A New Model to Describe the Magnetic Structure of CMEs

Al-Haddad, N.(1) & Lugaz, N.(2)

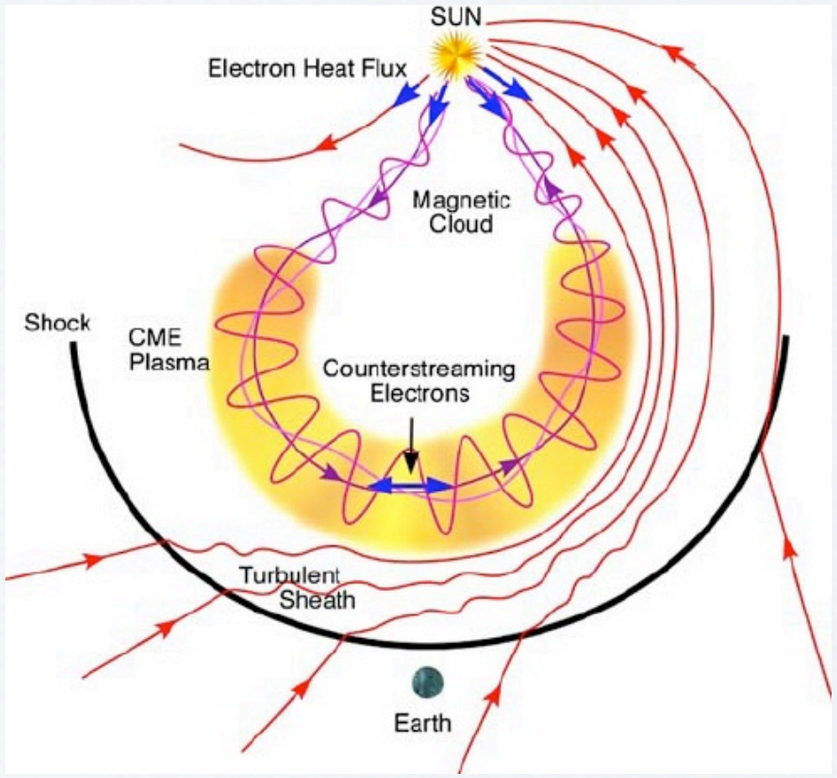
(1) Catholic University of America, USA; (2) University of New Hampshire, USA

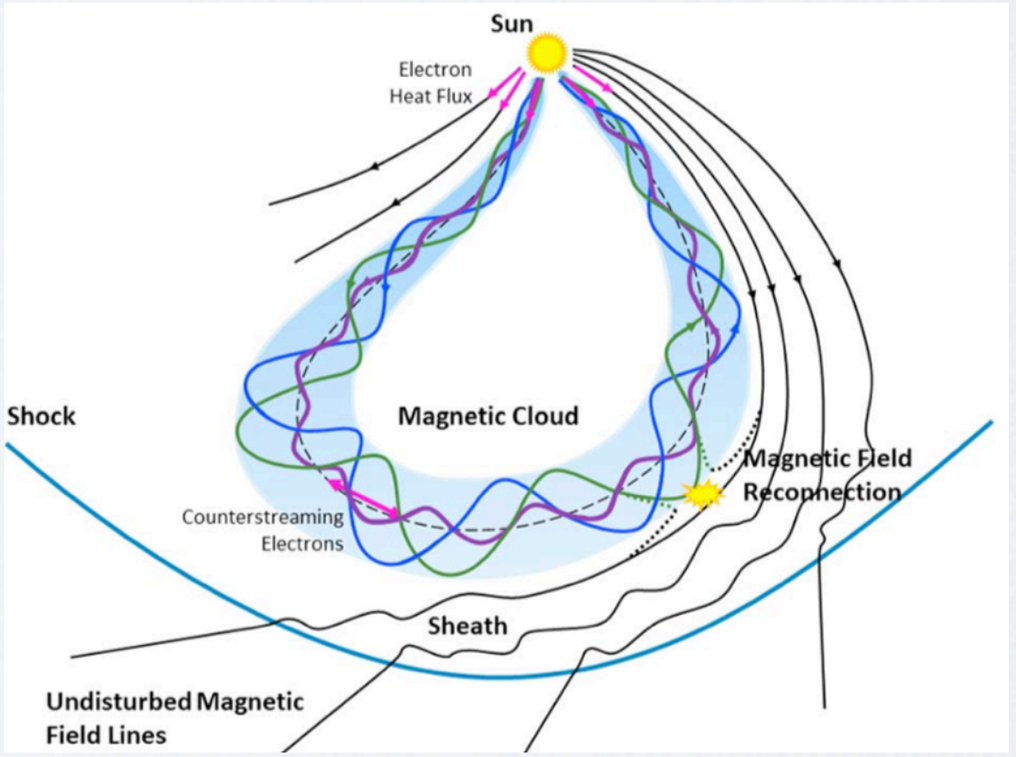
As this work is not published yet, we are only posting an extended version of the abstract.

