Sheath characteristics of ICMEs derived from Helios and PSP data

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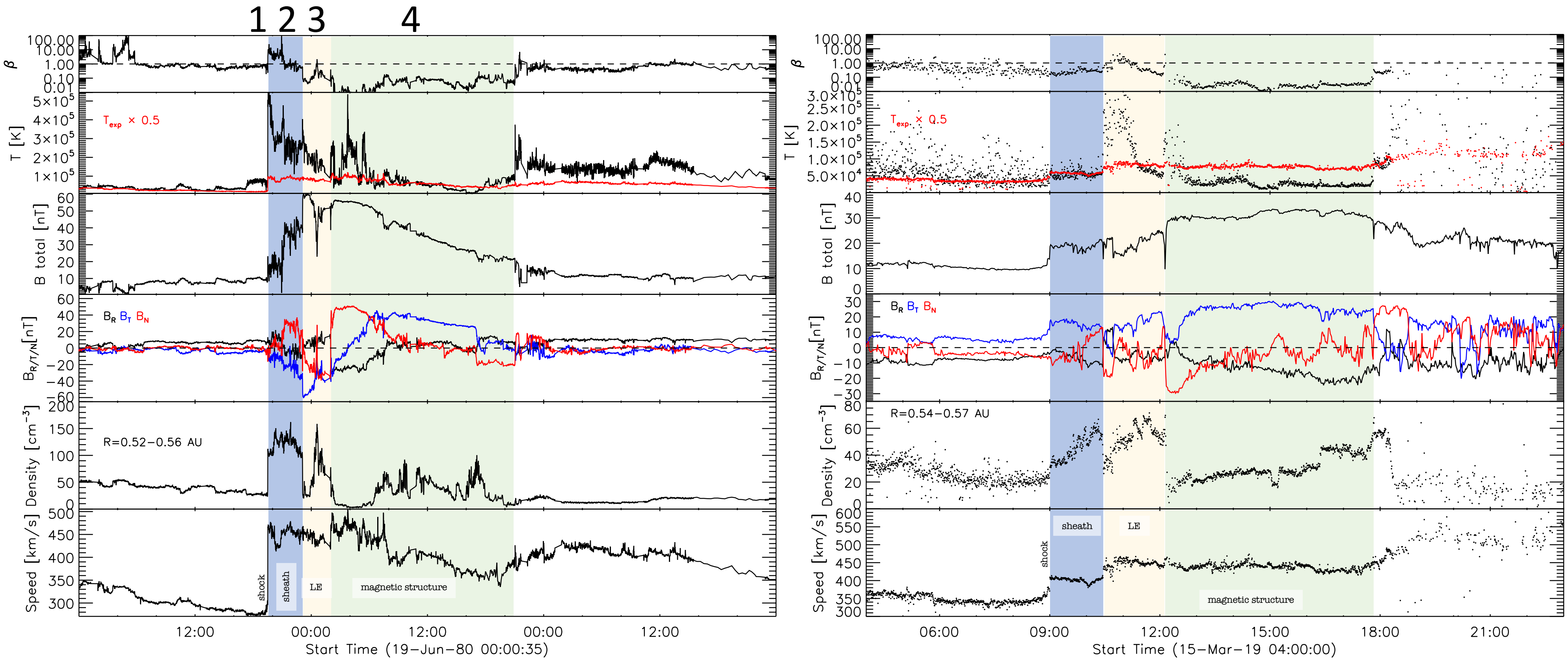
EGU talk:: May 26, 2022 :: Room 1.14

