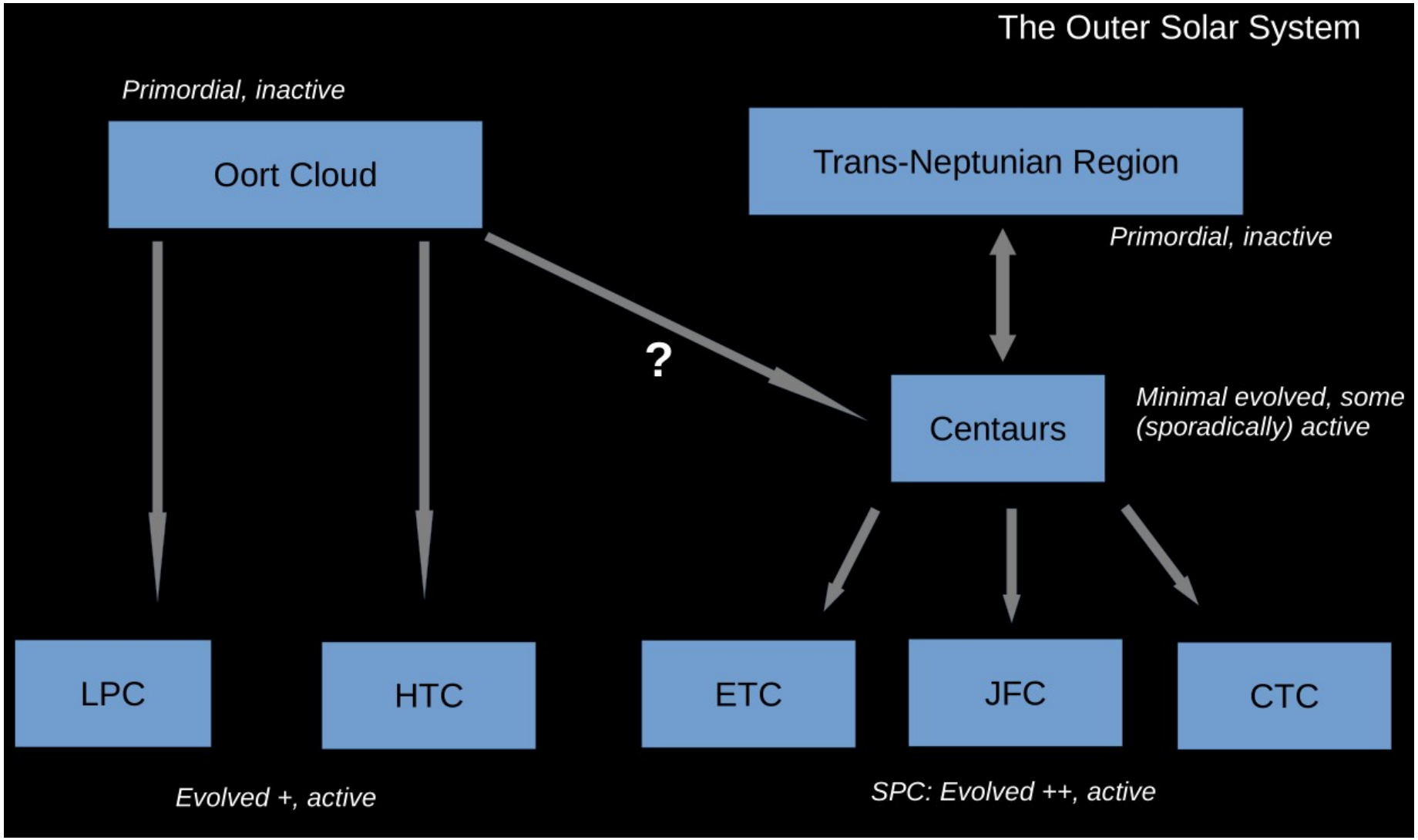
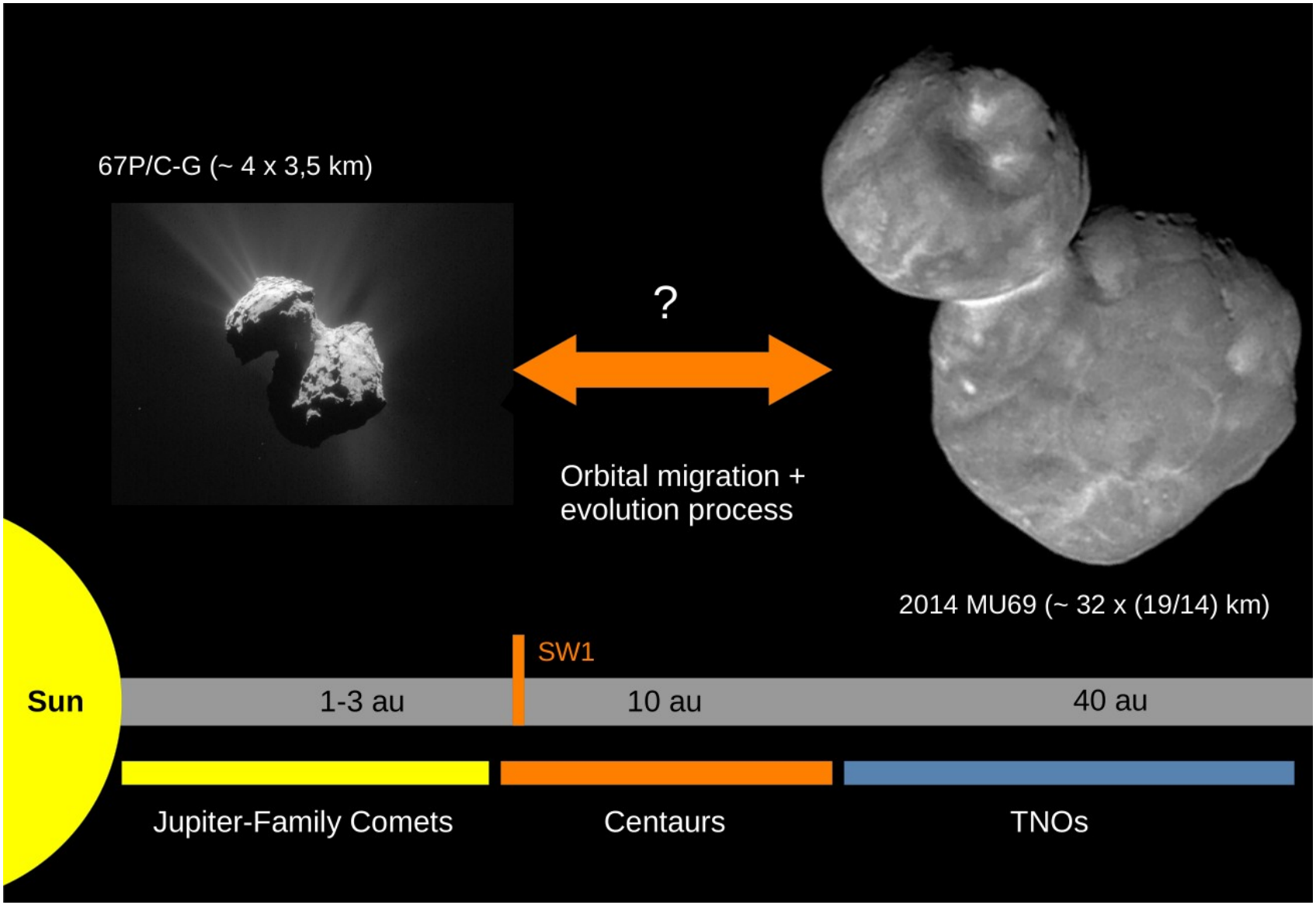
On the stellar occultations by comets 28P and 430P

