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# Dynamics of several ultra-cold particles in a double-well potential

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## Abstract content <br>   (Max 300 words)<br><a href="http://events.saip.org.za/getFile.py/a target="_blank">Formatting &<br>Special chars</a>

In nowadays experiments in ultra-cold physics it is possible to study dynamical properties of a few quantum particles confined in nontrivial potentials. Typically these experiments are described on theoretical level with simplified models based on mean-field description or Hubbard-like models with limited number of modes. In my talk I will present two examples showing that in the case of strongly interacting particles these approaches may lead to completely incorrect predictions.

1. In the case of two ultra-cold BOSONS confined in a one-dimensional double-well potential we compare the exact dynamics governed by a full two-body Hamiltonian with the dynamics obtained in a two-mode model approximation. We show that for sufficiently large interactions the two-mode model breaks down and higher single-particle states have to be taken into account to describe the dynamical properties of the system correctly. The fundamental difference between the exact and two-mode descriptions emerges when inter-particle correlations are considered. For example, the evolution of the probability that both bosons are found in opposite wells of the potential crucially depends on couplings to higher orbitals of an external potential [1].
2. In the case of a few ultra-cold FERMIONS confined in a double-well potential we show that the dynamics, which is governed by single-particle tunnelings for vanishing interactions, is completely different for strong interactions. Depending on the details of the configuration, for sufficiently strong interactions (repulsions or attractions) the particle flow through the barrier can be accelerated or slowed down. This effect cannot be explained with the single-particle picture. It is clarified with a direct inspection of the spectrum of the few-body Hamiltonian [2].

[1] J. Dobrzyniecki, T. Sowinski: EPJ D (in press).
[2] T. Sowinski, M. Gajda, K. Rzazewski: Europhys. Lett. 113, 56003 (2016).

## Apply to be<br> considered for a student <br>   award (Yes / No)?

No

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N/A

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