The use of storage rings in the study of reactions at low momentum transfers

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Several nuclear reactions are best investigated when the momentum transfer to the nucleus is small. Among these are the IsoScalar Giant Monopole Resonance (ISGMR) which helps determine one of the parameters of the equation of state, namely the incompressibility of nuclear matter, and proton elastic scattering from nuclei which is sensitive to parameters of nuclear density such as the matter root-mean-square radius. These have been extensively studied in the past using stable beams. However, with the advent of radioactive ion facilities around the world, it is desirable to study these reactions with unstable nuclei. The reactions, however, have to take place in inverse kinematics in which the radioactive ions impinge on a light target (hydrogen or helium). Simple kinematics calculations show that the outgoing recoil particles possess extremely low energies (down to few hundred keVs). External targets are, therefore, not suitable for these reactions. There are two alternative methods to deal with this challenge: either do the experiments in storage rings with gas jet targets or any other thin targets, or perform the measurements with an active target which also acts as a detector. In both cases, the energy threshold will be much lower than a fixed target of a reasonable thickness.

We have performed measurements with the radioactive ^{56}Ni using both methods. In the ring measurements, proton elastic scattering was the main goal for this nucleus while feasibility studies were done with ^{58}Ni and a helium target to investigate ISGMR. In this presentation, the experimental method used in the storage ring will be discussed along with some results to show the superiority of the rings for this type of measurements.