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Toward a dispersion model for magnetic reconnection: lessons from quantum vortex dynamics

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The phenomenon of quantum vortex reconnection as realized by a turbulent helium superfluid offers astrophysical plasma physicists a great amount of hints and ideas to extract the essence of collisionless magnetic reconnection. Based on the recent review of quantum vortex reconnection [Narita, Y. and Baumjohann, W., Lessons on collisionless reconnection from quantum fluids, Front. Phys., 2, 76, 2014], a scenario of dispersion model for magnetic reconnection is proposed here. In this scenario, the dispersion effect causing the wave packet broadening plays a more essential role in reconnection than other effects such as anomalous resistivity, electron pressure anisotropy and stress, or electron inertia. The nonlinearity is neglected in the weak magnetic field region of reconnection (i.e. diffusion region), and the reconnection dynamics is given as a linear dispersive picture. The dispersion effect can be found not only in quantum mechanics (the Schroedinger equation) but also in plasma physics as dispersive waves (whistler waves, for example). While magnetic reconnection is often associated with turbulence, the dispersion model suggests that reconnection be a smooth transition of magnetic field line topology.