die im Dampfzustande bestimmte Dissoziations-Energie für ein Mol Wasserstoff-Brücken der Dimeren von Monocarbonsäuren befinden sich im Bereich 7,0 bis 7,5 kcal Mol^{-1}. Nun ist zu berücksichtigen, daß in dem bekannten Sechser-Ring, aus welchem jedes Dimere der Monocarbonsäuren besteht, die Wasserstoff-Brücke infolge des besonders starken Resonanz-Effektes nach WIRTZ [9] eine um etwa 2 kcal überhöhte Energie haben muß. Dimere aber kommen in reiner Flüssigkeit der Monocarbonsäuren nach den bereits erwähnten Ergebnissen von CHAPMAN überhaupt nicht vor. Die H-Brücken-Energie der in der Flüssigkeit existierenden Assoziate sollte also um etwa 2 kcal/Mol kleiner sein als diejenige der Dimeren in der Dampf-Phase. Wenn eine Anzahl von Dimeren in der Flüssigkeit auch bestehen sollte, so würden doch vorzugsweise die Assoziate mit einer tieferen Energie der H-Brücken und nicht die Dimeren gespalten werden. Für die H-Brücken der Monocarbonsäuren in Flüssigkeit findet man in der Literatur Experimental-Werte von 4,6 und 6,0 kcal Mol [8].

Auf Grund der Aufteilung der Oberflächen-Energie von Flüssigkeiten mit kooperativen Effekten in einen den Dispersionskräften und einen den Wasserstoff-Brücken zugeordneten Term und der unter Verwendung der nach Formel (2) berechneten Neigung der Geraden in Abb. 1 und 2 ergibt also die Schätzung Energie-Werte für Wasserstoff-Brücken, welche in den Streu-Bereich der „guten" Experimentalwerte fallen.

Herrn Prof. Dr. K.-H. HELLWEGE verdanke ich die Ermöglichung ultrarot-spektroskopischer Messungen am Deutschen Kunststoff-Institut.

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NOTIZEN

Inelastic Scattering of 14.6 MeV Neutrons to Excited States of ^{12}C

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Angular distributions of 14.6 MeV neutrons inelastically scattered to the 9.64 MeV, 10.84 MeV and 11.83 MeV levels of ^{12}C have been measured by the nuclear emulsion technique. The distributions have been compared with the theoretical distributions calculated on the basis of the HAUSER–FESHBACH model with transmission coefficients obtained from the optical model potential.

The angular distribution of 14 MeV neutrons inelastically scattered to the first excited state of ^{12}C has been extensively studied by many authors. Similar measurements on higher excited states give less accurate results owing to the small cross sections. As pointed out by RETHMEIER et al. [1] experimental results should be compared carefully because the cross section depends on the incident energy. Most of the angular distribution measurements for the 9.64 MeV level were performed at an incident neutron energy of 14.1 MeV (refs. [2–6]). They all show a general decrease at large scattering angles. The angular distribution measured at an incident energy of 14.5 MeV (ref. [7]) is different in shape and on the average larger by a factor of two. A minimum at 90° appears in the angular distribution of neutrons scattered to the 10.1 MeV level [4]. Above this excitation energy angular distributions of inelastically scattered neutrons to separate levels have not been measured. The measurements of SINGLETARY and WOOD [2] attributed to unresolved levels at 10.8 MeV, 11.1 MeV and 11.8 MeV excitation energy show an isotropic distribution.

In the present work the angular distributions of inelastically scattered neutrons to the 9.64 MeV, 10.84 MeV and 11.83 MeV level of ^{12}C have been measured. The results have been compared with the HAUSER–FESHBACH model for the statistical decay of the compound nucleus.

1. Experimental Procedure

14.6 MeV neutrons were produced by the $^{3}T(d,n)^{4}He$ reaction using a magnetically analysed beam of deuterons from the COCKCROFT–WALTON accelerator at the Institute „Rudjer Bošković" [8]. The emerging neutron beam was collimated by a shield with a conical collimator hole. The shield was made of 20 cm iron and

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20 cm paraffin. The neutrons were scattered by a graphite scatterer of spherical form (3.7 cm in diameter) placed at 54 cm from the source. Nuclear emulsion plates Ilford C2 of 200 μ thickness were used as detectors. They were placed at a distance of 15 cm from the centre of the scatterer at scattering angles of 30°, 60°, 90° and 120°. To reduce the background both the source and the detector were shielded by paraffin blocks. The monitoring was done by counting the associated alpha particles from the T–D reaction by means of a CsI scintillation counter. An integrated yield of 1.4×10^{14} neutrons in 4π was attained during the exposure of the system.

