RANGE OF NITROGEN AND BERYLLIUM IONS IN AIR

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WE measured the range of nitrogen and beryllium ions in air in the velocity interval form 8×10^8 cm/sec to 11.5×10^8 cm/sec, using a cloud chamber filled with a mixture of air and water vapor under a pressure of 15 cm Hg before expansion. The N_{14}^{+3}, N_{14}^{+4}, N_{15}^{+3}, and Be_9^{+2} ions, accelerated by a 72 cm cyclotron, were bent by a focusing magnet and, after traversing a celluloid film 35 to 40 μg cm^{-2} thick, entered into the working volume of the cloud chamber. An electrostatic deflection scheme was used, activated by the governing system of the cloud chamber to ensure the entrance of the particles into the chamber at the exact instant of expansion.

The ion velocity was determined from laboratory data on the calibration of the focusing magnet, expressed in terms of the dependence of ME/Z^2 on I (M, E and Z are the mass, energy and charge of the ion, I is the current in the coils of the focusing magnet). The error in the velocity determination did not exceed $\pm 3\%$.

Ions of molecular deuterium D_2^+ were accelerated in addition to nitrogen and beryllium. Comparison of the ranges of nitrogen and beryllium ions with the range of deuterons obtained from the decay of molecular deuterium ions allows the determination of the ranges of nitrogen and beryllium in air under normal pressure. The range of deuterons in air under normal pressure was determined from the range-energy relations in Segre's book.[1] The air equivalent of the film was taken to be 0.045 cm in agreement with the data on α particles.[2] The error in the determination of the range of nitrogen and beryllium ions does not exceed $\pm 5\%$ and is due, mainly, to straggling in the range of deuterons and of the ions under study. The measured values of the range in air of the N_{14}, N_{15}, and Be_9 ions are given in the table.

Ion	N_{14}				N_{15}	Be_9	
$v \times 10^{-8}$ cm/sec	8.2	9.0	10.2	11.4	8.1	8.2	8.9
R_{air}, cm	0.66	0.78	0.88	1.13	0.69	0.78	0.85

The results for N_{14}^{+3} and N_{14}^{+4} are in good agreement with the data of Reynolds and Zucker[3] on the range of N_{14} in the photoemulsion, if the emulsion stopping power is assumed to be the same for nitrogen ions and α particles of equal initial velocities.

An estimate of the ranges by the Knipp and Teller method for $\gamma = 1.15$ (γ is the ratio of electron to ion velocities at which capture and loss of a given electron have equal probabilities) shows that the range of Be_9 ions at $v = 8.5 \times 10^8$ cm/sec should be smaller by about 10% than the range of N_{14} ions with the same initial velocity.

The measured ranges of Be_9 ions at $v = 8.2$ and 8.9×10^8 cm/sec exceed the corresponding ranges for N_{14} ions by 12 to 15%. This discrepancy is apparently explained by a peculiarity in the electronic shell structure of the beryllium atom whose successive ionization potentials are 9.3, 18.1, 153 and 216 v (the corresponding values for nitrogen are 14.9, 29.4, 47.4, and 77.0 v). Due to the strong binding of the K electrons the beryllium ions will have an anomalously low effective charge through a considerable part of their range, which explains the increase in the range.

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[3] H. L. Reynolds and A. Zucker, Phys. Rev. **96**, 393 (1954).

[4] J. Knipp and E. Teller, Phys. Rev. **59**, 659 (1941).

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