Advanced Magnetohydrodynamics of Laboratory and Astrophysical Plasmas

Prof. Dr. J.P. (Hans) Goedbloed

FOM-Institute for Plasma Physics 'Rijnhuizen', Nieuwegein
& Astronomy Department, Utrecht University, the Netherlands

e-mail: goedbloed@rijnh.nl

The two large application domains of plasma physics, research of laboratory plasmas (nuclear fusion) and of astrophysical plasmas (Sun, magnetospheres, stellar coronae, pulsars, accretion disks, etc.), may be described from the single point of view of magnetohydrodynamics (MHD). This yields effective methods and insights for the interpretation of plasma phenomena on all scales, from the laboratory to the Universe. It equips the student with the necessary tools to understand the complexities of plasma dynamics in the extended magnetic structures that are encountered everywhere.

This subject is taught in a course of 2 x 2 hour lectures every week at Departamento de Astronomia, Universidade de São Paulo, from 5 March to 31 May 2007 for advanced undergraduate and graduate students of physics and astronomy. The detailed contents of the lectures are appended.

The first part of the lectures is based on the textbook ***Principles of Magnetohydrodynamics, with applications to Laboratory and Astrophysical Plasmas*** (Volume 1) by J.P. Goedbloed and S. Poedts (Cambridge University Press, 2004), and the second part on the textbook ***Advanced Magnetohydrodynamic, with applications to Laboratory and Astrophysical Plasmass*** (Volume 2) that is being written at present. Notes, prepared in collaboration with Rony Keppens, are available electronically (pdf files on ftp://ftp.astro.iag.usp.br/pub/goedbloed/ and www.rijnh.nl/users/goedbloed)

Contents of the MHD lectures (pdf files in brackets)**:**

(1) Introduction (Vol. 1: MHD1/2/4/5.pdf)

-- Summary of basic plasma models
-- Scale independence: single view point for laboratory and astrophysical plasmas
-- Conservation laws: large-scale dynamics governed by magnetic flux

(2) Spectral Theory of Magnetohydrodynamics (Vol. 1: MHD6/7)

-- Force operator and energy: analogy with quantum mechanics
-- Waves and instabilities in inhomogeneous plasmas, singularities
-- Application to gravitational instabilities

(3) Magnetic Structures and Dynamics (Vol. 1: MHD8.pdf)

-- Solar magnetism: dynamo and coronal flux tubes
-- Planetary magnetospheres and stellar winds
-- Accretion disks and jets

(4) Flowing Plasmas (Vol. 2: MHDF.pdf)

-- Waves and spectra of stationary plasmas
-- Instabilities of plasmas with shear flow
-- Instabilities of rotating plasmas

(5) Resistive Plasmas (Vol. 2: MHDR.pdf)

-- Resistive instabilities
-- Reconnection
-- Extended MHD

(6) Toroidal Plasmas (Vol. 2: MHDT.pdf)

-- Axisymmetric equilibrium
-- Instabilities of toroidal systems, ballooning modes
-- MHD spectroscopy of tokamaks

(7) Transonic MHD flows (Vol. 2: MHDS.pdf)

-- Stationary MHD flows
-- Shocks
-- Perspectives