Quasi-omnigenous tokamak equilibria with fast poloidal flow

B. Hu, L. Guazzotto and R. Betti

University of Rochester and Laboratory for Laser Energetics,
Rochester, NY 14623

Abstract

Macroscopic plasma flow plays an important role in the equilibrium and stability of tokamak plasmas. While fast toroidal flow is routinely generated by neutral beam injections, fast poloidal flow may be difficult to drive because of the inherently large poloidal viscosity of standard tokamak plasmas. The viscous damping is caused by the so-called magnetic pumping due to the variation of the magnetic field strength along the flux surfaces. The poloidal flow damping can be greatly reduced in omnigenous equilibria where the magnetic field strength is approximately constant over the flux surfaces. In the case of tokamak plasmas, such equilibria usually develop for high values of beta (of order unity). High beta equilibria have so far only been investigated in static plasmas where they develop a configuration with magnetic surfaces squeezed against the outboard edge.[1] In the present work, we take advantage of the capabilities of the recently developed equilibrium code FLOW [2] in order to investigate the possibility of generating omnigenous equilibria with fast poloidal flow. Because of the reduced damping, such equilibria should be able to sustain poloidal flow. Two questions arise when fast poloidal flow is introduced: Do omnigenous equilibria still exist? And if so, how do they look like? Using the code FLOW, we were able to derive quasi-omnigenous equilibria with flow velocities greatly exceeding the poloidal Alfvén speed. Interestingly, such equilibria are very different from the static ones since their flux surfaces are squeezed against the inboard edge of the plasma. The inboard shift is induced by the large dynamic forces that far exceed the pressure forces. Possible applications of such equilibria to the Electric Tokamak (ET) [3] are presented and discussed. This work was supported by the US-DOE under contract No. DE-FG02-93ER54215.

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