Magnetic Fields throughout Stellar Evolution
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The Dominion Astrophysical Observatory Magnetic Field Survey (DMFS)

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Abstract. In this paper we present a few results from the first three years of an ongoing survey of globally-ordered magnetic fields in relatively faint (down to $V \approx 9$) upper main sequence peculiar stars that we are conducting on the Dominion Astrophysical Observatory (DAO) Plaskett telescope. The DMFS uses the inexpensive DAO polarimeter module, dimaPol, mounted at the Cassegrain focus of the 1.8 m telescope to detect new magnetic stars and determine rotation periods and longitudinal magnetic field curves using medium-resolution ($R \approx 10,000$) circular spectropolarimetry of both the Hβ line and metal lines in an approximately 280 Å wide wavelength region centered on Hβ. By concentrating on the mid-B to A-type peculiar stars, the DMFS provides an extension to the 'Magnetism in Massive Stars' (MIMES) Large Program which concentrated on similar field detections in more massive stars.

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1. The DAO Polarimeter Module: dimaPol

The DAO polarimeter module, dimaPol (Monin *et al.* 2012), consists of a fixed achromatic quarter-wave plate, a ferro-electric liquid crystal (FLC) half-wave plate, a simple calcite beam displacer and a mechanical shutter. The quarter-wave plate converts left and right circularly polarized light into linearly polarized light with orthogonal polarization directions. The orientation of the optical axis of the FLC can be rotated by 45° at a rate up to 1 kHz in order to switch the two output beams that exit the beam displacer.

During an exposure, switching of the FLC half-wave plate (at rates between 0.1 to 10 seconds depending on target brightness) is synchronized with charge shuffling on the CCD to reduce instrumental effects. Each observation then results in three spectra on the CCD consisting of distinct left ordinary (LO) and left extraordinary (LE) spectra and a combined right ordinary (RO) and right extraordinary (RE) spectrum.

The magnetic shift produced by the Zeeman effect and observed in a single spectral line is then measured by performing a Fourier cross-correlation of the final LO+LE and RO+RE spectra in a spectral window centered on the spectral line of interest. The magnetic shift in pixels (ΔX) is then translated into a longitudinal magnetic field according to the lines Landé factor (g) and the relation

$$B_l(\mathrm{G}) = \Delta\mathrm{X} \times 0.15/(2 \times 4.67 \times 10^{-13}\lambda^2\mathrm{g}). \quad (1.1)$$

For the Hβ line ($g = 1$) this gives B_l (kG) $= 6.8 \times \Delta X$.

2. The DAO Magnetic Field Survey (DMFS)

To date the DMFS consists of multiple observations of more than 125 stars, including well-known magnetic as well as null standards. A number of new magnetic stars have been

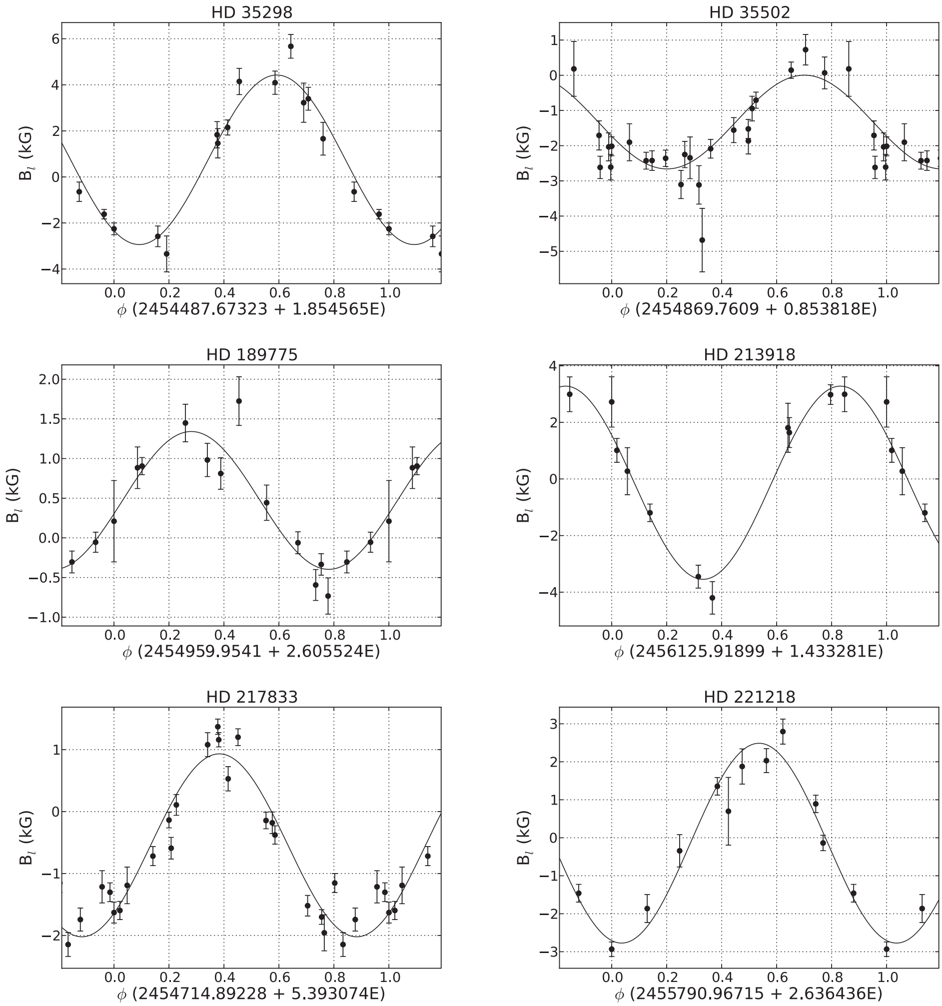

Figure 1. Magnetic field curves for a few of the stars observed in the DMFS. The solid lines through the data points are least-squares sinusoidal fits to the magnetic field variations phased on the periods indicated at the bottom of each plot.

discovered, including several with longitudinal magnetic fields that exceed 2 kG. Objects previously suspected of being magnetic but with a limited number of prior magnetic field observations have also been observed extensively to enable estimates of periods and magnetic field geometries. The unique capabilities of dimaPol also enable us to study the observed (and occasionally very large) differences in stellar longitudinal magnetic fields as measured with the Hβ line and metallic lines. A few magnetic field curves for stars observed in the DMFS are shown in Figure 1. Readers are encouraged to contact the authors to suggest additional program stars to add to the observing program.

References

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