distance geometry available at this moment and it is certainly useful to have a survey of the results obtained so far in the geometric study of metric spaces.

J. HAANTJES

Exterior ballistics. By E. J. McShane, J. L. Kelley, and F. V. Reno. The University of Denver Press, 1953. 834 pp., 15 figures, 24 plates. $12.00.

This book forms a welcome addition to the very limited number of works on exterior ballistics; had there been many more competitors I suspect its welcome would have been equally warm.

The first chapter, roughly one-sixth of the book, is devoted to mathematical and physical preliminaries and is intended "to make the book intelligible to anyone who has had a reasonably good undergraduate course either in mathematics or physics." This chapter discusses vectors, the equations of rigid body motion, dimensional analysis (including an original proof of the Buckingham Π theorem) and appropriate parts of statistics. I feel that it is impossible in a single chapter, even a chapter as long as this, to provide an adequate background to exterior ballistics and am of the opinion that the authors were over-ambitious to attempt it. Any complete background picture must contain the elements of aerodynamics as well as of dynamics, and any such inclusion would no doubt have made the space required entirely prohibitive. Leaving aside the desirability of such a chapter and its sins of omission I found the presentation of the material selected very satisfying and feel that the authors are to be congratulated on it, save on one point. This point concerns the equations of motion of a rigid body which are proved on the sweeping assumption that the internal forces between any two points of the body lie in the line joining them (for a discussion of this point see, for example, Jeffreys and Jeffreys, *Methods of mathematical physics*, Cambridge University Press, pp. 76 and 294).

Coming now to exterior ballistics proper the treatment starts in Chapter II by a discussion of the aerodynamic forces acting on the projectile; two force coefficients (K_{XF} the Magnus cross force due to cross spin and K_S the cross force due to cross spin) and a moment coefficient (K_{XT} the Magnus cross torque due to cross spin) are added to "complete" the system considered in the classical treatment of Fowler, Gallop, Lock and Richmond (Philos. Trans. Roy. Soc. London vol. 221 (1921) p. 295). The equations of motion (both C.G. and yawing) are then derived relative to axes fixed in the projectile—one along the projectile axis; the equations in the two directions perpendicular to the axis are combined, as is customary, into a single complex equation. Chapter III is devoted to methods of determining drag from velocity and retardation measurements, to wind tunnel methods of determining drag, lift, and overturning moment coefficients (K_D, K_L, and K_M) and to damping experiments in the wind tunnel for providing the yawing moment due to yawing (coefficient K_H) which by variation of the axis of oscillation can be made to give the cross force due to cross spin (coefficient K_S).

Chapters IV to IX are devoted to the "normal" equations of the trajectory, their solution and their differential effects. It is perhaps here that the time which has elapsed since the book was first projected is most manifest. There is no doubt in my mind that the advent of digital computing machines has vastly affected this side of the problem and that we are rapidly approaching a state where a trajectory and its differential effects can and will be obtained by brute machine force. In these circumstances the space devoted to these aspects of the problem appears unduly large but there is no doubt that the chapters do provide a most thorough survey of the whole field.

Apart from a short chapter on bomb-sights and an historical appendix, the rest of the book is effectively devoted to the angular motion of projectiles spun and unspun, and its effect on the C.G. motion; it is here that the book will, I think, capture most attention. I found it a most stimulating account of the subject and would single out for special mention the treatment of stability. As a finale to this part of the work the analysis of Spark Range data for the spun projectile is shown to lead theoretically to the determination of all the force and moment coefficients except K_{XT} (the Magnus cross torque due to cross spin). Practically, the accuracy with which the coefficients can be determined is severely restricted—the authors quote probable errors of 5% for K_L (the lift coefficient), 30% for K_F (Magnus cross force due to cross velocity), and over 50% for both K_{XF} (Magnus cross force due to cross spin) and K_S (cross force due to cross spin). This means that with existing methods of analysis and measurement, of the three additions to the force system used by Fowler et al., one (K_{XT}) is undetermined and two (K_{XF} and K_S) have probable errors in their determination of over 50%. Though one cannot help feeling therefore that, since the Spark Range measurements represent the most refined measurements available, the Fowler system is still adequate for many practical purposes, one cannot fail to see the need for further research. If the analysis presented here were to provide, as one hopes it will, a stimulus towards methods of measurement which will define the additional coefficients more precisely and this were the only outcome of the book, it would indeed have served its purpose.

L. HOWARTH

A first course in functions of a complex variable. By W. Kaplan. Cambridge, Mass., Addison-Wesley, 1953. 8+485–620 pp. $3.50.

The publishing of this text represents a new step by the publishing industry, taken presumably to help combat the sharply increasing price of textbooks. The author's *Advanced calculus* (A) published in 1952 contained a long chapter on complex variables, and it is this chapter now in separate binding that is offered at $5.00 less than the price of A. The only alteration, aside from the correction of misprints, is the addition of an appropriate index, a subset of the index of A.

The author has an attractive style of writing, the material is well organized and in a natural order, and despite the limited space available the author covers an amazing amount of material, including even a brief account of the applications of conformal mapping to the theory of elasticity. Answers are provided for all numerical exercises, a remarkable and refreshing innovation for advanced textbooks. On the debit side the treatment of the Riemann sphere and the linear fractional transformation is too brief, and the cross ratio is relegated to the exercise list.

Although the book has considerable merit and would certainly be a satisfactory text for a first course, the central question to be considered is the publisher's decision to reprint one chapter of A. Despite the author's assertion that "Outside of a few references to earlier chapters of A this book is essentially self-contained," there are a rather large number of places where the student who does not possess a copy of A will be at a distinct disadvantage. To cite only one such case, the author gives the Cauchy-Hadamard formula for the radius of convergence of a power series, and then for a proof states that "Since the ratio test, root test, and M-test all carry over to complex variables $\cdots$, the proof given in Section 6–15 can be repeated without change." But Section 6–15 is not in the complex variable chapter.

Although recent years have seen a substantial increase in the number of texts on complex variables available, there is still a need for a good elementary one. The author has here an excellent start, but the reviewer hopes he will continue the present book in both directions and expand it in the middle so that on the one hand it will really be