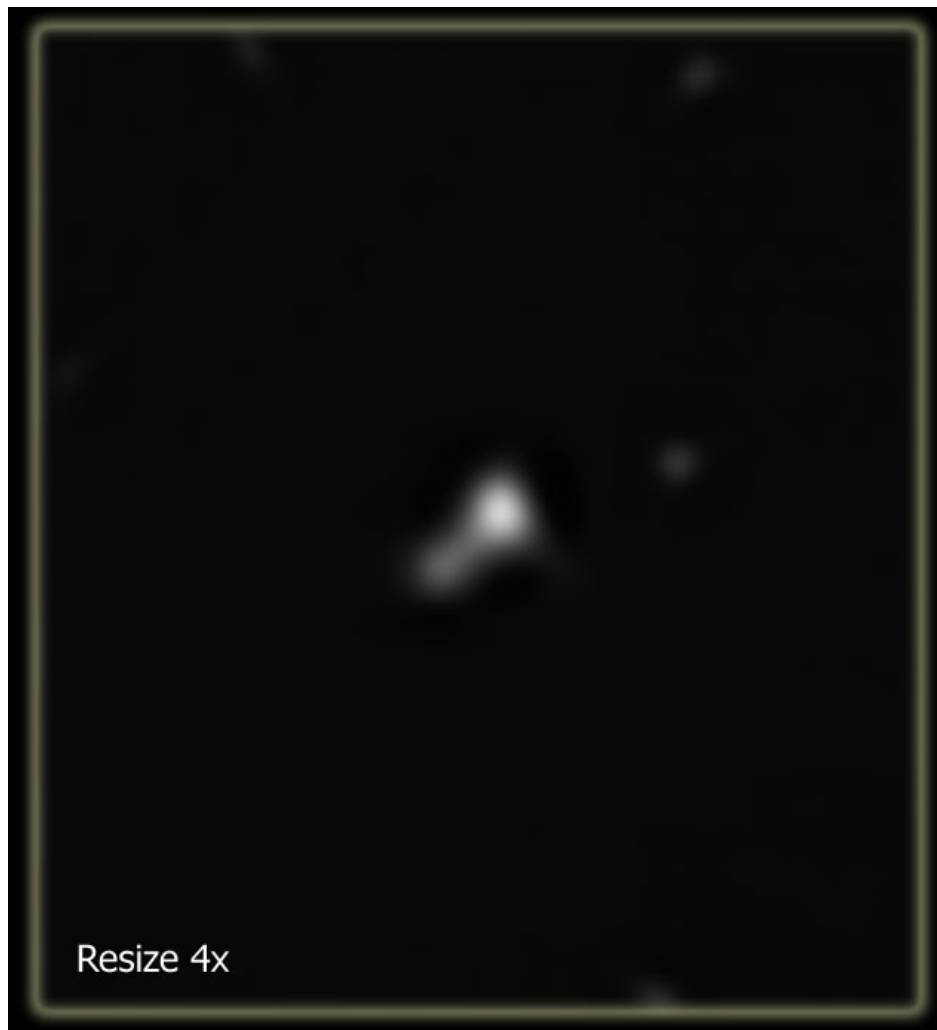


The Pluto - Charon system

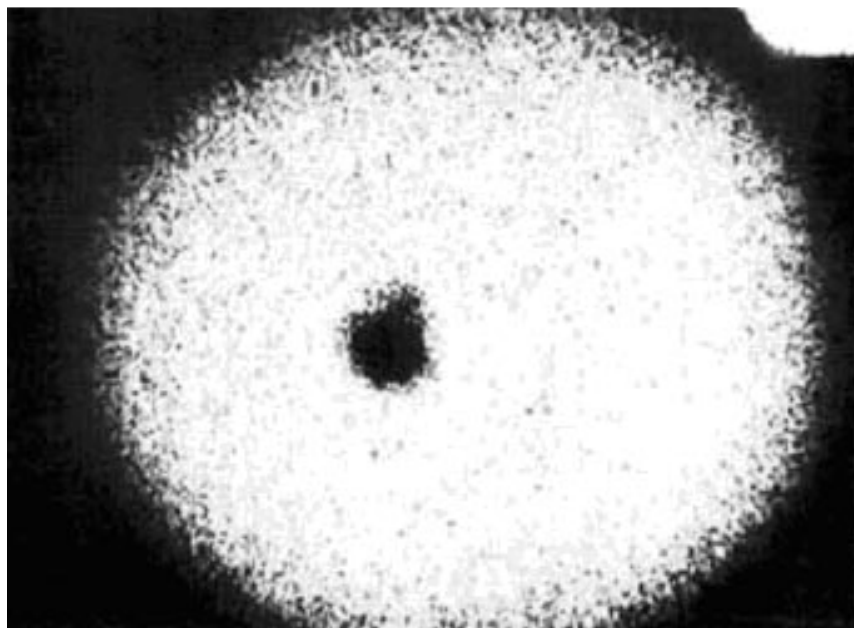
Antonello Medugno



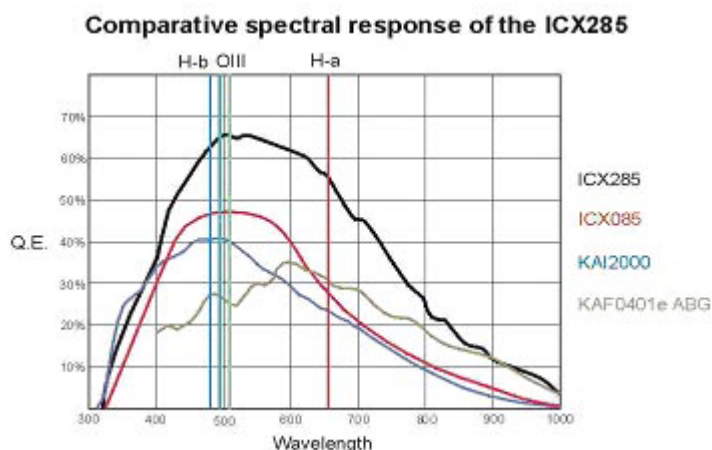
Undoubtedly, the biggest challenge I faced in my multiannual activities as astroimager trader its' my attempt, fortunately successful, to separate a pair of celestial objects more difficult, the Pluto-Charon system, generally considered a limit to the possibility of amatorial instrument. The occasion was made following the invitation of the journal Coelum groped for the challenge, which I call promptly accepted.

Once the decision to separate groped this incredible couple, I did a not efficacy web search to see if someone had already produced images of the couple with telescopes with a diameter less than a meter. In addition to the usual beautiful images of the Hubble telescope, incomparables of course, I found that one image of the discovery of Charon that I carryover below:

2 July 1978, the date of discovery of Charon on a photographic plate to the telescope USNO of 1.55m in diameter. The protrusion that alters the profile of Pluto in the upper side is the image of Charon. My goal was to produce with my instrumentation a similar result.



(This photo has appeared in: JW Christy, RS Harrington, The satellite of Pluto, The Astronomical Journal, 83, 8, pp. 1005-1008, August 1978).



The spectral response of Sony ICX285 sensor, installed on the Starlight SXV-H9 that I used to image the couple, compared with other commercial sensors. Particularly relevant quantum efficiency between 400 and 800nm, more than 25% over the spectral band, with a peak of 65% at 500nm. The photographic film have a maximum of 5%.

Immediately my goal was to emulate that result with my Meade 14 " LX200GPS, R + Ir filter and CCD Starlight Xpress SXV-H9 16-bit (an ABG CCD of good commercial performance). In practice, a challenge, only uneven appearance with a professional telescope 1.5 meters in diameter. The difference in my favor, is that we now have digital CCD sensors very highest performing of the "old" photo chemistry.

