# 2 Observations

Three observations were carried in Flat Roof Observatory of National Taiwan Normal University and Lulin Observatory of National Central University. A 14-inch Schmidt-Cassegrain telescope was used in NTNU for the test, and 1-m telescope was used in Lulin. An eyepiece is set in front of the focal plane to magnify the equivalent focal length to decrease pixel scale.

Before the binary observation with speckle Interferometric method using one-meter telescope at Lulin observatory (LOT), the whole hardware and software was set up completely, and was proved they were work well. For the observation on Lulin observatory on April 2006, the 14 binaries were chosen for speckle interferometric technique with Philip 840K webcam CCD equipped on 1-m telescope at Lulin observatory, and an eyepiece was set in front of the focal plane to magnify the equivalent focal length to decrease pixel scale. Scale and position angle of 12 binaries are calibrated in term of the bright binary, Castor.

For the second observation February 2007 with LOT, we collaborated with Dr. Cheng of the Department of Physics, National Chung Hsing University. A cooled frame transfer CCD iXon was supported by Dr. Cheng. This 1K*1K CCD could work upper 20 fps of frame rate, 4 stages TE cooler, and 14 bits grayscale sampling. Scale and position angle of 17 of 21 binaries taken with Andor iXon frame transfer CCD also equipped on 1-m telescope at Lulin observatory are calibrated in term of the fringe produced by double slit mask with 60-cm interval and position angle are calibrate in terms of drift scan images of each target.

Shutter speed faster than 0.02 second is required for grabbing speckle images in order to freeze the atmosphere turbulence. The exposure time scale, $\tau$ can be calculated by Eq1. (Fried, 1965)

$$\tau \cong (0.53)\left(\frac{r_0}{v_{wind}}\right)\left(\frac{B}{r_0}\right)^{\frac{1}{6}}$$

where B is beam diameter, $r_0$ is seeing cell size, and $v_{wind}$ is velocity of wind. For the wavelength of visible region, $\tau$ is about 15 milliseconds.

**Observation with Philips 840K webcam on April, 2006**

Philips 840K, a commercial camera with SONY ICX098BQ interline CCD chip, was used for the binary observation with speckle interferometry method on April, 2006. The advantages of this type of CCD for the speckle interferometric method includes,

1. ToUCam contains fully parameters required for speckle observations like brightness, gamma, gain, and shutter speed.

2. Normally, hundreds to a thousand of images are basically required to make a single target speckle observation. High frame rate will save a lot of time for taking speckle images. The highest bandwidth of ToUCam with full frame mode (640 pixel × 480 pixel) can be support in the rate of 10 frames per second. The record time for each series is under 100 sec, and the target will not drift out of field during exposure under LOT's tracking error (~20" FOV). Furthermore, a PJ20mm eyepiece was used for projection method to decrease pixel scale down as 0.043" to make better sampling Airy disk. The original color type of CCD chip (ICX098BQ) is replaced by a Monochrome type of CCD chip (ICX098BL), because for displaying images with color type CCD chips, the spatial interpolation is normally used that will decrease the image resolution fabout 2 times. This replaced will enhance the sensitivity and provide the better image resolution.

3. Image enhancement (internal high pass filter) is a basic function for most of webcams. The function will make images look more clearly. But the process causes strong ring effect to star images and destroy the point spread function. Image enhance function of ToUCam can be turned off to make signal output original.

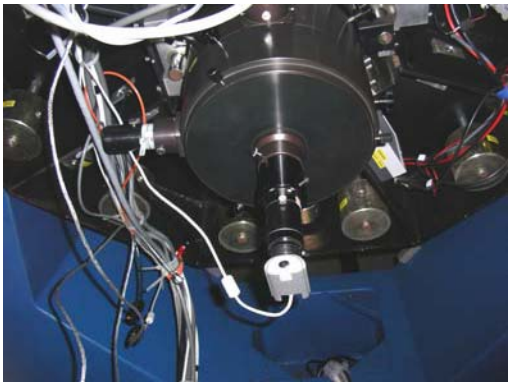

figure 2-1 Philips 840K Webcam installed with eyepiece projection on LOT.

**Observation with Andor iXon CCD on February, 2007**

In the second run of binary observation with speckle interferometry method at LOT, a camera Andor iXon which is cooled frame transfer CCD with higher sensitivity than Philips 840K is used as an imager. The frame rate and S/N ratio was set to enhance the image to approach magnitude to 9. With the higher sensitivity, it is possible to get longer focus in the pixel scale as about 1/3 of Airy disk size. A Pentax XP14mm eyepiece is used to project magnified image to increase the accuracy of scale.

figure 2-2 Andor iXon frame transfer CCD installed
with eyepiece projection method on LOT.

iXon frame transfer CCD is manufactured by Andor company, and it QE is about 65% at the peak of 600nm and noise is about 0.05 $e^-$/s at -85℃. The signal to noise ratio of images taken by iXon CCD is better than that by webcam CCD used before, and 2 magnitude fainter targets can be reached.

**Observing logs**

The weather conditions of two observations are clear and smooth wind speed, seeing conditions are from 1.0 to 2.0 arcsec. Optical axis of the 1-m telescope were aligned by adjusting secondary mirror using Takahashi collimation telescope and primary mirror using bright star image before observations both on 2006 and 2007.

| Date | Weather | Seeing ( " ) | Wind | note |
|---|---|---|---|---|
| Apr. 2~3, 2006 | Clear | 1.0-1.5 | smooth | |
| Feb. 9~11, 2007 | Clear | 1.3-2.0 | smooth | LOT after coating |