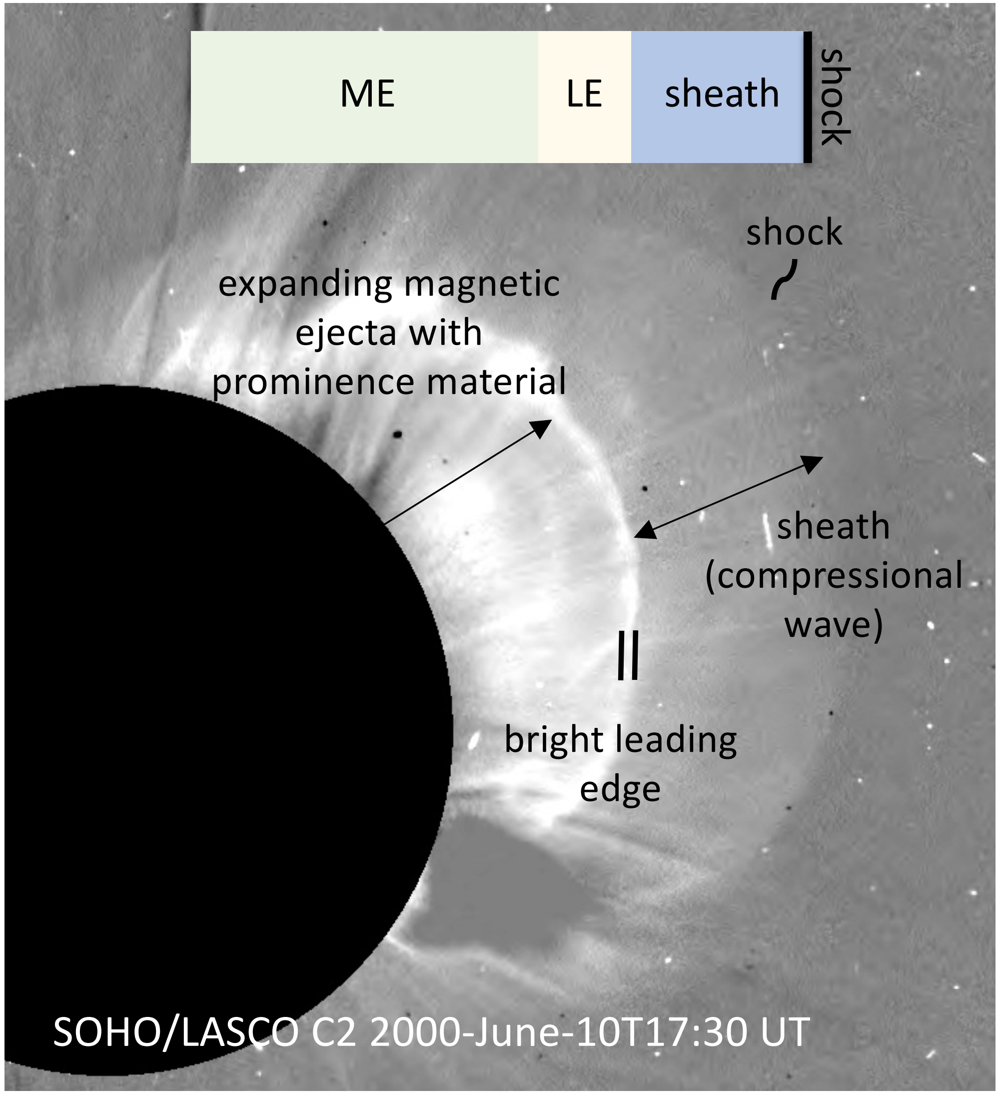
CME body (magnetic ejecta) and upstream regions – main density structures



Temmer and Bothmer, 2022 (A&A, in press)

From 45 Helios 1/2 and PSP events, we typically find 4 main density regions: *shock;* followed by a turbulent shock-compressed sheath region; followed by a separate density enhancement ahead of the CME body we refer to as leading edge (LE); the CME body itself, i.e., the magnetic structure.

