MAGNETIC RECONNECTION IN SPACE AND LABORATORY PLASMAS AND ITS IMPLICATION IN TOKAMAK PLASMA CONFINEMENT

Chase Johnson

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Abstract

Magnetic reconnection is the topological restructuring of magnetic field lines in high temperature plasmas. The aim of this paper will be to describe the fundamental physics of magnetic reconnection and discuss the various MHD models to describe magnetic reconnection. Magnetic reconnection as observed in both space plasmas and laboratory plasmas results in significant changes in kinetic and thermal properties of the plasma. This inherently deteriorates the ability to confine plasma in the laboratory. The second part of this paper will describe the fundamentals of sawtooth instabilities triggering magnetic reconnection in tokamak plasma devices. Due to the undesirable effects of magnetic reconnection in laboratory plasmas, several techniques have been developed to control sawtooth instabilities. The efficacy of these techniques to include current drive schemes and ion population control will be discussed.

1 Reconnection Defined

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1.1 What is Reconnection

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1.2 Where Does Reconnection Occur

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1.3 Why is Reconnection Bad

2 References

1. Aymar, R. *et al* "The ITER design" 2001 *Plasma Phys. Control Fusion* **44** 519.

2. Chapman, I. T. "Controlling sawtooth oscillations in tokamak plasmas" 2011 *Plasma Phys. Control Fusion* **53** 1.

3. Chapman, I. T. *et al* "Magnetic Reconnection Triggering Magnetohydrodynamic Instabilities during a Sawtooth Crash in a Tokamak Plasma" 2010 *Phys. Rev. Lett.* **105** 255002.

4. Chapman, I. T. *et al* "The physics of sawtooth stabilization" 2007 *Plasma Phys. Control Fusion* **49** 12B.

5. Fridman, Alexander and Lawrence A. Kennedy, Plasma Physics and Engineering, Taylor and Francis Books, Inc., 2004.

6. Harry, John Earnest, Introduction to Plasma Technology, Wiley-VCH, 2010.

7. Hastie, R. J. "Sawtooth Instability in Tokamak Plasmas" 1998 *Astrophysics and Space Science* **256** 177-204.

8. Priest, Eric, Magnetohydrodynamics of the Sun, Cambridge University Press, 2014.

9. Wagner, F. "A quarter-century of H-mode studies" 2007 *Plasma Phys. Control. Fusion* **49** B12.

10. Wagner, F. "The Physics Basis of ITER Confinement" 2009 *AIP Conf. Proc.* **1095** 31.

11. Yamada, Masaaki *et al* "Investigation of magnetic reconnection during a sawtooth crash in a hightemperature tokamak plasma" 1994 *Phys. Plasmas* **1** 3269.

12. Yamada, Masaaki *et al* "Magnetic Reconnection" 2010 *Rev. Mod. Phys.* **82** 603.

13. Yun, G. S. *et al* "Appearance and Dynamics of Helical Flux Tubes under Electron Cyclotron Resonance Heating in the Core of KSTAR Plasmas" 2012 *Phys. Rev. Lett.* **109** 145003.