Classification of ambiguity in polarimetric CMEs reconstruction

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Introduction

We suggest a classification for ambiguities in polarimetric technique. Based on the Thomson scattering theory, there exist explicit and implicit ambiguities. From three samples of space CME observations, we obtain double explicit, mixed and double implicit ambiguity. We believe that this classification is helpful to improve polarimetric reconstruction.

In Fig. 1, electron at Q receives radiation from S on the photosphere and produces polarized Thomson scattering. Polarization of the scattering light can be expressed by equation(1). Then we obtain Q and Q_s from equation(2) as candidates for the electron location where angle NOQ is equal to NOQ_s.

For CME composed with huge plasmas cloud, there exist explicit and implicit ambiguities shown in Fig. 2 for single viewpoint observation. Such ambiguities can be identified by morphological difference of material distribution near plane of sky(POS) as shown in Fig. 2. When symmetric CME locate away form the POS, we have explicit ambiguity; and when symmetric CME reconstructions locate on the POS, we have implicit ambiguity. For double viewpoint observations, we obtain double explicit, mixed and double implicit ambiguity shown in Fig. 3.

$$P=\frac{I_p}{I_{tot}}=\frac{[(1-u)A+uB]\cos^2\alpha}{2[(1-u)C+uD]-[(1-u)A+uB]\cos^2\alpha} \quad (1) \qquad QN=Q_sN=ON\tan|\alpha| \quad (2)$$

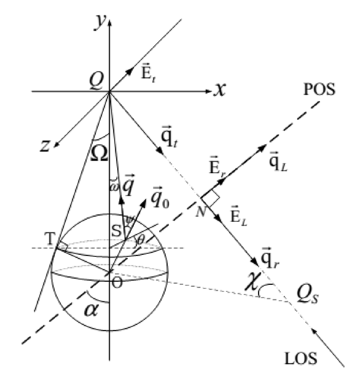

Fig. 1 Relations among Thomson scattering, polarization and ambiguity.

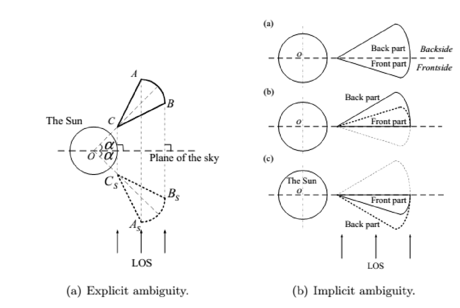

Fig. 2 Ambiguity for single viewpoint observation.

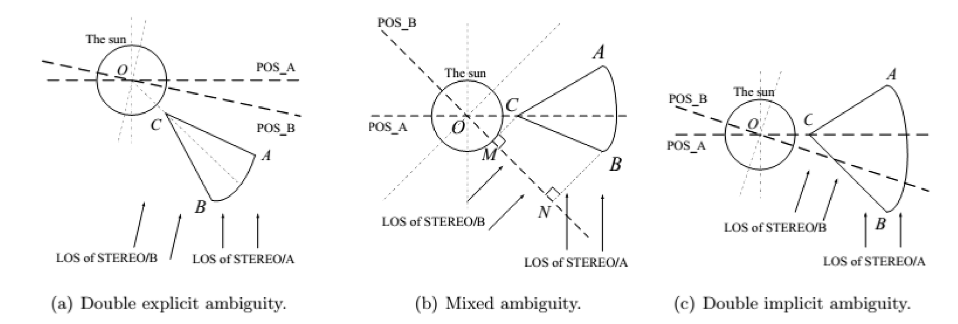

Fig. 3 Ambiguity for double viewpoint observations.

Examples of ambiguities for reconstruction from STEREO-A/B

From equation(2), we calculate distance of every CME pixel away from POS and do the reconstruction. For instance, information of Fig. 4(a) and (b) is used to obtain the reconstructed CME shown from (c) to (f). In order to identify the ambiguity, we pay attention to the view of the solar north pole. Directions of the Earth, STEREO/A and B are indicated with solid green, red and blue line segments. Corresponding POS is indicated with dashed line segments. Material distribution near plane of sky as shown in Fig. 4(f) and (l) indicate that it is a double explicit ambiguous CME. The same logic is applicable in Fig. 6 and Fig. 8. The mass center of CMEs are marked by black little spheres in reconstructed CMEs. Longitudes and latitudes of the mass centers are shown in Table 1 to Table 3.

