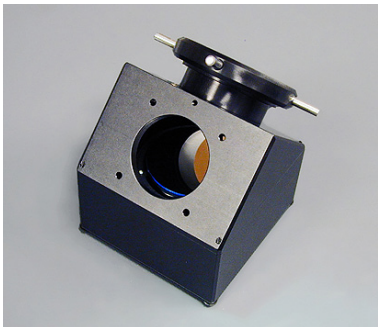
SBIG
ASTRONOMICAL INSTRUMENTS
a division of Aplegen, Inc.

AO-7 Adaptive Optics

For the ST-7/8/9/10/2000 Cameras



Model AO-7 Adaptive Optics System with SCT interface attached

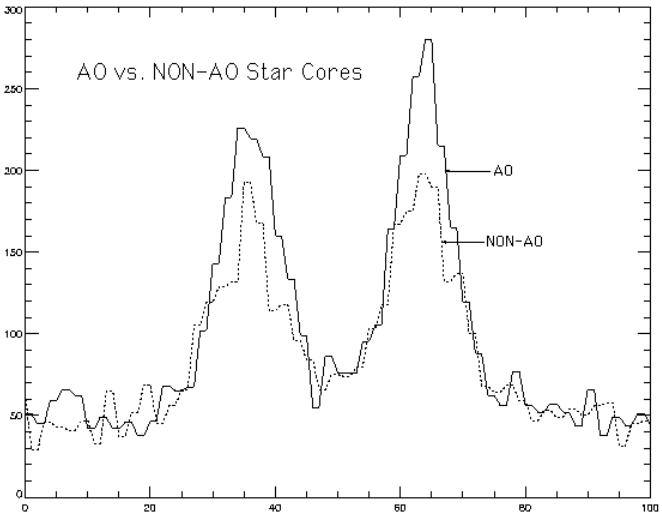
The Model AO-7 has been specifically designed to enable an ST-7/8/9/10/2000 camera user to obtain the ultimate in image resolution that his/her telescope and site can achieve. SBIG has exploited the second guiding CCD detector in these imaging cameras to stabilize stellar images, enhancing resolution. The AO-7 system has two components: a high speed tip-tilt mirror for atmospheric correction, and new image enhancement software implementing the Lucy-Richardson algorithm.

The AO-7 comes equipped with an SCT threaded interface for attachment to most commercial Schmidt-Cassegrain telescopes. The SCT interface may easily be removed, however, revealing t-threads for attachment to virtually any type of telescope.

In SBIG's AO-7, a tip-tilt mirror is used to make fine corrections to the position of a star to hold the image fixed on the CCD during the exposure. The tip-tilt mirror has magnets on the back, which interact with the current flowing through a set of voice coils on the AO module housing to rapidly move the mirror. The technique is very similar to that employed in loudspeakers, except there the magnet is fixed and the wires are on the moving speaker cone. We put the wires on the fixed housing to better conduct heat away from the moving mirror, where it might distort the optical element. The mirror and magnets are suspended using a flexible beryllium copper membrane. A needle pushes up against a jewel bearing mounted to the center of the mirror to hold the focus constant. SBIG has developed a proprietary technique to rapidly damp the motion of the mirror, so small moves are precise, with very little overshoot or ringing. The tilt of the mirror during operation is very slight, and does not lead to any measurable defocus at the edges of the frame, even on an ST-10. The correction range of the tip-tilt mirror is about +/- 30 pixels; the software adjusts the telescope position to take care of drive errors greater than this if they exist. The telescope position is adjusted while the AO is running, but this does not cause problems since the AO corrects much faster than the telescope drive. The telescope drive is adjusted to keep the AO-7 voice coil drive levels between 25 and 75%.

Tip-tilt High Speed Guiding

Utilizing the second guiding CCD as an imaging sensor the guide star's position is read out at rates up to 40 times a second, and the tip-tilt mirror adjusted to hold the star on the designated pixel for the length of the imaging CCD's exposure. The tip-tilt mirror moves and settles to within 20% of the commanded position in a mere 10 milliseconds, dramatically faster response than any telescope drive is capable of achieving. The result is sharper stars, and more clearly defined nebular features. As a general rule one can guide at 10 frames a second on a 10th magnitude star with a 10 inch (25cm) telescope. The range of the mirror for the Model ST-7 is ±5O pixels or 2 arcminutes of correction with an 80 inch focal length telescope, enough to accommodate the periodic error of many mounts without bothering to correct the RA drive axis directly. The Model AO-7 can do all of the guiding. Inexpensive telescope mounts are now entirely capable of producing well guided images.



This slice through the two fainter stars in the AO Comparison image shows the image improvement obtained by the use of the SBIG AO-7 System during 'FAIR' seeing conditions. The star on the left was 'sliced' somewhat off center but the star on the right was 'sliced' through the 'core' of the star image on both of the images. The plot shows that the star's core intensity in the AO images is some 50% brighter than the image in the NON-AO image.

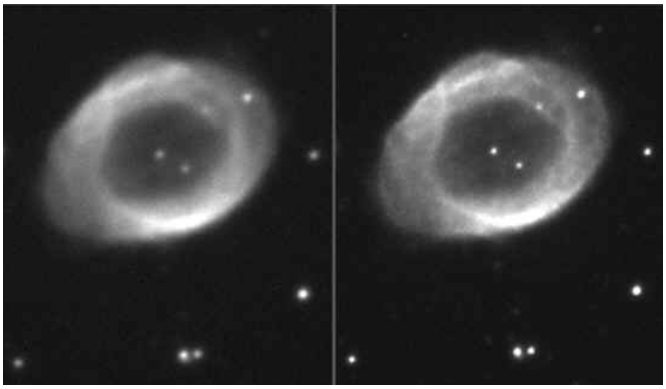
Images taken using a 12.5-in Ritchey at f/9. Brad D Wallis

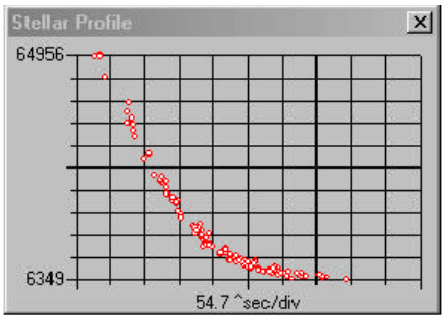
Lucy-Richardson Image Enhancement

SBIG, in association with Benoit Schillings and Brad Wallis, has developed a Lucy-Richardson image sharpening program that produces dramatic improvements in image detail. The

algorithms used are similar to those used on the Hubble Space Telescope images. The results are the best we have ever seen from amateur telescopes.

The enhancement program is Windows compatible. In addition to the enhancement capability, the program allows the display of multiple images, modification of background and range to enhance visibility of detail on the monitor, a crosshairs mode for inspecting pixel values, negative image display mode, and horizontal and vertical image rotation. The AO system can be retrofitted to all dual sensor Model ST-7/8/9/10/2000 CCD imaging cameras. This can be easily done by the user at his site. This remarkable system promises to have a profound effect on CCD imaging by reducing the atmospheric turbulence, wind induced vibrations, and eliminating the remaining periodic errors in most telescope drives





Stellar Profile Graph

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