Mike Kretlow, IAA-CSIC & IOTA / ES

ESOP41, Granada, Spain, 10-11 September 2022

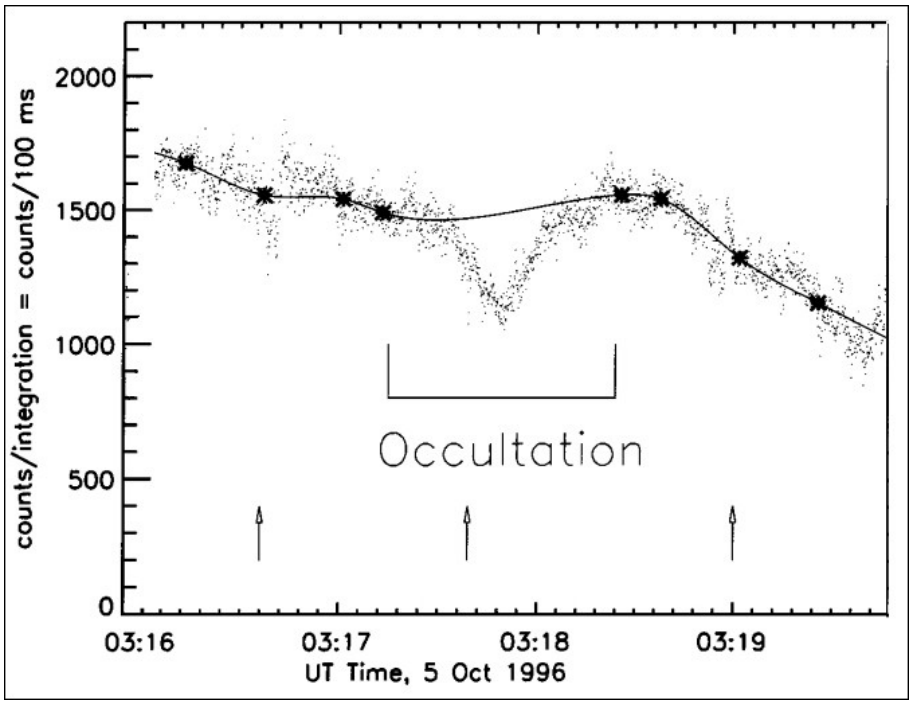
S. Sposetti, A. Ossola, L. Buzzi, A. Aletti, P. Baruffetti, G. Casalnuovo, C. Perello, A. Selva, and J.M. Winkel


The Outer Solar System
Primordial, inactive
Oort Cloud
Trans-Neptunian Region
Primordial, inactive
?
Centaurs
Minimal evolved, some (sporadically) active
LPC
HTC
ETC
JFC
CTC
Evolved +, active
SPC: Evolved ++, active


67P/C-G (~ 4 x 3,5 km)
?
Orbital migration +
evolution process
2014 MU69 (~ 32 x (19/14) km)
SW1
Sun
1-3 au
10 au
40 au
Jupiter-Family Comets
Centaurs
TNOs

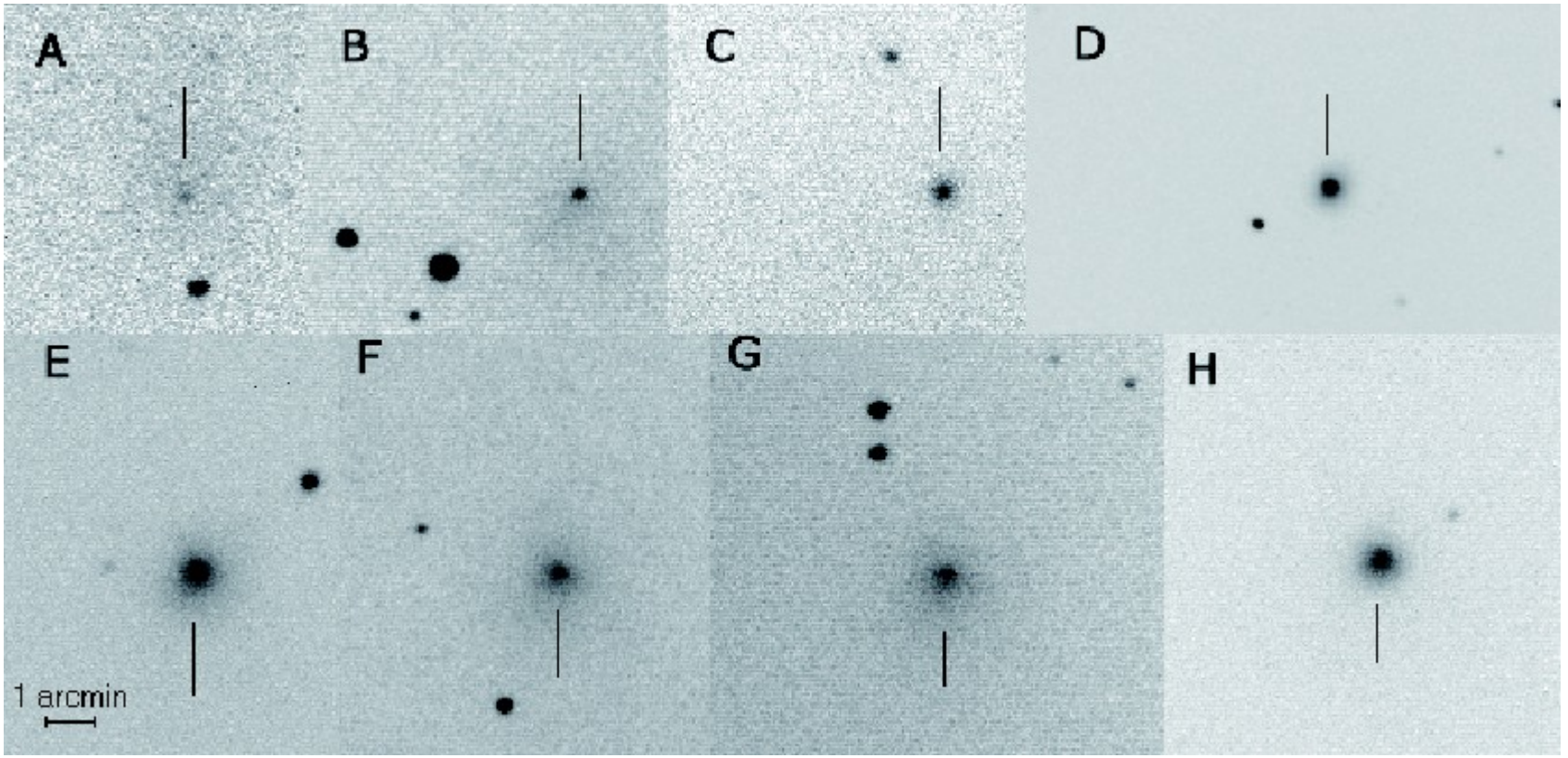
Challenges / problems

- Comet nuclei are typically small (SPC, JFC).
- Optical depth of the (gas) coma is very low. Flux drops might be detectable very close to the nucleus (appulse).
- Dusty / clumpy regions (shells etc.)



