My research focuses on using nuclear reactions to probe how nuclear matter assembles in systems ranging from nuclei to neutron stars. This work is split between two main concentrations: utilizing reactions to determine the nuclear equation of state and to understand exotic decay modes in nuclei.

After the groundbreaking measurement of a neutron-star merger two years ago, there has been a renewed interest in pinpointing the nuclear equation of state for matter about twice as dense as found in the middle of heavy nuclei. In particular, we seek to understand the density and momentum dependence of the symmetry energy. This is a repulsive term in the binding energy that arises from an imbalance in the numbers of protons and neutrons. Using heavy-ion collisions, my group can create these very dense environments in the laboratory, and by studying the particles that are ejected from the collision we can help determine the symmetry energy.

My second research focus is using reactions to populate some of the shortest-lived nuclei and studying their decays. The most recently discovered type of nuclear decay is the two-nucleon decay, where the nucleus spontaneously emits two protons or two neutrons in a single decay. These decays occur in nuclei at the extremes of neutron-to-proton ratios. By measuring the energy and angle of the nucleons relative to the remaining core, one can determine information about the original decaying nucleus, such as the excitation energy and lifetime. By modeling the data, we can also learn about the behavior of the nucleons inside of the nucleus prior to the decay.

These experiments are typically performed using small arrays of silicon and cesium-iodide detectors. Quite often we will use the High-Resolution Array (HiRA), which is a modular array of telescopes made of a combination of one to two silicon detectors followed by four cesium-iodide detectors arranged in quadrants behind them. These telescopes provide excellent energy and angular resolution, and the combination of detectors determines the identity of the charged particle. These detectors are often paired with neutron detectors, gamma detectors, and/or the S800 spectrometer.

Students in my group will take leading roles in the setup, execution, and analysis of these experiments. This can include design and testing of new detector systems, computer simulations of the experiment, or theoretical modeling depending on the interests of the student. Future experiments include using nuclear structure inputs to constrain the neutron skin in heavy nuclei, measuring two-proton decay in the A~30 mass region, and measuring transverse and elliptical flow observables from heavy-ion collisions.

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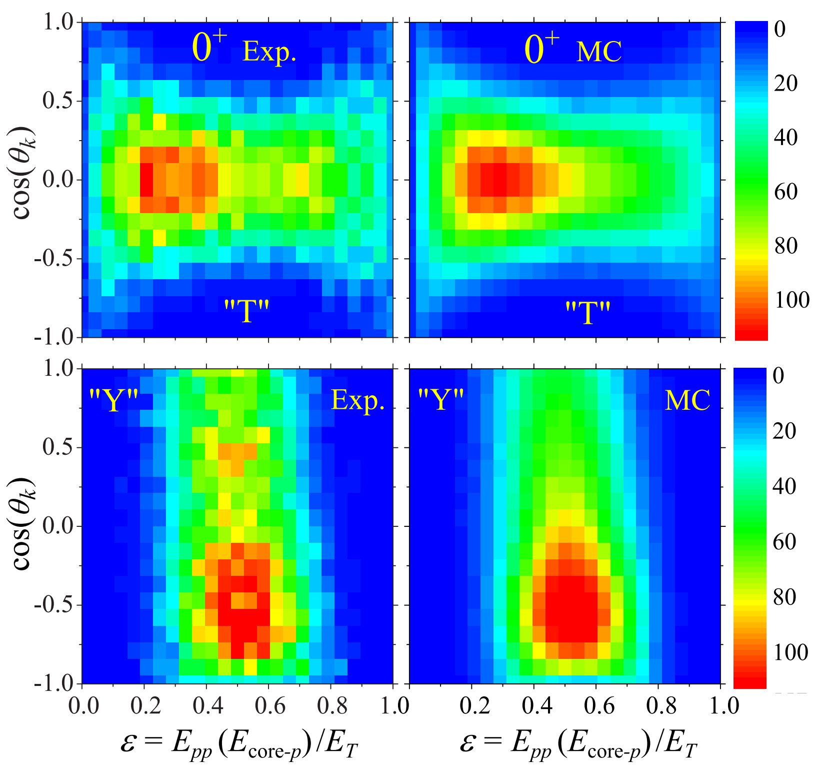

Energy-angular correlations for the two-proton decay of the ground state of ^{16}Ne. The experimentally measured distributions (left) are compared to a three body model prediction adjusted for detector resolution (right).

Selected Publications

First observation of unbound ^{11}O, the mirror of the halo nucleus ^{11}Li, T.B. Webb *et al. PRL* **2019**, *112*, 122501.

Large longitudinal spin alignment generated in inelastic nuclear reactions, D.E.M. Hoff *et al. Phys. Rev. C* **2018**, *97*, 054605.

Observation of long-range three-body Coulomb effects in the decay of ^{16}Ne, K.W. Brown *et al. Phys. Rev. Lett.* **2014**, *113*, 232501.