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2.5D and 3D Structure and Evolution of Solar Prominence Plasma Condensations

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Solar prominences exist as a delicate balance between both magnetic and gravitational forces, and thermal and mechanical energies, within the solar corona. Despite extensive research on the topic, many questions remain outstanding – most notably of which are as to their general internal structure, condensation formation, and subsequent evolution. From the pioneering work of [1] we have continued on our previous work [2] and extended the levitation-condensation prominence formation model and associated analysis to full 3D (as already achieved at modest resolutions by [3]). Our 2.5D approach in [2] achieved resolutions down to 5.6 km and revealed a plethora of condensation formation and evolution mechanisms: the convective continuum instability or CCI process, the thermal instability (TI), the Brunt-Väisälä frequency, baroclinicity, and the mass slippage theory of [4]. Our extension to 3D achieves a resolution still far in excess of all modern solar observatories at ~20 km. We find that the additional dimension permits additional dynamics that were previously suppressed within the 2.5D implementation [5]. Namely, we relate the interchange mode of the Rayleigh-Taylor instability, now explicitly linked to additional (baroclitic) solenoidal source terms within the evolving vorticity formalism [6], to the evolution of those falling 'fingers' and 'rising' plumes characteristic of solar prominences. Fundamentally, we will show that our visualisations of the condensations within the flux rope topology are able to reconcile the longstanding discrepancy between the filament and prominence projections [7&8].

References

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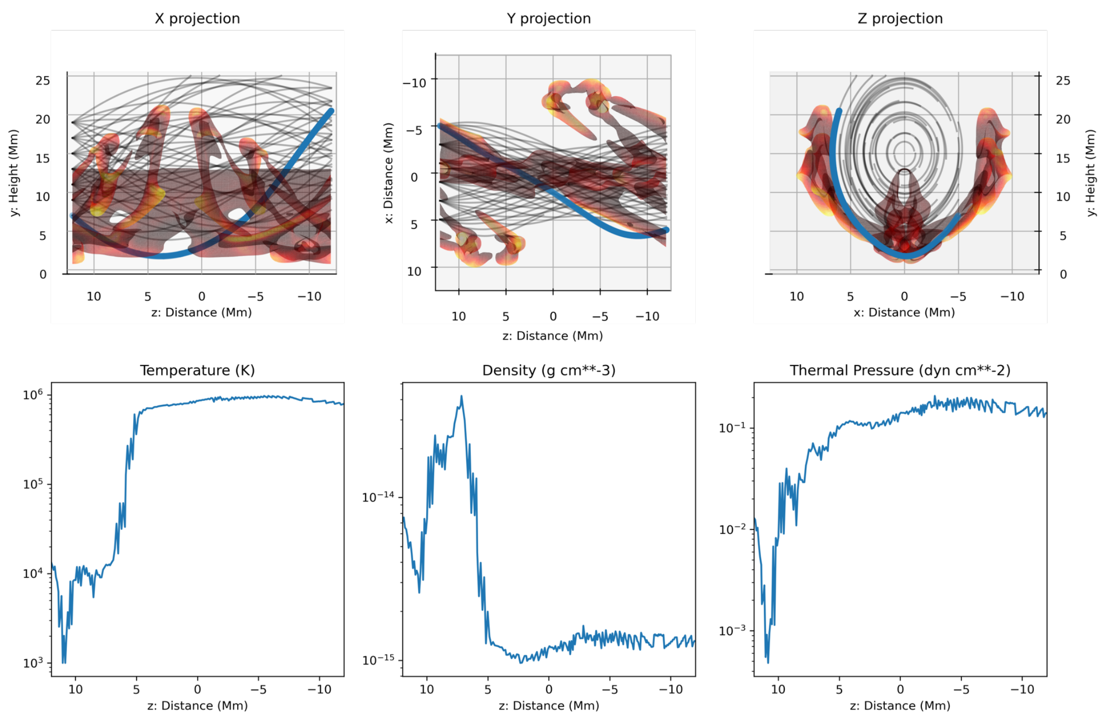

Figure 1: Appearance and distribution of plasma properties within a fully 3D flux rope – prominence simulation. *Top row*; Axis-projections detailing magnetic field streamlines, density iso-contours coloured according to temperature, and an isolated field line. *Bottom row*; distribution of plasma parameters along the isolated field line.