Positive event recorded showing the occultation of a 9mag star by the nucleaus or Near-nucleus region of comet Hale-Bopp (Fernández+ 1999)

Outburst of comet and Centaur object 29P/Schwassmann-Wachmann 1

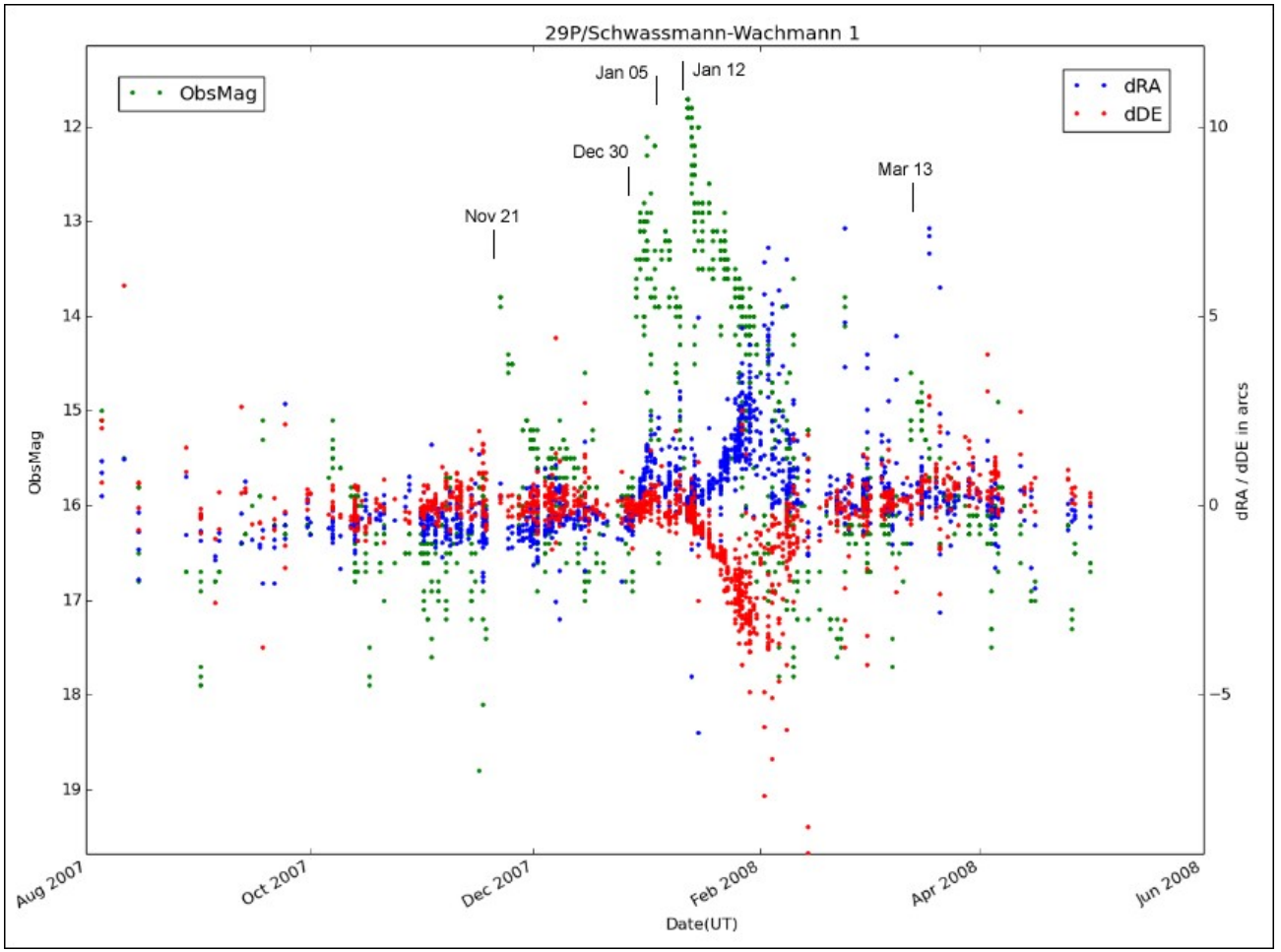


Trigo-Rodríguez+2008

This composite photo shows the fascinating evolution of Comet 29P/S-W1 starting during a previous bright outburst from June 16, 2013 (lower left) to July 28, 2013. The comet typically exhibits a characteristic horseshoe or spiral shape as it evolves because we view the outburst side-on across one hemisphere. Comet 29P appears to rotate slowly with a possible period of 57 days.
Damian Peach

From skyandtelescope.org

Astrometry biased by cometary activity

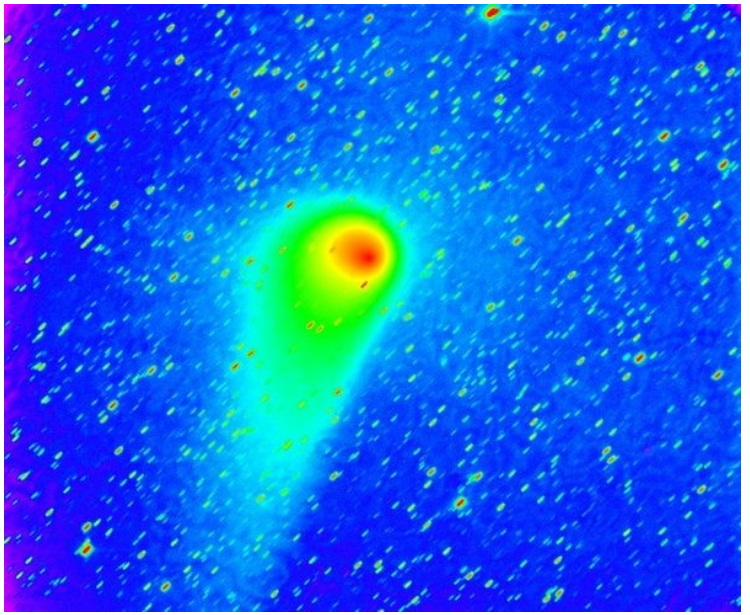


Existing weighting schemes (orbit fit) based on asteroidal residual statistics (e.g. Veres+2017) might be not appropriate / useful.

