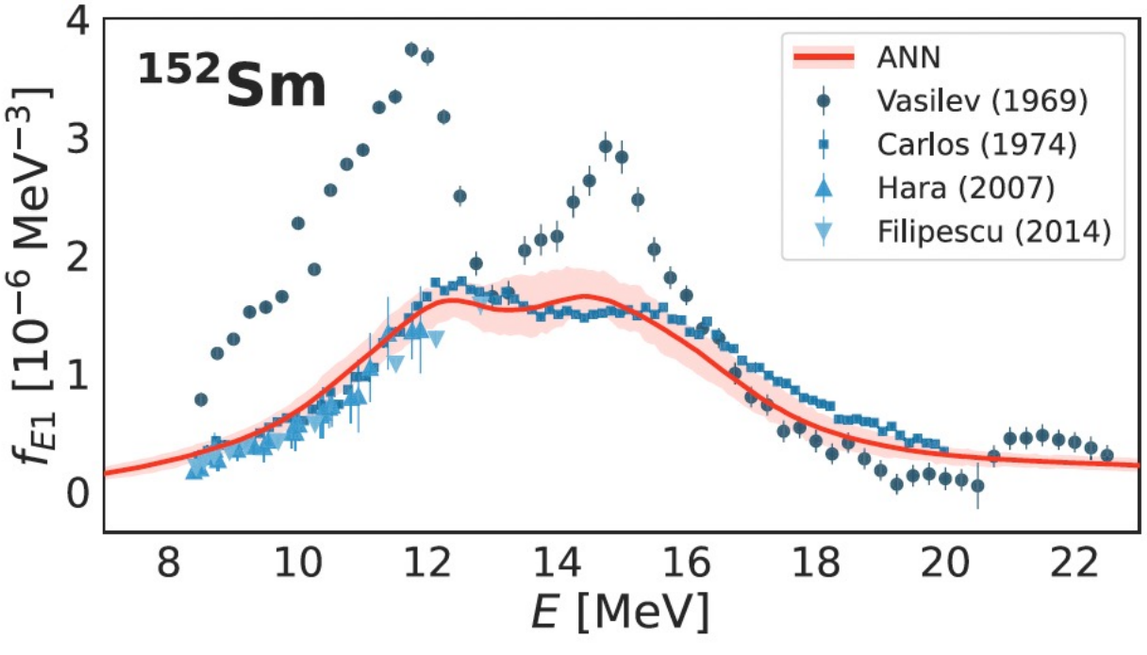
Data-driven analysis of dipole strength functions across the nuclear chart

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- Design an artificial neural network (ANN) to learn from available experimental data on nuclear dipole strength functions and generate synthetic predictions where data are conflicting or scarce.
- Leverage ANN predictions to extract electric dipole polarizabilities across the nuclear chart and infer key nuclear matter properties, such as the symmetry energy at saturation density.



ANN-predicted dipole strength function of ^{152}Sm compared to available experimental data. This nucleus was excluded from training due to the presence of conflicting experimental datasets. The ANN disfavors the trend of the 1969 Vasilev data, which could be discarded also based on experimental considerations.

Impact (as of now)

- First extraction of dipole strength functions using machine learning techniques for several nuclei across the nuclear chart.
- Robust reproduction of known data, with the ANN identifying inconsistencies in experimental datasets that may require further scrutiny.
- Strong interpolation performance across known nuclei, but limits in extrapolation highlight the need for additional data in the neutron-rich region.
- New constraint on the symmetry energy at saturation density using ANN-predicted polarizabilities, in agreement with recent determinations based on a combination of theory and experiment.

Accomplishments (as of now)

- Publication: W. Jiang, T. Egert, S. Bacca, F. Bonaiti, P. von Neumann-Cosel, Phys. Rev. C 111, L051308 (2025)