Validation of Image Based Method for Assessing Coronal Magnetic Field Models

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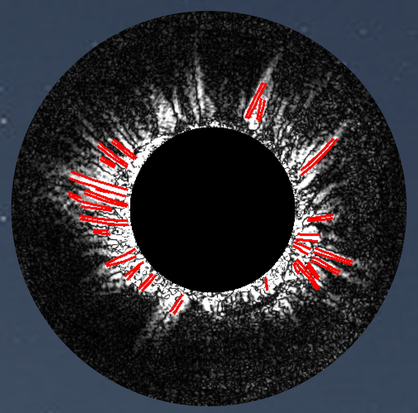
INTRODUCTION

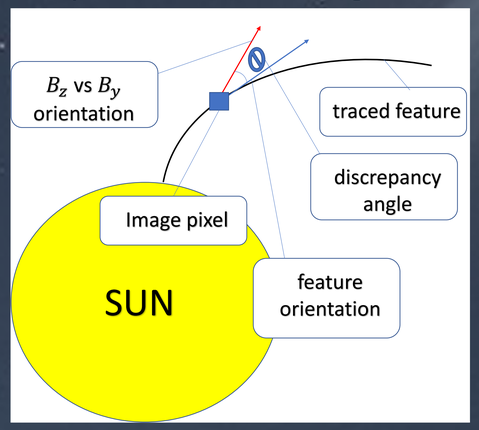
- Magnetic field models of the corona are key for accurate space weather forecasting.
- Observations of the solar corona provide key insight into the determination of the orientation of the Sun's magnetic field due to the frozen-in flux conditions of plasma in the solar corona.
- Since the plasma in the solar corona is weakly collisional but strongly magnetized, electromagnetic interactions dominate over gas kinetics, and as a result the solar plasma 'clings to' the magnetic field of the corona.
- The orientation of density features in the plasma of the solar corona can therefore be treated as a proxy to the orientation of features in the coronal magnetic field.
- Previous studies (Jones et al., 2017, 2020) provided a method of using quasi-radial features detected in coronagraph images to improve coronal magnetic field models by quantifying the disagreement between the orientation of these features to the projected orientation of model fields (Jones et al., 2017, 2020).
- Coronal features are traced using an automated Quasi-Radial Feature Tracing (QRaFT) algorithm (Uritsky et al., 2022, in prep.) that uses adaptive thresholds to extract candidate features and approximate their orientation using polynomials, which are then used as input for the optimization.



Example of QRaFT feature tracing algorithm

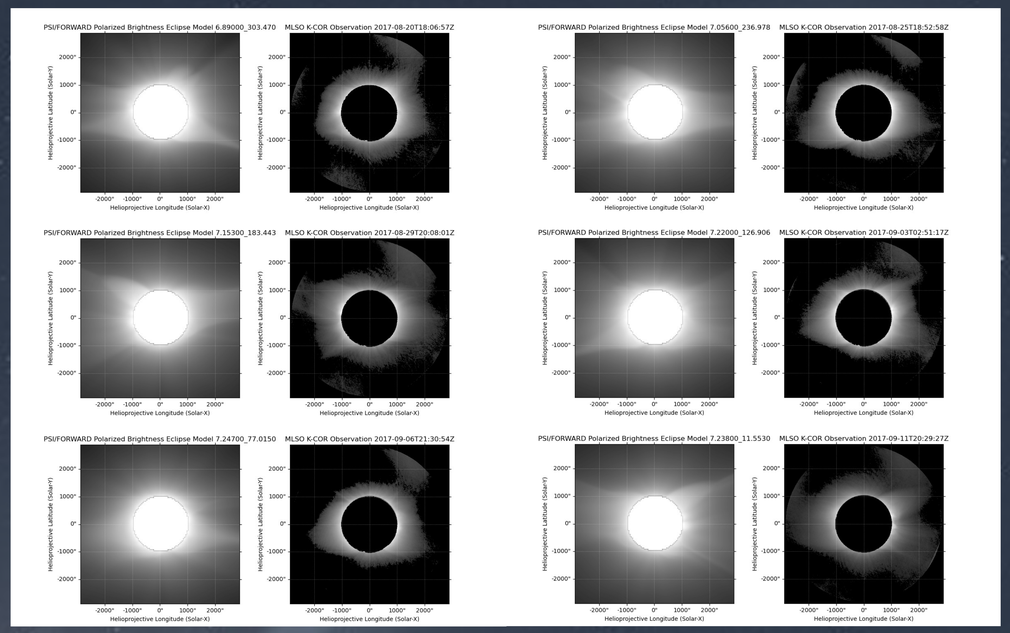
VALIDATION OF QUASI-STATIC CORONA FEATURES

