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Hα Doppler Tomography of AM Her: Evidence for Bipolar Accretion

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Abstract. We present Doppler maps of H*alpha* emission lines of AM Her from four differents epochs. The tomography shows a strong velocity "spot" emission at (−100,−100) km s^{-1} and a weaker "spot" emission at (−100,−400) km s^{-1} which is suggestive of bi-polar accretion onto the white dwarf with stronger emission from the main pole at phase ϕ=0.0.

1. Introduction

The emission lines of AM Her consist of apparently two components, a broad and a narrow component which have been related to the gas stream and donor star emission, respectively (Liebert and Stockman 1985). The long-term photometric light curve shows low and high states and therefore we embarked on a monitoring campaign in order to search for correlations between the emission line components and the optical/X-ray continuum level. The phase-resolved observations of AM Her were carried out with the 2.5 m Isaac Newton Telescope (INT) on 1989 July 21 (first epoch, V $\approx$ 14.4), on 1992 May 17 (second epoch, V $\approx$ 14.5), on 1995 July 3 (third epoch, V $\approx$ 13.2) and on 1995 July 27 (fourth epoch, V $\approx$ 12.9). We obtained 44, 31, 30, 24 spectra covering 1 orbital cycle at a resolution of 32, 44, 76, 76 km s^{-1}, respectively. The CCD images were reduced and the spectra extracted using the optimal extraction technique (Marsh 1989). The spectra were assigned orbital phases using the ephemeris HJD = 2443014.76614 + 0.128927041$\times E$ (Heise & Verbunt 1988).

2. Results

Image reconstruction was performed on the spectra using the linear, Fourier-filtered back projection technique (Horne 1991). The Doppler velocity maps show that the dominant emission rises from the ($-V_x$,$-V_y$) velocity quadrant in which the gas stream velocities lie. However, it is notable that this strong "spot" emission is of low velocity, (−100,−100) km s^{-1}, persists in all four epochs, corresponds to the narrow, low velocity 'S'-wave component on the trailed spectra and is not directly related to the gas stream ballistic trajectory. Such emission is also seen in the UV (SiIV 1394 Å, CIII 1176 Å) Doppler maps (Gänsicke et al. 1998) but in contrast to a HeII Doppler map of AM Her which shows "quasi-ballistic" gas stream emission (Schwarz et al. 2002). However, our Doppler maps show, in

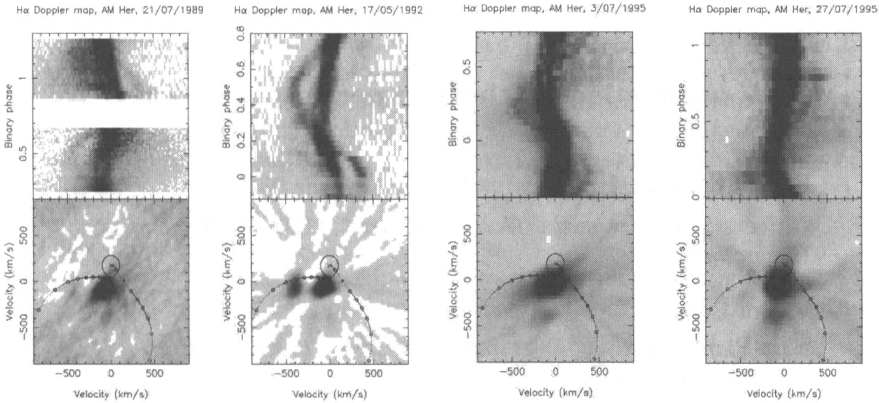

Figure 1. The Ha trailed spectra and Doppler maps of AM Her at four epochs. See text for interpretation. Binary parameters used for the Roche lobe and ballistic trajectory are K_2=174 km s^{-1} and q=0.7 (low mass white dwarf).

addition, a weaker "spot" emision at (−100,−400) km s^{-1} which is detectable in three epochs. This is compatible with bi-polar accretion (but not with the magnetic-propeller model, Wynn et al. 1997) with the emission from the main accretion pole (phase 0.0) much stronger than the secondary pole (phase 0.5). During one epoch (low state), Hα emission along the ballistic trajectory is detectable at 0.4-0.5 R_{L_1} which may well signify the impact of the gas stream on the Alfven radius of the magnetosphere.

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