books

The stuff the moon is made of

The Lunar Rocks

By B. Mason, W. G. Melson
177 pp. Interscience, New York, 1970. $8.95

Reviewed by Cornelis Klein, Jr

Approximately four years ago the National Aeronautics and Space Administration selected the groups of scientists who would work on the lunar material after its return to earth. About 300 principal investigators with their teams of co-investigators were chosen, involving between one and two thousand scientists in the western world. Upon completion of the highly successful Apollo 11 mission the lunar samples were distributed to the investigators, and after approximately five months of very intensive efforts the first scientific results were reported at the First Lunar Science Conference in Houston, Texas, 5–8 January 1970. Short articles on the findings at this conference were published in the 30 January 1970 issue of *Science.* Subsequently the complete proceedings of this conference were published in a supplement of *Geochimica et Cosmochimica Acta,* under the editorship of A. A. Levinson. These three volumes of proceedings total 2492 pages.

Neither the *Science* issue nor the *Geochimica et Cosmochimica* proceedings provide a general introduction to and overview of the results of the generally highly specialized studies of the lunar materials. *The Lunar Rocks* by Brian Mason and William G. Melson gives a clear and well written, objective account of many of the findings in mineralogy, petrology and geochemistry of the Apollo 11 and Apollo 12 rocks. The book is based heavily on the results published in *Science,* on the report by the Preliminary Examination Team on the Apollo 12 rocks in the 6 March 1970 issue of *Science* and on the authors' own continuing studies of lunar material, meteorites and terrestrial basalts. The authors' interest in mineralogy, petrology and geochemistry is clearly reflected in the treatment and balance of the material in *The Lunar Rocks.*

A very short introduction covers some of the aspects of the planning of the Apollo program, the selection of possible landing sites and the actual extravehicular activity of the astronauts during the Apollo 11 and 12 landings. Five chapters, totalling 120 pages, are devoted to the mineralogy, petrology and geochemistry of Apollo 11 material (rocks and fines, the latter being the loose aggregate on which the astronauts walked). Throughout, references are made to, and comparisons drawn with, the preliminary results for the Apollo 12 rocks, and studies of meteorites and terrestrial rocks that are relatively similar to those found on the moon. The last chapter very briefly deals with some aspects of lunar history in light of the recent scientific findings.

In the preface the authors state: "We have endeavored to write this book in such a way that it will appeal not only to the professional scientist but also to the interested student and layman. With this in mind we have avoided technical jargon as far as possible and have tried

Apollo 11 sample. Fine-grained lunar basalt with numerous glassy-lined spherical cavities. (From the book reviewed on this page.)

to provide adequate explanations of unfamiliar terms." Their efforts have been highly successful. On the one hand, the book is very informative for all scientists who are not directly involved in geology, and on the other hand, it provides enough detail and specific information to be of value to all geologists who have not themselves been active in the lunar-science program.

Many aspects of lunar science are in a state of rapid progress. Very preliminary results are now available on Apollo 14 materials and over the next two years three more manned missions will be completed to various parts of the moon. Undoubtedly some of the rock types will be different from those most common in Apollo 11 and 12 if geologically different areas are visited. This book, however, provides a broad background on several probably quite abundant lunar rock types and regolith ("fines") materials. The authors have provided a most timely and useful general account of a large aspect of the scientific effort on lunar materials and the interpretation of the results.

Brian Mason, who is chairman of the department of mineral sciences at the Smithsonian Institution, Washington, D. C., is author and co-author of several high quality texts on geochemistry, meteorites and mineralogy. These are *Principles of Geochemistry* and *Meteorites* and, with L. G. Berry, *Mineralogy* and *Elements of Mineralogy*. William G. Melson is curator and supervisor of the division of petrology and volcanology at the Smithsonian Institution, Washington, D. C. He served for NASA on the Preliminary Examination Team that studied the lunar samples from Apollo 14 upon their arrival at Houston. His research has dealt with the petrology and genesis of terrestrial and lunar basaltic rocks.

