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).

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[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).

of isotopes, there is little difference between the concentrations at which the most abundant and the least abundant isotopes produce their characteristic minima.

Experimental

C. p. sodium and cesium salts were dissolved in water freshly redistilled from an all Pyrex still and these solutions were examined by the magneto-optic method. A careful search in the appropriate regions of the scale revealed three minima for the chloride, phosphate, sulfate and nitrate of sodium. Six minima were found for each of the same four compounds of cesium. The presence of three minima for sodium and six for cesium compounds indicates that these elements have three and six isotopes, respectively. The scale readings are shown in Table I.

The greatest nicol rotation[1] at which each minimum could be seen was determined. The results in Table I show that all minima ascribed to each compound became visible at nicol settings which were very close together. Therefore, these minima must either be due to isotopes which become visible in close succession because of mutual influence[4] or to a contamination that has such a weight that it gives minima at these regions of the scale, and is consistently present at approximately the same concentration as the salt studied. The latter is highly improbable in several C. P. salts and, hence, it is concluded the minima are due to isotopes of sodium and cesium.

TABLE I

SCALE READINGS AND NICOL ROTATION OF SODIUM AND CESIUM ISOTOPES IN VARIOUS COMPOUNDS

Order of abundance	Nitrate Scale reading	Nitrate Nicol rotation	Sulfate Scale reading	Sulfate Nicol rotation	Chloride Scale reading	Chloride Nicol rotation	Phosphate Scale reading	Phosphate Nicol rotation
				Sodium				
3	7.15	28° 9′	12.83	28° 9′	18.72	28° 9′	23.84	28° 9′
1	7.21	29°59′	12.93	29°59′	18.83	29°59′	24.06	29°59′
2	7.27	29° 2′	13.03	29° 2′	18.92	29° 2′	24.26	29° 2′
				Cesium				
5	10.68	33°51′	26.70	33°51′	39.45	1°53′	50.15	1°53′
4	10.75	34° 9′	26.85	34° 9′	39.54	2° 8′	50.34	2° 8′
1	10.81	34°55′	26.97	34°55′	39.65	2°42′	50.49	2°42′
2	10.85	34°39′	27.06	34°39′	39.76	2°32′	50.68	2°32′
6	10.90	33°51′	27.18	33°51′	39.89	1°36′	50.85	1°36′
3	10.95	34°15′	27.33	34°15′	40.04	2°19′	51.04	2°19′

Water when examined immediately after redistillation from an all Pyrex still showed none of the minima attributed to sodium or cesium compounds. The minima of sodium chloride, however, appeared after the water had stood in the cell for a few minutes.

The nicol rotation determinations also gave the order of abundance of the isotopes. The most abundant isotope produces its minimum at the greatest angle. The great difference in nicol rotation was due to the different concentrations of sodium and cesium salts used in the experiments. In every case the order of appearance of the minima was the same in every compound of the same element. The results are shown in Table I.

The most abundant isotope of sodium must have an atomic mass of 23 as this is the only one detected by Aston[2] and Bainbridge.[2] Since the lightest isotope corresponds to the greatest scale reading,[5] the lightest isotope is the second in abundance and the heaviest the least abundant. Therefore, the atomic weight of sodium would be less than 23. This agrees with the chemically determined value of 22.997. The differences between the circle readings of the sodium minima are abnormally large, which probably indicates that the two least abundant sodium isotopes are present in very minute quantities.

The most abundant cesium isotope must have an atomic mass of 133 as this is the only one previously detected.[2] The isotopes which are second, third, and sixth in order of abundance are lighter than Cs^{133}, whereas the isotopes that are fourth and fifth in order of abundance are heavier than Cs^{133}. Therefore, cesium should have an atomic weight less than 133, which is consistent with the older chemically determined value of 132.81 or with the recent value of 132.91 obtained by Baxter and Thomas[6] or with Aston's value of 132.917.[7]

Summary

The magneto-optic method shows that sodium has three isotopes, one heavier and one lighter than 23, and that cesium has six isotopes, three lighter and two heavier than 133.

(5) Bishop, Lawrenz and Dollins, *Phys. Rev.*, [2] **43**, 43 (1933).
(6) Baxter and Thomas, THIS JOURNAL, **55**, 858–859 (1933).
(7) Aston, *Proc. Roy. Soc.* (London), **134**, 517 (1932).

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Solubility of Thallous Iodate and Thallous Chloride in the Presence of Amino Acids[1]

BY CRAWFORD F. FAILEY

The view that aliphatic amino acids exist in aqueous solution as molecules each of which bears both a positive and a negative charge has met with increasing acceptance. One question which arises in connection with this theory of ampholytes concerns their effect on the activity coefficients of electrolytes; does log $\gamma_{\pm}$ of a salt vary with the square root of concentration, as if amino acids contributed to the ionic strength, or is their known influence on the dielectric constant of the medium sufficient to account for any changes observed?

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