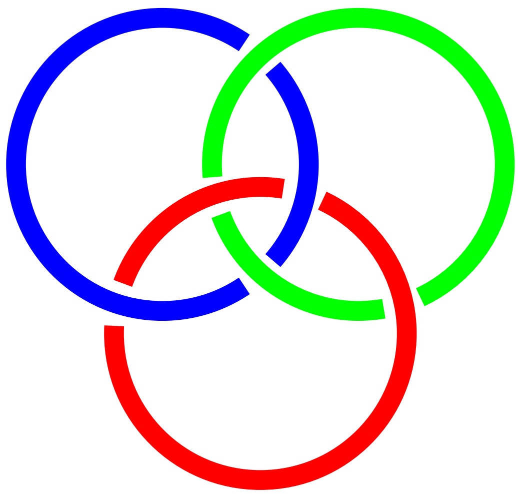
Critical Stability Abstracts



Abstracts submitted to the Sixth Workshop
on the Critical Stability of Quantum Few-Body Systems,
Erice, Sicily, October 2011.

This workhop is supported by EMCSC

Version of October 2, 2011

Abstracts

Introduction

This is the sixth Workshop on the Dynamics of Critically Stable Quantum Few-Body Systems. The previous ones were held at Trento, Les Houches, Trento, Dresden and Erice. For the four last ones, proceedings have been edited, and published as special issues of Few-Body Systems:

- Vol. 31, N. 2-4, p. 71-266 (2002),
- Vol. 34, N. 1-3, p. 3-208 (2004),
- Vol. 38, N. 2-4, p. 55-219 (2006),
- Vol. 45, N. 2-4, p. 77-243 (2009).

Stability of Bright, Vortex-Bright, and Gap Solitons in a Dipolar Bose-Einstein Condensate

Sadhan Adhikari[1,a], **Paulsamy Muruganandam**[2], **Luis Ever Young-s**[2]
[1] São Paulo State University, Institute of Theoretical Physics, Brazil
[2] São Paulo State University
[a] email: adhikari44@yahoo.com

Critical Stability, Erice, October 2011

We study the formation and dynamics of bright, vortex-bright, and gap solitons in a dipolar Bose-Einstein condensate (BEC). The bright and vortex-bright solitons are considered in a cigar-shaped dipolar BEC for large repulsive atomic interactions, while no solitons can appear in a BEC of atoms without dipolar moment. Phase diagram showing the region of stability of these solitons is obtained. We also study the dynamics of breathing oscillation of these solitons as well as the collision dynamics of two solitons at large velocities. Two solitons placed side-by-side at rest coalesce to form a stable bound soliton molecule due to dipolar attraction.

The gap solitons can appear and are considered in both disk- and cigar-shaped dipolar BEC with weak atomic attraction and repulsion. The gap solitons are localized, in the lowest band gap, by three orthogonal optical lattice (OL) potentials. The onedimensional version of these solitons of experimental interest confined by an OL along the dipole moment direction and harmonic traps in transverse directions are also considered. Dynamics of (i) breathing oscillation of a gap soliton and (ii) dragging of a gap soliton by a moving lattice along axial direction demonstrates the stability of the solitons.

We use both time-dependent variational analysis and numerical solution of the mean-field Gross-Pitaevskii equation in this study.

On the application of the Exterior Complex Scaling method to pure Coulomb potentials

L. U. Ancarani[1,a], **G. Gasaneo**[2], **D. M. Mitnik**[3]

[1] LPMC, Université Paul Verlaine-Metz, Metz, France

[2] Departamento de Física, UNS - CONICET, Av. Alem 1253, 8000, Bahía Blanca, Argentina

[3] Departamento de Física, UBA, and IAFE - CONICET, Buenos Aires, Argentina

[a] email: ancarani@univ-metz.fr

Critical Stability, Erice, October 2008

We study some formal aspects of the exterior complex scaling (ECS) method when implemented for both short and long–range two–body potentials. We raise some questions, provide some answers, and propose a distorted-wave reformulation within a ECS approach. Particular attention is put on the applicability of the method to the pure two-body Coulomb potential.

Complex scaling has been for a long time an important tool to study the structure of atomic systems as well as resonance states. The extension to two–body collision problems was performed by Rescigno and co-workers, see e.g. Ref. [1]. Since this first application to scattering, the ECS has proved to be one of the most successful numerical methods to deal with a large variety of collision processes between two or three particles (see, e.g., [2]). In Ref. [1], the authors showed how to deal with long–range potentials, but explicitly mentioned that the method does not apply for Coulomb potentials. Recently, the Coulomb case has been under scrutiny in a series of papers dedicated to the ECS approach [3]; in this respect, our work complements their investigation.

In view of the numerical success of the ECS method, and the importance of the Coulomb potential, we present a revision of the method for two-body scattering problems [4]. We propose a Coulomb–distorted initial state reformulation within which the ECS approach can be equally applied to long–range potentials including the pure Coulomb case, in contrast with a statement of Ref. [1]. Furthermore, when performing the exterior complex rotation, the ECS recipe requires the introduction of an (unbalanced) artificial cut–off of the potential. For the pure two-body Coulomb potential we present an analytical and numerical study of this procedure, identify some inconsistencies, and propose an alternative (balanced) procedure which leads to a well-defined scattering problem. The two–body case allows one to illustrate all the ingredients and associated difficulties of the ECS method. A similar analysis applies to three-body problems.

References

[1] T. N. Rescigno *et al*, Phys. Rev. A **55** (1997) 4253

[2] T. N. Rescigno *et al*, Science **286** (1999) 2474;
C.W. McCurdy *et al*, J. Phys. B **37** (2004) R137; C. W. McCurdy and F. Martín, J. Phys. B **37** (2004) 917

[3] M. V. Volkov *et al*, EuroPhys. Lett., **85** (2009) 30001; S. L. Yakovlev *et al*, J. Phys. A **43** (2010) 245302

[4] G. Gasaneo, L. U. Ancarani and D. M. Mitnik, submitted for publication

Bound States in Multilayers of Cold Dipolar Molecules

Jeremy Armstrong[1], **A. G. Volosnev**[1], **N. T. Zinner**[1], **D. V. Fedorov**[1], **A. S. Jensen**[1]

[1] Department of Physics and Astronomy, Aarhus University, Denmark
[a] email: jeremy@phys.au.dk

Critical Stability, Erice, October 2011

We consider the N -body problem in a layered geometry containing cold polar molecules with dipole moments that are polarized perpendicular to the layers. A harmonic approximation is used to simplify the Hamiltonian and bound state properties of the two-body inter-layer dipolar potential are used to adjust this effective interaction. To model the intra-layer repulsion of the polar molecules, we introduce a repulsive inter-molecule potential that can be parametrically varied. Single chains containing one molecule in each layer, as well as multi-chain structures in many layers are discussed and their energies and radii determined. We extract the normal modes of the various systems as measures of their volatility and eventually of instability, and compare our findings to the excitations in crystals. We find modes that can be classified as either chains vibrating in phase or as layers vibrating against each other. The former correspond to acoustic and the latter to optical phonons. Instabilities can occur for large intra-layer repulsion and produce diverging amplitudes of molecules in the outer layers.

