

MASTER SUMMER TRAINING PROPOSAL

Academic Year 2026/2027

TITLE: Surrogate models for linear response in finite nuclei.

FRIB ADVISOR: W. Nazarewicz and P. Giuliani.

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UNIVERSITY/RESEARCH CENTER of the TRAINING:

Michigan State University, Facility for Rare Isotope Beams (FRIB), East Lansing Michigan, USA;
International Research Laboratory NPA, East Lansing Michigan, USA;
IJCLab, Orsay, France.

LEVEL: Master 1 or 2.

DURATION: 3 months at FRIB, 1 month at IJCLab.

TOPIC: Many-body nuclear theory.

ABSTRACT

The collective excitation of nuclear systems close to their ground-state is very well described with the linear response theory, which is a well-established method in physics and chemistry. In particular, the quasiparticle random-phase approximation (QRPA) provides a powerful microscopic framework by building excitations on top of the mean-field vacuum; however, its high computational cost limits model calibration and uncertainty quantification studies. We have explored two complementary QRPA surrogate models and applied them to study response functions of finite nuclei. One is a reduced-order model that exploits the underlying QRPA structure, while the other utilizes the recently developed parametric matrix model algorithm to construct a map between the system's Hamiltonian and observables. Both emulators can achieve 0.1\%--1\% accuracy while offering a six to seven orders of magnitude speedup compared to state-of-the-art QRPA solvers. The QRPA emulators are well-positioned to enable Bayesian calibration and large-scale studies of computationally expensive physics models describing the properties of many-body systems.

The internship consists in learning this new technic and in applying it to the understanding of the isoscalar giant monopole resonance.

Please note that this summer training does not imply a continuation for a PhD, but a CNRS grant and support for local expenses are included during the training.

More information is available on the website <https://npa.in2p3.fr/summer-training-program/> and registration is mandatory on the following website: <https://indico.frib.msu.edu/event/87/>