Relating remote-sensing and in-situ data

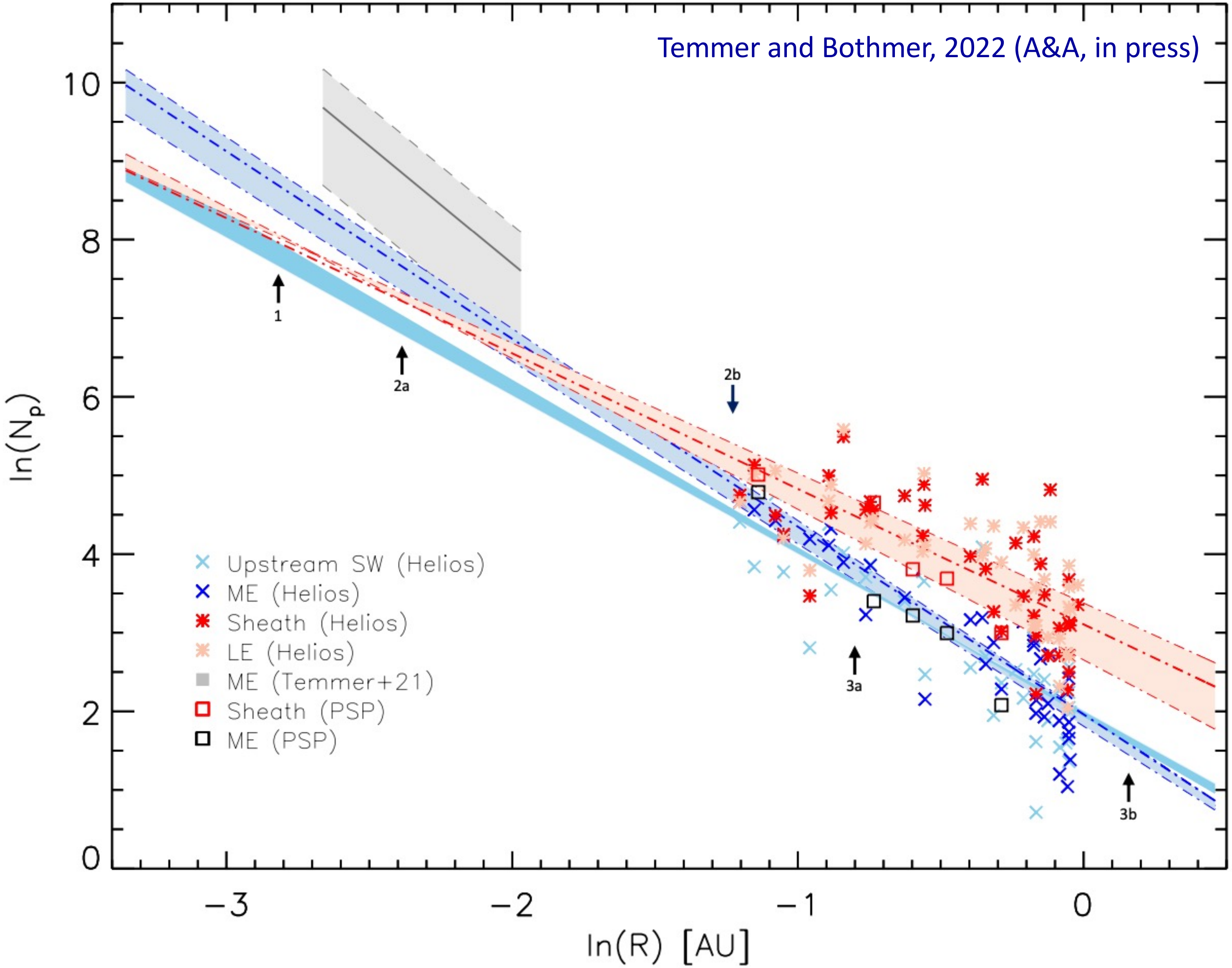


The leading edge (LE), which is typically found directly in front of the magnetic ejecta (ME), may be interpreted as being the in-situ signature of the bright leading edge commonly observed in remote sensing observations of CMEs.

It needs further investigations and discussions about local vs. global properties and in-situ vs. remote sensing observations.

Temmer and Bothmer, 2022 (A&A, in press)

Density evolution of sheath, LE, ME



1 @ 0.06au: Sheath becomes denser than SW.

2a-b @ 0.09-0.28au Sheath density dominates over ME density.

3a-b @ 0.45-1.07au ME density falls below ambient SW density.

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Use of empirical relations for improvements in CME propagation models

