Beitrag ID: **26** Typ: **Talk**

The High Energy Density Initiative (HEDI) in Rostock

Donnerstag, 29. Januar 2026 09:00 (20 Minuten)

States of extreme energy density –i.e., matter under high pressures and extremely high temperatures –are found in the interiors of planets (megabar pressures, several thousand kelvins) or stars (gigabar pressures, several million kelvins) and are highly relevant for the ultimate application of clean and reliable energy production by inertial fusion. A deep understanding of the complicated physical conditions along the compression path to inertial fusion plasmas and the dynamics on short timescales is essential for the eventual realization of an energy source based on this concept.

The physics of these extreme states is highly complex and the combined experimental and theoretical investigation of them has only recently been channeled into the new field of high energy density physics. The Helmholtz Association has initiated the development of world-leading research infrastructures to reproducibly create conditions of comparable energy density in a controlled laboratory environment and to enable highly precise in situ measurements of the microphysics in these exotic states of matter. One such initiative is the Helmholtz International Beamline for Extreme Fields (HIBEF) at the European XFEL, which was initiated and is operated by the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and has started to produce first breakthrough results.

To further establish and advance groundbreaking research with these unique capabilities in Germany, a university partnership within an interdisciplinary environment is required to efficiently utilize and develop the new facilities. Therefore, the HZDR together with the University of Rostock has established the High Energy Density Initiative (HEDI) as a Helmholtz Flagship Initiative and the State of Mecklenburg-Vorpommern has committed to finance the construction of a research building on the University of Rostock campus.

Based on a showcase of recent scientific results of the HEDI team, this presentation will discuss the planned research program of HEDI in the areas of theoretical and experimental high energy density physics and potential applications in the areas of inertial confinement fusion, astrophysics, planetary physics and materials science.

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Sitzung Einordnung: Session 8 - Astrophysics