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Magnetic Islands in Plasmas[1]

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Tearing modes are ubiquitous plasma instabilities whose final nonlinear stage involves the disruption of magnetic flux surfaces via the formation of magnetic islands. Over the years, a great deal of research has been performed on this subject within the magnetic fusion community, because an understanding of the dynamics of narrow magnetic islands is key to predicting under what circumstances such islands grow wide enough to adversely affect plasma confinement. The dynamics of magnetic islands which are sufficiently wide is well described by the celebrated single-fluid MHD theory of Rutherford. According to this theory, a magnetic island is essentially a three-dimensional plasma equilibrium which locally flattens the plasma pressure and grows on a resistive time-scale. Moreover, all of the free energy available to drive this growth comes from regions of the plasma well away from the island. On the other hand, the dynamics of a narrow magnetic island is influenced by a whole host of two fluid non-MHD effects. Some of these effects can prevent the complete flattening of the pressure profile across the island. Others lead to local sources of free energy which may greatly modify the island growth. This talk will describe the continuing efforts of plasma theorists to understand these effects, and hence to develop a fully comprehensive theory of magnetic island dynamics.

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