THE FLARES OF AE AQR

M. ERACLEOUS[1], K. HORNE[2], M. LIVIO[1], W. F. WELSH[3]
1 Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
2 Physics and Astronomy, The University of St. Andrews, North Haugh, St. Andrews, Fife, KY16 9AJ, UK
3 Physics Department, Keele University, Keele, ST5 5BG, UK

Abstract. The enigmatic flaring activity of AE Aqr, which extends from the radio to the X-ray bands, may be the exotic outcome of a relatively feeble accretion flow onto the rapidly spinning white dwarf. We summarize and interpret the results of recent observations by HST and ROSAT of the aperiodic flares. Optical and UV flares are tightly correlated and are clearly involved in powering the emission lines. The spectrum of a flare consists of a Balmer continuum, and a plethora of emission lines, which vary synchronously. The large optical/UV flares are *not* accompanied by *large* X-ray outbursts. The radial velocity curves of the UV lines, and of Hα, suggest that they originate in the accretion stream. The observational results dis-favor scenarios invoking coronal activity on the secondary star or instabilities at the disk/magnetosphere interface. Rather, they support a recently proposed scenario in which the accretion flow consists of blobs which are shocked upon encountering the white dwarf magnetosphere.

1. Observations and results

AE Aqr was observed twice in the UV with the HST: in 1992 November and in 1993 October (see the accounts by Eracleous et al. 1994, 1995). The second observation was made during the *World Astronomy Days* campaign, and coincided with a ROSAT observation (described by Osborne et al. 1995), yielding about 35 m of truly simultaneous X-ray and UV data.

The time-resolved UV spectroscopy carried out with the HST shows that the flare spectrum consists of a strong Balmer recombination continuum ($T \sim 10^4$ K), and a plethora of emission lines from highly ionized species (ionization energies: 50...100 eV). *All* the lines were observed to

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vary together through the flares, with no discernible time lag (down to a resolution of 2.5 m). The phase and amplitude of the radial velocity curves of the He II λ1640 and Si III] λ1892 lines suggest very strongly that the lines originate in the accretion stream from the companion star, much like the radial velocity curves of the Balmer lines (Welsh, Horne & Gomer 1993; Reinch & Beuermann 1994). Moreover, the simultaneous UV and X-ray observations show that the large optical/UV flares are not accompanied by *large* X-ray outbursts.

2. Discussion and conclusions

The observational results, and in particular the emission-line radial velocity curves, dis-favor an origin of the flares in material following the orbit of the white dwarf, or on the companion star. In view of these results, scenarios attributing the flares to instabilities at the white dwarf magnetosphere (van Paradijs, Kraakman & van Amerongen 1989; Spruit & Taam 1993), and suggestions invoking coronal mass ejections from the companion star (Chincarini & Walker 1981) appear unlikely. Rather, the observations favor a recently proposed scenario, in which the flares are the results of the impact of a fragmented ('blobby') accretion stream on the white dwarf magnetosphere (Wynn, King & Horne 1995; Wynn 1996).

In the context of the latter scenario, what is observed as a flare is the arrival of a new blob at the magnetosphere of the white dwarf, where it is shock-ionized and/or photo-ionized. Some of the matter is eventually accreted onto the white dwarf, but most of it is ejected from the system by a propeller-type mechanism. As the matter moves away from the system, it cools and recombines and the flare declines. All of the activity occurs near the white dwarf magnetosphere where the dynamical time and the recombination time for hydrogen ($n \sim 10^{10}$ cm^{-3}) are comparable to the rise time of the flares ($\lesssim$ 30 m).

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