

## DISCUSSION

HUGH S. TAYLOR

Princeton University, Princeton, N. J.

The choice of Professor Svedberg to give an exposition of his contributions to physical chemistry at the dedication of the Chemistry Building of the University of Delaware has permitted us a glimpse into the potentialities of a rapidly developing region of experimental research. Every invention or development of a new method of physical measurement enlarges the horizons of the sciences. That is particularly true in the subject to which our lecturer has addressed himself. The instruments which he has developed have made possible powerful new methods of approach to problems that the scientist earnestly desires to solve. We have been shown how these new technics are applicable to the more complex forms of matter, forms which originate in vital systems and which are being synthesized in increasing degrees in the laboratories and factories of the world. The complexity of these systems, the great size of the individual units or molecules of which these materials are composed has, hitherto, rendered the problem of their investigation a most difficult one.

Researches in the field of synthetic organic chemistry, notably in the synthesis of natural dyes and of similar but improved derivatives, the synthesis of sugars, of vitamins and hormones, are among the brilliant chapters of organic chemistry. Nevertheless, unaided organic chemistry has not appeared capable of carrying the synthesis of the more complex natural products, such as proteins, very far beyond the pioneering researches of Emil Fischer. To this problem the technic discussed today brings a vital contribution.

Professor Svedberg's centrifuge permits a determination of unit molecular size with a precision that is

truly remarkable. It permits a differentiation or determination of size distribution in groups of natural and synthetic products where heterogeneity obtains. Upon the firm basis of these unit mass determinations, science in many of its branches is preparing to push forward its horizons. Professor Svedberg's work is invaluable in the field of biochemical investigations where already technics have been developed to produce protein materials in crystallizable forms. Researches such as those of Northrop on pepsin and trypsin, of Sumner, of Stanley on the mosaic viruses of the tobacco plant—these represent achievements where the assistance of the supercentrifuge is evident and important for further progress. The unitary characteristics of these materials have been recognized and upon that as a foundation we may expect a development similar to that which occurred in inorganic and organic chemistry in the early part of the 19th century when the concept of atomic and molecular structure had been properly defined. Already there are signs that such a super structure of further discovery is being erected.

In our own field of reaction kinetics, attention is centering at the moment on the velocities of processes occurring among such complex systems. With our newly acquired knowledge of the unitary structure it has become possible to study more intimately processes of change, such as denaturation, of which the speeds can be measured. At the moment, there are surprising differences between the velocities of some of these biochemical processes and the type reaction velocities of classical physical chemistry. Investigators such as Pauling and Mirsky in California, Eyring in Princeton, and Steinhardt in Copenhagen, are concerning themselves with the problems of protein reaction velocities which occur very much more rapidly and with considerably higher temperature coefficients than are possible in the reactions of simpler molecules, whether inorganic or organic.

Recent discussions of the velocity of certain of these processes indicate that they may proceed at velocities

which can only be expressed in astronomical figures. I refer more particularly to two reactions recently studied which appear to proceed at velocities  $10^{72}$  and  $10^{26}$  times greater than might be expected. Students of reaction kinetics will ultimately solve these problems. The answer will be found in the pattern of the protein molecule and the count of the individual active groups in the unit molecule which Svedberg has described.

Another approach to the definition of the Svedberg units of complex matter is coming in the field of mathematics. That special branch of mathematics which deals with the subjects of topology has been shown by Dorothy Wrinch to be a very suggestive method of approach to the problem of the structure of the protein molecule. More especially is this the case with those globular proteins which Svedberg has shown to possess such different and discrete levels of molecular weight. These topographical approaches have also inspired a program of synthetic organic chemical research and have stimulated once more the brilliance of Langmuir to further researches on the properties of mono-layers on liquid and now on solid surfaces.

These contributions originating in or aided by a series of researches, cannot be other than inspiring to those fortunate younger generations who will pass through these laboratories of chemical science to the borderlands of scientific knowledge where they may with increasing opportunity and in increasing measure find the happiness and satisfaction of a life dedicated to scientific research.