Eqs. (5) and (6a) that near the lattice point (000), the scattering amplitude and consequently the intensity tend toward a constant value, in agreement with Guinier's observations.

The results of this section are valid only for infinitely extended crystal grains. When the grain is finite, but large enough to give rise to sharp lines, the statements of this section remain valid only for points well outside the line, as was shown in Section 2.

Near a lattice point $\mathbf{A}_h$, the scattering amplitude will be given by

$$G_1 = \frac{2\pi i}{v} |\mathbf{A}_h| \cos(\mathbf{A}_h, \mathbf{U}) \cdot |\mathbf{U}(\mathbf{R} - \mathbf{A}_h)|. \quad (27)$$

Now, if the force system $\mathbf{f}$ has a privileged crystallographic direction, then we must expect to obtain different scattering near different lattice points of similar absolute distance $|\mathbf{A}_h|$, because of the direction cosine appearing in Eq. (27). Conversely, observations of the disorder scattering near different lines should be able to show the crystallographic symmetry of distortions.

A disorder scattering of the type under consideration must affect the measured line intensity and line width. However, conditions are more complex within the line itself, because the grain size and the slowly variable stresses account for part of the line broadening.[6]

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Special Cases of Predissociation

B. Rosen
Department of Astrophysics, University of Liége, Liége, Belgium

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A study of the AlO spectrum indicates that a predissociation of the type one *b* takes place in the lower electronic state of the green system. It is suggested that the γ- and ϵ-bands of NO do not belong to a single system; the γ system shows a strong perturbation of the $v' = 4$ level. An accidental predissociation of the vibrational type is found in the spectrum of Te_2, and the analogy of the three molecules S_2, Se_2, and Te_2 is strengthened.

AlO

ONLY a few examples of predissociation involving the lower state of a molecule are known, among which the best studied case is that of HgH. However, in the type III of predissociation (by rotation) exhibited by HgH the widening of the predissociated levels is such that they cannot be observed. Holst[1] has reported predissociation effects in two systems of emission bands of AlH due to transitions ending on the unstable $^1\Pi$ level. But, so far as we know, this example has not been studied in detail. The observation of the predissociated lines in the above-mentioned examples is difficult on high dispersion spectrograms, on account of the intensity drop in the centers of the lines.

It is well known that, as a result of the rise in total absorption in the incompletely resolved predissociated lines (Loomis and Fuller),[2] predissociation may, under certain conditions be observed in absorption even with low dispersion. This criterion has been applied previously to the investigation of induced predissociation. In the case of natural predissociation, the criterion was first applied to the H_2 spectrum by Beutler, Deubner, and Jünger,[3] and to the S_2 spectrum by Rosen and Neven.[4] The latter example has recently been investigated in detail by Herzberg and Mundie.[5]

In emission, the widening of the lines of incompletely resolved bands manifests itself in different manners according to the position of

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[6]

[1] W. Holst, Thesis (Trondheim, 1936).

[2] F. Loomis and H. Fuller, Phys. Rev. **39**, 180 (1932).

[3] H. Beutler, A. Deubner, and H. O. Jünger, Zeits. f. Physik **98**, 181 (1935).

[4] B. Rosen and L. Neven, Comptes rendus **203**, 662 (1936); J. Chim. Phys. **35**, 58 (1938).

[5] G. Herzberg and L. C. Mundie, Phys. Rev. **8**, 263 (1940).

the first predissociated line relative to the head. If this first predissociated line is far removed from the head, a sudden breakdown in intensity should be observed, the band being thus shorter than the non-predissociated ones. If the predissociation occurs at a J-value nearer to the head, the effect of intensity drop may be partly compensated by the superposition of widened neighboring lines. Finally, a predissociation occurring in the region of the head should result in an abnormal weakening of the whole band, which should then appear diffuse and degraded in both directions. As the J-value corresponding to the head varies from one band to another, the extension and intensity of the bands in a given v'' progression varies in a characteristic manner according to v'. We have observed these characteristic changes in the spectrum of AlO and have applied them to the study of predissociation. In the $v''=7$ progression, for instance, the following observations can be made. The (4, 7) band is abnormally weak; it is diffuse and degraded in both directions. The (5, 7) band has a normal intensity in the region of the head, but this band is short and slightly degraded to the violet in addition to the normal degradation to the red. The (6, 7) and following bands have normal intensities and become gradually longer, the breakdown of intensity occurring at a greater distance from the head. Owing to superpositions, an accurate determination of the position of the breakdown is possible for the (9, 7) and (10, 7) bands only; it occurs in the former at a distance of 28 cm^{-1} from the head, in the latter at a distance of 37 cm^{-1}. From the molecular constants of the green system of AlO it is found that the intensity drop corresponds to $K=44$, $v''=7$. In the same manner the observations in the $v''=6$ progression are explained by a predissociation at $K=60$, and those in the $v''=8$ progression by a predissociation at $K=8$, whereas all the bands of the $v''=9$ progression seem to be predissociated.

The application of Herzberg's theory to these results indicates that the predissociation takes place in the lower state of the $^2\Sigma-{}^2\Sigma$ system of AlO, that it belongs to the type one b, and that the asymptote of the perturbing state is situated 0.93 volt above the $v''=0$, $K=0$ state of the lower $^2\Sigma$ level. It is probable that the predissociation observed by Coheur-Dehalu[6] in the (0, 0) band at $K=128$ belongs to the same limiting curve of predissociation.