Photodisintegration of three bosons at threshold

Nir Barnea[1,a]

[1] Racah Insitute of Physics, The Hebrew University, Jerusalem
[a] email: nir@phys.huji.ac.il

Critical Stability, Erice, October 2011

Photodisintegration is one of the basic tools through which we can study a microscopic system. In this work we have investigated the response of a trimer composed of 3 identical bosons to a photon like probe. In particular we have studied the quadrupole response of a shallow bosonic trimer, which in the long wavelength approximation is the leading contribution to the reaction cross-section.

Tunable Wigner states with dipolar atoms and molecules

Jonas Cremon[1,a], **G.M. Bruun**[2], **S.M. Reimann**[1],

[1] Lund University, Sweden
[2] Aarhus University, Denmark
[a] email: jonas.cremon@matfys.lth.se

Critical Stability, Erice, October 2011

We study the few-body physics of trapped atoms or molecules with electric or magnetic dipole moments aligned by an external field. Using exact numerical diagonalization appropriate for the strongly correlated regime, as well as a classical analysis, we show how Wigner localization emerges with increasing coupling strength. The Wigner states exhibit non-trivial geometries due to the anisotropy of the interaction. This leads to transitions between different Wigner states as the tilt angle of the dipoles with the confining plane is changed. Intriguingly, while the individual Wigner states are well described by a classical analysis, the transitions between different Wigner states are strongly affected by quantum statistics. This can be understood by considering the interplay between quantum-mechanical and spatial symmetry properties. Finally, we demonstrate that our results are relevant to experimentally realistic systems.

Universality of unstable bosonic tetramers

Arnoldas Deltuva[1,a]

[1] Centro Fisica Nuclear, U. Lisboa, Portugal
[a] email: deltuva@cii.fc.ul.pt

Critical Stability, Erice, October 2011

Few-particle systems with resonant interactions, i.e., large two-particle scattering length, possess a number of universal properties and correlations between observables. We focus on the four-boson system, in particular, on the two tetramer states associated with each Efimov trimer. However, only the two lowest tetramers are true bound states; all higher tetramers lie above the atom-trimer threshold and therefore are unstable bound states. Thus, a proper description of the four-particle continuum is needed. We use exact Alt, Grassberger, and Sandhas four-body scattering equations that are solved in the momentum-space framework. Universal relations are obtained for various atom-trimer and dimer-dimer scattering observables: scattering lengths, effective range parameters, elastic anf inelastic cross sections. Their behavior is greatly affected by the unstable tetramer states whose properties are thereby extracted from the atom-trimer and dimer-dimer scattering results [1].

References

[1] A. Deltuva, Phys. Rev. A 82, 040701(R) (2010).

The Persistence of Attraction: the Dipolar Efimov Effect

Jose D'Incao[1,a]

[1]JILA, University of Colorado and NIST

[a] email: jpdincao@jila.colorado.edu

Critical Stability, Erice, October 2011

In the past few years experimental and theoretical advances in the understanding of few-body physics in ultracold quantum gases with tunable interactions have lead to the confirmation of one of the most fundamental quantum phenomena involving just a few particles: The Efimov effect. In our recent work, we have extended our adiabatic hyperspherical representation to incorporate the effects of dipolar interaction, an important ingredient for studing few-body physics in ultracold dipolar gases. Even though a long-range anisotropic dipolar interaction has all the ingredients to "destroy" the Efimov effect, our work shows that not only does the effective attractive interaction that characterizes the Efimov effect persist, but also that the dipolar interaction is extremely beneficial for the study of the Efimov effect. We find dipolar Efimov states to be universal in the sense that the system has a universal three-body parameter. Consequently, energies of Efimov states in dipolar systems have a well-defined value and depend only on two-dipole physics. These states tend to be long-lived, making dipolar gases ideal candidates for studing Efimov states. In this talk, I will emphasize the importance of these findings and connect them to the theoretical extension of other few-body dipolar systems.

Resonances their relations to Spectral Densities and Scattering Cross Sections

Nils Elander[1,a],

[1] AlbaNova Univ. Ctr., Stockholm University, Sweden

[a] email: elander@fysik.su.se

Critical Stability, Erice, October 2011

In my talk will describe how resonance trajectories appear and how they are bounded on the complex energy plane. I will then introduce the mathematical spectral function and the spectral density. From there I will describe how the spectral density can be partitioned into contributions from uncovered resonances and the free particle spectral density. I will then turn to scattering cross section and discuss the influence of resonances on the cross section through a construction of a reduced partial wave S-matrix and a reduced partial wave cross section. This enables me to show that the Breit-Wigner formalism is not fully appropriate to describe a partial wave S-matrix and partial wave cross section.

Beyond the Efimov effect

Brett Esry[1,a], **Yujun Wang**[2], **Nicolais Guevara-Leon**[1]
[1]Kansas State University, USA,
[2]JILA, Colorado, USA
[a] email: esry@phys.ksu.edu

Critical Stability, Erice, October 2011

Few-body physics has seen a few rather dramatic experimental realizations of long-predicted Efimov physics in the last five years. These successes have come thanks to the unprecedented control that ultracold atomic gases afford for few-body systems. I will describe a new class of few-body states that might also be observable in ultracold systems. These states occur not for short-range two-body potentials, but rather for long-range $1/r^2$ potentials. Consequently, no scattering length can be defined in the usual sense, making the problem distinct from the Efimov scenario. Like the Efimov effect, however, an infinity of three-body bound states is possible even when there are no bound two-body states. I will discuss this point and our exploration of these novel states.

Collapse of Bose-Einstein condensate near Feshbach resonance in two-channel Gross-Pitaevskii model

Dmitri Fedorov[1,a], **Aksel Jensen**[1]
[1] Aarhus University, Denmark
[a] email: fedorov@phys.au.dk

Critical Stability, Erice, October 2011

Feshbach resonances are an experimental tool to effectively tune the inter-atomic interaction – in particular, the scattering length – in trapped cold gases. When the scattering length becomes large and negative, the condensed bose-gas collapses.

Theoretically condensates are often described using the Gross-Pitaevskii model with a variable-strength zero-range interaction which mimics phenomenologically the effects of Feshbach resonances.

