SYEP 1: Symposium Efimov Physics I

Time: Monday 11:30–13:00 Location: C/gHS

Invited Talk SYEP 1.1 Mon 11:30 C/gHS

Few-body physics with ultracold atoms: What we learned from cesium — •Rudolf Grimm — Institute of Experimental Physics, Univ. Innsbruck, Austria — IQOQI Innsbruck, Austria

The first experimental evidence for the existence of Efimov quantum states was obtained almost a decade ago in a gas of ultracold cesium atoms. Since then, experiments relying on the special interaction properties of ultracold cesium have provided us with much deeper insights into the few-body problem, concerning not only Efimov's original scenario of trimer states but also few-body phenomena beyond that. In my talk I will review the key developments in the field with emphasis on the cesium experiments, drawing an essentially complete picture of Efimov physics in single-species bosonic quantum gases. I will present the current state-of-the-art of the field and discuss future prospects of few-body physics with ultracold atoms.

Invited Talk SYEP 1.2 Mon 12:00 C/gHS

Universality in halo nuclei — •Daniel Phillips — Institute of Nuclear and Particle Physics and Department of Physics and Astronomy, Ohio University, Athens, OH 45701, USA

In the limit of a large two-body s-wave scattering length the properties of quantum-mechanical few-body systems become insensitive to details of the two-body potential. This leads to the emergence of universality: relations between different observables which rely for their validity only on the presence of a sizable scattering length. These relations apply across a wide range of scales: to hadrons, light nuclei, clusters of atoms, and to cold atomic gases with tunable interactions. The Efimov effect is one example of a universal phenomenon, but many other universal correlations also exist.

In this talk I will show that this type of universality provides an organizing principle for the physics of halo nuclei. These are systems in which a few nucleons are weakly bound to a nuclear core. They can thus be treated in a "clustered" description in which the core and the "halo" nucleons are the degrees of freedom. Since the halo nucleons are weakly bound universal correlations between observables exist. This unifies the physics of a diverse set of halo nuclei.

I will also discuss the ways in which details of nuclear interactions refine, but do not destroy, a universal description. Applications to the possibility of Efimov states in halo nuclei, as well as results for observables in halo systems where the unitary limit is close to being realized, will be displayed.

SYEP 1.3 Mon 12:30 C/gHS

Observation of the Efimov state of the helium trimer — •Maksim Kunitski[1], Stefan Zeller[1], Jörg Voigtsberger[1], Anton Kalinin[1], Lothar Schmidt[1], Markus Schöffler[1], Achim Czasch[1], Wieland Schöllkopf[2], Robert E. Grisenti[1], Till Jahnke[1], Dörte Blume[3], and Reinhard Dörner[1] — [1]IKF, Goethe-Universität Frankfurt am Main — [2]Fritz-Haber-Institut, Berlin — [3]Washington State University, Pullman, WA, USA

In 1970 Vitali Efimov predicted remarkable counterintuitive behavior of a three-body system made up of identical bosons. Namely, a weakening of pair interaction in such a system brings about in the limit appearance of infinite number of bound states. These three-body states possess universal properties, which are determined primarily by the s-wave scattering length and a single three-body parameter but do not depend on a particular short-range interaction. Helium trimer has been suggested to be an only native molecular system having an excite state of Efimov nature. Though many theoretical works predict the existence of this state in Helium trimer, it has not been observed experimentally so far. Here we report the first experimental observation of the excited state of He trimer by means of Coulomb explosion imaging. We show spatial images of an Efimov state, confirming the predicted size and a structure where two atoms are close to each other with the third one being far away. This structure is believed to be universal to all Efimov systems from nuclear and atomic physics to condensed matter and biology.

SYEP 1.4 Mon 12:45 C/gHS

Limit Cycles from the Similarity Renormalization Group — •Patrick Niemann[1] and Hans-Werner Hammer[1,2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Renormalization group (RG) limit cycles have been identified and studied in several systems. We investigate the limit cycle with the similarity renormalization group (SRG). In nuclear physics the SRG is applied to soften nuclear potentials in order to achieve improved numerical convergence.

We search for signatures of limit cycles in SRG evolved potentials. We examine two different systems, which exhibit the limit cycle. The first system is a two-body system with the $1/R^2$ potential and the second one is a three-body system with resonant interactions, where the Efimov effect occurs. Besides the standard kinetic energy generator we apply two other generators.