meV. With an assumed cross section of 10^{-16} cm^2 the value of τ becomes in its maximum about 10^{-13} sec. More detailed experiments are necessary to understand this resonance interaction at these very low electron energies.

Apparently similar processes produce the decrease of v_- in H_2 and N_2; however, the minima of q lie probably at lower energies in the region of the thermal velocity, so that Grünberg did not reach the minimum and the comeback to $q=1$.

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The $^{12}C(n,\alpha_0)^9Be$ Reaction at 13.9 and 15.6 MeV

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The investigation of (n,α) reactions has previously shown that both compound and direct processes are involved. The energy and angular distributions of the alpha particles from (n,α) reactions on heavy nuclei at 14 ... 16 MeV show that the direct mechanism predominates [1, 2]. In the case of medium mass nuclei, evaporation spectra and angular distributions which are symmetrical about 90° are observed. However, the few angular distributions of ground state transitions, which have previously been measured, indicate the (n,α_0) reaction to be a direct process even in this region of mass numbers [3, 4]. In the case of light nuclei it is less difficult to separate different alpha particle groups. Angular distributions corresponding to defined states of the final nucleus may therefore be obtained. In addition to information about the reaction mechanism, spectroscopical results may also be expected.

During the last year, some (n,α) reactions on light nuclei have been studied with neutrons near 14 MeV [5, 6]. In the present work, the differential cross section of the reaction $^{12}C(n,\alpha_0)^9Be$ has been measured at 13.9 and 15.6 MeV.

The neutrons were generated by the $^3H(d,n)^4He$ reaction, using a Van de Graaff accelerator. The neutron current density at the carbon target was approximately $5 \cdot 10^6$ sec^{-1} cm^{-2}. Natural carbon targets of 0.4 mg $\cdot$ cm^{-2} and 1.0 mg $\cdot$ cm^{-2} thickness were used with tantalum as a backing. In order to correct for the background, each carbon run was followed by a background run with the carbon target replaced by a tantalum target.

The alpha particles were detected with a counter telescope in which two proportional counters filled with 150 Torr CO_2 were followed by a Si semiconductor detector [7]. The angular distribution function of the telescope was calculated with a Monte-Carlo-technique. The full width at half maximum is typically 15°.

The proportional counter pulses were added to give a single ΔE-pulse. This was analysed in a two-dimensional pulse height analyser together with the E-pulses from the semiconductor detector. The resolution was 32 channels for the ΔE-pulses and 128 channels for the E-pulses. Timing information was obtained from each of the three counter pulses by means of the zero-crossing method. The gate of the analyser was opened by the presence of a triple coincidence; the resolution time was 100 nsec. For 5 MeV α-particles, the resolution is approximately 10% in the ΔE-channel and is better than 100 keV in the E-channel. For alpha particle energies greater than 2.5 MeV, the detection efficiency is 100%.

A long counter was used as a neutron monitor. In order to obtain the neutron current density in the position of the carbon target, it was replaced by a helium gas target. The recoil alpha particles were thus detected in the same arrangement as the alpha particles from the (n,α) process. The differential cross section for the elastic n-^{4}He-scattering was calculated from the phase shifts of HOOP and BARSCHALL [8].

Fig. 1 shows the energy spectrum of the alpha particles from the reaction $^{12}C+n$ at a telescope angle of 0° and with a carbon target thickness of 400 μg $\cdot$ cm^{-2}. The mean neutron energy was 13.9 MeV; upper and lower limits were 14.05 MeV and 13.75 MeV. The ground-state transition of the reaction $^{12}C(n,\alpha)^9Be$ is clearly separated from the lower part of the spectrum; the α_1-, α_2- and α_3-groups are visible as well. At the lower energies however, alpha particles of the 3 α breakup reactions [9] contribute to the spectrum of the $^{12}C(n,\alpha)^9Be$ reaction. The difference in energy between the ground state: $^9Be+\alpha$ and the state: $3\,\alpha+n$ is 1.5 MeV approximately. Therefore only the α_0 transition has been analysed.

