Researchers move forward in explaining atomic causes of high temperature superconductivity

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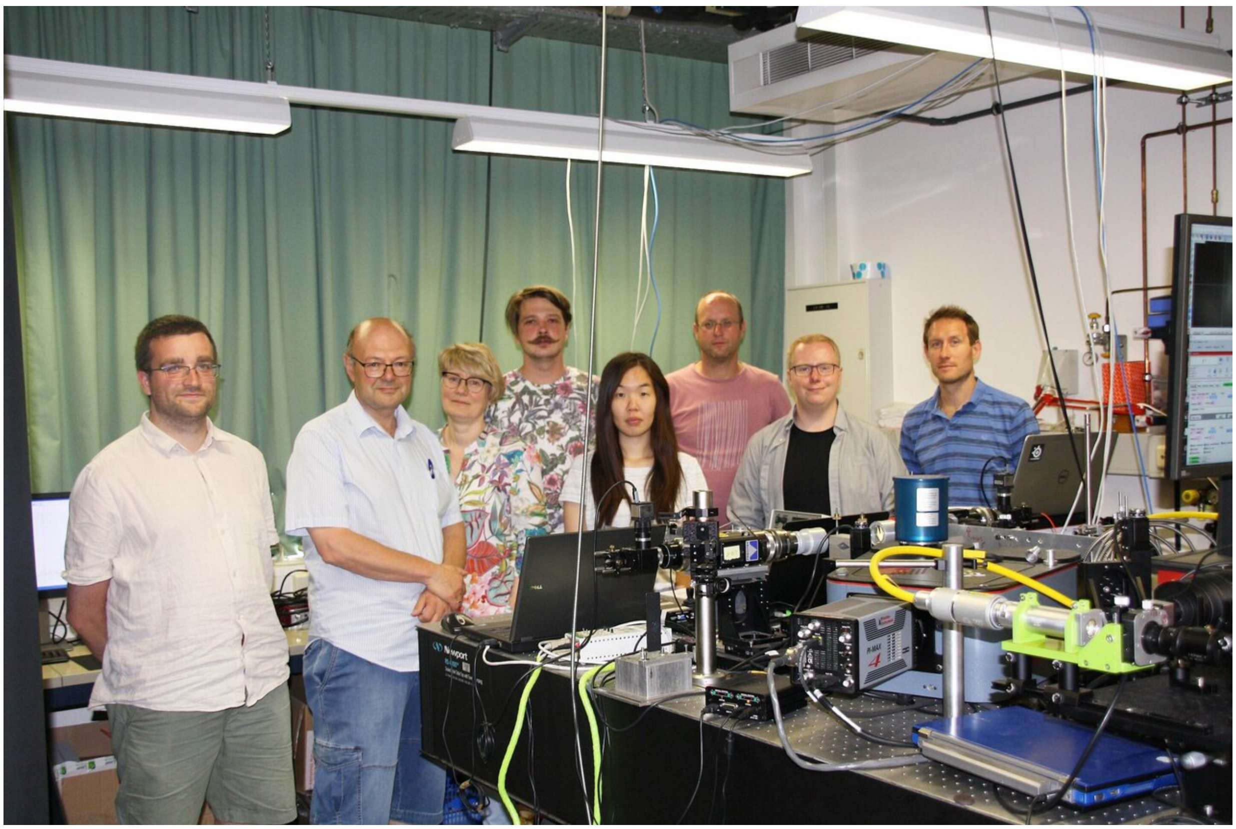

The research team at the University of Bayreuth: Dr. Thomas Meier, Prof. Dr. Leonid Dubrovinsky, Prof. Dr. Natalia Dubrovinskaia, Timofey Fedotenko M.Sc., Saiana Khandarkhaeva M.Sc., PD Dr. Gerd Steinle-Neumann, Florian Trybel M.Sc., Dr. Sylvain Petitgirard (from left to right). Credit: Christian Wissler

During the last five years, few scientists have successfully employed very high pressures in order to produce metal hydrides, rich in hydrogen, which become superconductive around -20 degrees Celsius. This so-called transition temperature of metal hydrides is therefore considerably higher than that of other materials, which become superconductive only at -200 degrees Celsius.

Why metal hydrides behave differently was unknown for a long time. Now, however, a research team from the Bavarian Geoinstitute (BGI) and the Laboratory of Crystallography at the University of Bayreuth has shown experimentally and described theoretically that hydrogen atoms in metal hydrides start to interact with each other at high pressure. This knowledge could lead to a deeper understanding of the superconductive state and its origin.

"We now have a valuable starting point for the design of metal hydrides which become possibly superconductive at even higher temperatures. With new technology of high-pressure research in the Bavarian Geoinstitute, we can synthesize these materials and check our predictions directly on site empirically. The measurements under high pressure will have, in turn, an impact on our theoretical assumptions. Thereby they allow increasingly exact predictions of the atomic processes which put metal hydrides into a superconductive state," says Dr. Thomas Meier, the leader of the Bayreuth research team.

Based on the interplay of theoretical predictions and empiric measurements, the researchers want to synthesize new materials and thereby achieve transition temperatures closer to normal ambient temperatures. One day, these materials could make a decisive impact on electric energy transport. Even then, one more hurdle remains: Metal hydrides exhibit superconductivity only as long as the high degree of compression under which they originated persists. As soon as pressure decreases, the materials disintegrate. However, if such superconductors prove to be stable under normal conditions, they could have important technological applications.

More information: Thomas Meier et al. Pressure-Induced Hydrogen-Hydrogen Interaction in Metallic FeH Revealed by NMR, *Physical Review X* (2019). DOI: 10.1103/PhysRevX.9.031008

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