

REVIEWS

Dynamics of Satellites. Edited by M. ROY. Springer-Verlag, 1963. 335 pp. This volume contains all twenty-five papers, three in French and the remainder in English, presented at the I.U.T.A.M. Symposium held in Paris in May 1962. Attendance was by invitation, and the contributions are of a high standard throughout. The stated object of the conference was to bring together and compare the results concerning the nature and the laws of the real forces acting on artificial satellites, and for obvious reasons the American and Russian contributions predominate although there are notable papers from Britain and Germany.

Although the papers are not grouped by subject-matter, the reviewer must venture to classify them. It is now well known that the density of the upper atmosphere can be determined from the secular decrease in the orbital period, and Jacchia presents a clear account of the principles and difficulties involved. Owing to the nearly exponential decrease in density with height, air drag is most effective over some region around perigee, and the size of the region depends on the assumed scale height. In his paper, King-Hele extends his previous work to allow for a linear variation of the scale height with height, and finds that this can make a considerable difference to the values of air density obtained. The picture of the upper atmosphere that has emerged shows that the density is considerably higher than had previously been thought and that the temperature is often above 1000° C. There are also considerable atmospheric variations between the day and night sides, as well as with the general level of solar activity. Priester gives an interesting discussion of the physical sources of these day-to-night variations.

The other major success of the observation and theory of satellite orbits has been the determination of the shape of the earth, or more strictly of its gravitational potential. Because of the rotation of the earth the potential is effectively smoothed out to an axially symmetric form, and Kozai describes a determination of the coefficients in this potential up to the ninth zonal harmonic. Fairly recently it has proved possible to determine the longitudinal dependence in the gravitational potential from very small variations in the orbit with periods of the order of a day. Both Kozai and Kaula report on this very difficult task, unfortunately rather briefly since the work was in its early stages at the time.

Turning to the small perturbing forces, two papers are devoted to aspects of radiation pressure. Although small for normal satellites, the effects can be very important for satellites like Echo and the West Ford needles with a large ratio of area to mass.

The advent of the artificial satellite has also sparked off a new interest in the old subject of celestial mechanics, partly because artificial satellites can have large inclinations and eccentricities not found in the solar system, and partly because of the availability of high-speed computers. Here Musen and Lidov give interesting discussions on the long-term evolution of very distant satellite

orbits which are considerably influenced by the gravitational forces of the sun and moon.

Four of the papers are devoted to the rotational motion of satellites, and Naumann in particular gives a full account of the various torques arising from gravity gradient forces, air drag, permanent magnetic moments, etc. Another valuable contribution in this area is Beletskii's discussion of the forced libration of a satellite in an elliptic orbit due to the gravity gradient torque.

This by no means exhausts the topics covered which include methods of observation, reduction to definitive orbital elements, charge drag, oscillation of synchronous satellites, satellite orbits in general relativity, oscillations of liquids in the weightless condition, to name but some. Also this review would not be complete if Shapiro's article were not singled out for special mention; this runs to over fifty pages and is virtually a monograph on the whole subject.

The book is handsomely produced in the Springer tradition. Minor criticisms are that the language of the Russian papers, in translations supplied by the authors themselves, is in some places quaint, and there are misprints throughout. However, this is a small price to pay for the timely appearance of this book, which is highly to be recommended as a survey of the field.

R. R. ALLAN