Effects of MHD-activity-induced low-*n* error magnetic fields on the neoclassical viscosities in helical plasmas

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Neoclassical analyses in helical plasmas often assume the toroidally periodic magnetic field strength of $B=\sum_{mn} B_{mn}\cos(m\theta-nN\zeta)$, where N is the toroidal period number, and thus effects of the low-*n* error magnetic fields in more general B expression $B=\sum_{mn} B_{mn}\cos(m\theta-n\zeta)$ had not been investigated. However, in recent tokamak studies [1-3], this kind of low-*n* error magnetic field component induced by MHD-activities is considered to be important since it causes various additional neoclassical effects relating to the rotational stabilization of the resistive wall mode and island physics. The toroidal viscosity caused by additional bounce-averaged bounce center motions has been mainly investigated in these studies in tokamaks. When the low-*n* modes exist in helical and stellarator configurations, it affects not only on the toroidally trapped particles but also on the ripple-trapped ones. Although these effects are already covered by a recently proposed basic framework for the neoclassical transport in general non-symmetric toroidal plasmas [4], the “full torus” calculation including the low-*n* modes will be huge if we adopt the numerical procedures (such as variational methods and Monte Carlo methods) described in Ref.[4]. Practically usable methods to obtain the viscosity coefficients have still remained as future theme. Even in our previous study deriving and testing various analytically approximated formulas [5], the bounce-averaged effects due to the low-*n* modes are not included. Therefore we recently started to study an extension of the analytical approximation methods for the drift kinetic equation in helical and stellarator configurations to include these additional drift effects [6]. In this presentation, we investigate the two types of trapped particles’ drifts (toroidally trapped and ripple trapped) by using both of the numerical [4] and the analytical [5-6] methods. This understanding for the trapped particles’ dynamics will be useful not only for studies of mean flows [1-3] but also for studies investigating a relation of the neoclassical transport with the zonal flow [7-8].

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