- We test this method using numerical outputs of an advanced solar coronal model developed for forecasting recent solar eclipses (Mikić et al., 2018).
- We compare features traced by the QRaFT code in coronagraph images obtained by the K-Cor instrument at the ground-based Mauna-Loa Solar Observatory (MLSO) to features traced in synthetic coronagraph images computed by Predictive Science's Magnetohydrodynamic Algorithm outside a Sphere (MAS) code (Mikić et al., 2018, and references therein), and generated using the SSWIDL package FORWARD (Gibson et al., 2016).
- We use both the central plane and line-of-sight (LOS) magnetic field parameters generated by the MAS model to correlate how well each traced feature matches the expected magnetic orientation by measuring the angle discrepancy for both the synthetic and MLSO images.
- We use six slices of model data spaced roughly 60 ° apart comparing them to six MLSO observations spanning a time of 17 days.
- Model images are coaligned to the MLSO observations taken from the same Carrington latitude/longitude to ensure consistency when performing this evaluation.
- Preliminary results show close correlation between the performance of feature tracing on both the synthetic and MLSO images.

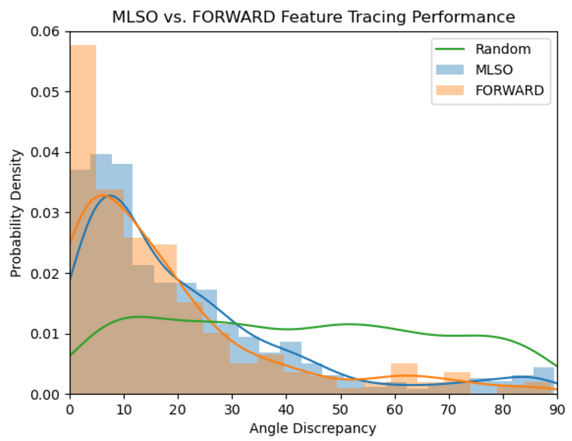


Schematic showing angle discrepancy calculation

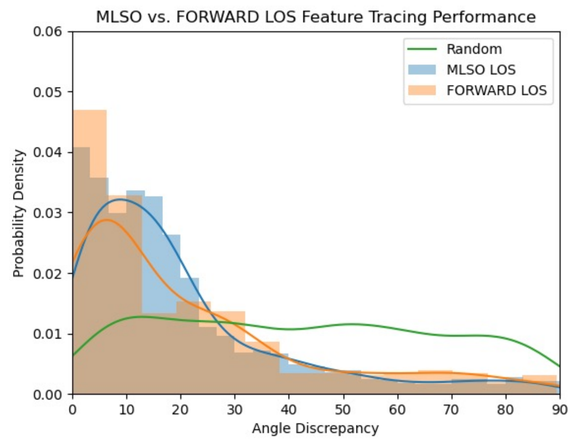
PRELIMINARY RESULTS



Synthetic coronagraph images from PSI MAS model coaligned to MLSO coronagraph observations



Histogram and probability density plot showing performance of QRaFT code on synthetic and MLSO coronagraph images against central magnetic field orientation



Histogram and probability density plot showing performance of QRaFT code on synthetic and MLSO coronagraph images against LOS magnetic field orientation

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