X-Ray Optical and ultraviolet observations of the Am-Herculis Object E2003+225

Osborne, J.P.; Mukai, K.; Charles, P.; Corbet, R.; Bonnet-Bidaud, J.M.; Henry, P.; Hill, G.; Kahn, S.; van der Klis, M.B.M.

Published in:
ESA Special Publications

X-RAY, OPTICAL AND UV OBSERVATIONS OF THE AM HER OBJECT E2003+225

J.P. Osborne[1], K. Mukai[2], J.M. Bonnet-Bidaud[3], P. Charles[2], R. Corbet[2], P. Henry[4], G. Hill[4], S. Kahn[5], M. van der Klis[6], L. Maraschi[7], A. Treves[7], S. Vrtilek[5]

[1]EXOSAT Observatory, Space Science Dept. of ESA, 6100 Darmstadt, F.R.G., [2]Dept. Astrophysics, Oxford [3]CEN Saclay, [4]Institute of Astronomy, Hawii, [5]Dept. of Physics, Berkeley, [6]ESTEC, Noordwijk, [7]Dipartimento di Fisica, Milano.

ABSTRACT

We present quasi-simultaneous EXOSAT, low resolution spectrophotometric optical and IUE observations of the AM Her object E2003+225 made in October 1983 and simultaneous high resolution optical and phase-resolved IUE observations made in July 1984. The soft X-ray light curve shows 2 maxima per orbital period and also 2 'eclipses'. The EXOSAT 500 l/mm grating observation limits the blackbody temperature to 18 eV< kT< 29 eV. The blackbody luminosity exceeds the bremsstrahlung luminosity by at least a factor of 2.3, in contradiction to standard accretion models. In July 1984 we find a systemic velocity, γ = -30 Km/s for all line components. The only previous observations (Nousek et al. (1984), N84) showed γ = 300-500 Km/s. We find that optical minimum and soft X-ray 'eclipse' occur at ϕ = 0.3, previous observation (N84) showed optical minimum at ϕ = 0.4.

INTRODUCTION

AM Her systems consist of a synchronously rotating magnetic (B ~ 30 MG) white dwarf accreting matter from a red dwarf. The magnetosphere of the white dwarf is larger than the binary system, so no disk can form and the accreted matter falls radially onto the magnetic pole(s) of the white dwarf. The accretion funnel covers only a small fraction (~10^{-3}) of the white dwarf surface. Above the white dwarf the supersonically falling matter is shocked and forms a settling atmosphere. AM Her and AM Her systems have been reviewed by Chiappetti et al. (1980) and Liebert and Stockman (1983).

Standard theories for the accretion of matter onto magnetised white dwarfs predict that the accretion luminosity will mainly appear in 3 components: a blackbody limited cyclotron component appearing in the IR and visual and becoming optically thin (and thus polarised) in the visual, originating from the shock or pre-shock flow; a thermal bremsstrahlung component appearing in hard X-rays from the shock; and a blackbody component appearing in soft X-rays/XUV from the heated white dwarf photosphere below the shock (Lamb and Masters, 1979, Imamura and Durisen, 1983). A high resolution observation of AM Her (Heise et al., 1982) showed that the blackbody luminosity was too great to be accounted for by the hard X-ray flux. Quiescent nuclear burning and diffusive electron conduction have been rejected as possible reasons for this. However clumpiness in the accretion flow (Kuijpers and Pringle, 1982) and heat transport by high velocity electrons (Frank and King, 1984) may be responsible.

The belief that these systems rotate synchronously arose from the equality of the orbital periods as determined by polarisation and radial velocity observations. However, there is evidence of short-term phase changes ($\Delta\phi$≥0.1) in a number of objects (eg. Bailey and Aron, 1981; Bonnet-Bidaud et al., 1985).

The observations presented here show that accretion geometry changes have also occurred in E2003+225. They also show that the blackbody luminosity is greater than the bremsstrahlung luminosity in contradiction to standard accretion theories. The soft X-ray light curve is complex and is not explained by the standard models of Imamura and Durisen (1983). A preliminary report of this work was given by Mukai et al. (1984). All phases given in this work are calculated from the linear polarisation ephemeris of N84.

OBSERVATIONS

Table 1 - Journal of Observations

	1983 Oct. 12	1984 July 24/25
Optical	Hawaii 88" low resln. spectrophotom 4400-6050A (0600-0900 UT)	La Palma 2.5m high resln. spectrophotom 4020-5040 (2300-0300 UT)
IUE	2 SWP + 1 LWP (1500-2200 UT)	6 SWP + 6 LWP (1925-0250 UT)
EXOSAT	2 low energy telescopes (LE's) + Medium energy detectors (ME) (0300-0920 UT) (LE2 + grating (0330-0920 UT))	

Proc. ESA Workshop: Recent Results on Cataclysmic Variables, Bamberg, 17–19 *April* 1985 (*ESA SP-236, June* 1985).