TIME TABLE

Registration on Monday at 8.30

TIME	Monday June 11	Tuesday June 12	Wednesday June 13	Thursday June 14	Friday June 15
9.00 - 9.45	Hillier	Hillier	Hillier	Yeates	Khomenko
9.45 - 10.30	Hillier	Hillier	Hillier	Yeates	Khomenko
11.00 - 11.45	MacTaggart	MacTaggart	MacTaggart	Pariat	Yokoi
11.45 - 12.30	MacTaggart	MacTaggart	MacTaggart	Pariat	Yokoi
14.00 - 14.45	Yeates	Yeates	Khomenko	Khomenko	
14.45 - 15.30	Yeates	Yeates	Khomenko	Khomenko	
16.00 - 16.45	Pariat	Pariat	Yokoi	Yokoi	
16.45 - 17.30	Pariat	Pariat	Yokoi	Yokoi	
18.00	Welcome Aperitif				

ADMISSION AND ACCOMMODATION

The registration fee is 600.00 Euro + VAT*, where applicable (bank charges are not included). The registration fee includes a complimentary bag, four fixed menu buffet lunches (on Friday upon request), hot beverages, downloadable lecture notes and wi-fi internet access.

Applicants must apply at least one month before the beginning of the course. Application forms should be sent on-line through the following web site: http://www.cism.it. A message of confirmation will be sent to accepted participants. Applicants requiring assistance with the registration should contact the secretariat at the following email address cism@cism.it.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email to cism@cism.it) no later than two weeks prior to the start of the course.

Cancellation requests received during the two weeks prior to the start of the course will be charged a 50.00 Euro handling fee. Incorrect payments are also subject to a 50.00 Euro handling fee.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered lodging and/or board, if available, in a reasonably priced hotel or student guest house.

Requests should be sent to CISM Secretariat by **April 11, 2018** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on the web site www.cism.it, or can be mailed upon request.

* Italian VAT is 22%.

For further information please contact:
CISM
Palazzo del Torso
Piazza Garibaldi 18
33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
fax +39 0432 248550
e-mail: cism@cism.it

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

ACADEMIC YEAR 2018
The Cowin Session

CISM

ADVANCED TOPICS IN MHD

Advanced School
coordinated by

Andrew Hillier
University of Exeter
UK

David MacTaggart
University of Glasgow
UK

Udine *June 11 - 15* 2018

ADVANCED TOPICS IN MHD

Magnetohydrodynamics (MHD) is a union of fluid mechanics and electromagnetism and describes the macroscopic interaction of electrically conducting fluids and magnetic fields. Since its initial development in the 1930s, MHD has blossomed into a major area of fluid mechanics, with applications ranging from industry to astrophysics. The original development of MHD lay mainly in dynamo theory, which describes how fluid motions within stars and planets can act to generate and sustain a global magnetic field. Later, MHD became popular in the fusion community as the language that could describe the stability of magnetic fields containing plasma.

MHD continues to grow and is an area of intensive research. In recent times, the phenomenon of 'space weather' has drawn much attention as solar storms that hit the Earth can have a major technological and economic impact. In order to understand the origin of space weather, we need to study the formation and eruption of storms on the Sun. To model the large-scale mechanics of solar storms, we require MHD. In particular, three key areas of MHD are important for the formation of solar storms: MHD stability theory, magnetic topology and magnetic reconnection. These three fields are active areas of research and have each already undergone significant development.

Often, these three topics are treated separately. However, for many applications, including the formation and eruption of solar storms in space weather, the three topics are inseparable. The application of these three topics is not only restricted to space weather but is also becoming essential in understanding plasma physics experiments, tokamaks and spheromaks, and many astrophysical applications. The purpose of this school is to focus on the above three areas and present a unified view, revealing how they connect intimately with each other and the role they play in space weather, astrophysical systems and plasma experiments. We shall go beyond the standard theory, as commonly found in textbooks and undergraduate and postgraduate courses.

The lectures will describe many recent developments. For MHD stability theory, classical theory will be reviewed and new mathematics required for important extensions of this theory will be developed. Models of plasmas which require physics that goes beyond standard MHD will be discussed. Magnetic topology will be presented from both theoretical and applied standpoints. The modelling of magnetic reconnection, with connections to helicity and turbulence, will be described. Throughout the school, the links between all the above topics will be emphasized and demonstrated.

This school would be ideal for PhD students and postdoctoral researchers working in MHD, both in astrophysical and experimental applications. The lectures would give students not only valuable information but an appreciation of how the various disciplines described above, which they may have encountered separately, fit together to give a more accurate picture of the evolution of magnetic fields in electrically conducting fluids and plasmas.

PRELIMINARY SUGGESTED READINGS

Goedbloed, J.P., Poedts, S., Principles of Magnetohydrodynamics, CUP (2004).

Schindler, K., Physics of Space Plasma Activity, CUP (2007).

Taylor, J.B., Relaxation revisited, Phys. Plasmas, 7, p1623 (2000).

Valori, G. et al., Space Science Reviews, 201, Issue 1-4, pp. 147-200 (2016).

Ballester, J. et al., Partially Ionized Plasmas in Astrophysics, submitted to Space Science Reviews (2017).

Yoshizawa, A. et al., Turbulence theories and modelling of fluids and plasmas, Plasma Physics and Controlled Fusion, 43, pp. R1-R144 (2001).

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from the CISM web site. Instructions will be sent to accepted

INVITED LECTURERS

David MacTaggart - University of Glasgow, UK
6 lectures on: Resistive MHD instabilities. We illustrate non-normal aspects of the resistive tearing instability and the development of mathematics necessary to describe non-normal systems in laboratory and astrophysical MHD. We shall calculate the transient growth due to non-normal effects and discuss the implications for the onset of the tearing instability.

Andrew Hillier - University of Exeter, UK
6 lectures on: Ideal MHD instabilities using normal mode analysis and energy methods. In particular, the magnetic Rayleigh-Taylor and Kelvin-Helmholtz instabilities will be studied, discussing the effects and implications of the inclusion of a magnetic field.

Elena Khomenko - Instituto de Astrofisica de Canarias, Spain
6 lectures on: Multi-fluid extensions of MHD and their implications on waves and instabilities. The lectures will focus on the effect of 'extra physics' that goes beyond standard MHD and is required for the study of many astrophysical and industrial plasmas.

Anthony Yeates - Durham University, UK
6 lectures on: MHD relaxation theory. Lectures will develop the theory of the various forms of magnetic helicity, and in particular how they evolve in both ideal and non-ideal MHD. The use of magnetic helicity as a guide for MHD relaxation will then be discussed, giving both a theoretical treatment and examples of applications from both astrophysics and plasma physics experiments.

Etienne Pariat - LESIA, Observatoire de Paris, CNRS, Paris, France
6 lectures on: The topological and geometrical analysis of magnetic field models. The lectures will focus on how to calculate global magnetic helicity in simulations and use geometric techniques, such as quasi-separatrix layers, to better understand complicated magnetic fields models. Applications for the use of these analysis techniques in space weather and plasma laboratory experiments will be given.

Nobumitsu Yokoi - University of Tokyo, Japan
6 lectures on: Turbulent magnetic reconnection. After outlining the theories of inhomogeneous MHD turbulence, the lectures will discuss the turbulent development of reconnection, the role played by helicity in this process and implications for modelling reconnection in simulations.