The plates were analysed by measuring the direction, length and dip angle of proton recoil tracks in order to obtain the energy of scattered neutrons. A total of 600 tracks remained after subtracting background tracks. The energy spectra were corrected for secondary reactions induced in the emulsion by neutrons scattered from the ground state and from the first excited state of ^{12}C. Corrections amount to less than 4% for all peaks at all measured angles except at 30° where the corrections are 10% for the 9.64 MeV and 10.84 MeV levels and 14% for the 11.83 MeV and 12.7 MeV levels, respectively. A possible contribution of the D–D neutrons from the Ti–D target was estimated to be less than 0.2%.

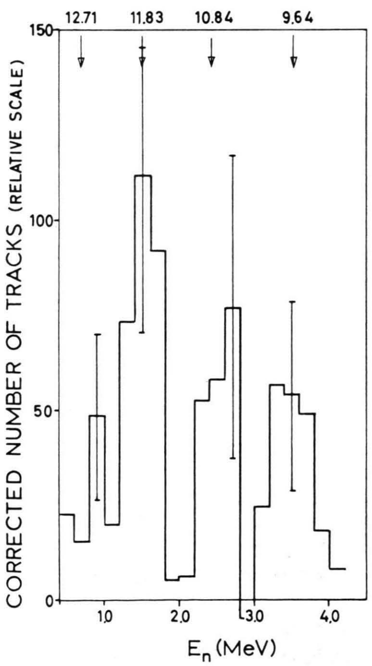

Fig. 1. C. m. energy spectrum of neutrons scattered to higher excited states of ^{12}C. The results at all measured angles have been added. Arrows indicate the expected position of known levels.

2. Results and Discussion

The energy spectrum of scattered neutrons in the c.m. given in Fig. 1 shows peaks corresponding to 9.64 MeV, 10.84 MeV, 11.83 MeV and 12.7 MeV excitation energy. The peak at 10.1 MeV is not visible. Owing to its large width [9] it might be included in the 9.64 MeV peak.

The angular distributions of scattered neutrons corresponding to the 9.64 MeV, 10.84 MeV, 11.83 MeV excited states are shown in Fig. 2. The errors are statistical errors. For the 9.64 MeV level no sudden decrease at large angles up to 128° (c.m.) has been observed. The results obtained agree with those of Duclos [7] at nearly the same incident energy. For comparison the measurements performed by Clarke and Cross [5] at an incident energy of 14.1 MeV are also shown. The distributions for the other two levels are isotropic within the limits of error and in the measured angular region.

The theoretical angular distributions based on the Hauser–Feshbach model for the statistical decay of the

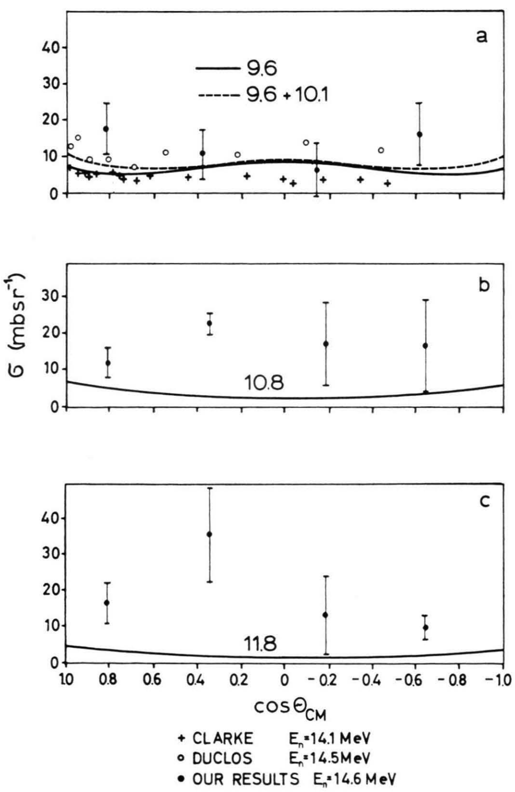

Fig. 2. Differential cross sections for inelastic scattering of neutrons to (a) 9.64 MeV, (b) 10.84 MeV, and (c) 11.83 MeV level. Theoretical curves are based on the Hauser–Feshbach model. The dashed curve represents the sum of the differential cross sections for the 9.64 MeV and 10.1 MeV levels.