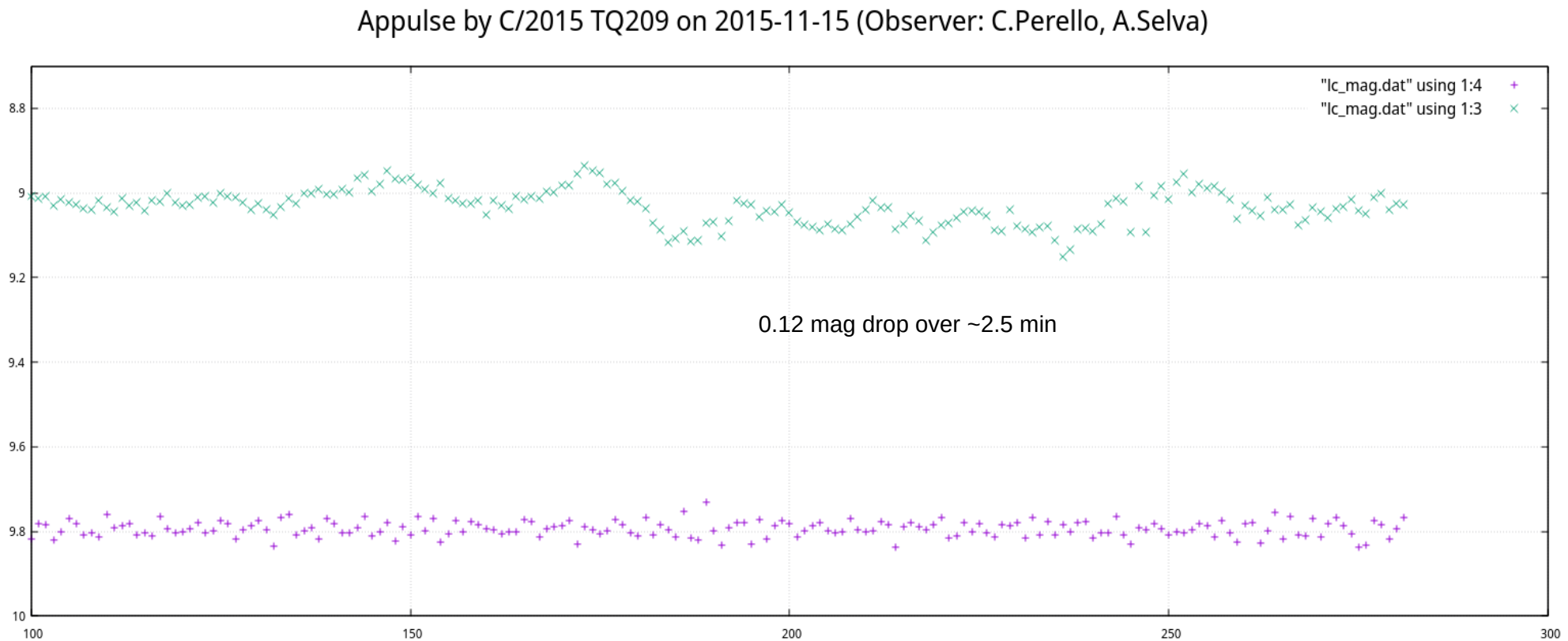
Careful selection of astrometric observations is needed.

Challenges / problems

- Cometary orbits are often less accurate than asteroid orbits due to less accurate astrometry.
- Biasing effects: photocenter offset / light-shift
- Orbital dynamics more complex (n.g. forces etc.)
- => ephemerides less accurate
- => less accurate occultation predictions => few O+/O? yet



Comet C/2017 K2 (PanSTARRS)
on 2022 July 27/28. CAHA 1.23-m


Appulse by C/2015 TQ209 on 2015-11-15 (Observer: C.Perello, A.Selva)
"lc_mag.dat" using 1:4
"lc_mag.dat" using 1:3
0.12 mag drop over ~2.5 min
8.8
9
9.2
9.4
9.6
9.8
10
100
150
200
250
300

t0 = 01:47:33 UT +- 0.2 min, Star: EDR3 0225755992321538048, Ast.Diam = 21 km, Orb.Ref.: JPL#63, Moon: 30° (45%)

Comet 28P/Neujmin 1

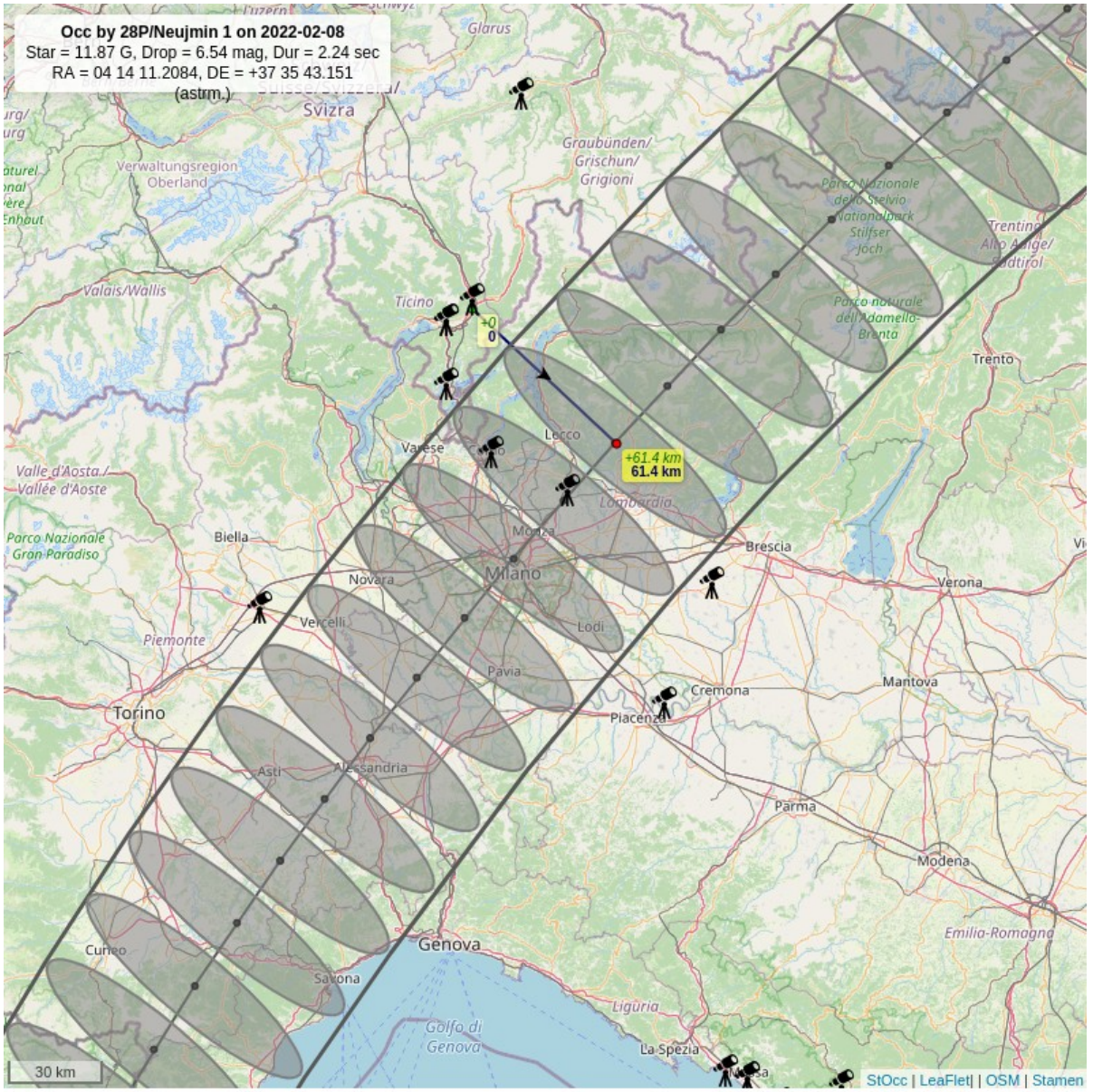
Jupiter family comet (JFC)

R = 10.6 +/- 0.5 km (a/b = 1.5)