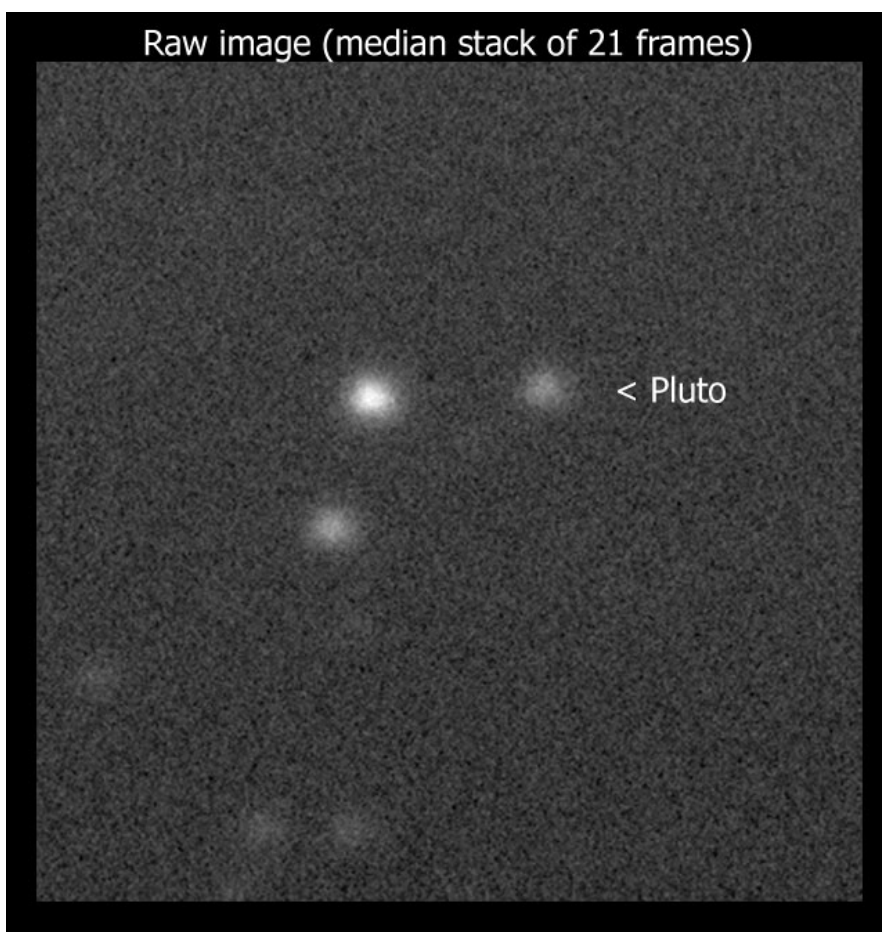
I immediately realized that I should treat very carefully the acquiring technique, so that the disk of Pluto had never, in any single image, bright pixels than 5000 ADU (value decided after tests conducted in preliminary sessions) and using a 9 meters focal shooting stars they were present at least the 16th magnitude.

The value of 5000 ADU was also dictated by the fact that the technical processing of the images suggested that I should be in accord with the data acquired and provided in two steps, by applying a Gaussian filter and a Richardson-deconvoluzione Lucy alternating Gauss0.5 + (RL 2.5x11) and Gauss1.0 + (RL 1.5x11). Fundamental rule was that at the end of the process the disk of Pluto should not be saturated. Condition that was absolutely essential to enable to detect the presence of Charon in an area with a radius of only 0.8" around Pluto.

Observational sessions were all over 15, of which 6 are dedicated to the acquisition of images, the remaining were testing and in two cases failed the pointing of the planet.

One difficulty was precisely the aim of Pluto at focal of 9mt. The method provided the shot of the field at f/10 and, once detected the planet using Cartes du Ciel, has passed to mount the barlow PowerMate 2.5x for the approximately focal of 9mt. This partially modified slightly the centering of the subjects and the subsequent focus could lead to further displacement.

For this reason I had back in the enlarged more maps trying to identify the planet and center it again. This led away at most 60 mins, here's why on two occasions I had to give up: exceeding the scheduled time for the centering of the subject. Exceeded this time limit, the planet would have found the hour following too low over and the conditions therefore not appropriate to efficacy images.



The 19 August 2008 session at 20:05 (average) TU showed the presence of a protuberance from the outset stack of 21 frames.

