A GLOBAL STUDY OF THE p + ^{27}Al REACTION AT 180-MEV*

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In order to derive a broader understanding of the mechanisms which characterize nucleon-nucleus collisions at intermediate energies, a global study of the p + ^{27}Al reaction has been performed at IUCF. In these measurements a channel-plate-fast-timing detector and a three element semiconductor detector time-of-flight telescope have been used to detect directly reaction products A $\leq$ 27 formed in the bombardment of a 100 μg/cm^2 ^{27}Al target with 180-MeV protons. With this system a timing resolution of < 140 ps was achieved yielding a mass resolution of ~0.4-0.8, depending on fragment mass and energy. A sample mass spectrum is shown in Fig. 1. For fragments with A > 6 the lower detection limit was > 0.05 MeV/amu. Due to the low energies of recoil nuclei from simple reactions such as (p,p') and (p,pn), the data for A > 25 may miss a substantial fraction of these isobaric cross sections. Consequently, for A=26 and 27 we have relied on in-beam gamma ray data;[1] the errors for A=25 are estimated to be about 30 percent.

Figure 2 shows representative energy spectra for A=7, 16 and 22 fragments over a range of angles. The spectra are characterized by a broad peak at low energies followed by an exponential decrease for the higher energies. The slopes of the spectra increase with increasing fragment mass and angle. For the lightest fragments, the angular distributions are strongly forward-peaked, whereas for the heaviest

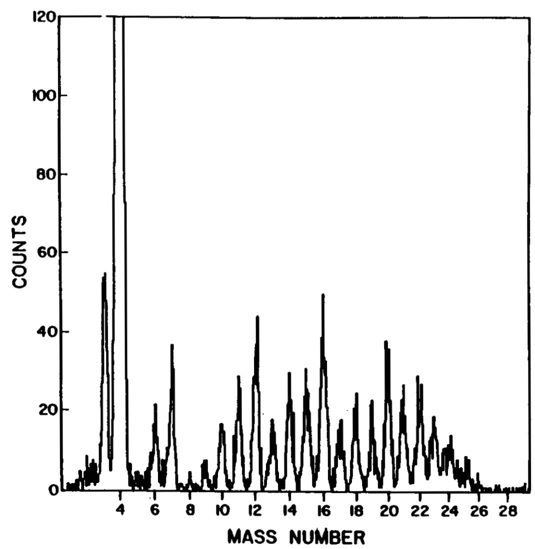

Figure 1. Mass spectrum for fragments with energies above 10 MeV observed at 20 deg in 180-MeV p + ^{27}Al reaction.

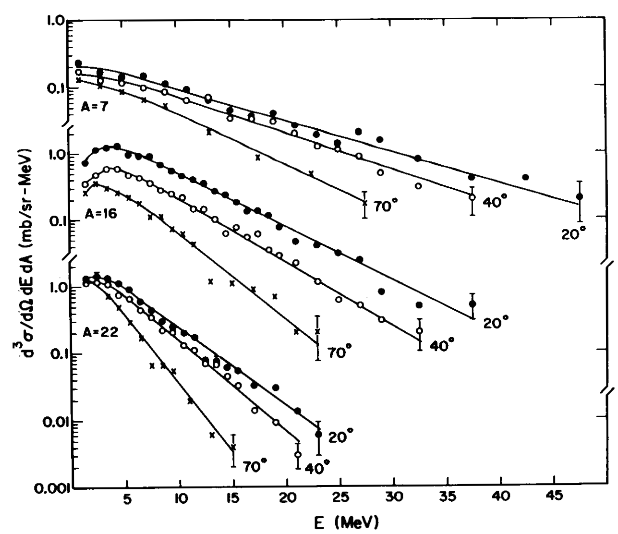

Figure 2. Energy spectra for fragments with A = 7, 16 and 22 at angles of 20°, 40° and 70° in the 180-MeV p + ^{27}Al reaction.

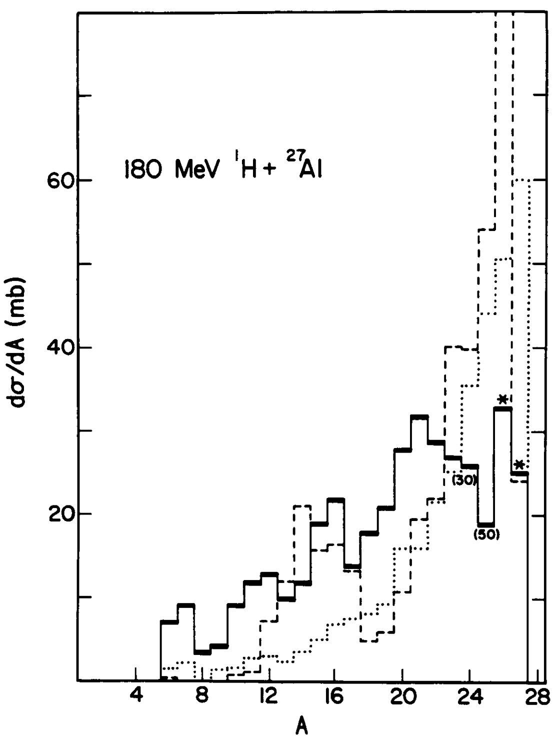

Figure 3. Isobaric cross sections for fragments from 180-MeV p + 27 reaction; solid line-experimental data, dashed line intranuclear cascade code prediction; and dotted line is semiempirical estimate of Silberberg and Tsao.

fragments two components appear in the data, presumably arising from fusion-like processes in the forward direction and peripheral collisions involving forward-peaked light-ions which lead to heavy fragment emission at more backward angles.

In Fig. 3 the mass distribution of the reaction products with $A > 6$ is shown. Also shown are yield predictions based on intra-nuclear cascade-evaporation calculations[2] and the semiempirical estimates of Silberberg and Tsao.[3] The calculations tend to overpredict the yields of target-like fragments and substantially underestimate yields of lighter fragments. This comparison suggests that proton-induced reactions lead to enhanced deposition relative to the model calculations, a result consistent with recent measurements on heavier nuclei.[4]

*Work supported in part by the U.S. Office of Naval Research and the Department of Energy.

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