ASYMPTOTIC DESCRIPTION OF PLASMA TURBULENCE: KRYLOV – BOHOLIUBOV METHODS AND QUASI-PARTICLES

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The asymptotic theory of charged particle motion in electromagnetic fields is developed for the general case of finite Larmor-radius effects by means of Krylov-Boholiubov averaging method. The correspondence between the general asymptotic methods, elaborated by M. Krylov and M. Boholiubov, the quasi-particle description and gyrokinetics is established. Such a comparison is used to shed more light on the physical sense of the reduced Poisson equation, introduced in gyrokinetics, and the particle polarization drift. It is shown that the modification of the Poisson equation in the asymptotic theory is due to the non-conservation of the magnetic moment and gyrophase tremblings. It is shown that the second-order modification of the adiabatic invariant can determine the conditions of global plasma stability and introduces new nonlinear terms into the reduced Poisson equation. Such a modification is important for several plasma orderings, e.g. MHD type ordering. The feasability of numerical simulation schemes in which the polarization drift is included into the quasi-particle equations of motion, and the Poisson equation remains unchanged is analyzed. A consistent asymptotic model is proposed in which the polarization drift is included into the quasi-particle equations of motion and the particle and quasi-particle velocities are equal. It is shown that in such models there are additional modifications of the reduced Poisson equation. The latter becomes even more complicated in contrast to earlier suggestions.