67. *Isotope Effect in the Spectrum of Neon.*

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Since Aronberg¹⁾ and Harkins²⁾ investigated the isotope effect in the spectrum of lead, it was put to further test by Merton³⁾ and recently by Perrete-Montamat.⁴⁾ Lithium was examined by McLennan and Ainslie,⁵⁾ and by Schüler and Wurm.⁶⁾ The effect was always too large from that expected from Bohr's theory on the change of Rydberg constant. Hansen⁷⁾ observed the doublets in neon, which may be due to isotopes, but his method of observation is not yet published.

For obtaining sharp interference fringes, it is necessary to lower the temperature of the gas as experimentally proved by Fabry and Buisson. As the Doppler effect is the principal cause of the broadening of lines, we can observe them distinctly by diminishing thermal agitation, especially with two isotopes of which the quantity of one is small compared with that of the other, as in the case of neon, for which Ne(20) is nine times Ne(22). Consequently a tube of neon was immersed in liquid air, and observed transversely to avoid self-reversal through an unsilvered part of the Dewar vessel. By observing the light with a sliding interferometer made by Hilger, fringes of neon lines were distinctly seen after analysing them with a constant deviation prism. When the air plate was about 4 cm. thick, every strong line in the red and yellow portions of the spectrum was associated with a weak one, nearly in the middle between succeeding fringes as shown in the figures. This character is evidently different from ordinary close doublets or hyperfine structure, and as the difference in wavelength did not show much deviation from the calculated value for Ne(22), by the change in Rydberg constant it must be attributed to the isotope effect. The weak lines were scarcely visible when excited at ordinary temperature. The accompanying table gives the position of the lines relative to the usually accepted lines of neon, measured on preliminary photograms taken with air plate of 40.02 mm. thickness.

1) Aronberg: Proc. Nat. Acad. Sci., **3** (1917), 710; Astrophys. Journ. **47** (1918), 96.

2) Aronberg a. Harkins: Journ. Am. Chem. Soc., **42** (1920), 1328.

3) Merton: Proc. Roy. Soc., **96** (1920), 388; **99** (1921), 87; **100** (1921), 84.

4) Perrete-Montamat: Thèses, Paris, (1928).

5) McLennan a. Ainslie: Proc. Roy. Soc., **101** (1922), 342.

6) Schüler & Wurm: Naturwiss., **15** (1927), 971.

7) Hansen: Naturwiss. **15** (1927), 163.

Series (Paschen)	λ	$\delta\lambda$ (calc.) (mÅ)	$\delta\nu$ (calc.)	$\delta\lambda$ (obs.) (mÅ)	$\Delta\delta\lambda$ (mÅ)	$\delta\nu$ (obs.)	$\Delta\delta\nu$
$1s_2-2p_1$	5852	-14.4	0.0422	-27.9	-14.5	0.082	0.039
$1s_2-2p_2$	6599	-16.3	0.0373	-34.1	-17.8	0.078	0.041
$1s_2-2p_4$	6678	-16.4	0.0368	-34.2	-17.8	0.077	0.039
$1s_2-2p_5$	6717	-16.6	0.0367	-36.1	-19.5	0.080	0.043
$1s_3-2p_2$	6164	-15.2	0.0400	-19.7	-4.5	0.052	0.012
$1s_3-2p_5$	6266	-15.4	0.0393	-20.0	-4.6	0.051	0.012
$1s_3-2p_7$	6533	-16.1	0.0377	-21.8	-5.7	0.051	0.013
$1s_4-2p_2$	6030	-14.9	0.0409	-20.7	-5.8	0.057	0.016
$1s_4-2p_3$	6074	-15.0	0.0406	-21.3	-6.3	0.058	0.017
$1s_4-2p_4$	6096	-15.0	0.0404	-20.8	-5.8	0.056	0.016
$1s_4-2p_6$	6305	-15.5	0.0390	-20.5	-5.0	0.052	0.013
$1s_4-2p_7$	6383	-15.7	0.0386	-21.6	-5.9	0.053	0.014
$1s_4-2p_8$	6507	-16.0	0.0378	-23.0	-7.0	0.054	0.016
$1s_5-2p_2$	5882	-14.5	0.0419	-19.7	-5.2	0.057	0.015
$1s_5-2p_4$	5945	-14.6	0.0414	-19.8	-5.2	0.056	0.015
$1s_5-2p_5$	5976	-14.7	0.0412	-20.2	-5.5	0.057	0.016
$1s_5-2p_6$	6143	-15.1	0.0401	-20.8	-5.7	0.055	0.015
$1s_5-2p_7$	6217	-15.3	0.0396	-20.9	-5.6	0.054	0.014
$1s_5-2p_8$	6334	-15.6	0.0389	-21.2	-5.6	0.053	0.014
$1s_5-2p_9$	6402	-15.8	0.0385	-21.7	-5.9	0.053	0.014
$1s_5-2p_{10}$	7032	-17.3	0.0350	-25.4	-8.1	0.051	0.016

