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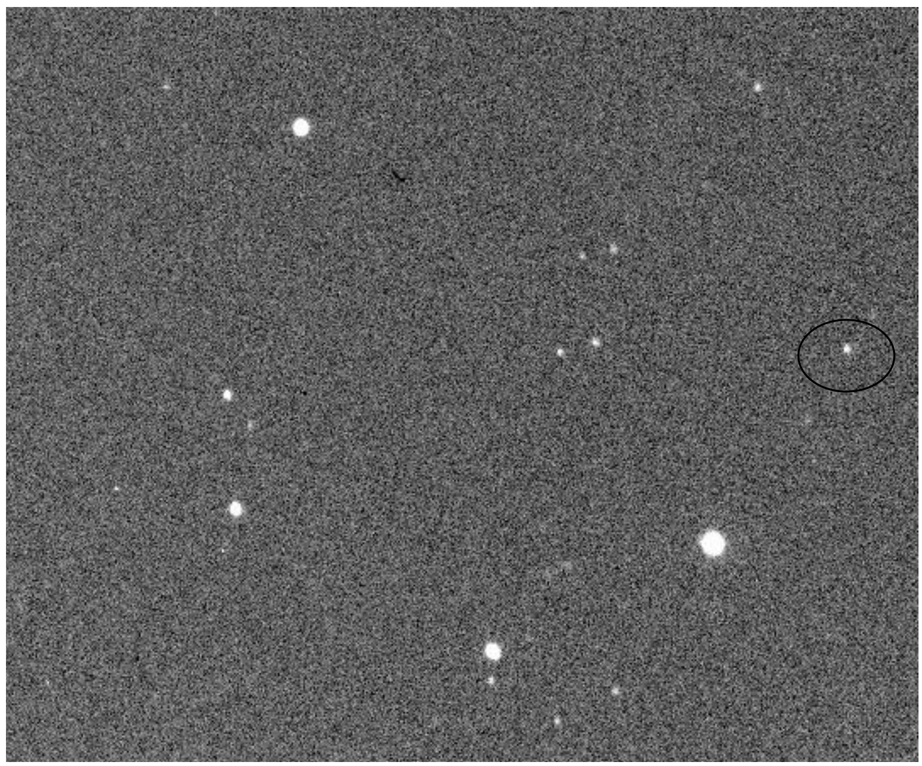
UROP 2008 Summary

This summer we used two 14-inch telescopes and their CCD cameras at Wallace Observatory to take astrometry observations of the KBOs 2005 FY9, 2003 EL61, and Eris, sample data of Asteroids 452 and 811, and various exoplanet transits. In lab, we prepared finder charts for our objects and then processed and reduced our data.

To take data on our targets, we had to find an exposure time in which the object was visible against the background noise, but not distorted by the tracking limitations of the telescopes. The KBOs were quite dim, so we were only able to take images were they were several hundred counts brighter than the background. After the first few nights, we decided to try stacking the images to boost the KBOs' signal and minimize the tracking issues. We changed the exposure time to one minute and then stacked images by three to replicate the three-minute exposure. While stacking increased the signal to noise ratio, it introduced a significant error when the data was run through the astrometry pipeline. However, since we now had 60 images instead of 20, the error went down when all 60 were processed individually. The error from stacking was probably due to the alignment process, where CCD soft aligns the images based on the bright stars. This removes the tracking problems, but since it rotates and shifts the images slightly, the clarity of the images is lost.



2005 FY9, also known as Makemake, in a flat field and dark corrected one-minute exposure from July 11th. The image was cropped from the full field of view to show the KBO.

To process our images, we used CCDsoft's reduction commands. Our June images were taken with the autodark feature, which automatically subtracts one dark frame as images are taken. In July, we took ten darks each night, which were averaged and subtracted to better correct for the random noise in the camera's chip. We also corrected our images with flat-fields, because the chip was much more sensitive in the middle than the edges.

By the middle of the summer, Eris, our third KBO target, had finally cleared the trees. Unfortunately, it is very dim (18.9th magnitude) so it was impossible to see even in the three-minute exposures. Stacking multiple images proved to be a success, and after 45 minutes worth of images were combined, Eris finally appeared against the background noise.

Objects of Eris's brightness are probably the dimmest objects the telescope and camera are capable of seeing. The brighter KBOs were far easier to see. 2005 FY9, at 16.9 magnitude, showed up in the one-minute exposures consistently. 2003 EL61, slightly dimmer at 17.6, showed up in the one-minute frames on clear, dark nights, but was sometimes impossible to see on nights with bad seeing or a bright moon. Brighter objects, such as the transits we tried to observe and the two asteroids we tracked, were always visible in short exposures unless there were clouds. Our observations were successful, and currently we are using the data we collected to write a paper on KBO astrometry with small telescopes.