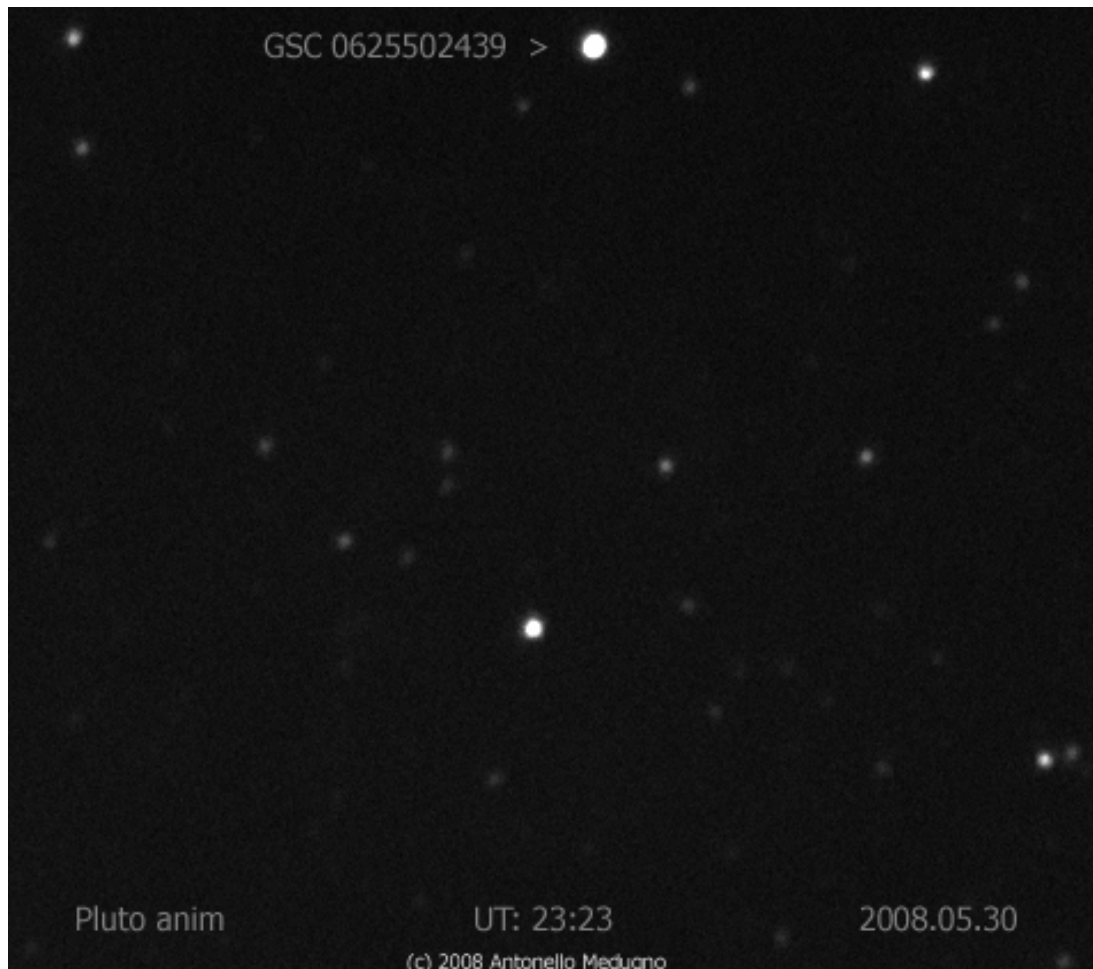
In that evening, particularly good in terms of seeing, the individual frames, although with some difficulty, showing a "elongation" of the planetary disk, but not only, also the star (a) (USNO J1753399-171359) as it looks in the following figure, which is actually double and whose components are much brighter for Pluto, shows a significant elongation for the presence of two stellar disks.



The majority brightness of the (a) star translates itself in a brightness level of their discs in excess than 5,000 ADU (average was 17,000) in each frame. Therefore, after processing of all the frames with the procedure I outlined above, the saturation of their discs has produced the merged and undifferentiated, making it impossible to separate the individual components.

Instead, if we look at the single star (b), the USNO J1753401-171408, which is not double and has a lower magnitude of (a), very similar to Pluto, we see that its disk hasn't saturated pixels after making process.

It might also be to add that the interval of time ever at the top and in this case less than 20mins, made it possible to not show the motion of Pluto as we see in this preliminary test in May more than one hour:

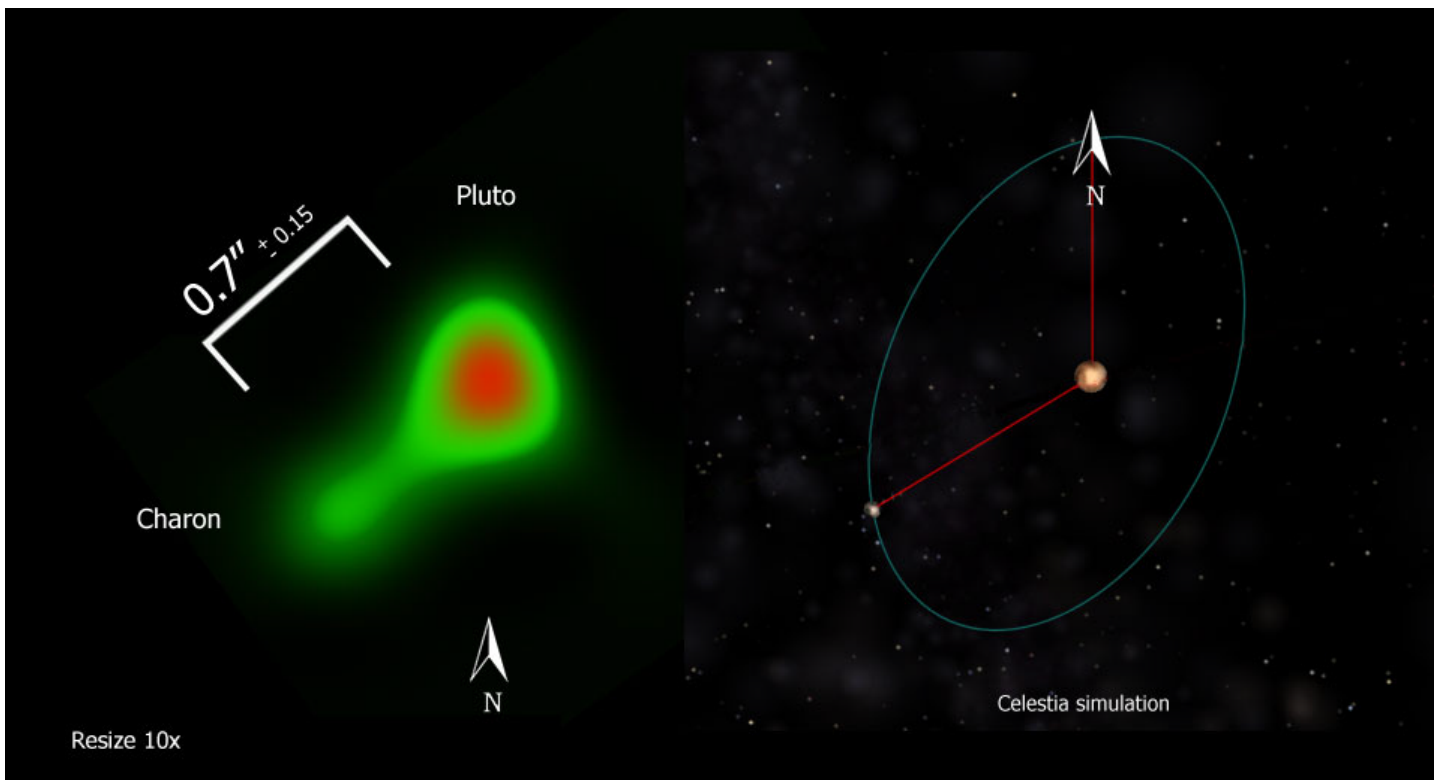


The measure of the distance between Pluto and Charon has reported a value of $0.7'' \pm 0.15''$.

It is consistent with that reported by many simulators: all values range is approximately $0.65''$ - $0.75''$, referring to 19 August at 20:50 UT.

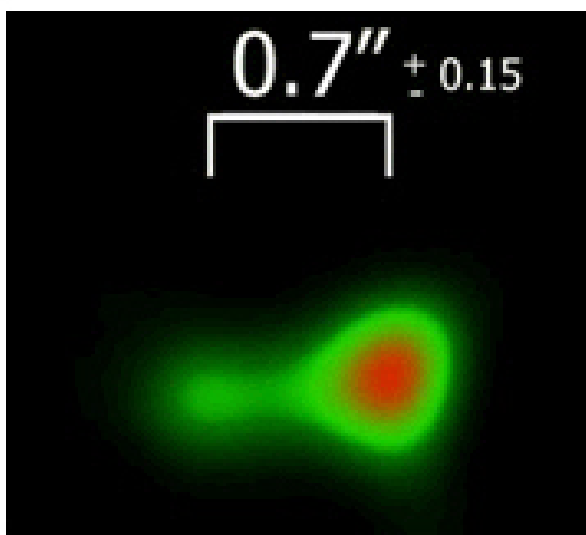
Even the angle of position of Charon is perfectly compatible with that given by the simulator: it is involved in a range between 108° and 125° .

It usefull to note that the uncertainty measure of $0.15''$ in the distance between Pluto-Charon produces an uncertainty of $\pm 15^\circ$ in the position angle and, taking into account of a probable error of $\pm 5^\circ$ in positioning N-S corner of the CCD camera, I can evaluated the final uncertainty of about $\pm 20^\circ$. This allows us to say that the source at this side of Pluto in my images and whose fault is all angular positioned inside of a range of $\pm 20^\circ$ with respect to the position calculated with different simulators, and, with reasonable certainty, Charon.



The success that I had to collect at least Charon has a double origin: a good seeing in the evening of August 19 (a stellar disks at efl of 9mt. around 1.8" of FWHM, that value is approximately twice the maximum distance of the two sources) and extreme care with which I planned acquisitions of individual frames to avoid saturation of the disk of Pluto to complete.

The collaboration with Daniele Gasparri, the drafting of Coelum merely blinded analysis of the best fits images of the sessions. Daniele has also developed separately fits of 19-08 and won with "his" method of a similar elongation. This confirms the fact that two different processors with different methods, have produced the same result.



Pluto + Charon & Antonello Medugno

I thanks to Rodolfo Calanca for coordination in the drafting of this short article.