Investigation of the reaction $^{20}Ne(p,\gamma)^{21}Na$ in the astrophysical interesting energy region*

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The nuclear reaction $^{20}Ne(p,\gamma)^{21}Na$ has been investigated in the astrophysical interesting energy region from $E_p = 600\,k\mathrm{eV}$ to $E_p = 1400\,k\mathrm{eV}$.
Furthermore several resonances of the reaction $^{27}Al(p,\gamma)^{28}Si$ have been measured in an energy range of $E_p = 400\,k\mathrm{eV}$ to $E_p = 1400\,k\mathrm{eV}$ to determine the calibration and efficiency of the detector setup.
The experiments and corresponding measurements have been performed at the Nuclear Structure Laboratory of the University of Notre Dame with the Van-de-Graaff accelerators KN and JN. Implanted or evaporated ^{20}Ne, respectively ^{27}Al beamstop targets have been bombarded with protons, and the induced reactions have been investigated. For the γ-spectroscopic measurements a Ge-detector and a pair of NaI-detectors have been used in 3 different setups.
The first setup included the positioning of the Ge-detector in an angle of 0° to the target. Here the Ge-detector and the target were surrounded completly by a pair of NaI-detectors.
For the second setup the NaI-detectors have been moved forward, so that the target was at the end of the NaI-detector annulus with the Ge-detectors positioned at 0°.
The difference between the second and the third setup is the mounting of a 45° target chamber and correspondingly the rotating of the Ge-detector.
For each setup, the NaI-detectors have been used as Veto-detectors to realize a cosmic background and a Compton continuum rejection.
To determine the setup with the best efficiency, several resonances of the reaction $^{27}Al(p,\gamma)^{28}Si$ have been measured and investigated.
Especially the behavior of the efficiency considering coincidence-summing has been taken into account.
Setup 1 has shown the best rejection while Setup 3 had the highest yields and was therefore chosen to measure the reaction $^{20}Ne(p,\gamma)^{21}Na$.
In our measurements, the resonance strength $\omega\gamma$ for the $^{20}Ne(p,\gamma)^{21}Na$ resonance at $E_p = 1169\,k\mathrm{eV}$ could be determined to a value of :

$$\omega\gamma = 1,12 \pm 0,02\,\mathrm{eV}$$

Tanner et al. [1] report a value of $\omega\gamma = 1,13 \pm 0,07\,\mathrm{eV}$ while E.Stech [3] published a value of $\omega\gamma = 1,17 \pm 0,06\,\mathrm{eV}$.

A measurement and correspondingly a detailed analysis of the direct capture reaction $^{20}Ne(p,\gamma)^{21}Na$ below the $E_p = 1169\,k\mathrm{eV}$ resonance allowed a comparison of the obtained results for the cross section of the $DC \rightarrow 2425\,k\mathrm{eV}$ component with previous results. Figure 1 shows our results in comparison to the results of Rolfs et al. [2] and Stech [3].

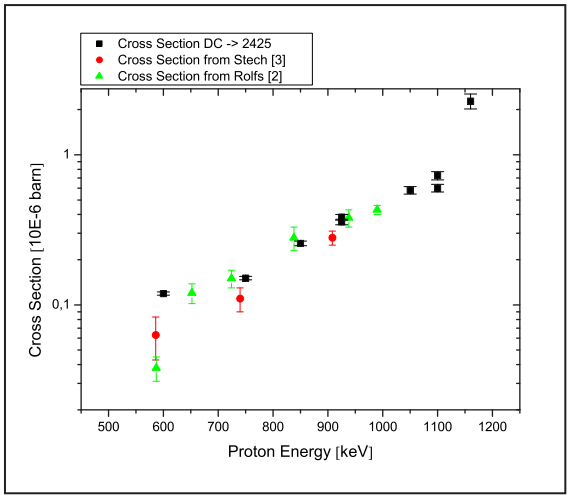

Figure 1: Comparison of the results from our experiments [4] and previous results [2], [3].

The results agree in their trend and partly in their absolute values. The detailed experimental procedures and analysis will be published in [4].

References

[1] Tanner N., 1959, Physical Review, 114, p. 1060

[2] Rolfs C.E., Rodney W.S., Shapiro M.H. and Winkler H., 1975, Nuclear Physics A, 241, p. 460

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