In order to determine an optimal value, we calculate weighted sums of the apertures. To calculate the errors, we consider areas composed of the innermost aperture and three annuli separated by the edge of each aperture. Each of these quantities is independent since there are no common pixels among the annuli. If the aperture sums are f_i, for i = 1, 2, 3, and 4, then the annuli sums will be $a_i = f_i - f_{i-1}$, where $f_0 = 0$ and a_1 is the innermost aperture f_1. We can weight these quantities: $T = \sum w_i a_i$, for $i = 1$ to n. As long as the weights (w_i) are the same for each stellar source in a given image, we will maintain "valid" ratios between each of the stellar sources. In terms of f_i, we have $T = \sum(w_i - w_{i+1})f_i$, where $w_{n+1} = 0$. The error on T is: $\sigma_T^2 = \sum(w_i^2 - w_{i+1}^2)\sigma_{f_i}^2$, since $\sigma_{a_i}^2 = \sigma_{f_i}^2 - \sigma_{f_{i-1}}^2$.

It is possible to remove the bias on the quantities a_i by dividing them by m_i, where m_i is the fraction of the total light falling within annulis a_i. The "total light" in this case is the light falling within the outermost aperture. Since these fractions are the same for each star in an image, they can be determined fairly accurately. This is effectively a crude PSF optimal weighting. Tests on simulated data have usually implied a very high weight on the innermost aperture ($a_1 \equiv f_1$). Unfortunately, the innermost aperture also has the highest pixelation error. After many tests, a compromise weighting set of 10, 6, 3, and 1 for w_1 to w_4 , (which leads to only slightly higher errors than the optimal case), was used for all images. Note that this is the same as summing all apertures, with weights of 4, 3, 2, and 1 for apertures f_1 to f_4. Referring the subsection 7.1.2, our simulated stellar images produce a pixelation error of ~0.3%, with these weightings.

7.3 Method for Deriving Relative Intensities

Unlike standard photometry, differential time series photometry does not attempt to measure a flux (or magnitude) for a source. We only wish to know the relative flux of an object over time. In this project, as a matter of interest we have calculated magnitudes for stellar sources, but these numbers are only accurate under photometric conditions (~25% of the nights at Lick Observatory). Also, even under good conditions these values are (at