Calibrating the pointing of the Hubble Space Telescope to find accreting binaries towards the Bulge of the Milky Way

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Abstract & Orientation
Accreting binaries consist of a compact object (a white dwarf, neutron star, or black hole) accepting material from a more normal star in close orbit. Detected at X-ray wavebands, these systems are the most easily-observed tracers of a much larger dark population of compact objects, and thus the accreting binaries are excellent tracers of the stellar remnant component of stellar populations. We are undertaking a project to find accreting binaries towards the crowded Bulge of the Milky Way galaxy, using the Chandra and Hubble (HST) space telescopes. In the first phase, we found a number of candidate accretors. However, because the error circle of the Chandra observations is quite large, and the fields have so many Hubble sources (roughly 800,000 in our four fields), it is crucial to determine the absolute astrometric calibration of the observation-sets in order to cross-identify genuine optical/X-ray matches.

Here we report on progress towards this goal. The first step is the astrometric calibration of HST reference images, which corrects the HST reference images for residual error in the HST pointing by transforming observed positions of stars onto their catalog positions. The second step is to remove as much as possible the population of contaminating stars onto their catalog positions. The second step is to in the HST pointing by transforming observed positions of which corrects the HST reference images for residual error

1. Internal alignment within a stack
Below: Before individual images taken with a given filter are combined into a stack, their relative misalignments must be corrected and removed. This panel shows the relative offsets between one member of a stack, and the chosen reference image.

2. Combination of image-stacks into median images
Above: sections from a visible-light panorama of the inner Milky Way galaxy (© Axel Mellinger). The top panel shows a (90×45′) field of view, the bottom a 6′×3′ sub-region. The HST field shown in Step 2 is the upper-left of the four cyan rhombus-shaped regions.

3. External alignment using gaia positions
Above: resampled median images from 4xF606W (red) and 3xF625W (green and blue), respectively. One pixel is 40 milli-arcsec (mas) on a side, or ~1.1×10⁻⁵ degrees. The relative alignment between the stacks is good to a few milli-arcseconds.

4. Plans
Cross-matching of the refined list with Chandra detections: Armed with a cleaner list of detections (at least H, R, V wavebands), the now-astrometrically calibrated and cleaned HST data will be cross-matched with the Chandra catalog for these fields. As part of this step, the boresight-correction for Chandra itself will be evaluated using at least one good candidate cross-match between the optical and X-ray source catalogs. In September 2016, the first data release from the gaia satellite was made available. While it cannot match Hubble’s precision for the faint majority of objects in these crowded regions, it does provide absolute positions for bright objects.

References & Acknowledgements
- Clarkson, W. I. et al., 2008 ApJ 684, 1110
- Dolphin, A. E., 2009 PASP 112, 1383
- Fruchter, A. S. & Hook, R. N., 2002 PASP 114, 144
- Sahu, K. C. et al., 2006 Nature 443, 534
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