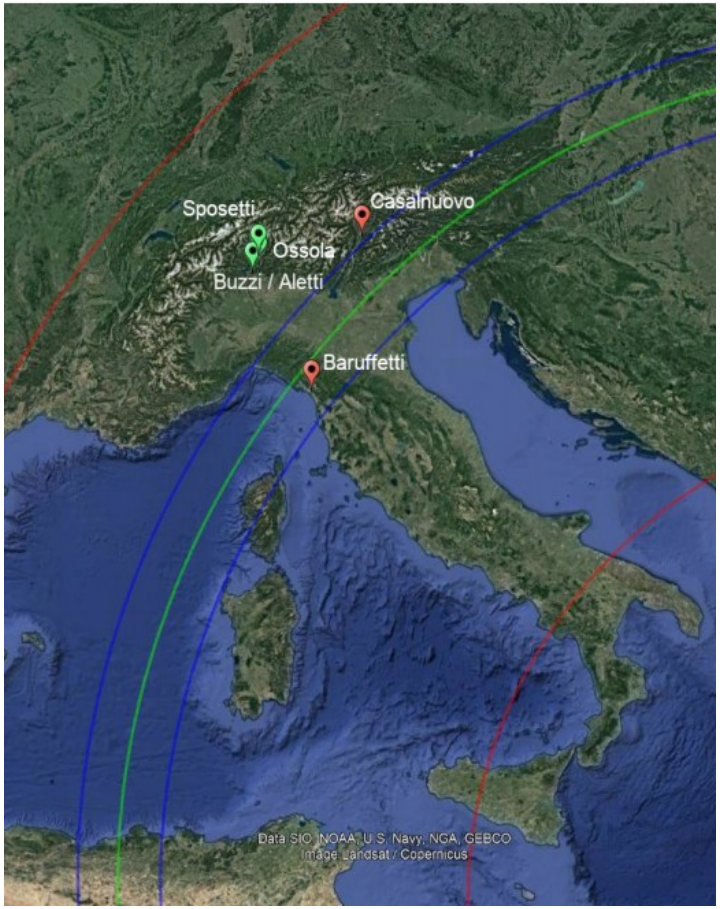
$p_V = 0.026$, $p_R = 0.04$

P = 12.75h

(Lamy et al., Comets II)



t0 = 01:47:33 UT +- 0.2 min, Star: EDR3 0225755992321538048, Ast.Diam = 21 km, Orb.Ref.: JPL#63, Moon: 30° (45%)



COMETOCC feed prediction
(from Sposetti 2022)

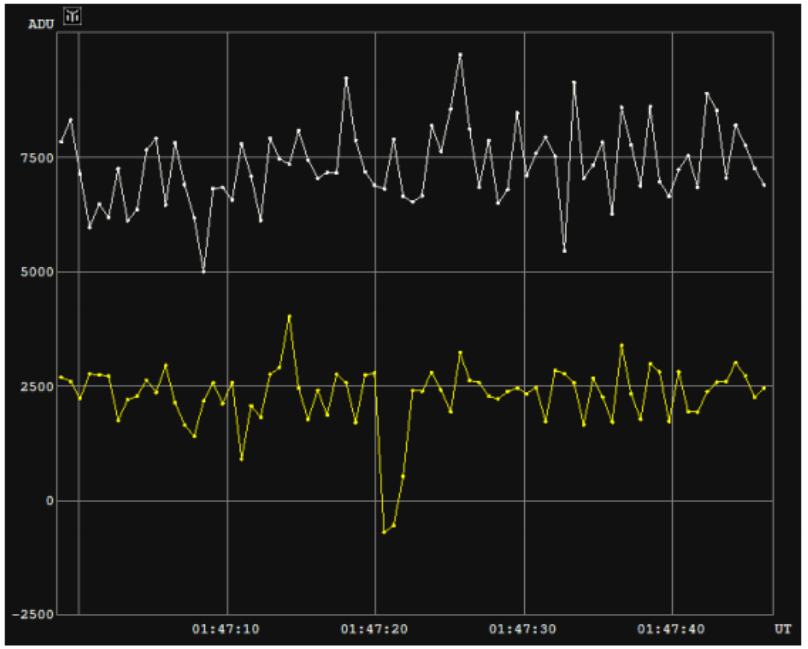
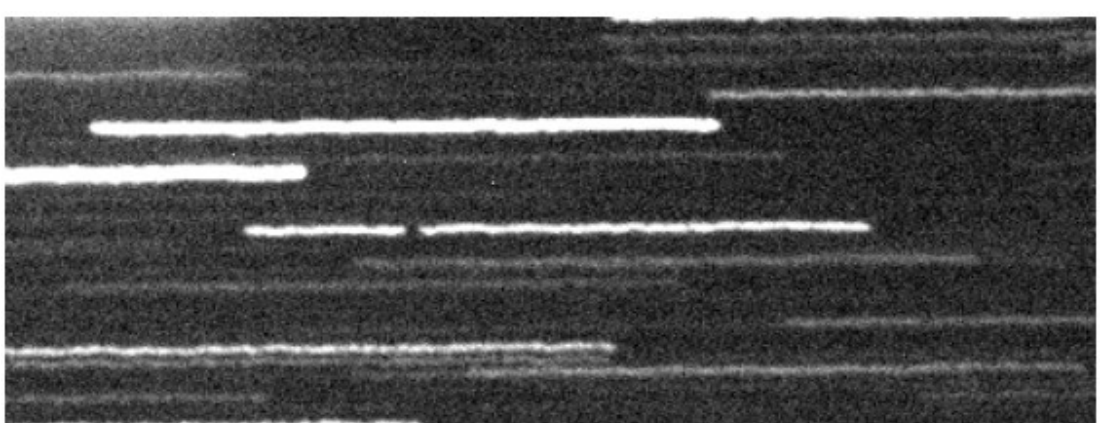


Figure 1. *The lightcurve (yellow) of the event and comparison star (white) obtained by S. Sposetti (0.64 s integration time, 0.20 m aperture telescope). Observed duration of the occultation: 1.76 ± 0.58 s, derived with Tangra.*

Figure 2. The lightcurve obtained by Alberto Ossola, Muzzano, Switzerland, 0.32 s integration time.
Observed duration: 1.28 ± 0.23 s, derived with Tangra.

