A New Afterglow Phenomenon

A new afterglow phenomenon, which has been observed in three separate discharge tubes at different pressures, is illustrated in the accompanying spectra (Fig. 1). These

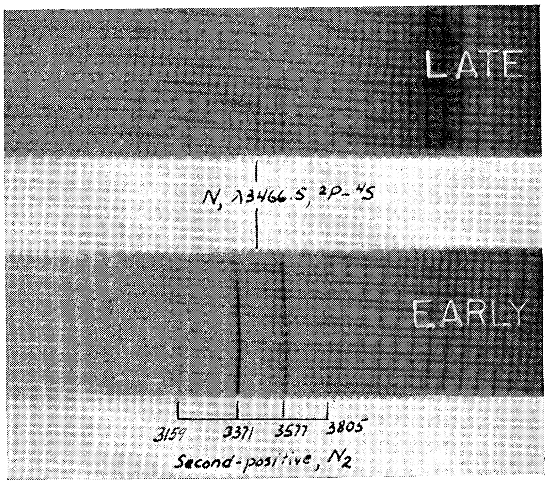

FIG. 1. Lower spectrum is of the early afterglow; the upper is that of the last part of the glow.

pictures were obtained on Eastman 33 plates in a small quartz spectrograph. They represent the early and late phases of a nitrogen afterglow at a pressure of the order of 20 mm. The bottom spectrum is that of the early and hence strong part of the afterglow, and the top one that of the last part of the glow. In order to obtain a plate strong enough to print it was necessary to expose the late part of the glow about three times as long as the early part. The contrast is striking. The forbidden nitrogen line, 3467, corresponding to the $^2P-^4S$ transition, is much more intense in comparison with the second positive N_2 bands late in the glow than it is in the early part. A long series of observations on the variation with pressure of this type of glow in the range thus far observed has shown that the ratio of forbidden to allowed radiation increases with pressure, a result which was quite surprising. In view of this, it is possible then to summarize the results in the present experiment by saying that the spectrum of the late phase of an afterglow corresponds to that of the early phase of a higher pressure afterglow or the effect on the spectrum of the afterglow as its lifetime increases is that of an apparent increase in pressure.

Observations on an afterglow at a lower pressure of about 10 mm shows this effect very clearly and these spectra will be published soon. It is believed that an explanation of this new afterglow effect will lead to an understanding of the puzzling afterglow phenomena which accompany discharges in nitrogen and further experiments are now in progress to study this effect under a variety of other conditions.

JOSEPH KAPLAN

Departments of Physics and Astronomy,
University of California at Los Angeles,
Los Angeles, California,
March 5, 1940.

Double Ionization by the Auger Effect: The Cause of a Satellite Intensity Anomaly for the X-Ray Diagram Line $M\alpha_1$

In a paper[1] published in 1936 the present author postulated an intensity anomaly due to the Auger effect, for the x-ray diagram line $M\alpha_1$, existing somewhere in the region immediately below atomic number 88. Some evidence in that paper was presented to show the existence of an Auger intensity anomaly.

Because of his interest Professor H. E. White reproduced in his book, *Introduction to Atomic Spectra*, some of the *M*-series plates[2] of the author's thesis (Cornell, 1931). Very recently, in looking at that book, it was of great interest to the present author to observe unmistakably the intensity anomaly which he had predicted (see p. 305).

To make this intensity anomaly more unmistakable, the plates are again reproduced. Fig. 1 shows the same $M\alpha$ lines; negatives were made, and finally a series of prints having the same maximum line density were secured. (The maximum density of the original plates was in the safe range to preserve density-intensity proportionality.) Hence it is felt that this presents a truer picture than Professor White's figure, although it was due to the original figure in Professor White's book that recognition of the Auger intensity anomaly was possible.

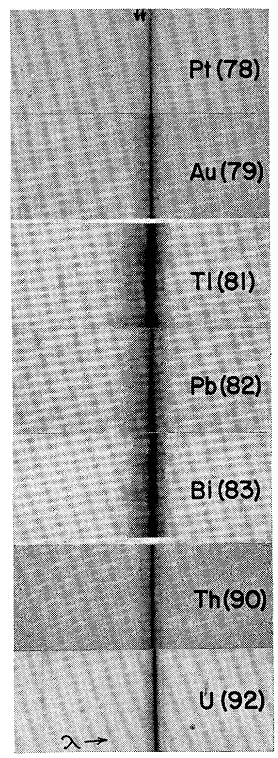

FIG. 1. $M\alpha$ lines of several elements. (The Pt and Au lines were taken with a quartz crystal; the rest by means of a calcite crystal.)

In reference 1, the writer pointed out that the radiationless transition $(M_{III}\rightarrow M_V)_z$ plotted on an energy scale against atomic number (see Fig. 2), intersects the $N_{IV,\,V}$ shell (for $z+1$ as an *M*-electron is already missing) in the region of $z=88$. This causes the Auger effect, acting to doubly ionize atoms for some atomic numbers below $z=88$, and preparing the respective atoms for the occurrence of the $M\alpha$ satellite group. (This work was patterned after the concepts of Coster and Kronig.[3])

Thus below $z=88$, for some atomic numbers, satellites should occur with considerable intensity: we should expect an intensity anomaly such as has already been described.[1, 4] The radiationless transition $M_{III}\rightarrow M_V$ initiated by electron ionization of the M_{III} shell, occurs with simultaneous ejection of an $N_{IV,\,V}$ electron. This process is especially probable when the normalized radial wave function for the

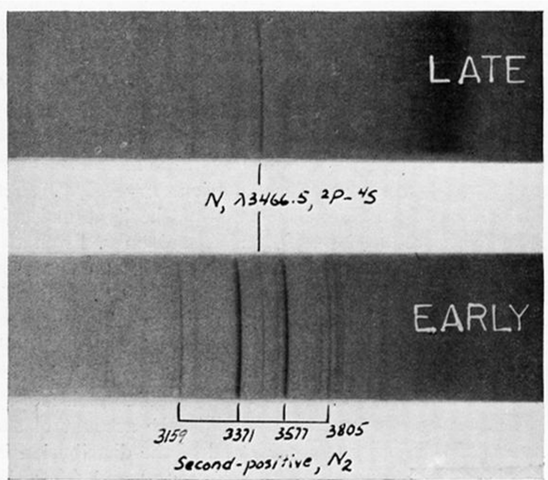

FIG. 1. Lower spectrum is of the early afterglow; the upper is that of the last part of the glow.