Effect of strong poloidal modulation of anisotropic plasma pressure on the Shafranov shift in tokamaks

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The task is related to the problem of the pressure anisotropy effect on the plasma equilibrium in tokamaks. Essential anisotropy is observed in tokamaks and stellarators at intensive additional heating by Neutral Beam Injection or Ion/Electron Cyclotron Resonance Heating, see, for example, [1–3]. Preliminary calculations show that it can appear in the T-15 tokamak [4] at full-scale heating. Strongly anisotropic plasma is expected in ITER [5].

We focus on the dependence of the Shafranov shift $\Delta$ on the poloidal modulation of $p_\parallel$ and $p_\perp$ (the plasma pressures along and perpendicular to the magnetic field). The plasma equilibrium is modelled with the multimodule code SPIDER [6] modified for anisotropic pressure with its parameterization proposed in [7, 8]. Our calculations confirm that $\Delta$ is mainly determined by $(\beta_\parallel + \beta_\perp)$ as it is predicted by the classical theory of plasma equilibrium [9] developed for pressures with weak poloidal dependence, where $\beta$ is the ratio of the plasma pressure to the magnetic field pressure. At the same time they show that at given $(\beta_\parallel + \beta_\perp)$ the shift also depends on the poloidal modulation of $p_\perp$. The Shafranov shift is larger when the maximum of $p_\perp$ is located in low-field side and smaller in the opposite case. This is a new result compared to predictions of [9].

We quantify it. The relations between the numerical results and analytical theory is discussed. The recommendations to the practical applications are given.