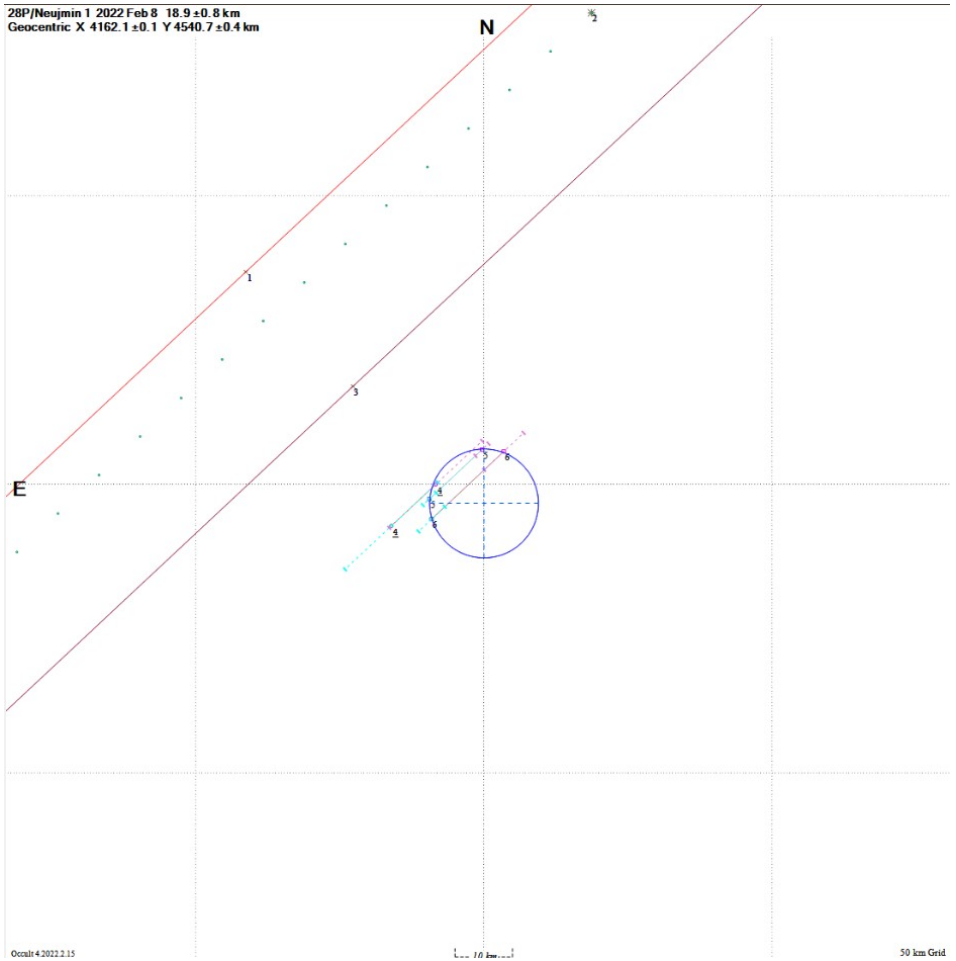


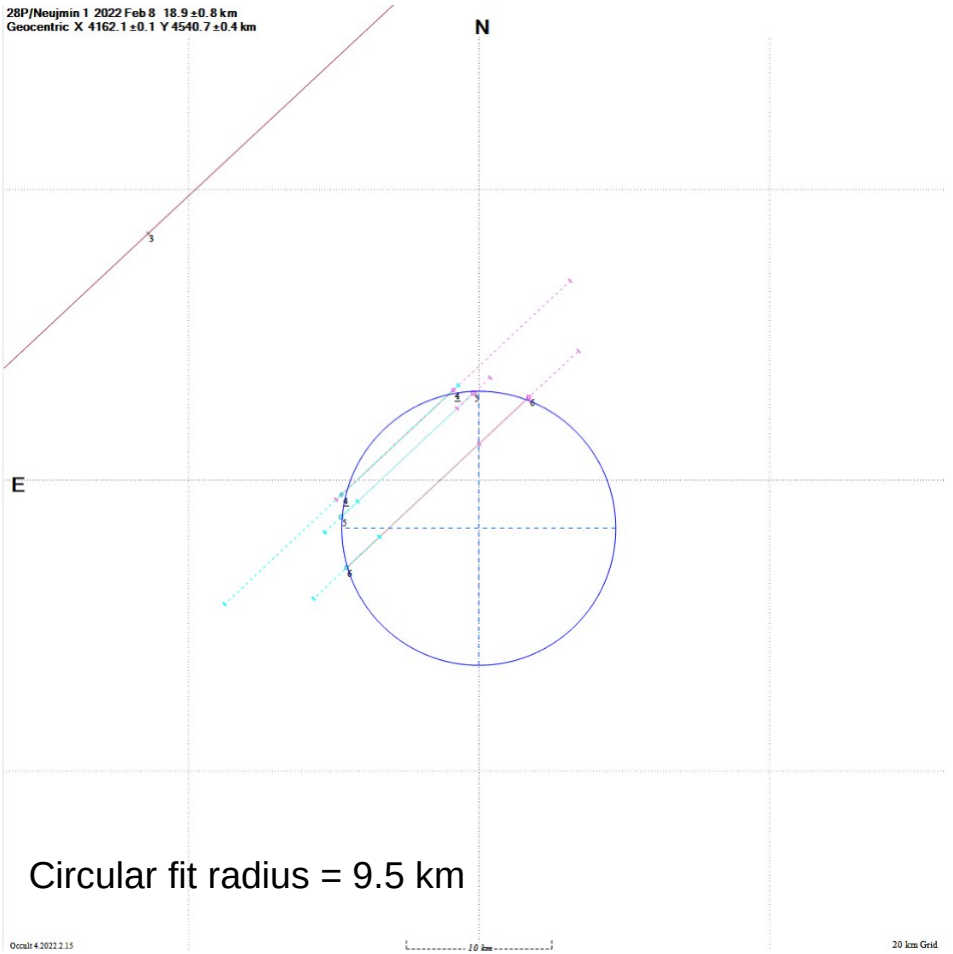
CCD drift-scan observation
(Luca Buzzi and Andrea Aletti)

From:
Sposetti 2022

Occultation by 28P on 2022-02-08

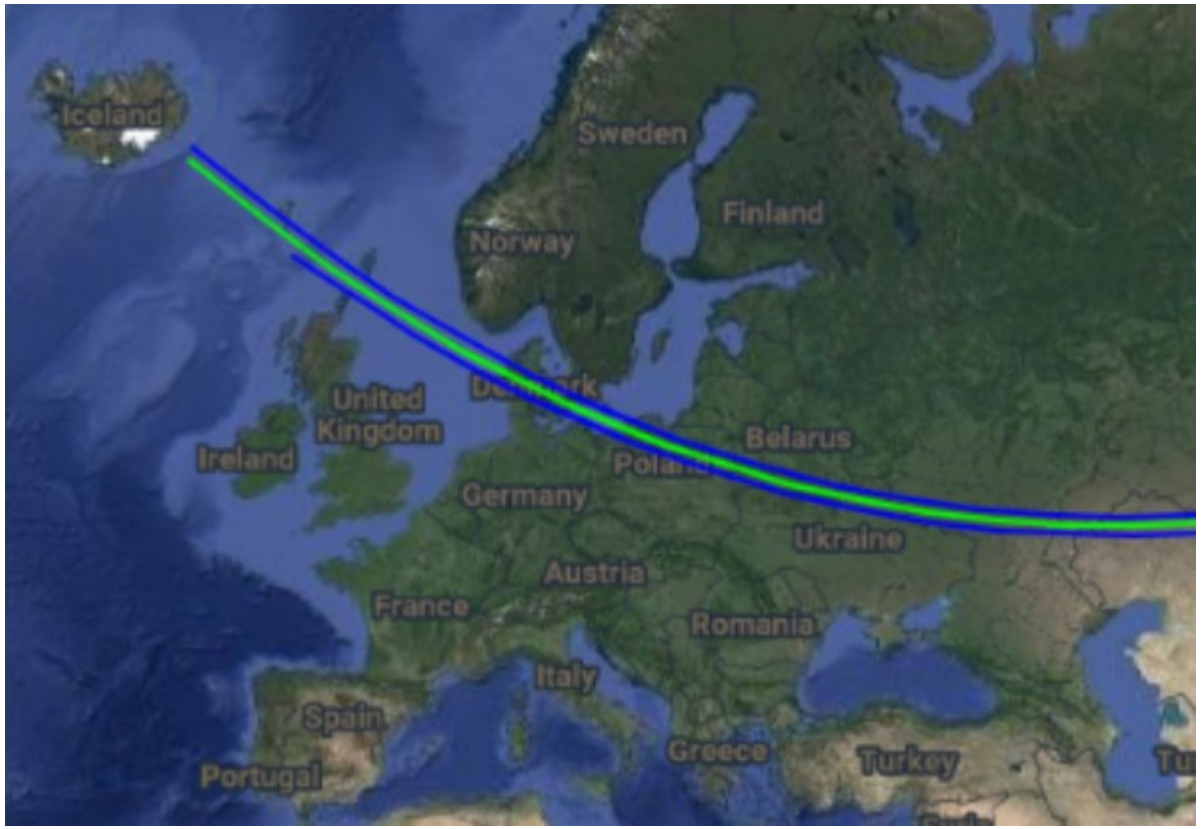
Observer: L. Buzzi/A. Aletti (O+),
S. Sposetti (O+), A. Ossola (O+),
P. Baruffetti (O-), G. Casalnuovo (O-)