We use here a Gross-Pitaevskii model with a two-channel zero-range potential which not only naturally describes the Feshbach resonance but also includes finite-range effects. We show that this model is able to naturally describe the collapse of the condensate, and we also compare the two-channel results with the ordinary single-channel Gross-Pitaevskii model.

Universality in Four-Boson Systems

Tobias Frederico[1,a], M. R. Hadizadeh[2], M.T. Yamashita[2], L. Tomio[2], A. Delfino[3]

[1] Instituto Tecnologico de Aeronautica, Sao Paulo, Brazil

[2] Instituto de Fisica Teorica-UNESP, Sao Paulo, Brazil

[3] Instituto de Fisica Univ Federal Fluminense, Brazil

[a] email: tobias@ita.br

Critical Stability, Erice, October 2011

The rich nature of quantum few-body systems interacting with short-ranged forces is not shaped only by three-body properties. Weakly-bound tetramers composed by identical bosons and their excited states have a characteristic scale, which is independent of the trimer one, for resonant pairwise interaction in the unitary limit (zero two-body binding or infinite scattering length. Such property can be revealed if one considers the general case, not constrained by some specific strong short-range interaction. The existence of an unsuspected new limit cycle is shown through calculations with Faddeev-Yakubovsky (FY) for a renormalized zero-range two-body interaction. The new limit cycle is expressed by an universal function relating the binding energies of two consecutive tetramer states, $B_4^{(N)}$ and $B_4^{(N+1)}$ (where for $N = 0$ we have the ground-state) and the corresponding three-body subsystem binding energy B_3 of an Efimov state [1]. We further derive that the $N+1$ tetramer emerges from the $3+1$ threshold for a universal ratio $B_4^{(N)} = 4.6\ B_3$, which does not depend on N. The tetramers move as the short-range four- body scale is changed. The existence of the new scale can be also revealed by a resonant atom-trimer relaxation. The resonant behavior arises when a tetramer becomes bound at the atom-trimer scattering threshold. Furthermore, the independent four-body scale implies in a family of Tjon lines in the general case. These findings give further support in favor of the independent role of a four-body scale near a Feshbach resonance and its implications for coldatoms.

Furthermore, we will present to some extend the momentum-space structure of the FY components of weakly-bound tetramers at the unitary limit [2]. We show that both channels of the FY decomposition [trimer plus atom (T+A), or $K-$type and dimer plus dimer (D+D), or $H-$type] present high momentum tails, which reflects the short-range four-body scale. We also found that the $H-$channel is favored over $K-$channel at low momentum when the four-body momentum scale largely overcomes the three-body one.

References

[1] M. R. Hadizadeh, M. T. Yamashita, Lauro Tomio, A. Delfino, T. Frederico, Phys. Rev. Lett. (2011); arXiv:1101.0378v1 [physics.atm-clus]

[2] M. R. Hadizadeh, M. T. Yamashita, Lauro Tomio, A. Delfino, T. Frederico, in preparation.

Study of $A \leq 6$ helium clusters using soft-core potentials

M. Gattobigio[1,a], **A. Kievsky**[2], **M. Viviani**[2]

[1] Université de Nice-Sophia Antipolis, INLN, CNRS
1361, routes des Lucioles, 06560 Valbonne, France
[2] Istituto Nazionale di Fisica Nucleare
Largo Pontecorvo 3, 56100 Pisa, Italy
[a] email: mario.gattobigio@inln.cnrs.fr

Critical Stability, Erice, October 2011

The helium-atom clusters have been the object of intense investigation both from a theoretical and experimental point of view. The interaction between helium atoms is such that the $^4\mathrm{He}_2$ molecule is one of the biggest diatomic molecule in nature; in spite of a range interaction of $\ell_{\mathrm{vdW}} \approx 10.2$ a.u., thus of a natural energy scale $\hbar^2/m\ell_{\mathrm{vdW}} \approx 400$ mK, the binding energy of the molecule is $E_2 \approx 1$ mK. In addition, also the value of the scattering length $a \approx 190$ a.u. is not natural, being $a \gg \ell_{\mathrm{vdW}}$.

The above properties place helium clusters in the frame of Efimov physics. As shown by Efimov, when at least two of the two-body subsystems present an infinitely large scattering length an infinite sequence of bound states (Efimov states) appear in the three-body system; their binding energies scale in a geometrical way and accumulate at zero energy. The scaling factor is universal and depends only on the ratio between particle masses, not on the details of the interaction.

When the ratio a/ℓ_{vdW} is large but finite, the number of Efimov states is finite. For the helium one expects only one Efimov state; indeed, the helium trimer has been produced, and its Efimov-like nature has been established.

The He-He ab-initio potentials show a sharp repulsion below an inter-particle distance of $r_0 \approx 5\,\mathrm{a.u.}$ This feature makes it difficult quantum mechanical calculations based on basis sets such as Hyperspherical Harmonics (HH). To overcome this problem, it has been proposed the use of soft-core potentials, with both two- and three-body terms, for the description of few-atoms systems, and it has been used to investigate the $^4\mathrm{He}_3$ [1].

We extend the use of the soft-core potentials to heavier-helium clusters, $^4\mathrm{He}_A$, with $A \leq 6$. We have performed the calculations using HH-expansion method with the technique recently developed by the authors; in our approach the HH basis is used without a previous symmetrization procedure. The aim of the study is twofold: first, we want to clarify the equivalence between hard- and soft-core-potential descriptions; the soft-core parameters are fixed by the two- and three-body low-energy physics, and then used to describe the helium clusters up to six particles. We find good agreement with previous calculations which used hard-core ab-initio potentials. Second, we investigate the Efimov physics in the four-, five-, and six-particle sectors; in agreement with the previous studies, we find two universal four-body states attached to each Efimov state. In addition, we also find two universal five- and six-particle bound states attached to each Efimov state and calculate universal ratio between binding energies.

References

[1] A. Kievsky, E. Garrido, C. Romero-Redondo, and P. Barletta Few-Body Syst (2011), in press

[2] M. Gattobigio, A. Kievsky, M. Viviani, and P. Barletta, Phys. Rev. A **79**, 032513 (2009)

[3] M. Gattobigio, A. Kievsky, and M. Viviani, Phys. Rev. C **83**, 024001 (2011)

[4] M. Gattobigio, A. Kievsky, and M. Viviani, arXiv:1106.3853v1 [physics.atm-clus] (2011)

AEGIS at CERN:
Measuring Antihydrogen Fall

Marco Giulio Giammarchi[1,a], **on behalf of the AEGIS Collaboration**
[1] Istituto Nazionale di Fisica Nucleare, via Celoria 16, 20133 Milano, Italy
[a] email: marco.giammarchi@mi.infn.it

Critical Stability, Erice, October 2011

AEGIS (Antimatter Experiment: Gravity, Interferometry, Spectroscopy) is an experiment at the CERN Antiproton Decelerator to study antimatter. The main goal of the AEGIS experimental programme is the test of fundamental laws such as the Weak Equilvalence Principle (WEP) and CPT symmetry. In the first phase of AEGIS, a beam of antihydrogen will be formed whose fall in the gravitational field will be measured in a Moire' deflectometer; this will constitute the first test of the WEP with antimatter.

