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Power-law relation between temperature and density in a promince and a coronal cavity

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In this study, we discuss the formation mechanism of a solar prominence by the radiative condensation by using MHD simulations including optically thin radiative cooling and thermal conduction. Our main focus is on the relationship between the temperature and density in a prominence and its coronal cavity.

Solar prominences are the cool dense plasma clouds in the hot tenuous corona. The formation model of prominences has not been established completely. The radiative condensation is believed to be a key process.

In the previous study, we proposed a model through the radiative condensation triggered by the formation of a flux rope: The flux rope is formed by the reconnection after imposing converging and shearing motion on the footpoints of the coronal arcade field. The radiative condensation is triggered by the thermal nonequilibrium inside the flux rope. We have demonstrated this model in our simulations and found an empirical scaling law between the temperature and the density of a prominence.

The remained issues in our previous study were that the prominence in our simulations had much higher temperature than that of the observed one, and that the physical meaning of the scaling law was unclear due to the unrealistic small contrast of temperature and density between the prominence and the corona.

In this study, we allow the prominence temperature in our simulations to be lower, and reproduce more realistic prominences. As a result, we successfully extend the previous empirical scaling law to a power law both in a prominence and its surrounding coronal cavity. We also found that the power depends on the temperature gradient of each field line.

Keywords: solar prominence, solar filament