MEASUREMENT OF THE CROSS SECTION OF THE REACTION $Kr^{80}(n, \gamma)Kr^{81}$ FOR THERMAL NEUTRONS

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The effective cross section of the reaction

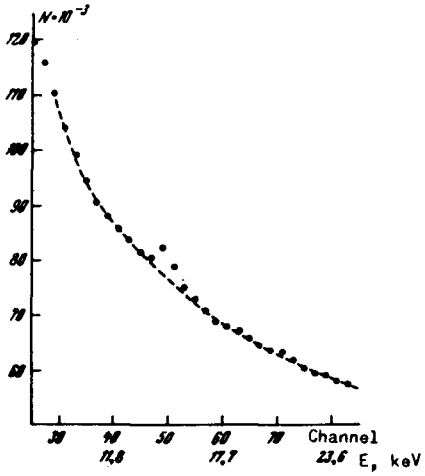
$$Kr^{80}(n, \gamma)Kr^{81} \qquad (1)$$

was measured twice [1, 2]. Greatly differing results, 12.5 ± 1.5 b and 95 ± 15 b, were obtained. The importance of knowing the exact value of the cross section of reaction (1) was increased recently because Kr^{81} was observed in atmospheric krypton. The amount of Kr^{81} in the atmosphere is associated with variations of the earth's magnetic dipole moment, and the rate of formation of Kr^{81} from atmospheric krypton is determined to a considerable degree by the cross section of the reaction (1).

The difficulty of measuring the cross section of reaction (1) lies in the fact that when a krypton sample is irradiated in a reactor, the background due to the decay of Kr^{85} makes it impossible to observe the decay of Kr^{81}.

This is apparently the very reason why the cross section of the reaction (1) was not determined by registering the decays of Kr^{81}, but by indirect methods.

We have measured directly the cross section of reaction (1) by irradiating gaseous krypton. To perform the experiment, a special multifilament cylindrical proportional counter was developed. The advantage of such a counter lies in the absence of a wall between the main counter and the counters connected for anticoincidence with the main one. As a result, all the β electrons produced in the decay of Kr^{85}, with the exception of the softest ones or those traveling along the counter axis, triggered the anticoincidence circuit and thus made no contribution to the background of the main counter, the anode of which was the central filament. Since the Auger electrons produced in the decay of Kr^{81} have a range of approximately 1 mm in gas at atmospheric pressure, only one of the counters, the central one or the ring one, operated in the overwhelming majority of cases of Kr^{81} decay. The calibration was with the aid of an Fe^{55} source and the characteristic K_α Cu line. The counter was filled with a mixture of 90% Ar and 10% CH_4 to a pressure of 760 mm Hg. The work was performed at a gas amplification coefficient 5000. In the region of energy release from the Kr^{81} decay (channels 45 - 54), the optimal reduction of the background when the anticoincidence counters were turned on was 14. The total measurement time was 2200 minutes. The results are shown in the figure. Although the neutron flux intensity was known directly when the sample was irradiated in the reactor, a more reliable absolute value of the cross section could be obtained from the ratio of the decay rates of Kr^{81} and Kr^{85}, for in this case all the uncertainties connected with the neutron flux and the different normalization volumes were eliminated in this case, and the cross section for the production of Kr^{85} were determined with high accuracy. As a result of the measurements and of allowance for all the corrections connected with the operating characteristics of the counter and the features of K-capture of Kr^{81}, we obtained the following value for the cross section of the reaction (1):



$$\sigma = 15.6 \pm 1.9 \text{ b.}$$

Thus, the question raised in [3], concerning the reasons for observing too large an amount of Kr^{81} in atmospheric krypton, becomes valid, since the rate of Kr^{81} production can be reconciled with the actually observed amount only if the cross section of reaction (1) is close to 100 b.

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[2] J. MacNamara and H.G. Thode, Phys. Rev. 80, 296 (1950).
[3] H.H. Loosli, H. Oeshger, and W. Wilst, J. Geophys. Res. 75, 2895 (1970).

DOUBLE IONIZATION OF MAGNESIUM BY THERMAL COLLISIONS WITH HELIUM IONS

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We establish in the present study the existence of double ionization of magnesium atoms by thermal collision with helium atoms, and show that this process can serve as an effective source of doubly-ionized impurity atoms, and is therefore important for gas discharges in mixtures.

There are about 30 elements whose double-ionization energy is lower than the ionization energy of helium, and for which double ionization by collision with helium atoms

$$He^+ + A \rightarrow He + A^{++} + e \qquad (I)$$

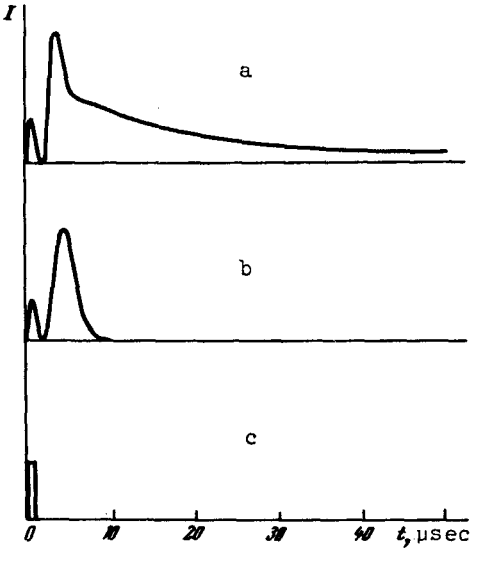
is energywise feasible.

Unlike the usual charge exchange at thermal velocities, the process (I) can proceed effectively without energy resonance, since the excess energy, just as in the Penning process [1], can be transferred to the released electron.

To detect the effect, we observed the afterglow of a pulsed gas discharge in a helium-magnesium mixture. Magnesium was chosen because the energy required for its double ionization is lower by 1.95 eV than the helium ionization energy, but is higher than the energies of the metastable states of helium.

The observations of the afterglow have shown the following:

1) At sufficiently strong currents in the pulse, the afterglow in all Mg II lines in the Mg + He mixture consists of a short flash, followed by a prolonged rather intense decreasing part (Fig. a).



Afterglow of Mg II lines: a) in a mixture with helium, b) in a mixture with argon, c) current pulse. Helium and argon pressure 3.5 Torr, magnesium pressure 2×10^{-3} Torr. Discharge tube diameter 8 mm.