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compound nucleus [10] have been calculated. The transmission coefficients used in the calculation have been extrapolated for mass 12 from neutron penetrabilities tabulated by MANI et al. [11]. In computing the transmission coefficients these authors used the optical potential comprising a real SAXON–WOOD term, a GAUSSIAN imaginary part and a spin-orbit term of the THOMAS form. The theoretical curves are shown in Fig. 2 (solid curves). In adding the theoretical angular distribution of neutrons scattered to the 10.1 MeV level to the distribution of neutrons scattered to the 9.64 MeV level (Fig. 2 a – dashed curve) the shape of the distribution was slightly altered though no appreciable change could be noticed, especially if compared to the experimental points with large errors. However, for the 9.64 MeV level a fairly good agreement between theory and experiment has been obtained.

The author is indebted to Professor M. PAIĆ for his constant interest and encouragement, and to Dr. B. ANTOLKOVIĆ for valuable discussions.

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High Sensitivity Bolometer Detector for Molecular Beams

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It is shown how a high sensitivity infra-red detector can be used as molecular beam detector.

The max sensitivity achieved is $2 \cdot 10^8$ molecules sec^{-1}.

Furthermore the advantages of using this kind of detector in scattering experiments are pointed out.

It is well known that in molecular beam experiments, severe intensity problems are posed by the constantly increasing demand in angular and energy resolution. Therefore in many laboratories workers are striving to find a simple, sensitive, stable and, if possible, small neutral molecule detector suitable for all kinds of molecules.

Up to now the effort to find a universal detector has mostly been taken in the direction of the so called electron bombardment detector, where the neutrals are ionized by a transverse electron beam and then measured by electrical means [1–3]. The most sophisticated versions of electron bombardment detectors can reach quite high degrees of stability and a sensitivity in the thermal energy range, as high as 10^6 molecules sec^{-1} on the detector surface, which, in most cases, is of the order of 1 mm². Therefore one needs:

a) Ultra high vacuum techniques to reach 10^{-9} mm Hg in the ionization volume to reduce concurrent ionization of the background.

b) Quite accurate electron and ion optics to improve the ion collection efficiency.

c) High transmission mass selection to further reduce the background.

d) Chopped operation of the beam with some kind of integration processing of the final signal. Usually one employs either a lock-in amplifier or a particle multiplier associated with a counting system.

It follows that such a kind of detector can be sensitive and stable but is far from being simple and usually is not shorter than 30 cm.

The purpose of this paper is to show the possibility of using a commercially available low temperature infrared bolometer [4] for detecting neutrals of energies down to the thermal range with a performance comparable to that of more complicated and bulky electron bombardment devices.

Fig. 1 shows the detector assembly. Through the 1 mm diameter channel C a chopped molecular beam impinges on the surface of a very thin doped germanium single crystal B originating periodic changes of its temperature. The crystal is electrically insulated but is in thermal contact with the high purity copper substrate A, which is kept at liq. He temperatures. The temperature oscillations of the crystal generate periodic variations of its resistance, which are the origin of an electrical signal. This is amplified by a low noise, low frequency amplifier and finally integrated by normal lock-in technique. For calibration purposes a beam was produced in the classical way by effusion from a hole in a very thin wall at room temperature and its

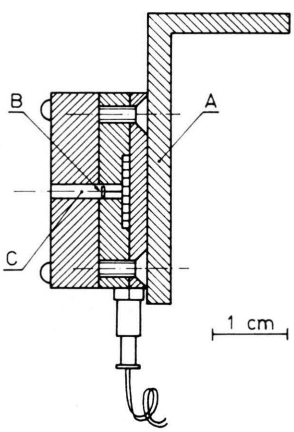

Fig. 1. Details of the bolometer assembly.

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