QUANTUM STATE-RESOLVED REACTIVE AND INELASTIC SCATTERING AT GAS-LIQUID AND GAS-SOLID INTERFACES

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Quantum state-resolved reactive and inelastic scattering at gas-liquid and gas-solid interfaces has become a research field of considerable interest in recent years[abc]. The collision and reaction dynamics of internally cold gas beams from liquid or solid surfaces is governed by two main processes, impulsive scattering (IS), where the incident particles scatter in a few-collisions environment from the surface, and trapping-desorption (TD), where full equilibration to the surface temperature ($T_{\mathrm{TD}} \approx T_{\mathrm{s}}$) occurs prior to the particles' return to the gas phase. Impulsive scattering events, on the other hand, result in significant rotational, and to a lesser extent vibrational, excitation of the scattered molecules, which can be well-described by a Boltzmann-distribution at a temperature ($T_{\mathrm{IS}} >> T_{\mathrm{s}}$). The quantum-state resolved detection used here allows the disentanglement of the rotational, vibrational, and translational degrees of freedom of the scattered molecules.

The two examples discussed are (i) reactive scattering of monoatomic fluorine from room-temperature ionic liquids (RTILs) and (ii) inelastic scattering of benzene from a heated (~ 500 K) gold surface. In the former experiment, rovibrational states of the nascent HF beam are detected using direct infrared absorption spectroscopy, and in the latter, a resonace-enhanced multi-photon-ionization (REMPI) scheme is employed in combination with a velocity-map imaging (VMI) device, which allows the detection of different vibrational states of benzene excited during the scattering process.

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