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crophysical processes. For many complex reasons then, it appears most promising to attempt to modify the microphysical contents of clouds, thereby changing the character of the precipitation into a more desirable form, for example, changing damaging hail to rain or to smaller or softer hail. Seventh, all aspects of weather modification are in the research or research-operational stage in which we must incorporate physical understanding with statistical evaluation. And finally, the economist and social scientist perform a valuable service when they interact with the scientist to interpret his activities for the citizenry and when they evaluate the ultimate value to mankind of weather and climate modification possibilities.

Even though this book fills a need in allied scientific fields and for the educated layman, I feel that one or more of the present contributors to this book should be encouraged to provide a more comprehensive scientific text for the serious student of weather modification.

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Introduction to the Properties of Crystal Surfaces

J. M. Blakely

261 pp. Pergamon, New York,
1973. \$10.50

There has been a dramatic increase of interest in the physics and chemistry of surfaces in recent years due to the rapidly expanding importance of surfaces in modern technologies such as solid-state electronics and catalysis. This interest has undoubtedly been strengthened by the significant improvements in surface analytical equipment that have been made during the last decade. New experimental techniques and modern ultrahigh vacuum apparatus are allowing the experimental study of well-characterized surfaces for the first time. While a number of surface science texts have appeared recently, they have generally been limited to some specialized aspect of surface properties.

Introduction to the Properties of Crystal Surfaces, by J. M. Blakely, is intended to provide a much needed general introduction to the study of surface phenomena for the advanced undergraduate or beginning graduate student. The book begins with a discussion of the thermodynamics of surfaces, the foundations of which are found in the work of Willard Gibbs in the 1800's. In the first three chapters Blakely develops this material with a well-referenced survey of both theoretical and experi-

mental studies of the macroscopic thermodynamic properties of solid surfaces. He develops the concepts of surface tension and surface stress with clarity and illustrates them well with experimental results.

An introduction to the atomic structure of surfaces is provided in chapter 4, and a brief view of the consequences this holds for surface properties is given. The remainder of the text surveys both theoretical and experimental studies of the atomistic nature of crystal surfaces. A major defect is the lack of discussion of the electrical properties and electronic analytical techniques available. It seems unwise in an introductory text to omit completely such an important aspect of the properties of crystal surfaces. It would also be desirable to have a more extensive description of Auger electron spectroscopy, the most common surface elemental analysis technique, and the modern apparatus available for this spectroscopy.

The lack of depth throughout the book is inevitable given the broad range of surface properties covered. This necessary deficiency is, however, offset by the excellent bibliography of additional reading provided at the end of each chapter. Blakely has done a commendable job of listing in the bibliography other texts and articles that will be useful to a student beginning the study of surface properties.

This text will serve well as a general introduction to the field and it provides a brief survey of the current state of knowledge thereby fulfilling the need for a general introductory text on the properties of crystal surfaces.

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Cosmic Gas Dynamics

E. Schatzman, L. Biermann
291 pp. Wiley, New York.
1974. \$14.95

Cosmic gas dynamics is a fascinating but difficult field, which seeks to describe quantitatively a myriad of phenomena that occur in the rarefied medium between planets such as in our solar system, between stars and between galaxies. This medium is becoming increasingly accessible to observations made by sophisticated techniques using instruments that are ground based as well as on-board balloons, rockets and satellites. The medium is also known to be threaded by a large-scale magnetic field, be it in interplanetary or interstellar space. It contains simple, neutral atoms such as hydrogen as well as molecules of varying degrees of com-

plexity. Generally speaking, the medium can be thought to consist of two distinct regions, either where the matter exists largely in un-ionized form with atoms, molecules and solid grains or where the matter is largely ionized.

It should be remembered also that such a classification is only schematic. The medium can also be thought of as consisting of islands of cold, denser material embedded in a hot, rarefied gas, permeated by a magnetic field. Motions in such a medium are often turbulent, and ionized nuclear particles called cosmic rays with relativistic velocities stream through it. The "pressure" exerted by this relativistic component is significant, and therefore it plays an important role in the dynamics of the medium as a whole. Such is the case with the "magnetic pressure" also.

Young stars are born out of this medium, and to this medium the aging stars return stellar material that is enriched by elements heavier than hydrogen and helium, which are the predominant elements there. This return of material is either gentler, in the form of winds, or more dramatic, in the form of supernova explosions. Some of the most intricate molecules are known to exist in it, and the list of such discoveries is growing. In view of the rapid advances being made today, a comprehensive account of these phenomena and of the dynamics of the medium in which they take place is surely needed, not only to educate interested people but also to steer and stimulate further work along most useful lines.

The book under review contains material that was initially presented at a summer school in Colorado in 1968, by Evry Schatzman and Ludwig Biermann, two of the internationally regarded experts in the field, with wide experience of long standing. The first part, by Schatzman, a leader from the French school of astrophysics, includes discussions of stellar classification, structure and evolution. It goes into a description of the outer layers of stars as well as of solar and stellar activity, surface nuclear reactions, accelerating mechanisms and concludes with the very interesting subject of the role of electromagnetic activity in stellar evolution.

The second part, by Biermann, a leader of the German school of astrophysics, deals with the dynamics of the interplanetary medium. It starts with coronal physics and includes a discussion of the solar wind, the interaction of the interplanetary medium with the magnetic field convected outward by the solar wind and concludes with the very important question of how one should understand the termination of the solar wind at the boundary between interplanetary and interstellar regimes.

The undertaking of a survey of cosmical gas dynamics, to the extent cov-

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