Kepler-2 Field1 Proposal:

The Cataclysmic Variable RZ Leo

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Cataclysmic variables (CVs) provide the cleanest available natural laboratories to investigate the physics of accretion. The timing capabilities and sensitivity of Kepler are well matched to the timescales and amplitude of accretion variability in these sources. The combination provides an unprecedented opportunity to test and refine the paradigms of stellar accretion with high-precision, uniform data containing no diurnal or seasonal gaps. We propose a continuation of our multifaceted observational and modelling program that puts our current understanding of accretion to the test and has the potential to measure the spatial structure of model-dependent disc parameters. Kepler observations of CVs are profoundly impacting our understanding of accretion dynamics and the nature of viscosity in the wider astrophysical context, and these data will provide an outstanding astrophysical legacy for the Kepler mission archive.

Since the launch of Kepler we have developed a programme to observe the known CVs in the Kepler field. Our results include modelling the light curves of V344 Lyr (a previously little studied system) using the thermal viscous disc instability model (Cannizzo et al. 2010). In Wood et al. (2011) we presented a detailed analysis of the orbital and superhump periods present in the V344 Lyr Q2-Q4 time series data. V447 Lyr was the first eclipsing CV to be studied using Kepler data and Ramsay et al. (2012) presented evidence for a changing disc size during the outburst cycle. However, perhaps the most surprising result from Kepler is that long outbursts appear to be triggered by a short outburst.

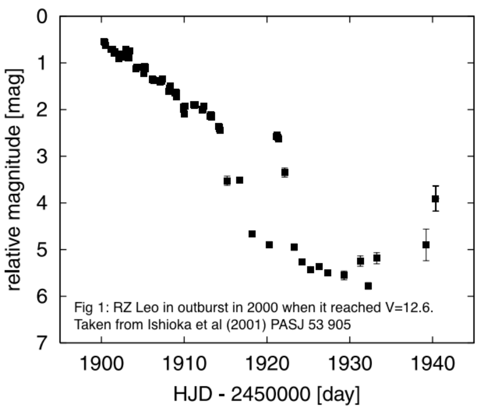

Fig 1: RZ Leo in outburst in 2000 when it reached V=12.6. Taken from Ishioka et al (2001) PASJ 53 905

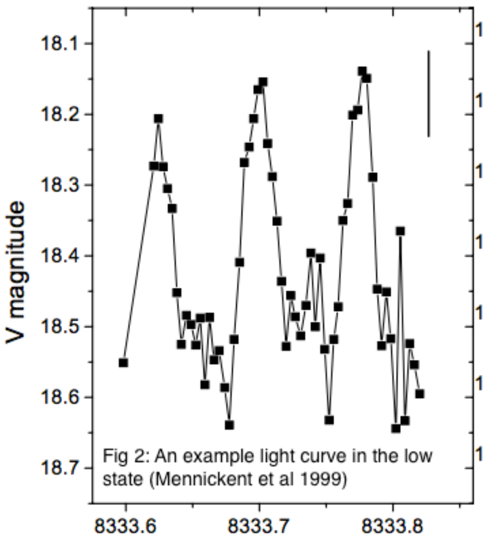

Fig 2: An example light curve in the low state (Mennickent et al 1999)

The next phase of Kepler provides an exciting opportunity to study other CVs, in particular those kinds of systems which have not been well observed using Kepler so far. We cross correlated the established CV catalogue of Ritter & Kolb with the quoted boresight pointing of the Kepler 2 Field 1 and used a 8.5 degree radius. We find one CV in Field1 which, according to the Kepler 2 FOV viewer, is `on silicon': **RZ Leo** (EPIC 201585290).

RZ Leo was discovered as a nova in 1918 but it wasn't until relatively recently that it was identified as a WZ Sge system with 8 superoutbursts being detected since its discovery. The WZ Sge systems show superoutbursts every decade or so with only very few (if at all) `normal' outbursts. Figure 1 shows the optical light curve for RZ Leo when it was last seen in a superoutburst in 2000.

There are only a handful of known WZ Sge stars and apart from RZ Leo (which has an orbital period of 113 mins), they all have orbital periods between 79 and 84 mins. RZ Leo is thought to have a normal low mass main sequence star rather than a brown dwarf as in the other WZ Sge systems.

Although RZ Leo is `due' a superoutburst, it would be rather unlikely that we caught the next outburst with Kepler. We therefore expect RZ Leo to be in a quiescent state (g~18.7). Given the mass in the accretion disc has been building up since 2001, it will be interesting to determine the shape and extent of the disc through modelling the superhump behaviour (see Fig 2). Given the need to well sample the superhump phenomena we require short cadence mode observations.

The study of a broad range of CVs in terms of orbital period (which implies mass ratio for the component stars, accretion disk size and mass accretion rate) will allow a wider range of test cases to be brought to bear on the model work described above and advance the physics of accretion discs and accretion in general. In particular, Kepler observations of RZ Leo — a member of the rare WZ Sge subclass — have the potential to reveal in unrepeatable detail the changing size and shape of the accretion disk in a system with a low accretion rate and hence will be seen as a legacy dataset. We would obtain contemporaneous spectroscopic observations of RZ Leo in a manner similar to our previous work (Howell et al 2013).