Foreshadowing Elements of Atomic Numbers 75, 85, 87, and 93 by means of X-rays.

IN your columns of Current Topics and Events, Dec. 26, 1925, p. 943, I notice a critical abstract of a series of articles by Dr. Druce and myself, relative to the existence of elements of atomic numbers 75, 85, 87, and 93, which appeared in the *Chemical News*, Oct. 30, Nov. 6, 13, 20, and 27. A later communication in the issue of Dec. 11, 1925, should be included, as reference will be made to it below.

In justification of our work I must state that Film No. 3, which gave us the evidence of the presence of element 75 and meagre evidence of the presence of element 87, is completely ignored in the critical argument in question. Manganese sulphate was used in this case.

The line on which we have attempted to establish element 87 (Film No. 3) is one of wave-length 1·032, a fairly strong line considering the range of exposure; not $\lambda = 1{\cdot}040$, because this line seemed to represent some other element, and in one case it was wide enough to include several lines ($\lambda 1{\cdot}040$ was, however, mentioned in this connexion, and I tried to make something of it, as an attempt was made by Dr. Druce to isolate element 87 chemically from pyrolusite, but this substance has, as regards this element, so far proved to be disappointing). On p. 289 of the *Chemical News* we say: "On investigation we find that this line of wave-length 1·032 Å units fell exactly between the theoretical La_1 and La_2 lines of element of atomic number 87. We looked for the $L\beta$ line of this element, but failed to find it, as the bromine-silver absorption bands on the film fell in the region where the line should appear as a very faint one." In the same journal for Dec. 11, 1925, this obscured line was indicated as it was seen by one of Messrs. Adam Hilger's research staff when I was examining the film on one of their spectrum comparators.

Had mercury been present sufficient to give rise to an L radiation, the whole of this radiation would have been excited at the voltage used, and the comparatively strong $HgL\beta_1$ line would have appeared on the film; whereas, only the lines corresponding to the La_1 and $L\beta_1$ radiations of 75 were present, in addition to those mentioned above of wave-lengths 1·032 and 0·837 (the latter as afterwards approximately determined by means of the spectrum comparator). The three lines were of sufficient strength to stand out well on the film, which was clear and free from fogging and other obscuring effects, except in respect of the Br-Ag absorption region.

Referring to p. 339 (Nov. 27 issue of the *Chemical News*), Film No. 1 was not perfect throughout and the exposure was more on the long wave-length side, but the 1·43 line was clearly revealed. Film No. 2 showed fairly strong lines $\lambda = 1{\cdot}43$ and $\lambda = 1{\cdot}233$, but the range of oscillation was limited to the region where these lines fell. Film No. 3, therefore, afforded a crucial test, for it covered the range below $\lambda = 0{\cdot}837$ to that beyond $\lambda = 1{\cdot}539$. When this film was taken, two other films were consecutively obtained with the same exposure (6 hours) and the same range of oscillation of the crystal and the same setting of the spectrograph. One showed only the copper lines, and it was a perfect film in every way. The other showed only the $K\alpha$ and $K\beta$ lines of both zinc and copper, for a substance containing zinc had been rubbed on the copper anticathode. Two of these sets of lines on their respective films were used to check the 75 La_1 line on one of them by noting the displacement of this line relative to that of the $K\alpha$ line of zinc, using for this purpose the spectrum comparator mentioned above. The copper lines were used for registration in the usual way. This test showed a slight displacement of the line towards the shorter wave-length side relative to that of zinc.

Furthermore, had mercury been the cause of one of our lines in the above tests, the $HgL\beta_1$ line should have appeared on these three films and the $HgLa_1$ line as well on the films containing the zinc and copper lines only, but no sign of these lines could be detected. All three films were clear and the copper lines were quite strong, as were the zinc lines in the one case where a zinc compound was placed on the anticathode as stated above.

Films Nos. 4 and 5 were taken, when a sample prepared from pyrolusite was rubbed on the face of the anticathode. Lines $\lambda = 1{\cdot}086$ and $\lambda = 0{\cdot}895$ were obtained corresponding very closely with the La_1 and $L\beta_1$ lines of element 85, which we commented upon thus: "They are too ill-defined for us to establish their identification with this possible element." Pyrolusite samples have so far given a number of lines we could not identify. In two cases "93" appeared to be foreshadowed, but we dismissed this matter in the following terms: "The last element of all, of atomic number 93, was discussed in our first communication . . . the possibility of this element existing having stimulated our research from the start. There is some evidence of its existence, but to be critical, the line 0·693 comes near to the limit of the region explored by the setting (oscillation) of the rocksalt crystal of the spectrograph, and edge effects are possible here. At any rate this may account for some of the extreme 'lines' given at the foot of columns 12 and 13"—p. 340, *loc. cit.* It is true another likely pair of lines of wave-lengths 0·888 and 0·897 appeared on another film, but we still hold the same view that 93 is too imperfectly foreshadowed to be seriously considered. The calculated wave-length of the La_1 line of 93 I find to be 0·8877.

With regard to the brass of the apparatus giving rise to a zinc line, Messrs. A. Hilger, Ltd., say no such line ever appeared on their films except in the case of the tungsten target, which has a brass overlapping edge that holds the target in place.

Referring to the last remark in the note in NATURE, this, in my opinion, is uncalled for, since we have placed all the cards on the table, and then say in effect "that the research we have started on the missing elements in, or in connection with, Group VII., is promising and the work is being continued." All the quotations are from our own writings as listed at the opening.

In conclusion, I only regard 75 and 87 as identified by means of X-rays, and these, so far as published, from manganese sulphate, and not from pyrolusite. Pyrolusite gives lines difficult to identify, but with manganese sulphate all the proper lines were, in my opinion, identified.

As regards the confirmatory evidence from Dr. Druce's chemical side of this research I instigated, this might be mentioned, but I must leave the chemical side to my colleague.

F. H. LORING.

WE have carefully examined Mr. F. H. Loring's part in six contributions as published in the *Chemical News*, and also the above communication, all in respect of the X-ray side of the research, and we have pleasure in stating that Mr. Loring has correctly transcribed our measurements, and the statements made as coming from us are correctly so described.

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