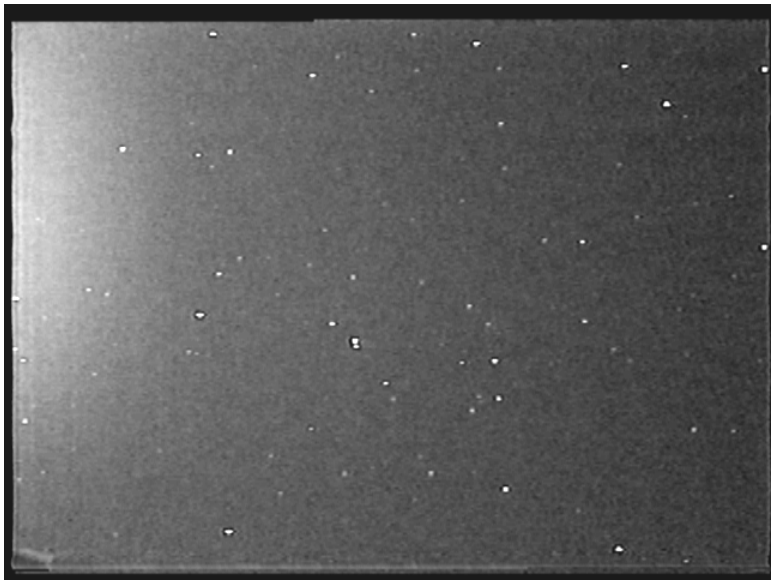
How I Found Pluto using a Meade LX-90 and an Astrovid StellaCam EX

Version 6/11/2003

May 21, 2003. It was a clear night in the country several miles east of Bowling Green, Ohio at the home of Dennis and Heidi Bisbee. There was some light pollution caused primarily by high-altitude jet trails which were spreading to make a faint haze. There was no moon with an occasional light breeze and temperatures in the low 50's.

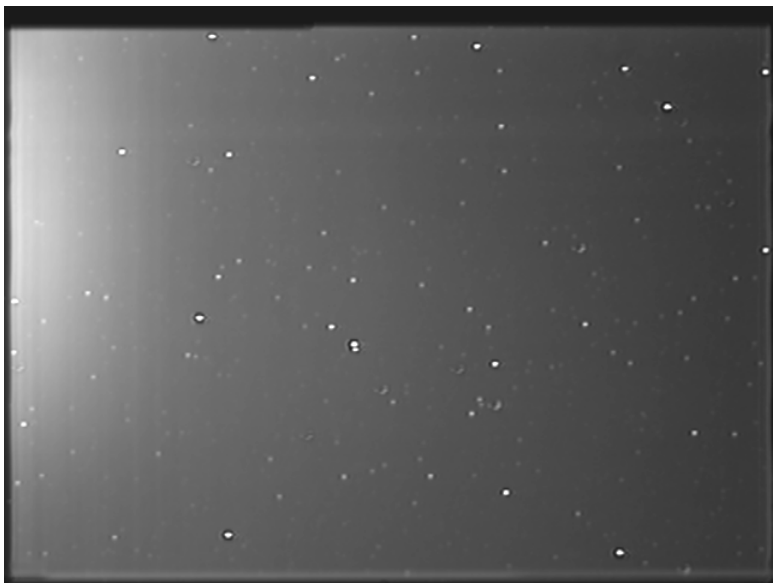
My mission was to create a digital image which contained Pluto; then find out which dot in the image actually was Pluto. I used my Meade LX-90 8 inch SCT in polar-alignment mode in conjunction with a 3.3 focal reducer and a StellaCam EX video camera set in 128X sense up mode at 5/9 gain to take 5 minutes of video of the area which the Meade (in "high precision" mode) said was where Pluto was located (20 x 25 arc minutes). This turned out to be only about 10 degrees above the south-east horizon. I was in a rural location, but still this area appeared quite bright and I could see no stars there visually. I brought the data home and dumped 299 images from the video into my HP Pavilion ze5185 laptop using Video Capture Essentials set at 45% brightness and 100% contrast. One of these images is reproduced below:

Single frame from video



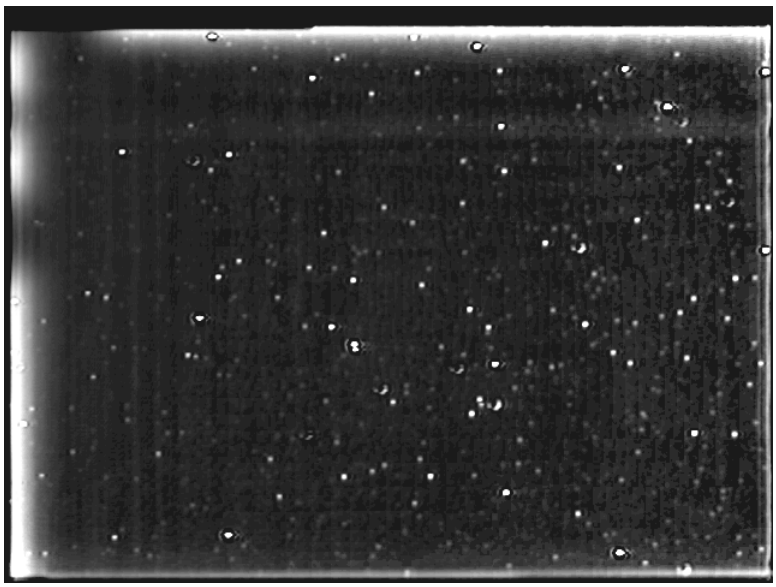
I then used Registax to align and stack 284 of the 299 images applying image quality weighting. This resulted in the following average image:

Average of 284 frames



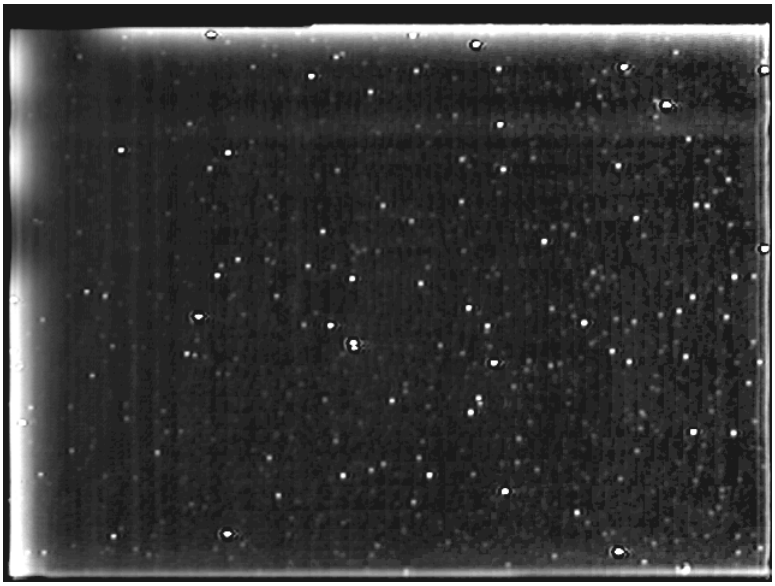
To remove the background gradient, I went to AstroArt 2.0 and created a flat field using the plug-in from Chris Icough (v1.1). I smoothed this flat field using a Gaussian filter with a sigma of 15. Then I divided the original image by the flat field. The result is shown below:

Background gradient removed



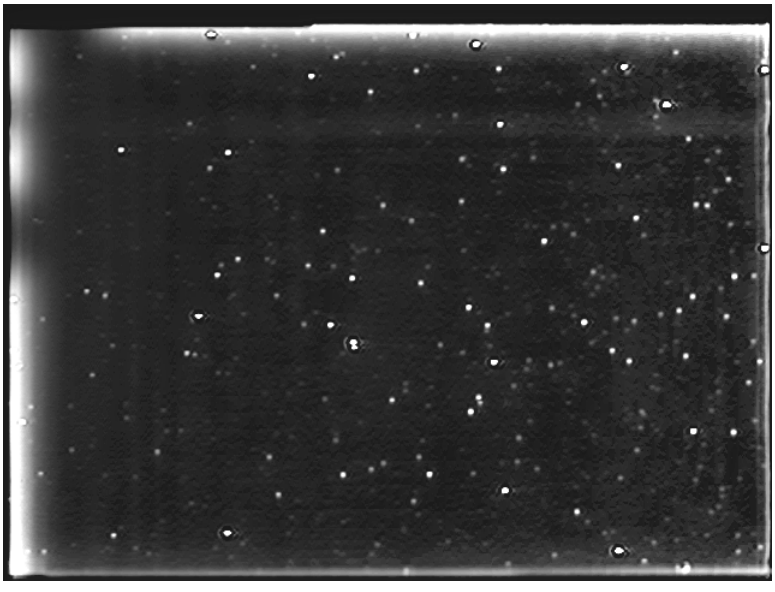
The telescope had been so stable during the five minutes of data collection time that the hot pixels were only very short trails, but still recognizable as different from the stars. I used Adobe Photo Deluxe Home Edition 4.0 to carefully “clone” out the hot pixels, resulting in the next image:

Hot pixels removed



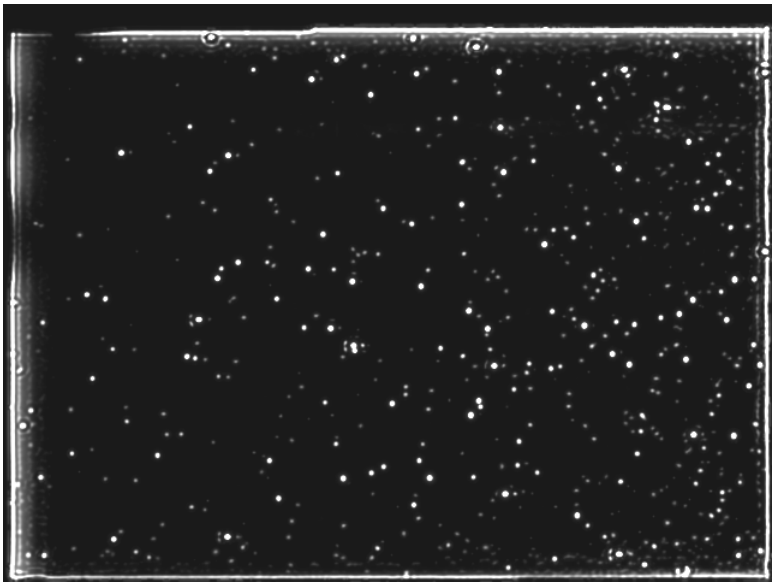
The gradient removal algorithm tends to leave vertical streaks in the image. Adobe Photo Deluxe has a great “moiré removal” algorithm for such cases. I used it with the angle set to 90 degrees and the amount of smoothing set to 30:

Vertical streaks reduced



Now I was quite sure I had captured Pluto, but which one was it? Only a few hundred to choose from! Just to make sure the image was really clear, I did some additional processing. Using AstroArt 2.0 I offset the image with a value of plus 10 on each pixel. Then to sharpen the star images I did a maximum entropy deconvolution with 20 iterations and not "cut sky background". Then a Gaussian smooth with sigma equal to 0.7. Next, to smooth out the low level background I did a convolution with a Gaussian point spread function of sigma equal to 2.0 and level 40. I did this twice. Then repeated it again with the level equal to 30. The background was now quite smooth but the stars were still sharp. Now I repeated the flat field correction which I had done earlier, smoothed it as before and this time subtracted it from the image. Next I applied an unsharp mask with parameters of 2 and 7, adaptive. Then another convolution with Gaussian 2.0 sigma and level 10. The histogram was set to minimum 8, maximum 493 and linear transfer. Finally a Gaussian smooth of sigma equal to 0.7 was applied. The end result is below:

Processed to enhance stars

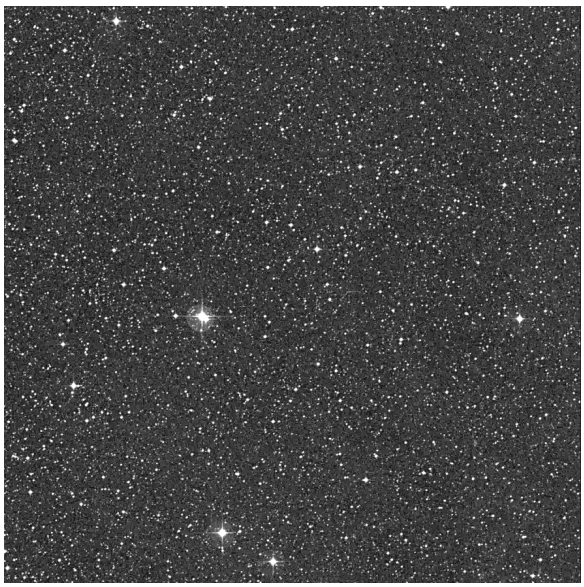


I needed to eliminate all known stars and any artifacts which could be mistaken for stars, (or planets). Knowing that the StellaCam EX has a very high sensitivity in the infrared, I was aware that there could be several candidates for Pluto after I performed this elimination procedure. I have already seen obvious stars in my images that do not appear on or are very dim in the Digitized Sky Survey! Anyway, the next part of the process was to get the appropriate segment of the DSS centered on the location of Pluto given in Astronomy Magazine for May 15th. This position was RA: 17h 16.2m, decl: –13d 29m. The image is below showing a 25 arc minute square centered on this location using the First Generation Survey:

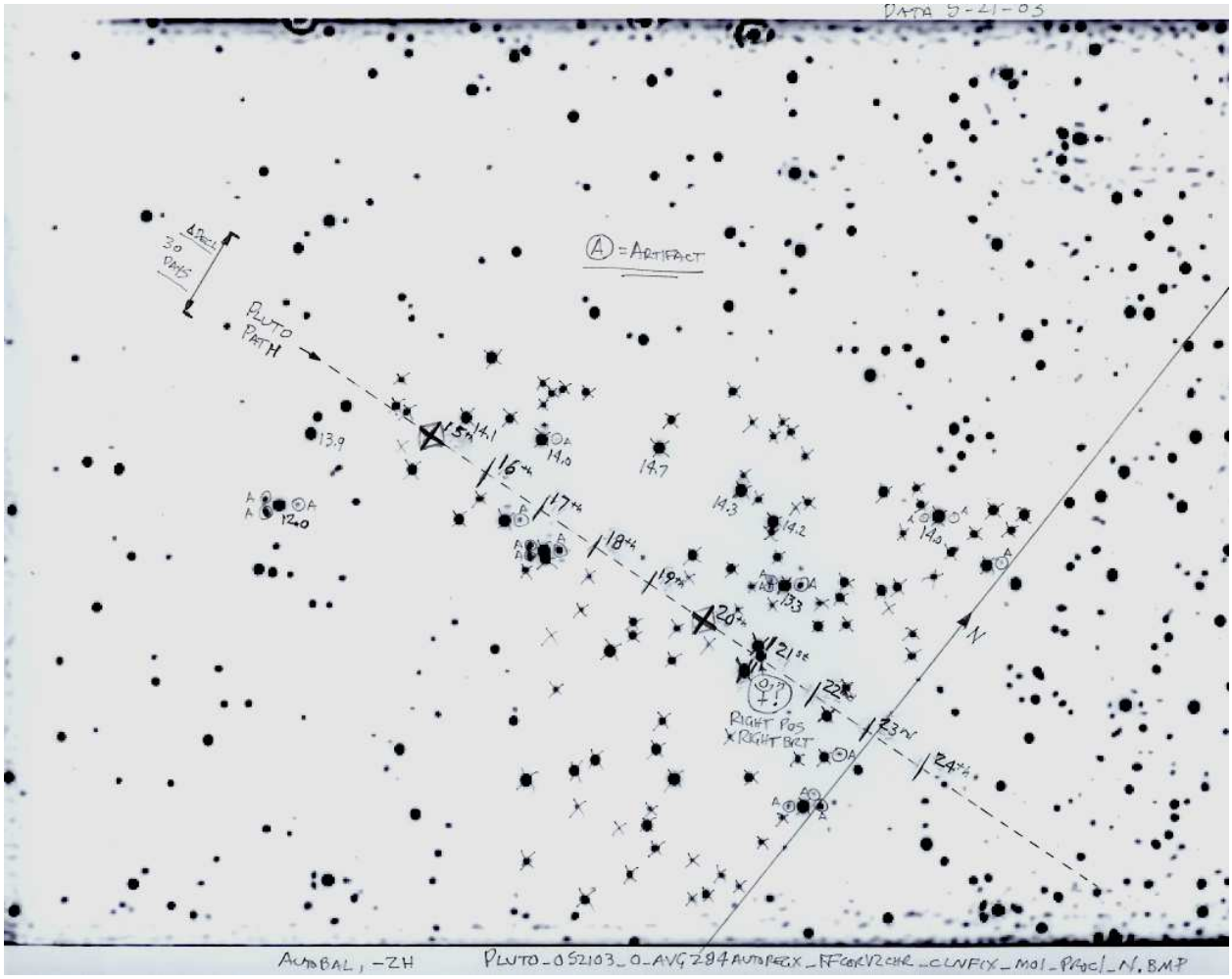
DSS Image centered on Pluto's position for May 15

