Space weather: Can we forecast using atomic filters?

Danielle Pizzey[1], Steven A. Wrathmall[1], Timothy Butterley[2], Tim Morris[2] and Ifan. G. Hughes[1].

[1]Joint Quantum Centre (JQC) Durham-Newcastle, Department of Physics, Durham University, South Road, Durham, DH1 3LE, United Kingdom.
[2]Centre for Advanced Instrumentation, Department of Physics, Durham University, South Road, Durham, DH1 3LE, United Kingdom.

Due to our reliance on global technological systems, extreme space weather is believed to be one of the biggest threats to civilisation. It is for this reason why there has been much interest in solar flare forecasting [1]. These models require data from solar observations, which often require telescopes with optical filters to reduce the amount of light detected. Such filters have a defined bandwidth at a specific frequency for which they have high on-peak transmission and off-peak extinction. In particular, magneto-optical filters (MOFs), as shown in figure 1, rely on a particular atomic species within a magnetic field to produce a narrow transmission centred on the atomic resonance frequency [2]. Using MOFs on solar telescopes will enable the line-of-sight (LoS) component of the magnetic and velocity (i.e. Doppler) fields to be observed, which can be used in the $\mathrm{WG_M}$ forecasting model to predict when solar flares might happen [3].

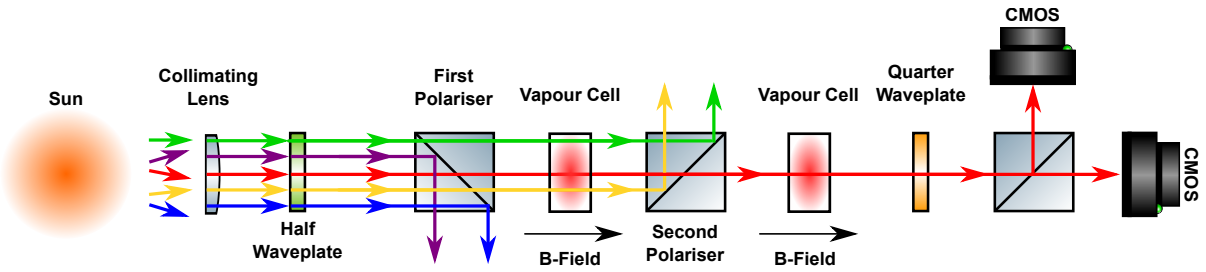

Figure 1. A schematic illustration of the concept of the MOF. Collimated sunlight passes through a two-stage filtering process. The filter section consists of an atomic vapour subject to an axial magnetic field placed between crossed polarisers. The temperature of the vapour and the strength of the magnetic field are chosen to achieve a suitable narrow transmission profile – with two wings – centred on the atomic resonance. The second vapour cell and quarter waveplate are used to encode the transmission of the opposite handedness of circularly polarised light into vertical and horizontally polarised light, which are subsequently imaged by cameras (CMOS).

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[2] M. A. Zentile *et al.*, Opt. Lett., **40**, 2000-2003 (2015).
[3] M. B. Korsós *et al.*, Astrophysics Journal, **896**, 119 (2020).