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Kinetic simulations of highly magnetized solar plasmas

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Kinetic plasma turbulence phenomenon has a crucial importance for explanation of a number of high-energy processes related to the solar flares. This includes such open questions as the triggering of magnetic reconnection, the origin of radio-bursts, mechanisms of particle acceleration and the transport of energetic beams in the solar coronal plasma. Since fine phase space effects may control the macro-physical dynamics of the collisionless coronal plasma, it is appropriate to use a kinetic treatment based on the Vlasov-Maxwell equations (3D in space and 3D in velocity). This most fundamental kinetic description of the collisionless plasma involves plasma temporal and spatial scales within many orders in magnitude. Consequently, it is extremely difficult to perform numerical simulations within the fully kinetic approach. We will review the modern models used recently for simulation of kinetic processes in space plasmas. One of promising reduced models is a drift-kinetic model for the magnetized plasma which includes important kinetic aspects (Landau damping, wave-particle interaction) and retains the coupling between the fast temporal and small spatial scale kinetic physics, from one side, and the slow temporal and large spatial scale fluid physics, from the other. Applications of the considered models cover several topics such as beam-plasma interactions in the magnetized coronal plasma, anomalous flux dissipation of high-energy electron beams and instabilities in current sheets.