was odourless. The only explanation that we are able to offer for this remarkable thermocline of Lake Edward is that the heavy layer of more saline water in the hypolimnion has been introduced by rivers from the surrounding volcanic regions or from underground sources, and is prevented from mixing with the epilimnion owing to its greater density. We should suggest that the thermocline found by Ruttner in large lakes, such as Lake Toba, may also be of this nature and not a true temperature thermocline.

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[1] *Archiv für Hydrobiol.* Suppl., Bd. 8, p. 197; 1931.
[2] *Verhandl. der Intern. Verein. für Limnol.*, Bd. 5, p. 44; 1931.

Anomalous Scattering of α-Particles by Hydrogen and Helium.

IT is well known that when light is scattered by an object small compared with the wave-length, the scattered wave is spherically symmetrical. Similarly, in the wave mechanical treatment of the scattering of α-particles by hydrogen and helium, the 'α-particle wave' scattered by the nucleus will differ from that scattered by a Coulomb field only by the spherically symmetrical wave scattered by that region (small compared with the wave-length of the incident α-particles) where the interaction energy differs from the Coulomb value. Thus, without any specific model of the nucleus, we deduce that the anomalous scattering at a given velocity should be expressible in terms of a single parameter only, which determines the amplitude of this spherically symmetrical wave. Denoting by R the ratio of the number of α-particles scattered through an angle ϕ, to the number predicted by the inverse square law, it is shown in a recent paper[1] that, for scattering in helium,

$$R = \frac{|\operatorname{cosec}^2\phi.e^{-ia\log\sin^2\phi} + \sec^2\phi.e^{-ia\log\cos^2\phi} + 2i(e^{2iK}-1)/a|^2}{\operatorname{cosec}^4\phi + \sec^4\phi},$$

where K is the single parameter referred to, and $a = 8\pi\epsilon^2/vh$, v being the velocity of the incident α-particles. A slightly simpler formula of the same type is found for scattering in hydrogen.

The experimental value for R at one given value of ϕ and v determines K for that velocity, and the formula will then predict R for other angles. It has been found that the formula gives good agreement for the angle distribution in both helium and hydrogen, accounting even for the anomalous scattering at small angles, as is illustrated in the accompanying tables.

SCATTERING IN HELIUM.

$v = 1{\cdot}73 \times 10^9$ cm./sec. $K = 1{\cdot}65$.

Angle (ϕ)	10°	34°	45°
R (calculated)	0·62	3·8	8·0
R (observed)[2]	0·56	3·6	8·0 *

SCATTERING IN HYDROGEN.

$v = 1{\cdot}84 \times 10^9$ cm./sec. $K = 0{\cdot}96$.

Angle (ϕ)	0°-10°	10°-15°	15°-20°	21·4°-31·2°	30°-40°	40°-50°	50°-60°
R (calculated)	42	43	39	29	17	7·8	2·4
R (observed)[3]	44	50	48	29*	13	7	1·4

* The values marked with an asterisk were used to determine K.

If the values of K are calculated for two or more different velocities, they can be used to determine a model for the nuclear field. This model is spherically symmetrical and is of the type already postulated by Gamow to account for radioactive phenomena. Thus the wave mechanical solution of the scattering problem avoids the difficulty encountered by classical mechanics whereby the anomalous scattering at small angles required a nucleus with different properties in different directions.

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Clare College, Cambridge,
Dec. 3.

[1] Taylor, *Proc. Roy. Soc.*, A, vol. 134, p. 103; 1931.
[2] Rutherford and Chadwick, *Phil. Mag.*, vol. 4, p. 605; 1927.
[3] Chadwick and Bieler, *Phil. Mag.*, vol. 42, p. 923; 1921.

Nuclear Spin and Hyperfine Structure in Band Spectra.

RECENTLY, S. Mrozowski[1] has found that the band lines in the spectrum of mercury hydride (HgH) are split into several narrow components of constant or nearly constant separation (~0·02 A.). The bands investigated belong to a sequence $v' = 0$, $v'' = 0, 1, 2, 3$ in the transition $^2\Pi_{\frac{1}{2}} \longrightarrow {}^2\Sigma$. Apparently the approximate formula for the isotope effect in band spectra, $\Delta\nu_1 = \delta(\frac{1}{2}\nu_{\text{osc.}} \pm \nu_{\text{rot.}})$, fails completely to explain this case, and so Mrozowski concludes that the separation may be interpreted as a hyperfine structure in a more restricted sense, that is, it is caused by the magnetic or electric constitution of the atomic nuclei.

The isotope formula above, however, is not applicable to this case, the normal state $^2\Sigma$ forming a unique example of an unstable molecule. The following figures on the vibrational effect, calculated with the aid of the more correct formula of Birge,[2] may be taken as an evidence for this: $\Delta\nu_{\text{osc.}}\binom{2\,0\,0}{2\,0\,2} = +0{\cdot}017, -0{\cdot}031, -0{\cdot}049, -0{\cdot}026$ cm.$^{-1}$ in the (0, 0), (0, 1), (0, 2), (0, 3) bands respectively. In the lines investigated by Mrozowski, the rotational isotope effect is predominant, but using Birge's formulæ, I find a reasonable agreement with his data. Thus, the arguments for a nuclear spin effect in the mercury hydride bands considered are of little weight. It may also be mentioned that R. Rydberg,[3] analysing the ultra-violet spectrum of mercury hydride with a spectrograph of high resolving power (~300,000), found a fair agreement between the observed and the calculated isotope effect.

Investigating the band spectrum of bismuth hydride (BiH), Mr. A. Heimer and I had good reasons to search for an eventual hyperfine structure, arising from the high nuclear spin ($i = 9/2$) in the bismuth atom. A band system $^1\Sigma^* \longrightarrow {}^1\Sigma$, already reported,[4] showed no effect, the lines being extremely sharp. However, pursuing the analysis of a $^1\Sigma^* \longrightarrow {}^1\Pi$ system in the red part of the spectrum, a small but distinct broadening of the first few lines in the series was observed and can be interpreted as an effect of the nuclear spin in bismuth.

The rôle played by the nuclear spin in the vector model of a diatomic molecule is analogous to that of the spinning electron in Hund's cases *a* and *b*. The energy of interaction between nuclear spins and the electronic system in the model of fixed centre is then given by $(a_1\iota_1 + a_2\iota_2)\Lambda$, a_s and ι_s denoting the coupling factor and the spin component along the figure axis of the molecule, while the mutual interaction between both spins, $a_{12}\, i_1 i_2 \overline{\cos(i_1 i_2)}$, is omitted on account of its smallness. Accordingly, the hyperfine structure of electronic terms is limited to the cases $\Lambda > 0$ (Π, Δ, Γ . . . terms), Σ-terms showing no effect. In the rotating model this coupling will break down as K, the quantum number of rotation, increases.