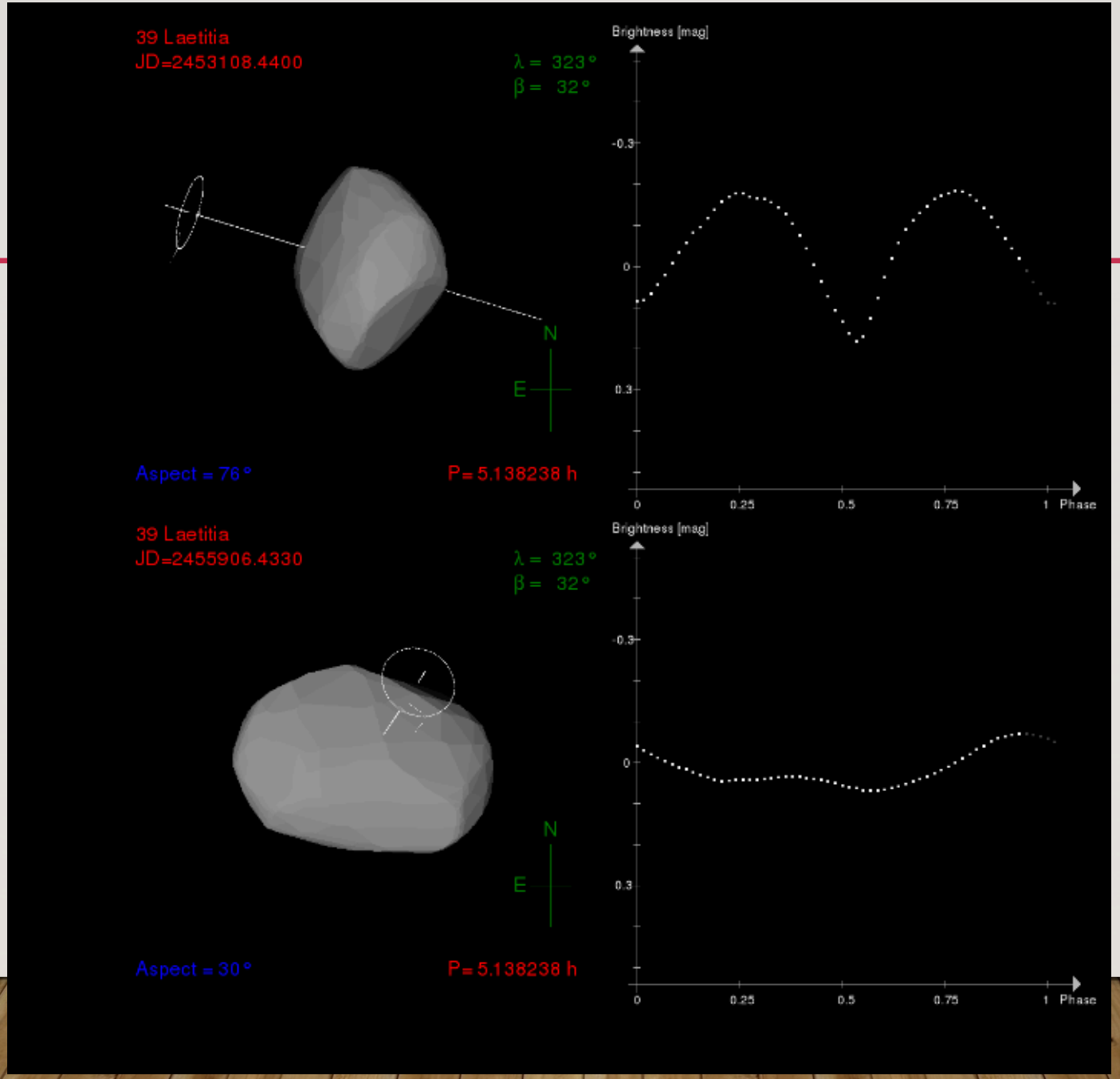


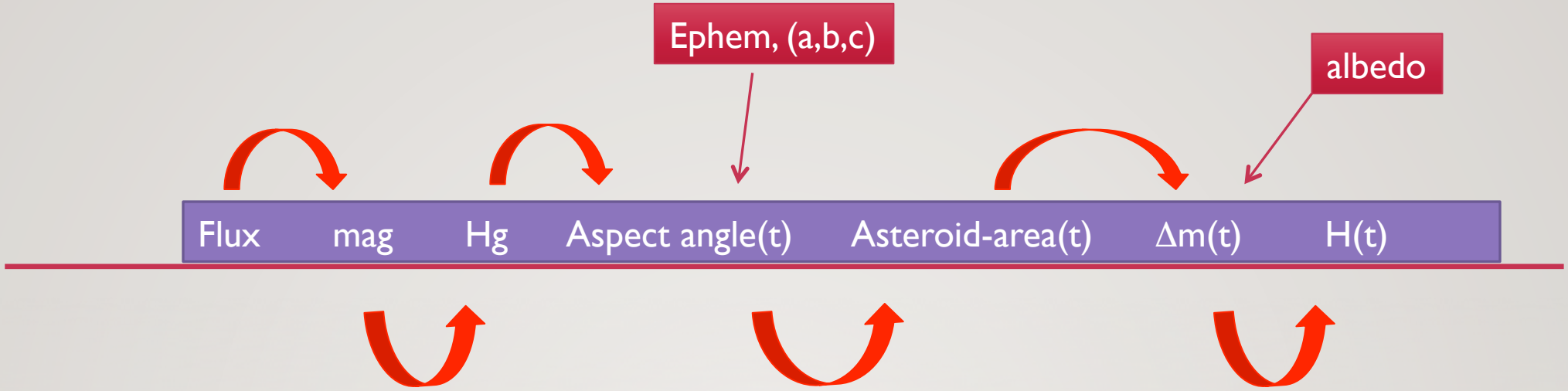
39 Laetitia

P = 5.138238 hrs

H = 6

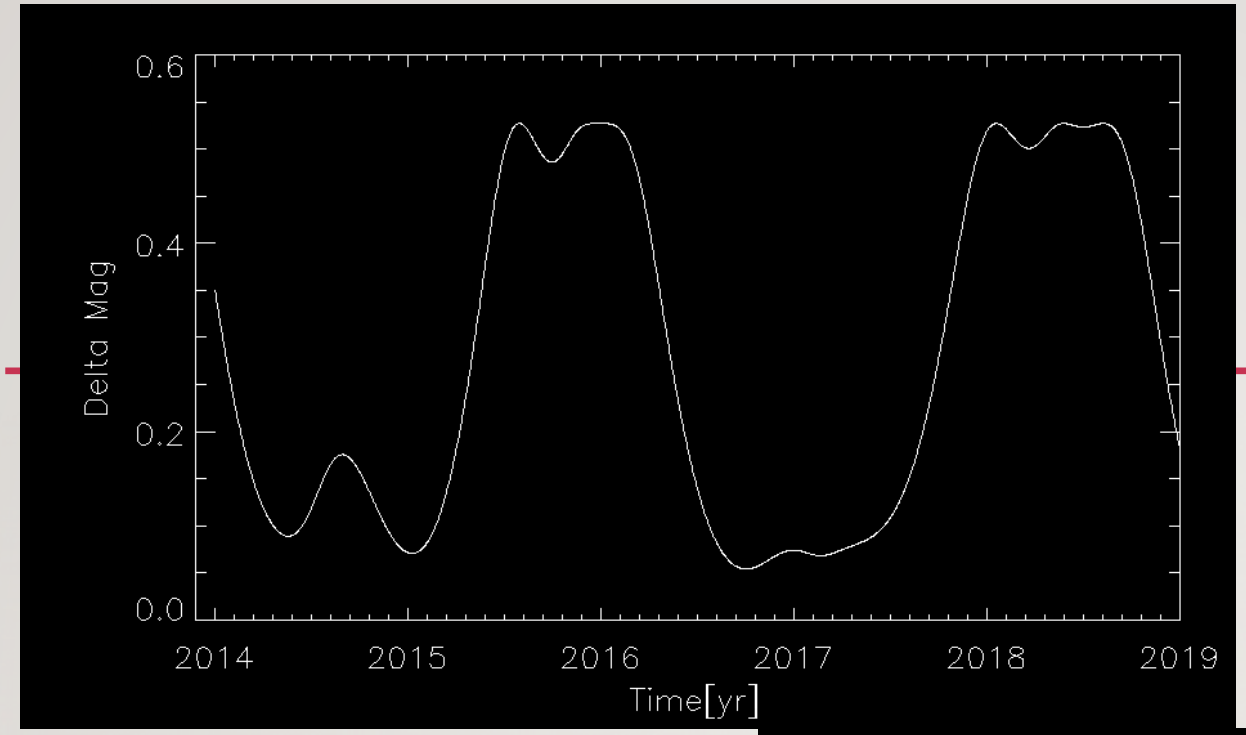
- Use of well determined shape from LC database (http://isam.astro.amu.edu.pl/)
- Use of ellipsoidal shape
- With pole determination to check if the result is correct


39 Laetitia
JD=2453108.4400
λ = 323°
β = 32°
N
E
Aspect = 76°
P= 5.138238 h
Brightness [mag]
-0.3
0
0.3
0
0.25
0.5
0.75
1
Phase
39 Laetitia
JD=2455906.4330
λ = 323°
β = 32°
N
E
Aspect = 30°
P= 5.138238 h
Brightness [mag]
-0.3
0
0.3
0
0.25
0.5
0.75
1
Phase



