

NICMOS OBSERVATIONS OF GG TAU'S CIRCUMBINARY DISK

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GG Tau is an ideal system for studying the structure of a circumbinary disk. Separated by $0.''25$ (35 AU at $d=140\text{pc}$; Ghez et al. 1993, AJ 106), the stellar components of the binary are surrounded by a massive disk. Originally detected through thermal dust emission at millimeter wavelengths (Dutrey et al. 1994, A&A 286; Guilloteau et al. 1999, A&A in press), the disk was subsequently imaged in scattered light at near-infrared wavelengths with adaptive optics (Roddier et al. 1996, ApJ 463). Both of these earlier studies characterize the integrated, large-scale, disk properties. In order to study the internal structure we have carried out a high resolution imaging program at 1.1, 1.6, and $2.0\mu\text{m}$ with NICMOS aboard the Hubble Space Telescope.

Figure 1 shows the resulting images minus a model for the central binary star, clearly revealing the circumbinary disk. Compared with earlier ground-based images, the sensitivity is increased by two orders of magnitude. The extended disk structure covers radii ranging from $0.''9$ to $2.2''$ and has integrated intensities and colors that agree well with previous results. Internal variations in intensity and color are also observed. At low spatial frequencies, the top half of the disk is distinct from the bottom half. Radially averaged azimuthal changes in flux reveal a constant flux ratio (top:bottom) of 2:1, independent of wavelength. This angular dependence can be explained in terms of the difference between forward and back scattering (Close et al. 1998, ApJ 499; Wood et al. 1999, ApJ 516). The images also reveal higher spatial frequency variations (see Figures 1 and 2). Color maps reveal clumps in the disk that vary in color. These unusual intensity and color variations can not be explained by a simple scattering plus extinction model.

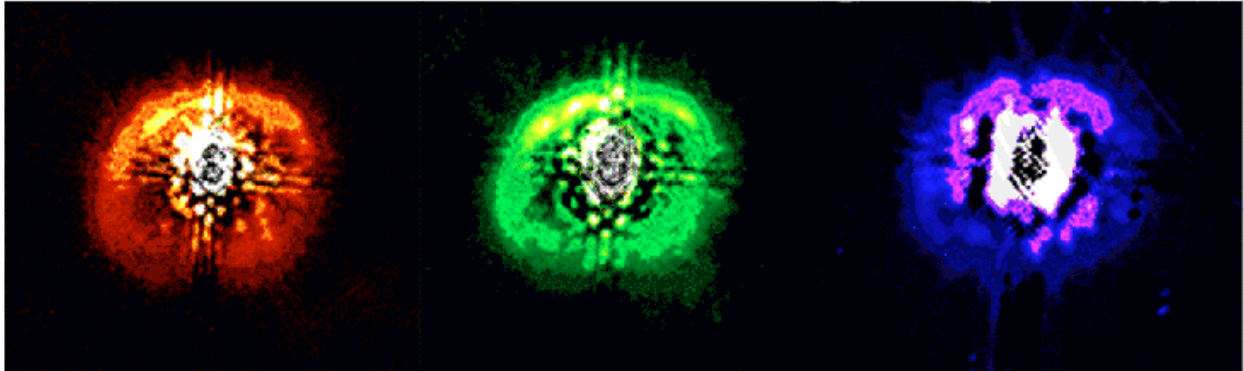


Figure 1: The 1.1, 1.6, and 2.05 μm images of GG Tau A with the stellar components subtracted out. The near-infrared emission is interpreted as primarily scattered light from the inner edge of the ring. In addition to the general ring appearance, the disk appears to have significant small scale variations, both in intensity and in color (see Figure 2).

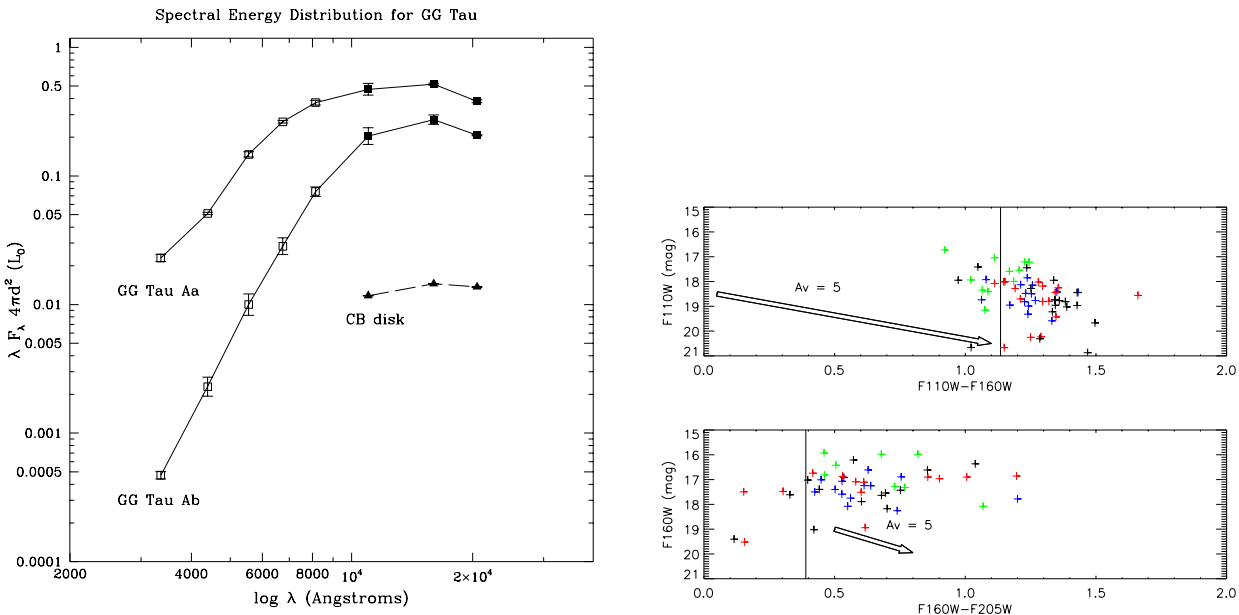


Figure 2: *left* : The visual-IR Spectral Energy Distribution of the GG Tau system - GG Tau Aa (primary), GG Tau Ab (secondary) and the circumbinary disk. The visual points are WFPC2 data points from Ghez et al. 1997. *right* : Color-magnitude diagrams show the range of colors from independent points within the disk. The difference in scatter between the F110W-F160W and F160W-F205W colors when compared to the reddening arrows show that the disklight is inconsistent extinction. The vertical lines represent the mean stellar color.