Studying the region below 900A Henning has found three types of absorption in CO_2, continuous, a Rydberg series of bands and a series of bands equally spaced at intervals of 1120 ± 50 cm^{-1}. These last bands are eight in number with wave-lengths corresponding to from 15.7 to 16.7 volts. Excepting the one of longest wave-length each band is double with a doublet separation of about 350 cm^{-1}. Now the upper levels of the CO_2 emission bands have separations given by $1135-3.7v'$, ($v'=1\cdots 9$), are eight to ten in number and have an excitation potential probably a little below 16.7 as we have seen. There is therefore good reason to identify them with the upper levels of Henning's absorption bands. It is true that the scheme of vibration levels I gave in my earlier paper would give triplet levels with a total spread of only 166 cm^{-1} but that scheme was admittedly subject to correction (see below). I think that we can conclude with assurance that the two sets of upper levels belong to the same electronic state and are probably identical and that consequently the CO_2 emission bands come from a neutral molecule excited above its I.P.

Proceeding on this assumption it is possible to construct an electron level diagram for CO_2 and compare it with the similar scheme for CO. I have included in the figure below the upper level of Leifson's bands[3] though its location can only be guessed.

With reference to the discrepancy between Henning's doublet separation and the narrower triplet predicted by my analysis I may say that the relative intensities of certain bands within the CO_2 system are not the same in my recent plates as in those taken with electron beam excitation last year and that it seems possible that some rearrangement of the levels may be necessary to explain these variations. But as I have not been able to find any equally simple scheme which fits the wave numbers equally well I prefer not to present a different scheme until further data are available. I feel this the more strongly because the proof that this spectrum comes from the neutral molecule makes the application of Dennison's theory more plausible. Attempts to rearrange the levels along the lines of Fermi's recent discussion[4] of the Raman effect have not been successful.

I need hardly say that I am continuing the study of this spectrum. Thanks to the support of the Guggenheim Foundation I am doing so in Professor Franck's Institute where my sojourn has already been profitable as well as pleasant. I am indebted to him, to Dr. Sponer, Mr. Henning and others for making it so.

H. D. Smyth

Zweites Physikalisches Inst. d. Univ.
Göttingen,
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[3] Leifson, Astrophys. J. **63,** 73 (1926).

[4] Fermi, Zeits. f. Physik **71,** 250 (1931).

Some Studies of Negative Point Discharges at Low Pressures

Only a few spectrographic investigations of point discharges at low pressures have been published.[1] Therefore, the results of some experiments may be of interest which were undertaken to find the lowest pressures at which negative point discharges may be maintained and to study their spectrum emitted in the vacuum.

The main difficulty encountered with point discharges is that a discharge from a pointed conductor is well defined for a very short time only as then the shape of the point will change and accordingly the characteristics of the discharge. For this reason, a wire was taken as cathode; the discharge takes place then only from distinct points which are assumed to be caused by submicroscopic summits on the surface of the wire. The tube used for the investigations was evacuated to a pressure of about 10^{-3} mm Hg. If now a rectified voltage was applied, from one to three bright *light brushes of blue color* appeared starting near the cathode wire. With the pressure decreasing to about 10^{-4} mm Hg the brushes became shorter and finally only bright *blue points* were observed on the wire. The voltage necessary to excite now the point discharges was 78 kv$_{\max}$, the current passing through the tube being 10^{-4} amp. If the pressure was lowered to $< 10^{-5}$ mm Hg it was not possible to excite the appearance of the blue points with voltages up to 95 kv$_{\max}$.

The point discharges were not affected if the cathode wire was slowly *heated,* at a high temperature, however, the points could visually not be detected. Together with the excitation of the point discharges a considerable *sputtering* from the cathode wire took place.

The light emitted by the point discharges in a high vacuum showed *no polarization.*

Spectrographic investigations were carried by means of a Fuess quartz spectrograph with a dispersion of 17A per millimeter at 2500A. The spectra were examined with a Goos-Koch registering microphotometer[2] with two photocells. Fig. 1 shows some microphotometer curves of spectra from point discharges taken at a pressure of 10^{-4} mm Hg; the abscissas being wave-lengths, the ordinates, intensities in an arbitrary scale.

It is to be seen that *point discharges at a high vacuum emit mainly a continuous spectrum,* some bands and lines from the gas and vapor content of the tube are merely indicated. If the pressure is raised inside the tube, the bands and lines appear with increasing intensity in comparison to the continuous spectrum. The maximum of intensity of the continuous spectrum (photographically determined from many exposures) is found at 4600 ± 50A, the spectrum could be traced from 6200 to 2150A. From these results follows:

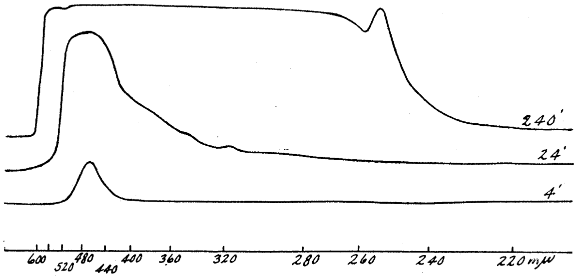

Fig. 1

(1) The pressure necessary to excite bands and lines with negative point discharges is to be $\geqq 10^{-4}$ mm Hg. According to different investigators—cf. Mierdel[3]—negative point discharges will lead by means of ionization by impact to both negative and positive ions near the cathode; beyond a thin layer, only negative ions are considered to be present. In this way, the excitation of the bands and lines from the gases and vapors contained in the tube may readily be explained.

(2) To excite the continuous spectrum of negative point discharges only a very small amount of gases and vapors is to be present in the tube, the pressure being of the order of 10^{-4} mm Hg. The distribution of intensity in the continuous spectrum received from the discharges at a low pressure recalls the observations of the author on exciting continuous spectra by means of electron bombardment of solid bodies, gases and vapors,[4] and we may assume that the continuous spectrum of point discharges is generated by means of an action of electrons emitted from the cathode points on ions present in the tube in a corresponding way as with electron bombardment of solid bodies, gases and vapors as outlined in detail in my former papers. Thus is to be concluded that the emission of band and line spectra and the emission of the continuous spectrum connected with negative point discharges are to be considered as resulting from two different processes of excitation.

It seems to be likely that also in other types of discharges which usually show lines, bands and a "continuous background" the discontinuous and continuous parts of the spectrum are excited by such different processes of excitation as found with negative point discharges.

WILLI M. COHN

Cambridge, Mass.
December 29, 1931.

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