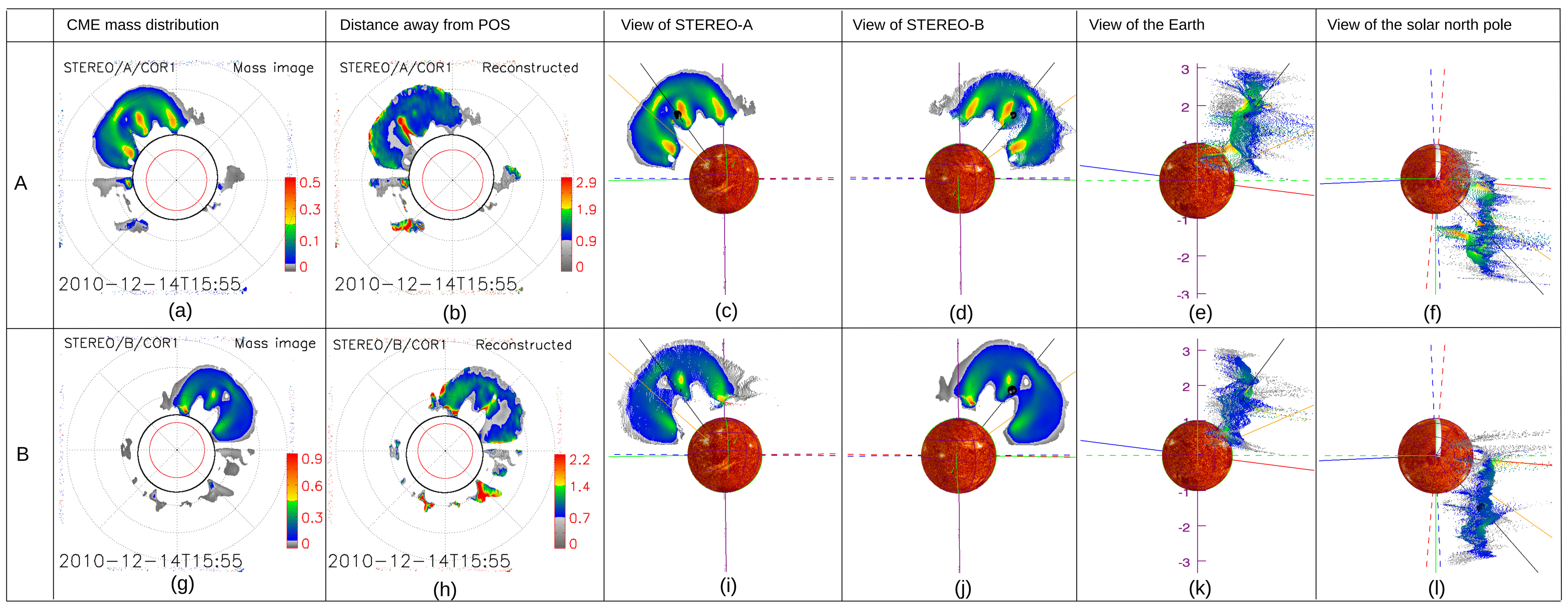

Fig. 4 Double explicit ambiguity.

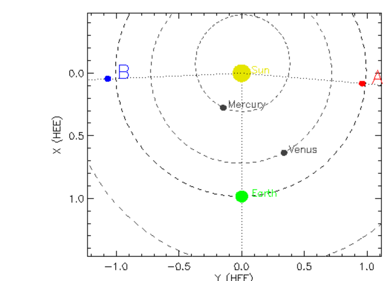

Fig. 5 Locations of STEREO/A and B

Table 1: Stonyhurst longitudes and latitudes of reconstructed CME observed on 2010 December 14 at 15:55 UT. Reconstruction under front side assumption is denoted by + and reconstruction under back side assumption is denoted by -.

