

## MASTER SUMMER TRAINING PROPOSAL

### Academic Year 2026/2027

**TITLE:** Charge Exchange Reactions with the Nuclear Shell Model

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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:** theory of nuclear reactions.

**ABSTRACT**

The equation of state (EoS) of dense matter governs the structure, composition, and stability of neutron stars. Among the least understood terms of the nuclear EoS is the isovector dependence of the symmetry energy. Charge exchange reactions, which occur when a proton collides with a target nucleus, gets absorbed, and emits a neutron, are important for constraining this dependence. Within a recently developed framework, such reactions can be directly computed from microscopic many-body predictions, treating both structure and reactions on equal footing.

In this project, the student will analyze isotopic chains of both Mg and Ca. They will generate, using the microscopic shell models, all relevant spectroscopic amplitudes up to a few MeV above the proton threshold. This includes all compound, compound-minus-neutron, and compound-minus-proton amplitudes. They will extend the formalism, improving the single-particle description of the resonant parameters to proton states. They will combine the single-particle and many-body contributions within the microscopic S-matrix framework to extract cross sections and compare with experiment when available, as well as make predictions where no data exists. The latter can act as a motivation for future experiments.

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/>