

# The Evolution of Photoevaporating Disks

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Numerical simulations are performed in order to investigate the evolution and photoevaporation of protostellar disks under the influence of an external radiation field. For this purpose we use a 2D radiation hydrodynamics code which calculates the transfer of direct EUV ( $h\nu > 13.6$  eV) and FUV ( $6$  eV  $< h\nu < 13.6$  eV) radiation from a point source located on the rotation axis of a star-disk model. In addition, the diffuse EUV radiation field originating from direct recombinations of hydrogen into the ground state and the diffuse EUV and FUV radiation fields resulting from scattering on dust grains are considered. Ionization of hydrogen and carbon is calculated and for the determination of cooling functions we simply assume that the material is atomic before and molecular behind the carbon ionization front (C I-front). Shortly after the external radiation field is turned on the C I-front completely encloses the densest parts of the disk. FUV photons heat the region between the C I-front and the hydrogen ionization front (H I-front) and produce a neutral evaporating flow (Fig. 1 & 2). The approaching H I-front compresses the neutral flow but is not able to reach the surface of the disk. In the subsequent evolution the H I-front sweeps up material behind the disk and a tail develops. In contrast to simulations without FUV radiation, the cometary tail still exists at the end of the simulation. Both long-lived tails and a stand-off of the H I-front from the disk surface are attributes of the proplyds in the Orion Nebula.

For direct comparison with the observations a frequency-dependent ray-tracing code is used to calculate emission line maps of the system at various evolutionary states and viewing angles (Fig. 2). The H $\alpha$  maps show the emission of the hot ionized gas at the head and along the tail. A silhouette disk is visible for viewing angles  $\geq 90^\circ$ . The emission in [OIII] is more diffuse around the head and weaker along the tail since the diffuse EUV photons are not sufficient to ionize OII there. The [CII] maps show the strong emission of the warm gas at the disk's surface and the fainter emission between the C and H I-front.

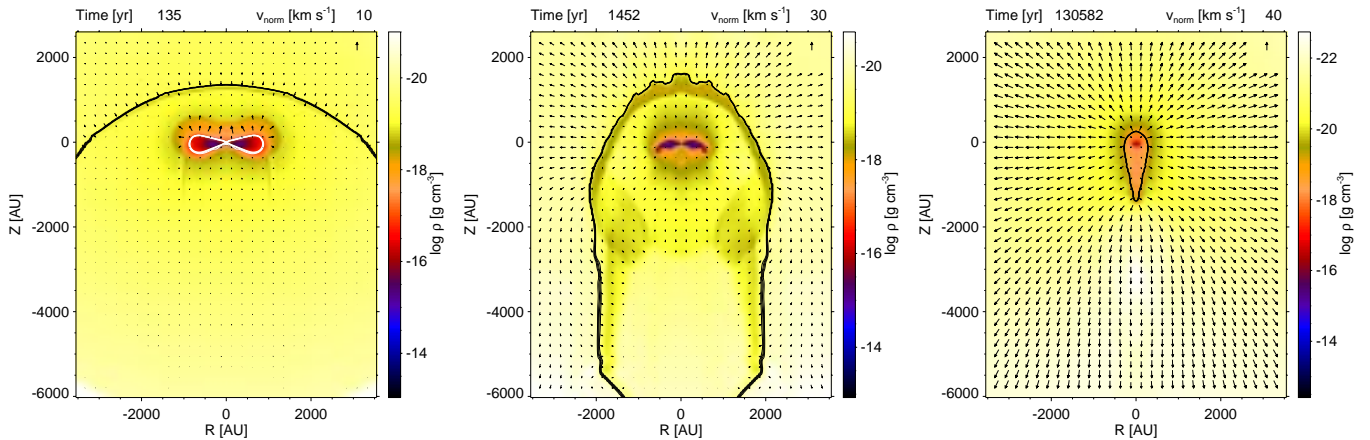


Figure 1: Density (color scaled), I-front (solid lines) and gas velocity (arrows) for selected times during the external illumination of a protostellar disk with FUV/EUV radiation by an O star located 0.1 pc above the disk.

