Contribution ID: **129** Type: **Poster**

Optically thin cooling curves and thermal instability

Wednesday, 8 September 2021 10:18 (13 minutes)

Condensations are observed in many astrophysical environments. In solar physics, common phenomena are coronal rain and prominences. Coronal rain consists of transient dense blobs that form in magnetic loops and rain down along the magnetic field lines. The prominences are cold, dense structures suspended in the hot, tenuous corona by the magnetic field.

Those structures are formed due to energy loss via optically thin radiative emission. Instead of solving the full radiative transfer equations, precomputed cooling curves are typically used in multidimensional, magnetohydrodynamic (MHD) simulations assuming an optically thin and fully ionised plasma. Precomputed cooling curves used in literature differ greatly, depending on the incorporated plasma emission processes, atomic physics data, and solar abundances.

We study the effect of the optically thin cooling curves on the formation and evolution of condensations. The condensations are formed due to thermal instability. We use the open-source software MPI-AMRVAC to setup idealised simulations, i.e. a thermal equilibrium in a 2D local coronal volume perturbed by interacting slow MHD waves. For all cooling curves, condensations are formed by thermal instability. However, the differences are twofold. First, the growth rates of the thermal instability are different, leading to condensations being formed at different times. Second, the morphology of the condensations is widely varying. This is influenced by the low-temperature treatment of the cooling curves. Furthermore, we discuss a bootstrap procedure that allows us to continue high-resolution simulations of thermal instability far into the nonlinear regime.

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Session Classification: Poster Session 5.2

Track Classification: Session 2 - The Solar Atmosphere: Heating, Dynamics and Coupling