	A+	A-	B+	B-
Longitude(degrees)	43.08	-41.42	-24.12	41.39
Latitude(degrees)	40.43	50.38	49.19	41.26

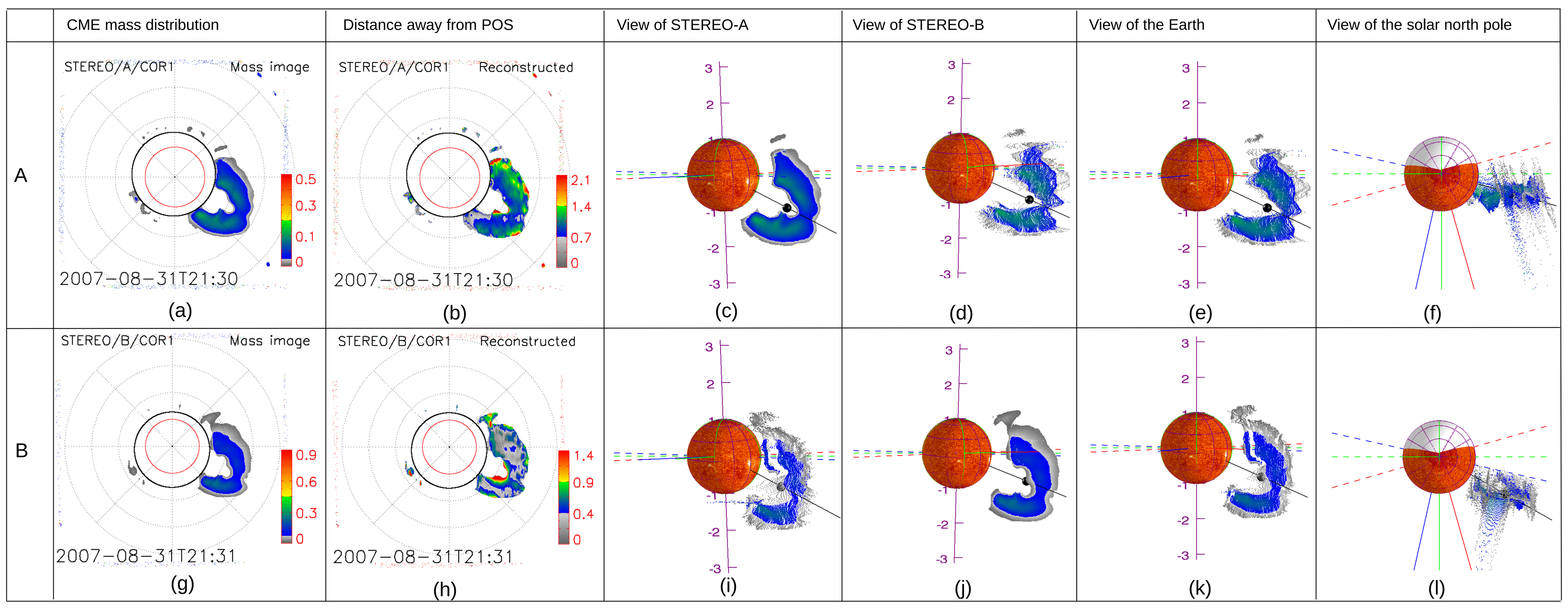

Fig. 6 Mixed ambiguity

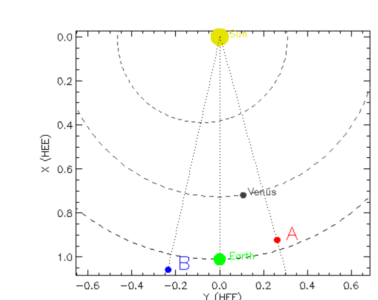

Fig. 7 Locations of STEREO/A and B

Table 2: Stonyhurst longitudes and latitudes of reconstructed CME observed on 2007 August 31 at 21:30 UT and 21:31 UT.

