On the formation of multi-threaded prominences

V. Jerčić, R. Keppens

Centre for mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven , Leuven, Belgium

Prominences are plasma structures, usually found high up in the Sun's corona. They represent a laboratory for plasma processes, as it is still not fully understood how a structure, two orders of magnitude colder and denser than the background corona, can be sustained there. Even though they seem to be stable, monolithic bodies, we know they are in fact, highly dynamic and highly structured. The building blocks of prominences are relatively small thread-like structures, fibrils. Although a prominence can persist for days or even weeks, the individual fibrils have a lifetime on a scale of minutes. They are characterized by multiple flows (so-called counterstreamings). One of the ways the fibrils are formed is as a result of multiple heating events at the footpoints of the coronal loop or arcade. Those heating events cause evaporation of the chromospheric plasma that in the corona experiences 'catastrophic cooling'. Condensation happens and prominence fibrils are formed. There have been multiple attempts to study this formation process via numerical simulations [1, 2, 3], most commonly in 1D and recently, the setup was recreated in 2D [4]. However, in order to fully understand the mechanisms of prominence formation and the resulting behavior, many details still need to be explored. Hence, we further extend on our former 2D adiabatic study of a prominence with fine structure [5], by including non-adiabatic effects (thermal conduction, radiative cooling, steady background and random localized heating). Using localized heating events we are able to realistically form prominence fibrils. We explore how different parameters of the formation process affect the properties of the formed fibrils. What makes counterstreaming flows in the domain and how different energy inputs change the resulting fibrils? The magnetohydrodynamic (MHD) equations were solved using an open-source MHD code, MPI-AMRVAC [6] (http://amrvac.org/).

References

[1] Karpen, J.T. and Antiochos, S.K., Astrophys. J., **676**, (2008)

[2] Antolin, P., Shibata, K., and Vissers, G., Astrophys. J., **716**, (2010)

[3] Johnston, C.D., Cargill, P.J., Antolin, P., Hood, A.W., De Moortel, I., and Bradshaw, S.J., Astron. Astrophys., **625**, (2019)

[4] Y. H. Zhou, P. F. Chen, J. Hong and C. Fang, Nature Astronomy, 994 (2020)

[5] Jerčić, V., Keppens, R., and Zhou, Y., Astron. Astrophys., **658**, (2022)

[6] C. Xia, J. Teunissen, I. El Mellah, E. Chané, and R. Keppen, Astrophys. J. Suppl. Ser, **234** (2018)