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Istituto Nazionale Fisica Nucleare
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F. Fabiani[x], U. Fasoli, D. Toniolo and G. Zago: "TOTAL NEUTRON CROSS SECTION OF Na IN THE ENERGY INTERVAL 5.4 - 8.5 MeV[+]. -

Recently fluctuations have been observed of several percent in the total neutron cross section of various elements up to about 10 MeV bombarding energy which apparently cannot be attributed either to individual resonances or to fluctuations in level density. These fluctuations having a width of some hundred KeV and spacings of the same order of magnitude, are interpreted in terms of an intermediate state[1].

More recently fluctuations have been observed in the total neutron cross sections of Si[2] and Al[3] above 5 MeV neutron energy, whereas no deviations from a smooth energy dependence were found in heavier elements ranging from Co to Bi[3].

We have considered to be worthwhile to measure the total neutron cross section of other light elements. In the present work results are given for Na in the energy interval between 5.4 and 8.5 MeV. This energy interval has been already explored[4, 5] but with lower resolution.

The present measurement has been performed by the 5.5 MeV Van de Graaff accelerator of the University of Padua al Legnaro, equipped with a 10 ns pulsed ion source. The time of flight technique was used to discriminate against background.

The experimental apparatus is shown in fig. 1. The neutron source was a gaseous deuterium cell 1,1 cm long. The deuterium at the pressure of 36 cm Hg was sealed in the cell by a nickel window 1.46 μm thick.

(x) - From Centro di Calcolo del CNEN - Bologna.

(+) - Work carried out under Contract EURATOM/CNEN-INFN.

The window thick ness was checked by determining the neutron threshold shift of the Li^7 (p, n) Be^7 reaction due to the nickel foil.

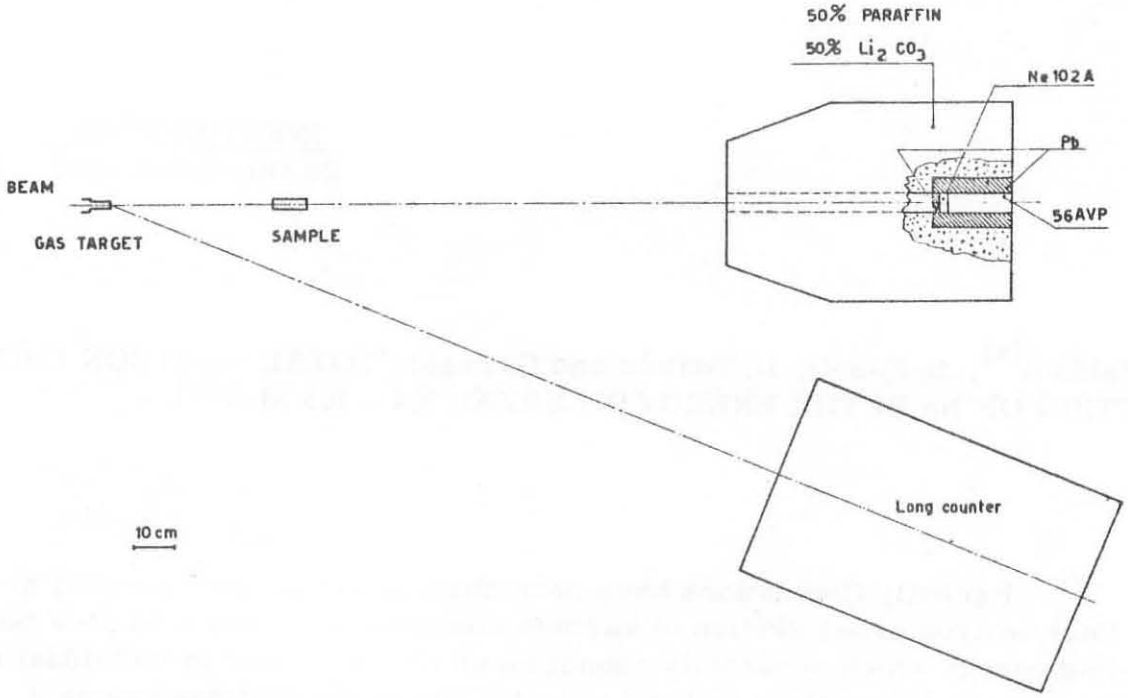

FIG. 1 - Experimental apparatus layout.

The energy spread of neutrons due to the energy spread of the deuteron beam, the straggling in the nickel window, the energy loss through the gas cell and the finite angle subtended at the detector was 40 and 30 KeV respectively at 2.00 and 5.00 MeV deuteron energy.

The neutron energy uncertainty was about 3 KeV up to 7.25 MeV and rised gradually to 30 KeV from 7.25 to 8.5 MeV.

The energy shift due to the carbon deposited by the beam on the nickel foil was reduced to negligeable amount by a liquid nitrogen trap located immediately before the gas cell.

The Na sample was contained in an aluminum can 78.4 mm long and 29.2 mm in diameter. The sample trasmission throughout the energy range was about 80%. The homogeneity of the sample density was checked by X-rays photograph. A dummy can identical with the sample container was used in order to subtract the background.

The neutrons were monitored by integrating the deuteron beam current on the target. A long counter was used for controlling the neutron production and for evaluating the analyzer dead time.

