d'ondes, elles-mêmes plus sensibles aux détails du modèle que la position des niveaux.

Enfin nous remarquons la faible valeur de la section efficace intégrée d'émission de photoneutrons. Plusieurs causes y concourent:

a. le facteur de transmission des protons est, pour les noyaux étudiés, plus grand que celui des neutrons;
b. l'amplitude d'une composante $T = 0$ dans les états excités $T = 1$ peut être importante et favorise l'émission de protons [15];
c. la densité des niveaux observés dans $N^{15}$ est très supérieure à celle de $O^{15}$, d'où une plus grande densité d'états finals dans le cas de l'émission de photoprotons;
d. l'absorption dipolaire est encore importante au delà de la "résonance géante".

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# EXCITATION AND POLARIZATION OF BALMER-$\alpha$ RADIATION IN ELECTRON-HYDROGEN ATOM COLLISIONS

H. KLEINPOPPEN, H. KRÜGER and R. ULMER
Physikalisches Institut der Universität Tübingen, Germany

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The cross section for excitation of the hydrogen levels 2 S and 2 P in electron-hydrogen atom collisions have been measured by different authors [1,2] with an accuracy that allows them to compare their results with those of theoretical approximations. However, sufficient accuracy has not previously been attained in the measurement of the polarization of atomic hydrogen lines, excited by electron bombardment, to permit comparison to theoretical predictions. In this letter we report the results of measuring the relative cross-section and the polarization of the Balmer-$\alpha$ radiation on electron impact. The experimental method was as follows: a low-energy electron beam crossed an intensive hydrogen atomic beam. After passing through an interference filter for the Balmer-$\alpha$ line and a polarizer, the Balmer-$\alpha$ radiation, emitted at right angle to the directions of the atomic and electron beam, was observed by a photomultiplier. The cross-section and the polarization of the Balmer-$\alpha$ light were measured as a function of electron energy.

In order to produce the atomic beam, hydrogen was introduced into a highly evacuated chamber through a tungsten oven * with many long and small parallel channels **, heated to 2650$^{\circ}$K, where the molecules were dissociated to a high degree [5]. The electron bombarder, used in the excitation chamber, consisted of an oxide-coated cathode, two accelerator grids and an anode. The atomic beam passed through the electron bombarder between the second accelerator grid and the anode. The interference filter for the Balmer-$\alpha$ light had a half-width of about 120 Å. In spite of the interference filter the intensity of the background light from the cathode and the tungsten oven was much larger than the intensity of the collision light. Therefore we applied the "lock-in" technique, in order to separate the desired signal of the Balmer-$\alpha$ intensity from the background. The electron beam was modulated with 200 c/s and the modulated sig-

* The setup of this tungsten oven was similar to that described by Kleinpoppen [3], where only one long tube was used instead of the many small parallel channels.

** This technique was first used by Zacharias [4].

nal of the multiplier output was amplified, phase-sensitive detected and recorded. The time constant of the phase-sensitive detector was 90 sec. The recorder signal consisted of the Balmer-$\alpha$ intensity of the beam and of the intensity of the collision light from the residual gas in the vacuum chamber. Both contributions were of about the same size. The second one was measured by stopping the atomic beam with a cone-shaped obstacle. The difference between the total signal and the signal of the residual gas was attributed to the Balmer-$\alpha$ radiation. The pressure in the vacuum chamber was not changed by the obstacle.

Fig. 1 shows the measured, relative differential cross-section of the Balmer-$\alpha$ line as a function of electron energy, observed perpendicular to the direction of the electronic beam. The threshold agrees satisfactorily with that deriving from the hydrogen level diagram.

In fig. 2 the polarization fraction $P = (I_{\parallel} - I_{\perp})/(I_{\parallel} + I_{\perp})$ is plotted versus electron energy. ($I_{\parallel}$, $I_{\perp}$ = intensity of Balmer-$\alpha$ radiation with the electric vector parallel or perpendicular to the direction of the electron impact.) The polarization of the collision light of the residual gas was found to be zero within the errors; similarly the collision light polarization of the molecular beam was zero when the tungsten oven was not heated. The collision light of the molecular beam was about one fifth that of the atomic beam under the same experimental conditions. Since Balmer-$\alpha$ radiation is electric dipole radiation, the angular distribution must be proportional to $1 - P\cos^2\varphi$, where $\varphi$ is the angle between the direction of the photon emission and the direction of the incident electron beam. Therefore the correlation between the differential cross-section $q(\varphi)$ and the total cross-section $Q$ is described by: $q(\varphi) = 3Q(1 - P\cos^2\varphi)/4(3 - P)$. Fig. 3 shows the relative total cross-section, calculated by this formula. The errors consist of twice the rms statistical error and an estimated systematic error which is small compared to this and which is mainly caused by the fact that the degree of dissociation of the hydrogen beam was not exactly known.

On account of the bad signal noise ratio the polarization near threshold could not be measured so far. More accurate measurements near the threshold as well as measurements above 100 eV are planned.

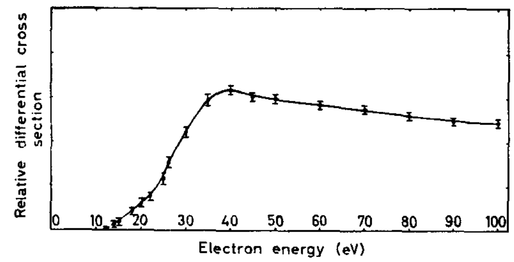


Fig. 1. Relative differential cross-section for excitation of Balmer-$\alpha$ line in electron-hydrogen atom collisions, observed perpendicular to the direction of the electron beam (twice rms).

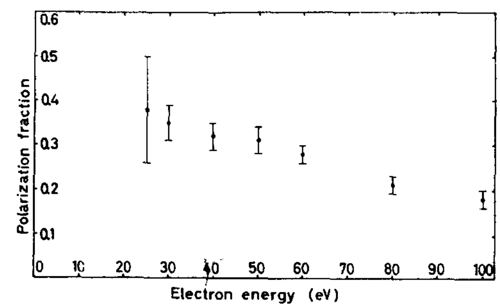


Fig. 2. Polarization fraction for Balmer-$\alpha$ radiation in electron-hydrogen atom collisions (twice rms).

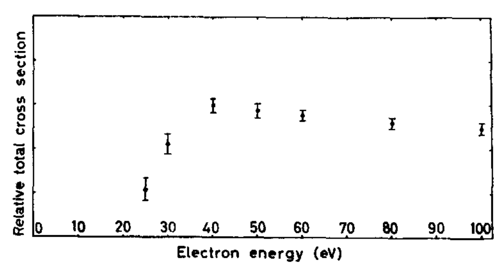


Fig. 3. Relative total cross-section for excitation of Balmer-$\alpha$ radiation in electron-hydrogen atom collisions (twice rms).

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