to IVa (*ca.* 50% of total product) was esterified (CH_2N_2) and examined by v.p.c.[9] The most prominent peaks were at 6.1 (B), 6.5 (C), and 8.9 (D) min. (65, 10, and 16% of total area); preparative v.p.c. yielded pure specimens[10] of each. Compound B, m.p. 53–55°, was shown to be IVb by infrared and n.m.r. comparison with A' methyl ester (CH_2N_2). Compound D, λ_{max} 5.73 μ, showed n.m.r. absorption for primary methyl (δ 0.95, triplet, 3 H), no tertiary methyl, and a $-CH_2O-C=O$)– group (δ 4.20, multiplet, 2 H). These data are in accord with formulation of D as IIb. Thus the reported[8] major product, IIa, of this sequence is produced to the extent of at most 8%.[11]

As published procedures[3,5] showed little promise for useful synthesis of IIa, an alternate sequence was devised: diethyl ethylmalonate was alkylated ($Na-C_6H_6$) with Δ^3-cyclopentenyl tosylate[12] to give V, 80%, b.p.

(9) We are indebted to J. Lockard and A. Post (Smith Kline and French Laboratories) for these determinations.

(10) Compound C was not investigated further.

(11) A compound described as II, m.p. 98–100°, was obtained by degradation of oleuropeina [L. Panizzi, M. L. Scarpati, and G. Oriente, *Gazz. chim. ital.*, **90**, 1449 (1960)]. Again, the sequence included an acidic ether cleavage and certainly produced IVa rather than IIa. The only previous potentially authentic synthesis of IIa proceeds from 2-(4-pyridyl)butanol. IIa is described as an oil, b.p. 140–160° (0.05 mm.) [M. Pailer and G. Beier, *Monatsh.*, **88**, 830 (1957)].

(12) E. L. Allred, J. Sonnenberg, and S. Winstein, *J. Org. Chem.*, **25**, 26 (1960).

96–97° (0.7 mm.). V was hydrolyzed to a mixture of acid ester and diacid which was decarboxylated (Cu-quinoline). The resulting mixture of VIa and VIb upon reduction ($LiAlH_4$) gave VIIa, b.p. 99–100° (11 mm.); α-naphthylurethan, m.p. 86–88°; the corresponding acetate, VIIb, b.p. 99° (10 mm.), λ_{max} 5.77 μ; δ 0.94 (triplet, 3 H) and 4.05 (doublet, 2 H), was obtained with acetic anhydride (from V, 70%). Oxidation ($O_3-CH_2Cl_2$; $Ag_2O-NaOH$) of VIIb gave the diacid acetate IIIc which was directly saponified to IIId. This diacid was lactonized by heating in xylene to IIa, b.p. 215–218° (3 mm.), λ_{max} 5.74 and 5.80 (sh) μ, and aliphatic carboxylic acid absorption in the 2.8–4 μ region, δ 0.90 (triplet, 3 H) and 4.20 (multiplet, 2 H); p-bromoanilide, m.p. 133–134°; λ_{max} 5.74 and 5.91 μ; δ 0.90 (triplet, 3 H) and 4.15 (multiplet, 2 H). The methyl ester (CH_2N_2) IIb was identical with compound D obtained by preparative v.p.c. (above) by infrared and n.m.r. comparison and v.p.c. retention times.

J. A. Weisbach, J. L. Kirkpatrick
E. L. Anderson, K. Williams, B. Douglas
Smith Kline and French Laboratories
Philadelphia, Pennsylvania

H. Rapoport
Department of Chemistry
University of California, Berkeley, California

Book Reviews

Statistical Theory of Liquids. By I. Z. FISHER with a supplement by STUART A. RICE and PETER GRAY. The University of Chicago Press, 5750 Ellis Ave., Chicago, Ill. 1964. xii + 335 pp. 14.5 × 22 cm. $12.50.

This book is a translation of a monograph in Russian. As with any translation, the first question a reviewer should ask is "was the effort of translation worthwhile?" The answer is an emphatic yes. The statistical theory of liquids had, some years ago, already developed to the stage where a book length monograph giving a coherent picture of the field was feasible. Although there are some excellent review articles, and chapters in some texts, no comprehensive full length account was available before the appearance of Fisher's book. The well-known treatise of Hirschfelder, Curtiss, and Bird may appear to be an exception, but, in fact, these authors emphasize lattice theories. Fisher treats such theories very briefly, finally dismissing them with the remark that they are based on a physical model which itself is not well founded.

The main subject matter of the book is the equilibrium theory of simple liquids based on the method of molecular distribution functions. A simple liquid is one consisting of "spherically symmetrical, nondipolar particles with interactions which are non-directional and non-saturating van der Waals forces." Generalizations are occasionally indicated. Such emphasis is entirely justified in a book, because simple liquids are the only ones for which anything approaching a reasonable theory exists at the present time.

The book begins with the phase integral, defines molecular distribution functions, and develops their properties. The relations of these functions to thermodynamic properties, structure, surface phenomena, and phase stability are discussed at length. A final chapter on the determination of the pair distribution by the use of high speed computers, with emphasis on the Monte Carlo method, closed Fisher's part of the book.

The development is very well done. In general, the highlights of the mathematics are emphasized and interpreted physically as far as possible. But this does not mean that the book will be easy reading for the nonmathematical reader; on the contrary, it implies the ability to fill in the omitted details. The level is such

that graduate students interested in theory should not find difficult. Comparison with experiment and rough order of magnitude estimates help to keep the physics from being buried in the mathematics. On the other hand, the technique of leaving out "routine" details can lead to puzzles. For example, on page 144 Fisher claims that the virial series for hard spheres can be proved to converge for $v > 2$ (in units of the sphere volume). No reference is given, and I am not aware of any published proof of this assertion.

In addition to being timely and well done, the book serves another purpose for Western readers. Fisher emphasizes important Russian contributions to the theory which are little known outside of the U.S.S.R., although he gives due credit and space to the work done in other countries. In this connection the equation which Fisher calls the Bogoliubov equation, with the side remark that it was independently derived by Born and Green, is called in the West, the Born–Green equation, with a side remark that it was derived independently by Bogoliubov. Either name is justifiable, but the contrast is amusing.

Fisher's book was originally published in the Soviet Union in 1961, and Rice and Gray have written a long supplement (half as long as the original book) to bring it up to date. In fact, the supplement does more than that; some of the results in the main text are rederived by different methods, usually more completely. Among the additional topics discussed are recent developments in technique, such as diagram summations, cumulant expansions, and functional derivatives. The integral equations of Percus–Yevick and hypernetted-chain are derived and their solutions discussed. Generally speaking, the tone of the supplement is more formal and less physical than the main text. It is a pity that Rice and Gray felt it necessary to use a different notation from Fisher; aside from this, the supplement is a very worthwhile addition to the main text.

The translation reads well, and the production is excellent. The book should be of great interest to graduate students and research workers in statistical mechanics.

Robert M. Mazo
Institute of Theoretical Science, University of Oregon
Eugene, Oregon