



# Innsbruck Physics Colloquium

Low-temperature adsorbate quantum dynamics  
observed using a mid-ir superconducting nanowire  
single photon detector

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Superconducting nanowire single-photon detectors (SNSPDs) enable laser-induced fluorescence (LIF) experiments in the mid-infrared, which are useful for vibrational spectroscopy. This lecture outlines SNSPD functionality, usage, and showcases findings from experiments on CO vibrational dynamics on NaCl surfaces. Employing time-resolved infrared LIF spectroscopy, the experiments reveal astonishing phenomena arising from dipole-dipole coupling between molecules. By exciting CO with IR laser pulses, the SNSPD captures mid-infrared emissions and detects vibrational states up to  $v=27$  formed via vibration-vibration (V-V) energy transfer. Kinetic Monte Carlo simulations replicate population distribution evolution, indicating energy concentration in a few CO molecules. Surprisingly, vibrating CO molecules transfer energy electromagnetically to NaCl lattice-vibrations, behavior that resembles Sommerfeld's ground wave theory for radio waves while defying typical expectations based on anharmonic vibrational couplings. Emission spectra elucidate the presence of an orientational isomer of CO—the up-side down CO. Moreover, the heavy-atom kinetic isotope effect showcases unconventional tunneling rates in the isomer's return to the right-side up structure, challenging conventional understanding that light molecules tunnel faster than heavy ones.

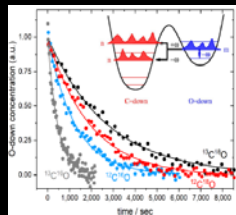


Figure: Isotope effect for thermally assisted tunneling in the CO back-flipping reaction for  $T=21\text{K}$ . Note that the unexpected mass dependence. The inset shows the tunneling gateway mechanism employed in an FGR model of resonant tunneling, which is capable of explaining the unexpected mass dependence of tunneling. Conventional reaction theories currently in use, for example, in astrochemistry fail to describe the observed isotope effect.

**DK-ALM Pre-Talk:**  
**Thomas Gstir**

**The influence of fluorination on the dynamics of the  $\text{F} + \text{CH}_3\text{CH}_2\text{I}$  reaction**

**Time & Location: Tuesday, 16.01.2024, 16:30 h & 17.15 h HS C**  
**Snacks will be provided in between the pre-talk and the colloquium.**