

Proton Production Cross Sections for Reactions Induced by 392 MeV Protons.

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Recently, nuclear data which are measured by using intermediate energy accelerators are needed in many fields of engineering, medicine, science and so on. In particular, they are required to estimate exposed dose of human in the space craft and cancer therapy. However only few studies have so far been made at the region above 200 MeV on (p,p'*x*) reaction.

There are many simulation codes for nuclear reaction : for example INC, QMD [1, 2], AMD etc. Especially, QMD model code is widely-applied for not only simulation but also evaluation of nuclear data. But because of short of data, we don't confirm its accuracy well. Therefore we measured the ²⁰⁹Bi(p,p'*x*) reaction DDX and compared it with QMD model calculation.

Measurements of proton production reactions were carried out at RCNP. Proton beam was accelerated to 392 MeV by the ringcyclotron. The target of ²⁰⁹Bi located at the center of a one-meter-diameter chamber. Energy spectra of emitted protons were measured by using stacked scintillator detectors (**Fig.1**) [3] placed out of the chamber.

The detectors are most suitable for investigating gross structures of energy spectra. Measurements were made at ten laboratory angles from 20 deg. to 105 deg. Energy calibrations were made with pp scatterings with a target of polyester foil. The particle identification was successfully done by a ΔE -E prescription in off-line analyses.

The measured energy spectra were compared with the QMD and the INC models. In this work, we employed the JQMD code for the QMD model calculation. The INC code used presently was developed in our laboratory. The ground state for the INC model calculation is same as for the QMD model. **Fig.2** shows energy spectra for ²⁰⁹Bi(p,p'*x*).

Circles in this figure are experimental value. The solid lines and the dotted lines are simulated value by the INC and the QMD, respectively. The QMD overestimates the DDX very much at low energy region. But at the peak of quasi free it has good reproducibility. The INC shows good reproducibility at wide energy range and all scattering angles.

In summary, we investigated energy spectra of (p,p'*x*) reactions at 392 MeV with ²⁰⁹Bi target. Experiment was carried out at the RCNP ring-cyclotron facility. The measured spectra were compared with the QMD and the INC models. And the reproducibility of the INC code that we developed is very good in intermediate energy range reactions.

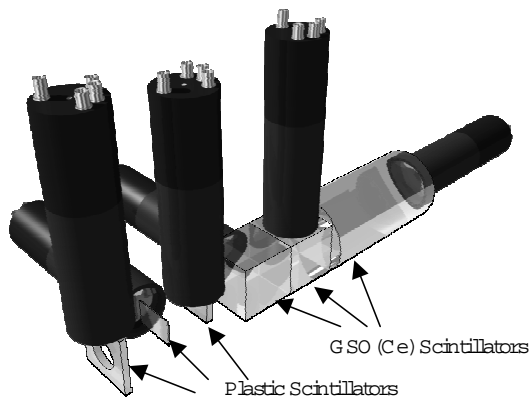


Fig.1 A sketch of the detector

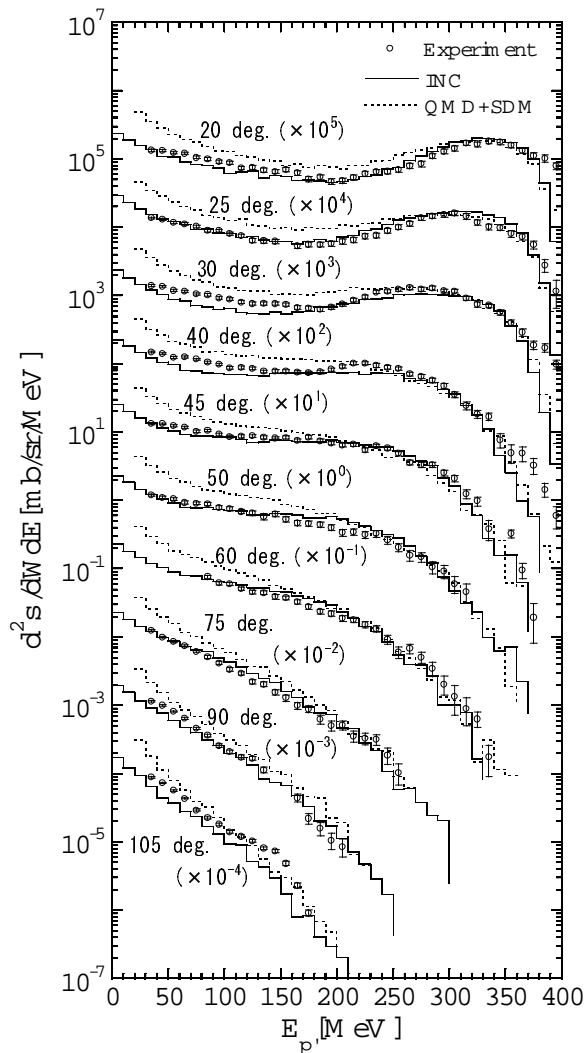


Fig.2 Proton production reaction
DDX for $^{209}\text{Bi}(p,x)$ at 392 M.eV

References

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