

investigation of the observed torques acting on *Explorer XI* (15 pp.). These attempt to relate the observed motion of the *Explorer XI* satellite to the environmental factors causing the motion. The two chapters are complementary rather than overlapping. Chapter 13 gives some details of the attitude determination procedures, and examines the orders of magnitude of the various torques. Chapter 12 attempts a detailed explanation of the motion in terms of gravity and magnetic torques.

Chapters 14, 15 and 16 deal with various aspects of Earth horizon sensing. Chapter 15 surveys the physical phenomena and scanning methods which could be used, some mention being made of possibilities with regard to other planets and the Sun. Chapters 14 and 16 present, respectively, theoretical and experimental results concerning the infra-red radiation emitted by the Earth, the object being to discover which spectral bands should be used to give greatest reliability and accuracy in this method of attitude determination.

W. G. HUGHES

LUNAR TOPOLOGY

The Lunar Surface Layer

Materials and Characteristics. Edited by John W. Salisbury and Peter E. Glaser. Pp. xxvi+532. (New York: Academic Press, Inc.; London: Academic Press, Inc. (London), Ltd., 1964.) 86s.

THE lunar surface, which tantalizingly beckons the astronaut of the space age, has long been the subject of astronomical investigation at a distance (though we have probably never felt the limitations of this acquaintance more keenly than at the present time); but the urgency of engineering deadlines to be met in the next few years makes it desirable to take stock of our present knowledge in this field, to see what kind of physical picture it will make. A three-day symposium on the lunar surface layer, its materials and composition, was held in Boston in May 1963, the purpose of which was to bring together relevant astronomical observations and supporting laboratory data. The symposium was organized by the editors of *The Lunar Surface Layer*, and thirty-three different authors contributed to its proceedings; their communications are published in this volume.

A wide diversity of subjects relevant to the physics of the lunar surface were covered—including aspects of soil mechanics; the effects of micro-meteoroid bombardment and meteoritic impacts; spattering effects, electro-dynamical effects, photometric and thermal emission examinations, and many other lines of investigation which must be integrated in a coherent picture. Perhaps the most interesting contributions to the symposium were those in the field of photometric investigations and, in particular, on the interpretation of the lunar photometric function (unique among all bodies of the solar system) which makes the intensity of moonlight vary so steeply about the time of full Moon. Hapke's recent laboratory work on the dendritic growth *in vacuo* is both presented and critically discussed. Of other noteworthy contributions, a gradual understanding of the low albedo of the lunar globe has emerged from laboratory investigations of the radiation damage suffered by unprotected solid surfaces exposed to the full range of solar radiation—both electromagnetic and corpuscular.

The most significant feature of this symposium—and hence of the volume—was its attempt to blend together astronomical observations and laboratory investigations into a coherent physical and mechanical model of the lunar surface. It would be too much to hope that an undisputed picture of it would emerge in advance of the actual instrumental or manned landings—everyone seems to have managed so far to draw support from the recent photographs of *Ranger VII* for his preconceived

opinions. Drs. Salisbury and Glaser are to be congratulated on a distinct measure of success in advancing this aim. Perhaps the best tribute one can pay to their efforts is to say that, although the parent symposium was held eighteen months ago, its *Proceedings* have lost little of their interest and relevance in the intervening time.

ZDENEK KOPAL

A MEDIEVAL MASTER CRAFTSMAN

On Divers Arts

The Treatise of Theophilus: Translated from the Medieval Latin with introduction and notes by John G. Hawthorne and Cyril Stanley Smith. Pp. xxxv+216+16 plates. (Chicago and London: The University of Chicago Press, 1963.) 63s.; 8.50 dollars.

THE treatise *De diversis artibus* ascribed to Theophilus is the most interesting of the small group of craft handbooks surviving from the European Middle Ages; as such, it has been often edited, several times rendered into English, and also translated into French, German, and Polish. The text was most recently edited (and translated) by C. R. Dodwell (1961); the present book, though begun earlier, was able to make some use of its immediate predecessor. Its particular advantage is the metallurgical and historical experience of Prof. Cyril Stanley Smith, whose previous work of the same kind is well known.

The present translators agree with Dodwell in identifying the pseudonymous author with a Benedictine monk and metal-worker, Roger of Helmarhausen, examples of whose skill are preserved at Nuremberg and Paderborn. *On Divers Arts*, accordingly, was written in the first half of the twelfth century, at a time when the first renaissance of learning was commencing. The author, however, was no literary technologist nor compiler of traditional recipes; rather "when first written down his *Treatise* had a comprehensiveness and originality, a down-to-earth quality that makes it far superior to any other technological manuscript for some centuries to come". Theophilus, avoiding idleness and frivolity as productive of nothing but "slander, idle curiosity, drunkenness, brawling, fighting, murder, riotous living, thieving, sacrilege, perjury and other things of this kind", sought to be "the humble quiet man working in silence in the name of the Lord and obedient to the precept of the blessed apostle Paul" enjoining worthy labour. His experience extended to three of the arts most closely associated with the Church: painting on walls, wood panels, and vellum; glass-making including vessels, windows and faience glazes; and fine metal-working. The craftsman, of course, began at the beginning; he prepared his own pigments from mineral or herbal sources; fused glass from sand and beech-ash; made his glues from fish-bones, cheese, leather and horn; formed the mould in which the lead came for his windows would be cast, built his own furnaces from clay and horse-dung, and so on. The art was in the preparing and the doing; there was no theory, no calculation, and very little design. No one need reasonably feel that there was some lost science behind medieval works of art, on either the small scale or the large.

The translation is agreeable to read, and is copiously supplied with the technical annotation without which the methods and processes described would be virtually unintelligible. Where necessary figures (derived largely from Theobald's German edition of 1933) have been added to improve intelligibility. A series of fine plates illustrates the works produced by Theophilus's techniques. There may be occasional slips (surely cinnabar was not "to Theophilus . . . artificial mercury sulphide"?), but these are few indeed in a volume which is—if a slight emphasis on the Gothic be accepted—splendidly produced.

A. R. HALL