Imperial College London

Module Outline

Space Physics

Module Code	PHYS97093	FHEQ Level	Level 7
Pre-requisites	Fluid Dynamics (Plasma Physics)	Co-requisites	None
Primary Department	Physics		
Module Leader	Dr Marina Galand		
Additional Teaching Departments	None		
Teaching Staff	Dr Marina Galand + Course Associate		

Programmes on which the Module is delivered	Core/Elective
All UG Physics programmes (F300, F303, F309, F325, F390, F3W3)	Elective

Learning Outcomes	On completing the Space Physics course, students will be expected to be able to: • Classify the main domains where space physics applies and enumerate their properties, • Describe and apply the relevant key physical theories (particularly from plasma physics) that control the properties of different space plasmas and plasma phenomena, • Calculate the quantitative behaviour of different space physics phenomena using plasma physics analysis methods, • Demonstrate an understanding of how space physics has a practical impact on everyday life in the field of space weather, • Identify ways in which experimental studies of space physics phenomena have advanced our understanding of basic plasma physics.
Description of Content	Space physics is the pursuit of knowledge relating to: the Sun; solar wind and the material that fills interplanetary space; the properties and behaviour of astronomical bodies ranging from large planets to tiny comets; and the way in which these bodies interact with the solar wind. **Space physics thus focusses on developing theories and models to explain the physical processes that control objects, material and phenomena in space.** This course will introduce you to space physics, and some of its underpinning processes and phenomena. We will mainly stay inside the solar system, examining what governs the flow of energy and material from the Sun through the solar system and to its various constituent bodies. In doing this we will explore and explain various natural phenomena, such as the aurora, solar flares, the solar wind, the radiation belts, and also explore interesting questions, such as “Why is the Sun generating explosive events?”, “Why is the solar wind supersonic?” or “Why does Jupiter produce so many energetic particles?”. Space physics is a very active area of research, and illustration from recent results from cutting-edge research will be provided, while all the theory (primarily MHD) will be presented on blackboard.

	What does space physics involve? Space physics involves using a mix of plasma physics, fluid mechanics, thermodynamics, and electricity and magnetism, underpinned by vector calculus. Of these, plasma physics is of particular importance, because much of the material in space is in the plasma state. A very important property of space plasmas is that they are often (though not always) collisionless, and so can behave very differently from laboratory plasmas. Consequently, we send satellites and spacecraft into the solar system to measure space plasmas and understand the physical principles controlling them. In this sense, the solar system is a diverse natural laboratory which we can use to advance our knowledge. We continue to push back the frontiers of our understanding of many areas of plasma physics, including universal processes, such as collisionless shocks, magnetic reconnection, and particle acceleration. Space physics also has a practical impact on everyday life: so-called space weather (i.e., the conditions in space) can affect human activity and technology both in space and on the ground. **Course Outline:** 1. Introduction: the domains of space physics/ plasma physics for space physics 2. The Sun and its atmosphere 3. The solar wind and the heliosphere 4. The interaction of the solar wind with planets, comets and moons 5. Magnetospheric dynamics 6. Space weather **Structure, course materials and support:** The course consists of 26 lectures in Term 2 and 1 revision lecture in Term 3. The lectures are primarily chalkboard and limited powerpoint. Handout will be available on Blackboard, along with the powerpoint slides and problem sheets. Reading list of suggested textbooks. **Pre-requisites:** Space physics involves a mix of plasma physics, fluid dynamics, thermodynamics, and electricity and magnetism, underpinned by vector calculus. **The course is self-contained, and students do well on the course without having done the plasma physics course. However, taking the plasma physics course is very compatible and makes a sensible course combination.** I am very happy to discuss any concerns you may have, e.g. if you are on the MSci Year in Europe or MSc course; please get in touch!

Assessment		Assessment Type	Weighting
Written Exam		Exam	100%
Learning & Teaching Hours	Independent Study Hours	Placement Hours	Total Hours
47	103	0	150
ECTS Credit	6	CATS Credit	12
Date of introduction	October 2016	Date of Last Revision	22 April 2020