MODELLING OF CORONAL MASS EJECTIONS USING REALISTIC INVERSION OF THE PHOTOSPHERIC ELECTRIC FIELD

E. Lumme, J. Pomoell, and E. K. J. Kilpua

Deparment of Physics, P.O. Box 64, FI-00014 University of Helsinki, Finland
email: erkka.lumme@helsinki.fi

Coronal mass ejections (CMEs) are huge clouds of plasma and magnetic field that erupt regularly from the Sun. A CME can hurl billions of tons of solar material at supersonic speeds into the interplanetary space, and when expanding through the heliosphere it has a dramatic effect on the local interplanetary conditions. The resulting space weather disturbances may harm modern technologies both in space and on the ground.

CMEs originate in the upper solar atmosphere, the *solar corona*, and erupt as twisted *magnetic flux ropes*. Characterisation of the magnetic structure of the CME flux rope in the corona is crucial both for studying the eruption mechanisms of the CME as well as for forecasting accurately its space weather effects. Since direct remote sensing measurements of the coronal magnetic field are not routinely available, the most promising approach to determine the magnetic structure of an erupting CME is *data-driven modelling*, in which available measurements from the surface of the Sun, the photosphere, are used as a boundary condition.

From the variety of existing data-driven modelling approaches we haven chosen to employ the *magnetofrictional method*. The approach is computationally inexpensive enabling long-term time-dependent modelling of the coronal magnetic field from the emergence of an active region until the eruption of a CME, and the method has sufficient physical accuracy to constrain the magnetic properties of the erupting CME flux rope. However, the success of the approach depends heavily on the realism of the photospheric boundary condition, the electric field. For this purpose we have created ELECTRICIT, a practical software toolkit for routine inversion of the electric field from time series of photospheric magnetic field and plasma velocity measurements. In this work we present the basic properties of the ELECTRICIT toolkit and the results of an example magnetofrictional simulation which was driven by the electric fields inverted using the toolkit. We illustrate the feasibility of our data-driven approach in determining the magnetic structure of an erupting CME and discuss the sensitivity of the simulation output to the properties of the driving electric field, such as the Poynting and magnetic helicity fluxes from the photosphere to the corona.