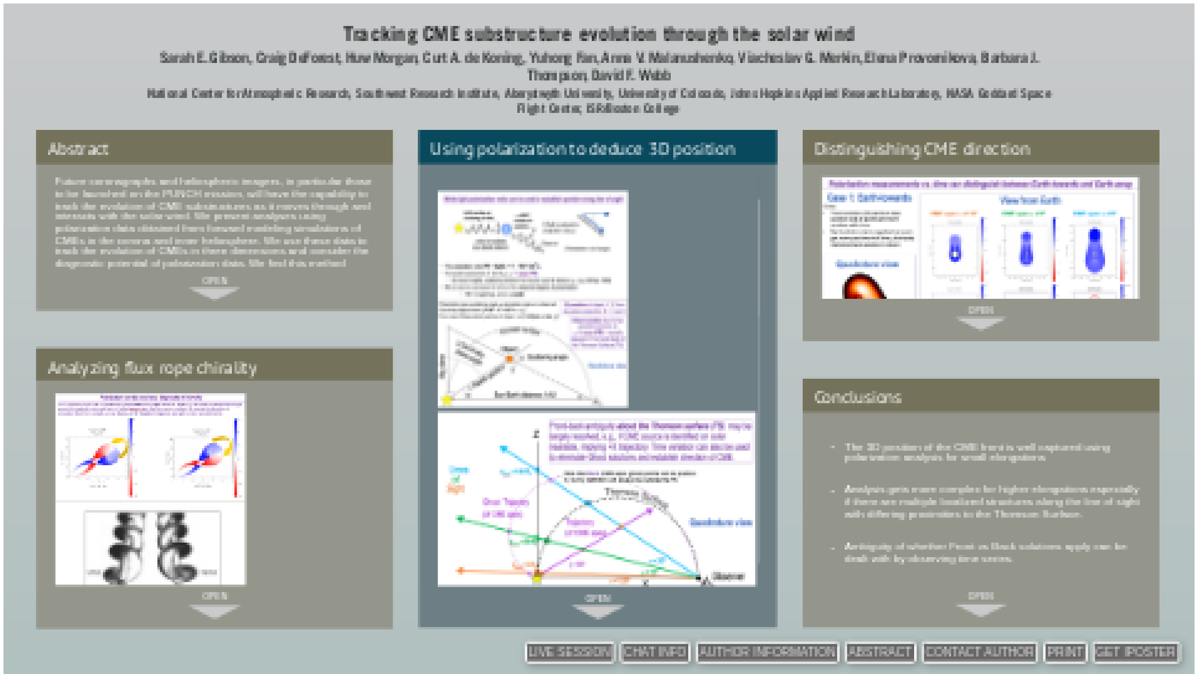
Tracking CME substructure evolution through the solar wind



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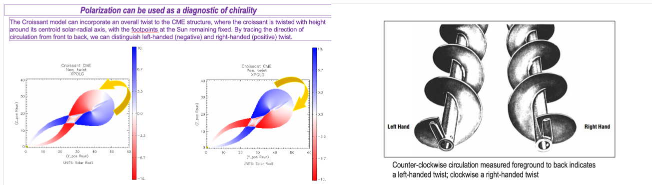
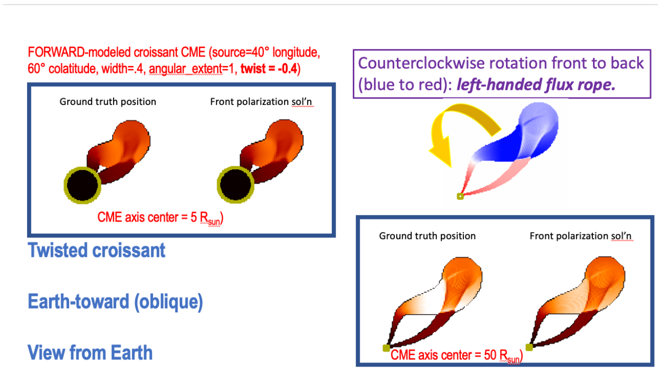
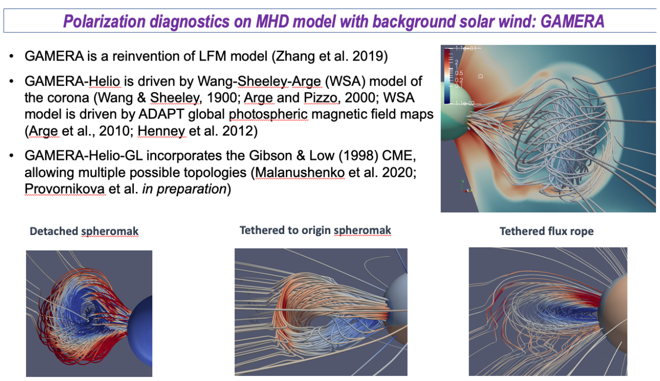
ABSTRACT

