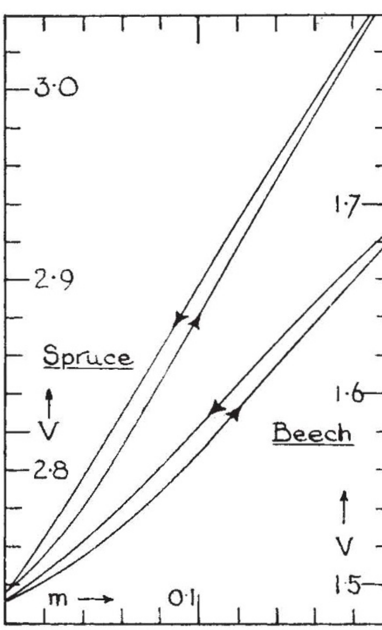
Units: $k = 10^{10} \times$ dynes/sq. cm.; V = c.c./gm. dry weight; m = gm. water/gm. dry weight.

	Solid fibres V (dry) = 0·0661 k 0·86		Spruce V (dry) = 2·731 (75·3% void space)				Beech V (dry) = 1·492 (54·8% void space)			
m	ε_p	ΔV (calculated)	ε_p	k	ΔV (calculated)	ΔV (observed)	p	k	ΔV (calculated)	ΔV (observed)
0·05	0·73	0·0045	1·58	2·55	0·020	0·016	0·833	3·37	0·0144	0·0081
0·10	0·90	0·0016	1·74	1·20	0·048	0·015	1·041	1·80	0·0253	0·0105
0·15	0·95	0·0008	1·62	0·70	0·054	0·008	1·087	1·05	0·0216	0·0119
0·20	0·98	0·0003	1·50	0·55	0·042	0·000	1·071	0·82	0·0185	0·0027

Δp can be obtained from the vapour pressures, h' on adsorption, and h'' on desorption, from the approximate relation $\Delta p = -(RT/M\varepsilon_p) \log (h'/h'')$, in which $\varepsilon_p = (dV/dm)_p$ the differential volume swelling of the gel. Thus, if the origin of sorption hysteresis lies in plasticity, the volume swelling should show hysteresis if plotted against the moisture content, such that the volume will be smaller on adsorption than on desorption.

Calculations of ΔV can be compared with experiment by using the measurements of Hermans[3] on solid fibres of regenerated cellulose, or those on beech[4] and spruce, made in this Laboratory. Approximate values of k may be taken from calculations made here. In the case of the solid fibres these are incomplete, since the variation of k with m is not known and a single mean value must be used for all moisture contents.

The table gives these estimates of ΔV. For the solid fibres all values of ΔV (except at $m = 0·05$, where k is most in doubt) lie below the limit of accuracy claimed by Hermans (0·002 c.c./gm.) and will therefore not be detectable. This agrees with Hermans' own statement that no volume hysteresis is found. For spruce and beech the values of ΔV lie well above the limit of accuracy and a hysteresis of this order of magnitude is found experimentally, as can be seen in the accompanying graph.



So far as I am aware, this graph records the only experiments so far made which show volume hysteresis in the swelling of gels. This is no doubt because in most solid gels, such as Hermans', k is large and the hysteresis is too small for easy detection; whereas in porous gels such as wood, k is much smaller and the hysteresis therefore more prominent.

The above calculation has tacitly assumed that the gel is plastic to shear stresses and elastic to the hydrostatic stresses. It can be shown both by theory and experiment[2] that some plasticity to Δp occurs in complex porous structures such as wood, so that some relaxation in Δp is to be expected. This effect would be more marked at the higher moisture contents where the wood is more plastic, and would account for the observed fall in ΔV to very small values in this region.

A full discussion of this subject is given in an internal unpublished Laboratory report, No. P.82 (1948).

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Fine Structure of the He II Line λ = 4686 A.

According to the Dirac theory of the energy states in hydrogen-like spectra, levels of the same principal quantum number n which have the same value of the quantum number of total angular momentum j should coincide. Lamb and Retherford[1] have shown that in the second quantum state of the hydrogen atom the 2 $^2S_{1/2}$-level lies 0·03 cm.$^{-1}$ above the 2 $^2P_{1/2}$ term. Bethe[2] has tried to explain this discrepancy by an interaction of the electron with the radiation field. His preliminary calculations show complete agreement with experiment for the hydrogen atom. For the He II spectrum he predicts a shift of the 3 $^2S_{1/2}$-level with respect to the 3 $^2P_{1/2}$-level by 0·13 cm.$^{-1}$.

We have investigated the fine structure of the He II line λ = 4686 A. ($n = 4 \rightarrow n = 3$) with a Fabry – Perot interferometer and have found that the 3 $^2S_{1/2}$-level lies 0·137 ± 0·015 cm.$^{-1}$ above the value given by the Dirac theory. Greater accuracy has not yet been possible because of the breadth of the lines.

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