Magnetic confinement of coronal material around low mass stars

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0. Motivation

- This confinement can lead to large prominences which can:
  - remove angular momentum from the star and influence the spin-down [1, 2]
  - impact with orbiting planets [2]

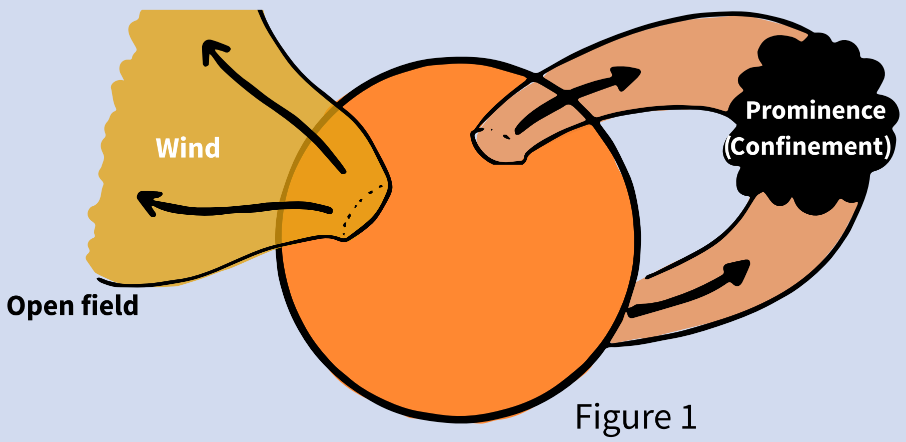

Figure 1

- Magnetic confinement has also been observed around the young-Sun AB Doradus through radio emission [3].

1. Method

1. Prescribe a background coronal magnetic field.

   An equatorial dipole (Figure 2a)
   An aligned dipole (Figure 2b)
   An aligned dipole that becomes radial at r_{ss}

   "Source surface"

2. Find the shapes of the cooled loops by force balance.

$$\underline{F_B} + \underline{F_g} + \underline{F_c} = \underline{0}$$

Magnetic force — Gravitational force — Centrifugal force

3. Generate the synthetic dynamic spectra.

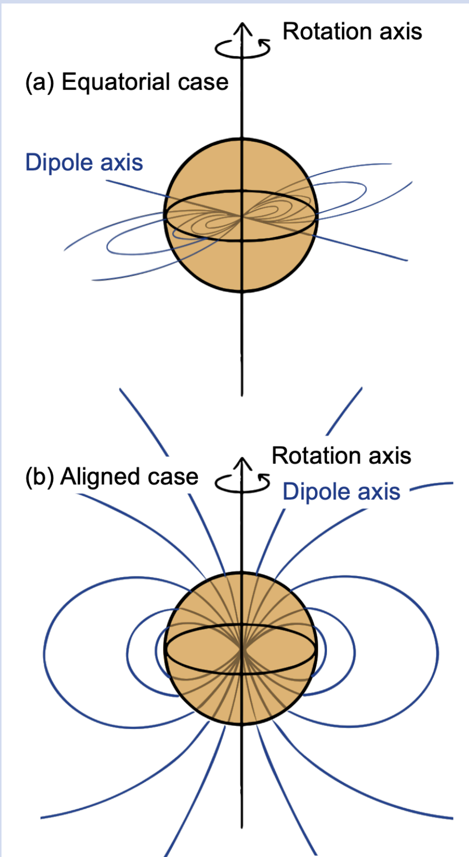

Figure 2

2. Results

2.1 We find two types of solution: solar-like and slingshot prominences

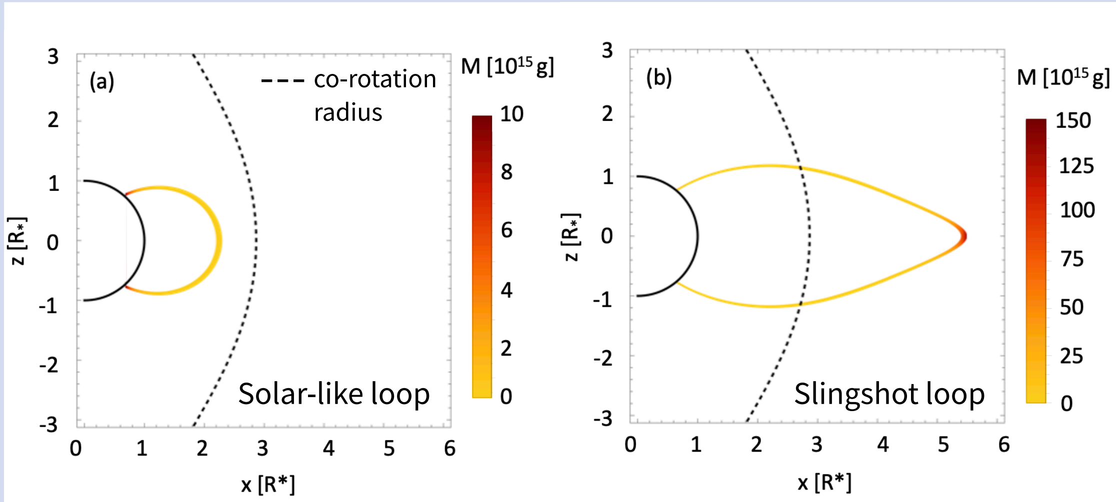

Figure 3

- Two loops can have the same width but different heights.
- The short loop has heavy footprints but an empty summit.
- The tall loop is summit heavy.
- We find loop masses on the order of 1-2.5 x 10^{17}g for the tall solutions, which is consistent with observations [4].

