

INELASTIC REACTIONS OF  $^{238}\text{U}$  ON DIFFERENT HEAVY TARGETS AT 16.7 MeV/N

S. Jokić\*, Z. Todorović and R. Antanasijević

Institute of Physics, 11001 Belgrade, POB 57, Yugoslavia

\* University of Kragujevac, Yugoslavia

M. Debeauvais and J. Ralarosy

Centre de Recherches Nucléaires, 67037 Strasbourg Cedex, France

In this paper we report the reaction cross sections of 16.7 MeV/N  $^{238}\text{U}$  projectiles on  $^{238}\text{U}$ ,  $^{209}\text{Bi}$ ,  $^{197}\text{Au}$ ,  $^{107}\text{Ag}$ ,  $^{63}\text{Cu}$  targets, as well as the excitation function in the  $^{238}\text{U} + ^{238}\text{U}$  reaction at energies between 7.5 and 16.7 MeV/N.

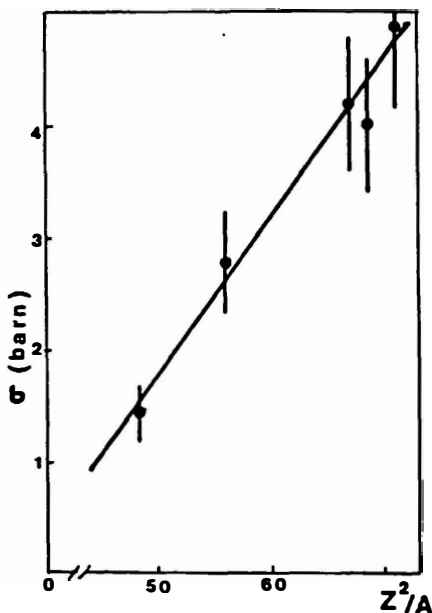


Fig. 1 Experimental reaction cross sections versus  $Z^2/A$  of the projectile and the target.

The SSNT detector Makrofol was used. This threshold detector is sensitive to a linear energy loss of the order of  $8 \text{ MeV cm}^2/\text{mg}^{(1)}$ . The target material was evaporated directly onto the detector foil surface. Since the recoil energy is high, all reaction products are confined to the forward hemisphere and thus the detecting geometry of  $2\pi$  is nearly 100 % efficient. Usual chemical development was employed i.e., a 5N NaOH etching solution at  $60^\circ \text{C}$ . A 100 mn etching time was necessary to visualize the whole lengths of all tracks.

Events with 2, 3, 4, 5 and 6-prongs were observed. As the 2-pronged events are due to elastic scattering, only the other events were used to determine cross sections. The number of incident ions was  $1-3 \times 10^6$  per  $\text{cm}^2$ . This was determined by counting their impact points within the detector bulk, the irradiation being perpendicular to the foil surface.

In the interaction of  $^{238}\text{U}$  projectiles on different targets, the cross section are plotted as a function of the ratio  $Z^2/A$ , the fission parameter, where  $Z = 92 + Z_T$  and  $A = 238 + A_T$ , where  $Z_T$  and  $A_T$  are the charge and the mass numbers respectively of the considered target. The reason is that

events with 3 or more prongs can be considered as sequential fissions<sup>(2)</sup> and thus, comparison can be made with usual fission cases. Fig. 1 shows the plot for the targets used.

It can be seen that the total cross section appears to increase linearly with  $Z^2/A$ . Let us mention that for the reaction  $^{238}\text{U} + ^{238}\text{U}$ , the cross section determined here is about 90 % of the calculated theoretical cross section, whereas for the reaction  $^{238}\text{U} + ^{63}\text{Cu}$  it is only about 41 %.

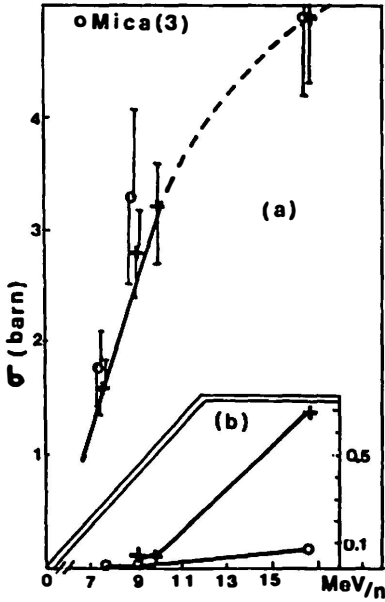


Fig. 2 Excitation function for the reaction  $\text{U} + \text{U}$   
 a) 3-, 4-, 5-, 6-pronged events  
 b) only 5-pronged events

Fig. 2a shows the plot of the excitation function for the reaction  $^{238}\text{U} + ^{238}\text{U}$ . It seems that at 16.7 MeV/N incident energy a plateau is already reached. At the present date, this incident energy is the maximum available at the GSI in Darmstadt for uranium ions. Results of Vater et al<sup>(3)</sup> are also reproduced in the same figure. Good agreement is noted. In addition, it can be pointed out that the multiplicity of events also increases when the incident energy increases. Let us mention that four 6-pronged events were found in our laboratory at 16.7 MeV/N.

Fig. 2b shows the excitation function of the 5-pronged events. Comparison is also made with the results obtained by Vater et al<sup>(3)</sup>. Our values are much higher than theirs. This is due to the fact that our detector is more sensitive. Nevertheless,

increasing similarity can be noted in both results.

In conclusion, these SSNT detectors are well adapted for determining the cross sections of reactions involving products with many correlated fragments. Such experiments are much more difficult using other methods. The expected precision for such detectors is about 10 %.

1. M. Debeauvais, J. Tripier, S. Jokic, Z. Todorovic and R. Antanasijevic, Phys. Rev. C23 (1981) 1624.
2. P.A. Gottschalk, P. Vater, H.J. Becker and R. Brandt, Phys. Rev. C27 (1983) 2703.
3. P. Vater, E.U. Khan, R Beckmann and R. Brandt, 12<sup>th</sup> Int. Conf. on SSNTD, Acapulco (Mexico) (1983).