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The Fascinating Physics of 5f electrons

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Abstract: The actinides are perhaps most well known for their nuclear properties. However, the 5f electrons show many remarkable phenomena themselves. Often this is a consequence of an intriguing conundrum they face: Should they participate in bonding or remain localized close to their parent nuclei? This is a difficult question for 5f electrons to answer due to competing interactions. These competing desires lead to many fascinating phenomena (such as superconductivity, magnetism, and fractionalized excitations) that fall under the general heading of strongly correlated electrons. Importantly, these competing interactions are directly responsible for the structure and bonding that occurs in the actinides, and explains why elemental plutonium has six allotropic phases at ambient pressure. In addition, it is recently recognized that heavy elements such as the actinides can cause the electronic structure of a material to have different so-called topologies. An important consequence is that insulating materials may be required to maintain metallic surface states. In this talk, I will draw on examples of research at Los Alamos to illustrate and explain the phenomena described above.

Filip Ronning received his Ph.D. at Stanford University in 2001 for his angle-resolved photoemission work on copper based high Tc superconductors. Subsequently, he did a postdoc at the University of Toronto, performing low-temperature thermal conductivity measurements of strongly correlated systems. In 2003, he moved to Los Alamos National Laboratory where he is currently a staff member in charge of the transport and thermodynamic measurement team exploiting extremes of pressure, temperature, and magnetic field. His interests are in novel states of matter and emergent phenomena often found due to the presence of strong electronic correlations in f-electron materials. He is a fellow of the American Physical Society.