condition for the formation of liquid in the capillary is therefore given by

$$2\pi r\Delta r\rho g h_1 < 2\pi\Delta r H, \quad \text{or} \quad r < H/\rho g h_1. \qquad (1)$$

A capillary placed 2 mm above the bath level for instance, will show according to formula (1) a critical diameter of 0.2 mm.

Finally the statement can be made that h_1 should be smaller than $\frac{1}{2}h_m$ in order to open the possibility for the capillary to fill itself with liquid helium-II.

[1] Dyba, Lane, and Blakewood, Phys. Rev. **95**, 1365 (1954).

Neutron Diffraction by Metallic Erbium

W. C. Koehler and E. O. Wollan
Oak Ridge National Laboratory, Oak Ridge, Tennessee
(Received December 29, 1954)

As a part of a neutron diffraction study of rare earth metals we report here some results which have been obtained on metallic erbium. The data obtained may be grouped into three temperature regions for convenience of discussion: room temperature to 80°K, 80°K to 35°K, and 35°K to 4.2°K. At room temperature the neutron pattern is characteristic of a paramagnetic material. The magnitude and angular variation of the paramagnetic diffuse scattering agree within experimental error with the previously reported results[1] for the trivalent erbium ion in Er_2O_3 and thus indicate essentially the full L and S contribution from the eleven $4f$ electrons. The coherent nuclear reflections can be interpreted in terms of a simple hexagonal close-packed structure.

At temperatures below about 80°K some additional coherent reflections are observed which are believed to be of magnetic origin for the following reasons: (1) A characteristic diminution of the background scattering is observed; (2) The magnitudes of the integrated intensities are too large to be accounted for by nuclear scattering alone; and (3) x-ray diffraction measurements show the h.c.p. structure to persist to 43°K.[2] The temperature dependence of a number of these reflections is shown in Fig. 1 (the nuclear contribution has been subtracted off so that these refer to magnetic intensities only), in which are plotted values of $j|F|^2$/atom expressed on an absolute scale in units of 10^{-24} cm^2.

Two lines, which are denoted by I and II, occur at angular positions forbidden to the simple h.c.p. structure; the indices given refer to this structure. No change of intensity is noted above about 35°K for the (101) and (102) reflections but below this temperature the experimental points lie on a line which shows little tendency to curve toward the temperature axis. On the contrary, the (100) and (110) reflections, and the extra reflections I and II exhibit a measurable growth in intensity at 77°K. It is also to be noted that the intensities of the extra lines begin to decrease at about 35°K although there is still a measurable contribution to the pattern from these lines at the lowest temperature studied. For the (100) and (110) lines the intensities continue to increase with decreasing temperature but the intensity-temperature curves tend to bend toward the temperature axis. A possible explanation of these data is that a magnetic transition, the detailed nature of which is still unknown, sets in at about 80°K and this phase contributes intensity to the (100) and (110) positions as well as to the lines denoted I and II. At about 35°K a second magnetic transition occurs from which intensity is contributed to the (101) and (102) reflections as well as to the (100) and (110). The shapes of the latter two curves would then be attributed to competition between the two phases.

At the lowest temperature studied, 4.2°K, the magnetic reflections, disregarding a small contribution from the high-temperature phase, are those characteristic of a ferromagnetic substance with the simple hexagonal close-packed structure and for which the moments are directed parallel to the hexagonal axis. The $j|F|^2$ values for the (101) and (102) reflections which are presumably uncontaminated by the high-temperature phase may be used to calculate the ferromagnetic contributions to the (100) and (110) reflections and these are indicated by dashed straight lines. The dashed curved line may then be taken to represent the fall-off with temperature of the high-temperature phase contributions to these reflections. The ferromagnetic moment derived directly from the (101) magnetic intensity at 4.2°K is 7.2 Bohr

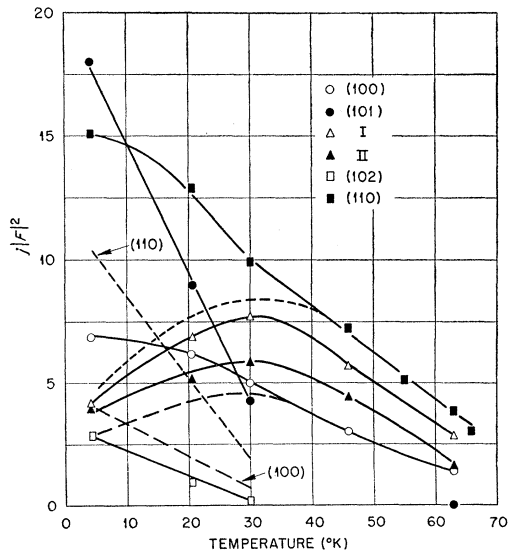

FIG. 1. Temperature dependence of the magnetic coherent scattering by metallic erbium. The low-temperature ferromagnetic transition is shown by the (101) and (102) reflections. The dashed lines indicate how the (100) and (110) reflections may be resolved into high- and low-temperature phase contributions.

magnetons. This value is undoubtedly too low both because of the presence of the high-temperature phase and because the temperature is too high for complete saturation, but it does demonstrate a sizeable orbital contribution to the magnetic moment of metallic erbium.