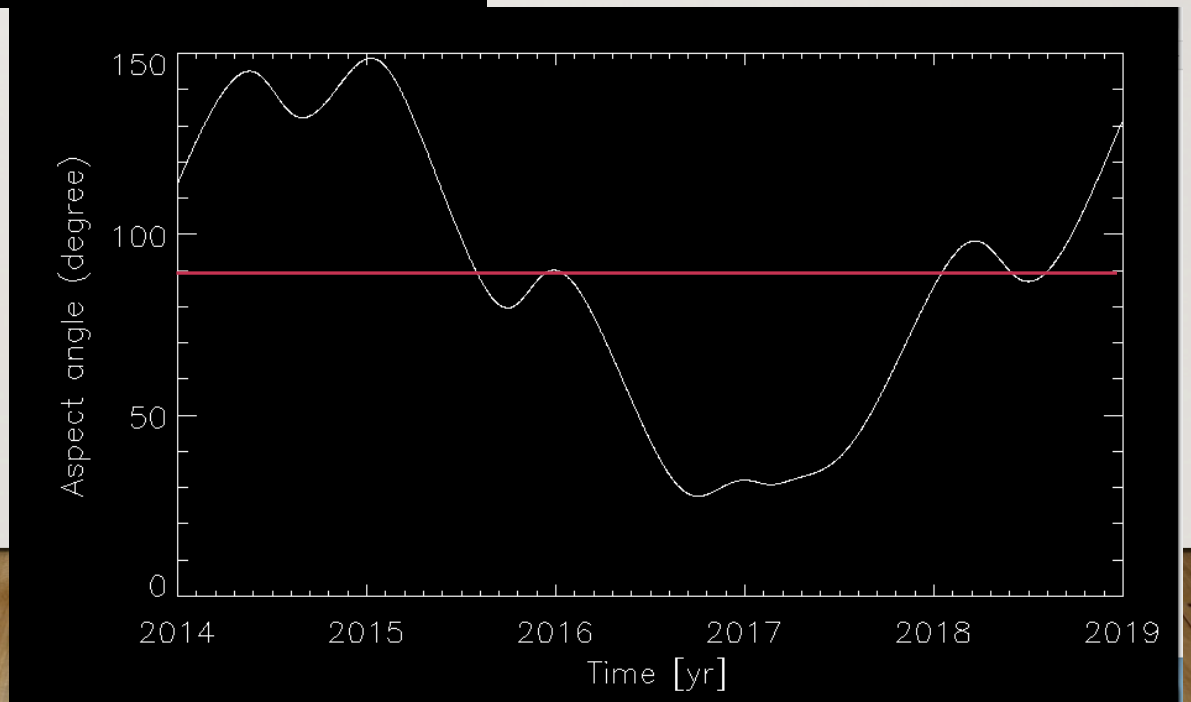
Inputs: (a,b,c in Km), albedo, λ_p, β_p

Outputs

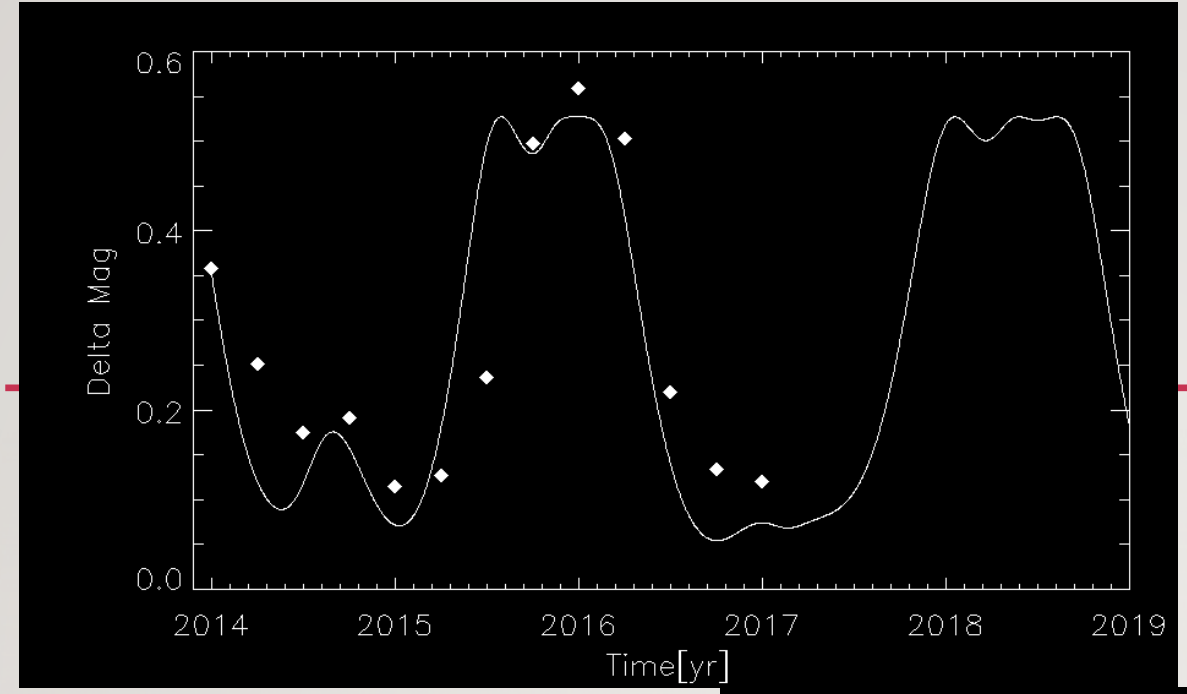


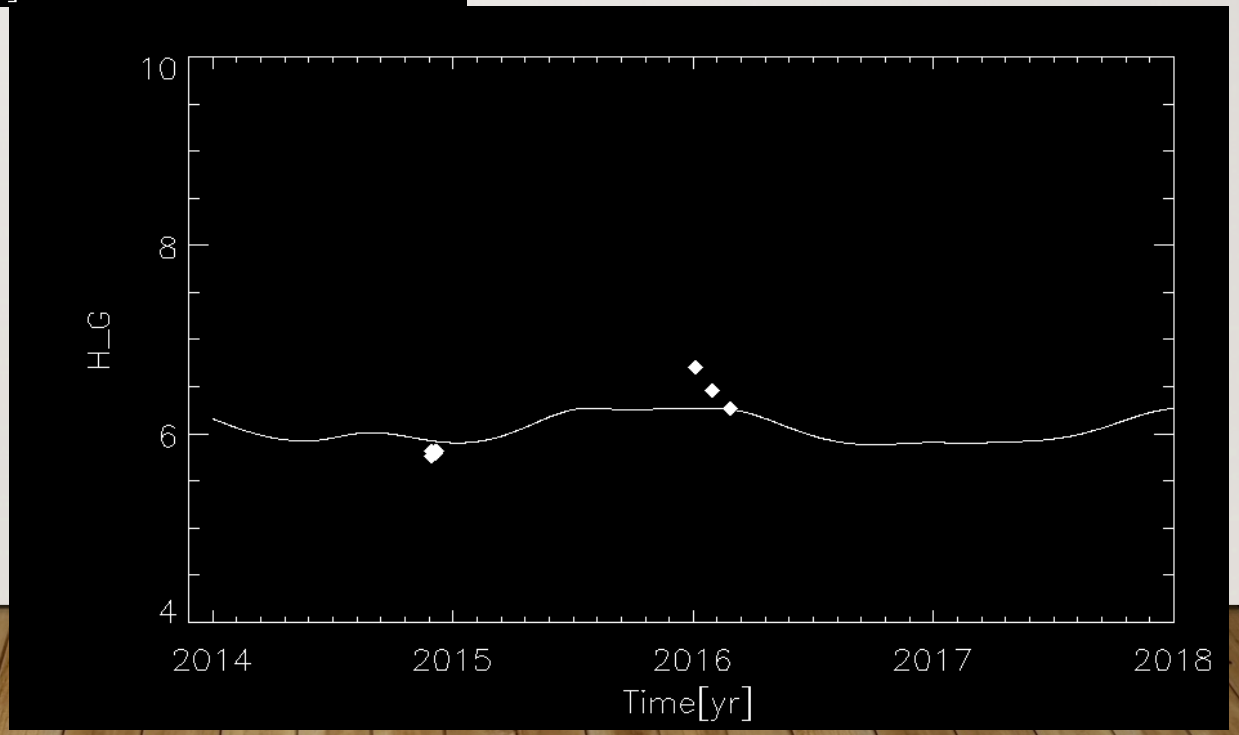
Δm vs. Time

Aspect angle vs Time



39 LAETITIA


0.6
0.4
0.2
0.0
Delta Mag
2014
2015
2016
2017
2018
2019
Time[yr]


10
8
6
4
H_G
2014
2015
2016
2017
2018
Time[yr]

RESULTS: 39 LAETITIA

H = 6
λ_P = 317
β_P = 33

a = 130 km
b = 80 km
c = 65 km

Albedo = 0.20

H = 6.1
λ_P = 323
β_P = 33

Neowise Diam = 179 km
NeoWise Albedo = 0.22

Sumary for DR2

- Very good for stellar occultations

- Still not good for asteroid astrometry → search for satellites, mass determination

- Very good for asteroid photometry → H, G determination
  - → phase angle coverage (15° – 30°)
  - → Size determination (model dependant)

Future: More time coverage, more points. Better astrometry/photometry. Mass determination. SPECTRA !!