[CONTRIBUTION FROM THE ALABAMA EXPERIMENT STATION]

# Manganese Isotopes

BY IRENE G. OTTO AND EDNA R. BISHOP

Before entering upon a study of the quantitative determination of small amounts of manganese by the magneto-optic method,[1] it was necessary to locate the position of the minima of manganese compounds on the wire-path scale. This location can be accurately predicted since it is a function of the equivalent weight of each constituent element. This means also that elements having more than one valence will have minima in different scale regions for each valence and that only elements having similar equivalent weights can possibly be confused with each other.

## Experimental

Solutions for examination by the magneto-optic method were prepared by dissolving C. P. manganous salts in water freshly redistilled from an all Pyrex still. Examination of the appropriate regions of the wire-path scale showed seven minima for each compound as shown in Table I.

The nicol rotation method[2] was employed in order to show whether these minima were due to isotopes of manganese or to contaminations and, if to manganese isotopes, to establish their order of abundance. The greatest rotation of the analyzing nicol at which each minimum could be seen is shown in Table I. Since these angles are close together for all compounds, they must either be due to manganese isotopes which follow each other in close succession because of mutual influence,[3] or to a contamination which has a weight that gives minima in these regions of the scale and is consistently present at approximately the same concentration as the manganese salts studied. The latter is highly improbable in several C. P. salts.

To test further whether these minima all belonged to manganese, hydrogen peroxide was added to the manganous phosphate solution, whereupon its seven minima disappeared while seven minima in a scale region

TABLE I

SCALE READINGS AND NICOL ROTATION OF MANGANESE ISOTOPES IN VARIOUS COMPOUNDS

| Order of abundance | $MnSO_4$ | | $MnCl_2$ | | $Mn_3(PO_4)_2$ | | $MnPO_4$ | |
|---|---|---|---|---|---|---|---|---|
| | Scale reading | Nicol rotation | Scale reading | Nicol rotation | Scale reading | Nicol rotation | Scale reading | Nicol rotation |
| 2 | 13.25 | 46°58′ | 19.01 | 58°42′ | 24.45 | 66°1′ | 21.43 | 66°18′ |
| 7 | 13.38 | 44°56′ | 19.08 | 56°10′ | 24.64 | 64°17′ | 21.58 | 64°21′ |
| 5 | 13.54 | 45°56′ | 19.13 | 57°7′ | 24.86 | 64°59′ | 21.63 | 65°02′ |
| 1 | 13.69 | 47°27′ | 19.22 | 59°13′ | 25.04 | 66°22′ | 21.70 | 66°41′ |
| 4 | 13.85 | 46°18′ | 19.31 | 57°34′ | 25.25 | 65°18′ | 21.78 | 65°29′ |
| 3 | 14.02 | 46°50′ | 19.45 | 58°18′ | 25.43 | 65°42′ | 21.85 | 65°50′ |
| 6 | 14.14 | 45°32′ | 19.54 | 56°40′ | 25.64 | 64°37′ | 21.91 | 64°35′ |

---

(1) Allison and Murphy, THIS JOURNAL, **52**, 3796 (1930).

(2) Bishop, Dollins and Otto, *ibid.*, **55**, 4365 (1933).

(3) Allison, *Ind. Eng. Chem.. Anal. Ed.*, 4, 9 (1932); *Science*, **77**, 494 (1933).

appropriate to manganic phosphate appeared. Perchloric acid was added and all these minima disappeared. A few drops of oxalic acid solution were added and both sets of minima became visible. After a second addition of oxalic acid, however, the minima attributed to manganic phosphate disappeared and those of manganous phosphate remained.

Examination of the angles of rotation shows that in every case regardless of compound or valence state the seven minima make their appearance in the same order. The differences in the nicol rotation between the several compounds is due to differences in concentration of the solutions employed.

The isotope which can be observed at the largest nicol rotation is the most abundant and thus corresponds to manganese of atomic mass 55, which is the only one reported by Aston.[4] The three isotopes having a higher scale reading would be lighter and the three having a lower scale reading would be heavier[5] than 55 which would be consistent with an atomic weight of 54.93.

## Summary

The magneto-optic method shows that manganese has seven isotopes, of which three are lighter and three heavier than 55, the most abundant one.

---

(4) Aston, *Nature*, **112**, 449 (1923).

(5) Bishop, Lawrenz and Dollins, *Phys. Rev.*, [2] **43**, 43 (1933).

AUBURN, ALABAMA

RECEIVED MAY 29, 1933
PUBLISHED NOVEMBER 7, 1933

---

[CONTRIBUTION FROM THE ALABAMA EXPERIMENT STATION]

# Isotopes of Sodium and Cesium

BY C. B. DOLLINS AND EDNA R. BISHOP

During quantitative studies of calcium by the magneto-optic method,[1] persistent setting on points at which no minima were known, demanded investigation. These minima were more persistent on dilution than those of calcium compounds and, therefore, could not be attributed to another isotope of calcium and so led to a study of the isotopes of sodium and this in turn to those of cesium.

Several investigations[2] by other methods have failed to give evidence of the existence of isotopes of either sodium or cesium and have shown that if isotopes exist they must be present in very small amounts.

The magneto-optic method[3] is well adapted to the study of isotopes that are present in very small amounts, because, due to the mutual influence[4]

---

(1) Bishop and Dollins, THIS JOURNAL, **54**, 4585 (1932); Bishop, Dollins and Otto, *ibid.*, **55**, 4365 (1933).

(2) Aston, *Phil. Mag.*, **42**, 436 (1921); Aston, *Nature*, **107**, 72 (1921); Bainbridge, *Phys. Rev.*, **36**, 1668 (1930); Bainbridge, *J. Franklin Inst.*, **212**, 317 (1931); Aston, *Proc. Roy. Soc.* (London), **134**, 371 (1932).

(3) Allison and Murphy, THIS JOURNAL, **52**, 3796 (1930).

(4) Allison, *Ind. Eng. Chem., Anal. Ed.*, **4**, 9 (1932); *Science*, **77**, 494 (1933).