SATELLITE WAKE

Interactions of Space Vehicles with an Ionized Atmosphere

Edited by S. F. Singer. (International Series of Monographs in Aeronautics and Astronautics. Division 9: Symposia, Vol. 18.) Pp. viii + 510. (London and New York: Pergamon Press, Ltd., 1965.) 150*s*. net.

THE classical problem of the motion of a particle in a central force field takes on some complications when interactions between more than one such particle have to be considered and when the radial variation of the force is, in consequence, no longer as the inverse square of the distance. This problem has a number of applications—the accretion of electric charge by dust particles in the interstellar gas, the theory of the operation of the Langmuir probe and the development of a satellite wake in the ionosphere. This last example forms the central topic of this book.

The book is based on material originally presented at a symposium of the American Astronomical Society in Washington, D.C., but an attempt has also been made to cover the subject more completely by means of additional papers. In all there are fourteen contributions, divided into two parts. As is often the case with such books, this one presents a difficult problem for the reviewer on account of the varying standard of the contributions, and also of their completeness of coverage, which combine to make it difficult to indicate how thoroughly different portions of the subject have been covered.

Part I deals principally with the interaction with a plasma of a charged body which may be moving. This is discussed in considerable generality in the first contribution by E. J. Opik in a chapter which represents a most valuable contribution to the subject, especially in the discussion of central force fields where the index of the force law is greater than 2. The following chapter, by E. H. Walker, develops the ideas of the first for two applications—the potential distribution about a stationary sphere in a plasma and about a hypersonic moving object. The first of these is the ordinary Langmuir probe; for some reason the greater part of the discussion is for the physically unrealized case in which both ions and electrons are all reflected at the surface of the sphere, though the case which actually occurs is also treated. Results for the moving object—the case of a satellite wake—are also given. It is unfortunate that no comparison with Russian work, that of Al'pert and his collaborators, is attempted as this is in many respects complementary. In fact, it is a noticeable feature of the book generally that the references to other work, particularly that done outside the United States, are often inadequate. This is possibly partly due to its having been a long time in preparation, but it is a weakness.

The next chapter, by R. T. Bettinger, deals with probe methods of measurement in the ionosphere. This is the longest single contribution; from the acknowledgments it appears to have been written as a doctoral thesis and reproduced in its entirety, an impression supported by the review (actually a very poor one) at the beginning. In any event, it was a clear case for firm editorial action. The main sections deal with some trivial calculations of probe characteristics, and then with obviously preliminary results of rocket firings using some novel probe types. The latter are certainly not without interest, but could have been adequately treated in much greater brevity.

The three remaining contributions to Part I are all shorter and deal with measurements on the sheath about a cylindrical aerial (W. Pfister and J. C. Ulwick), heating effects due to recombination at a satellite surface (L. M. Gilbert and S. M. Scala) and the possible role of secondary electrons produced by neutral particles impacting on a rather low altitude satellite (D. B. Medred).

Soon after the launching of *Sputnik I* a number of different radio-wave propagation effects aroused some interest, such as long-distance reception of the satellite transmitters. Another effect observed by J. D. Kraus at the Ohio State University was thought to be scattering of WWV transmissions from the satellite or its wake, the remarkable feature being the strength of the received signal which corresponded to a scattering cross-section of 10^4–10^6 m^2, several orders of magnitude greater than the geometrical area. To explain this observation provided the original incentive for much of the work on satellite wakes. However, radio signals are also reflected from ionized meteor trails, and the association of some signals with satellites has always been controversial. Part II is devoted to this topic, and the first three contributions (by J. D. Kraus, by T. G. Hame and W. D. Stuart, and by T. A. Croft and O. G. Villard) describe different experimental investigations of this correlation. In the work by Kraus, an effort is made to correlate specific strong bursts with satellites; it is concluded that positive results are obtained. In the next two papers a more statistical approach is used but negative conclusions are reached—neither investigation yielded effects which could be ascribed with certainty to a satellite. The general impression left on the reader is that this conclusion is more likely to be correct. The next three papers (by E. H. Walker, by L. Peters and W. G. Swarner, and by K. M. Chen) discuss the calculation of the scattering of electromagnetic waves by a satellite wake. Rather oddly, in view of the above conclusion, it is found that because of the rod-like form of the trail sufficient energy might be focused in an approximately normal direction to give effects comparable with those observed.

The uneven quality of its subject-matter makes it difficult to recommend this book without reservations, though, at best, as in the chapter by Opik, it is very good. The subject-matter for the most part covers a rather narrow field and will, therefore, interest specialists. On the other hand, three contributions have some general application in astronomy and plasma physics and will attract a wider audience. The index is comprehensive and, for the most part, well selected. A. P. WILLMORE

QUANTUM APPROXIMATIONS

JWKB Approximation

Contributions to the Theory. By Nanny Fröman and Per Olof Fröman. Pp. viii + 138. (Amsterdam: North-Holland Publishing Company, 1965.) 32*s*.

THE subject of this book is the mathematical approximation method, which to most authors in theoretical physics is known as the Wenzel–Kramers–Brillouin (WKB) method. Apart from an orthodox derivation of the WKB formulae in Chapter 2, the book is based entirely on the original work of the authors.

Their aim has been to provide a mathematical apparatus required for a rigorous treatment and systematic application of the method. In this, they have added considerably to the understanding of the method. The important problem of obtaining general limits of error in applications of the method has been solved, and is clearly discussed in Chapter 8 for classically allowed and forbidden regions. Particular attention has been given to the exact status of the connexion formulae, which the authors feel is unsatisfactorily established in the literature. In Chapter 8 the allowed connexions across a classical turning point are derived along with estimates of the errors involved, and emphasis is given to the irreversible nature of the connexions.

An exact treatment of the one-dimensional Schrödinger equation forms the basis of the book, and is presented in Chapter 3. Following Kemble, the authors transform the original equation into two first-order differential equations.