References

[1] A. Kellerbauer et al. (AEGIS Collaboration), *Nucl. Instrum. & Methods B*, **266**, 351 (2008).

[2] R. Ferragut et al. (AEGIS Collaboration), *Canadian J. of Physics*, **89,** 17 (2011).

The LUNA experiment : direct measurement of thermonuclear cross sections of astrophysical interest

Alessandra Guglielmetti[1,a]
[1]Universita' degli Studi di Milano and INFN Milano
[a] email: alessandra.guglielmetti@mi.infn.it

Critical Stability, Erice, October 2011

The LUNA (Laboratory for Underground Nuclear Astrophysics) experiment has been measuring nuclear cross sections of astrophysical interest since 1990. Two accelerators have been installed underground in the Gran Sasso laboratory where the cosmic bakground is very much reduced with respect to a laboratory on the Earth's surface. Therefore, a direct measurement of thermonuclear cross sections belonging to the pp chain or to the CNO cycle of Hydrogen burning or essential for the big bang nucleosynthesis is possible even if the expected rate is extremely low. After a general introduction,the most important results obtained up to now will be reviewed and their astrophysical implications discussed. The future perspectives of the LUNA experiment will also be presented.

Quantum coherence in many-body systems

Paul-Antoine Hervieux[1,a]
[1]Université de Strasbourg, France
[a] email: paul-antoine.hervieux@ipcms.u-strasbg.fr

Critical Stability, Erice, October 2011

A particularly attractive estimation of the coherence of a quantum system is provided by the Loschmidt echo (or quantum fidelity), which is a measure of the reversibility properties of the system. Most existing results are restricted to single-particle systems evolving in a given Hamiltonian. Our team has extended these studies to systems of interacting particles, revealing an anomalous behaviour of the quantum fidelity, which drops suddenly after an initial quiescent period [1].

The common feature of these investigations was that the inter-particle interaction is treated within the mean field approximation. The exact dynamics of the quantum fidelity for a system of N electrons is an open question of fundamental interest, particularly because confined few-electron systems can nowadays be realized in practice using semiconductor quantum dots [2].

In the framework of a collaboration with the Technical University of Munich (Germany) and the University of Louvain-la-Neuve (Belgium), we are currently developing a numerical approach to study the quantum fidelity for a few-body system of interacting electrons. The goal of this research project is to develop a computationally exact treatment of the quantum evolution of few electrons confined in a two-dimensional harmonic potential with a quartic perturbation and full Coulomb electron-electron interactions. The quantum fidelity provides crucial information on the stability (sometimes critical) and coherence of few-body systems, with both fundamental and practical implications for emerging fields of research such as quantum computing.

References

[1] G. Manfredi and P.-A. Hervieux, Phys. Rev. Lett. 97, 190404 (2006); Phys. Rev. Lett. 100, 050405 (2008); New J. Phys. 11, 013050 (2009).

[2] T. Sako, P. -A. Hervieux and G. H. F. Diercksen, Phys. Rev. B 74, 045329 (2006).

Resonant and bound states of ${}^{10}_{\Lambda}$Be and ${}^{10}_{\Lambda}$B with the four-body cluster model

Emiko Hiyama[1,a]

[1]RIKEN, Japan

[a] email: hiyama@riken.jp

Critical Stability, Erice, October 2011

One of the primary goals in hypernuclear physics is to extract information about baryon-baryon interactions in a unified way. By making use of the hyperon(Y)-nucleon(N) scattering data and the rich NN data complementarity, several types of the YN/YY interaction models have been proposed on the basis of the SU(3) and SU(6) symmetries. However, these YN/YY interaction models have a great deal of ambiguity at present, since the YN scattering experiments are extremely limited and there is no YY scattering data. Therefore, it is important to extract useful information on YN/YY interactions from studies of hypernuclear structures. In the case of ΛN sectors, the results of the high-resolution γ-ray experiments have been quite important for such a purpose, where level structures of Λ hypernuclei can be determined within order of keV.

In this work, on the basis of our previous studies, we investigate structures of ${}^{10}_{\Lambda}$Be ($\alpha\alpha n\Lambda$) and ${}^{10}_{\Lambda}$B ($\alpha\alpha p\Lambda$) and properties of underlying ΛN interactions therein. These Λ hypernuclei provided us many interesting subjects so far. For example, aiming to study ΛN spin-dependent interactions, the high-resolution γ-ray experiment has been performed to measure the splitting energy of 1^--2^- of ${}^{10}_{\Lambda}$B at BNL-E930. However, they could observe no energy splitting: this means that the excited 2^- state lies by less than 100 keV above the ground 1^- state, or the ground state in this hypernucleus is of a 2^- state. It should be noted here that the ^{10}B(K^-, π^-) reaction produce the 2^- state far more strongly than the 1^- state, and then the ordering of 1^--2^- states cannot be obtained from the data of the peak structure in this reaction. For instance, it has to be determined by observing the pionic decay whether the ground state is of a 1^- or 2^- state.

Another interesting subject is the charge symmetry breaking (CSB) components in ΛN interactions. It is considered that the most reliable evidence for the CSB interaction appears in the Λ binding energies B_Λ of the $A = 4$ members with $T = 1/2$ (${}^{4}_{\Lambda}$He and ${}^{4}_{\Lambda}$H). Then, the CSB effects are attributed to the differences $\Delta_{CSB} = B_\Lambda({}^{4}_{\Lambda}\mathrm{He}) - B_\Lambda({}^{4}_{\Lambda}\mathrm{H})$, the experimental values of which are 0.35 ± 0.06 MeV and 0.24 ± 0.06 MeV for the ground (0^+) and excited (1^+) states, respectively. There exist mirror hypernuclei in the p-shell region such as the $T = 1$ multiplet with $A = 7$ (${}^{7}_{\Lambda}$He, ${}^{7}_{\Lambda}$Li*, ${}^{7}_{\Lambda}$Be), $T = 1/2$ multiplet with $A = 8$ (${}^{8}_{\Lambda}$Li, ${}^{8}_{\Lambda}$Be), $T = 1/2$ multiplet with $A = 10$ (${}^{10}_{\Lambda}$Be, ${}^{10}_{\Lambda}$B), and so on.