The lower state of the $^2\Sigma$ system is generally considered as being the normal state of AlO, this system being observed in absorption in the laboratory under special conditions. On the other hand the vibrational levels of this state are known up to 2.2 ev.[7] It follows that one of the atoms resulting from the dissociation of AlO in the normal state must be excited; probably the end products of the dissociation are Al(^2P) and O(^1D). A detailed account will be published elsewhere.

NO

Herzberg and Mundie[5] have suggested that the bands previously attributed to the γ- and ϵ-systems of NO belong to a single system, the ϵ-bands corresponding to transitions to the levels $v\geq 4$ of the $^2\Sigma$ state. The considerably greater intensity of the ϵ-bands is explained as a predissociation effect.

The observation by Guillery[8] of γ-emission bands corresponding to $v\geq 4$ was not considered by Herzberg and Mundie as a conclusive objection to their suggestion. But Guillery's observation, together with several other facts, such as the general character of the absorption bands of NO studied by Leifson[9] made a re-examination of this question desirable. Measures by P. Migeotte and the writer of all the NO bands excited in emission have enabled us to improve the vibrational classification of the γ-bands previously published by Guillery on the basis of the measures by Bair and Deslandres. A considerable perturbation of the vibrational type (displacement of about 90 cm^{-1}) affects the $v'=4$ level, but the γ-bands attributed by Guillery to $v'\geq 4$ appear with great intensity. An elaborate discussion to be published soon proves conclusively that these bands belong to the γ-system. In addition, our observations of the emission bands in the region of 1900A exclude the possibility of considering the ϵ-bands as part of

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[6] F. Coheur-Dehalu, Bull. Acad. Roy. Belgium **23**, 604 (1937).

[7] E. Bodson and F. Coheur-Dehalu, Bull. Acad. Roy. Belgium **23**, 408 (1937).

[8] M. Guillery, Zeits. f. Physik **42**, 121 (1927).

[9] S. W. Leifson, Astrophys. J. **63**, 73 (1926).

the γ-system. Hence the hypothesis of Herzberg and Mundie and its conclusions should be abandoned.[10]

Te_2

In collaboration with R. Migeotte we have recently studied the ultraviolet part of the Te_2 spectrum.[11] The following observation concerning a predissociation effect is of interest. The ultraviolet end of the Te_2 spectrum consists of the $v''=0$ progression. Theoretically this progression should have a regular intensity distribution with a single maximum. This is what we observe in absorption, the maximum being found at $v'=15$. In emission, however, the bands $v'=14$ and $v'=16$ are abnormally weak (for the numbering of the Te_2 bands).[12] It seems that we are confronted with a predissociation phenomenon which can be accounted for as an accidental predissociation of the vibrational type analogous to a vibrational perturbation affecting a whole band.

The unresolved isotopic bands $v'=14$ and $v'=16$ are not only weakened, but they present in emission a very pronounced asymmetry. In connection with the observations of Olsson,[13] who states that the positions of the individual absorption bands are quite normal, this means that the weakening by accidental predissociation is different for different individual isotopic bands. No such asymmetry is observed in absorption.

Two regions of predissociation are known in the S_2 and Se_2 spectra. In S_2, predissociation occurs at the levels $v'\geq 10$ and $v'\geq 17$[5] whereas in Se_2 it occurs at the levels $v'\geq 10$ and $v'\geq 22$.[14] In the spectrum of Te_2 only one predissociation region, setting in at $v'=21$, has been reported.[15] Our new observation indicates that the Te_2 molecule also can predissociate at intermediate v' values. However, contrary to the other molecules of the same group, the predissociation of Te_2 at intermediate v' values is only possible through an intermediate state, by an accidental predissociation of the vibrational type. The close analogy existing between the spectra of the three molecules is thus strengthened, especially since considerable perturbations of the vibrational type are known for numerous excited levels of S_2 and Se_2.

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[10] We have recently published a detailed investigation of the various ultraviolet band systems of NO (Bull. Soc. Roy. Sci., Liége, Belgium, pp. 40 and 49, 1945). Subsequently we have learned that three papers had been recently published on the NO molecule, one by Gerö, Schmid, and Szily (Physica **9**, 144 (1944)); the others by Gaydon (Proc. Phys. Soc. **56**, 95, and 160 (1944)). As far as predissociation is concerned, these authors reach the same conclusion as we do.

[11] R. Migeotte and B. Rosen, Bull. Soc. Roy. Sci., Liége (in press).

[12] R. Migeotte, Bull. Soc. Roy. Sci., Liége **13**, 48 (1942).

[13] E. Olsson, Thesis (Stockholm, 1938); Zeits. f. Physik **95**, 215 (1935).

[14] B. Rosen, Physica **6**, 205 (1939).

[15] E. Hirschlaff, Zeits. f. Physik **75**, 315 (1932).

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Space Charge between Coaxial Cylinders

Leigh Page and Norman I. Adams, Jr.
Sloane Physics Laboratory, Yale University, New Haven, Connecticut

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New solutions of the space charge equation are obtained, which converge much more rapidly than Langmuir's solution in the important case where the radius of the outer electrode is large compared with that of the inner electrode.

The theory of the limitation of a current by space charge in an evacuated region containing ions of one sign only was given first by Child[1] for parallel plane electrodes and later by Langmuir[2] and Langmuir and Blodgett[3] for the far more important case of coaxial cylindrical electrodes, as found in the usual construction of

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[1] C. D. Child, Phys. Rev. **32**, 498 (1911).

[2] I. Langmuir, Phys. Rev. **2**, 450 (1913).

[3] I. Langmuir and K. B. Blodgett, Phys. Rev. **22**, 347 (1923).