

Cockcroft Institute Seminar

Space is not empty: a natural history of cosmic plasmas

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Abstract

Much of the universe is filled with plasmas – ionised matter whose properties are dominated by electromagnetic interactions. This talk will start by introducing some of the basic concepts that distinguish the behaviour of plasma from other states of matter and outlining examples of plasma regimes across the universe. This introduction will particularly emphasise collisionless plasma regimes and the fascinating properties that flow from that regime, especially the frequent lack of thermal equilibrium. We will then move to the main focus of the talk - looking at some of the key processes that determine the behaviour of cosmic plasmas. Magnetic reconnection is perhaps the most important of these because of its ability to transform the topology of plasma structures as well as its role in energising particle populations. We will also look other key processes including shocks, turbulence and particle energisation in general. We will end the discussion on processes by looking briefly at the dynamics of magnetospheres and considering if the so-called sub-storm cycle should be considered as a fundamental process in cosmic plasmas. The talk will highlight open issues in studies of these key processes and discuss current and future capabilities to progress those studies. Finally we will outline the potential impact from improved knowledge of cosmic plasmas. We will look at the scientific impact to be gained by understanding plasma physics as an agent for structuring the universe (complementing the role of gravity) and at the practical impact in terms of understanding “space weather”, the severe disturbances of the upper atmosphere and near-space environment that can disrupt many technologies critical to our modern civilisation.