Laboratory exploration of planetary materials using high power lasers

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Abstract

We are exploring various states planetary materials in the laboratory, using high-power lasers to drive shock waves propagating within their synthetic samples. Here recent results of these experiments were reviewed. Planetary ices made of hydrogen, oxygen, carbon and nitrogen are the primary components of icy giant planets such as Uranus and Neptune. At high pressure and temperature conditions relevant to the interiors of these planets, such ices were proved to become a good electronic conductor, which is the best-possible rationale of strong magnetic fields originating from insides of these planets. Using high-power lasers coupled with ultrafast optical diagnostics, such exotic properties of planetary ices have been revealed. We are also exploring shock-compressed states of planetary minerals represented by forsterite olivine, Mg_2SiO_4, which is the most important constituent of terrestrial planets. Its shock-compressed states induced by another high-power laser were analyzed by an X-ray free electron laser to reveal an occurrence of ultrafast transformation of crystal structures to become much denser, which have important implications on the origin of high-density minerals occurring in the meteorites.

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