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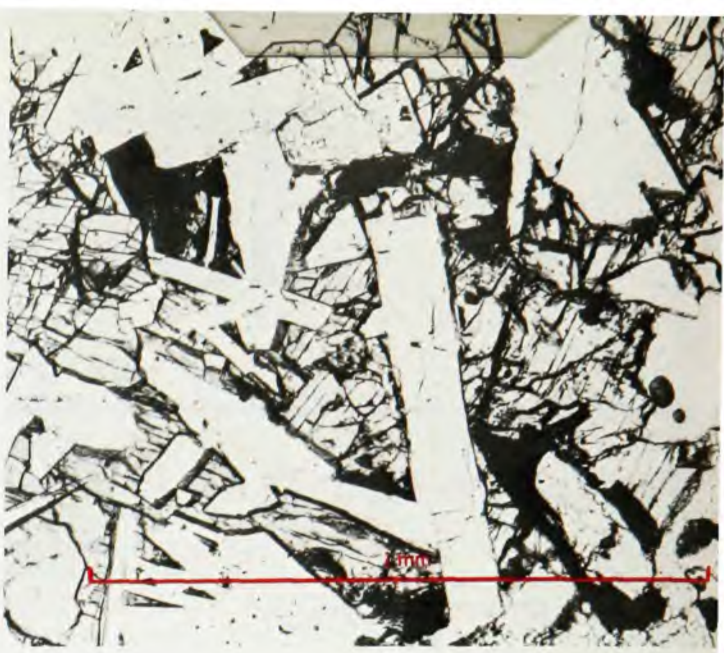

Micrograph of an Apollo 11 sample. This is a thin petrographic section of coarse-grained lunar basalt. (From the book reviewed on this page.)

Applications of Group Theory in Quantum Mechanics

By M. I. Petrashen and E. D. Trifonov
318 pp. MIT Press, Cambridge, Mass., 1969. $12.50

From the pioneering work of Eugene Wigner in applying group theory in the field of atomic spectra to the achievement of Murray Gell-Mann and Yuval Ne'eman in classifying elementary particles according to the representations of SU(3), group theory has been an amazingly successful tool in quantum mechanics. Its use has enabled physicists to exploit their knowledge of the symmetry of physical systems without a detailed understanding of the dynamics.

In recent years a large number of books have appeared that are devoted to various aspects and applications of group theory. The present book by the two Russian authors M. I. Petrashen and E. D. Trifonov is one of the better of these efforts. Writing for students who have a knowledge of quantum mechanics, including matrix mechanics, the authors prove a variety of the simpler and more useful theorems about abstract groups and their representations. They also give a wide selection of the more common applications.

The authors present simple applications of the point groups to molecular physics and of the space groups to crystal physics. A nice discussion of the permutation group, and its application to the physics of identical particles, puts its greatest emphasis on many-electron systems.

Of all the groups considered, the authors devote the most time to the three-dimensional rotation group, presenting the usual applications to atomic physics. Although this treatment is standard and has appeared in the literature many times, it is a classic application of group theory, and certainly belongs in texts such as this. Among the spherically symmetric potentials, the Coulomb and harmonic-oscillator potentials have special properties. The energy levels of a particle in either of these potentials have greater degeneracy than the degeneracy arising from rotational invariance alone. The authors show that the additional degeneracy arises from the presence of a larger symmetry, that of the four-dimensional rotation group in the case of the Coulomb potential and of the three-dimensional unitary group in the case of the harmonic oscillator.

Among the other topics discussed, the application of group theory in perturbation theory is especially worth mentioning. If the Hamiltonian describing a physical system can be divided into two parts, the larger of which has greater symmetry than the smaller, group theory can be used to describe how the degeneracy is partially or totally broken by the perturbation. Among the applications given are the well known examples of the splitting of energy levels in electric and magnetic fields.

Unfortunately, very few examples are from the field of elementary-particle physics. There is some discussion of reflection symmetry and a simple treatment of the Lorentz group, but little else. For example, there is no discussion of the symmetries connected with charge and baryon-number conservation or with approximate symmetry under rotations in isospin space and SU(3) space. Perhaps the reason for the omissions is that these are mysterious internal symmetries, apparently unrelated to symmetries under transformations in ordinary space and time. Yet, students must learn about what is not well understood in addition to what is already known if they are to make new breakthroughs in our knowledge of the physical world.

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Men of Physics: L. D. Landau, Vol. 2: Thermodynamics, Plasma Physics and Quantum Mechanics

By D. Ter Haar
198 pp. Pergamon, New York, 1969. Cloth $5.50; paper $3.25

That massive volume, *The Collected Papers of L. D. Landau*, stirs feelings not unlike those evoked by the complete plays of William Shakespear, or the Köchel catalogue of W. A. Mozart. The immensity of the total achievement of one man is almost beyond belief.

Unfortunately, so is the price of the volume. However the publisher, Pergamon Press, is now offering "the undergraduate" (and others too poor for the