Contribution ID: **117** Type: **Oral**

Modelling the non-thermal emission and polarisation from the white dwarf pulsar AR Sco.

Thursday 1 September 2022 11:15 (15 minutes)

AR Sco is a binary system that contains both a white and red dwarf. Optical emission from this system is observed to be highly linearly polarised. The spin rate of the white dwarf has been observed to slow down with time, analogous to rotation-powered radio pulsars; it has thus been dubbed a “white dwarf pulsar”, also given the lack of evidence for accretion activity in the system. We previously fit the traditional radio pulsar rotating vector model to linearly polarized optical data from this source, constraining the system geometry and white dwarf mass. Next, using a much more extensive dataset from the South African Astronomical Observatory (SAAO) HIPPO Polarimeter on their 1.9-m telescope, we also explored the application of the same geometric model to the orbitally phase-resolved optical polarimetric data. The optical emission is thought to be the result of non-thermal synchrotron radiation. We constrained the magnetic inclination angle and the observer angle at different orbital phases finding evolution of these parameters over the orbital period. This could indicate precession of the WD, an asymmetric emission source, a non-uniform distribution of injected particle pitch angles or complicated time-dependent particle injection. Now we have constructed a much more sophisticated emission model, solving the particle dynamics from first principles, including a generalized radiation reaction force, and implementing similar techniques to what were used in a pulsar emission code developed by A.K. Harding and collaborators to produce emission maps, light curves and spectra. We present some of our results from the geometric model as well as how we intend to calculate the polarisation of the particles in our new model to create polarisation emission maps. With spectral, light curve, and polarisation predictions in hand we will be able to constrain the emission mechanism and magnetic-field structure more robustly of this novel source.

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Session Classification: Polarization and neutron stars and pulsars