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Drift-Alfven Instabilities and Turbulence of Magnetic Field Aligned Shear Flows

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Numerous experimental observations from number of tokamaks and stellarators have found large nearly sonic magnetic field aligned (parallel) shear flows that are peaked at the last closed flux surfaces and extend for a few centimeters into the plasma and into the far SOL. The important consequence is that these plasma regions are unstable in the presence of shear flows. The shear flows along the magnetic field are the additional sources of free energy for the modification of the instabilities, existing in shearless plasma flows, as well as for the development of specific shear flow driven (SFD) instabilities, which are absent in the shearless plasma. It was reported recently, that in plasmas with ion temperature equal to or even higher than the electron temperature, that is the case relevant to tokamak plasma, the Kelvin-Helmholtz (or D'Angelo) driving mechanism of the excitation the hydrodynamic instabilities changes onto the combined effect of the velocity shear and ion Landau damping. It results in the development of a new set of the ion-kinetic SFD instabilities, which distinguish by strong interaction of waves with thermal ions. This is a striking difference between the instabilities of the parallel shear flows and the shearless plasma, where the ion Landau damping is, as a rule, a process that suppresses the development of the drift instabilities. It was found, that in the parallel shear flow of plasmas with comparable ion and electron temperatures two distinct drift–Alfven instabilities(DAI) may be developed: the shear flow modified DAI, which develops due to the inverse electron Landau damping and exists in the shearless plasma as well, and the SFD DAI, which develops due to the combined effect of the velocity shear and ion Landau damping and is absent in the shearless plasma flows. In this report, we present the results of the investigation of the nonlinear saturation of both these instabilities and the processes of the anomalous heating and transport of ions. The results of the analytical and numerical investigations of the SFD DAI and corresponding turbulence of the shear flow with inhomogeneous ion temperature, which develops due to the coupled reinforcing action of parallel flow shear, ion temperature gradient and ion Landau damping, will be given.

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