Circular fit radius = 9.5 km

430P/Scotti occults 6-mag star on 27 April 2022

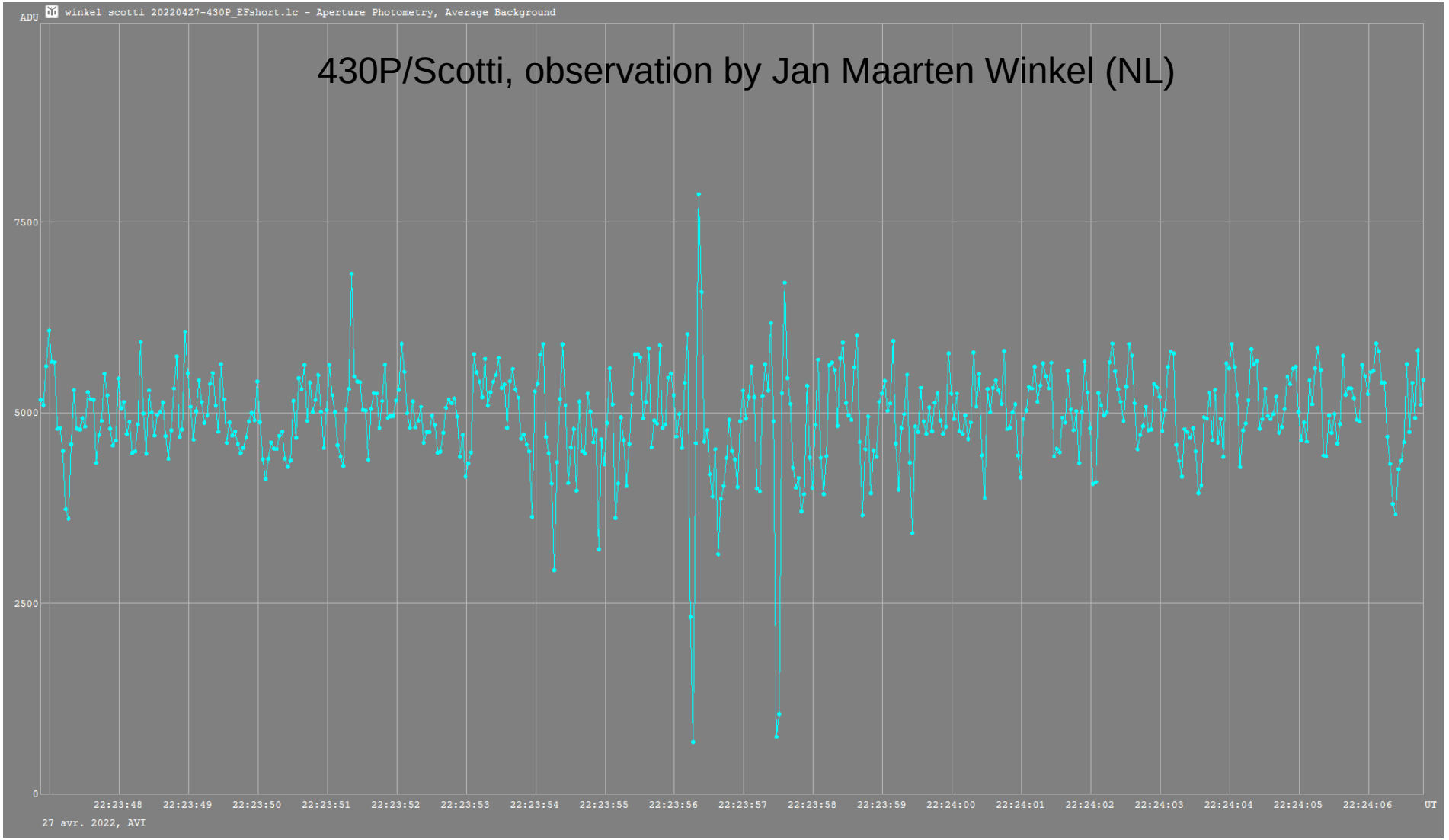


Integration time: 0,02 s

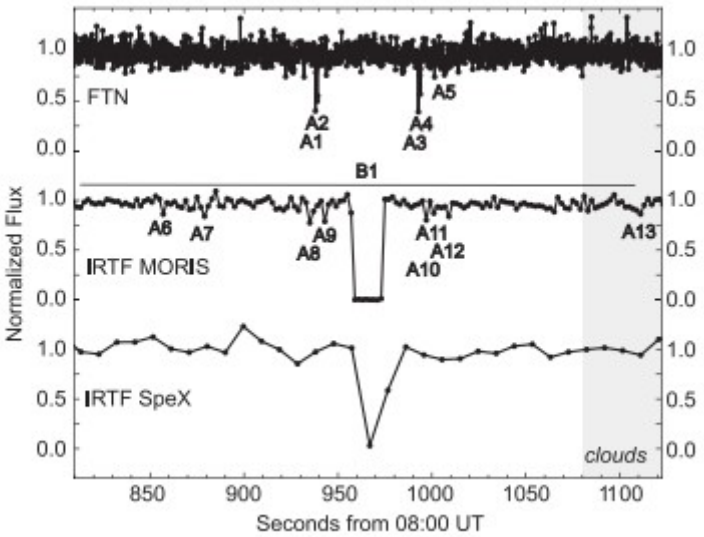
The magnitude drop was 1,4 resp. 1,9 magnitude, predicted drop was 12,3 magnitude

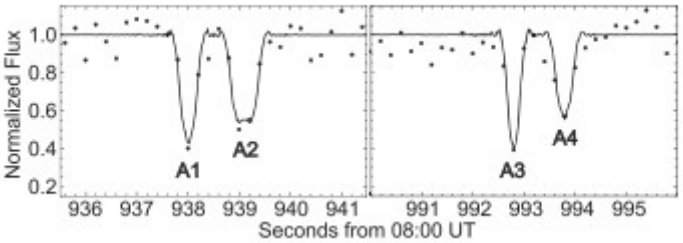
The predicted max duration was 4,2 seconds
The occultation took place 42 seconds after the predicted time.

