Influence of Toroidicity on Reversed Field Pinch Dynamics

W.J.T. Bos\textsuperscript{1}, J.A. Morales\textsuperscript{2}, K. Schneider\textsuperscript{3} and D.C. Montgomery\textsuperscript{4}

\textsuperscript{1}LMFA, CNRS, École Centrale de Lyon, France
\textsuperscript{2}CEA / IRFM, Cadarache, Saint-Paul-Lez-Durance, France
\textsuperscript{3}M2P2, CMI, CNRS, Aix-Marseille Université, France
\textsuperscript{4}Department of Physics and Astronomy, Dartmouth College, NH, USA

The Reversed Field Pinch (RFP) possesses the technical advantage that the imposed toroidal magnetic field needs not to be as large as for a tokamak. However, it was shown that RFP devices are plagued by magnetohydrodynamic (MHD) instabilities, leading to a turbulent state which degrades the confinement quality. However, in the last two decades quasi-single helicity (QSH) states were observed in RFP experiments, where the full turbulent regime is avoided and one helical mode predominates [1, 2, 3, 4]. In the QSH state there is a decrease of magnetic chaos and the formation of a coherent helical structure within the plasma. This helical state has been found in simulations in straight cylinders \textit{e.g.} [5].

In this study we investigate the influence of the curvature of the magnetic field on the RFP dynamics by comparing two distinct geometries: a torus with a periodic cylinder. It is found that an axisymmetric toroidal mode is always present in the toroidal, but absent in the cylindrical configuration. In particular, in contrast to the cylinder, the toroidal case presents a double poloidal recirculation cell with a shear localized at the plasma edge. Quasi-single-helicity states are found to be more persistent in toroidal geometry than in periodic cylinder. Also quantitatively, better agreement in the decrease of the magnetic toroidal field at the edge, as a function of the pinch parameter is observed for the toroidal geometry simulations rather than for the straight cylinder case.

References