9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Data-Driven Modelling of Solar Eruptive Flares

Mark C. M. Cheung[1]
[1] CSIRO
e-mail (speaker): mark.cheung@csiro.au

This presentation will review advances in using observational data to drive models of solar flares and eruptions. Tremendous advances in this area have been made since the launch of NASA's Solar Dynamics Observatory in 2010 [1]. The talk begins by discussing the astrophysical and plasma processes that are important in solar flares and eruptions (e.g. magnetic flux emergence, stratification, thermal conduction, magnetic reconnection and more) [2,3,4,5]. We then present the challenges of turning observational (vector) magnetogram [6] sequences into appropriate boundary conditions for data-driven models [7,8,9]. We illustrate attempts to address these challenges with a review of existing data-driven models and validation efforts.[10,11,12] Finally, we discuss outstanding problems and opportunities for improvements [13].

References

[1] Pesnell, W.D., Thompson, B.J., Chamberlin, P.C. (2011). The Solar Dynamics Observatory. Springer, New York, NY.
[2] Shibata, K., Magara, T., 2011, Living Rev. Sol. Phys. 8, 6.
[3] Cheung, M.C.M., Isobe, H. Flux Emergence (Theory), 2014, Living Rev. Sol. Phys. 11, 3.
[4] Toriumi, S., Wang, H., 2019, Living Rev Sol Phys 16, 3.
[5] Cheung, M.C.M., Rempel, M., Chintzoglou, G. et al., 2019, Nat Astron 3, 160–166.
[6] Hoeksema, J.T., Liu, Y., Hayashi, K. et al., 2014, Sol Phys 289, 3483–3530.
[7] Cheung, M. C. M. and DeRosa, M. L., 2012, ApJ 757 147
[8] Fisher, G. H., et al., 2015, Space Weather, Volume 13, Issue 6, pp. 369-373
[9] Pomoell, J., Lumme, E. & Kilpua, E., 2019, Sol Phys 294, 41.
[10] Guo, Y., Guo, J., Ni, Y. et al., 2024, Rev. Mod. Plasma Phys. 8, 29.
[11] Chen, F et al., 2023, ApJ 949 118
[12] Rempel, M et al 2023, ApJ 955 105
[13] Cheung, M. C. M. et al, 2022, ApJ 926 53

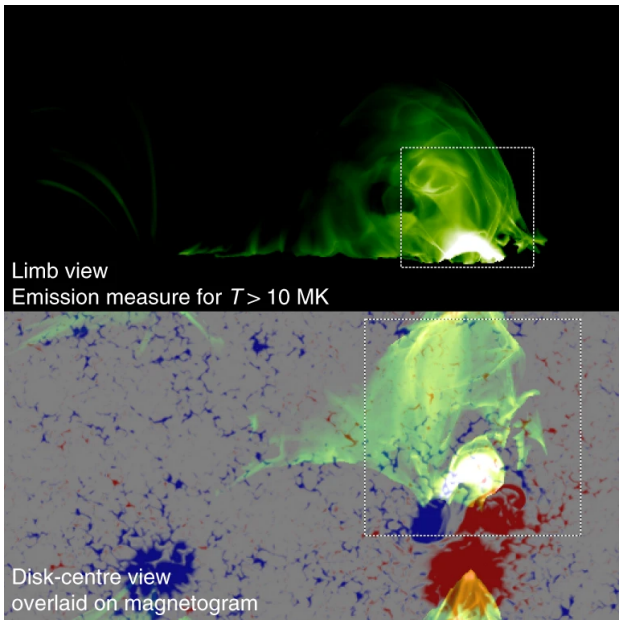

Figure 1: Radiative magnetohydrodynamics simulation of a solar flare [5].