disintegration of radium E deduced from our measurement is 320,000 ± 5·000 ev. The most probable value is rather near the inferior limit given by our results.

The detailed description of our experiments will be given elsewhere.

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Thickness of Built-up Films

THE thickness of films built up on solid surfaces has formerly been measured by several methods: optically[1,2,3,4], by X-ray measurements[5,6], by the use of an interferometer[6], and directly with a screw-micrometer[6]. All these, except one modification of the first, required the deposition of some hundreds of layers, and the modification[4] involved a comparison with barium stearate films. During our investigation of protein films on solid surfaces, we have used a method which avoids this comparison and enables thicknesses of as little as 20 A. to be measured rapidly and accurately.

For a thin film on a metal surface the difference of optical path between the ray reflected from the film surface and that from the film metal interface is $d = 2\mu.e \cos \theta$, where μ is the refractive index of the film, e the thickness, and θ the angle of refraction. For minimum intensity of reflection, d must equal an odd number of half wave-lengths, that is, $4\mu.e \cos \theta = (2n+1)\lambda$, where n is any integer. Instead of keeping the wave-length, λ, constant and increasing e until two intensity minima are observed[1,2], we have measured the change in λ necessary to preserve an intensity minimum as the thickness of the film is increased by the addition of further monolayers.

The wave-length of the light which gives an intensity minimum for a given film-thickness was determined by means of a Hilger-Nutting spectrophotometer. This instrument is well suited for such measurements, since the monochromator enables any visible wave-length to be used for the photometric measurement, and the light reflected from the plates is polarized before passing through the spectrophotometer. Measurements must be carried out with the ordinary ray owing to the birefringence of the film. The accuracy of the method was tested with films of barium stearate deposited on stainless steel plates by the method described by Blodgett[1]. Measurements were made on films of ten or twelve monolayers deposited on a base of approximately forty stearate layers. The thick base is essential in order to bring the wave-length for minimum intensity into the visible region. Column A below gives the wave-length in angströms for the intensity minimum of the base, B the number of monolayers deposited on the base, and C the new wave-length for an intensity minimum. The light was incident at 75°.

A	*B*	*C*	*D*
5550	10	6650	24·2
4990	12	6310	24·2
5080	10	6160	23·8

Column D gives the thickness in angströms per layer, t, calculated from the equation, $t = \Delta\lambda/(4\mu \cos \theta.\Delta N)$, where $\Delta\lambda$ is the wave-length increment, μ the refractive index[2], taken as 1·491, θ the angle of refraction, and ΔN the number of additional layers deposited. The validity of the method is established by the agreement of the calculated mean thickness of 24·1 A. for barium stearate with the value 24·2–24·4 A. obtained by other methods.

Further details, with the results obtained for protein films, will be published elsewhere.

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Kepler's Law of Refraction

IN his review of the second volume of the new edition of Kepler's works in NATURE of August 19, p. 306, Prof. H. C. Plummer states that Kepler's formula for the law of refraction is

$$\alpha - \beta = k\alpha \sec \beta,$$

where α is the angle of incidence and β the angle of refraction. This reduces to the law

$$\sin \alpha = n \sin \beta$$

for small angles if $(1 - k)^{-1} = n$. Prof. Plummer also states that as the formula is really empirical, being founded on the flimsiest physical argument, it seems strange that a form so inconvenient for the derivation of β from α should have been adopted.

The following table which I published fourteen years ago in the *Notes of the Edinburgh Mathematical Society* may be of interest in this connexion:

α	β Vitellio's observations	Excess of β calculated by Kepler's formula over Vitellio's observations	Excess of β calculated by modern formula over Vitellio's observations
10°	7° 45′	− 11′	− 16′
20°	15° 30′	− 29′	− 39′
30°	22° 30′	− 19′	− 28′
40°	29° 0′	+ 2′	− 10′
50°	35° 10′	+ 14′	+ 4′
60°	40° 30′	+ 22′	+ 1′
70°	45° 30′	+ 19′	− 41′
80°	50° 0′	+ 0′	− 2° 22′

The first two columns give Vitellio's observations on air-water. The third gives the excess of β over Vitellio's observations calculated by Kepler's formula for $n = 1·317$ and the fourth the excess of β over Vitellio's observations calculated by the modern formula for $n = 1·333$. It will be seen that Kepler's formula agrees much better with the observations than the modern one does, owing to the last experimental value being very far out.

The result, of course, bears out the statements made in the previous paragraph of the review, that Kepler was no experimental physicist and that the experimental data at his command were incredibly slight.

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