KINETIC ALFVEN INSTABILITIES AND ANOMALOUS RESISTIVITY IN INHOMOGENEOUS CURRENT SHEETS

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As it has been shown recently, the current-driven instability (CDI) of kinetic Alfven waves (KAWs) has a lower threshold current density than other known instabilities in low-beta uniform plasmas. The currents flowing between interacting magnetic fluxes are concentrated in thin current sheets and are thus very inhomogeneous, which makes waves and instabilities in such sheets much different from those in uniform plasmas. We show that the current inhomogeneity has a profound influence on KAWs and their CDI. The KAW phase velocity spans a wide velocity range decreasing from super-Alfvenic velocities to zero with increasing current shear. In this velocity range KAWs undergo a kinetic instability that depends on both destabilizing factors: current strength and current shear. The kinetic instability has a low threshold and can attain a high growth rate with moderate current shears. For stronger current shears, the KAW phase velocity becomes imaginary and the KAW transforms into a purely growing mode (aperiodic instability). Both instabilities can develop in the same current sheet simultaneously but in different regions: aperiodic instability at the flanks of the current sheet where the current shear maximizes, and the kinetic instability shifted towards current sheet center, where the current density is higher. The anomalous resistivity generated by the near-threshold regime of the inhomogeneous CDI of KAWs is capable of supporting a fast (Petschek) magnetic reconnection. The corresponding current sheet width is about 20 gyroradii, which is 3 times thicker then in the case of homogenous CDI. It seems that the interplay of kinetic and purely growing KAW instabilities can make magnetic reconnection intrinsically intermittent. Possible implications of our results are discussed in the context of magnetic reconnection at the Earth’s magnetopause and in the solar corona.