Advanced Fluid Dynamics and Applications

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Overview

In the modern global aspects of science and technology, understanding the advanced concepts and application about the physical behaviour of various fluids (non-magnetized and magnetized) is at frontline. The basics of fluids and their analyses are significant for the engineering applications, while their advanced concepts establish a vital bridge to research and developments in science and technology. There are several branches of engineering (e.g., civil, mechanical, electrical/electronics, chemical, aviation, space engineering, plasma and fusion technology, industrial applications etc.) as well as science (e.g., atmospheric, geo- & space science, high-energy physics, chemical and biological sciences, applied mathematics) where knowledge of basics and advanced fluid mechanics is important. Recently, there is high requirements of the experts having the basic training of analytical & computational fluid dynamics in the above mentioned fields. Therefore we propose a course entitled "Advanced Fluid Dynamics and Applications", which will consists of the understanding of various fluids and their analyses both at microscopic and macroscopic levels, and their applications to science and engineering.

Modules	**Advanced Fluid Dynamics and Applications : September 12 – September 22, 2016** **Number of participants for the course will be limited to fifty (50).**
You Should Attend If…	▪ Student from B.Tech/IMD/IDD (Civil, Mechanical, Electronics, Electrical, Chemical Engineering; Engineering Physics); as well as Ph.D students pursuing the research in Space Science at IIT (BHU). ▪ Master of Science (M. Sc.) from Universities/Colleges ▪ Faculty from different reputed academic and technical institutions of India.
Fees	The participation fees for taking the course is as follows: **Registration Fee for the Students from Academic Institution :** 2500/-Rs (Two Thousand Five Hundred Rupees) The fee includes all instruction materials in hard-print, computer access time and internet, CD/DVD's of the lecture and course material. **Outside participants will be provided with accommodation (based on availability) and food on payment basis. Alternatively, the participants need to arrange their accommodation and daily expanses (food, living etc) on their own.**

The Faculty

Prof. Robertus von Fay-Siebenburgen (a.k.a Robertus Erdelyi, as publishing) is working as a professor and head of Solar Physics and Space Plasma Research Centre in School of Mathematics and Statistics, University of Sheffield, UK. He is also the Director of Debrecen Observatory in Hungary. His expertise lie in the general field of space plasma physics. The heating processes that generate and sustain the observed high temperature of the solar and stellar atmospheres have so far defied a quantitative understanding despite the multitude of efforts spanning over half a century. The aim of his research is to address these questions through theoretical (both numerical and exact analytical methods) and observational studies (joint ground-based and satellite missions). Particular attention is paid to the solar influence on the magnetosphere and Space Weather. Understanding the subtleties of plasma confinement at high temperatures is also strongly linked to modern fusion physics. His interdisciplinary research (including e.g. magnetohydrodynamics [MHD], computational fluid dynamics [CFD], kinetic theory) has direct applications in the new and rapidly emerging discipline of helioseismology and Space Weather, as well as basic teaching to engineering and science students .

Prof. Erdelyi has a wide expertise in teaching and research of space science, plasma physics, magetohydrodynamic (MHD) waves, fluid dynamics, analytical & computational techniques. He is one of the world leaders in the field of solar & space plasma research (Citations > 5400, H-Index- 41) with an outstanding track record of publications in

Course Co-coordinator

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peer-reviewed journals (e.g., 02 Nature, 02 Science, 01 Nature Communication, and numerous papers in ApJ, A&A, Solar Physics, MNRAS, Space Science Reviews: The top-most journals in Astronomy and Astrophysics). His expertise and collaboration could be very significant in adding-up to the Departments' academics both in teaching and research. He has been the part of similar types of programme in the Nanjing University, China; Univ of Balears, Mallorca, Spain; IAC, Tenerife, Spain; Eotvos University Budapest, Hungary, to name a few, where He visited and delivered series of lectures. The interaction with China resulted not only in research projects, but also contributed significantly to a new solar mission where he is the chief scientific advisor. He is also the scientific advisor in various Indian national projects, e.g., NLST, MAST etc, therefore, has a significant role in Indian Solar Physics. Moreover, SP2RG member Dr. A.K. Srivastava of the Department of Physics, IIT (BHU) has long track-record of joint collaboration with Prof R. Erdelyi. Therefore the proposed tachign collaboration will also support and strengthen the cutting-edge research in "Solar & Space Plasma Physics".