2.2 Dynamic spectra look similar with varying field topologies

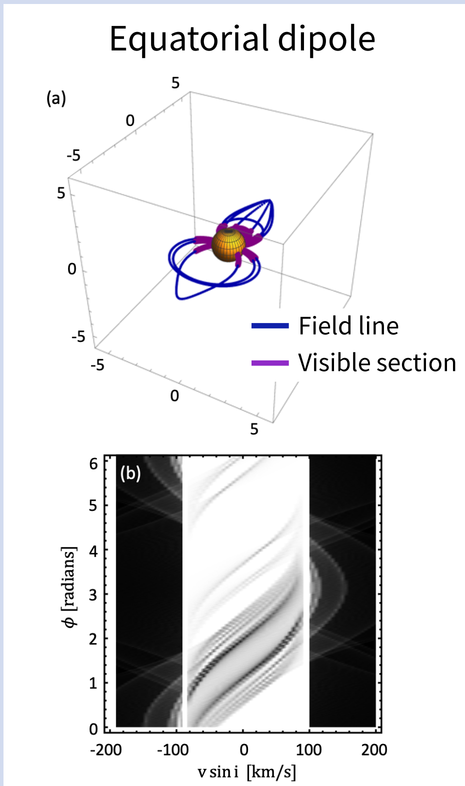

Figure 4

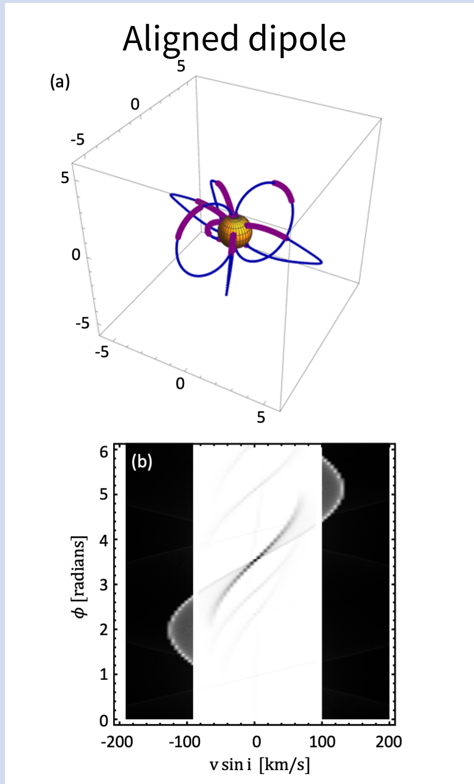

Figure 5

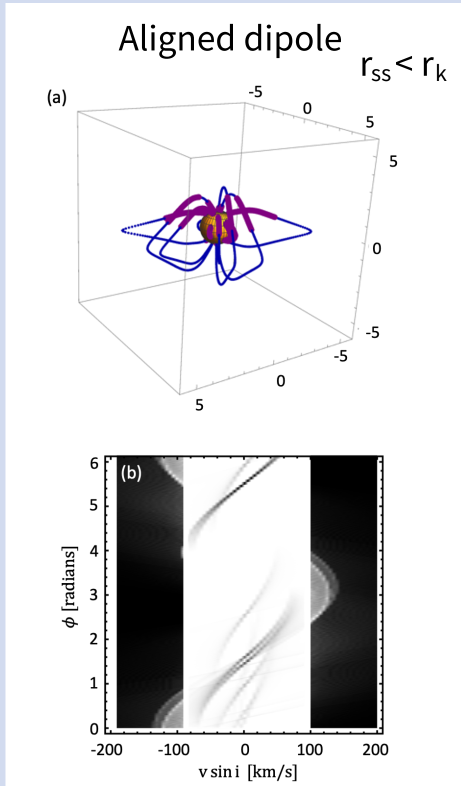

Figure 6

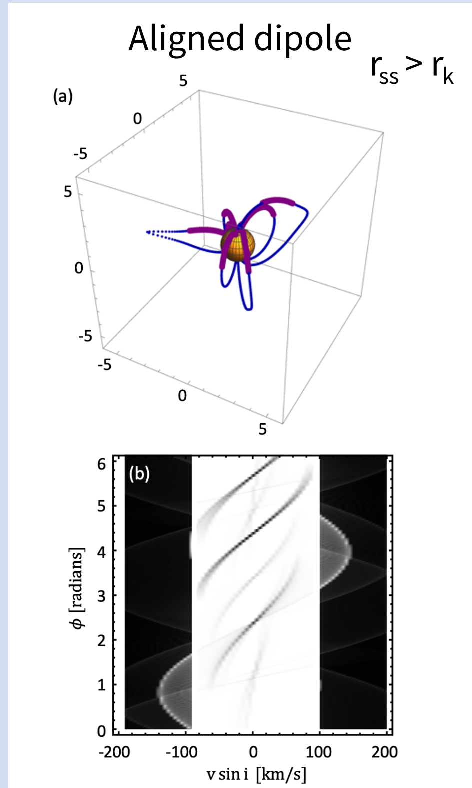

Figure 7

- The equatorial case (Figure 4b) differs from the remaining spectra since both loop legs transit the disc.
- Much of the field lines aren't visible/don't contribute to the dynamic spectrum for this stellar inclination.
- Loop summits of the tallest prominence loops never transit, so never appear in the spectra.

3. Conclusions

- Confinement occurs in two types of loop (i) low-lying and (ii) tall, slingshot loops.
- Spectra similar to observations can be found with a range of field structures.

References
[1] Villerreal+, MNRAS 2018 [2] Waugh+, MNRAS 2019 [3] Climent+, A&A 2020 [4] Collier Cameron+, MNRAS 1989