For ${}^{10}_{\Lambda}$Be, hypernuclear experiment of ${}^{10}_{\Lambda}$B $(e, e'K^+){}^{10}_{\Lambda}$Be was performed at Thomas Jefferson National Laboratory and the analysis is in progress. In this experiment, it is possible to measure resonant states as well as bound states. Then, it is required to predict theoretically.

For this purpose, the theoretical results of ${}^{10}_{\Lambda}$Be will be reported within the framework of $\alpha+\alpha+\Lambda+N$ four-body model in the workshop.

Near-Far Description of Elastic and Breakup Reactions of Halo Nuclei

Mahir Hussein[1,a]

[1]University of Sao Paulo, Brazil

[a] email: hussein@if.usp.br

Critical Stability, Erice, October 2011

The angular distributions for elastic scattering and breakup of halo nuclei are analysed using a near-side/far-side decomposition within the framework of the dynamical eikonal approximation. This analysis is performed for ^{11}Be impinging on Pb at 69 MeV/nucleon. These distributions exhibit very similar features. In particular they are both near-side dominated, as expected from Coulomb-dominated reactions. The general shape of these distributions is sensitive mostly to the projectile-target interactions, but is also affected by the extension of the halo. This suggests the elastic scattering not to be affected by a loss of flux towards the breakup channel.

Leaky Repeated Interaction Quantum Systems

Alain Joye[1,a], **Laurent Bruneau**[2], **Marco Merkli**[3]

[1]Institut Fourier, Université de Grenoble, France

[2] Université de Cergy-Pontoise, France

[3] Memorial University, St John's, Canada

[a] email: alain.joye@ujf-grenoble.fr

Critical Stability, Erice, October 2011

We consider a model of a one-atom maser that consists in the following ingredients: a small reference system S corresponding to one mode of the EM field in a laser cavity, an infinite chain C of identical independent quantum subsystems E, corresponding to a sequence of atoms passing through the laser cavity, and heat reservoir R modeling the losses in the device. On the one hand the system S interacts for a fixed duration with the successive elements E of the chain C, and, on the other hand, it interacts continuously with the reservoir R. We describe the large time behaviour of the fully coupled system S+R+C, its asymptotic state and the exchanges between the chain and the reservoir in the large times limit.

On the breakup of ^{12}C resonances into three α particles

Oliver Kirsebom[1,2,a]
[1]Aarhus University, Denmark
[2] TRIUMF, Vancouver, Canada
[a] email: oliver.kirsebom@gmail.com

Critical Stability, Erice, October 2011

Data from a recent experiment, in which the momenta of α particles from the three-alpha breakup of ^{12}C resonances were measured, will be presented and compared to the predictions of different theoretical models. The following questions will be addressed: What can the momentum distribution of the α particles teach us about the symmetries and dynamics of the three-α system that forms in the breakup process? And what (if anything) can the momentum distribution of the α particles teach us about the structure of the initial nuclear resonance which does not necessarily resemble that of three interacting α particles?

Universal and non-universal Efimov physics with strongly interacting atoms

Servaas Kokkelmans[1,a]
[1] Eindhoven University of Technology, The Netherlands
[a] email: s.kokkelmans@tue.nl

Critical Stability, Erice, October 2011

We observed the existence of a universal regime for Efimov trimers through three-body recombination loss in the vicinity of a Feshbach resonance, for ultracold ^{7}Li atoms. The reported results crucially depend on a careful mapping of the scattering length on the magnetic field. We characterize two broad Feshbach resonances in different spin states via the binding energies of weakly bound molecules, created by radio-frequency association, by making use of a theoretical coupled channels analysis.

We also investigate the possibility to stabilize Efimov trimers in optical lattices. We present universal solutions of three bosons in a harmonic potential, for all ranges of the scattering length and harmonic oscillator length. We compare our results to the limiting cases, such as that of a vanishing trapping potential. The combination of being able to tune both length parameters gives rise to quite distinct solutions of these trimers, and allows for minimizing the inelastic losses.

Application of the complex-scaling method for few-body scattering

Rimantas Lazauskas[1,a]
[1]IPHC, Strasbourg, France
[a] email: rimantas.lazauskas@ires.in2p3.fr

Critical Stability, Erice, October 2011

Formalism based on complex-scaling method will be presented, which enables solution of the few-body scattering problem using trivial boundary conditions. Several applications will be presented proving efficiency of the method in describing elastic and three-body break-up reactions for Hamiltonians which may include both short-range and Coulomb interaction.

Correlation properties of few charged bosons in anisotropic traps

Anna Okopinska[1,a], **Przemyslaw Koscik**[1]

[1]Jan Kochanowski University, Kielce, Poland

[a] email: okopin@fuw.edu.pl

Critical Stability, Erice, October 2011

We study systems composed of up to four charged bosons within strongly anisotropic traps. A detailed examination of the correlation properties is carried out within the framework of the single-mode approximation of the transverse component. The correlation entropy of the quasi-one dimensional systems is discussed in dependence on the confinement anisotropy and the interaction strength. A comparison with a strictly one-dimensional limit is performed.

Study of frame dependence of response functions

Guiseppina Orlandini[1,a]

[1] University of Trento, Italy [a] email: orlandin@science.unitn.it

Critical Stability, Erice, October 2011

I intend first to introduce the response function as a general observable common to many fields of physics and describe how it can be calculated ab initio also in the continuum regime.

Then I will discuss results obtained in different frames for the 3-body system and for different operators. Quantitative estimates of the limits of the non relativistic quantum mechanical framework will be given.

Models of interaction and few-body problems in ultra-cold physics

Ludovic Pricoupenko[1,a]

[1]LPTMC, Université Pierre et Marie Curie, Paris, France

[a] email: pricoupenko@lptmc.jussieu.fr

Critical Stability, Erice, October 2011

Ultra-cold atoms permit to explore few-body 3D or 2D systems in regimes where two-body scattering is resonant. The zero-range approximation of the pairwise interaction is especially adapted to the so-called unitary regime, while for a large but finite scattering length or also in p wave resonances, more detailed approaches are needed for describing few-body systems. In this talk, we show the interest of different models of interaction in the analysis of several few-body properties found recently. In particular, the separable two-channel model which encapsulates the Feshbach resonance mechanism appears as a relevant tool for ultra-cold atoms and the description of deviations to universal laws while leading to integral equations having the same degree of complexity as zero-range approaches.

