The Isotope of Hydrogen in the Atomic Spectrum

Urey, Brickwedde and Murphy[1] have shown the existence of H^2 by photographing the lines due to H^2 in the atomic spectrum with a 21-ft. grating. Professor Urey has informed the author that Professor Shenstone at Princeton has succeeded in getting some indication of the H^2 lines but his photographs were complicated by very bad ghosts from his grating (see also[2]).

Using a long discharge tube of the type described by Wood[3] the $H^2\gamma$ line was photographed with a glass prism spectrograph. The tube used was 220 cm long and 8 mm diameter and was observed end on through about 40 cm of the central portion of the tube. The tube was supplied with moist electrolytically prepared hydrogen which was admitted by means of a long fine capillary. This tube operated in a very black stage and the spectra was excited by a transformer which could deliver a maximum current of about 310 m.a.

The spectrograph was a six prism glass instrument used as a littrow which makes it effectively twelve prisms and gave a dispersion in the $H\gamma$ region of about 1.09 angstroms per mm. The author expects to publish a full description of this instrument as well as a photograph showing the $H^2\gamma$ line in J.O.S.A. in the near future.

On passing a current of 190 m.a. through the tube a 2.5 hour exposure did not record the presence of the $H^2\gamma$ line although a 1 sec. exposure recorded $H^1\gamma$ with about five times the intensity necessary to make it visible on the plate. Upon increasing the current to 310 m.a. the $H^2\gamma$ line appeared with a 35 minute exposure. This type of behavior has been observed and explained by (U.,B. and M.[4]). Since the transformer used could only deliver 310 m.a. a further enhancement of $H^2\gamma$ with respect to $H^1\gamma$ could not be produced. From these results it might be concluded that the ratio of H^2 to H^1 is not more than 1 part in 80,000 in ordinary H_2 if the reciprocity law held for the photographic plate. Due to failure of this law for low intensities Bleakney's[2] value of 1 part in 30,000 is probably much more reliable. Measurements of the plates gave for the wave-length of $H^2\gamma$ 4339.256A or $d\lambda = 1.211$ in substantial agreement with U., B. and M.'s value of 1.206 for ordinary hydrogen.

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October 10, 1932.

[1] Urey, Brickwedde and Murphy, Phys. Rev. **39**, 164 (1932); **40**, 1 (1932).

[2] Walker Bleakney, Phys. Rev. **41**, 32 (1932).

[3] R. W. Wood, Proc. Roy. Soc. **97**, 455 (1920).

[4] Urey, Brickwedde and Murphy, Phys. Rev. **40**, 464 (1932).

Intensity of Cosmic-Ray Ionization in Western North America

This letter is a preliminary report of one of the ten cosmic-ray expeditions organized and supplied with apparatus by Professor A. H. Compton and supported in part by the Carnegie Institution of Washington. Measurements of ionization intensities due to penetrating radiation were made by this expedition in Alaska, California and Colorado.

The apparatus was a duplicate of that already described in this journal,[1,2] and the method of making measurements was also essentially the same. It might be mentioned that the effect of high humidity made it necessary to discard some of the earlier observations. This difficulty was overcome by maintaining a fairly constant high temperature in the observation tent by means of a stove.

Table I gives the time, place, elevation, mean barometer, and duration of observations at each place where measurements were made. One observation (column 7) involved a radium comparison test, a ground radiation test and a cosmic-ray test, and required about 3 hours. Thus a six-hour shift consisted of (1) four electrometer drifts in each direction with the radium at 1 meter; (2) four cosmic-ray drifts in each direction with the radium distant; (3) three cosmic-ray drifts in each direction with the radium distant and the outer of the three shields removed; (4) a repetition of

[1] A. H. Compton, Phys. Rev. **41**, 111 (1932).

[2] A. H. Compton, Phys. Rev. **41**, 681 (1932).

TABLE I. *Relative cosmic-ray intensities.*

Place	Dates	Lat. N	Long. W	Elev. meters	Mean bar cm	No. of obs.	Mean C_{123}	Mean dev. % δ	$\delta/n^{1/2}$%
Ft. Yukon	6/24–7/2	67°	145°	129	75.1	61	0.170	2.8	0.4
Kennecott	7/9–7/19	62°	143°	1840	61.2	75	0.254	2.8	0.3
Berkeley	7/30–8/2	38°	122°	116	75.1	18	0.166	5.2	1.2
Tioga Pass	8/4–8/15	38°	119°	3040	53.0	80	0.363	3.9	0.4
Pasadena	8/17–8/21	34°	118°	259	73.6	30	0.174	3.8	0.7
Denver	8/26–8/29	40°	105°	1616	62.3	23	0.240	4.4	0.9
Summit Lake	8/30–9/9	40°	105°	3900	48.3	80	0.492	3.7	0.4

(1); (5) a repetition of (2). The single set of measurements (3) served to make the small ground radiation correction for both cosmic-ray measurements. The electrometer sensitivity was adjusted at each elevation to such a value that a single cosmic-ray drift required about ten minutes. Observations at each place were made continuously, the shortest series being 54 hours and the longest 240 hours.

The value C_{123} is a net ratio of cosmic-ray ionization current to gamma-ray ionization current, corrected for ground radiation. Therefore these values are only relative.

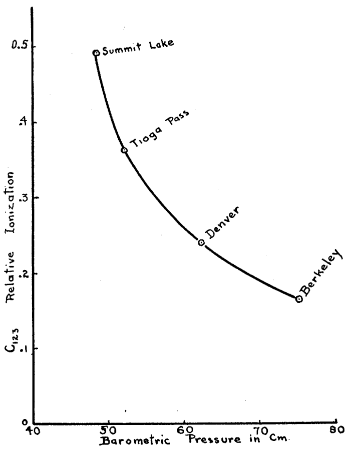

Fig. 1. Variation of ionization with barometric pressure at lat. 40°N.

Because of possible systematic errors we feel that the values of $\delta/n^{1/2}$ give an unduly optimistic indication of the probable error of these measurements. It may be as large as one or two percent even in the longer series of observations.

The values obtained at Berkeley, Tioga Pass, Denver and Summit Lake represent intensities at nearly the same latitude. These four sets of observations give the curve of ionization against barometric pressure shown in Fig. 1.

This curve agrees fairly well with those obtained by Millikan and Cameron[3] and Compton.[1] Using this curve to reduce the values at Pasadena, Berkeley and Ft. Yukon to sea level, we get the lower curve of variation with latitude for this region, shown in Fig. 2. The upper curve of this figure shows the relative values at Denver and Kennecott both reduced in the same manner to 1840 meters.

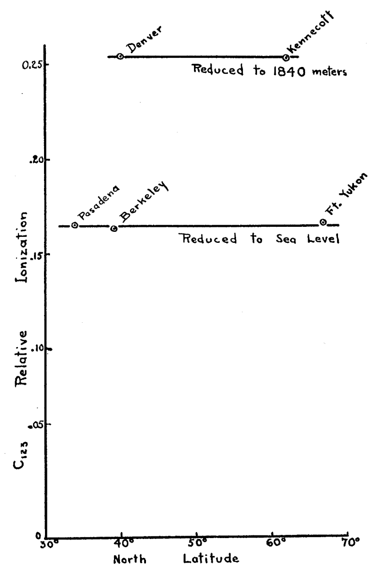

Fig. 2. Variation of ionization with latitude.

These results indicate no significant variation of intensity of ionization due to penetrating radiation (when measured by this method) in the region covered.

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October 14, 1932.

[3] Millikan and Cameron, Phys. Rev. **37**, 242 (1931).