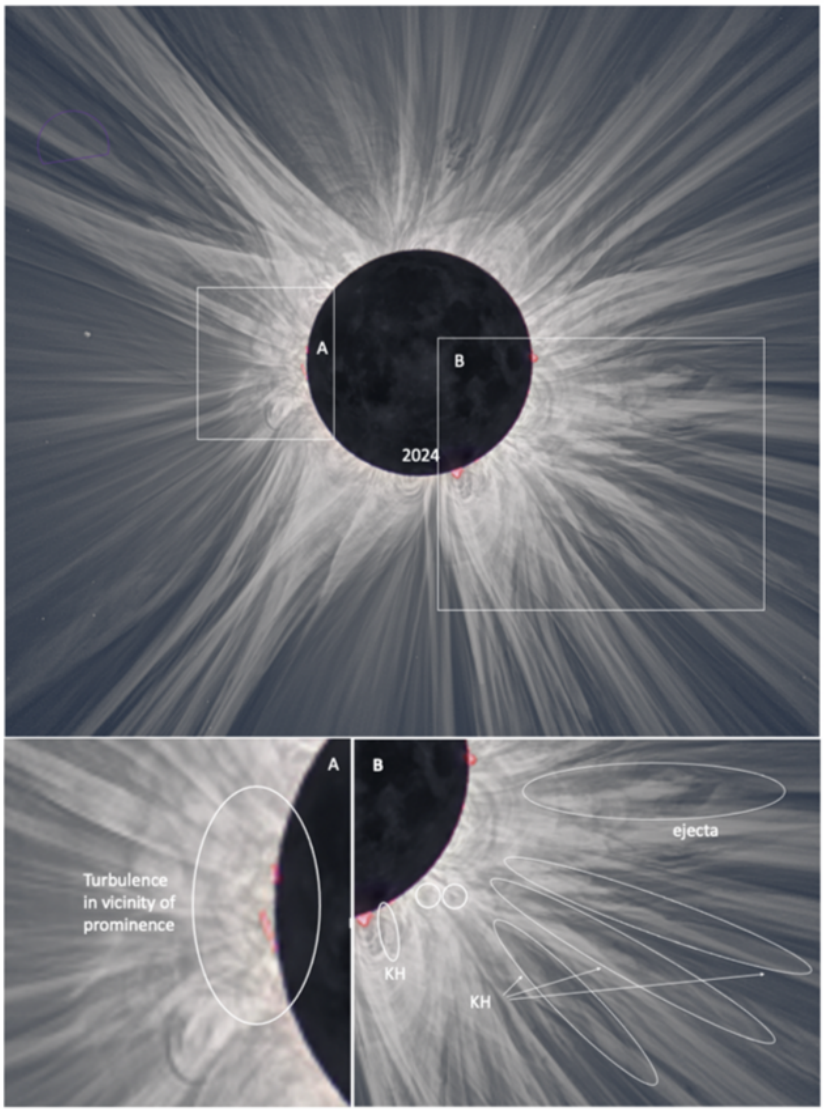
On the evolution of the solar wind, plasma instabilities and coronal mass ejections from the Sun into interplanetary space as inferred from total solar eclipse multi-wavelength observations

Shadia Habbal[1]

[1]Institute For Astronomy, University Of Hawaii, Honolulu, United States



Total solar eclipses offer the only observing opportunities, at present, to track the evolution of coronal structures and turbulence from the solar surface out to several solar radii. As such, they are key for exploring the physical parameters defining the origin of different solar wind streams and manifestations of plasma instabilities, including explosive events such as coronal mass ejections (CMEs), at the Sun. Multi-wavelength observations in the Fe sequence of coronal emission lines, namely FeX 637.4 nm, Fe XI 7892. nm, Fe XIII 1074.7 nm and Fe XIV 530.3 nm, with peak ionization temperatures at 1, 1.2, 1.6 and 1.8 MK, together with broadband white light, have recently demonstrated that quiescent solar wind streams in situ are associated with the cooler 1 - 1.2 MK originate from a significant fraction of the solar surface (Habbal et al., 2021) These observations have also demonstrated that different manifestations of plasma instabilities, including Kelvin-Helmoltz waves, Rayleigh-Taylor and vortex rings, originate within the immediate environment of prominences which are the coolest and densest magnetized structures, characteristic of chromospheric emission, protruding into the bulges of streamers (Habbal et al., 2026). Complementing these observations, which span a field of view of about 10 solar radii, the Wide-field Imager for Parker Solar Probe (WISPR) has demonstrated how different manifestations of plasma instabilities originating in the corona propagate unscathed into interplanetary space. Eclipse observations thus continue to mine the physics of the closest astronomical observatory to Earth, and unveil some of its secrets.

References:
Habbal et al., ApJ L 911, L4 (2021)
Habbal et al. ApJ 998, 51 (2026)