The change ΔR in Rydberg constant shifts the line to shorter wavelength by $\delta\lambda = -0.000002641\lambda$. The final column $\Delta\delta\nu$ gives the remainder, after deducting $\delta\nu$ (calc.) caused by ΔR from the observed value.

The table shows the difference to be always greater than the value given by ΔR , but not so great as with other elements. This is most pronounced in $1s_2$, while $1s_3$, $1s_4$, $1s_5$ indicate deviations of similar order. If we assume Paschen's value for $1s$ and $2p$, the deviations from Ne(20) become $\Delta 1s_2 = 0.082$, $\Delta 1s_3 = 0.051$, $\Delta 1s_4 = 0.055$, $\Delta 1s_5 = 0.054$, while all $\Delta 2p$'s are nearly zero, except for $\Delta 2p_{10} = 0.009$. Next taking ΔR into account, the difference in term values becomes $\Delta 1s_2 = -0.012$, $\Delta 1s_3 = -0.045$, $\Delta 1s_4 = -0.042$, $\Delta 1s_5 = -0.043$, and $\Delta 2p_1 = -0.054$, $\Delta 2p_2 = -0.058$, $\Delta 2p_3 = -0.060$, $\Delta 2p_4 = -0.057$, $\Delta 2p_5 = -0.060$, $\Delta 2p_6 = -0.055$, $\Delta 2p_7 = -0.055$, $\Delta 2p_8 = -0.060$, $\Delta 2p_9 = -0.059$, $\Delta 2p_{10} = -0.054$. The deviation of $1s_2$ from others may have some significance. It is to be remarked that $\Delta 1s_2 : \Delta 1s_3 : \Delta 1s_4 : \Delta 1s_5$ first mentioned are in the inverse ratio $1 : 1.61 : 1.49 : 1.56$ while Land's g -values $g(s_2) : g(s_3) : g(s_4) : g(s_5) = 1 : ? : 1.39 : 1.46$. The approximate coincidence indicates vaguely that the magnetic character of the nucleus of Ne(22) is somewhat different from that of Ne(20) by the addition of two protons and electrons.

These values are however of minor importance, as the deviation of $1s$ and $2p$ in different lines of Ne(20) from the mean value is of the same order of magnitude as $\Delta 1s$ above cited. The probability is that the lines of neon are slightly diffuse towards shorter wave-length due to the presence of the weak lines of Ne(22), so that the centroids appear displaced by small amount during the measurement of grating spectra. It thus seems necessary to remeasure the lines. The values of $\Delta 1s$ and $\Delta 2p$ and other terms not here mentioned, deduced after adding the said correction, will be of theoretical value in drawing conclusions as regards the difference in the character of the nuclei of the isotopes for causing the deviations in spectral terms.

Further experiments are now in progress to obtain more accurate data of $\delta\lambda$ by a combination of concave grating with Fabry-Perot interferometer. The detailed description of the experiment will be given in the Scientific Papers of the Institute.