Report on the CORENet program on "Quantum dynamics for superheavy elements"

2020/4/30

1. Title of research:

Quantum dynamics for superheavy elements

2. List of participants (*: a contact person):

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3. Period of research:

From September, 2019 to March, 2021.

4. Main location:

RCNP

5. Publication list:

K. Ogata,
"Spatial coherence of multistep direct reactions studied by a one-dimensional model" (the 75th JSPS annual meeting).

6. Description of the outputs

So far we have had two one-day discussion meetings.

The first meeting was held on October 8, 2019 at RCNP. The aim of this meeting was to share physics problems among the participants and to discuss how to proceed during the period of this project. The program of this meeting was: 1. Overview (Hagino), 2. Issues on quantum decoherence (Shima), 3. Towards a quantum extension of the Langevin approach

(Tokieda) and 4. Friction in reactions for superheavy elements (Washiyama). In addition to the members of this program, Dr. Hirohiko Shimizu (Nagoya University) also attended the meeting. In the meeting, recent experimental data on a formation probability of a compound nucleus in heavy-ion fusion reactions for superheavy elements, measured by the group of the Australian National University (ANU), were intensively discussed, and we reached a conclusion that these data could be analyzed with a quantum Langevin approach. We expect a paper or two on this topic will come out during the period of this project. In addition to this, we agreed that we would need continuous discussions on general aspects of quantum decoherence and quantum friction.

The second meeting was held on February 3, 2020, again at RCNP. The program of this meeting was: 1. Open quantum systems and biological phenomena (Tokieda), 2. A derivation of the Langevin equation from the Caldeira-Leggett model (Abe), 3. The quantum Langevin approach and the ANU data (Washiyama), 4. Motto oscillations and quantum decoherence (Hagino), 5. A toy model for decoherence (Ogata), and 6. Quantum decoherence and neutron interferometer (Shima). A key issue in both quantum decoherence and quantum friction is how to treat couplings of a system to environmental degrees of freedom. In this regard, Tokieda's presentation on biological phenomena clearly showed a similarity to quantum walk, which was intimately related to the presentations of Ogata and Shima. We also confirmed that a theoretical analysis of the ANU data with the quantum Langevin approach was going steadily.