Probing Coronal Mass Ejections with Faraday Rotation Measurements

Steven R. Spangler and Catherine A. Whiting
Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242

Coronal mass ejections are important solar and interplanetary transients. An impact between a large coronal mass ejection (CME) and the Earth can produce geomagnetic storms. It is important to measure the structure and physical properties of CMEs while they are still close to the Sun. Information on the density and magnetic field structure of these objects is important for understanding their physics and predicting their geoeffectiveness. Faraday Rotation is a radio science measurement that contains information on the plasma density and magnetic field in a CME (or any other plasma interposed between the source of radio waves and the receiving antenna). Bird et al (Solar Phys., 98, 341-368, 1985) reported several cases in which the linearly-polarized transmitter of the Helios spacecraft was occulted by a CME.

Recently, we (Ingleby et al, Astrophys. J., 668, 520-532, 2007) briefly described a case in which the rotation measure to a radio galaxy observed through the corona was apparently affected by a CME. The observations were made with the Very Large Array (VLA) at frequencies of 1465 and 1665 MHz. There were also observations by the LASCO (Large Angle and Spectrometric Coronagraph) instrument on the SOHO spacecraft. The Faraday rotation event reported by Ingleby et al was observed for the source 2337-025. This line of sight of passed through the corona at a minimum heliocentric distance of 6.6 solar radii. The outer loop of the CME was reaching the source at the end of the observing session, and the polarization position angle at 1465 MHz had changed by 25 degrees over a period of about two hours. This corresponds to a change in the rotation measure of 10 radians/square meter. The change in the rotation measure before the arrival of the CME indicates that there is a magnetized plasma precursor ahead of the visible CME in the coronagraph data.

These observations will be discussed in the context of recent calculations of the Faraday rotation signatures of model CMEs published by Liu et (Astrophys. J., 665, 1439-1447, 2007). Finally, we will discuss the detectability of CMEs at greater distances in the interplanetary medium.