Levitating Frogs and Polluted White Dwarfs

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Berry (1997)

Diamagnetism is a property found in most planetary material. The idea being that a repulsive force is felt by a material when exposed to a magnetic field. In Berry(1997), physicists were able to demonstrate this repulsion could overcome gravity by levitating a small frog. In this poster, I will apply the same physics that levitates the frog to tidally disrupted material around a magnetic white dwarf.

Magnetism in White Dwarfs was first observed in 1970 and the first confirmed polluted White Dwarf was found in the 1987. The composition of polluted White Dwarf atmospheres infers the presence of debris discs that are Carbonaceous and Silicate rich, both of which are diamagnetic. Given that White Dwarfs can hold magnetic field strengths over 100s of Mega-Gauss, the dynamics of diamagnetic debris passing through these fields needs to be modelled.

$$F_m = \frac{V}{R_c}\frac{B(r)^2}{8\pi}$$

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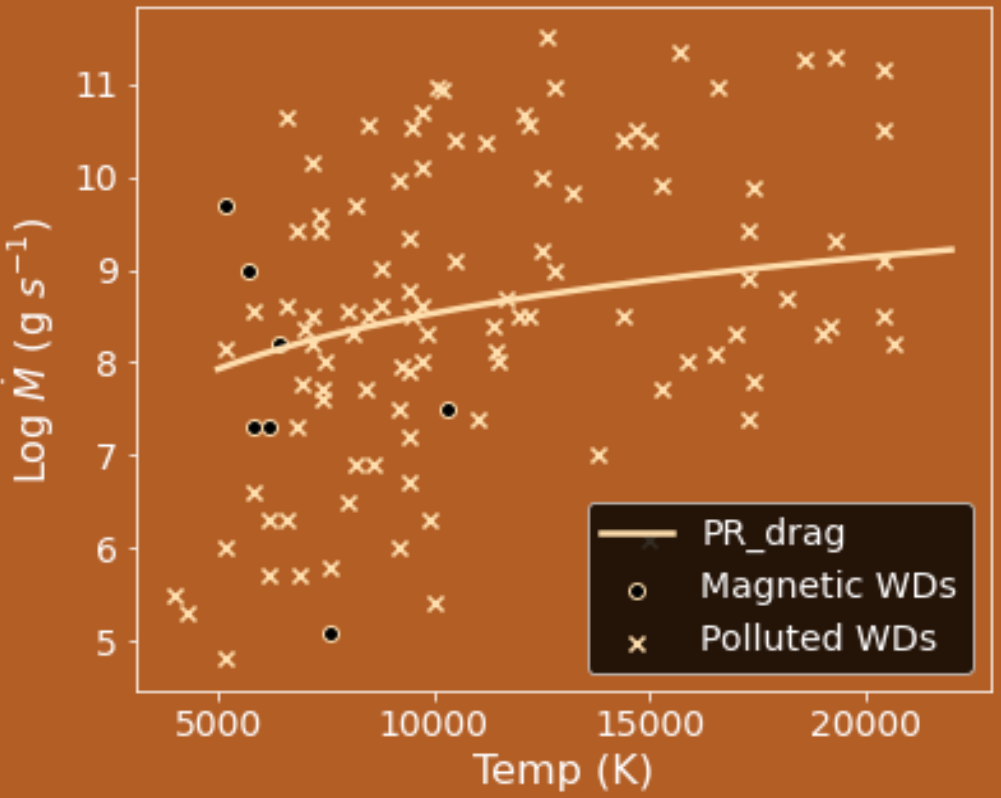
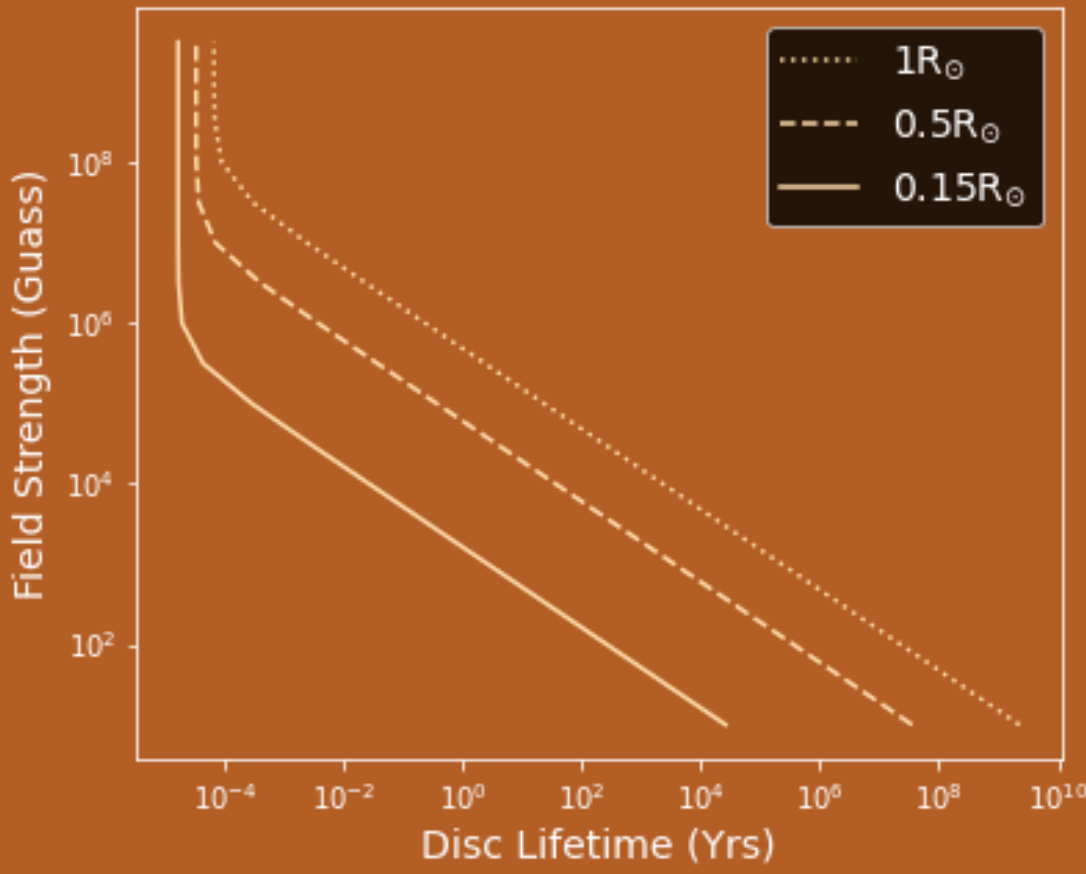
When a rocky body passes too close (usually a solar radius) to its host star, the object is torn apart by tidal forces. This leaves a stream of debris which will eventually become a disc. By applying varying magnetic field strengths to the debris, the lifetime of the disc can be significantly reduced.





This is important, because shorter disc lifetimes mean higher accretion rates. Presently, many of the accretion rates observed in white dwarfs are beyond the allowable range predicted by current theories (see left).

