with the residual ^{17}O nucleus in its ground-state. Gailer⁷ gives maxima at 1.7, 2.4, 3.8, 4.8 and 5.3 MeV., though they are not very pronounced. The curve of Ortner and Protiwinsky⁸ shows twelve peaks, including distinct ones at 1.73, 2.27 and 2.70 MeV. Zagor and Valente⁹ find maxima at 0.85, 1.05 and 1.68 MeV. The work of Ortner and Protiwinsky, therefore, appears to be most consistent with the present work. On the other hand, no maximum at 2.7 MeV. is found by Gailer, and no peak at 2.3 MeV. appears in the curve of Zagor and Valente. Graves and Coon⁶ give for the $(n\alpha)$ reaction in neon a cross-section of 0.5×10^{-26} cm.² at 2.5 MeV. neutron energy.

I wish to thank Prof. D. Coster for his interest in the work, Mr. H. Nauta for assistance during the measurements, and the "Stichting voor Fundamenteel Onderzoek der Materie" for financial support.

C. P. SIKKEMA

Natuurkundig Laboratorium
der Rijks-Universiteit,
Westersingel 34, Groningen.
Feb. 10.

¹ Sikkema, C. P., *Nature*, **162**, 698 (1948).

² Argo, H. V., *Phys. Rev.*, **74**, 1293 (1948).

³ Bennett, W. E., Mandeville, C. E., and Richards, H. T., *Phys. Rev.*, **69**, 418 (1946).

⁴ Livingston, M. S., and Bethe, H. A., *Rev. Mod. Phys.*, **9**, 245 (1937).

⁵ Graves, E. R., and Coon, J. H., *Phys. Rev.*, **70**, 101 (1946).

⁶ Jordan, E. B., and Bainbridge, K. T., *Phys. Rev.*, **51**, 385 (1937).

⁷ Gailer, K., *Z. Phys.*, **110**, 605 (1938).

⁸ Ortner, G., and Protiwinsky, G., *Mitteilungen des Inst. f. Radiumf.*, Nr. 434 (1939); *Wien. Ber.*, **114**, 148, 349 (1939); *Phys. Z.*, **44**, 116 (1943).

⁹ Zagor, H. I., and Valente, F. A., *Phys. Rev.*, **67**, 133 (1945).

A Test of the Interpretation of X-Ray Patterns of Micelles

In a recent communication¹ with the above title, Davies and Phillipoff have described X-ray diffraction experiments with multilayers of lead stearate on chrome-plated brass, which they interpret as deciding certain controversies regarding the micellar structure of soap solutions and the X-ray diffraction patterns from such solutions. Actually, it appears that their experiments have little bearing upon the soap solution results, because they differ in at least three important ways from the situation in real soap solutions.

In the first place, their multilayers, built upon the chrome plate from surface films, have dimensions parallel to the chrome surface far greater than the corresponding dimensions of lamellar micelles as commonly postulated in soap solutions. This will greatly modify their distribution of scattering power in reciprocal space as compared with that of a micelle if, as seems likely, the latter has widths which are comparable with their thicknesses.

Secondly, in these experiments the incident X-ray beam always made a small grazing angle with the chrome surface and thus was always nearly parallel with the multilayers. Consequently, the diffracted beam reveals only a small sample of the distribution of scattering power in reciprocal space. In soap solutions, on the other hand, the micelles are randomly oriented with respect to the beam, and the observed intensity at any point on the X-ray film is an unweighted average of the scattering power over the surface of a sphere in reciprocal space, provided the soap solution is sufficiently dilute so that the micelles are far enough apart to be spaced randomly and to scatter independently.

This last remark introduces the third source of error in the experiments. In most soap solution experiments described so far, the solutions are so concentrated that the distances between surfaces of adjacent micelles are of the order of the diameters of the micelles themselves. Due to anisotropy of both shape and surface-distribution of charge, neighbouring micelles certainly are partially ordered both in distribution of centres and in relative orientation. There will be diffraction effects arising from this partial ordering. The actual diffraction pattern from a soap solution is the result of a complex phenomenon in which the role of the distribution of scattering matter inside the micelle and that of the distribution of micelles about each other are so mixed up as to defy exact analysis except for very simple cases.

One of the latter is the model consisting of uniform spherical micelles distributed in space in a partially ordered way similar to that of molecules in an ordinary liquid. Corrin² has calculated the X-ray diffraction pattern for such a model. Using a square-topped distribution function to simplify the calculations, he showed that the scattering was similar to that from soap solutions. Using punched card methods³ to ease the calculations, I have repeated his work with more reasonably shaped distribution functions and have obtained results identical within experimental error with the scattering curves from potassium laurate solutions, the agreement including not only the shape of the curve but also the position of the maximum. I do not propose this as a proof for spherical micelles, but merely to illustrate the point that there is literally an infinite number of models which will explain a given diffraction pattern, and one must utilize a wide variety of data to select the most plausible model.

Thus the conditions inside soap solutions are so different from those of the experiments described that the conclusions of Davies and Phillipoff can scarcely be accepted. This is particularly true with regard to their contention that Bragg spacings should be accepted at face value. It is the mixing-in of the intermicellar diffraction and the averaging over the surface of a sphere in reciprocal space, described above, of a diffuse pattern from a non-periodic structure, that vitiates the application of Bragg's law to patterns from soap micelles; and it is particularly these features of the problem that their experiment leaves out. On the other hand, the practice of multiplying Bragg spacings by the factor 1.23 is only slightly less naive. From the above discussion it is clear that Bragg spacings corresponding to maxima in soap solution patterns, which although appearing fairly sharp to the eye are actually quite diffuse in comparison to the total scattering angle, usually have no direct significance as actual distances or constant ratios to distances in or between micelles.

EDWARD W. HUGHES

Gates and Crellin Laboratories of Chemistry,
California Institute of Technology,
Pasadena, California.

¹ Davies, J. T., and Phillipoff, W., *Nature*, **164**, 1087 (1949).

² Corrin, M. L., *J. Chem. Phys.*, **16**, 849 (1948).

³ Shaffer, jun., P. A., Schomaker, V., and Pauling, L., *J. Chem. Phys.*, **14**, 659 (1946).

A DISCUSSION of the points raised by Dr. E. W. Hughes is postponed for inclusion in a full report of the results to be published elsewhere.—W. PHILLIPOFF.