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Radiative Capture Cross Section for Fast Neutron

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Neutron capture cross section have been measured for 8 elements. The method used was detection of capture gamma rays in a one-meter-diameter liquid scintillator. Capture cross sections have been determined by comparison with the capture cross sections of Au-197.

Introduction

Capture cross sections for fast neutron are important data in nuclear reaction theory and reactor design. Seeing from the published experimental data, some of them are not ideal. Particularly for some nuclides, Either there are few data, or some disagreements exist in these data.

For capture cross section measurements of Cd, Nd, Sm, Dy and Yb there are two works in 0.3 - 1.7 MeV neutron energy range. Diven [1] measured only one experimental point at 0.4 MeV for Cd. Poenitz [2,3] used a liquid scintillation counter measured these capture cross sections in 0.5 - 4.0 MeV. For Ag, In and Ta there are a few works [1,3-8] in this energy range but some disagreements exist in these data.

Experiment

Fast neutron capture cross sections for cadmium, silver, indium, tantalum, neodymium, samarrium, dysprosium and ytterbium have been measured relative to that of Au-197 at 6 energy points. The prompt gamma-ray were detected by a 680 liters liquid scintillation tank. The shape of the tank approximate a sphere with a diameter 100 cm. The tank have a central channel with a diameter 20 cm. It is shielded by 10 cm lead and 40 cm paraffin on all sides except the rear. In order to reduce backgrounds the TOF technique and the coincidence technique between the two half-sphere of the tank have been used. The $T(p,n)^3He$ reaction was used as a neutron source. A pulsed and bunched proton beam was accelerated by a 2.5 MeV Van de Graaff. The repetition frequency was 2 MHz and the pulsed width was 10ns.

The capture sample is placed at the center of the tank. Rare-earth samples were in the form of natural element oxides. Metal samples were used for Cd, Ag, In, Ta and Au. The purity of all samples is better than 99.9%.

Discussion

These results are shown in Fig.1 and Fig.2 as a function of neutron energy. It can be observed that our results agree well with those of Poenitz [2,3]. For Nd and Sm our results are lower than the evaluated data [9] Rn-3. For Ta our results agree well with those of Macklin [5] but is obviously lower than the measurements of Diven [1].

Within the framework of the Hauser-Feshbach statistical model, we calculated average capture cross sections for Dy and Yb in the 0.1 - 2.0 MeV neutron energy range. Our calculation is also shown in Fig.2 along with experimental results.

Reference:

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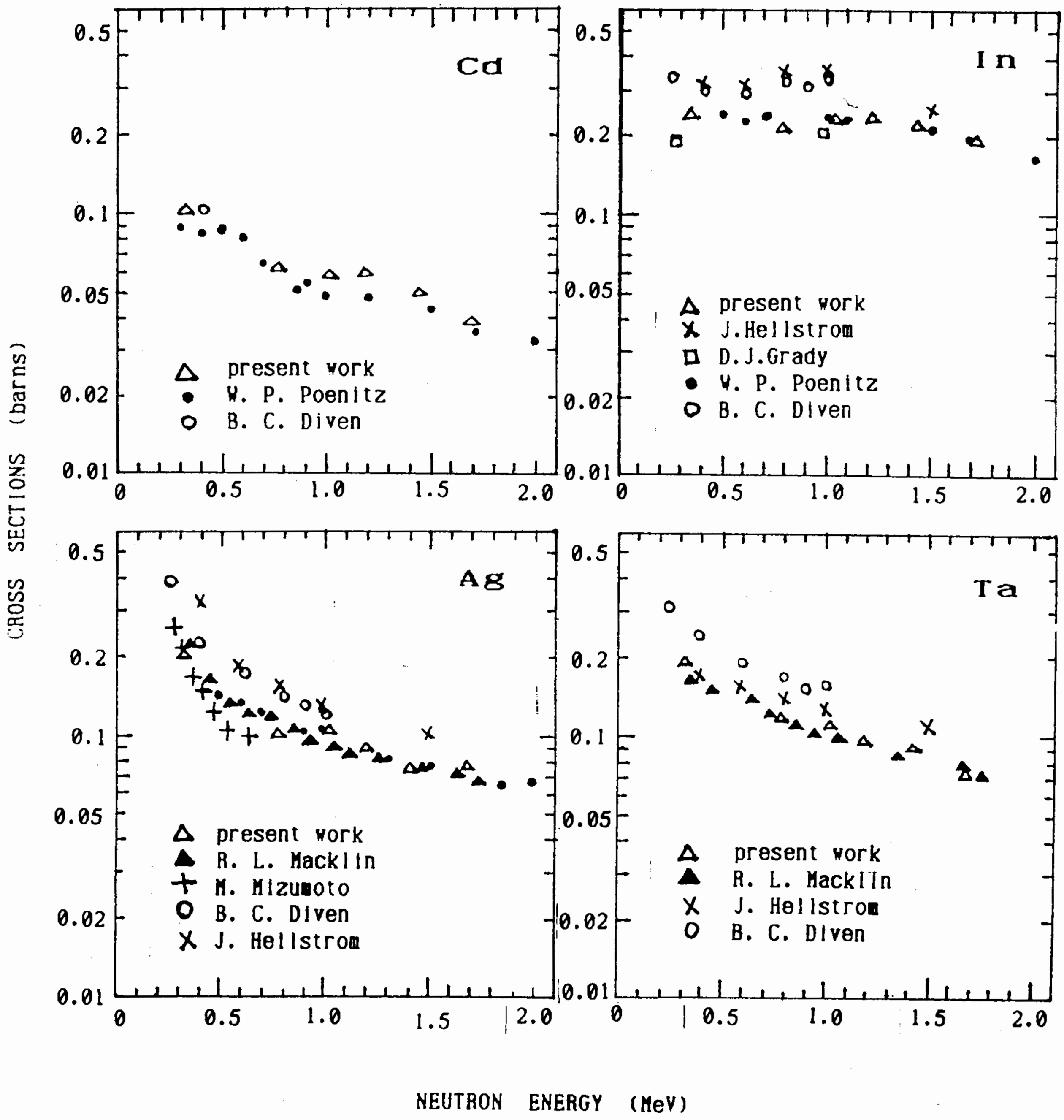

Fig. 1. Neutron capture cross sections for 4 elements as functions of neutron energy

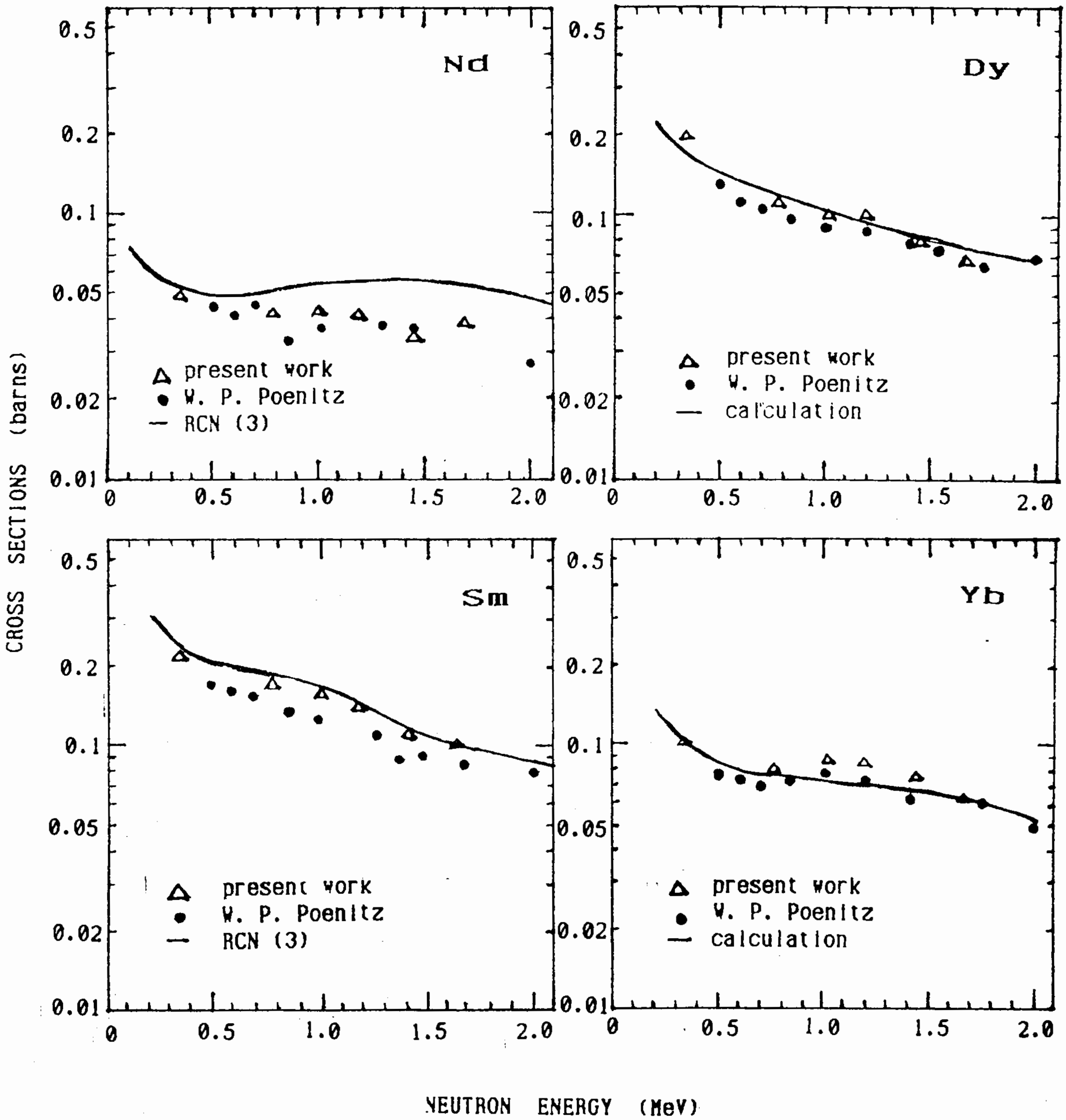

Fig. 2. Neutron capture cross sections for 4 elements as functions of neutron energy