Generation of Planetary Core Conditions Using Intense Heavy Ion Beams at Facility for Antiprotons and Ion research

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Recent discoveries of a large number of extrasolar planets has very much increased the importance of planetary physics. Most of the exoplanets discovered so far are gas giants like Jupiter, but a number of rocky planets with mass equal to a few Earth masses, have also been found. These planets are called Super-Earths. The existing planetary models predict that extreme conditions of pressure and temperature exist in the planetary interiors. As a result of the vast knowledge collected over the past many decades due to the seismic activity, it is estimated that the temperature at the Earth core is about 6000 K while the pressure is around 3.5 Mbar. Recently developed planetary models predict [1,2] that in planets having mass between 1 – 10 Earth masses and with the same internal structure as Earth, the inner pressure could be between 3.5 to 15 Mbar while the temperature may be in the range 6000 – 10000 K.

Intense heavy ion beams have been proposed as a very efficient tool to generate samples of High Energy Density (HED) matter with physical conditions similar to the planetary interiors. Previously, we published detailed two-dimensional simulations of low-entropy compression of hydrogen [3] and water [4] to generate the inner core conditions of hydrogen rich planets, Jupiter and Saturn as well as water rich planets, Uranus and Neptune, respectively. This implosion scheme is named LAPLAS [Laboratory Planetary Sciences] and represents one of the key HED physics experiments to be done at the **F**acility for **A**ntiprotons and **I**on **R**easearch [**FAIR**] in Darmstadt. Since it is believed that the Earth core is mostly comprised of iron, we have recently done extensive simulations of compression of iron samples using the LAPLAS scheme. These studies have shown that the intense uranium beam at FAIR has the potential to induce the extreme physical condition in Fe that are believed to exist in the core of the Earth and of more massive. Super-Earts of with mass up to 10 Earth masses. This work is presented in this contribution.

References

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