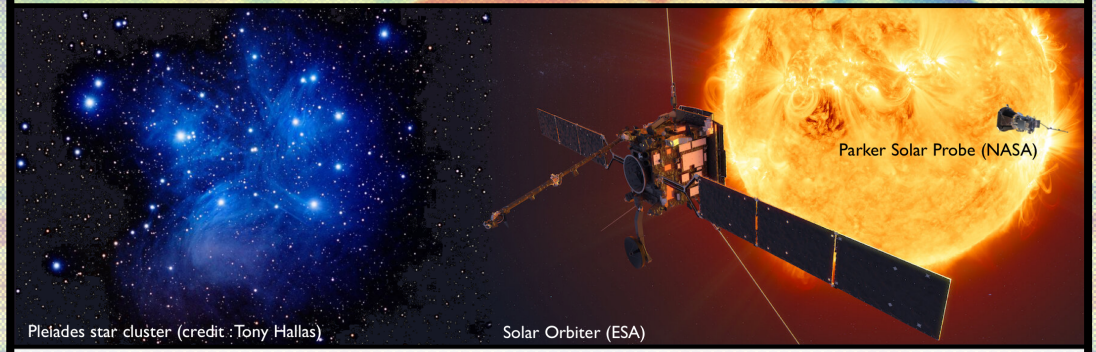
Measuring the Solar Wind Angular Momentum Flux and Examining its Astrophysical Implications



Summary: *The solar wind is removing angular momentum (AM) from the Sun. For Sun-like stars on the main sequence this process dominates their rotation period evolution as the effectiveness of the wind at removing AM is increased by the presence of their dynamo-generated magnetic fields. By measuring the Sun's AM-loss rate with in situ spacecraft, it may be possible for us to further constrain the rotation evolution of Sun-like stars and produce more reliable ages from Gyrochronology.*

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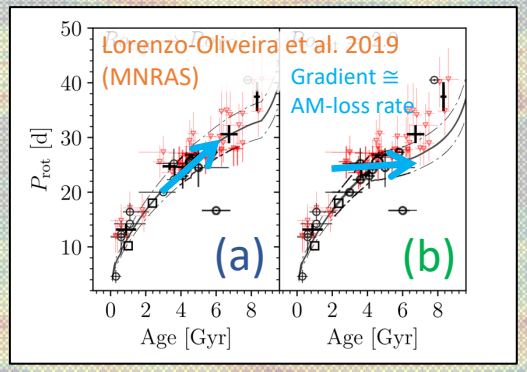
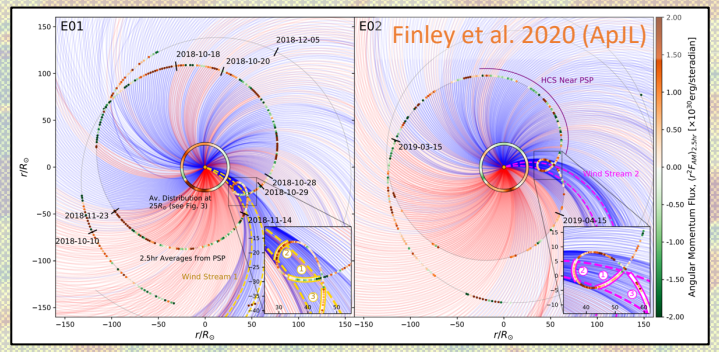
A Test for Rotation Period-Evolution Models:

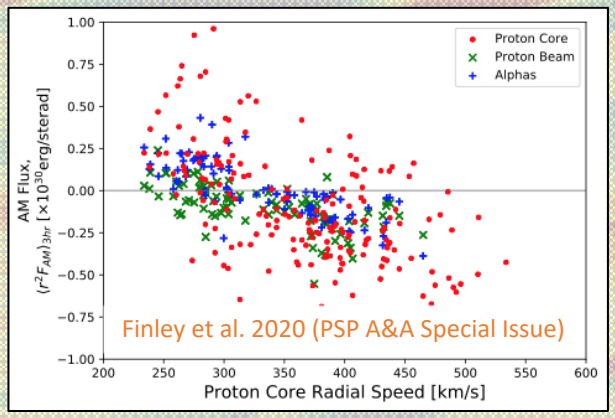
The Sun's AM-loss rate constrains the slope of rotation versus age at the solar-age. So rotation-evolution models can be tested, to see which are compatible with the current solar wind AM-loss rate and the observed rotation periods of other Sun-like stars, e.g. model (a) with "Skumanich" spin-down or model (b) with weakened AM-loss at the solar age.



In situ Measurements of the Solar Wind:

Facilitated by Parker Solar Probe we find that the AM flux in the proton core of the solar wind can be highly variable in both time and spatial-scale. However given sufficient averaging, as ***below***, we reconcile the AM flux observed by PSP with previous observations from *Wind, Helios,* etc. Furthermore, the alpha-particles, and other populations like the proton beam, must be taken into account as they carry significant AM fluxes.





The AM flux transported by each particle species ***above*** is dependent on the radial wind speed of the solar wind. So much so that the "fast" and "slow" solar wind streams observed by PSP carry oppositely signed values. A similar trend Is observed by SolO (Verscharen et al. in prep).

Future Prospects:

Multi-spacecraft measurements of the solar wind AM flux will help us understand how the AM distributed between particles species, and transported by stresses in the interplanetary magnetic field, evolves with radial distance.

Out of the ecliptic observations from Solar Orbiter will allow us to constrain the variation of solar wind AM flux versus latitude. This is crucial information when inferring the global AM-loss rate from measurements of the equatorial AM flux.

Constain other processes responsible for AM transport like pressure anisotropies, heavy ions, MHD waves, etc.