Universal physics in the crossover between three and two dimensions

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Collaboration:
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Purpose of the visit

During the visit to ICFO, the aim was to finish the theoretical model describing the confinement of bosonic atoms to a quasi-two-dimensional geometry, in particular to study the way in which Efimov states disappear when the 2D limit is approached. Additionally the purpose was to perform sophisticated numerical simulations of the spectrum of three-body states in the dimensional crossover in collaboration with Dr. Massignan.

Description of the work carried out during the visit

During the visit we finished the theoretical model and performed numerical simulations as mentioned above. We also carried out extensive discussions with the Innsbruck group led by Prof. R. Grimm, discussing the optimal experimental configuration in which to observe universal physics in the crossover between three and two dimensions.

Motivated by the very recent observation of interspecies Feshbach resonances in Cesium-Lithium mixtures (http://arxiv.org/abs/1211.2139, http://arxiv.org/abs/1211.2888), we additionally derived the theory for a mass-imbalanced system. The advantage in this system is that the scaling factor which describes the ratio of energies of Efimov states is smaller for such a large mass-ratio, and our approach may capture more than one Efimov state starting from the 2D limit.

Description of the main results obtained

The main results was a complete theoretical model enabling the calculation of the spectrum of energies of three-body bound states in the dimensional crossover, including the description of mass-imbalanced systems such as in Cesium-Lithium mixtures. Our numerical simulations have further led to additional understanding of the conditions under which universal physics may be observed close to the 2D limit.

Future collaboration with host institution

Future collaborations are planned in several areas, including the present line of work. We also discussed other possible future projects, for instance relating gauge fields to SU(N) magnetism.

Projected publications/articles resulting or to result from your grant

We are still working closely with the Innsbruck group with the aim of a combined experimental/theoretical work, which is likely to appear in a high-impact journal. In

addition, our new work on mass-imbalanced mixtures is likely to lead to a purely theoretical publication.