Anomalous diffusion and emergent localization of light atoms in an ideal, heavy fermion gas

Matteo Zaccanti*[1,2]

[1]Istituto Nazionale di Ottica- Consiglio Nazionale delle Ricerche (INO-CNR) – Via N. Carrara 1, Sesto Fiorentino (FI), 50019, Italy

[2]European Laboratory for Non-Linear Spectroscopy – Italy

Abstract

I will discuss recent studies of the dynamics of a small ultracold sample of fermionic lithium atoms – acting as light impurity particles – released from a species-selective potential into a large, ideal gas of chromium – that plays the role of a bath of heavy, point-like scatterers (mass ratio MCr /mLi =8.8). A Feshbach resonance allows us to finely tune the Li-Cr short-range interaction and to explore different transport regimes.
At high temperatures we characterize the crossover from ballistic to diffusive lithium transport: under resonant interactions, we measure slow but normal diffusion, consistently with Fermi liquid theory and previous observations on homonuclear mixtures. Reducing the Cr temperature, we instead unveil anomalous, *sub-diffusive* transport, where the lithium mean square radius grows sub-linearly in time. Parallel to this, the lithium cloud develops a "localized" core that exhibits no dynamics over the entire observation time, and whose weight monotonically increases with decreasing Cr temperature.
Our findings, quantitatively reproduced by a model for scalar waves in a random Lorentz gas of point-like scatterers, point to a key role of quantum interference in heavy-light atomic mixtures, the heavy component acting as a quasi-static random medium for the light particles and promoting their localization.

*Speaker