Inelastic Hydrogen Atom Scattering: Importance of Electron-Hole-Pair Excitations

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Obtaining an atomic-level understanding of the dynamics of energy conversion at surfaces remains a richly complex and challenging area of modern research in physical chemistry. A general strategy to this field follows the lessons of gas-phase bimolecular chemical dynamics, where simple model systems are studied experimentally with great care while theoretical simulations are developed.
One of the simplest systems to think of is Hydrogen atom scattering from a single crystalline surface. A new apparatus to experimentally investigate this model system with extraordinary precision is presented. Laser photolysis of Hydrogen Iodide is employed to produce a monochromatic Hydrogen atom beam with well-defined initial directions. The final kinetic energy and scattering angle of the H-atoms are measured with extraordinary resolution employing Rydberg Atom Tagging. Both techniques are adopted and combined with a state of the art surface scattering machine, introducing an entirely new approach to surface analysis. High control of experimental parameters as well as angular and energy resolved detection give a very detailed picture of the scattering process.
First experiments scattering Hydrogen atoms from an Au(111) surface will be presented. Furthermore, Hydrogen atoms were scattered from a Xeon covered Au(111) surface to allow a comparison between insulator and metal surface. Experimental results are compared to high level theoretical calculations. The importance of electronically non-adiabatic processes and multi-bounce and penetrating collisions is discussed.