we have used. Comparing the results obtained with counters (c') and (d') with the corresponding results obtained from (c) and (d), a small increase in the coincidence rate is noted. Considering the fact that the counters (c') and (d') are more sensitive to photons of low energy, the increase in the number of coincidences observed can be explained by the hypothesis that a fraction of the coincidences are due to the association between γ-radiation and x-rays subsequent to K-capture. A sensible increase in N is obtained only for counters with KF ($N_{d'}-N_d=0.48\pm0.26$) and not for those with KCl. This agrees with the hypothesis that the increase is actually caused by x-rays of the K_α line of argon which are strongly absorbed in chlorine.

The hypothesis that there is an association between K-capture and γ-radiation justifies the magnitude of the observed effect.

Further details on this experiment will be found in a paper to appear shortly in *Nuovo cimento.*

We are indebted to Professor A. Rostagni for suggesting this investigation, to Dr. M. Ceccarelli for his assistance in the first phase of the experiment, to S. A. D. E. for the facilities afforded us, and to Soc. Montevecchio for lending the lead.

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Detection of Millimeter Wave Solar Radiation*

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VAN VLECK has calculated the transmission of the atmosphere in the millimeter wave region.[1] His results show that the region from one to three millimeters, with the exception of the vicinity of the 2_2-3_{-2} rotation line of water vapor predicted at 1.6 mm (6.15 cm^{-1}), will be substantially transparent to solar radiation. Radiation in this region has now been detected from the sun. The detecting equipment consisted of a Golay infrared detector at the focus of a modified, 24-inch searchlight. The filters used to isolate these long wavelengths were three sheets of photographic wrapping paper, the quartz window of the detector, and the pure rotation spectrum of the water vapor in the atmosphere. The rotation spectrum of the water vapor removes the region 50 to 1000 microns, and black paper is opaque from the visible to 100 microns or more but is found to be transparent to these radiations.

Figure 1 shows two records which were obtained by allowing the sun to drift across the sensitive field of the millimeter wave telescope. The reduction in the signal which was obtained on February 2 was due more to the higher water vapor content of the air than to the clouds. Measurements indicate that clouds are quite transparent.

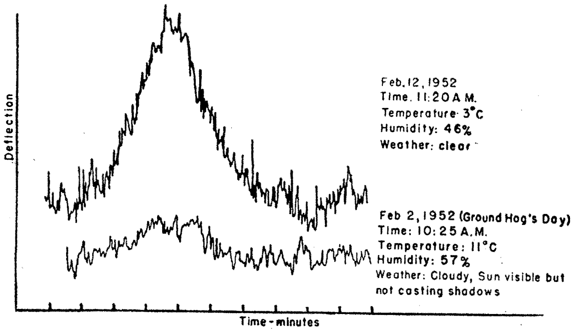

FIG. 1. Transits of the sun across the field of the millimeter wave telescope.

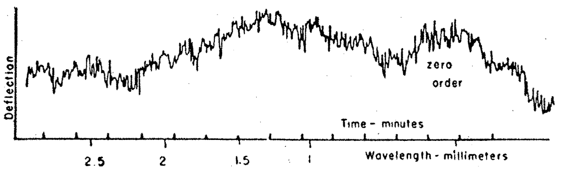

FIG. 2. Solar spectrum obtained with an echelette grating.

Assuming that the sun radiates as a blackbody at 6000°K, then the illumination just outside the earth's atmosphere is 9.5×10^{-11} watts per cm^2 in the wavelength region one to three millimeters. The maximum signal so far received was 6×10^{-12} watts per cm^2 which was obtained when the ground level atmosphere contained 2.7 grams of water per cubic meter. This signal was estimated by comparison to the signal received from a blackbody source of the same apparent diameter as the sun. The amount of water vapor absorption in the 45-foot path to the blackbody was estimated from ground level absorption measurements made in the laboratory.

One way in which the wavelength of this radiation has been checked involved measurements of the extinction coefficient of rocksalt. This has been measured in the far infrared by McCubbin and Sinton[2] and in the microwaves by von Hippel. A linear interpolation for the intervening wavelengths is sufficient since they are well removed from any eigenfrequency. The average wavelength found from the measured extinction coefficient is 1.4 mm.

A coarse transmission echelette grating was used to obtain the spectrum of the solar radiation. It was made of paraffin and had six lines per foot and an echelette angle of two degrees. Figure 2 shows the spectrum which was obtained when this grating was placed in front of the telescope and the sun allowed to move ahead without the telescope tracking. It is uncertain whether the dip in the spectrum near two mm is the 2_2-3_{-2} line of water vapor, or whether the peak after two mm is the second order of the shorter wavelength radiation. However, since the wavelength of the blaze is calculated to be one mm, the second order of this wavelength should be nearly absent.[2]

This work was carried out under the supervision of John Strong.

* This research was supported by a Navy contract.
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Hexagonal Iron-Oxide Compounds as Permanent-Magnet Materials

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A CLASS of oxides with hexagonal crystal structure has been the subject of a detailed magnetic investigation. These oxides are characterized by the formulas $Me\mathrm{O}\cdot6\mathrm{Fe_2O_3}$, and $Me\mathrm{O}\cdot2\mathrm{Fe_3O_4}\cdot6\mathrm{Fe_2O_3}$, respectively, where Me stands for the divalent metals Ba, Sr, or Pb. Only the Ba-compounds will be dealt with in this communication. The saturation magnetic moment per gram as measured for small single crystals along the direction of preferred magnetization is plotted in Fig. 1 as a function of temperature. The value of the saturation magnetization at absolute zero temperature can be accounted for on the basis of the crystal structure[1,2] as being caused by noncompensated antiferromagnetism, along the lines of Néel's[3] and Anderson's[4] theories. The paramagnetic behavior above the Curie point (at about 450°C) is shown in Fig. 2 for the compound $\mathrm{BaO\cdot6Fe_2O_3}$. It points equally to noncompensated antiferromagnetism.

The crystal anisotropy of the hexagonal compounds is large. Approximate values of the anisotropy constant K (in erg/cm^3) for $\mathrm{BaO\cdot6Fe_2O_3}$ have been plotted against temperature in Fig. 3. K is defined by the relation: crystalline energy $=K\sin^2\varphi$, where φ is the angle between the magnetization and the hexagonal axis.

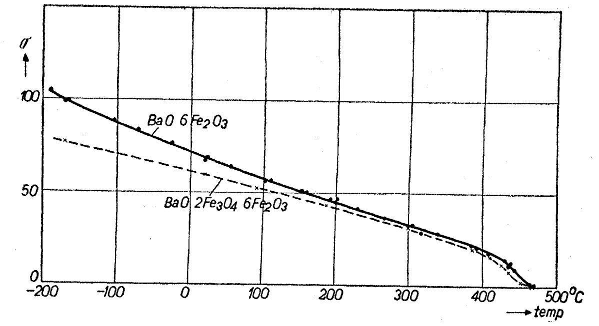

FIG. 1. Saturation magnetic moment per gram, measured for small single crystals along the direction of preferred magnetization, as a function of temperature.

The hexagonal axis is the direction of preferred magnetization while no anisotropy has been found within the basal plane.

The ratio K/I_s, which is related to the coercive force expected for pure rotation, does not decrease appreciably with temperature up to 300°C. I_s denotes the volume magnetization. The critical crystal size, which must be exceeded to allow the formation of a stable Bloch-wall within an isolated single crystal in its own demagnetizing field, contains as the temperature-dependent part the ratio $K^{\frac{1}{2}}/I_s$.[5,6] This ratio increases with rising temperature up to about 400°C.