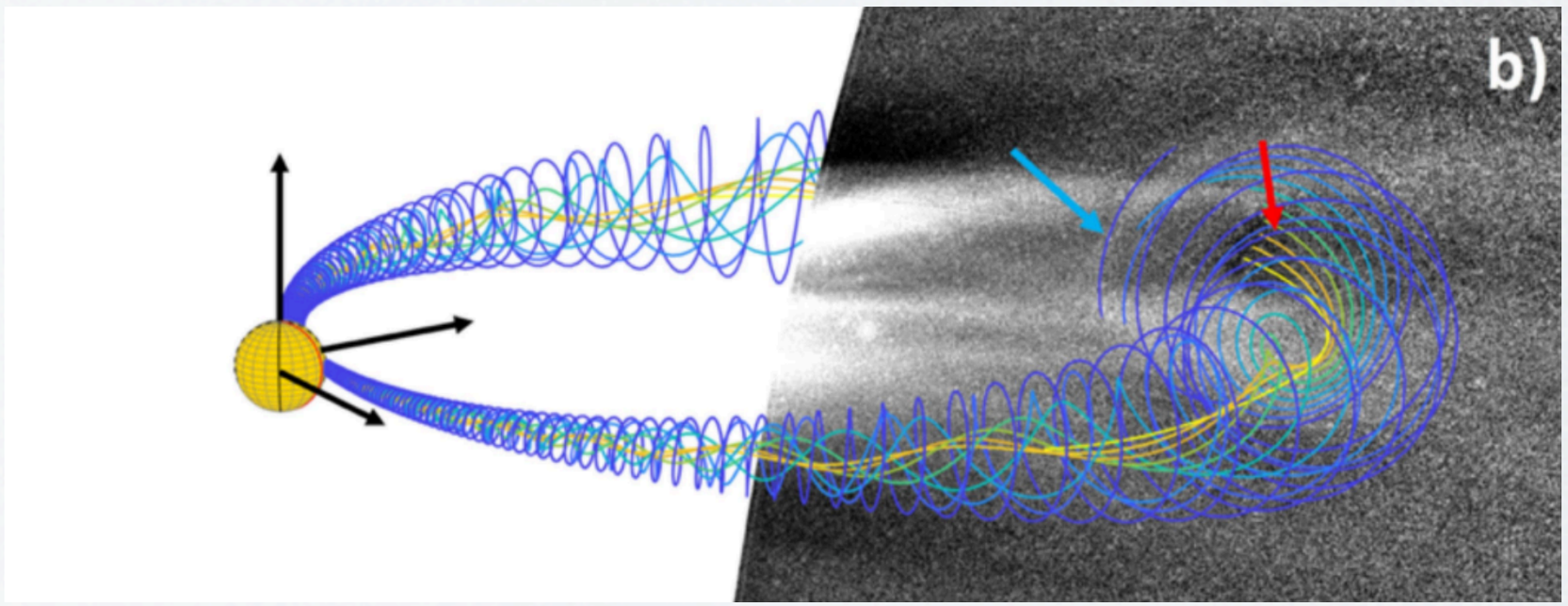
The structure of coronal mass ejections (CMEs) has been the center of numerous studies over the past few decades. Defining the magnetic field orientation locally and globally has proven to be a challenging problem, due to the limited nature of observations that we have, as well as our reliance on the current paradigm of highly-twisted flux ropes. Studies suggest that not all CMEs measured in situ fit within the simple twisted and well-organized flux rope topology. Additionally, many of the events that can be well fitted by existing static flux rope models, do not have as simple a structure as that assumed by the models. This is clear from remote observations and multi-spacecraft measurements. With the wealth of data that we have today, as well as the affluence of research and analysis performed over the last 40 years, it is dues time to present an alternative paradigm, that better represents those data. In this work, we discuss this new paradigm and the literature leading to it.

What is the magnetic structure of CMEs?

