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Small-scale loops heated to transition region temperatures and their chromospheric signatures in the simulated solar atmosphere

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Recent observations revealed loop-like structures at very small scales visible in observables that sample transition region (TR) and coronal temperatures. Their formation remains unclear.

We study an example of a bipolar system in realistic magnetohydrodynamic simulations and forward synthesis of spectral lines to investigate how these features occur.

Computations are done using the MURaM code to generate model atmospheres. The synthetic Hα and Si IV spectra are calculated at two angles (μ=1, μ=0.66) using the Multi3D code. Magnetic field lines are traced in the model and the evolution of the underlying field topology is examined.

The synthetic Hα dopplergrams reveal loops that evolve dramatically within a few minutes. The synthetic Hα line profiles show observed asymmetries and doppler shifts in the line core. They, however, also show strong emission peaks in the line wings, even at the slated view. The synthetic Si IV emission features partly coincide with structures visible in Hα dopplergrams and partly follow separate magnetic field threads. Some are even visible in the emission measure maps for the lg(T/K)=[5.0, 5.5] temperature interval. The emission areas trace out the magnetic field lines rooted in opposite polarities in a bipolar region.

We find that our results largely reproduce the observed features and their characteristics. A bipolar system with footpoints undergoing rapid movement and shuffling can produce many small-scale recurrent events heated to high temperatures. The morphology and evolution of the resulting observable features can vary depending on the viewing angle.

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