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Generation and characterisation of warm dense matter in the laboratory

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The study of warm dense matter is a key part of the research programme in many and varied plasma physics laboratories around the world. The reasons for such interest are several fold. Firstly, it presents a key academic challenge. Warm dense matter is a state where partial ionisation, electron degeneracy and strong coupling exist side by side and theoretical modelling is a challenge. Secondly, the existence of warm dense matter in large planets gives hope that a detailed understanding of warm dense matter will help understand the formation and evolution of planets. The discovery in recent years that stars with planets are by no means rare gives added impetus.

There are currently several principal ways in which warm dense matter is generated in the laboratory. Firstly, large pulse laser systems have been around for some time and can be found in Europe, the USA, China and Japan. In addition there are a smaller number of Z pinch machines capable of warm dense matter research. There are now X-ray FELs online that can generate warm dense matter and ion beam facilities capable of warm dense matter research are being constructed. For the latter two, building a large pulsed laser alongside allows the facilities to operate either as a generator or probe.

In this talk I will outline the methods of generation and probing of warm dense matter. I will compare the relative advantages of the facilities and approaches and discuss future prospects. I will pay attention to the prospects for FAIR and where it can best compete as a WDM research facility with unique capabilities.

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