

# A Dynamical Study of Fusion Hindrance with Nakajima-Zwanzig Projection Method

Y. Abe<sup>1</sup>, D. Boilley<sup>2</sup>, Quentin Hourdillé<sup>2</sup>, and Caiwan. Shen<sup>3</sup>

<sup>1</sup>*Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

<sup>2</sup>*GANIL, CEA/DRF-CNRS/IN2P3, BP 55027, F-14076 Caen cedex 5, France  
Normandie Univ. / Unicaen, Caen, France*

<sup>3</sup>*School of Science, Huzhou Teachers College, Huzhou, Zhejiang, 313000 China*

A new framework is proposed for the study of collisions between very heavy ions which lead to the synthesis of Super-Heavy Elements (SHE), to address the fusion hindrance phenomenon[1]. The dynamics of the reaction is studied in terms of collective degrees of freedom undergoing relaxation processes with different time scales. The Nakajima-Zwanzig projection operator method is employed to eliminate fast variable and derive a dynamical equation for the reduced system with only slow variables. There, the time evolution operator is renormalised and an inhomogeneous term appears, which represents a propagation of the given initial distribution. The term results in a slip to the initial values of the slow variables. We expect that gives a dynamical origin of the so-called “injection point  $s$ ” phenomenologically introduced by Swiatecki et al[2] in order to reproduce absolute values of the measured cross sections for SHE. A formula obtained for the slip is expressed with physical parameters of the system which confirms the results recently obtained with a Langevin equation[3], and permits quantitative comparisons among production cross sections of SHE with different incident channels. Preliminary results have been published in Ref. [1] and a full presentation is under preparation[4], which is expected to provide a new visage generally to the fluctuation-dissipation dynamics of heavy-ion collisions, not only to SHE synthesis.

## References

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