Book Reviews

Vehicles as Particles

Kinetic Theory of Vehicular Traffic. ILYA PRIGOGINE and ROBERT HERMAN. Elsevier, New York, 1971. xx, 102 pp., illus. $12.50.

The subject of this book is a nonlinear integro-differential equation (Eq. 3.25, p. 25), its derivation, justification, solution, and especially its application to the mathematical theory of vehicular traffic flow. The branch of traffic flow theory characterized by this equation has been the creation of Prigogine and Herman, with a few coauthors. It occupies a curious position within the larger field, having been pursued systematically for more than a decade by two authors who, without exaggeration, must be considered the most celebrated and sagacious contributors to traffic theory, and yet having had little if any impact in terms of publications by other research workers.

The Prigogine-Herman theory—often called the "Boltzmann-like theory"—is based on an analogy between vehicles and the particles of classical physics. There has been so much discussion of the possible significance of the analogy that one must welcome this definitive statement by its authors of its status in 1971.

The book is ideal: compact (though expensive), complete, well referenced and indexed, lucidly and persuasively written. With regard to the theory, there seem to be three categories of nonbelievers: those who claim that it is demonstrably contradictory (the critics), those who challenge its adequacy to explain the phenomenon (the skeptics), and those who find it difficult to understand (the agnostics).

It is a pleasure to report that the gap separating Prigogine and Herman from the critics is nearly bridged. A comparison of pages 26–27 with the paper being rebutted shows that it is now only a question of whether or not "a queue of n vehicles with speed v and position x would be represented in our theory by a value of $f(x,v,t)$ that would be n times as high as for the case of one vehicle with the same x and v."

With regard to the skeptics the situation is a little more difficult. The theoretical and technical problems of testing any theory of traffic flow are acknowledged to be staggering. The demands for "validation," which have been a standard feature of congresses since 1959, have not been satisfied (except for the admitted special cases of tunnel traffic) until quite recently. Within the past two years a large contract with the Department of Transportation has made possible data collection and analysis of freeway traffic on an unprecedented scale. The first publication of data seems to indicate that the Prigogine-Herman theory is highly unsatisfactory, and the rebuttal given on page 32 seems rather unspecific: "It is regrettable that [the] verification techniques contain undesirable features that render [the] results inconclusive with respect to the assumptions and properties of the model." This is very probably only the beginning of an extended controversy, and it will be most interesting to see where it leads.

Finally, a word on behalf of the agnostics. Prigogine and Herman warn that readers "without the necessary background in physics" may form misconceptions of the theory. This is especially true in view of the fact that the fundamental equation of the theory is not so much derived as assembled.

An example of this tinkering approach is the following quotation: "A qualitatively similar effect can be achieved by adding to the kinetic equation a term of the general form

$$(\partial f/\partial t)_{\text{adj}} = \lambda(c)(1 - P)c[c\delta(v - \bar{v}) - f]."$$

It appears that the Prigogine-Herman theory will not find general acceptance, and bring forth useful research, until it is expressed in clearer arguments based less on analogy. Failing that, in another decade it will be considered idiosyncratic. Meanwhile, the present book should by all means be compulsory reading for serious students of traffic flow theory.

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Organometallic Compounds of Arsenic, Antimony, and Bismuth. G. O. DOAK and LEON D. FREEMAN. Wiley-Interscience, New York, 1970. xiv, 510 pp., illus. $25. The Chemistry of Organometallic Compounds.

The authors in writing this book set out to give examples of all of the methods that have been used to prepare organoarsenic, organoantimony, and organobismuth compounds but without covering all known compounds; to emphasize procedures that appear to be of most general utility; to cover the chemical reactions of each class of compounds; to discuss reaction mechanisms only when sufficient data are available to justify such discussions; and to review structure, spectra, and physical properties of these classes of compounds in considerable detail. All pertinent literature through the end of 1967 has been included, and a few important papers published in 1968 and 1969 are also discussed.

Within the limitations imposed by the literature itself, the authors have attained their objectives. It is doubtful whether the literature of any area of organic chemistry contains more errors and nonreproducible results than that of organoantimony chemistry (and possibly organobismuth chemistry). Thus, in the chapters devoted to organoantimony chemistry, the authors quite properly make many statements such as "it can only be concluded that aromatic stibonic acids exist as polymeric species of unknown structure" (p. 293), "there is little evidence that any of the proposed structures are correct" (p. 294), and "the exact structure of these compounds is not known" (p. 295). It is the experience of the reviewer that even some of the most highly regarded and most often cited work in organoantimony chemistry is nonreproducible, and no research worker in the field can accept much of the literature with complete confidence. Fortunately, most of this book is devoted to organoarsenic chemistry, and the literature of that field is relatively reliable.

As mentioned previously, the authors have not discussed mechanisms of reactions unless there is some valid evidence for the mechanisms under consideration. Unfortunately, relatively little attention has been paid by physical-organic chemists to mechanism studies in the areas covered by this book; consequently, most of the writing is of a descriptive nature. On the