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Heating of solar wind plasma by ion beams and waves: 2D hybrid models

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We study the heating and the acceleration of protons, and heavy ions by waves and by He^{++} ion beams in the solar wind using 2D hybrid simulations. The hybrid model consist of kinetic description of protons and ions, and electrons as neutralizing background fluid. We investigate the nonlinear evolution of the heating, and the influence of heavy ions on the wave dispersion. In the 2D model parallel, as well as obliquely propagating waves are included. The linear dispersion relation for oblique modes is solved and compared to the initial evolution of the model ($t < 100\Omega_p$). The 2D hybrid model provides the nonlinear evolution and saturation levels of the heating at later times for $\sim 1500\Omega_p$. The driving source of the waves is localized at the center of the modeling domain. We discuss the observational implication of the results to the solar wind.