Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **2636** Type: **Poster (Non-Student) / Affiche (Non-étudiant(e))**

38 - Radio-frequency spectroscopy of one-dimensional Fermi gases near a p-wave Feshbach resonance

Tuesday, June 4, 2019 4:51 PM (2 minutes)

Interacting fermions with odd orbital exchange parities are of long-standing interest, but has also proven to be challenging to explore both in materials and with ultracold gases. A p-wave Feshbach resonance is known for several alkali gases, but has been associated with strong loss due to recombination. In contrast to broad s-wave resonances, a high closed-channel fraction of the Feshbach dimer is inevitable because the dimer is "stuck" behind a large (typically millikelvin-high) centrifugal barrier. The collisional wave function thus has excellent overlap with lower bound states, to which it decays quickly through various channels.

Recently, it has been conjectured that odd-wave collisions in quasi-one-dimensional traps might have a larger open-channel fraction, and thus a higher ratio of elastic-to-inelastic collisions [Zhou 2017, Kurlov 2017]. Since there is no rotation associated with odd-wave collisions in 1D, there is no centrifugal barrier. This may free the Feshbach dimer to have a large spatial extent, much like s-wave dimers.

We have investigated the effects of dimensionality and orbital parity on pairing in a degenerate Fermi gas of potassium (40K) atoms near Feshbach resonances. Dimensionality is controlled by loading atoms into one or two optical lattices, to create ensembles of 2D or 1D samples, respectively. At various s-wave or p-wave scattering lengths, we perform radio-frequency spectroscopy, which can associate or dissociate Feshbach dimers, or cause bound-to-bound transitions. From these spectra, we plan to measure the energetic widths of resonances, the nature of the pair wave function, and the strength of short-range correlations, i.e., the contact parameter. The contact is the central quantity in a set of universal relations recently discovered for 3D p-wave gases [Yoshida 2015,Yu 2015,Luciuk 2016], which are anticipated to carry over to 1D [Yin 2018]. Our work aims to understand the effect of strong confinement on pairs interacting with exchange-antisymmetric orbital wave functions.

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Session Classification: DAMOPC Poster Session & Student Poster Competition Finals (26) | Session d'affiches DPAMPC et finales du concours d'affiches étudiantes (26)

Track Classification: Division of Atomic, Molecular and Optical Physics, Canada / Division de la physique atomique, moléculaire et photonique, Canada (DAMOPC-DPAMPC)