consequence of the meson theory and the results turn out reasonably in every respect. These questions are dealt with in a paper to appear shortly in the *Proceedings of the Cambridge Philosophical Society.*

[1] F. L. Code, Phys. Rev. 59, 229 (1941); R. P. Shutt, Phys. Rev. 61, 6 (1942).
[2] Wilson, Proc. Roy. Soc. 174, 73 (1940).
[3] Heitler, Proc. Roy. Soc. 166, 529 (1938).
[4] The case of "strong coupling" has recently been studied by Wentzel [Helv. Phys. Acta. 13, 269 (1940)] and by J. R. Oppenheimer and J. Schwinger, Phys. Rev. 60, 150 (1941).
[5] Heitler, Proc. Camb. Phil. Soc. 37, 291 (1941); Wilson, Proc. Camb. Phil. Soc. 37, 301 (1941).
[6] Fierz, Helv. Phys. Acta. 14, 257 (1941).
[7] Bhabha, Nature 145, 819 (1940); Proc. Ind. Acad. Sci. 11, 247 (1940); Proc. Roy. Soc. 178, 314 (1941); Bhabha and Corben, Proc. Roy. Soc. 178, 273 (1941).
[8] Heitler, Nature 145, 29 (1940); Bhabha, Proc. Ind. Acad. Sci. 11, 347 (1940); 13, 9 (1941); Heitler and Ma, Proc. Roy. Soc. 176, 368 (1940).

The Effect of Polarized Light on the Absorption Spectrum of the Neodymium Ion in Crystals

E. L. KINSEY AND ROBERT W. KRUEGER
University of California at Los Angeles, Los Angeles, California
June 11, 1942

IT has been found that the visible absorption spectrum of certain crystals containing neodymium is dependent in a striking manner upon the polarization of the light passing through the crystal. During the last year and a half after we discovered the effect in crystals of neodymium chloride we have examined the absorption spectra, using polarized light, of neodymium nitrate, sulphate, and bromate, and have obtained a quantum mechanical explanation of the effect.

The bromate spectrum has been so fruitful in giving a clue to the nature of the effect that we present in this preliminary note a photograph (Fig. 1) of a small section of it
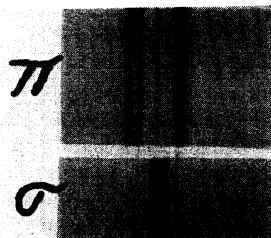

FIG. 1. Absorption of $Nd(BrO_3)_3 \cdot 9H_2O$ near 5750A when polarized light is sent through the crystal perpendicular to optic axis.

taken with the Hilger E1 spectrograph. Fortunately the crystal is uniaxial and has a known structure.[1] The salient feature is the group of five electronic lines spread over a region of 70A near 5750A which is produced by light passing through a crystal plate 0.5 mm thick, cut with the optic axis lying in the surface of the plate. The spectrum marked π is produced by light polarized with the electric vector parallel to the optic axis, and the other marked σ occurs when the electric vector is perpendicular to the axis. When light is sent along the optic axis, only the σ spectrum is observed. The five lines are assumed to correspond to transitions from the lowest component of the ground level $^4I_{9/2}$ of the neodymium ion, which is split by the crystal field, to components of an electrically split upper level.

The levels of the free ion are characterized by values of L and J, the total orbital angular momentum, and total

