# Modeling the Faraday Rotation of Coronal Mass Ejections with Increasingly Complex Forms of Plasma Density

Mohammad Ashas* [(1)], Madison L. Asicone[(2)], Jason E. Kooi[(3)]
(1) Department of Physics, California State Univeristy at Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840, USA
(2) Department of Physics, Georgetown University, 3700 O St. N.W., Washington, DC 20057, USA
(3) U.S. Naval Research Laboratory, Code 7213, 4555 Overlook Ave. SW, Washington, DC 20375, USA

Catastrophic solar events such as coronal mass ejections (CMEs) and how they affect Earth can be better understood through observation and modeling of the solar corona. CMEs are large eruptions of plasma from the surface of the sun, which can result in billions of tons of coronal material being ejected into space. Faraday rotation has proven to be a very reliable method of measuring the magnetic field of the solar corona. Similarly, Faraday rotation observations of CMEs can provide a better understanding of their magnetic field morphology. Faraday rotation occurs when polarized light passes through a magnetized plasma which causes the plane of polarization to rotate in a way that can be quantified reliably. Faraday rotation depends on the plasma density and the magnetic field along the line of sight to the radio source. By modeling a CME's plasma density and magnetic field, it is possible to understand how passing radio waves are affected by the CME. Previous work (e.g. Kooi et al., 2017, Solar Phys., 292, 56, and Wood et al., 2020, Astrophys. J., 896, 99) assumed a flux rope configuration and constant plasma density; however, it is expected that plasma density is not constant.

We report model results exploring three different plasma density models for a CME: a constant density model, a piecewise shell density, and a graduated cylindrical shell (GCS) density. Faraday rotation corresponding to the constant density model has been discussed by, e.g., Jensen et al. (2008, Geophys. Res. Lett., 35, L02103); however, the shell and GCS models add multiple regions with different densities throughout the CME. When the CME's axial magnetic field is parallel to the line of sight, all models demonstrate that Faraday rotation is strongest near the central axis of the CME and decreases to zero near the edge of the CME. Of the models we examined, two (constant density and shell density) were compared to triggered *Karl G. Jansky Very Large Array* CME Faraday rotation observations from 2015. The GCS model was not applied because the observations do not have the resolution in time to clearly distinguish between the shell and GCS models. We applied two versions of the shell model: thin shell (corresponding to a strong CME shock front) and thick shell. The thin shell and constant density models provide a better overall fit to the observational data.