	A+	A-	B+	B-
Longitude(degrees)	74.57	131.06	60.80	89.35
Latitude(degrees)	-22.77	-29.68	-17.79	-21.13

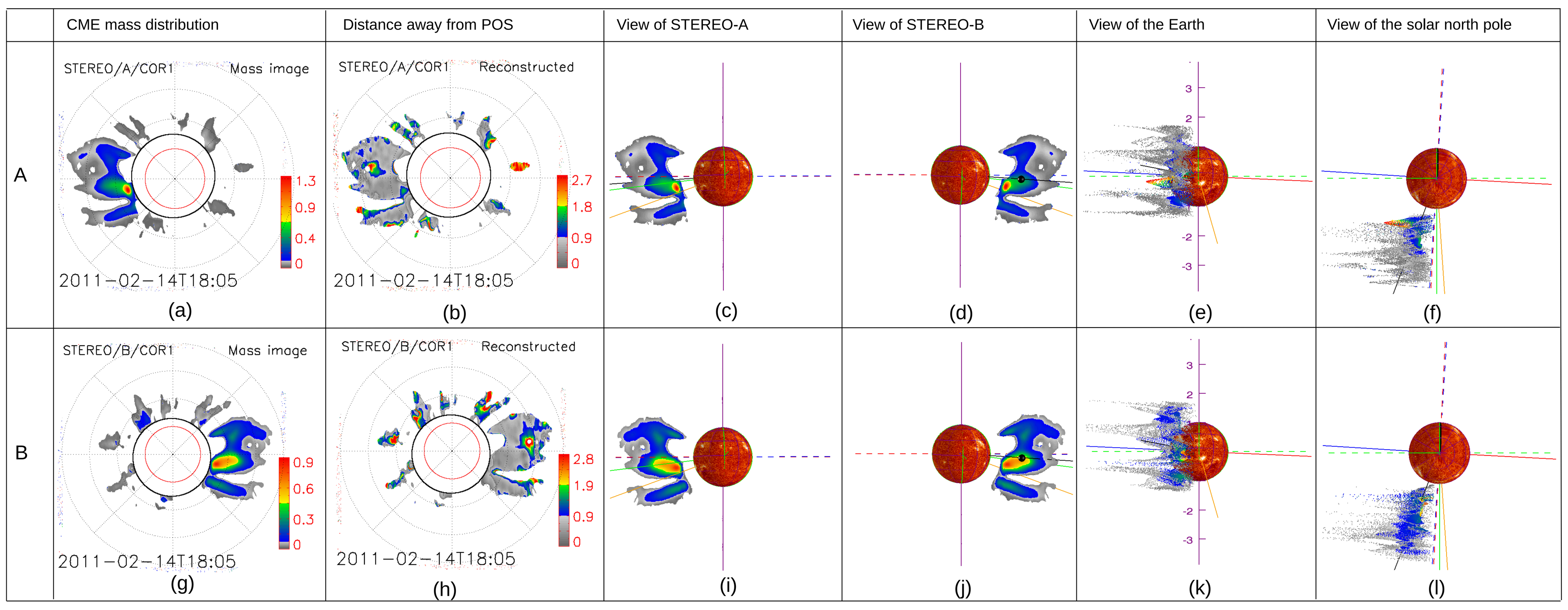

Fig. 8 Double implicit ambiguity.

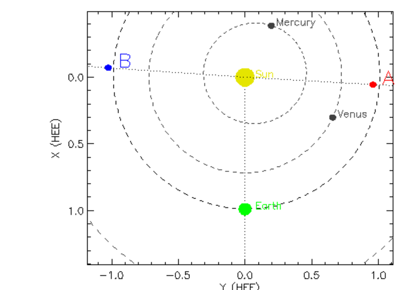

Fig. 9 Locations of STEREO/A and B

Table 3: Stonyhurst longitudes and latitudes of reconstructed CME observed on 2011 February 14 at 18:05 UT.

	A+	A-	B+	B-
Longitude(degrees)	14.48	-20.70	-21.05	13.26
Latitude(degrees)	-4.32	-2.61	-2.49	-4.41

Conclusion

The ambiguity classification indicates a way for improving polarimetric reconstruction. Morphological difference between explicit and implicit ambiguity provides us an operational classification. Applications to CMEs with different ambiguities demonstrate that CME mass distributions near the POS are the key to ambiguity classification.

References

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