Figure 4 shows the intrinsic coercive force $_IH_c$ for a fine-grained sintered sample of $BaO\cdot 6Fe_2O_3$ as a function of temperature. The curve shown cannot be explained by pure rotational processes since the observed values of $_IH_c$, though large, are appreciably lower than K/I_s, while also the shape of the curve differs from that of the curve K/I_s *versus* temperature. We believe that the maximum of $_IH_c$ at about 250°C is due to the interplay of two effects: the decrease of the number of stable Bloch-walls at higher temperatures, of which only the most stable will probably persist, and the increase of the mobility of a particular wall when K decreases. It may be added that, because of the high anisotropy coupled with a relatively low saturation magnetization single domain crystals can be expected at much larger crystal sizes than is the case with ordinary materials.

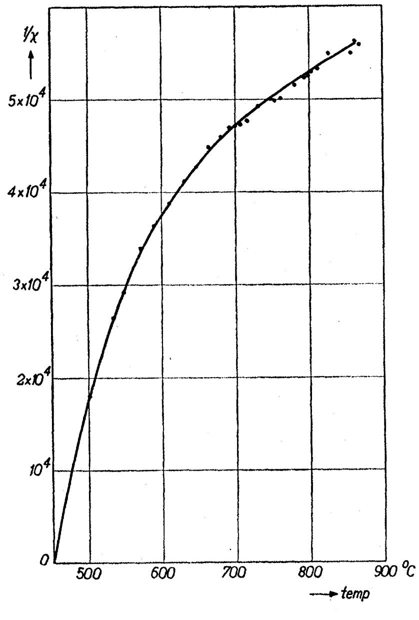

FIG. 2. Paramagnetic behavior of $BaO\cdot 6Fe_2O_3$ above the Curie point.

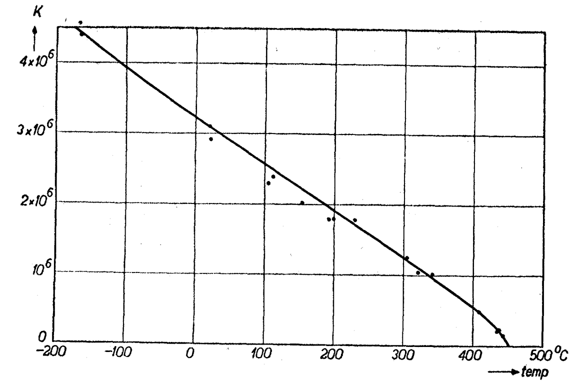

FIG. 3. Anisotropy constant K for $BaO\cdot 6Fe_2O_3$, as a function of temperature.

In connection with the increase of the coercive force $_IH_c$ with temperature the following experiment is interesting. A magnetized specimen of $BaO\cdot 6Fe_2O_3$ (demagnetization factor 0.1) is heated up to 400°C, whereby the remanence decreases to about 30 percent of the room-temperature value, and cooled to room temperature again without application of an external magnetic field. The room-temperature value of the remanence is again obtained.

The $(BH)_{max}$ value of fine-grained sintered material at 20°C amounts to about 0.85×10^6 gauss oersted at $B=1100$ gauss. The material contains only trivalent iron ions and accordingly shows a high resistivity (well above 10^7 ohm cm at room temperature).[7]

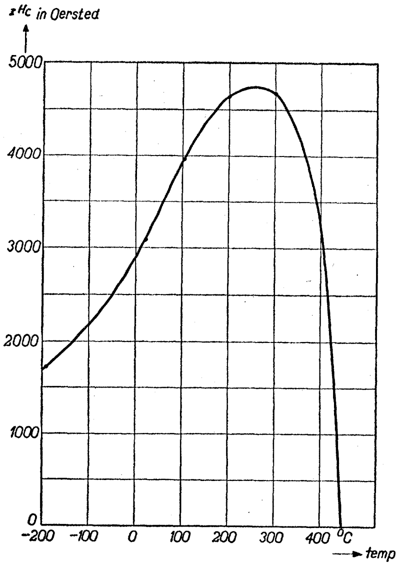

FIG. 4. Intrinsic coercive force $_IH_c$ for a fine-grained sintered sample of $BaO\cdot 6Fe_2O_3$, as a function of temperature.

A detailed publication will appear elsewhere.[8]

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* Now with N.V. K.E.M.A., Arnhem (Netherlands).

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