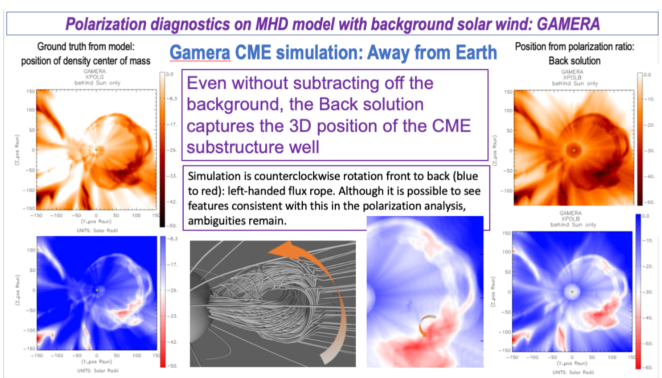
Future coronagraphs and heliospheric imagers, in particular those to be launched on the PUNCH mission, will have the capability to track the evolution of CME substructures as it moves through and interacts with the solar wind. We present analyses using polarization data obtained from forward modeling simulations of CMEs in the corona and inner heliosphere. We use these data to track the evolution of CMEs in three dimensions and consider the diagnostic potential of polarization data. We find this method reproduces 3D position well for structures at small elongation, whereas higher elongations are more impacted by multiple features along the line of sight. We demonstrate that front-back ambiguities may be resolved by observing time evolution of structures, and explore capabilities for extracting information about the chirality of CME magnetic flux ropes from polarization data.

ANALYZING FLUX ROPE CHIRALITY

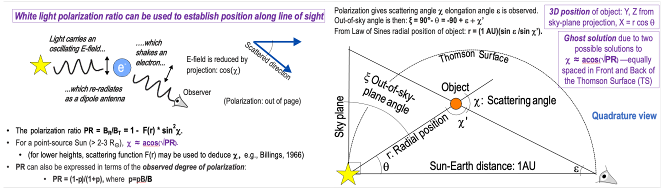


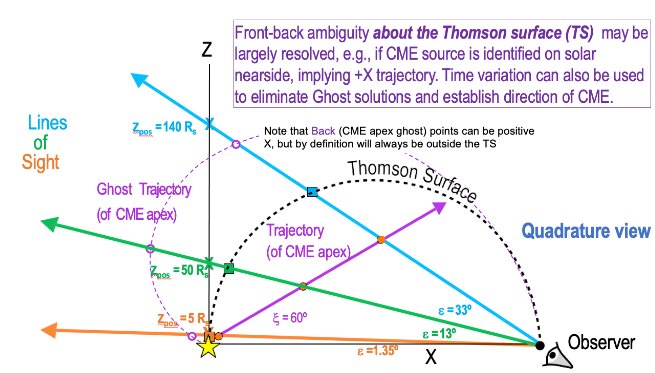


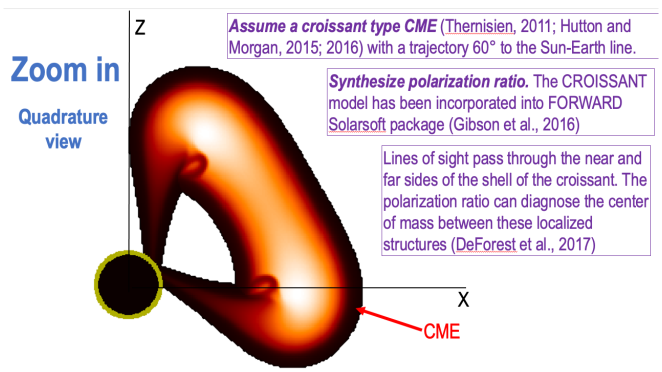


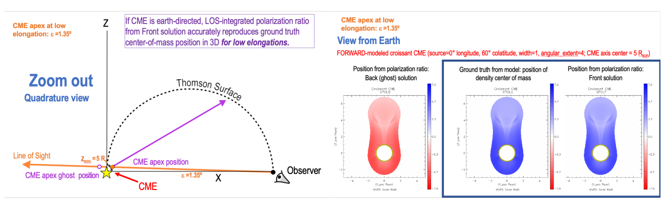


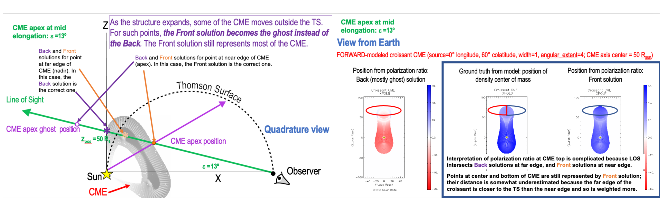
USING POLARIZATION TO DEDUCE 3D POSITION

