EF Eri in a low accretion state

Peter J. Wheatley

X-ray astronomy group, Dept. of Physics and Astronomy, Leicester University, University Road, Leicester LE1 7RH, UK

Gavin Ramsay

Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, Surrey RH5 6NT, UK

1. Introduction

In Jan & Feb 1997 we obtained optical photometric and spectroscopic observations of EF Eri which showed it to have entered a low accretion state. This is the first observed interval of reduced accretion in EF Eri, which is normally one of the brightest polars in the sky ($m_{\rm V}$ typically 14).

2. Observations

In Jan 1997 we measured B & V band lightcurves with the Dutch 1.0m telescope at La Silla, Chile. We found that EF Eri was about four magnitudes fainter than usual, though still modulated in both bands by ~ 0.2 mag. On 7 & 8 Feb 1997 we observed EF Eri spectroscopically using the ESO 3.6 m telescope at La Silla. We covered 1.3 orbital cycles the first night ($P_{\rm orb} = 81$ min), taking five-minute exposures with a low-resolution blue grism (3800–6800 Å). The second night we covered 2.1 orbital cycles with a red grism (5900–9800 Å). The mean spectrum from each night is plotted in Fig. 1.

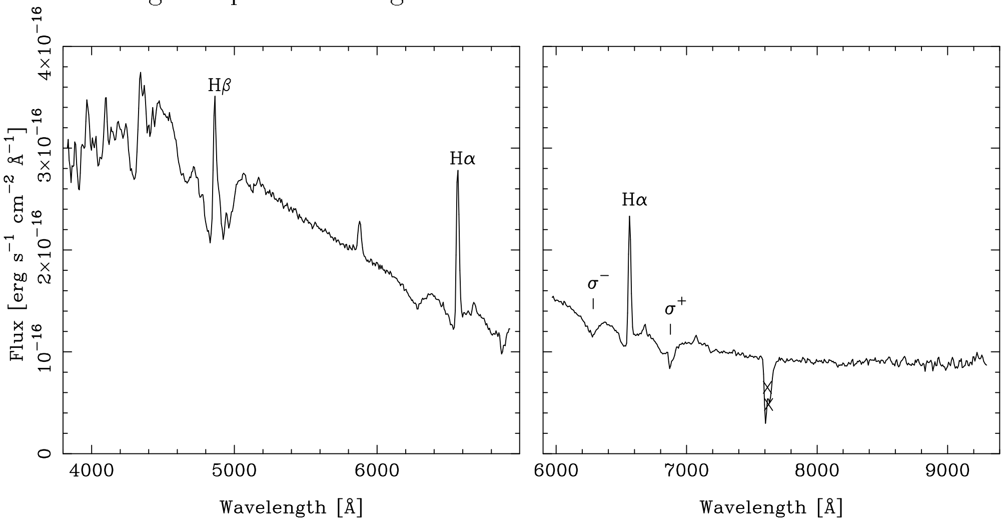

Figure 1: Phase-averaged spectra of EF Eri in a low accretion state.

3. Results

The continuum rises steeply into the blue, with absorption components of Hα and Hβ indicating that the photosphere of the white dwarf has been revealed. The emission lines and flattening of the spectrum in the red, indicates that accretion continues: albeit at a much reduced rate. The photospheric absorption lines show considerable structure due to the Zeeman effect — as is often observed from the strongly-magnetised white dwarfs in polars. The sigma components of Hα are easily identified, and yield an estimate of the field strength of 14 MG (by comparison with Fig. 1 of Henry & O'Connell 1985, PASP 97, 333). This is relatively low for a polar, but consistent with other estimates of the white-dwarf field strength in EF Eri (Östreicher et al. 1990, ApJ 350, 324; Ferrario et al. 1996, MNRAS, 282 218). Our estimate probably represents an average over the surface of the white dwarf, so it is surprising that it is consistent with other estimates: which apply to the small accretion regions and may be expected to have significantly higher field strengths. This maybe understood if either: 1) the field structure is complex, resulting in a rather uniform field strength over the white dwarf; or 2) our spectra are dominated by light from accretion heated spots on the white dwarf surface.

Inspecting the phase-resolved spectra, we find that the red emission is dominated by a component that is present for a little less than half the orbital period. Figure 2 shows the spectrum of this component, which is very smooth, with no line features (except the atmospheric feature at 7600 Å). It cannot be the secondary star, the spectrum of which would be dominated by molecular absorption bands. Instead we attribute this red component to cyclotron emission from an accretion site on the white dwarf. The very red spectrum, with no resolvable cyclotron lines, also indicates a low magnetic field strength. This component is brightest at orbital phase $\phi_{\rm dip}$ ~0.4, and its duty cycle suggests it is located on the lower hemisphere of the white dwarf. It is not a prominent accretion region in the high state.

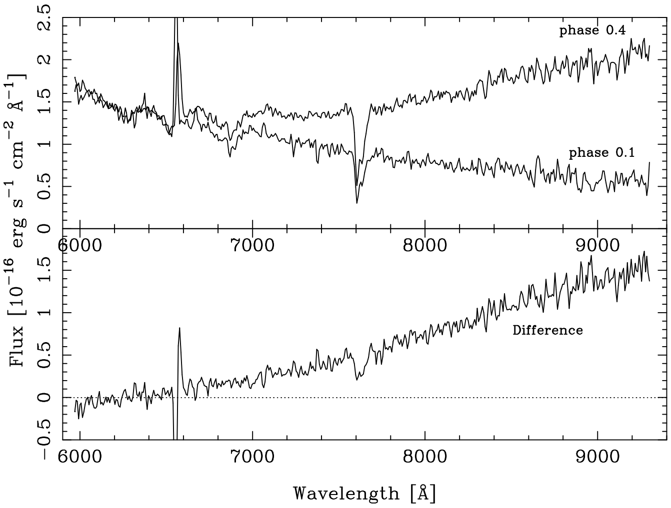

Figure 2: The spectrum of the red component.

Finally, we detect no features attributable to the donor star. This star must be very red/faint: as is indicated by the short orbital period of EF Eri.