My station was 538 km south of the predicted central line, 495 km outside the shadow zone



Double dip 1.2sec apart.
Double star? Material around 430P (shell, ring?). Nucleus size << e.g. Chiron





Sickafoose+ 2019

Occultation by (2060) Chiron on 2011-11-29

D ~ 160 km

Summary

- Occultations by comets are still difficult to predict and hard to observe.
- Only a few occultations (or appulses) observed so far.
- Deriving nucleus sizes by direct measurement (occultations) independently verifies estimated by other methods (photometry).
- Probing the environment around a comet.
- Please try to observe even the chances for O+ are still small !
- Predictions => next slides.

Stellar Occultations > Predictions

Predictions | Reports | Info + Credits | Admin | Login

Start Date:	2022-09-10	(Start date, Format: yyyy-mm-dd or yyyy-mm or yyyy)
End Date:	2022-09-17	(Ende date, Format: yyyy-mm-dd or yyyy-mm or yyyy)
Site Coord:	50.038 8.56	(Latitude Longitude in deg (Lng. > 0 to the East) OR MPC code (XXX))
Site Name:		(Free name, just for the header. Optional)
Max Dist:	200	(Approx. maximum distance (km) of site from central line in kilometers)
SMag Limit:	16	(Limit query to this star magnitude)
Min Dur:	0	(Only occultations with expected duration (sec) >= Min Dur)
Min Diam:	10	(Only occultations with object diameter >= Min Diam)
Min P1:	0	(Currently unused)
Object:		(Filter for Asteroid / Comet / Planet name: Examples: (41), Pallas, 1997 RB7)
Sso tags:		(Just objects with selected Tag)
Sort by:	Date	(Sort resulting table according to this criteria)
Occ dbase:	Comets	(Select Database of predicted occultation events (see explanation at bottom))
Twighlight:	☐	(Include twighlight events)
Show all:	☐	(Show all entries without any distance constraint (but others still apply))
Info box:	☑	(Show textbox on map with occ. data (for screenshots etc.))
	Submit	(Depending on your input response may take some ten seconds!)

Basic information and usage

Usage: As quick start you only have to enter the latitude and longitude of your observing site in decimal degrees (long: + is east of Greenwich), seperated by a comma or space. Alternatively you can enter the 3-letter MPC station code (always in the form XXX, even for stations 000...099). In that case the site name will be taken from the MPC record. The 'Show All' checkbox is useful if you search for (all) events by a specific object. Enter the name of that object in the 'SSO Name' field and check 'Show All'.

Occultation Databases

Asteroids: The main (default) database contains worldwide predictions of stellar occultations by asteroids (currently for about 2-6 months time span before a new run is made; otherwise the DB would be too large and it will take too much time to get the event list). Predictions are for asteroids (sometimes plus some special targets) with diam > 10 km and Gaia EDR3 stars brighter than G = 15 mag. JPL Horizons (JPLH) ephemerides are used by default.

CeTNO: This database contains occultations by Centaurs (diam > 50 km) and TNOs (diam > 150 km) for the whole year. Gaia EDR3 stars brigther than G = 18 mag. JPL Horizons (JPLH) ephemerides are used by default.

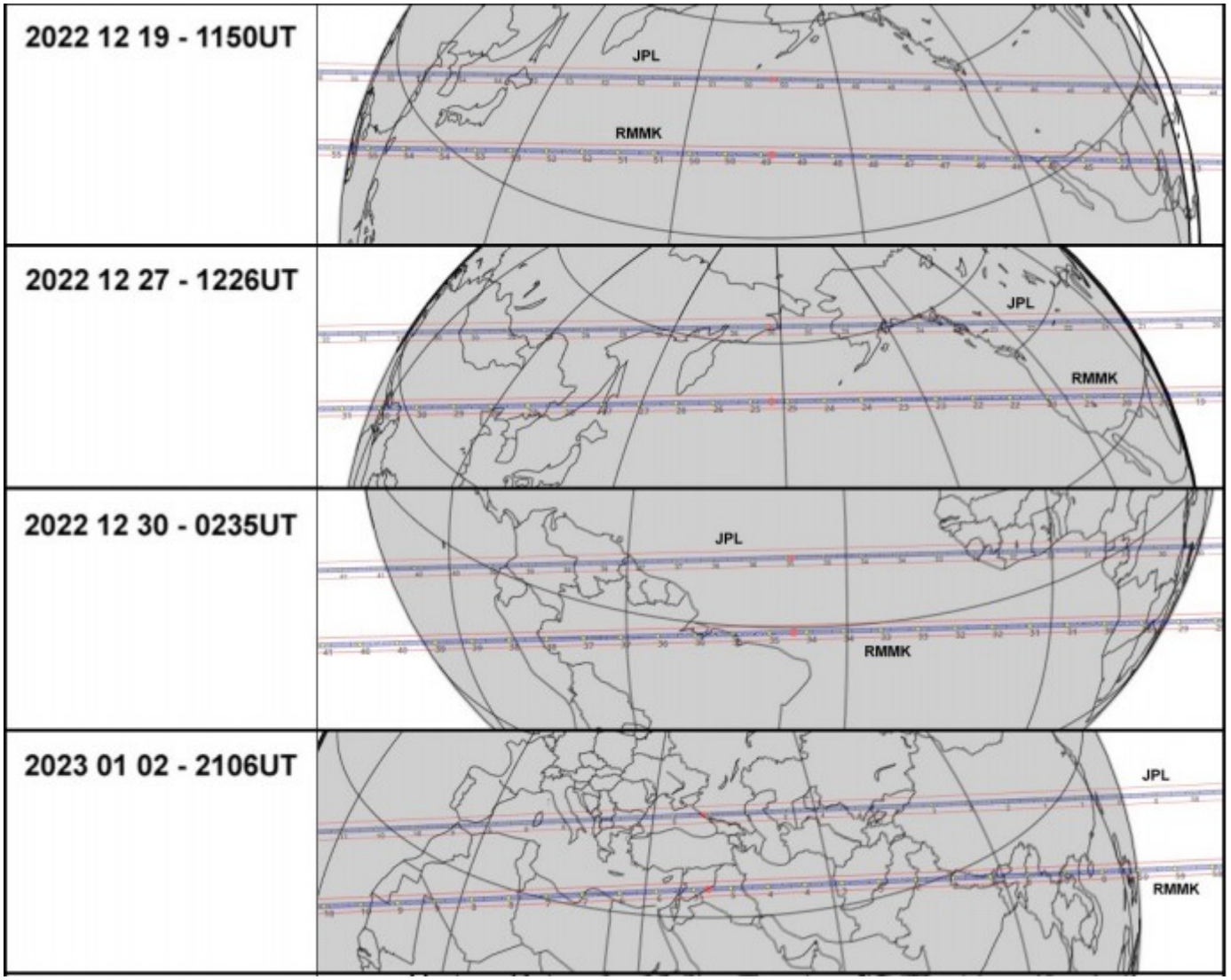
Comets: A small list of numbered comets with expected diameter > 5 km (JPL SBDB). Currently ~25 comets. Gaia EDR3 stars brighter than G = 15 mag. JPL Horizons (JPLH) ephemerides are used by default.

astro.kretlow.de/stocc/

Other predictions:

OccultWatcher Feed: COMETOC

ocultacions.astrosabadell.org/COMETOC/index.html



Occultation predictions for 29P/SW1
Selected astrometry outside outbursts etc.

Miles & Kretlow (2021)