

Scientific rationale and observation protocol for the stellar occultation by Pluto on August 15, 2018 ERC Lucky Star project

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Brief scientific rationale:

Pluto suffers drastic atmospheric changes due to its highly eccentric orbit and peculiar obliquity of 98 deg. The NASA mission New Horizons revealed in July 2015 a large reservoir of nitrogen ice ("Sputnik Planitia") that is thought to be the main driver for Pluto's atmospheric pressure variations, through a seasonal cycle involving sublimation and condensation.

Current models (Bertrand and Forget, Nature 2016) predict that after decades of increase, Pluto's atmospheric pressure should decrease after 2015. A stellar occultation observed in 2016 does show (at low significance level, though) that the turning point has been reached, and that the pressure started its decay.

The August 15, 2018 stellar occultation is thus very important because it could confirm/reject more firmly this suspicion. Moreover, it is a rare opportunity to detect the central flash from a narrow band on Earth, at a time where the ESA Gaia mission provides much more accurate predictions than a couple of years ago.

As the dwarf planet is receding away from the galactic plane, occultations by Pluto are now becoming rare. For instance, no event has been observed in 2017, and no favorable occultation (other than the August 15 one) is foreseen in a year from now.

1) Predictions and websites with informations:

You can find prediction and information in those four websites:

<http://lesia.obspm.fr/lucky-star/predictions/special/pluto20180815.html>

2) Time of observation

The occultation will be visible (during the night from 14th to 15th of August) between 5h27 and 5h34 **UT** depending of your location in North America. In order to harmonize observations, **please record images at least between 5h20 and 5h40 UT**

3) Exposure time considerations

Be careful about the readout time (dead time) between images. USUALLY, we ask that the exposure time be at least the value of the dead time (for example if the dead time is around 1.5s, exposure time should be 1.5s or 2s). This allow us not to lose more than 50% of information.

BUT things are different with a smooth atmospheric occultation: not so much information is lost if dead times are larger than exposure times. **In practice, you should not have exposure times larger than ~2 sec (SNR permitting)**. Otherwise complicated effects arise, due to the convolution of the large exposure time with the stellar flux variations due to Pluto's atmosphere.

4) Field of view

A reference star is essential for reconstructing the occultations light curve, see <http://lesia.obspm.fr/lucky-star/predictions/special/pluto20180815.html#sm> for a choice of possible reference stars. The best ones being those that are comparable to or slightly brighter than the Pluto+occulted star (mag 12.7), ie in the the range R=10-12. There are several of them within 5 arcmin.

The most important is to avoid saturation of the target and the reference stars. For stations close to the centrality, the central flash may be brighter than Pluto+occulted star. So, allow for some margin to avoid saturation during the flash.

5) Calibrations images : VERY IMPORTANT

Dark, flat and dark flat images must be recorded. If you have difficulties, however, the priority is to get darks over flats, as flats usually bring less improvements to the photometric quality.

Calibration images must be recorded with same set up than occultation when Pluto and the occulted star are far enough to measure the star flux without Pluto's. This record must be made at same elevation than the occultation to preserve the flux ratio of various stars with different colors, due to differential extinction.

Please record 10 minutes of images during this period using same set up (FOV, exposure time...) than during the occultation. If not possible, images should be taken nights after when the star is at same elevation.

Elevation of objects can be obtained here : <http://catserver.ing.iac.es/staralt/index.php>

6) For Raptor Merlin and Watec users

For Raptor Merlin camera users, do not forget to run the GPS and synchronize it at the beginning and the end of the recorded sequence and deliver the GPS log file together with the images.

For Watec users, please use a **linear gamma******

7) Time synchronization

For observers without GPS-based systems, you should keep the Windows PC time synced with UTC using Windows Internet Time (also known as NTP). As reference, the instructions for Windows 7 is found here:

<http://mintywhite.com/windows-7/7maintenance/windows-seven-7-sync-system-clock-with-internet-time-how-to/>

The use of a software such as Dimension 4 is more recommendable. If you use Dimension 4, activate the log and send it back together with the rest of the data.

<http://www.thinkman.com/dimension4/>

Thank you for your participation!

If you have questions, do not hesitate to contact Bruno Sicardy (bruno.sicardy@obspm.fr), Joana Oliveira (joana.oliveira@obspm.fr), Erick Meza (erick.meza@obspm.fr), Josselin Desmars (josselin.desmars@obspm.fr).