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Magnetic Reconnection in the partially ionized low solar atmosphere

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Recently, the high resolution Solar telescopes in space and ground have discovered many small scale, intense, transient brightenings which are related with magnetic reconnection in the low solar atmosphere. The complex Si IV emission lines and Fe II, Ni II absorptions indicate that the initial high density and low temperature plasmas should be heated above several tens of thousand Kelvins during the reconnection process. Since the highly stratificated plasmas there are dense and partially ionized, the radiative cooling and the interactions between ions and neutrals are important. In this talk, I will introduce our numerical results which are based on both the single-fluid and reactive muti-fluid models. Our numerical results indicate that ambipolar diffusion and radiative cooling both result in the much faster current sheet thinning and lead fast reconnection to appear earlier in the case with zero guide filed. When the reconnection magnetic field is weak, recombination is the main mechanism to lead fast reconnection. In the case with strong magnetic field around the solar temperature minimum region (TMR), the ionization is always faster than the recombination within the current sheet region, plasmoid instability is still the main mechanism to lead fast reconnection. Ambipolar diffusion does not significantly affect the temperature increase inside the current sheet. The non-equilibrium ionization-recombination dynamics play a critical role in determining the structure of the reconnection region, lead to much lower temperature increases as compared to simulations that assume plasma to be in ionization-recombination equilibrium. However, the maximum value is still above 20000 K when the reconnection magnetic field strength is greater than 500 G around the solar TMR.

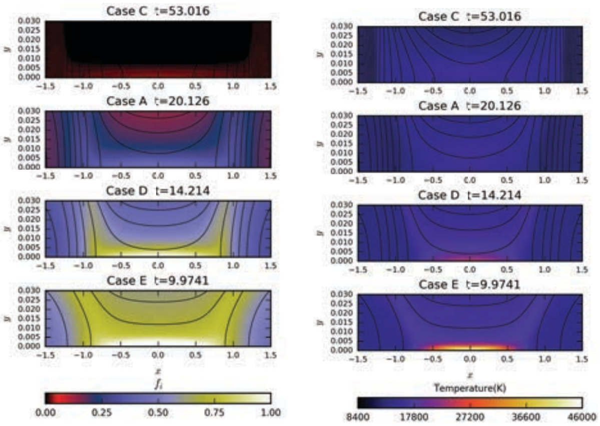

Fig. 1 In the multi-fluid simulations, the distributions of ionization degree f_i and plasma temperature at the end of the simulations in four different cases with different strengths of magnetic fields. The initial magnetic fields are B_0=100 G in Case C, B_0=500 G in Case A, B_0=1000 G in Case D, and B_0=1500 G in Case E.

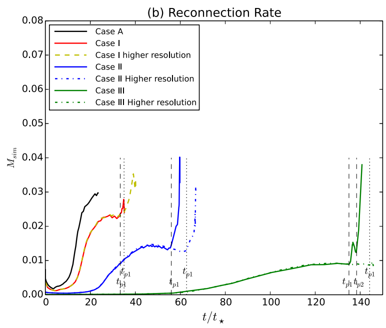

Fig. 1 In the multi-fluid simulations, the reconnection rates evolve with time . The initial magnetic fields are B_0=500 G in all cases. t_{p1} is corresponding the time when the first magnetic island appears. The characteristic length scale is L_0= 100m in Case A, L_0=200 m in Case I, L_0=1000 m in Case II, L_0=1000 m in Case III.

References:

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