Alpha particle spectra of the reaction $^{12}C(n,\alpha)^9Be$ have been measured several times [10—13]. However, the experimental techniques used (emulsion technique [10, 11],

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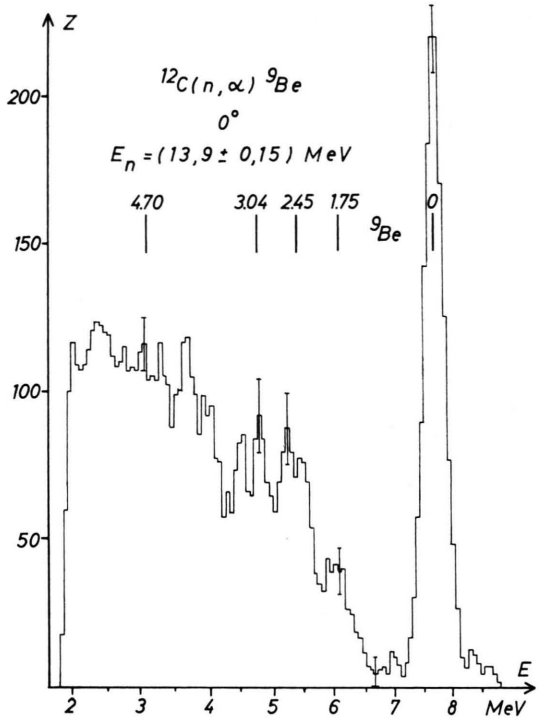

Fig. 1. Energy spectrum of α-particles from $^{12}C(n,\alpha)$ reactions at $E_n = 13.9$ MeV, observed at 0° counter angle. Thickness of the carbon target: 400 μg/cm².

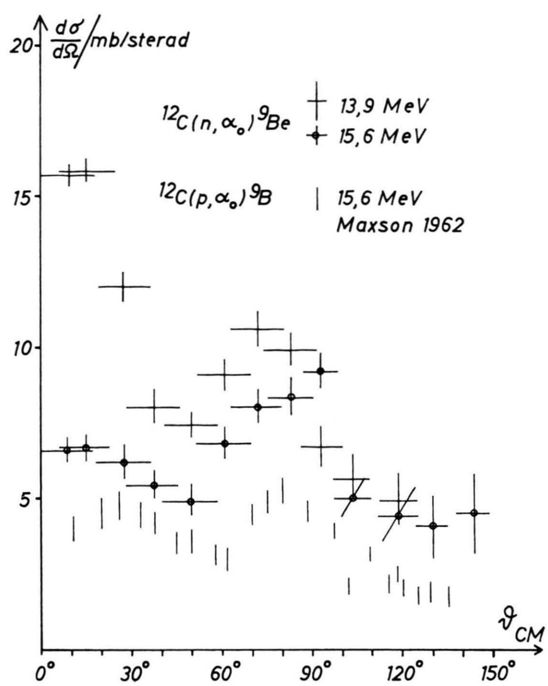

Fig. 2. Angular distributions for the $^{12}C(n,\alpha_0)\,^{9}Be$ ground state reaction at $E_n = 13.9$ MeV and 15.6 MeV. For comparison with the results of this experiment, the data for the $^{12}C(p,\alpha_0)\,^{9}B$ reaction measured by MAXSON [14] are also plotted.

plastic scintillator with pulse shape discrimination [12, 13]) result in a poorer resolution.

Fig. 2 shows the differential cross section of the reaction $^{12}C(n,\alpha_0)\,^{9}Be$ at the neutron energies $E_n = (13.9 \pm 0.15)$ MeV and $E_n = (15.6 \pm 0.25)$ MeV. The differential cross section of the reaction $^{12}C(p,\alpha_0)\,^{9}B$ at 15.6 MeV measured by MAXSON [14] is also plotted.

The diffraction-like structure of the observed angular distribution indicates a direct reaction mechanism. The strong forward peak at 13.9 MeV was also observed by AL-KITAL and PECK [10]. It is absent at 15.6 MeV. The angular distribution of the reactions $^{12}C(n,\alpha_0)\,^{9}Be$ and $^{12}C(p,\alpha_0)\,^{9}B$ at 15.6 MeV are similar, but the cross section of the latter reaction is smaller by approximately a factor of two.

The total cross sections, obtained by integration of the differential cross sections, are compiled in Table 1 together with the previously published values.

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	E_n/MeV	σ/mb
GRAVES and DAVIS (1955) [15]	14,1	80 ± 20
AL-KITAL and PECK (1963) [10]	14,1	62 ± 15 *
CHATTERJEE and SEN (1964) [11]	14,5	69 ± 13
HUCK, WALTER and COCHE (1966) [12]	16	(0,71 ± 0,23) · σ(15 MeV) ⁺
	17	(0,78 ± 0,26) · σ(15 MeV) ⁺
KOPSCH and CIERJACKS (1967) [13]	14,1	72,7 ± 6,8 ⁺
this work	13.9	79 ± 20 *
	15.6	77 ± 20

* Differential cross section integrated from $\vartheta_{CM} = 0°$ to 105° (AL-KITAL) and from $\vartheta_{CM} = 0°$ to 125° (this work).
⁺ The α_0-transition is not accurately separated. At large angles α_0-particles are lost.

Table 1. Total cross section for the reaction $^{12}C(n,\alpha_0)\,^{9}Be$.

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