



Special Joint Quantum Sciences Seminar

Thursday, January 14, 1:30 pm

Jefferson 356

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Molecular Rotor in Cold Reactions

The role of the internal molecular degrees of freedom, such as rotation, in low energy reactions has been unexplored experimentally despite their significance to cold and ultracold chemistry. Particularly important to astrochemistry is the case of the most abundant molecule in interstellar space, hydrogen, where two spin isomers with rotationally ground and excited levels have been detected. Here we demonstrate that quantization of molecular rotation plays a key role in cold reaction dynamics, where rotationally excited *ortho*-hydrogen reacts faster due to a stronger long-range attraction. We observe rotational state dependent non-Arrhenius universal scaling laws in chemi-ionization reactions of *para*-H₂ and *ortho*-H₂ by He(2³P₂), spanning three orders-of-magnitude in temperature. Different scaling laws serve as a sensitive gauge enabling us to directly determine the exact nature of the long-range intermolecular interactions. Our results show that the quantum state of the molecular rotor determines whether or not anisotropic long-range interactions dominate cold collisions. We will also discuss the effect of molecular rotation on orbiting resonances that we have observed in our earlier work in the case of normal H₂. We will demonstrate that orbiting resonance structure is highly dependent on the rotational state of a molecule.

Coffee service will be provided