

A BROWNIAN MOTION THEORY FOR UNIFYING THE
TREATMENT OF STATISTICAL EXCITATIONS AND DEFORMATIONS
IN DEEP INELASTIC HEAVY-ION COLLISIONS

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With the projection operator technique of Mazur and Oppenheim¹⁾ used by Gross²⁾ to describe the relative motion in deep inelastic collisions, we derive a Fokker-Planck equation that treats simultaneously relative motion and surface vibrations.

The kinematical condition that the collective variables are much slower than the bath particle motion leads to the quantities $(\frac{m}{M})^{1/2}$ and $(\frac{m}{D_\lambda})^{1/2}$ as useful expansion parameters in the evaluation of the Liouville propagator. (m = nucleon mass, M = reduced mass, D_λ = mass parameter of the surface modes λ). The leading terms for the microscopic friction and diffusion terms agree with the expressions of linear response theory³⁾.

Having reported on an application to a focussing system in Ref.⁴⁾ we present here the results for an orbiting case ($Kr^{86} + Er^{166}$, 8.18 MeV/U). Only quadrupole deformations are included and the phenomenological parameters of Ref.⁵⁾ are used. It turns out to be very important to take into account non-diagonal frictional coupling terms between relative motion and vibrations, which occur in the theory in a natural way. These terms are also evident from a classical picture by assuming that friction is a surface effect⁶⁾.

The dynamical deformations allow for energy losses below the Coulomb barrier of spherical nuclei, which is shown in fig. 1-3, where comparison is made between experiment and calculations with (——) and without deformations (-----).