Short visit grant

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Host Scientist: Dr. Meera Parish

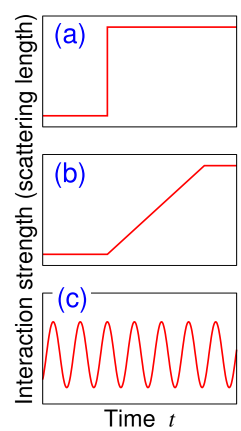
Grant reference number: **4584**

Visit took place in November 2011 —
traveled from Dresden to London 18/11/2011, returned 24/11/2011.

Purpose of the visit

The purpose of this research visit was to continue our research on non-equilibrium dynamics of a cold-atom system of intense current interest, namely, the *polaron* in spin-polarized Fermi gases.

Context. The physics of polarized fermionic atom gases, especially in the vicinity of a Feshbach resonances, has been of intense and sustained theoretical and experimental interest during the last five years. When the number of up and down fermions is mismatched, a variety of novel effects appear, beyond the better-known physics of superfluid fermionic pairing in spin-balanced gases.



Interaction variations driving nonequilibrium dynamics:
(a) interaction quench;
(b) slow ramp;
(c) oscillatory driving.

An extreme case of spin imbalance is the situation of a single $\downarrow$ atom in the presence of a Fermi sea of $\uparrow$ atoms, known as a *polaron*. This problem has emerged as a rich subfield of its own, stimulating a stream of theory work (Refs. [1–3] provide only representative references), as well as experimental study [4].

The present collaboration is investigating *non-equilibrium dynamics* of polarons.

Independently of the polarized fermion literature, non-equilibrium dynamics in quantum many-particle systems has emerged as one of the fastest-growing fields in contemporary theoretical physics, motivated in part by novel experimental possibilities opened up by cold-atom systems [5]. The current work is partly motivated by this direction of research, and translates questions from the non-equilibrium literature to the polaron system.

Formulation; questions and issues. We are using the variational wavefunction proposed by Chevy [1] to describe the polaron. Since we are interested in dynamics out of equilibrium, we treat the wavefunction parameters as *time-dependent* variational parameters. We are working with equations of motion we have derived for these parameters.

We are addressing the following issues: (1) time evolution following an interaction quench; (2) adiabaticity and violation thereof, in slow interaction ramps; (3) response to oscillatory interaction; (4) necessity of including physics beyond the above variational class in dynamical situations. The first three physical situations are associated with time-dependences of the interaction strength (scattering length) shown in the figure. At present, we have results for the first issue listed above, while work on the other questions are under way.

Description of the work carried out during the visit + main results obtained

During this visit, we:

- Analyzed numerical results that we have obtained using the equations of motion described above.
- Reformulated the problem in terms of Hamiltonian evolution in a restricted and finite Hilbert space, so that the problem can be analyzed in terms of a finite energy spectrum.
- Formulated ways of analyzing *decay* of excited states within our restricted Hilbert space.

Future collaboration with host institution

The current project has now moved beyond formulation and initial calculations toward more complex calculations.

Collaboration with Dr. Parish (and hence the host institution) is thus very likely to continue.

Projected publications/articles resulting from grant

I expect this research to lead to at least one publication. The time scale for the work to be completed is estimated to be 1 or 2 years.

Other comments

I thank the ESF and the POLATOM program for funding this research visit.

References

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