Contribution ID: **35** Type: **not specified**

Bayesian extrapolation of nuclear observables towards the neutron drip line

Wednesday, 3 July 2019 15:05 (35 minutes)

Quantifying the mass, or nuclear binding energy, of atomic nuclei is fundamental for understanding the origin of elements in the universe. The astrophysical processes responsible for the nucleosynthesis in stars often take place far from the valley of stability, where experimental masses are not known. Taking advantage of the information contained in mass model residuals, where the experimental information exists, we utilize Bayesian machine learning techniques to provide the missing nuclear information using extreme extrapolations of theoretical predictions.

Our methodology was developed on the two-neutron separation energies S2n of even-even nuclei, where we consider 10 global models. Quantified emulators of S2n residuals are constructed using Bayesian Gaussian Processes (GP) and Bayesian neural networks of which we assess respectively predictive power and honesty of credibility intervals with rms deviation and empirical coverage probability, using the AME2003 dataset for training and a testing dataset at its external boundary composed of all ulterior measurements. While both statistical models reduce the rms deviation from experiment significantly, GP offers a better and much more stable performance. After statistical corrections all models display similar rms deviations on the testing dataset.

This methodology is applied to the one- and two-neutron separations energies of the nuclei in the region of heavy calcium isotopes, which is at the frontier of experimental and theoretical nuclear structure research. The recent discovery of the extremely neutron-rich nuclei around 60Ca and the experimental determination of masses for 55-57Ca provide unique information about the binding energy surface in this region. To assess the impact of these recent discoveries on the nuclear landscape, we compute the posterior probability for nuclides between Si and Ti to be bound to neutron emission. We find that extrapolations for drip-line locations are consistent across the global mass models used, in spite of significant variations between their raw predictions. In particular we predict that 68Ca has an average posterior probability pex ≈ 76% to be bound to two-neutron emission while 70Ca is a threshold system with pex ≈ 57%; 61Ca is expected to decay by emitting a neutron (pex ≈ 46%). This analysis is finally extended to the full nuclear landscape.

Presenter: NEUFCOURT, Leo (Michigan State University)

Session Classification: Session