Observation of new neutron-rich Mn, Fe, Co, Ni, and Cu isotopes in the vicinity of ^{78}Ni†

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The neutron-rich nucleus ^{78}Ni is expected to be a doubly magic nucleus with the proton magic number 28 and the neutron magic number 50. To study the magicity of ^{78}Ni far from the stability line, the production of new isotopes beyond ^{78}Ni, such as the previous discovery of neutron-rich isotopes at RIBF,[1] is the first step.

In the present study, new isotopes in the vicinity of ^{78}Ni were produced via the in-flight fission reaction of a primary ^{238}U beam with a higher intensity than the previous one.[1] The beam energy was 345 MeV/nucleon and the average intensity was 6.84 particle nA. The fission fragments were purified in the BigRIPS separator and transported to the ZeroDegree spectrometer. For particle identification, the time of flight (TOF) and magnetic rigidities in the second stage of BigRIPS, as well as the energy loss in a multisampling ionization chamber (MUSIC) placed at the end of the ZeroDegree spectrometer, were measured. The atomic number, Z, and the mass-to-charge ratio, A/Q, were deduced as shown in Fig. 1. A significance test using p values was performed for 8 new isotopes ^{73}Mn, ^{76}Fe, ^{77,78}Co, ^{80,81,82}Ni, and ^{83}Cu, as described in the previous study.[1] The p values, which are all less than 1%, show evidence for these isotopes including the cases of ^{76}Fe, ^{81}Ni, and ^{82}Ni with a single event. The production cross sections, shown in Fig. 2, were also checked and found to be consistent with model predictions.[2]

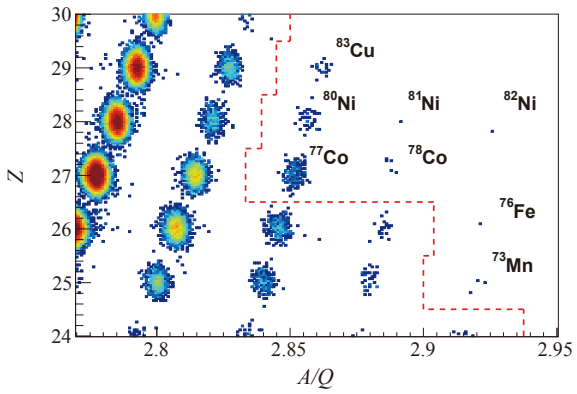

Fig. 1. Particle-identification plot of Z versus A/Q. Isotopes located on the right side beyond the red line were discovered in the present study.

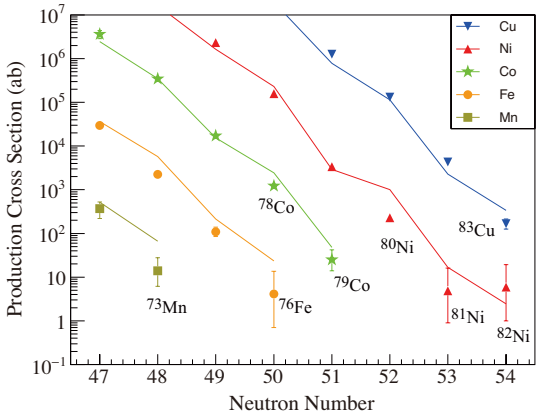

Fig. 2. Production cross section as a function of the neutron number. The lines present model predictions.[2]

References

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† Condensed from the article in Phys. Rev. C **95**, 051601(R) (2017)

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