SUGGESTED REFERENCES: Chapter 3

E.I. WHITTAKER, *Analytical Dynamics.* Almost every text on mechanics devotes considerable time to central force motion and only a few of the many references can be listed here. Sections 47—49 of Whittaker's treatise form a concise discussion of the subject that, despite its brevity, manages to consider many out-of-the-way aspects. It is practically the only source for the analysis of which force laws are soluble in elliptic functions.

W. D. MACMILLAN, *Statics and the Dynamics of a Particle.* Chapter XII of this reference provides a mast elaborate discussion of central force motion, including detailed consideration of the orbits for some force laws other than the customary inverse square law. The treatment is elementary and does not use the Lagrangian formulation. Kepler's equation is derived, along with variant forms for various types of orbits, and several methods of solution are described. The Laplace—Runge--Lenz constant of motion is mentioned briefly, in a 'throw-away" line as a "constant of integration" in Section 301.

L. D. LANDAU and **E. M. LIFSHITZ**, *Mechanics.* As might be expected, in its coverage of the subject of central force motion and scattering, this reference includes many original and unusual insights. The constancy of the Laplace- Runge—Lenz vector is explicitly demonstrated and used to derive the orbit equation. Kinematics of collisions are described in some detail.

J. B. MARION, *Classical Dynamics of Particles and Systems.* This fine intermediate-level text has an unusually detailed chapter on central force motion, including discussions on Kepler's equation, stability of circular orbits, and some elementary results on the famous three-body problem. As befits the author's involvement in experimental nuclear physics the chapter on kinematics of collisions and cross section calculations is exceptionally complete in coverage.

J. 0. HIRSCHFFLDER, **D. F. CURTIS**, and **B. B. BIRD**, *Molecular Theory of Gases and Liquids.* A veritable encyclopedia on the chemical physics of gases and liquids, this reference is probably the best source for applications of the classical virial theorem. There is also much material on interatomic potentials and scattering cross sections, although the substantial advances in the field since 1953 are naturally not included.

S. W. MCCUSKEY, *Introduction to Celestial Mechanics.* Two-body motion in a mutual $1/r$ potential forms the first approximation to the motion of the planets, satellites, and space craft. All books on celestial mechanics therefore devote considerable attention to the "Kepler problem." Of the vast literature on celestial mechanics only a few can be cited here. McCuskey's book covers a wide range of information compactly, including a discussion on motion in time in various orbits, and approaches the subject on a relatively elementary level.

J. M. A. DANBY, *Fundamentals of Celestial Mechanics.* Written by a well-recognized and highly respected master of celestial mechanics, this text covers much of the classical area of celestial mechanics on an intermediate level, with a leavening of more recent material inspired by the advent of the computer and space age. Exercises and references are plentiful. The motion in time and Kepler's equation are discussed at length, but neither the Laplace—Runge—Lenz vector nor Bertrand's theorem is mentioned.

H. C. PLUMMER, *An Introductory Treatise on Dynamical Astronomy.* Although relatively old (1918, but with a 1960 reprint) this remains the most available reference on Bertrand's theorem, and the presentation in this Chapter is based on Plummer's approach. A different method of proof is briefly described in the classic treatise by F. Tisserand, *Traité de mécanique céleste,* Tome 1, Chapter 1, Section 6. Plummer's book also presents some special tricks for approximate solution of Kepler's equation.

H. V. MCINTOSH, "Symmetry and Degeneracy," in *Group Theory and its Applications,* Vol. II, E. M. Loebl, ed. This article contains an enthusiastic overview of the internal symmetries of simple physical systems, developed in a historical fashion. Though the discussion has a high words-to-formula ratio, it presupposes that the reader has some acquaintance with group theory and with quantum mechanics. But it is by far the best survey of what in 1970 was thought to be the connection between symmetries and degeneracies. Both the Kepler problem and the harmonic oscillator symmetries are described, as well as the implications of Bertrand's theorem.

R. *G.* NEWTON, *Scattering Theory of Wares and Particles.* Although this book is mainly involved with the quantum theory of scattering, Chapter 5 is concerned with scattering of classical particles and gives a concise discussion of "orbiting" and "glories," based for the most part on the fundamental paper of K. **W. Ford** and **J. A. Wheeler,** *Annals of Physics (N Y.* **7** *259* **(**1959).