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Using Kepler transit observations to measure stellar spot belt migration rates

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Planetary transits provide a unique opportunity to investigate the surface distributions of star spots. Our aim is to determine if, with continuous observation (such as the data that will be provided by the Kepler mission), we can in addition measure the rate of drift of the spot belts. We begin by simulating magnetic cycles suitable for the Sun and more active stars, incorporating both flux emergence and surface transport. This provides the radial magnetic field distribution on the stellar surface as a function of time. We then model the transit of a planet whose orbital axis is misaligned with the stellar rotation axis. Such a planet could occult spots at a range of latitudes. This allows us to complete the forward modelling of the shape of the transit lightcurve. We then attempt the inverse problem of recovering spot locations from the transit alone. From this we determine if transit lightcurves can be used to measure spot belt locations as a function of time. We find that for low-activity stars such as the Sun, the 3.5 year Kepler window is insufficient to determine this drift rate. For more active stars, it may be difficult to distinguish subtle differences in the nature of flux emergence, such as the degree of overlap of the "butterfly wings". The rate and direction of drift of the spot belts can however be determined for these stars. This would provide a critical test of dynamo theory.

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