Abstract for an Invited Paper
for the DPP06 Meeting of
The American Physical Society

**Effects of finite poloidal gyroradius, shaping, and collisions on the zonal flow residual**[1]

YONG XIAO, MIT Plasma Science and Fusion Center, Cambridge, MA 02139, USA

Sheared zonal flow is known to be the predominant saturation mechanism of plasma turbulence. Rosenbluth and Hinton[2] (R-H) have shown that the zonal flow level is inversely proportional to the plasma radial polarizability due to magnetic drift departure from a flux surface. In another calculation, Hinton and Rosenbluth[3] (H-R) considered the weakly collisional case in the banana regime and calculated the neoclassical polarization and associated zonal flow damping in the high and low collisionality limits. The work presented here extends R-H's calculation in several aspects. The neoclassical polarization for arbitrary radial wavelength zonal flows is evaluated with finite ion banana width and ion gyroradius retained. Plasma shaping effects are retained in the R-H collisionless calculation. Elongation is shown to strongly reduce the neoclassical polarization and thereby strongly increase the zonal flow residual, while the Shafranov shift and triangularity result in a more moderate increase in the zonal flow level. In addition, the H-R collisional calculation is extended by using an exact eigenfunction expansion of the collision operator to calculate the neoclassical polarization for the entire range of collisionality. A simple, semi-analytical fit of these exact results based on the lowest eigenfunction gives the polarization to within 15% and allows the collisional zonal flow damping rate to be evaluated for arbitrary collisionality.

[1]In collaboration with Peter J. Catto, MIT Plasma Science and Fusion Center, Cambridge, MA 02139, USA.
[2]M.N. Rosenbluth and F.L. Hinton, Phys. Rev. Lett., 80, 724 (1998)
[3]F.L. Hinton and M.N. Rosenbluth, Plasma Phys. Control. Fusion, 41, A653 (1999)Work supported by U.S. DoE