

# FAST CONTROL OF TOPOLOGICAL VORTEX FORMATION IN BEC BY COUNTER-DIABATIC DRIVING

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Fast creation of single vortex in BEC of alkali atoms at a prescribed position and time is still challenging even though various methods to create single and multiple vortices have been proposed and demonstrated experimentally. Topological vortex formation [1] is advantageous in this respect over other methods in that the position and the time of vortex formation is highly controllable. This method requires inversion of the bias magnetic field along the axis of the condensate, which leads to unwanted atom loss due to non-adiabatic transitions when the bias field crosses zero. Then the gap among hyperfine states disappear along the axis of the trap and atoms are lost by the Majorana flops. It is the purpose of this talk to propose a scheme that enables a fast creation of a vortex in much shorter time than needed for adiabatic control time by introducing the counter-diabatic field to avert the atom loss. Our result shows that atom loss is greatly reduced by introducing two sets of Ioffe-Prichard traps, one for trapping and the other for counter-diabatic control. However such an experimental set up is challenging for experimentalists. To avoid this problem, we further introduce a gauge transformation so that the required magnetic field is generated by manipulating the current of the Ioffe bars, which makes our proposal experimentally feasible.

This talk is based on [2]

[1] M. Nakahara, T. Isohima, K. Machida, S.-I. Ogawa, and T. Ohmi, *Physica B* **284**, 17 (2000).

S.-I. Ogawa, M. Möttönen, M. Nakahara, T. Ohmi, and H. Shimada, *Phys. Rev. A* **66**, 013617 (2002).

[2] S. Masuda, U. Güngördü, X. Chen, T. Ohmi, and M. Nakahara, arXiv:1507.03052. Accepted for publication in *Phys. Rev. A*.