The presence of superlattice reflections in the high-temperature magnetic phase is suggestive of an antiferromagnetic or ferromagnetic structure. An antiferromagnetic structure is suggested by the anomalous behavior of the initial susceptibility in the neighborhood of 80°K,[2] which is similar to that found in dysprosium[3,4] at 176°K but not as well developed. The magnetic reflections in the high-temperature region can indeed be indexed on a unit cell which is three times the h.c.p. unit, but a consideration of absent reflections suggests that the true unit may even be larger. We have, however, not yet found a structure which will satisfactorily account for the higher temperature magnetic scattering data.

Further experiments are being planned in which the specimen will be carried to temperatures below 4.2°K, and where a magnetic field will be applied to the scattering specimen. One can, in principle, control ferromagnetic scattering by the application of an external field and it is hoped such measurements can establish the nature, and structure, of the high-temperature phase by removing the contribution from the ferromagnetic low-temperature phase.

It is a pleasure to acknowledge the continuing interest which Dr. F. H. Spedding has shown in this problem and his cooperation in providing the specimen of erbium metal.

[1] W. C. Koehler and E. O. Wollan, Phys. Rev. **92**, 1380 (1953).
[2] Banister, Legvold, and Spedding, Phys. Rev. **94**, 1140 (1954).
[3] Elliot, Legvold, and Spedding, Phys. Rev. **94**, 1143 (1954).
[4] F. Trombe, Compt. rend. **236**, 591 (1953).

Excitation of the Sodium *D* Lines in the Nightglow*

D. M. Hunten
University of Saskatchewan, Saskatoon, Canada
(Received May 14, 1954)

In a recent letter,[1] Foderaro and Donahue have suggested that the sodium radiation observed in the nightglow is transmitted around from the sunlit side of the earth. This requires several diffuse reflections from the surface and several resonant scatterings from the layer of free sodium in the upper atmosphere. It is therefore to be expected that the intensity ratio D_2/D_1 would be very large, since D_2 is scattered more strongly than D_1 (twice as strongly by a thin layer). However, the measurements of Berthier[2] show the ratio to be 1.98 ± 0.05.

Another argument against the suggested mechanism depends on the thickness of the sodium layer. Apparently a thickness of 10^{11} atoms/cm^2 column is required, and the final intensity would be expected to vary as a rather high power of the thickness. But the thickness deduced by Bates and Massey[3] is only 10^9 atoms/cm^2, and recent unpublished measurements on twilight by G. G. Shepherd and the writer give 2.8×10^9 atoms/cm^2.

It thus appears that resonant scattering cannot be important in the excitation of the nightglow emission; however, it may still play a part in the twilight.

* Supported by the Geophysics Research Division of the U. S. Air Force Cambridge Research Center.
[1] A. Foderaro and T. M. Donahue, Phys. Rev. **91**, 1561 (1953).
[2] P. Berthier, Compt. rend. **234**, 233 (1952).
[3] D. R. Bates and H. S. W. Massey, Proc. Roy. Soc. (London) **A187**, 261 (1946).

Energy Distributions of Photoelectrons from Au and Ge in the Far Ultraviolet*

William C. Walker and G. L. Weissler
Department of Physics, University of Southern California, Los Angeles 7, California
(Received December 13, 1954)

Electron energy distributions for the external photoelectric effect have been extensively investigated only for photon energies within a few electron volts of the photoelectric threshold; for incident photon energies comparable with the width of the Fermi band of the photoelectric sample little work has been done.[1,2] The present note concerns preliminary measurements of the electron energy distributions of Au and Ge photocathodes for incident photon energies of 10.2, 14.9, and 17.6 electron volts corresponding to wavelengths of 1216 A, 833 A, and 704 A respectively.

In this work retarding potential techniques with a spherically symmetric photocell were used to obtain current-voltage saturation curves, from which the desired energy distributions were obtained by graphical differentiation. The monochromator, light source, and current-recording equipment used have been described elsewhere.[3]

Figure 1 shows the energy distributions obtained for an Au photocathode which had been cleaned by heating in a vacuum at a temperature near the melting point. In this figure the ordinate is one hundred times the ratio of the number of emitted electrons per incident photon with energies between E and $E+dE$ to the photoelectric yield, $\gamma(\lambda)$, in electrons per photon, that is, the quantity plotted is $[N(E)/\gamma(\lambda)]\times100$ (ev)$^{-1}$. The electron energy in electron volts is plotted along the abscissa. A striking feature of these curves is the large proportion of low-energy electrons emitted for photon energies several volts larger than the width of