Analytic structure and power-series expansion of the Jost matrix

S. A. Rakityansky[1,a], **N. Elander**[2]

[1] Dept. of Physics, University of Pretoria, South Africa

[2] Dept. of Physics, Stockholm University, Sweden

[a] email: rakitsa@up.ac.za

Critical Stability, Erice, October 2011

The N-channel Schrödinger equation has exactly N linearly independent regular solutions. Each of them is a column-matrix of the length N. Written next to each other, they form a square $N \times N$-matrix $\Phi(E,r)$, which is called the fundamental matrix of regular solutions. Any physical solution is a linear combination of its columns. Asymptotically, $\Phi(E,r)$ behaves as the superposition $\Phi(E,r) \underset{r\to\infty}{\longrightarrow} W^{(\mathrm{in})}(E,r)F^{(\mathrm{in})}(E) + W^{(\mathrm{out})}(E,r)F^{(\mathrm{out})}(E)$ of the incoming and outgoing multi-channel spherical waves $W^{(\mathrm{in/out})}$ (composed of the Riccati-Hankel functions). The energy dependent amplitudes $F^{(\mathrm{in/out})}(E)$ of these waves are the Jost matrices that determine the S-matrix: $S = F^{(\mathrm{out})}\left[F^{(\mathrm{in})}\right]^{-1}$. For a short-range interaction, at each threshold energy $\mathcal{E}_n$ (where a channel momentum $k_n = \sqrt{2\mu_n(E-\mathcal{E}_n)}$ is zero) the Jost matrices have a branching point. Separating the odd powers of all k_n and then expanding the remaining single-valued functions of E in power series near an arbitrary point E_0, we obtain the following expansions for the elements of the Jost matrices

$$F_{mn}^{(\mathrm{in/out})}(E) = \sum_{j=0}^{\infty}(E-E_0)^j\left[\frac{k_n^{\ell_n+1}}{2k_m^{\ell_m+1}}(a_j)_{mn} \mp i\frac{k_m^{\ell_m}k_n^{\ell_n+1}}{2}(b_j)_{mn}\right], \quad (1)$$

where ℓ_n are the channel angular momenta and the energy-independent matrices a_j and b_j can be obtained as asymptotic values of the solutions of a set of simple differential equations. This approach generalizes the standard effective-range expansion that now can be done not only near the threshold, but near an arbitrary point on the Riemann surface of the energy within the domain of analyticity. The semi-analytic expression (1) for the Jost-matrix (and therefore for the S-matrix) can be used to locate the spectral points (bound and resonant states) as the S-matrix poles. Alternatively, it can be used for extracting the resonance parameters from experimental data. In doing this, the coefficients $(a_j)_{mn}$ and $(b_j)_{mn}$ can be treated as fitting parameters to reproduce experimental data on the real axis (near a chosen E_0) and then the functions (1) can be used at the nearby complex energies for locating the resonances. Similarly to Eq. (1), which is valid in three-dimensional space, we obtained the expansions for the Jost functions describing the systems in a space of an even dimension, where the logarithmic branching points are present.

Exotic atoms in two dimensions

Jean-Marc Richard[1,a], **Monique Combescure**[1], **Claude Fayard**[1], **Avinash Khare**[2]

[1]IPNL, IN2P3 & University of Lyon, France

[2] Raja Ramanna Fellow, IISER, Pune 411021, India

[a] email: j-m.richard@ipnl.in2p3.fr

Critical Stability, Erice, October 2011

Exotic atoms were first studied as the strong interaction supplementing the Coulomb potential in atoms where an electron is replaced by a negatively-charged hadron. The energy shift is usually rather accurately described by a formula due to Deser et al. and Truemann, except in the situation where the hadronic scattering becomes very large.

The problem can be generalised to a variety of problems where a short-range potential is added to a long-range one. For a review, see, e.g., [1], with in particular a discussion about the phenomenon of *level rearrangement* which is observed when a zero-energy bound state occurs in the short-range part of the interaction.

Recently, the case of two space-dimensions has been studied [2]. The energy shift is given by a Deser–Truemann type of formula

$$\delta E \simeq \frac{A}{\ln a/R} \ , \tag{2}$$

where A is the square of the unperturbed wave function at the origin, and a the scattering length in the short-range potential.

The quantity R is more delicate: it is related to the derivative with respect to the energy of the coefficient of $\sqrt{r}$ in the solution of unperturbed radial equation that is regular at large distances. As seen in the example displayed in Fig. 1, the energy shift given by this formula reproduces quite well the exact energy obtained from a numerical calculation and improves the result of ordinary perturbation theory.

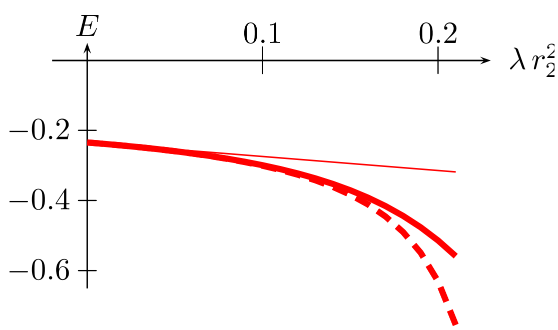


Figure 1: Energy in a 2D exponential well supplemented by another exponential of shorter range. Thick line: exact, dashed line: equation (2), thin line: perturbation theory. We use here $V = -g_1 \exp(-r/r1) - \lambda \exp(-r/r_2)$ with $r_1 = 2$, $g_1 = 1$ and $r_2 = 0.02$.

References

[1] Monique Combescure, Avinash Khare, Ashok Raina, Jean-Marc Richard, Carole Weydert, "Level Rearrangement in Exotic Atoms and Quantum Dots", Int. J. Mod. Phys. B, **21** (2007) 3765.

[2] Monique Combescure, Claude Fayard, Jean-Marc Richard, Avinash Khare, "Exotic atoms in two dimensions", J. Phy. A: Math. Gen., **44** (2011) A265302.

Effective Field Theory for light nuclear systems

Jimmy Rotureau [1,a]

[1] Chalmers University, Gothenburg, Sweden

[a] email: rotureau@chalmers.se

Critical Stability, Erice, October 2011

Systems with large scattering length a_2 are of particular interest since they exhibit universal properties when particle momenta are small compared to $1/r_0$ with r_0 being the range of the interaction. This situation occurs for instance, in nuclear physics where the two-nucleon system has two S-wave channels where $a_2 \gg r_0$. Using the principles of the pionless Effective Field Theory (EFT), two-nucleon and three-nucleon interactions can be constructed as controllable series of contact interactions with an increasing number of derivatives. The many-body dynamics of few-nucleon systems can then be described by solving the Schrödinger equation with the No Core Shell Model formalism. In [1] we described few-fermion systems trapped within a harmonic oscillator potential characterized by the frequency ω and interacting with EFT potentials constructed up to Next-to-Next-to-Leading-Order(N^2LO). In [2] using the same method, we have considered trapped few-nucleon systems : in that case, the trap is just an artefact allowing us to fix the coupling constants in the EFT expansion and eventually, the trap needs to be removed. During my presentation, I will show results for the three-nucleon and four-nucleon systems as the frequency ω of trap approaches zero.

