Hyperfine Structure of the Resonance Lines of Rubidium

The resonance lines λ7800 and λ7947 of rubidium have been photographed with Fabry-Perot etalons of spacing 1.5 and 1.8 cm. Two experimental arrangements were used: (1) The light from a helium-filled Geissler tube containing a small quantity of rubidium was focused directly on the slit of the hyperfine structure spectrograph. The tube was cooled below the point of appreciable self-reversal. (2) Light from the same source was passed through a Jackson-Kuhn atomic beam tube before entering the slit.

Patterns shown in Figs. 1 and 2 were observed for the two lines. Relative positions of the components were measured within 0.003 cm^{-1}. The measured values of the separations agree with those of Kopfermann and Krüger[1] within the error of these measurements. The values of the separations are compared in Table I.

TABLE I. *Comparison of measurements on Rb resonance lines.*

Separation ($cm^{-1} \times 10^{-3}$)	*A–B*	*a–b*	*B–b*	*C–D*	*c–f*	*D–f*
Kopfermann and Krüger	96	220	82	107	255	93
Author	97	217	79	107	252	91

The components *A*, *B*, *C*, and *D* are ascribed to isotope 85 and *a*, *b*, *c*, and *f* to isotope 87, the isotopes being present in the ratio 3 : 1. Values of $\Delta^2S_{\frac{1}{2}}$, $\Delta^2P_{\frac{1}{2}}$, and $\Delta^2P_{\frac{3}{2}}$, the hyperfine structure separations of the levels, obtained from the above data, were 0.102 cm^{-1}, 0.016 cm^{-1}, and 0.009 cm^{-1} for isotope 85, and 0.225 cm^{-1}, 0.027 cm^{-1}, and 0.015 cm^{-1} for isotope 87. $\Delta^2P_{\frac{3}{2}}$ represents a total separation of extreme levels; $S_{\frac{1}{2}}$ and $P_{\frac{1}{2}}$ being double only.

In addition to the above measurements, experimental arrangement (2) made it possible to resolve components *C* and *D* each into two components whose separation is due to $\Delta^2P_{\frac{1}{2}}$. The separation of components *C* was measured and a value of 0.015 cm^{-1} obtained for $\Delta^2P_{\frac{1}{2}}$, in agreement with the above value. This experimental value in conjunction with the separation *C–D* of the unresolved components leads to a value of 0.102 cm^{-1} for $\Delta^2S_{\frac{1}{2}}$. Millman and Fox[2] obtained 0.1018 cm^{-1} for this separation by the atomic beam method of "zero moments."

The value of $\Delta^2S_{\frac{1}{2}}$ for isotope 85 gives, from Goudsmit's formula for *s* electrons $g(I)=0.55$. $\mu=1.4$ nuclear magnetons on the basis of the value $I=5/2$ of Millman and Fox. The experimental value of $\Delta^2P_{\frac{1}{2}}$ obtained from experimental arrangement (2) makes it possible to calculate $g(I)$ from Goudsmit's formula for *p* electrons, giving $g(I)=0.68$ and $\mu=1.7$ nuclear magnetons. The percent difference between the two values for μ is the same as the percent error in the measurement of $\Delta^2P_{\frac{1}{2}}$.

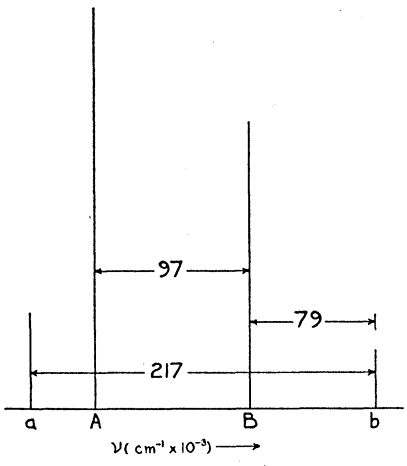

FIG. 1. Hyperfine structure pattern for λ7800.

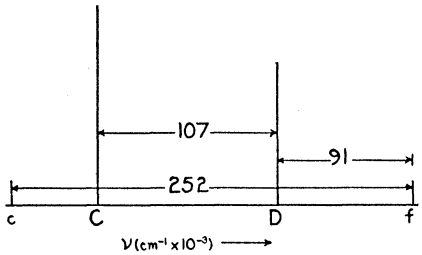

FIG. 2. Hyperfine structure pattern for λ7947.

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[1] H. Kopfermann and H. Krüger, Zeits. f. Physik **103**, 485 (1936).
[2] S. Millman and M. Fox, Phys. Rev. **50**, 220 (1936).

Artificial Radioactivity Produced by Alpha-Particles

Bothe and Gentner[1] have reported the production of a radioelement of 38 minutes half-life in zinc bombarded with 16 Mev gamma-radiation; this activity they have attributed to Zn^{63}, produced in the reaction Zn^{64} $(\gamma, n)Zn^{63}$. In an earlier communication,[2] we stated that this activity did not appear in the case of Ni bombarded with 7 Mev alpha-particles, although it might have been expected according to the reaction Ni^{60} $(\alpha, n)Zn^{63}$. We did find a new radioactive isotope of copper, Cu^{61}, formed in the reaction Ni^{58} $(\alpha, p)Cu^{61}$. The same activity has been reported by Thornton[3] in nickel bombarded with deuterons.

We have now removed the thin platinum foil which served as an exit window for the alpha-particles, so that targets can be bombarded directly in the main vacuum chamber of the cyclotron. The additional 1 Mev of particle energy gained thereby has enhanced greatly the total activity in Ni bombarded with alpha-particles, and the presence of a radioelement of half-life about 37 minutes is now evident. The short-period activity is chemically separable from the much stronger Cu^{61}, and is doubtless due to Zn^{63}. The relative initial intensities, corrected to infinite bombarding time, are in the ratio $Cu^{61} : Zn^{63} = 1.9 : 10$. We believe that a small amount of Zn^{63} was present in Ni bombarded with the 7 Mev alpha-particles, accounting for the fact that the period given by us[2] for Cu^{61} (3.25 hours) was too low, the correct value being that reported by Thornton:[3] 3.4 hours.

A paper dealing in detail with our experiments is in preparation.

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[1] Bothe and Gentner, Naturwiss. **25**, 191 (1937).
[2] Ridenour and W. J. Henderson, Phys. Rev. **51**, 1102 (1937).
[3] Thornton, Phys. Rev. **51**, 893 (1937).