

## Chapter 6 : Direct Imaging- Reduction Methods and Software Development

Our goal was to reduce the set of “raw” images into a set of intensities for each QSO and comparison star on each image for each observing run. Everything up to the derivation of these values will be referred to as *reduction* and everything after will be referred to as *analysis*. During the process of reduction, we will also record information on such things as the peak pixel, FWHM, and the adjacent background for each stellar source, for later reference. Although not critical for the differential light curve, information on the conversion of intensities to apparent magnitude and the orientation (relative to North) and scale of the CCD for each night were also recorded.

The principle software package used in the reduction of the data set is called *Vista*, first developed at UCSC for Lick Observatory and later converted to run on Unix/X- Windows based systems by workers at Lowell Observatory. Roughly the first third of our reductions were done on the  $\mu$ Vax VMS based computer system. The remaining reductions and all the analysis were done on the Sun SparcStation 2 and 10 computer systems with a Unix/X-Windows based operating system. To facilitate the speed and accuracy of the reductions, we have developed FORTRAN and C routines some of which were incorporated into the Vista software package.

In this chapter, we give brief descriptions of the standard and specialized image reductions necessary for this project.

### 6.1 : Standard Image Reductions

Raw CCD images contain a variety of systematic and random deviations from an ideal detector. Fortunately, most of the systematic errors can be calibrated out, and the random errors can be accurately estimated. The techniques of CCD reductions have been discussed many times in the literature (*cf.* Howell 1992).

The basic principle of a CCD is that photons incident on a semi-conducting material liberate electron-hole pairs which are maintained in the material until they can