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Prominence Formation by Levitation-Condensation at Extreme Resolutions

Jack Jenkins & Rony Keppens (2021) A&A 646 A134

Aim: Explore the physical mechanisms involved in the formation and evolution of solar prominence condensations at a resolution of ~5.6 km.

Method: Use the open source MPI-AMRVAC (amrvac.org) toolkit to build an initial linear force-free magnetic arcade into a 2.5D solar flux rope that simultaneously (1) levitates coronal plasma high into the corona and (2) thermally-isolates it from the associated background heating mechanism.

Results: Plasma no longer heated by the prescribed coronal heating model begins to cool due to optically-thin radiative losses until “runaway”/“catastrophic” cooling is initiated and condensations form. The formation and evolution of these condensations is found to follow a specific order of (1) convective-continuum instability (2) thermal instability (3) evolution due to formation outside of pressure equilibrium (4) baroclinitic rotation with dimensions on the order of a flux tube.

Moving forward: 2.5D simulations provide the opportunity to explore these dynamics at a very high resolution but inhibit the formation of instabilities such as Rayleigh-Taylor or interchange. Although these simulations provide unprecedented insights into internal prominence dynamics, to produce more ‘realistic’ evolutions, and appearances therein, we need to move to full 3D.

Interested in hearing more? Perhaps about the 3D extension to this work? Come find me!

Simulation setup: non-ideal MHD 2.5D cartesian | exponential background heating profile to balance radiative losses at t=0 | “SPEX_DM” radiative losses with 1e3 K minimum temperature | Magnetic field handled in a split fashion with auxiliary internal energy solved to ensure positive pressure.