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Hydrodynamical Simulations of Hα Emission in Algol Binaries

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1. Introduction

Two-dimensional hydrodynamical simulations of mass transfer in short period Algol type binaries were performed using the numerical code VH-1. This code uses the Piecewise Parabolic Method with a Lagrangian Remap. Our version of the code also accounts for radiative cooling processes. The purpose of performing the simulations was to study the Hα emission from circumstellar gas in the Algols. Using observational evidence from the literature to constrain the gas stream properties, hydrodynamical maps of the Hα emissivity in the two systems β Per ($P = 2.87^d$) and TT Hya ($P = 6.95^d$) were made in both Cartesian and velocity coordinates from the simulation data. The velocity maps were then compared to Doppler tomograms constructed from observed Hα line emission in these systems. Since the tomograms cannot be directly transformed to maps of emission in spatial coordinates, the simulated Cartesian maps enable us to interpret the dynamical processes which produce the features observed in the Doppler tomograms. We find that the simulations produce asymmetric accretion structures with many features similar to those found in the Doppler tomograms of Algol systems.

2. Conclusions

The hydrodynamical simulations prove useful in understanding the gas dynamics and emission properties found in these Algol systems. We find that the inner boundary of the ring of emission in the longer period system TT Hya is displaced left of center in the integrated velocity image due to the asymmetry in the shape of the accretion annulus. The accretion annulus formed in this system is quite stable with emission strength similar to that found in the gas stream. However, in the shorter period system β Per where the gas stream directly impacts the primary, the emission strength of the accretion annulus is much more dependent upon the initial density of the gas stream and the process of radiative cooling. Only the simulation with initial stream density of $n_s = 10^9$ cm^{-3} shows emission strength in the disk comparable to that found in the gas stream.

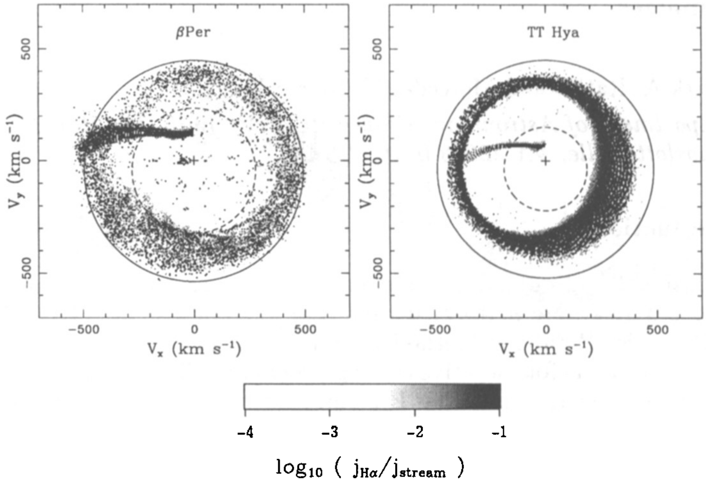

Figure 1. Integrated velocity images constructed by integrating the Hα emissivity calculated from the hydrodynamical simulations of β Per and TT Hya over one orbital period. The initial density of the gas stream in both these simulations was $n_s = 10^9$ cm^{-3}. The Hα emissivity depicted in these images is scaled to the emissivity in the gas stream for each simulation.

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