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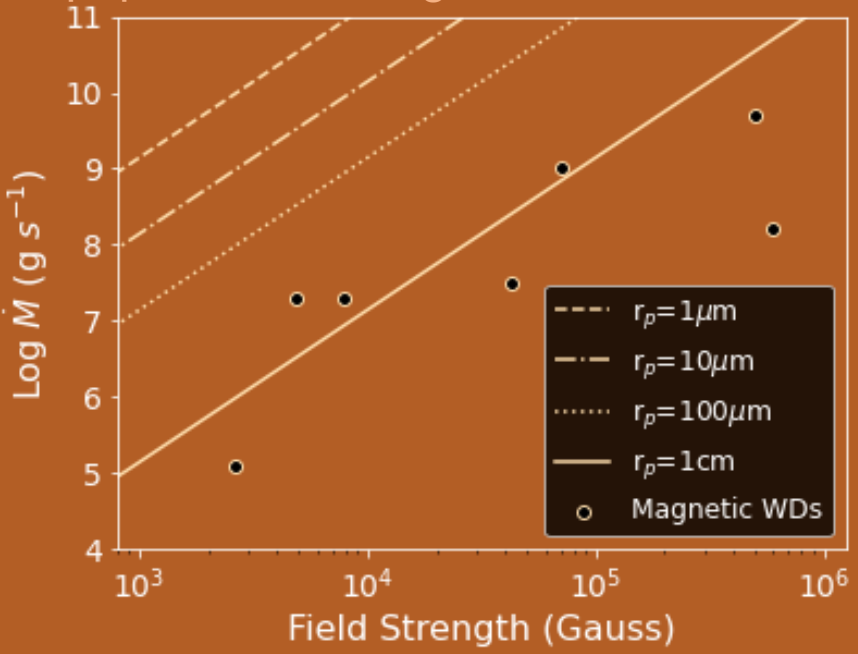
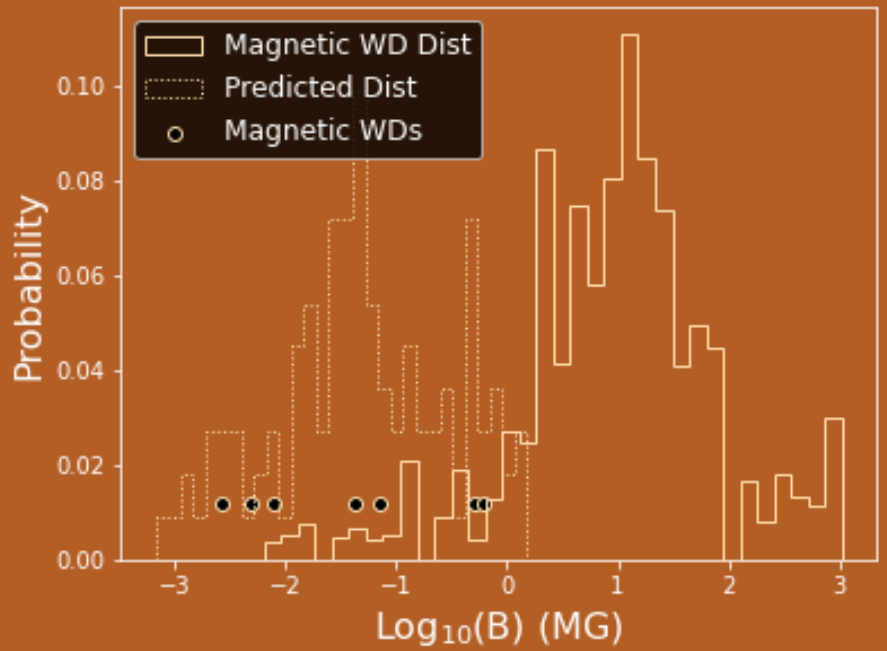
By making some assumptions about the disc mass, the accretion rate of a disc exposed to magnetic field can be estimated. Reverse engineering the relationship between lifetime, field strength, and inferred accretion rates, a distribution of magnetic field strengths is created. Potentially revealing a whole population of magnetic white dwarfs that have gone unnoticed due to detection limits.





This study shows that when looking at accretion of planetesimals around white dwarfs, the influence of a magnetic field needs to be considered. Furthermore, this work highlights the possibility that most white dwarfs exhibit some level of magnetism; a large portion of which have fields strengths below detectability.

More Information:

Arxiv Link: https://arxiv.org/abs/2009.03444

Kawka, et al, A&A, 538, A13 (2012)
Ferrario, et al, Space Science Reviews , 191, 1-4, 111 (2015)

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