I also had the position for Pluto for June 15th from Astronomy. This position was RA: 17h 13m and decl: -13d 27m. From these two positions I estimated the position on May 20th which came out to be RA: 17h 15.67m and decl: –13d 28.67m. I obtained the DSS image centered on this position:

DSS Image centered on Pluto's position for May 20



I drew lines connecting the opposite corners of these images to find their centers, i.e. where Pluto was located on those two dates. Then I printed out a black-stars-on-white-background version of my image and plotted the two locations onto it as closely as I could (large crosses made into diamonds). I drew a line connecting them representing a "best guess" of Pluto's path. I divided the segment between the 15th and the 20th into 5 parts representing 1 day each, then projected increments of this size out to the 24th. This image follows:



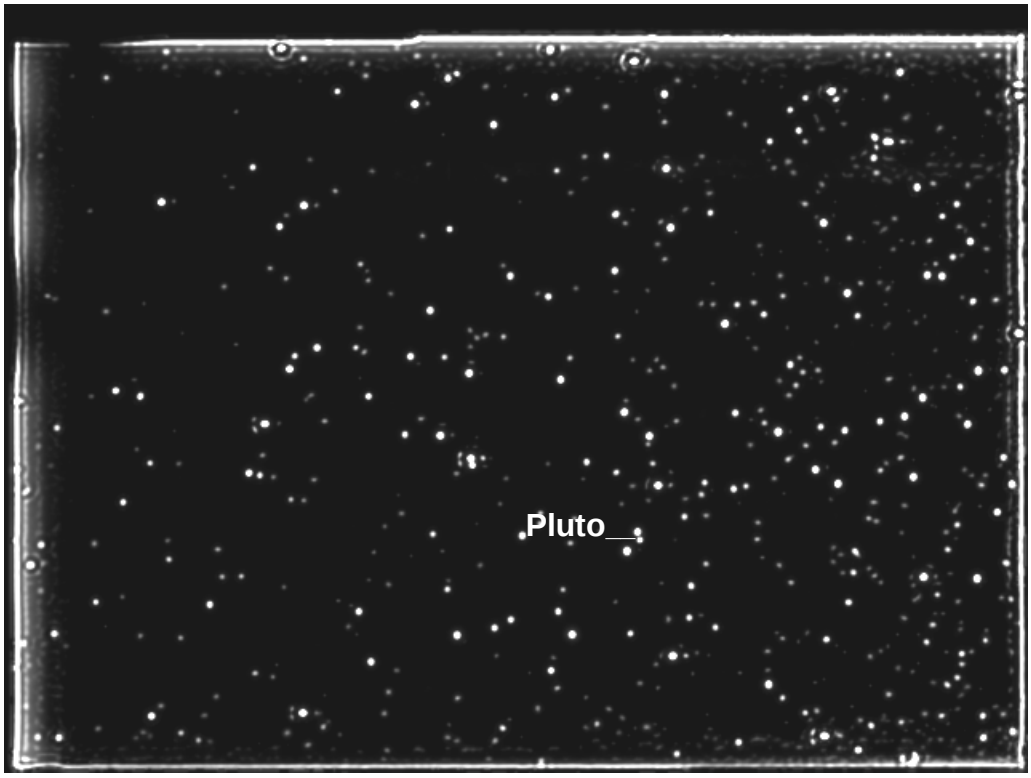
I proceeded to use the DSS images to eliminate all known stars along the orbital path from the 15th to the 23rd positions. The brighter stars had ring artifacts (diffraction rings) that had broken into segments and looked like stars. But the same pattern (one dot to the right and two to the left) appeared around 6 separate bright stars, so they were obvious artifacts and were likewise eliminated. Finally it came down to one candidate which was not visible in the DSS. It was slightly dimmer than I would have expected, but not much. It was located exactly on the orbit line at the position for the 21st! The data from Astronomy Magazine was probably calculated for around 11pm on the days given and I took the photo just before 11 pm. I therefore decided this was Pluto with a very high probability.

