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The magnetosphere of the close accreting PMS binary V4046 Sgr AB

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Abstract. We present a preliminary 3D potential field extrapolation model of the joint magnetosphere of the close accreting PMS binary V4046 Sgr. The model is derived from magnetic maps obtained as part of a coordinated optical and X-ray observing program.

Keywords. stars: formation, stars: interiors, stars: magnetic field, stars: pre-main sequence

1. Introduction - large multi-wavelength observing campaign

V4046 Sgr is a close (separation $\sim 9\,R_\odot$; Donati *et al.* 2011) circularised and synchronised PMS binary, accreting gas from a large circumbinary disk (Rosenfeld *et al.* 2012). It was observed as part of a coordinated X-ray and spectropolarimetric observing program with *XMM-Newton* and ESPaDOnS@CFHT during 2009. The observational highlights include: (i). the derivation of the first magnetic maps of a close accreting PMS binary system, see Fig. 1 (Donati *et al.* 2011). (ii). The detection of rotationally modulated soft X-ray emission associated with accretion shocks where accreting gas impacts the surface of the stars (Argiroffi *et al.* 2012). The modulation period is half of the binary orbital period. (iii). The realisation that V4046 Sgr may be a quadruple system, with GSC 07396-00759 a distant (projected separation ∼12,350 au) companion to V4046 Sgr AB (Kastner *et al.* 2011). The companion itself is likely a non-accreting PMS binary.

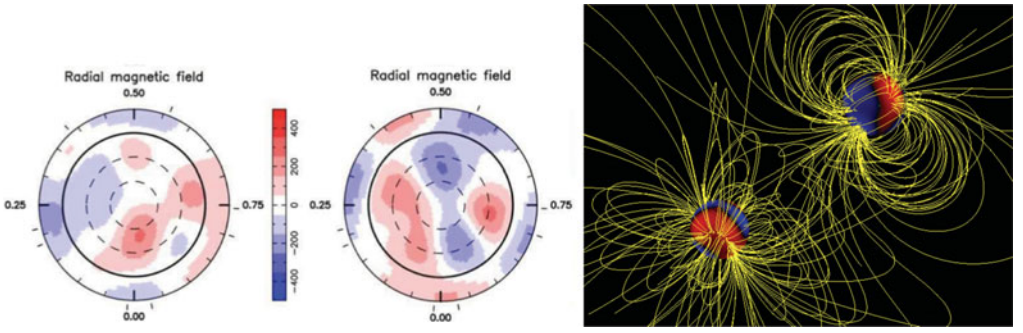

Figure 1. Magnetic maps of the primary/secondary star of V4046 Sgr (left/middle respectively). Blue/red is negative/postive field, with fluxes labelled in Gauss. Tick marks/numbers denote the phases of observation/rotation phase. The maps are shown in flattened polar projection with the bold circle/dashed lines the stellar equator/lines of constant latitude. Maps of the other field components & brightness/excess accretion-related emission maps can be found in Donati *et al.* (2011). The right panel shows a binary magnetic field extrapolation from the magnetic maps of V4046 Sgr. Only the large-scale field lines are shown. The magnetic fields are highly tilted with respect to the stellar rotation axes. Field lines connect through the interior of the binary from the nightside of one star to the dayside of the other.

2. The magnetic field of V4046 Sgr & field extrapolation

Magnetic maps of V4046 Sgr, derived from Zeeman-Doppler imaging, are shown in Fig. 1 (Donati *et al.* 2011). Only the radial field components are shown. Both stars are found to host complex large-scale magnetic fields with weak dipole components, consistent with their partially convective internal structure (Gregory *et al.* 2012).

A binary magnetic extrapolation is shown in Fig. 1. This has been constructed using a newly developed binary magnetic field extrapolation code that will be described in a forthcoming paper (Holzwarth in prep.). The code assumes that the large-scale field is potential and subject to three boundary conditions: the magnetic field is as measured from the maps at the surface of the each star, and a source surface boundary condition designed to mimic the pulling open of the large-scale magnetic loops by the stellar wind. The magnetic fields of both stars are linked, with loops connecting the dayside of one star to the nightside of the other. The field geometry, and the distribution of accretion columns and hot spots, will be detailed in a future paper (Gregory *et al.* in prep.).

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