angular momentum quantum numbers, respectively. In a weak crystal field the degeneracy for the free ion caused by the fact that states of different M values (projection of J on the singular axis of the crystal) have the same energy, is partially removed. This effect causes the eigenfunctions of the perturbed levels to be linear combinations of the unperturbed eigenfunctions of the free ion. We have calculated in zero-order approximation, using perturbation and group theory methods, how the unperturbed functions mix to produce the perturbed ones, and have explained the observed polarizations as arising from the particular way in which this mixing occurs. It is found, for example, that the unperturbed functions characterized by the values $\pm\frac{1}{2}$, $\pm 5/2$, $\pm 7/2$ for M enter several perturbed states for $J=9/2$; in fact these values describe the ground state. Those characterized by $M=\pm\frac{3}{2}$ enter others. Transitions from a level of the first type to one of the second involve changes in M of $\Delta M = \pm 1$. Transitions involving $\Delta M = 0$ are not present. According to electric dipole selection rules (which we can show operate here) lines corresponding to these transitions are polarized with the electric vector perpendicular to the singular direction of the crystal. On the other hand, transitions between levels of the first type involve changes corresponding to $\Delta M = 0$ as well as changes corresponding to $\Delta M = \pm 1$. Lines of this type may be predominantly π lines, or they may be unpolarized. If each one of the six unperturbed eigenfunctions enters the level $M(\pm\frac{1}{2}, \pm\frac{5}{2}, \pm 7/2)$ with equal coefficients, it turns out that the transition produces a predominantly π line. We have accounted in this way for the polarization of most of the lines in four groups throughout the visible region in the bromate spectrum.

The complete work is described in a doctorate thesis written by one of us (R. W. K.) and is being prepared for journal publication.

[1] L. Helmholz, J. Am. Chem. Soc. 61, 1544 (1939).

On Perturbations Causing Apparent Convergence in the C_2 Spectrum

L. GERÖ AND R. F. SCHMID
Physical Institute, Royal Hungarian University for Technical and Economic Sciences, Budapest, Hungary
January 15, 1942

ON the basis of the rotational analysis of some $^1\Pi - ^1\Pi$ Deslandres-d'Azambuja and tail bands of the C_2 molecule, carried to moderate rotational quantum numbers only, by Herzberg and Sutton [1] these authors assume a convergence limit about 35,900 cm^{-1} above the lower $^1\Pi$ state of C_2.

In this laboratory an extensive search has been started concerning perturbations in the C_2 spectrum and well-exposed plates of the $^1\Pi - ^1\Pi$ system disclose that (1) the bands could be followed up to rather high rotational quantum numbers, the involved upper $^1\Pi$ states being several thousand cm^{-1} units higher in energy than 35,900 cm^{-1} above the lower $^1\Pi$ state; and (2) while upper and lower $^1\Pi$ states show numerous local perturbations, which bring in either both or sometimes only the one Λ-type doubling components (Herzberg and Sutton's analysis ends at such

places), the upper $^1\Pi$ states are influenced by an extensive homogeneous perturbation also. It is this latter which causes the appearance of convergency. The rapid decrease of upper state rotational spacing towards higher v values is a general behavior in the perturbation area, if the perturbing state has the smaller rotational constants, and its narrower vibrational structure also causes decrements in the vibrational spacings of the perturbed state. Such phenomena and the usefulness of constructing $[B'-B'']$ curves in detecting perturbations of any kind has been pointed out by Schmid and Gerö.[2]

A detailed report of the perturbations in the C_2 spectrum will be given later. At this time it seems inadvisable to draw conclusions concerning dissociation possibilities of the C_2 molecule, especially not on the basis of any apparent "convergence limit."

[1] G. Herzberg and R. B. Sutton, Can. J. Research 18, 74 (1940).
[2] R. F. Schmid and L. Gerö, Ann. d. Physik 33, 70 (1938).

Investigation of the X-Radiation from Te^{121} (125 Days) by Critical Absorption and Fluorescence

R. D. O'NEAL AND GERTRUD SCHARFF-GOLDHABER
Department of Physics, University of Illinois, Urbana, Illinois
June 25, 1942

THE radioactive tellurium isotope Te^{121} (125 ± 5 days) has been investigated by Seaborg, Livingood, and Kennedy,[1] who found that the isotope emits a very complex radiation consisting of electrons and gamma-rays. They considered it probable that Te^{121} decays by K-electron capture to the stable Sb^{121}, but left the possibility open that the radiations are due to an isomeric transition in tellurium. We have now studied the radiations of this isotope in order to find out whether a characteristic x-radiation is emitted. For this purpose we have used the well-known critical absorption method as well as a new "fluorescence method."
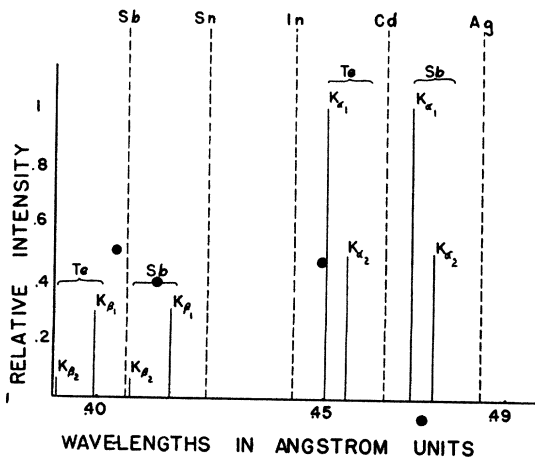

