Pounding particles to create Neptune's water in the lab

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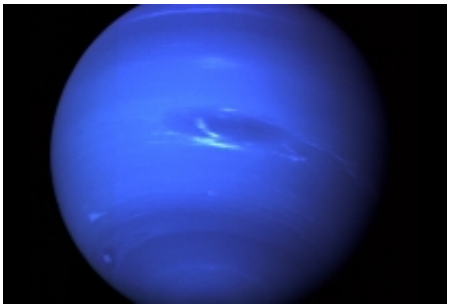

We know 'icy' Neptune is partially comprised of water molecules but until now we have had little means to test how water behaves in the extreme conditions that Neptune presents.

This is about to change as an international group of physicists draw up plans to use the new Facility for Antiprotons and Ion Research (FAIR) in Germany, which will be ready in 2015, to expose water molecules to heavy ion beams and thereby generate the same level of pressure on the water molecules that they experience within the very inhospitable core of Neptune.

The new plans being published in New Journal of Physics today, Thursday 22 July, explain how using high energy uranium beams in the future German facility is going to enable researchers to create conditions

that push water molecules into a 'superionic' state and thereby observe water in conditions never before replicated.

The predicted 'superionic' state is an exotic hybrid phase of water composed of an oxygen lattice and a hydrogen liquid which under ambient conditions form stable H_2O molecules in an ice lattice or in a liquid.

A total of 15 European, Russian and Chinese researchers from GSI Helmholzzentrun fur Schwerionenforschung, Universitat Rostock, Universidad de Castilla-La Mancha, Universite Paris-Sud, the Russian Academy of Sciences, and the Chinese Academy of Science explain how the use of the new heavy ion beams can simulate pressures up to several million times greater than anything on the surface of the Earth.

The researchers suggest that research into this 'superionic' state could be of paramount importance for the understanding of the magnetic field of Neptune and Uranus, which are very different from that of the Earth's.

The researchers cite the past decade's progress in the technology of strongly bunched, well focused, high quality intense heavy ion beams as the enabling force for this experiment - such beams will be made available when construction of FAIR is complete.

The heavy ion beams, which will be generated by the new particle accelerator at FAIR, will have advantages over other methods of exposing particles to high pressure, such as high explosives, gas guns, lasers, or pulsed power, because they will be able to apply a more uniform and more targeted pressure on the water molecules.

The researchers write, "The FAIR accelerator facilities will provide very powerful high quality heavy ion beams with unprecedented intensities. Extensive theoretical work on beam matter heating over the past decade

has shown that the ion beams that will be generated at FAIR will be a very unique and very efficient tool to study High Energy Density Particles in those regions of the parameter space that are not so easy to access with the traditional method."

More information: "Ultra high compression of water using intense heavy ion beams: Laboratory planetary physics" Tahir N et al 2010 *New J. Phys.* 12 073022. iopscience.iop.org/1367-2630/12/7/073022

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