the measured wave-lengths. On the other hand, Ruark, Mohler, and Chenault attribute the fine structure of the lines to "transitions between components of complex spectral levels" (NATURE, Oct. 18, 1924). They are satisfied that in the great majority of cases it can be proved that fine structures are not due to isotopy.

There are two conditions which must be satisfied by lines arising from isotopes: (1) the intensities of the several isotope lines in the radiation from a thin layer must be in the ratio of the concentrations of the respective isotopes; (2) the radiation from the end of a long column should be distinguished by the equalisation of the brightness of corresponding lines when the column is sufficiently long for the lines to be "saturated." We have directed attention to this point in a recent paper (Proc. Roy. Soc. 105, p. 527, 1924).

The application of the first test is difficult, but the second is possible in some cases. In the case of 5461 Å all the satellites approximately satisfy the second condition, with the exception of one, namely, —·024 Å. In the long column radiation the satellite —·024 Å is the brightest line of the group, and all the others are so nearly of equal brightness among themselves that the distinction, based on difference of intensity, between "main line" and "satellite" is lost. It appears to us that if the components of this group are to be attributed to the isotopes of mercury, the line —·024 Å must be excluded from the list. It appears, however, from the note of Nagaoka and his co-workers that they include this line in the isotopic group of 11 satellites, which, together with the main line, make up the whole group of 12 constituting 5461 Å.

In the case of the two yellow lines 5791 Å and 5769 Å, these authors state that the observed wave-lengths of the satellites of 5791 Å agree with the calculated wave-lengths, whereas there is no agreement in the case of 5769 Å. We, however, find that the side components of 5769 Å can be reversed on a continuous background, and that in long column radiation they approach the main line in brightness, whereas in the case of 5790 Å, we have been able to reverse the main line only, and the ratio of emission to absorption is greater for the satellites than for the main line. Thus the components of 5769 Å appear to satisfy the second condition we have mentioned above, while those of 5971 Å do not.

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November 27.

Chemical Combination of Helium.

THE views of Franck on the existence of a metastable form of helium capable of forming chemical compounds have led me, at the suggestion of Sir Ernest Rutherford, to search for such compounds. The experiments carried out during the past year indicate the existence of helium compounds of a different type from the mercury helide described by J. J. Manley in NATURE of December 13, p. 861.

I have examined mixtures of helium with the vapours of mercury, iodine, sulphur, and phosphorus under the influence of electron bombardment and in the presence of surfaces cooled by liquid air. I find the helium disappears almost completely at a rate much greater than that observed under the ordinary conditions in a discharge tube. Solid substances, which I believe to be compounds of helium, were condensed on the cold surface together with an excess of the other element used.

Numerous experiments were carried out which showed that the effect was not due to mechanical occlusion or adsorption. In the absence of a cold surface, a slow and very slight disappearance occurred, and the helium could only be recovered by heating the apparatus to 300° C. Experiments showed that this absorption or mechanical occlusion of helium in condensed vapours was very slight.

The substances obtained have a vapour pressure of the order of 0·005 mm. of mercury at −185° C. On allowing them to warm up, they decompose very suddenly at definite temperatures, and the original amount of helium is recovered. In the cases of mercury and iodine, this temperature is approximately −70° C. and for sulphur and phosphorus −125° C. The only disappearance of helium above these temperatures was of the order to be expected from the experiments described in the preceding paragraph. In appearance, the compounds of mercury and iodine are not like the pure elements, but at the temperature of decomposition the appearance changes to that of ordinary deposits. In the case of phosphorus, when the reaction is allowed to proceed, the deposit is yellow, but, if no reaction occurs, red phosphorus is obtained as might be expected since the vapour passes over a hot filament.

Preliminary determinations of the velocity of reaction have been carried out, and further work on this point is in progress, as well as experiments which it is hoped will determine the composition of the products.

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Double Rainbows.

WHEN the source of light is at a practically infinite distance, as in the case of the sun, the position of the bow is determined only by the positions of the source and of the observer's eye. When, therefore, a bow is seen double, there must be two effective sources. The phenomenon described by Mr. Deodhar in NATURE of December 13, p. 860, cannot be explained as due to two parallel rain showers. Moreover, his laboratory experiment with a source of light near to the observer would be likely to mislead him, for the conditions brought about by the near approach of the source are greatly and strangely modified (see NATURE, Vol. 105, May 27, 1920, p. 389).

Two bows of the same radius but about two centres, one above the other, have been observed by the writer, the lower cast by the sun and the upper by the image of the sun reflected in a surface of water. In the case described by Mr. Deodhar the sun was low and rising, and if the upper bow were due to a reflected image the two bows would gradually separate and not approach one another as he observed them to do.

Mr. Deodhar does not state in his letter whether he looked round to observe the sun at the moment. Perhaps he would have seen a second source of light, such as a small patch of brilliantly illuminated cloud near to and approaching the sun. Another explanation that may be suggested is the duplicating of the sun's image by mirage or some other form of abnormal atmospheric refraction. The low altitude of the sun would favour this latter explanation.

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