# Constrained Fermionic Dynamics of Nuclear Systems:

# Ground states and Giant Dipole Resonances

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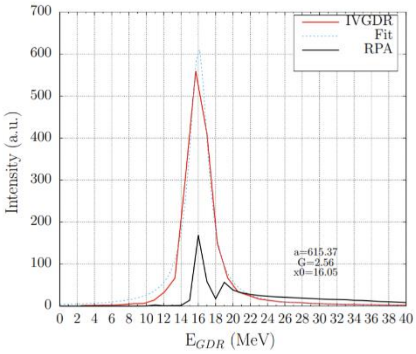
The nuclear interaction is one of the most fascinating and complicated forces responsible for stuctures in nature, while its understanding is the key for a broad range of applications. The nuclear interaction manifests itself in the nuclear N-body problem. In the present work, we employed the CoMD (Constrained Molecular Dynamics) model that provides an approximate solution of this problem through the Time Dependent Variational Principle leading to Hamiltonian equations of motion [3]. The total nuclear wavefunction is taken as the product of one-body nucleonic wavefunctions, parametrised as Gaussian wavepackets. For the solution of the equations of motion, the initial configuration of nucleons is needed. This is obtained via a Simulated-Annealing algorithm. The characteristics of the configuration space depend heavily on the parameters of the effective interaction. We studied the effects of these parameters and developed a process for global optimisation of a configuration based upon its binding energy, rms radius, average density and average phase space occupation fraction.

In parallel, we studied the Giant Dipole Resonance (GDR) which is one of the most interesting phenomena of low energy nuclear dynamics. This resonance mode consists of an off-phase oscillation of neutrons against the protons. In our study, we developed a theoretical treatment of GDR based on the CoMD formalism. The effect of the parameters of the effective interaction to the GDR characteristics were studied. Finally, we calculated the GDR spectra for the optimised configurations of several nuclei. We plan to systematically study the characteristic energy and the width of the GDR peak across the nuclear chart with the goal of obtaining stringent constraints of the nuclear equation of state [1,3].



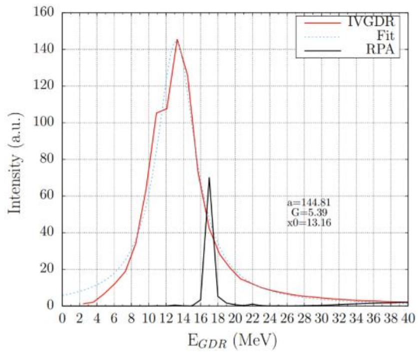




*Figure 1 GDR spectra of optimised configurations for $^{40}$Ar (left) and $^{208}$Pb (right). The black curve is a Random Phase Approximation (RPA) calculation from the literature[2].*

[1] R. Wang, Z. Zhang, L.W. Chen, C.M. Ko, Y.G. Ma Phys. Let. B **807**, 135532 (2020).

[2] G. Giuliani, H. Zheng, A. Bonasera Prog in Part and Nuc Phys **76**, 116-164 (2014).

[3] M. Papa, T. Maruyama, A. Bonasera Phys. Rev. C **64**, 024612 (2001).