The nuclei located in the vicinity of drip-lines have very different properties from the well-bound systems in the valley of stability. Typical examples of such peculiar features are for instance, the appearance of halo configuration and the presence of strong couplings to the continuum. In a second part of my talk, I will present a description of the halo nucleus ^{6}He, as a three-body system with interactions constructed using the halo-EFT formalism. The three-body dynamics is solved using the Gamow Shell Model which is a shell model approach where the coupling to the continuum is explicitly taken into account.

References

[1] J. Rotureau, I. Stetcu, B. R. Barrett, M. C. Birse, and U. van Kolck , Phys. Rev. A 82, 032711 (2010).

[2] J. Rotureau, I. Stetcu, B. R. Barrett and U. van Kolck , in preparation.

Dynamical properties of the unitary Fermi gas: collective modes and shock waves

Luca Salasnich[1,a]

[1]Department of Physics, University of Padova, Italy

[a] email: luca.salasnich@unipd.it

Critical Stability, Erice, October 2011

The unitary Fermi gas made of dilute and ultracold atoms with an infinite s-wave inter-atomic scattering length is discussed. First we introduce an efficient Thomas-Fermi-von Weizsacker density functional which describes accurately the density profile of the unitary Fermi gas trapped by an external potential. Then, the collective frequencies of monopole, quadrupole and octupole oscillations are derived from superfluid hydrodynamic equations which are the time-dependent extension of the Thomas-Fermi-von Weizsacker density functional. Finally, we show that this amazing Fermi gas supports supersonic and subsonic shock waves.

References

[1] L. Salasnich and F. Toigo, "Extended Thomas-Fermi Density Functional for the Unitary Fermi Gas", Phys. Rev. A 78, 053626 (2008).

[2] L. Salasnich, F. Ancilotto, and F. Toigo, "Surface Effects in the Unitary Fermi Gas", Laser Phys. Lett. 7, 78-83 (2010).

[3] L. Salasnich, "Low-temperature thermodynamics of the unitary Fermi gas: superfluid fraction, first sound and second sound", Phys. Rev. A 82, 063619 (2010).

[4] L. Salasnich, "Supersonic and subsonic shock waves in the unitary Fermi gas", submitted for publication (2011).

Exploring the pion phenomenology within a fully covariant constituent quark model

Giovanni Salmè[1,a]

[1]Istituto Nazionale di Fisica Nucleare, Roma, Italy

[a] email: giovanni.salmeg@roma1.infn.it

Critical Stability, Erice, October 2011

Within a fully covariant constituent quark model, based on i) a phenomenological Ansatz of the Bethe-Salpeter amplitude describing the quark-pion vertex and ii) the Mandelstam description of the hadronic tensor, we have investigated both generalized parton distributions and transverse momentum distributions of the pion. The carefully comparison of our results with the available *i)* Experimental data (spacelike elastic form factor and parton distribution) and *ii)* Lattice data (generalized form factors for both no-spin flip and tensor cases), has shown that a surprisingly good description can be achieved, despite a relatively simple product form for the covariant Ansatz of the pion. This gives us confidence to extend our fully covariant approach by considering dynamical inputs through the so-called Nakanishi integral representation of the quark-pion vertex.

Unquenching the quark model

Elena Santopino[1,a]

[1]INFN, Genova, Italy

[a] email: santopinto@ge.infn.it

Critical Stability, Erice, October 2011

The formalism for a new generation of Constituent Quark Models, in which the higher Fock components of the baryon wave functions are explicitly and systematically introduced through a QCD inspired 3P0 pair-creation mechanism, has been recently constructed [1]. This unquenching of the Quark Model will be presented discussed. It will be shown how after renormalization, the unquenching [1] is able to preserves the phenomenological successes of the old constituent quark model, but opening the possibility to address open problems in hadron structure and spectroscopy. Interesting results for the spin of the proton [1] and the flavor asymmetry of the nucleon sea [2] will be presented. New results on open problems in hadron spectroscopy and structure will be presented.

References

[1] R. Bijker and E. Santopinto, Phys. Rev. C80, 065210 (2009).

[2] E. Santopinto and R. Bijker, Phys. Rev. C82, 062202R (2010).

Finite-range and Mean-field Effects in Recombination Rate of Trapped Cold Atomic Gasses

Peder K. Sørensen[1,a], **D. V. Fedorov**[1], **A. S. Jensen**[1]

[1] Department of Physics and Astronomy, Aarhus University, Denmark

[a] email: pks05@phys.au.dk

Critical Stability, Erice, October 2011

The zero-range model subjects free solutions to the Schrödinger equation to the Bethe-Peierls boundary condition at zero separation as a way of implementing the scattering length. The range of the potential can be incorporated by using the effective range expansion in the boundary condition [1]. This removes the problematic Thomas collapse yet the Efimov effect remains. Alternatively, a multichannel model [2] not only has finite effective range but also naturally describes the otherwise phenomenological dependence of the scattering length on applied magnetic field as utilised in Feshbach resonance techniques.

We calculate the recombination rate of cold bosonic gases within the three-body hidden crossing theory [3], and investigate finite-range effects by comparing the results from the zero-range and finite-range models.

Finally we extend the model to include many-body effects through the mean-field and investigate how this affects the recombination rate.

References

[1] D. V. Fedorov and A. S. Jensen. Regularization of a three-body problem with zero-range potentials. *Journal of Physics A*, 34(30):6003, 2001.

[2] J. H. Macek. Multichannel zero-range potentials in the hyperspherical theory of three-body dynamics. Few-Body Systems, 31:241?248, 2002.

[3] E. Nielsen and J. H. Macek. Low-energy recombination of identical bosons by three-body collisions. Phys. Rev. Lett., 83(8):1566?1569, Aug 1999.

New advances in the Trojan Horse Method as an indirect approach to nuclear astrophysics

Aurora Tumino[1,a]