Classical models of CMEs







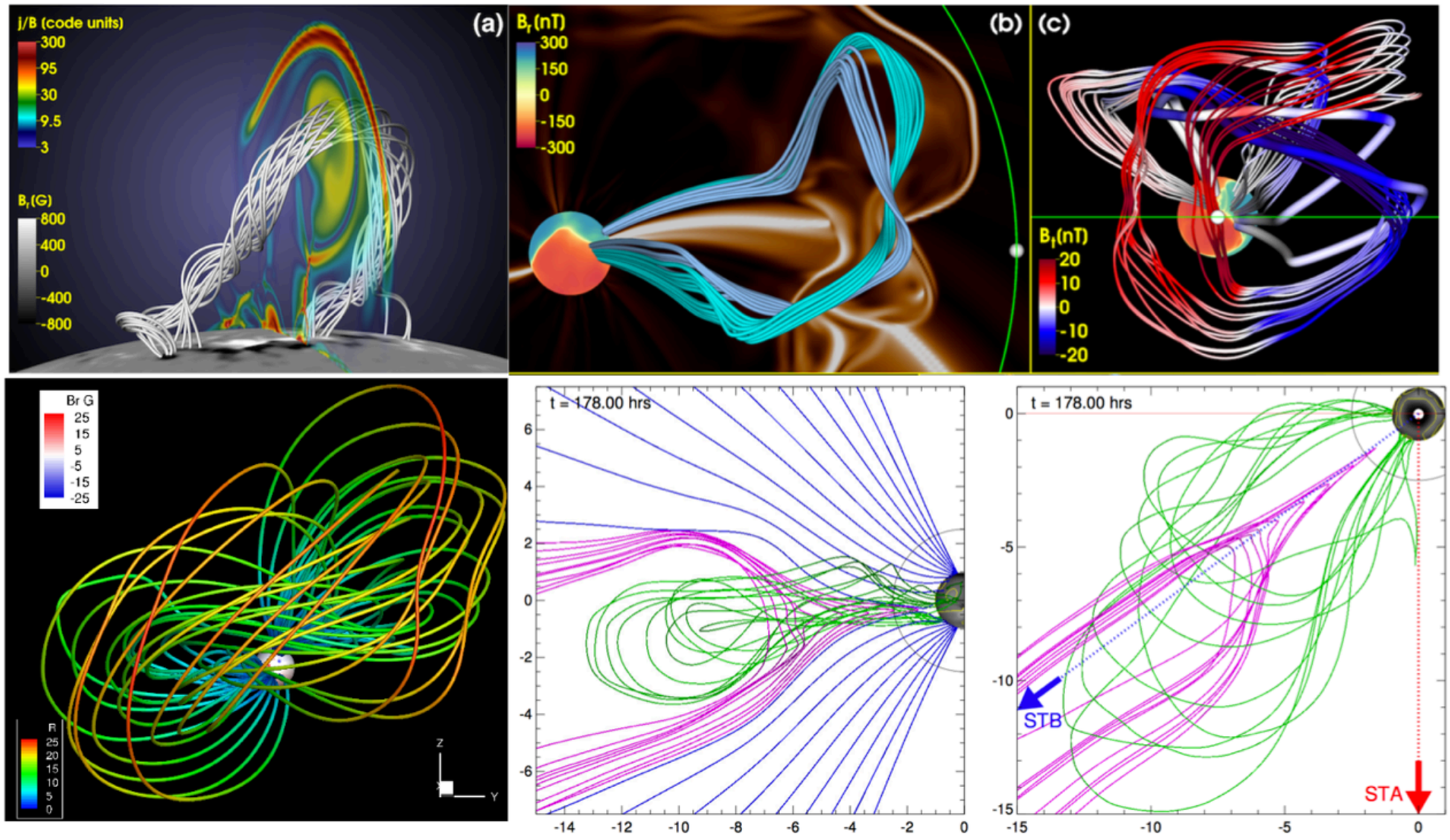
Top Right: Cartoon model of Zurbuchen & Richardson(2006) showing a representation of a force-free magnetic ejecta with a circular cross-section.

Top Left: updated cartoon by Wang et al. (2018) showing a more twisted core than outside shell, as well as a possibility for magnetic reconnection.

Bottom: A model by Rouillard et al. (2020) fitting an image by PSP WISPR, with a highly twisted field lines

What is the magnetic structure of CMEs?

Modeling results showing the complexity of CMEs.



Top: Simulation by Török et al. (2018) of the Bastille Day event showing (a): the initial highly twisted erupting flux rope, (b) and (c) the resulting magnetic field at Earth, which can hardly be described with a Lepping model. Note that the resulting magnetic field was a decent comparison to the measured one. **Bottom left**: Writhed model of Jacobs et al. (2009) as analyzed in Al-Haddad et al. (2018b). **Bottom right**: Simulation of Lynch et al. (2016) showing a weakly twisted eruption at 15 solar radii.