The results of our measurements performed in steps of 25 KeV are shown in fig. 2a, b along with the data of references(4) and (5) and the

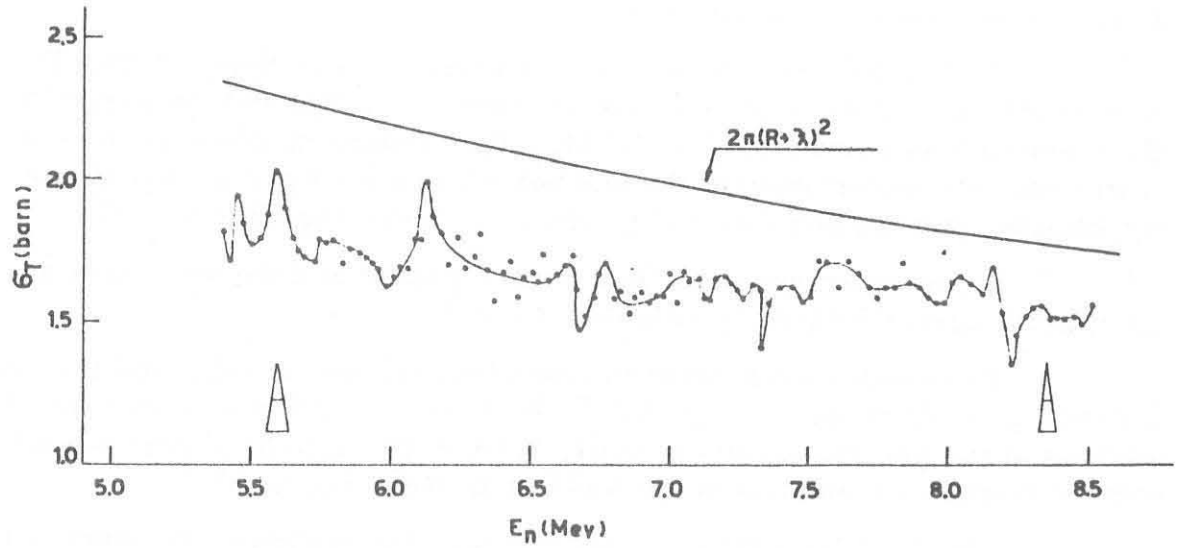

FIG 2a) - The total neutron cross section of Na as measured in the present work.

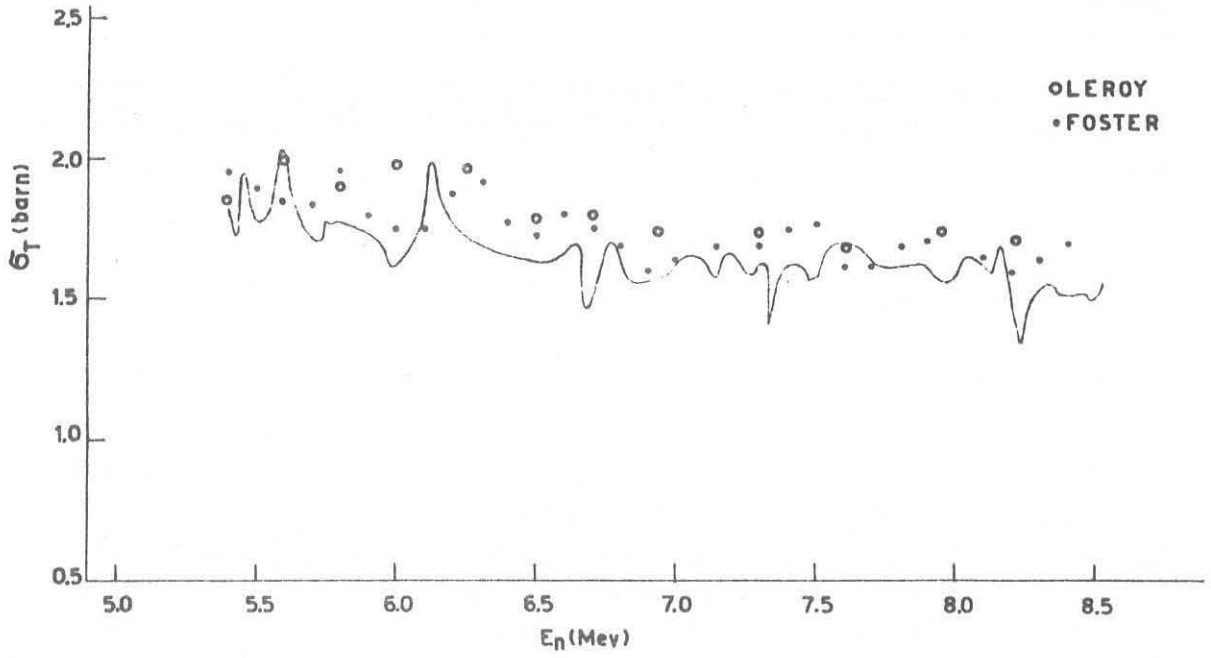

FIG. 2b) - Results of references (4) and (5). The continuous curve is the same as that drawn through our data.

$2\pi (R + \lambda)^2$ curve. The data were corrected for the counting loss which was less than 6.0%; the inscattering correction was less than 0,2% and therefore has not been carried out.

The global error of the measurement is less than $\pm$ 3,2%. The main contributions were the statistical error ($<$ 2.7%) and the error in the counting loss correction ($<$ 1.5%). Other causes of error such as inscattering, the uncertainty of the number of Na nuclei per square cm of the sample, and the neutron background, amounted together to $\pm$ 1%.

Some measurements have been repeated at different times and the results agreed within the calculated error.

Reasonable agreement is found between our results and the data of previous authors as shown in fig. 2. It is interesting to note that the fluctuations at the neutron energy of 5.67, 6.10, 6.70, 7.35 MeV correspond to some resonances observed in the Na^{23} (n, p) Ne^{23} reaction(6).

Except these points, no outstanding fluctuations are observed within the experimental errors. Measurements of this kind concerning Al, S and P are in progress.

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