Université Paris-Saclay
IJCLab
(Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)
Bât. 100, F-91405 Orsay

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Toward a beyond mean field description of the nucleon pair transfer during the collision of two superfluid nuclei

David Regnier
(IPNO)

Recent progresses in the time-dependent description of superfluid nuclei enable the simulation of heavy ion collisions around the Coulomb barrier within symmetry unrestricted time-dependent HFB approach. This level of approximation breaks down the symmetry associated to the number of particles and involves a gauge angle that appears as its conjugated variable. Although the choice of this gauge angle does not affect the description of an isolated system, recent studies report a surprisingly large impact of the relative orientation of the gauge angles when two superfluid nuclei collide with each other. As an example, the barrier height of a ^{90}Zr+^{90}Zr head-on collision shows variations up to 30 MeV when changing the relative gauge angle. Whether such an effect coming from pairing correlations is realistic and how strong it remains in a symmetry conserving theory are now questions under investigation. In this talk, I will first summarize some recent TDHFB predictions for the low energy collision of two superfluid nuclei and focus on the role of the gauge angle in its dynamics. Since there is a priori no privileged relative gauge angle orientation, one should at least average over different relative gauge-angle orientations to approach experiments. This leads naturally to a beyond mean-field picture. Following this idea, I will emphasize recent attempts to treat such collisions within symmetry restored approaches and propose a new method based on semi-classical phase-space averaging [1]. This approach will be illustrated on the description of particle transfer between two superfluid systems interacting for a short time.

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