Now, how to confirm my suspicions? One choice was to go out the next night and collect an identical image to see if the object had moved by the required amount, or blink the two images and see if some other object I had missed was possibly Pluto. This was not possible for several reasons. Instead I decided to see what Starry Night Pro had to say about Pluto's position. I set the date and exact time for when I had recorded the data. The image it came up with, cropped for relevance, is below:

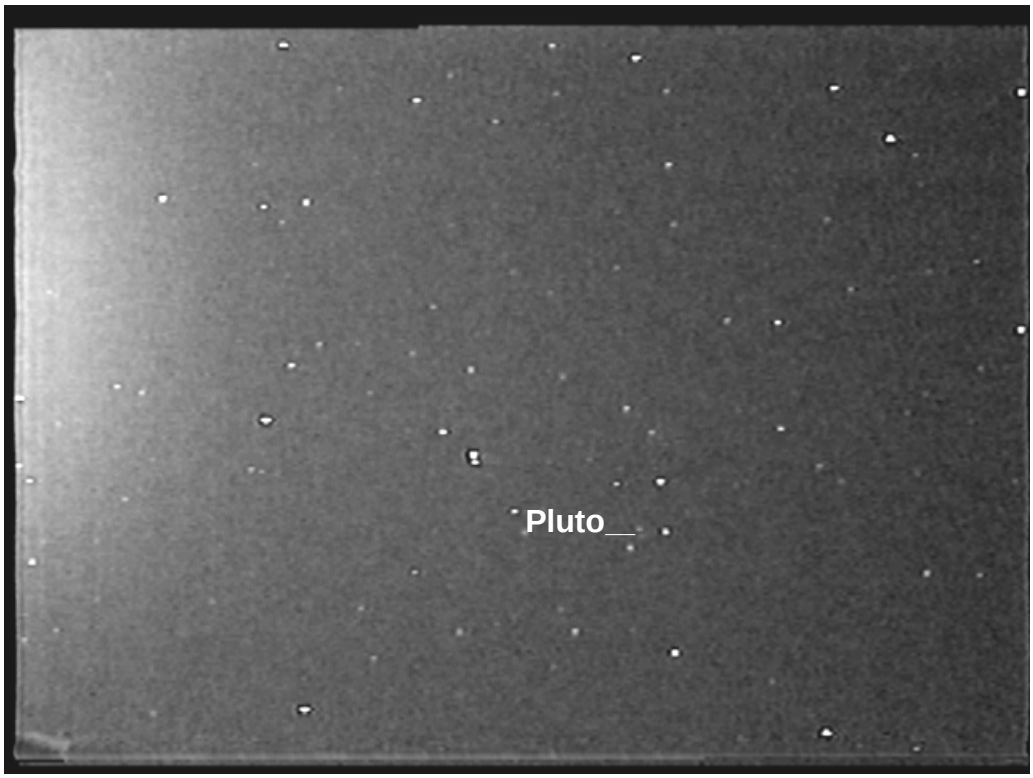
Indeed, it confirmed Pluto's location at that time as being nearly identical to where my prime (and only) candidate was located!

Mission accomplished. Pluto had been rediscovered for the umpteen millionth time on planet Earth. One interesting note is that Pluto is actually barely visible on a single unprocessed frame of the original video. This means it was visible on the TV monitor during the data collection process if one knew where to look! Not bad for an 8" SCT looking 10 degrees above a not-so-dark horizon. The comparison images follow:

Fully processed image



Single unprocessed frame



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