Pairing effects in nuclear fusion reaction

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The time-dependent Hartree-Fock theory (TDHF) is well-known as one of tools to study nuclear reaction phenomena like a heavy ion collision. The recent progress for numerical technique and resource enables us to execute the TDHF calculation with a modern effective interaction (Skyrme, Gogny, etc.) in three-dimensional (3D) space. However, TDHF neglects a nuclear pairing correlation.

The time-dependent Hartree Fock-Bogoliubov theory (TDHFB) can describe the pairing correlation in nuclear dynamics. But, there is no study of heavy ion collision using TDHFB with a modern effective interaction in 3D space. They need the huge computational resource. And it is hard to prepare the initial state of TDHFB.

To study the nuclear dynamics including pairing correlation, we proposed the canonical-basis TDHFB theory (Cb-TDHFB) which can be derived from TDHFB represented in the canonical basis while treating the pairing functional in BCS-like approximation[1]. We can execute Cb-TDHFB calculation for heavy ion collision in 3D coordinates space due to the small computational cost same as TDHF. We show that the developments of Cb-TDHFB to study heavy ion collision and the effects of pairing correlation in fusion phenomena for 22O+22O (Fig.1).

[1] S. Ebata et al., Phys. Rev. C 82, 034306 (2010).

Figure 1: Neutron-density distributions in each time of 22O+22O collision.