THE 35 DAY CYCLE OF HER X-1

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Abstract. The 35 d period in the observed X-ray and optical light curves of Her X-1 can be understood in terms of a warped accretion disk precessing in the tidal field of the companion. We propose that repulsive forces of the X-ray driven coronal wind acting on the disk causes and maintains the warp of the disk (Fig. 1). The resulting shape of the precessing disk reproduces the main features of the observed X-ray light curve [1]. Based on the calculated disk shape we model the dip structure in the X-ray observations as caused by the interaction between the accretion stream and the warped disk.

The interaction yields a thickening of the involved disk region which is carried through the disk at the corresponding radii because of the Keplerian motion. Therefore the whole disk 'rings' are involved in this thickening (Fig. 2) which gets smoothed out on the thermal time-scale $(\alpha\Omega)^{-1}$. Because of the warped shape of the disk each disk 'ring' gets thickened twice per orbit, once the accretion stream hits the disk at the upper surface, 0.5 in orbital phase later at the lower surface. At turn-on we look marginally over the disk surface and thus the additional small thickening can cover the X-ray source at those orbital phases where the disk ring which does the turn-on is thickened (**anomalous dip**). This explains naturally that anomalous dips occur only at turn-on and only at two special orbital phases around 0.2 or 0.7. The dip spectrum shows cold matter absorption as expected from the disk matter.

The interaction yields also a cold and clumpy spray which covers the source at orbital phases just before each eclipse (Fig. 2). Because of the twist these **pre-eclipse dips** march backwards in orbital phase, as is observed. The observations show also strong intensity variations on short time-scales ($\sim$ min) and cold matter absorption features in the spectrum which the assumed cold and clumpy spray can reproduce (submitted to A&A).

The observed optical data depend on the phase of the 35 d precession.

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The most striking feature is the relatively high luminosity around phases $\phi_{\text{orbit}} = 0.3$, $\phi_{\text{precession}} = 0.0$. The corresponding feature in the simulation is caused by the interaction of the accretion stream with the disk **rim**.

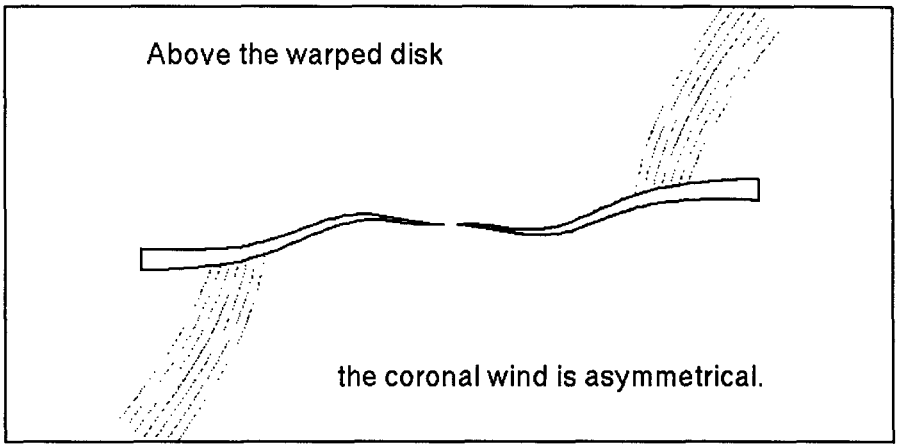

Figure 1. The vertical cut through the warped disk, with its X-ray driven coronal wind above the asymmetrical illuminated surface, shows schematically the mechanism which produces and maintains the tilt and twist of the accretion disk.

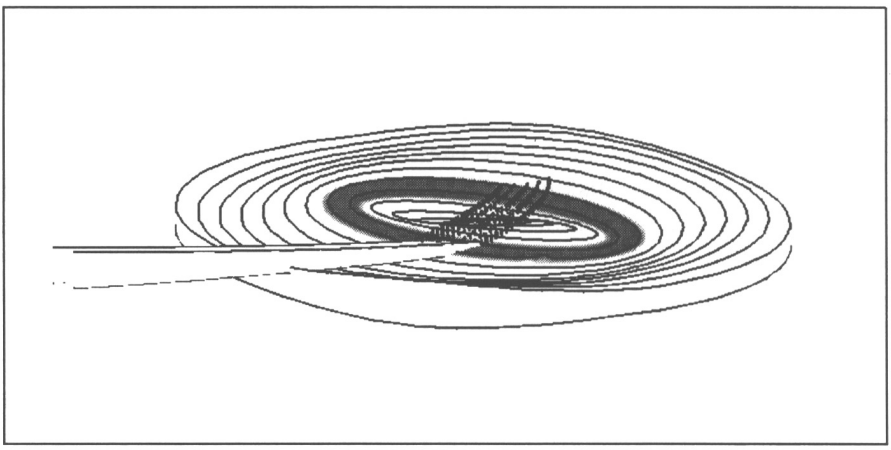

Figure 2. The impact of the accretion stream on the disk surface causes a spray of matter and a thickening of the disk which is carried through the disk along Keplerian orbits (shown grey). Both effects reproduce the observed pre-eclipse and anomalous dips.

References

1. Schandl, S., Meyer, F., 1994, A&A, **289**, 149

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