Iranian Journal of Physics Research, Vol. 20, No. 3, 2020
DOI: 10.47176/ijpr.20.3.51052

Evolution of a protoplanetary disc with the magnetic wind

M Shadmehri

Department of physics, Faculty of Sciences, Golestan University, Gorgan, Iran

E-mail: m.shadmehri@gu.ac.ir

(Received 04 May 2020 ; in final form 01 August 2020)

Abstract

Theoretical studies and numerical simulations of the protoplanetary discs (PPDs) indicate that magnetorotational instability (MRI) is a dominant mechanism in the accretion process. Recent observational evidence, however, implies that magnetic winds are present in these systems. Launching the magnetic winds leads to further angular momentum removal and a higher mass accretion rate. Non-ideal MHD disc simulations have shown that there is a correlation between MRI and magnetic winds. Thus, exploring the structure of PPDs with the magnetic winds plays a vital role. We fully present the analytical solutions for the evolution of a PPD with the magnetic wind. Relations for the stress tensor components associated with the disc turbulence and the magnetic wind are motivated by the recent MHD disc simulations. These relations are written in terms of the ratio of the gas and magnetic pressures. In the case with a strong magnetic field, the role of the magnetic wind in the angular momentum removal is dominant. We show that a PPD undergoes a non-significant mass loss during the early stage of the evolution. However, the mass loss rate is significantly amplified beyond a certain time. It seems, therefore, that the role of the magnetic wind in the older PPDs is more noticeable. We also indicate that the two-stage evolution of a PPD with the magnetic wind is more or less independent of the disc radial temperature distribution.

Keywords: accretion, disc, protoplanetary disc, wind, magnetic field

For full article, refer to the Persian section