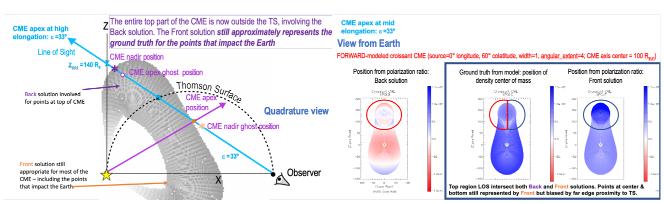












DISTINGUISHING CME DIRECTION

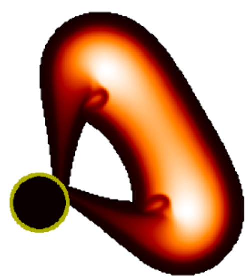
Polarization measurements vs. time can distinguish between Earth-towards and Earth-away

Case 1: Earth-towards

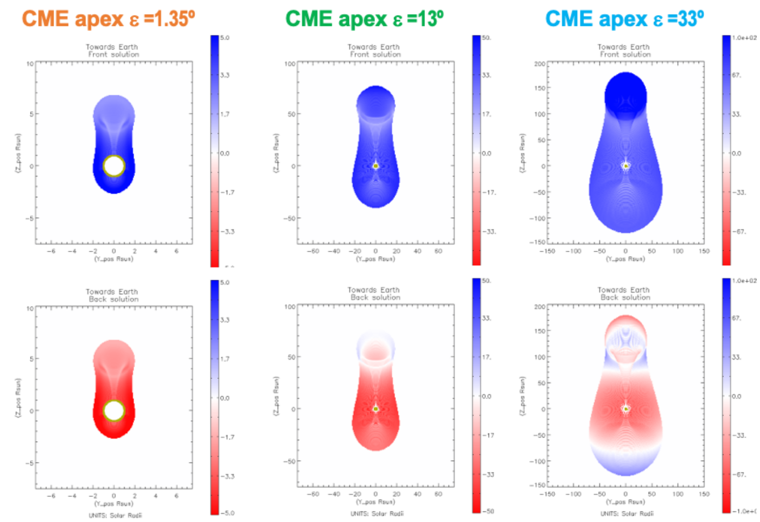
Clues:

- Front solution LOS position stays positive and all points get more positive with time
- Back solution starts negative but parts get more positive with time, ultimately transitioning to positive X (blue)

Quadrature view



View from Earth

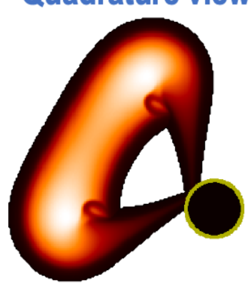


Case 2: Earth-away

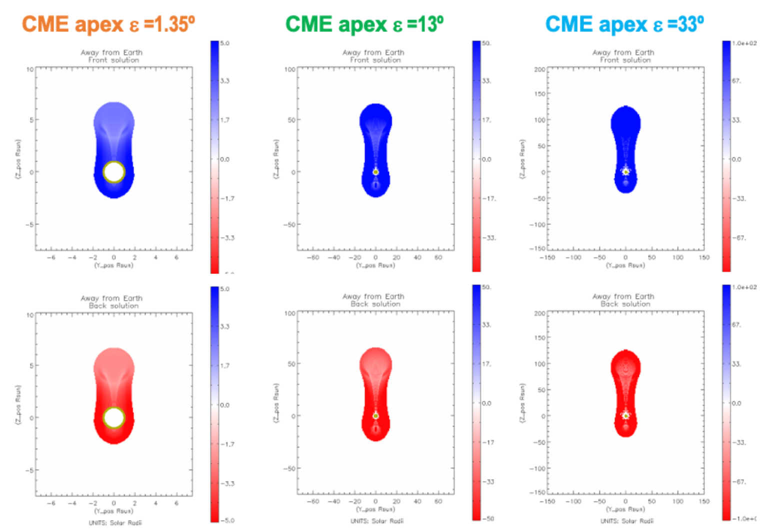
Clues:

- Back solution LOS position stays negative the whole time and all points get more negative with time
- Front solution LOS position stays positive the whole time and all points get more positive with time

Quadrature view



View from Earth



CONCLUSIONS

- The 3D position of the CME front is well captured using polarization analysis for small elongations
- Analysis gets more complex for higher elongations especially if there are multiple localized structures along the line of sight with differing proximities to the Thomson Surface.
- Ambiguity of whether Front vs Back solutions apply can be dealt with by observing time series.
- Polarization presents a tool for distinguishing between left-handed and right-handed CME flux ropes. However, the oblique view (perpendicular to the axis) can be ambiguous. 3D realization of the feature allows rotation to a viewing angle along the axis, ultimately required for establishing chirality.
- Future work: Consider effect of noise

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