Q 26: Quantengase: Fermionen

Zeit: Dienstag 16:30–18:00 Raum: VMP 6 HS-A

Q 26.1 Di 16:30 VMP 6 HS-A

Rotating Fermi Gases in an Anharmonic Trap — Kiel Howe[1], •Aristeu Rosendo Pontes Lima[2], and Axel Pelster[2,3] — [1]Department of Physics, University of Arizona, Tucson, AZ 85721, USA — [2]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [3]Fachbereich Physik, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany

Motivated by recent experiments on rotating Bose-Einstein condensates, we investigate a rotating, polarized Fermi gas trapped in an anharmonic potential [1]. We apply a semiclassical expansion of the density of states in order to determine how the thermodynamic properties depend on the rotation frequency. The accuracy of the semiclassical approximation is tested and shown to be sufficient for describing typical experiments. At zero temperature, rotating the gas above a given frequency $\Omega_{\rm DO}$ leads to a 'donut'-shaped cloud which is analogous to the hole found in two-dimensional Bose-Einstein condensates. The free expansion of the gas after suddenly turning off the trap is considered and characterized by the time and rotation frequency dependence of the aspect ratio. Temperature effects are also taken into account and both low- and high-temperature expansions are presented for the relevant thermodynamical quantities. In the high-temperature regime a virial theorem approach is used to study the delicate interplay between rotation and anharmonicity.

[1] K. Howe, A. R. P. Lima, and A. Pelster, `arXiv:0810.4983`

Q 26.2 Di 16:45 VMP 6 HS-A

Interference of Two Molecular Bose-Einstein Condensates — •Christoph Kohstall[1,2], Stefan Riedl[1,2], Edmundo R. Sánchez Guajardo[1,2], Leonid A. Sidorenkov[1], Johannes Hecker Denschlag[1], and Rudolf Grimm[1,2] — [1]Inst. of Experimental Physics and Center for Quantum Physics, Univ. Innsbruck, 6020 Innsbruck, Austria — [2]Inst. for Quantum Optics and Quantum Information, Acad. of Science, 6020 Innsbruck, Austria

Interference of Bose-Einstein condensates (BEC) strikingly demonstrates the wave nature of matter. In this talk, we present the observation of interference of BECs made of molecules. Our starting point is a BEC of weakly bound Feshbach dimers consisting of fermionic lithium atoms in two different spin states. The condensate is split by slowly changing the trapping potential into a double well. Then, the two clouds are released and overlap. We record high-contrast interference fringes by absorption imaging. We explore different scenarios that affect the contrast of the interference fringes. First, contrast is lost when the interaction strength between the molecules is increased. The mean field of one cloud repels the other and the overlap is disturbed. Second, the contrast periodically changes when we excite collective modes along the line of sight. We attribute the change in contrast to the spatial change of the relative phase between the two clouds.

Q 26.3 Di 17:00 VMP 6 HS-A

Thermodynamic and Dynamic Properties of a Dipolar Fermi Gas — •Aristeu Rosendo Pontes Lima[1] and Axel Pelster[1,2] — [1]Institut für Theoretische Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg, Germany

We present a variational Hartree-Fock approach to treat a Fermi gas of fully polarized particles interacting through a dipole-dipole potential. Starting from a Thomas-Fermi approximation for the Wigner function, we obtain analytical information on this system from a parabolic ansatz, which is exact in the non-interacting limit and discuss the resulting equilibrium properties of the cloud. For example, we analyze the how the Thomas-Fermi radii, the aspect ratio and the release energy depend on the dipolar interaction strength. We confirm the numerically indicated nonexistence of absolute stability [1] and attribute it to the incapability of the Fermi pressure to suppress the attractive part of the dipole-dipole interaction. This is in contradiction to the dipolar Bose gas [2], which is stabilized by the contact interaction. Furthermore, we analyze the frequencies of the collective oscillations of a dipolar Fermi gas within a variational sum-rule approach.

[1] L. He, J.-N. Zhang, Y. Zhang, and S. Yi, Phys. Rev. A **77**, 031605(R) (2007)

[2] C. Eberlein, S. Giovanazzi, and D.H.J. O'Dell, Phys. Rev. A **71**, 033618 (2005)

Q 26.4 Di 17:15 VMP 6 HS-A

Freaky phase from frosty fermions: a geometric phase in BCS-BEC crossover — •Bernhard M. Breid and James R. Anglin — Technische Universität Kaiserslautern, Germany

The formation of a molecular Bose-Einstein condensate (BEC) from a BCS state of fermionic atoms as a result of slow sweeping through a Feshbach resonance is analyzed. We apply a path integral approach using adiabatic approximations to solve for an effective action for the molecules. The non-standard aspects of the resulting effective action and its effect on semiclassical dynamics are discussed. Considering this time-dependent process as an analogue of the cosmological Zurek scenario, we compare the way condensate growth is driven in this rigorous theory with its phenomenological description via time-dependent Ginzburg-Landau theory.

[1] B. M. Breid and J. R. Anglin, *Phil. Trans. R. Soc. A* (2008) **366**, 2813-2820

Q 26.5 Di 17:30 VMP 6 HS-A

Stability of the three-component ^{6}Li^{40}K Fermi mixture with a single resonant interaction — •Andreas Trenkwalder[1], Frederik Spiegelhalder[1], Eric Wille[1], Devang Naik[1], Gerhard Hendl[1], Florian Schreck[1], and Rudolf Grimm[1,2] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Experimentalphysik und Zentrum für Quantenphysik, Universität Innsbruck, Innsbruck, Austria

We report on the stability of a strongly interacting ^{6}Li two-component mixture in presence of weakly interacting ^{40}K. The sample consists of ^{6}Li in the two lowest spin states and ^{40}K in the ground state held in an optical dipole trap. The temperature of ^{40}K is close to the Fermi temperature, ^{6}Li is degenerate. We measure loss rate coefficients of this mixture for different magnetic fields around the 834 Gauss ^{6}Li Feshbach resonance. Despite the mixture consisting of three distinguishable particles, we observe stability against three-body recombination. On the resonance as well as on the BCS side the mixture is very stable. On the molecular side losses increase due to atom-dimer collisions. The stability around the Feshbach resonance will allow to use ^{40}K as a probe for the BEC-BCS crossover of ^{6}Li.

Q 26.6 Di 17:45 VMP 6 HS-A

Exact numerical simulations of interacting fermions in 1D trapping potentials — •Bernd Schmidt, Dominik Muth, Alexander Mering, and Michael Fleischhauer — Fachbereich Physik, Technische Universität Kaiserslautern, Germany

We discuss p-wave interacting spin-polarized fermions in a 1D trapping potential for arbitrary interaction strength. Using a boson-fermion mapping in 1D, interacting fermions with p-wave interaction strength $g^F_{\rm 1D}$ can be mapped to bosons with s-wave interaction strength $g^B_{\rm 1D} = -1/g^F_{\rm 1D}$. As a consequence a weakly interacting Fermi gas behaves in local properties like a strongly interacting Bose gas and vice versa. We derive a proper discretized model for the interacting fermions and compare its predictions with that obtained by the Bose-Fermi mapping using DMRG simulations. We calculate the realspace and momentum distributions of the fermions for arbitrary interaction strength starting at a weakly interacting gas to the Fermi-Tonks limit. and compare the results to predictions from field theoretical approaches.