THE CIRCUMSTELLAR STRUCTURE OF THE CLASS I PROTOSTAR TMC-1 (IRAS 04381+2540) FROM HUBBLE SPACE TELESCOPE NICMOS DATA. S. Terebey[1], D. Van Buren[2], M. Brundage[3] and T. Hancock [4], [1]Department of Physics and Astronomy, California State University at Los Angeles, Los Angeles, CA 90032, sterebe@calstatela.edu, [2]Jet Propulsion Laboratory, [3]Microsoft, [4]Anansi Spaceworks

Introduction: The class I protostar TMC-1 (IRAS 04381+2540) located in the Taurus star-forming region is oriented favorably for determining the properties of its circumstellar envelope and outflow cavity. The source shows both a narrow jet and a wide-angle outflow. We compare Hubble Space Telescope NICMOS data at 1.6 microns with model images generated from a Monte Carlo scattering code. The models fit the intensity profile well, reproducing both the apparent width of the outflow cavity and the observed limb brightening. The main differences are a lack of observed emission from the rear of the outflow cavity, as well as observed small-scale structure due to density fluctuations that is not accounted for in the axisymmetric models.

Previous work shows that the extended nebulosity seen around protostars at near-infrared wavelengths can be explained by stellar photons that scatter off circumstellar dust. The assumed density distribution for the model consists of the Terebey, Shu, and Cassen (1984) cloud collapse model ("infall envelope"), a conical outflow cavity, and a geometrically thin but opaque disk. The best fit model for TMC-1 has 45 +/-5 degree source inclination and 80 +/-5 degree deprojected wind opening angle (full width). The infall rate dM/dt and central mass M are correlated such that dM/dt/(5 x 10^{-6} Mo per yr) = (M/0.5 Mo)^{0.68} The disk size is not well constrained by the data except that large disks (>160 AU) are ruled out. The age, normally a poorly known quantity, is well constrained by the models. The protostar age, i.e. time since the onset of collapse, is 1 x 10^5 yr to within a factor of two.