Effect of line-of-sight integration on locations of coronal mass ejection in the sky projection map of interplanetary scintillation observations

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The g-value derived from interplanetary scintillation (IPS) observations abruptly enhances when a high density (i.e. shocked) plasma associated with a coronal mass ejection (CME) intersects the line-of-sight (LOS). The plane-of-sky location of the line-of-sight, which shows the g-value enhancement, provide information of the radial distance of the CME-driven shock, and enables determination of the shock transit speed in the solar wind between the Sun and the Earth. It should be noted here that IPS measurements include an effect of the LOS integration, and the plane-of-sky location of g-value enhancements is affected significantly by this effect for some cases. The most significant bias is expected for an Earth-directed event. In this study, we investigated the dependence of the LOS integration effect on the radial distance, the angular width, and the non-uniform expansion for an Earth-directed CME. We made calculations of the sky projection map of g-value using the CME model (Tokumaru et al., 2003). As the result, we found that the plane-of-sky location of g-value enhancements tends to underestimate the actual distance of CME, and that this tendency is distinct in the region near the Sun, being less as the CME moves further from the Sun. This means that apparent acceleration is observed for an Earth directed CME propagating with a constant speed. The degree of this tendency is significant for a case with a small angular extent of CME and also for a case with the non-uniform expansion. Such apparent acceleration of CME near the Sun has seldom reported from IPS measurements for Earth-directed CMEs. This fact may suggest that the CME detected by IPS has a sufficiently large angular width, and hence that the acceleration effect is counterbalanced or overwhelmed by intrinsic deceleration of CME during propagation.

Keywords: interplanetary scintillation, solar wind, coronal mass ejection, space weather

