Roche tomography of the donor stars in CVs
Motivation - Understanding binary evolution

Understand magnetic activity in binaries

- understand CV evolution
- understand their behaviour?
CVs and interacting binaries in general provide excellent labs for the study of:

- rapid rotation on magnetic activity
- tidal effects on stellar dynamos
- the effects of activity on accretion dynamics
Motivation - Starspots & accretion dynamics

Hessman, Gänsicke & Mattei (2000)
Direct images of the donor stars are impossible as they are

- typically several hundred parsecs distant
- have radii of ~400,000 km

This means that to resolve the star, we would require a ~100km class telescope!
Roche tomography - Technique

Rutten & Dhillon (1994)
Star spots produce emission bumps in donor star line profiles.

Typically, the largest star spot distortions are \( \sim 10\% \) of the profile depth.
Roche tomography - LSD

Typical multi-plex gain in S/N of 20 over using a single line.
Roche tomography - AE Aqr (2001)

AE Aqr - 9.9hr period

Observations taken on 2 consecutive nights.

WHT+UES
Simultaneous JKT Photometry

Watson et al. (2006)
Roche tomography - BV Cen

Magellan + MIKE echelle spectroscopy
Simultaneous Photometry (1-m Henrietta Swope)

Watson, Steeghs, Shahbaz & Dhillon (2007)
RU Peg (novalike) observed with WHT+ISIS in high state
(See poster by Robert Smith, Alex Dunford & myself)
Roche tomography - V426 Oph

Orbital Period = 6.8 hours

Magellan + MIKE echelle spectroscopy
Simultaneous Photometry (1-m Henrietta Swope)

Watson, Steeghs, Dhillon & Shahbaz (2007)

No pronounced polar spot.
Caught in a year long <low> state.
Roche tomography - Spot distributions

Seeing the impact of Coriolis + Tidal forces?
High spot coverages found around the mass transfer nozzle.

Close to predictions by modeling light curves.
Roche tomography - Slingshot prominences

Emission feature observed outside stellar line profile. Observed at phases 0.328 → 0.366. Also at phases 1.974 → 2.038.

Centred on systemic velocity of BV Cen.

Illuminated by irradiation?

2001 parameters

\[ i = 66^\circ \]
\[ M_2 = 0.50 \, M_\odot \]
\[ M_1 = 0.74 \, M_\odot \]

2004 parameters

\[ i = 64^\circ \]
\[ M_2 = 0.53 \, M_\odot \]
\[ M_1 = 0.82 \, M_\odot \]
Roche tomography - Spot distributions

AE Aqr (2004)01
BV Cen
RU Peg

0.1 milli-arcseconds
Roche tomography - Conclusions (?)

CV donor stars show large spot coverages (e.g. AE Aqr ~20%; BV Cen ~25%)

High spot coverages near mass transfer nozzle:
- seeing influence of tidal forces on magnetic tube emergence?
- launching site of ‘slingshot’ prominences?
- bloby magnetized accretion stream/flickering?

All but V426 Oph show prominent high latitude spots

V426 Oph seen in low-state
- link between activity cycle and accretion rate?

Possible deflection of ‘polar’ spots?