FIG. 1. The diagram shows the K x-ray lines of antimony and tellurium. The intensity of the $K\alpha$ lines is put equal to one. The dashed lines indicate the position of the K-absorption edges of silver, cadmium, indium, tin, and antimony.

The tellurium was separated chemically from a sample of antimony which had been bombarded with deuterons in the 60-inch cyclotron in Berkeley. The radiations from the aged tellurium deposit were detected with a thin walled glass Geiger counter and as absorbers we used thin foils of Ag, Cd, In, and Sn. Figure 1 shows the wave-lengths of the various K x-ray lines of $_{51}$Sb and $_{52}$Te and the K-absorption edges of the neighboring elements for $Z=47-50^2$. Figure 2
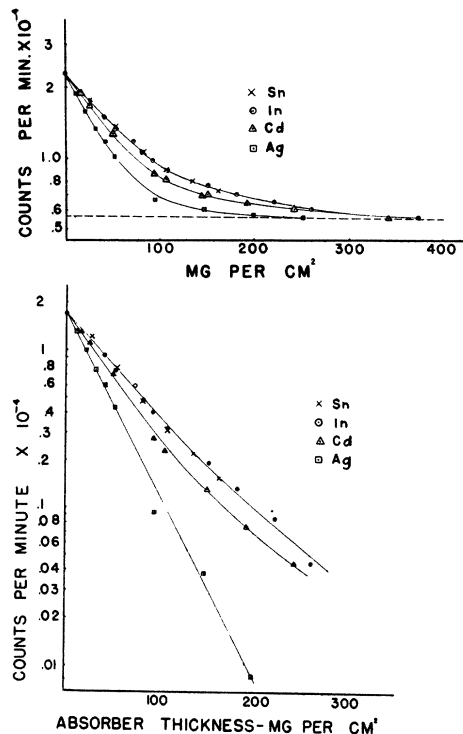

FIG. 2. The upper part of the figure shows the absorption curves of the total radiation from the tellurium sample for tin, indium, cadmium, and silver. The dashed line indicates the contribution of the hard gamma-ray, which was followed up for thicker samples (up to 1 g/cm^2) of the four elements. In the lower part, the curves obtained after subtraction of the gamma-ray background are plotted.

shows the absorption curves obtained from the Te sample. The strong absorption in silver indicates that K radiation of antimony is present, but the absorption in cadmium appears to be stronger than might be expected, if no K radiation of tellurium were emitted in addition.

We have therefore investigated the radiation further by a "fluorescence method," which may prove more convenient than the absorption method under certain conditions. For this experiment, the tellurium sample was mounted at a distance of about 5 cm from the counter and a lead wedge was interposed to shield the counter from the direct radiation. Secondary radiation emitted from thin metal foils under an average angle of 100° was recorded by the Geiger counter. The foils, which consisted of the elements Ag, Cd, In, and Sn were of very nearly equal size and weight ($\sim$50 mg/cm^2). In order to cut out soft electrons an aluminum foil of 21 mg/cm^2 was wrapped around

FIG. 1. Absorption of
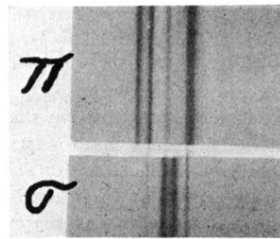Nd(BrO$_3$)$_3$·9H$_2$O near 5750A
when polarized light is sent
through the crystal perpendic-
ular to optic axis.