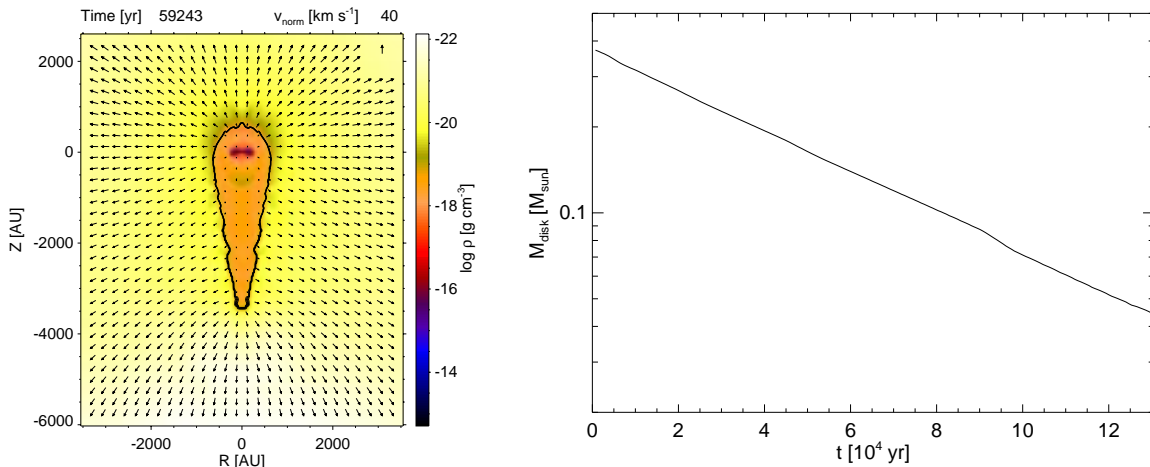


Figure 2: *left*: Same as in Fig. 1 but for an intermediate time. *right*: Evolution of disk's mass.

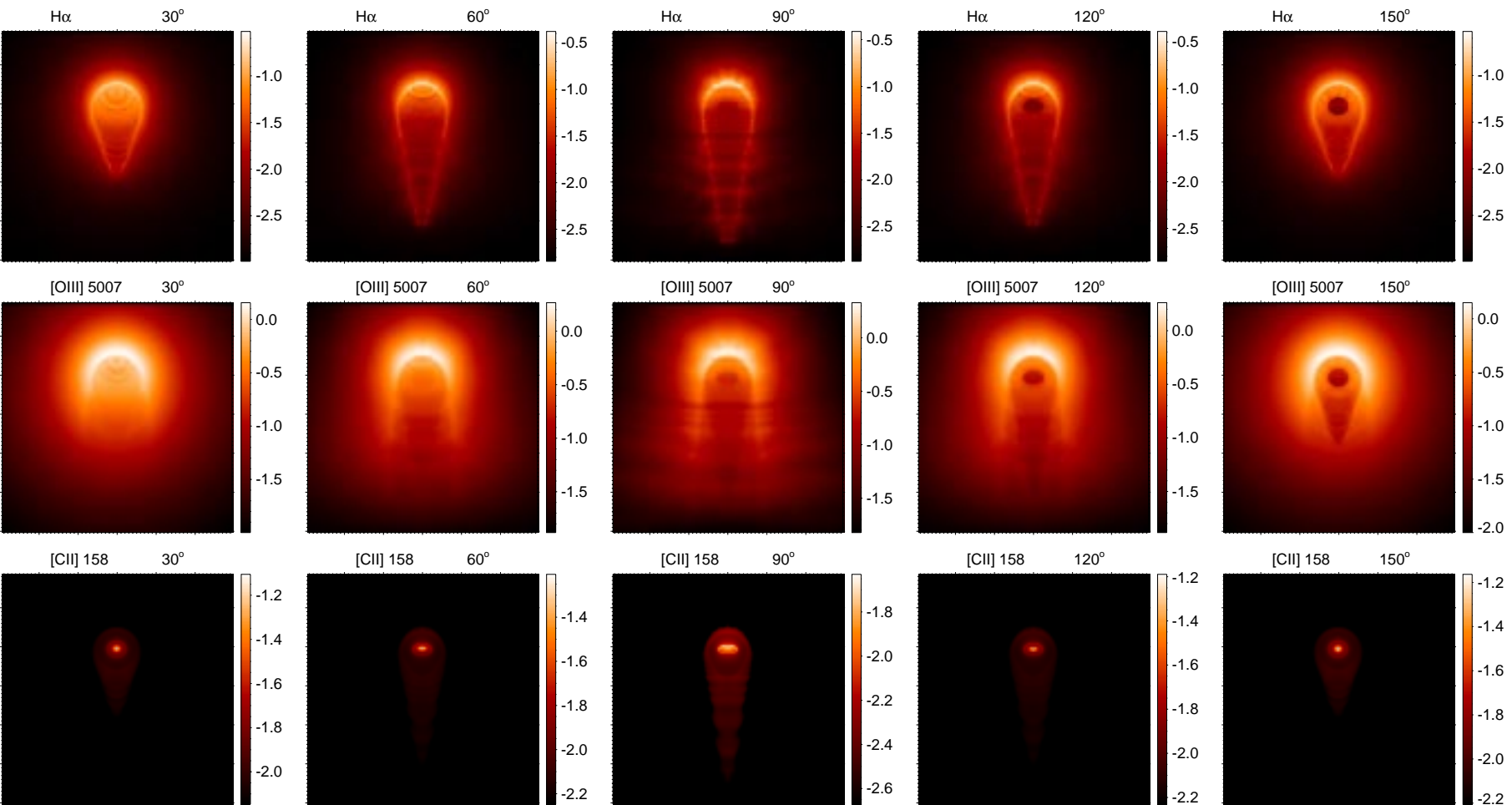


Figure 3: Emission line maps for the model at  $t = 59243$  yr shown in Fig. 2. The maps are displayed for H $\alpha$ , [OIII] 500.7 nm and [CII] 158  $\mu\text{m}$  at five different viewing angles. A viewing angle of  $0^\circ$  corresponds to pole-on from the direction of the illuminating star. The intensity is in cgs units.