[1] Laboratori Nazionali del Sud - INFN, Catania, Italy and

Universitá degli Studi di Enna "Kore", Enna Italy

[a] email: tumino@lns.infn.it

Critical Stability, Erice, October 2011

According to our knowledge, the source of energy that sustains burning stars for millions to billions of years is represented by nuclear reactions which are responsible also for the continual conversion of one element to another inside them. Over the past fourty years nuclear physicists have been trying to measure the rates of the most relevant reactions, but there is still considerable uncertainty about their values. Although the stellar temperatures are high, on the order of hundred million degrees, they correspond to sub-Coulomb energies. As a consequence, the Coulomb barrier causes a strong suppression of the cross-section, which drops exponentially with decreasing energy. Thus, the corresponding reaction rates are extremely small , making it difficult for them to be measured directly in the laboratory. In addition, the electron screening effect due to the electrons surrounding the interacting ions prevents one to measure the bare nucleus cross-section. Typically, the standard way to get the ultra-low energy bare nucleus cross-section consists in a simple extrapolation of available higher energy data. This is done by means of the definition of the astrophysical S(E) factor which represents essentially the cross-section free of Coulomb suppression. However, the extrapolation may introduce additional uncertainties due for instance to the presence of unexpected resonances or to high energy tails of subthreshold resonances. A valid alternative approach is represented by the Trojan Horse Method (THM) [1, 2] that provides at present the only way to measure the bare nucleus S(E) factor down to the relevant ultra-low energies, overcoming the main problems of direct measurements. The THM selects the quasi-free (QF) contribution of an appropriate three-body reaction $A + a \to c + C + s$ performed at energies well above the Coulomb barrier to extract the cross section of a charged particle two-body process $A + x \to c + C$ in the Gamow energy window. This is done with the help of direct theory assuming that the nucleus a is described in terms of the x+s cluster structure. The THM has been successfully applied to several reactions connected with fundamental astrophysical problems [3, 4, 5]. I will recall the basic ideas of the THM and show some recent results.

References

[1] C. Spitaleri *et al.*, Phys. Rev. C **63**, 005801 (2001).

[2] A.M. Mukhamedzhanov *et al.* J. Phys. G: Nucl. Part. Phys. **35**, 014016 (2008).

[3] A. Tumino *et al.*, Phys. Rev. **67**, 065803 (2003).

[4] M. La Cognata *et al.*, Astrophysical J. **708**, 796 (2010) and references therein.

[5] A. Tumino *et al.*, Phys. Lett. B **700**, 111 (2011).

Fermionic Efimov States

Masahito Ueda[1,a]

[1]University of Tokyo, Japan

Critical Stability, Erice, October 2011

Recent theoretical and experimental efforts to create and understand the Efimov states in a three-component mixture of ^{6}Li are reviewed [1,2]. It is pointed out that the recently observed loss peaks at 602G and 685G [3,4], which are the crossing points of the atom-dimer threshold and the ground and first excited Efimov states, show significant deviations from the universal Efimov theory predictions. The Efimov binding energy, which was observed via radio-frequency association, shows a marked temperature dependence and its temperature-independent part shows significant deviations from nonuniversal theory prediction based on a three-body parameter with a monotonic binding-energy dependence [5,6].

References

[1] P. Naidon and M. Ueda, Phys. Rev. Lett. 103, 073203 (2009).

[2] P. Naidon and M. Ueda, Comp. Rend. Phys. v. 12, iss. 1, p. 13 (2011).

[3] S. Nakajima, et al., Phys. Rev. Lett. 105, 023201 (2010).

[4] T. Lompe, et al., Phys. Rev. Lett. 105, 103201 (2010).

[5] T. Lompe, et al., Science 330, 940 (2010).

[6] S. Nakajima, et al., Phys. Rev. Lett. 106, 143201 (2011).

Recent progress in ab-initio four-body scattering calculations

Michele Viviani[1,a]

[1] INFN, Sezione de Pisa, Italy

[a] email: michele.viviani@pi.infn.it

Critical Stability, Erice, October 2011

In this contribution, we discuss some recent developments in the study of four-nucleon scattering. In the first part of the talk, we will focus on n-^{3}H and p-^{3}He elastic scattering below the trinucleon disintegration thresholds, where a detailed comparison between the phase-shifts calculated using three different theoretical approaches (the Alt, Grassberger-Sandhas, Hyperspherical-Harmonics, and Faddeev-Yakubovsky methods) has been recently completed. Moreover, we will report on the study of the charge exchange reaction ^{3}He(n,p)^{3}H reaction. In the second part of the talk, we will discuss the calculation of the longitudinal asymmetry induced by parity-violating (PV) components in the nucleon-nucleon interaction in the ^{3}He(n,p)^{3}H reaction.

Few-body structure of polar molecules in two dimensions

Artem Volosniev[1,a], Dmitri Fedorov[1], Aksel Jensen[1], Nikolaj Zinner[1]

[1]Aarhus University, Denmark

[a] email: artem@phys.au.dk

Critical Stability, Erice, October 2011

We investigate two, three and four polarized cold dipolar molecules in layered structures [1]. We first study the two-body problem with anisotropic potential. We found numerically that the two particles always form a bound state. We shall give analytical expressions for energies and wave functions in the weak coupling limit where universality or model independence are approached, and the binding energy is extremely small [2,3]. The universal limit is essentially reached for experimentally accessible strengths. We compare analytic and numerical results obtained by the stochastic variational method.

We then turn to three identical dipolar molecules occupying only two layers. We show that all these structures are unbound but a reduction of the in-layer repulsion to about one third of the natural value would lead to binding. Extension to four dipolar molecules in two planes are always unbound. Two molecules in a central layer with one molecule in each of the neighboring layers is the structure closest to forming a stable four-body configuration with energy below the threshold energies. We calculate numerically the repulsion reduction in the central layer necessary to provide stability for both bosons and fermionic systems. We shall discuss the different two-dimensional few-body configurations, their structures and energies.

References

[1] J. R. Armstrong, N. Y. Zinner, D. V. Fedorov, A. S. Jensen, J. Phys. B: At. Mol. Opt. Phys. - B/374825/PAP/197920

[2] A. G. Volosniev, N. T. Zinner, D. V. Fedorov, A. S. Jensen, Phys. Rev. Lett. **106** (2011), 250401.

[3] A. G. Volosniev, N. T. Zinner, D. V. Fedorov, A. S. Jensen, B. Wunsch, J. Phys. B, **44** (2011), 125301

Scales and Universality in three-body systems

Marcelo Yamashita[1,a]
[1] Sao Paulo State University - Institute of Theoretical Physics, Brazil
[a] email: yamashita@ift.unesp.br

Critical Stability, Erice, October 2011

In this presentation we will review the role of scales in the physics of large three-body systems. It will be considered weakly-bound three particles with point-like interactions with a renormalization scheme characterized by the emergence of physical scales fixed by observables. The results will be presented in a form of universal scaling plots in the nuclear and atomic contexts. We will also show some results with finite range potentials and the corresponding range corrections in our scaling functions.

Efimov Physics in a Many-Body Background

Nikolaj Zinner[1,a], **Nikolai Nygaard**[1]
[1]Aarhus University, Denmark
[a] email: zinner@phys.au.dk

Critical Stability, Erice, October 2011

Recent success in the field of ultracold atomic gases has lead to the identification of universal low-energy three-body bound states as predicted by Efimov four decades ago. Some of these experiments are performed at such low temperatures that the three-body states have a background which can be a condensate or a degenerate Fermi gas. An interesting question is how this background will influence the properties of the Efimov states. We make an attempt to answer such a question in the case of a multi-component Fermi system.