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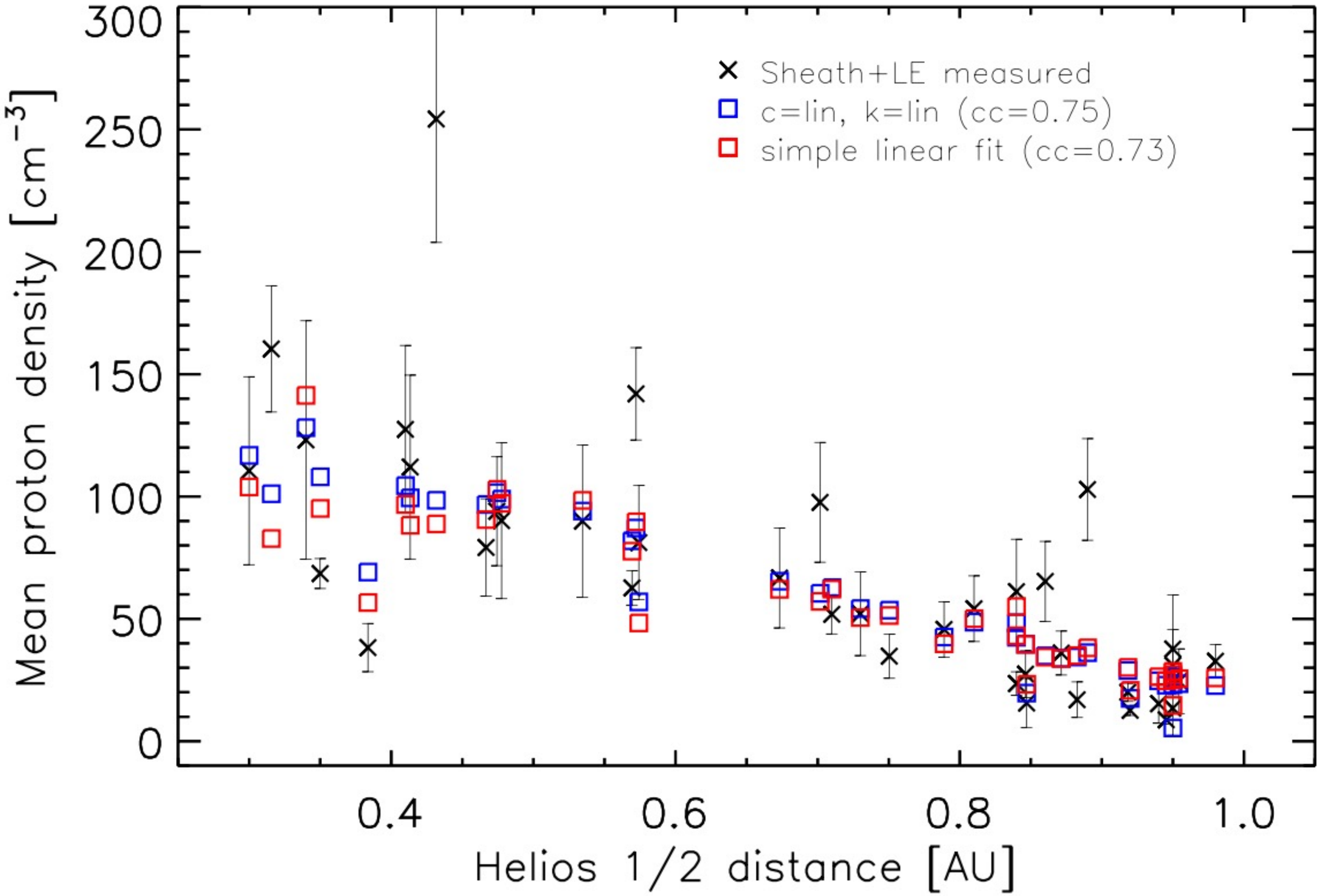

Temmer and Bothmer, 2022 (A&A, in press)

An empirical relation between sheath and leading edge density and ambient SW speed can be used for more detailed modeling of ICME evolution in the inner heliosphere. *See also Temmer et al., 2021*

$$N_p(u, r) = k(r)u + c(r)$$

$$c(r) = p_1(r)r + p_0$$
$$k(r) = q_1(r)r + q_0$$

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Summary and conclusions

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- Four main density structures, namely shock, sheath, leading edge, and magnetic ejecta are identified in plasma and magnetic field measurements of 45 ICMEs observed by the Helios 1 and 2 and Parker Solar Probe spacecraft.
- The radial distance from the Sun at which the sheath forms, is estimated to be at about 0.06 au where the inferred sheath density exceeds the ambient solar wind density.
- The sheath density starts to become prominent over the ME density in the distance range 0.09–0.28 au where the ME expansion should be stronger than further out in the heliosphere.
- The ME density is becoming lower than the ambient solar wind density in the distance range from 0.45–1.18 au.
- The sheath characteristics seem to be related to the upstream solar wind and ME properties.
- Assuming a local linear relation between sheath density and ambient solar wind speed, the results provided can be applied for improving CME propagation models.

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