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Magnetic reconnection in the strongly magnetized plasma of the low solar chromosphere

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Magnetic reconnection is the most likely mechanism for the high temperature events frequently observed around the temperature minimum region (TMR) with strong magnetic field. We studied magnetic reconnection in a partly ionized plasma around TMR by employing MHD-based simulations in a reactive 2.5D multi-fluid model. Our results show that the non-equilibrium ionization-recombination dynamics plays a critical role in determining the structure of the reconnection region, giving rise to magnetic reconnection faster than that occurring in the plasma in ionization-recombination equilibrium, and leading to apparent increase in the temperature around TMR. The rate of ionization of the neutral component of the plasma is always faster than that of recombination inside the current sheet (CS) even when the initial plasma beta reaches up to1.46. In a low beta plasma, on the other hand, the ionized and the neutral fluid are well-coupled throughout the reconnection region in the absence of the magnetic null point. Decoupling of the ion and the neutral inflow occurs obviously in the higher beta case with beta = 1.46, which leads to a reconnection rate about three times faster than that predicted by the Sweet-Parker model. The reconnection process more closely resembles the Sweet-Parker model when plasma beta is lower in our simulations with low magnetic Reynolds number. Two different radiative cooling models have been applied to the simulations, the thermal energy due to the Joule dissipation is mainly radiated no matter under which radiative cooling model, but strong radiative cooling does not affect the reconnection rate. The plasma temperature increases with time inside CS, and the maximum value is above 20,000 K when the background magnetic field is stronger than 500 G. The Hall effect enhances reconnection slightly, but does not cause significant asymmetries or change the characteristics of CS down to meter scales in the absence of the magnetic null point.