

Physics & Astronomy Colloquium

Presents

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Instructor

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Thursday, January 31, 2019

4:10 pm, Webster Room 17

Nuclear Magnetic Resonance Investigation of Actinide Tetrafluoride Compounds

Plutonium (Pu) plays a central role in the U.S. Department of Energy's core missions in energy production, national defense, waste management, and environmental remediation. My own research interests, geared towards basic science, stem from the fact that Plutonium has a very unique place in the periodic table, at the intersection between elements that are considered itinerant (Neptunium) and localized (Americium), and is recognized as the pivotal element to study for insights on the unique electronic properties of the actinide series. The complexity of the actinide elements comes from the presence of 5f electrons in the valence shell, which display both atomic (ionic bond) and band-like (covalent bond) character. This duality is at the heart of vibrant research at the crossroads of chemistry, physics and material science. It is also behind many interesting phenomena observed in actinide compounds in general, Plutonium in particular, such as extremely slow conduction electrons with large mass renormalization ("heavy fermions"), unusual magnetic ordering of quadrupolar (or higher order) moments, and superconductivity (a quantum state of matter that sustains dissipationless currents).

Due to the shortcomings of current theoretical models, thorough experimental investigations of the Pu compounds are needed to reveal the electronic configuration of f-orbitals. I will report the first NMR investigation in Plutonium Tetrafluoride (PuF₄) at room temperature. We have investigated this compound in order to shed light on the relation between electronic configuration and magnetic moment of the Pu⁴⁺ ions. We have focused our efforts on the ligand nuclei ¹⁹F after our attempts to detect ²³⁹Pu directly have yielded no result. We observe an unusually broad fluorine spectrum which scales with the applied magnetic field in PuF₄, compared to the isostructural, tetravalent ZrF₄ and CeF₄ compounds with no f-electrons. The experimental lineshape is consistent with a dipolar type hyperfine interaction between the F-nuclei and the Pu valence electrons, but the effective moment derived from it is much larger than the moment of the 5f⁴ electronic configuration that was assigned to Pu based on previous bulk magnetic susceptibility data. One possible interpretation is that Pu is in a mixed valence states in this compound. Efforts are underway to expand this investigation over a broad temperature range, as well as to the related actinide compounds such as ThF₄, UF₄ and NpF₄.

*Please meet our guest speaker and share in refreshments,
3:45-4:10 p.m. in the foyer on floor G above the lecture hall*