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THE EFFECTS OF WINDS AND PHOTOIONIZATION ON THE EVOLUTION OF PROTOSTELLAR DISKS

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The evolution and appearance of circumstellar disks in star forming regions can be influenced strongly by the radiation from nearby hot stars. UV radiation heats the outer layers of the disk and induces expansion up to escape velocities. Hollenbach, Yorke, & Johnstone (2000) identify this "photoevaporation" process as a principal, if not the most important, disk destruction mechanism. Here, we describe the results of numerical simulations of the evolution of protostellar disks and their surroundings under the influence of external UV radiation. In order to assess the role of central stellar winds, we have included the effects of an isotropic wind in the numerical models.

Using a 2D (axial symmetry assumed) radiation hydrodynamic code described in detail by Richling & Yorke (2000), we calculate the evolution of externally UV-irradiated protostellar disks with the added influence of isotropic winds from the disk's central star. The initial disk model was taken from Yorke & Bodenheimer (1999).

The UV-irradiation of the disk results in dissociation of H_2 and CO as well as heating of the outer disk layers. This warm material is no longer gravitationally bound to the disk at disk radii where the sound speed exceeds the escape velocity, and a neutral "photoevaporation" flow results. The disk and the outflow is surrounded by a teardrop shaped ionization front. A shock front is located between the disk and the I-front. During its photoevaporation the disk decreases in size and mass.

An initially isotropic stellar wind is collimated by the disk's neutral outflow into a bipolar outflow (Fig. 1). Because there is some degree of mixing of stellar wind (with no angular momentum) with disk material (rotating at Keplerian velocity) at the disk's inner edge, the collimated outflow contains angular momentum. As this "loaded" material moves to ever larger distances from the star, centrifugal forces cause it to expand in the radial direction. The net result is that the outflow lies in a conical shell; very little material lies inside this shell close to the rotation axis and what little is there has a very low temperature.

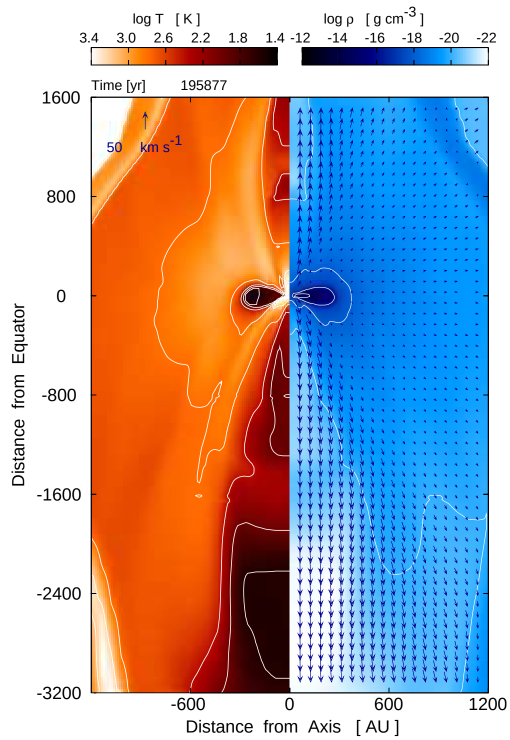

Fig. 1. Temperature (left), density (right), and velocity (arrows) structure of a photoevaporating disk with a moderate stellar wind.

Because of the focusing of the stellar wind, it had little affect on the disk itself. Although the radio continuum emission does show evidence for the existence of a jet, the spectral energy distribution and the rate at which the disk is destroyed by UV irradiation were hardly affected.

REFERENCES

Hollenbach, D., Yorke, H.W., Johnstone, D. 2000, in Protostars and Planets IV, eds. V. Mannings, A. P. Boss, & S. S. Russell (Tucson: University of Arizona Press), 401

Richling, S., Yorke, H. W. 2000, ApJ, 539, 258

Yorke, H. W., Bodenheimer, P. 1999, ApJ, 525, 330

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