Direct observation of the mystery of 'hidden order' in condensed-matter physics

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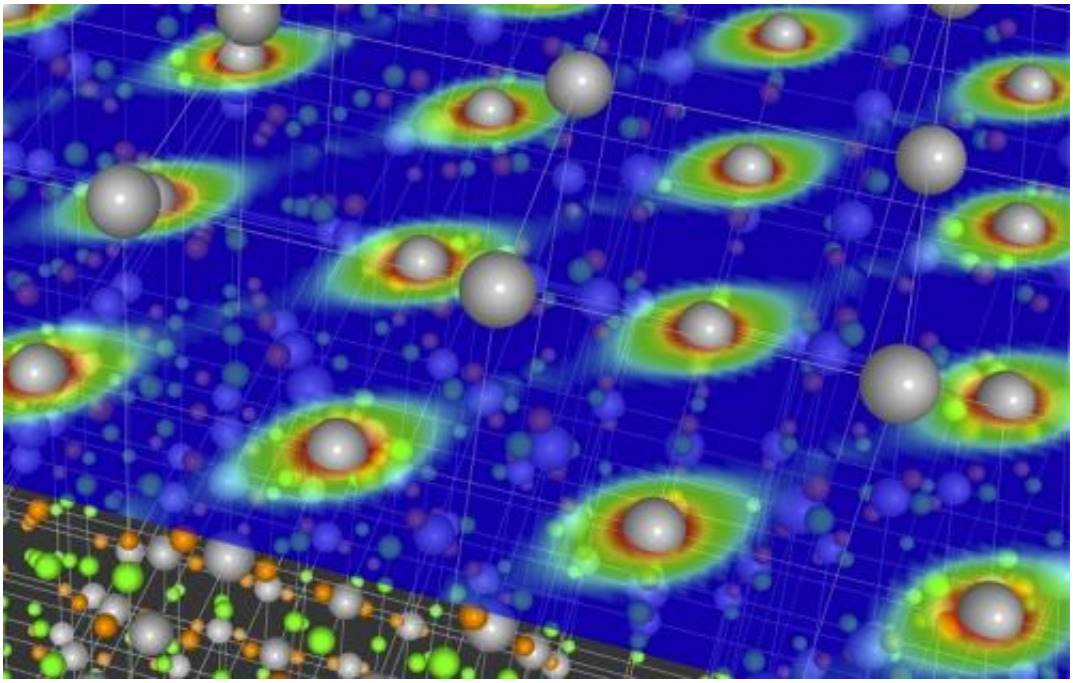

Gray spheres are uranium atoms, around which the electronic state exhibits ellipsoidal anisotropy, being different on the left and right diagonals, breaking fourfold symmetry in the basal plane (blue). (c) 2014 Takasada Shibauchi.

The research team of Professor Takasada Shibauchi and Assitant Professor Yuta Mizukami in the Department of Advanced Materials Science at the University of Tokyo Graduate School of Frontier Sciences and Professor Yuji Matsuda in the Kyoto University Graduate School of Science have observed directly that the crystal structure in the enigmatic

"hidden order" phase of the uranium compound URu_2Si_2 is slightly deformed to an orthorhombic (diamond-like) shape with twofold rotational symmetry by ultra-high resolution synchrotron crystal-structure analysis at the Spring-8 synchrotron radiation facility.

The nature of this so-called "hidden order" electronic state in URu_2Si_2 is a 30-year-old mystery in condensed-matter physics. Previously, the research group had obtained indirect evidence that the crystal structure possessed twofold symmetry, but previous research had reported a tetragonal square shape with fourfold symmetry. The present direct observation of the crystal structure change clarifies decisively the mystery as to the space symmetry exhibited by the electronic structure of the hidden-order state. The space symmetry found reveals a nontrivial electronic state, which will pave the way for understanding of new electronic states of matter.

This research was conducted in collaboration with the groups of Kunihisa Sugimoto, Researcher in Japan Synchrotron Radiation Research Institute, and Yoshinori Haga, Chief Scientist in Japan Atomic Energy Agency.

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