Dr. A.K. Srivastava is an Assistant Professor in Department of Physics, IIT (BHU) Varanasi, Varanasi, India. He has approximately 9 years of research experience in the field of Solar and Space Plasma Physics. His research mainly focus on understanding the magnetohydrodynamic (MHD) waves and transients in the atmosphere of our nearest star Sun, as well as Space Weather candidates. He does pursue the latest space borne and ground based solar observations and modeling in his research. He has excellent track-record in his early career scientific research in the field of Solar Physics. He has published approximately 46 research papers in various international peer-reviewed journals of high repute (Impact Factor > 4.0) on timely scientific themes in his area of research. His early career citation is ~796 with H-index of '16' (as per Google Scholar). He has wide experience in running international (e.g., Indo-Russian, Indo-US, Indo-Bulgarian, Indo-Austrian, Royal Society International Exchange Scheme, Polish National Science Foundation etc.) and national (e.g., SERB-DST Young Scientist; RESPOND-ISRO) projects. He is also the part of Science Teams of Aditya/SUIT, Aditya/Space Coronagraph. He is a member of International Astronomical Union (IAU), Astronomical Society of India (ASI), and elected as a Fellow of Royal Astronomical Society (FRAS).

Objectives :

The major objectives of this course are as follows :

[1] Delivery of the basic concepts of fluid dynamics and their analyses;

[2] Establish the advanced concepts of fluids at both micro- & macro-scopic levels;

[3] Demostrate applications to science and engineering;

[4] Gear towards research and development in science and engineering;

[5] Flavours to analytical and computational techniques in fluid dynamics.

Course details:

Maximum Lectures : ~30 (Theory and Assignments)

Contact Hours : 03 Hours/ 01 Day (Time will be allotted after the registration of the participants).

Maximum Duration : 10 Days

Course-Credit : 02

Host : Department of Physics, Indian Institute of Technology (BHU) Varanasi-221005, India.

Local Contact Person and Collaborator (Host) : Dr. A.K. Srivastava, Assistant Professor, Department of Physics, IIT (BHU).

Syllabus of the Proposed Course :

Continuum Fluids; Mass conservation and continuity equation; Navier-Stokes equations & forces; Steady and transient flows; Vorticity and rotation; Laminar flows; Flow through pipe; boundary layers, characteristics; Momentum thickness, Flow with circular shape, Couette flow, Spherical polar co-ords, flow past a sphere, Reynolds Number; Vorticity equation and the role of irrotational flow, Burgers Vortex, Vortex lines; The Blasius solution, the von Karman-Pohlhausen method simple applications.

[06 Lectures; First 02 Days]

Classification of PDEs. Wave equation. Waves on strings. D'Alembert solution. Standing and propagating waves. Normal modes.Use of Fourier series for solving one-dimensional wave problems. Sound waves. Plane, cylindrical and spherical sound waves. Water waves. Wave dispersion. Group velocity. Traffic waves introducing the method of characteristics

. **[09 Lectures; 03 Days]**

Magnetized fluid as a plasma; Debye length and plasma oscillations; Magnetohydrodynamic equations; Magnetohydrostatics; Induction equation; Magnetic Reynolds number; Plasma beta; transport coneffieicnts in presence of magnetic field; Magnetic reconnection; MHD waves; shock waves; instabilities; Characteristics in MHD

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Introduction to essential analytical and numerical methods to model the HD/MHD systems.

[06 Lectures; Last 02 Days]

After Introducing all the basic concepts in novel ways, the we will be devoting on soving some excercises, problems, and introduction to applications/computations.

Further Details:

The course will be conducted at IIT (BHU) Varanasi, Varanasi, UP, India. The course will start on **September 12, 2016** (Monday) and will be held over 10 working days till September 22, 2016. This will be executed at the Department of the Physics http://www.iitbhu.ac.in/app/ of the institute.

An Image of IIT (BHU)

About Varanasi

Varanasi is one of the oldest continuously inhabited cities of the world. The city is situated at the bank of river Ganges, and well known for its rich cultural heritage and vibrant life style. This is also one of the top education centers in India having various reputed academic institutions and universities, e.g., Banaras Hindu University (BHU), Indian Institute of Technology (BHU) Varanasi, etc. The following websites can be useful in obtaining detailed information about Varanasi :

[1] Tourism Guide Varanasi : http://www.tourismguideindia.com/varanasi-(banaras).htm

[2] Uttar Pradesh Tourism : http://uptourism.gov.in/

[3] Varanasi Official Website : http://www.varanasi4u.com/touristoffice.htm

[4] Varanasi Official Website : http://varanasi.nic.in/

[5] Important Tourist Information : http://varanasi.nic.in/tourist/tourist3.html

Connections :

Varanasi is connected well by road, rail and air route with all the important cities of India. Regular flights are available from Varanasi to Delhi, Mumbai, Chennai, Bangalore, Kolkata, Khajuraho and Lucknow, as well as to some foreign countries, e.g., Thailand. The IIT (BHU) campus is ~10 Km from Varanasi Cant, ~20 km from Mughalsarai railway station, and ~35 Km from the airport.