Abstract for an Invited Paper
for the DPP08 Meeting of
The American Physical Society

Finite drift orbit effects in a tokamak pedestal[1]

GRIGORY KAGAN, Mass. Inst. of Technology

Experiments show that the pedestal width is typically of the order of the poloidal gyroradius. Therefore, an analytic pedestal model should treat physics on this scale. It is also desirable to include finite Larmor radius (FLR) effects. To keep these features we develop a special version of gyrokinetics that employs canonical angular momentum as one of the variables. This technique encompasses both of the preceding scales in an uncoupled manner. In particular, it allows considering the limit in which FLR effects are neglected, while neoclassical and zonal flow phenomena are retained. Using our gyrokinetic equation in this limit we find that the background ion temperature profile cannot vary on the scale of the poloidal gyroradius. Pressure balance analysis in the pedestal for subsonic ion flow then yields that the ions in the pedestal are predominately electrostatically confined, giving a strong pedestal radial electric field consistent with recent C-Mod measurements. As a result, particle trajectories in the pedestal are very different from those in the core and zonal flow and neoclassical phenomena are altered. Therefore, we are led to consider single particle motion in a tokamak in the presence of a strong radial electric field and its impact on collisionless zonal flow in pedestal. For instance, we find that due to large ExB, the neoclassical polarization response of trapped particles is different from that in the Rosenbluth-Hinton (RH) case. To treat this problem kinetically our version of gyrokinetics turns out to be convenient. Using it we obtain an analytical expression for the zonal flow response. Interestingly, our analysis predicts a spatial phase shift in the residual relating the final and initial electrostatic potential level of the zonal flow - an effect absent in the RH case.

[1]Work supported by U.S. DoE