

Fowler *et al.*⁵, reduced to give the result of van Allan and Smith² at 6.2 MeV. energy.

In all three cases the efficiency of the anthracene phosphor was found to be what would be expected from known absorption coefficients⁶, when all quanta which are absorbed are also counted.

In addition, by placing a 1-mm. sheet of lead before the phosphor, an increase in efficiency was obtained, which corresponded well with the number of secondary electrons to be expected when a gamma-ray of certain energy passes through a sheet of lead of known thickness⁷. The results obtained were:

Gamma-ray energy	Efficiency of:	
	2 cm. anthracene	1 mm. lead
6.2 MeV.	6.0 per cent	3.5 per cent
9.5 MeV.	5.5 ..	6.0 ..
17.5 MeV.	4.0 ..	11.5 ..

The results are considered reliable within 10 per cent.

OLE LÖNSJÖ

Physical Institute,
University of Oslo. Sept. 28.

¹ Morton and Sherwin, *Rev. Sci. Instr.*, 20, 766 (1949).

² van Allan and Smith, *Phys. Rev.*, 59, 501 (1941).

³ Bonner and Evans, *Phys. Rev.*, 73, 666 (1948).

⁴ Tangen, *K.N.V.S. Skrifter*, No. 1 (1946).

⁵ Fowler, Lauritsen and Lauritsen, *Rev. Mod. Phys.*, 20, 236 (1948).

⁶ Snyder and Powell, *AEC-D-2739*.

⁷ Rossi and Staub, "Ionization Chambers and Counters", Table 5, 1.

Adiabatic Magnetization of Superconductors

THE past few years have seen a large increase in the number of laboratories using liquid helium, and with it interest in methods for obtaining temperatures below 1° K. has been renewed. The only method which has so far been used is the adiabatic demagnetization of a paramagnetic salt; but this is not the only process known by which a cooling can be effected. Two other low-temperature phenomena yield an appreciable degree of cooling and have a satisfactory velocity of reaction even below 1° K., namely, the mechano-caloric effect in liquid helium¹ and the magneto-caloric effect in superconductors². For reasons which have recently been discussed by Simon³, we have never contemplated using the first effect as a cooling method; but the second one offers interesting possibilities. Some experiments were, in fact, carried out fifteen years ago⁴ in which final temperatures were reached which had been estimated as between 0.2° and 0.3° K. However, lack of data on magnetic threshold values at low temperatures made an accurate determination of the degree of cooling impossible at the time.

Recent measurements⁵ have revealed the interesting fact that near absolute zero the threshold curves seem to be strictly parabolic, which allows the degree of cooling obtainable with this method to be expressed in a general form. Equating the entropies of the metal in the normal and the superconductive states, we arrive at the following relation between the starting temperature T_i and the final temperature T_f :

$$a(T_f/\theta)^3 + \gamma T_f = T_i^3(a/\theta^3 + b),$$

where θ is the Debye characteristic temperature of the metal, γ the coefficient of the electronic specific heat and a has the value 154.8. In the case of a threshold curve which retains its parabolic form up to the transition temperature T_c , b would be γ/T_c^3 , and for

less regular curves the exact value of b can easily be derived from the measured values above 1° K.

The equation shows that, using metals with high T_c and high θ , such as tantalum and niobium, one can, when starting at about 1° K., reach temperatures well below 0.1° K. While the cooling efficiency measured in calories per c.c. is smaller than in the paramagnetic method, the necessary fields are also smaller and therefore permit a larger volume to be cooled. The best application of the method would, however, not be as a rival but as a supplement to the paramagnetic one. The latter is particularly suited for the region below 0.3° K., but work with it becomes difficult at higher temperatures owing to the rapidly increasing heat influx. In the proposed method, on the other hand, the entropy of the final phase, the normal state of the metal, increases proportionally with the absolute temperature. Thus, as the temperature of the specimen rises, the heat influx will be balanced by a steadily increasing heat capacity, and the warming-up rate will be retarded. It therefore seems that the chief use to which the superconductor method can be put will be in the temperature region between 0.3° K. and 1° K.

K. MENDELSSOHN

Clarendon Laboratory,
Oxford. Dec. 17.

¹ Daunt, J. G., and Mendelsohn, K., *Nature*, 143, 719 (1939).

² Mendelsohn, K., and Moore, J. R., *Nature*, 133, 413 (1934).

³ Simon, F. E., *Physica*, 16, 753 (1950).

⁴ Mendelsohn, K., Daunt, J. G., and Pontius, R. B., *Actes du VIIe Congrès Intern. du Froid, The Hague, 1936*, 1, 445.

⁵ cf. Goodman, B. B., and Mendoza, E., *Phil. Mag.*, 42, 594 (1951).

Interference Microscopy and Mass Determination

THE development of phase-contrast and interference-contrast methods has focused attention on the possibility of improved accuracy in the determination of refractive indices of microscopic objects, particularly living cells¹. In many cases immersion methods can conveniently be used², but with *living* cells no great variation in the refractive index of the immersion medium can be tolerated.

It is, however, possible to measure the optical path-difference or phase-change ϕ produced by the object. We then have

$$\phi = \int (\mu_o - \mu_m) dt,$$

where μ_o is refractive index of object, μ_m is refractive index of immersion medium and t is thickness of object. For a homogeneous object we can write,

$$\phi = (\mu_o - \mu_m)t.$$

Thus, in order to determine the refractive index from a knowledge of ϕ , we must also know the thickness. It is well known that thickness determinations in the case of thin microscopic objects are subject to very considerable errors. Shadowing or interferometric methods involving the deposition of metallic films on the object can sometimes be used, but not in the case of living cells. It may, however, be possible to make use of the phase-change ϕ without having to measure either the refractive index or thickness. Refractometry is frequently used for the determination of concentrations of substances in solution³. The underlying principles and some of the difficulties in the case of protein solutions have been discussed by Adair and Robinson⁴ and Craig and Schmidt⁵. The former workers showed that, in the case of serum albumin and serum globulin, the simple relationship: