Book Reviews

Supernova Remnants

Supernova Remnants and Their X-Ray Emission. JOHN DANZIGER and PAUL GORENSTEIN, Eds. Reidel, Boston, 1983 (distributor, Kluwer Boston, Hingham, Mass.). xviii, 614 pp., illus. $72; paper, $38. International Astronomical Union Symposium No. 101. From a symposium, Venice, Aug. 1982.

The Einstein x-ray satellite has made substantial contributions to virtually every branch of astronomy in a lifetime of only three years. Some of the most fruitful subjects for the satellite's manifold capabilities have been supernova remnants, dramatic in high-resolution images and after solar flares the best subjects for detailed spectral study. Most of us have seen highlights from the first flood of Einstein's results: the impressive maps of Cassiopeia A, spectacular x-ray spectra of Puppis A, the large catalogue of remnants in the Magellanic Clouds. As workers in the field settled down to digest these results, a timely International Astronomical Union symposium was held. The proceedings of this symposium contain a remarkably complete report on the effects of x-ray information on our ideas about supernova remnants. The meeting occurred early enough to be full of the excitement of new results and ideas, yet late enough that most of the Einstein data were in, so that knowledge of the subject as summarized in the proceedings is not likely to change much until the launching of a next-generation x-ray observatory such as AXAF.

The conference organizers wisely included reviews of radio, optical, and theoretical results, so that the x-ray results could be seen in context. However, the x-rays take center stage. We are presented with good high-resolution images (a few of them still not published elsewhere) of Tycho, Cassiopeia A, the Crab, the Cygnus Loop, IC443, and other, less well-known remnants. Spectra from the Solid State Spectrometer and Focal Plane Crystal Spectrometer appear for the Crab, Cassiopeia A, SN1006, Kepler, Tycho, Puppis A, and N132D. Many of these have appeared in the literature, but here the data analysis is refined, and it is useful to have the spectra all in one place.

The growing conviction that nonequilibrium ionization conditions hold in the 10^6 to 10^8K x-ray–emitting plasmas is documented in detail; several groups report theoretical work on modeling such spectra. The chemical abundances derived from x-ray spectra are sensitive to the presence or absence of ionization equilibrium. The important results are that, though early inferences of very high enhancements (relative to solar abundances) of calcium and sulfur in Tycho's remnant, for instance, are much tempered by including time-dependent ionization, abundance anomalies persist. There is still a great deal we do not understand about the x-ray spectra of young remnants.

Danziger, one of the editors of the proceedings, provides a good review of optical properties of remnants, listing in particular those with strong abundance anomalies such as the oxygen-rich knots of Cassiopeia A. A number of other papers present optical spectra of remnants, and several groups contribute theoretical models of optical emission in shocks. D'Odorico and Dopita review the use of optical observations of remnants in other galaxies as indicators of those galaxies' chemical abundances.

A few new radio images appear, notably the Cambridge 3″ resolution map of Tycho by Green and Gull. Dickel's review of radio observations suffers from a lack of illustrations that presumably accompanied the talk, but otherwise surveys the subject adequately. Strom gives a fine summary of proper-motion observations, in radio and optical, of young remnants. Weiler's excellent review of filled-center or Crablike remnants includes a detailed object-by-object discussion and radio maps of all objects and should remain an important starting point for studies of these odd objects for some time to come. Notable theoretical contributions include McKee's discussion of the effects of an inhomogeneous interstellar medium on the evolution of remnants, effects that may help explain anomalous observational results presented in papers by Long and others on statistical properties of remnants in the Large Magellanic Clouds. Cox ably summarizes the physics of heating of the interstellar medium by supernova remnants, and Chevalier discusses new results on the interaction of remnants with surrounding material having different density profiles, results confirmed by numerical hydrodynamic calculations presented in papers by several groups.

The volume contains transcriptions of some of the discussions that followed the papers. The transcripts are useful guides to the reception of the papers, and even occasionally contain quantitative information. Indexes of both subjects and objects have been attempted. The former is quite incomplete, but it is rare to find even an attempt in a conference proceedings. Both are useful additions, in any case.

To whom can this volume be recommended? Certainly to any workers in the field; the scope of the material is such that few researchers would command all of the information here. A graduate student with some basic knowledge of remnants and wishing to specialize will find the compilation quite valuable. I venture to predict that it will remain useful rather longer than the typical conference proceedings, even though it did not appear until over a year from the date of the symposium; the state of the field, and the quality and generality of many of the contributions, should ensure this.

STEPHEN P. REYNOLDS
National Radio Astronomy Observatory, Charlottesville, Virginia 22901

Hot Atoms

Fundamental Processes in Energetic Atomic Collisions. H. O. LUTZ, J. S. BRIGGS, and H. KLEINPOPPEN, Eds. Plenum, New York, 1983. xii, 675 pp., illus. $95. NATO Advanced Science Institutes Series B, vol. 103. From an institute, Maratea, Italy, Sept. 1982.

Atomic physics research is primarily concerned with the deeper understanding of nature in the atomic environment. Since the fundamental interactions are well known, the challenge to atomic physicists is to apply the basic tool of quantum mechanics to gain a knowledge of the structure of atoms and the underlying energy transfer pathways between the collisions of atoms with other atoms and with electrons, positrons, and photons.

In the past 25 years there have been significant advances in the understanding of atoms and atomic collisions as new experimental techniques (for example, accelerators and synchrotron radiations) have become available and as demand

for atomic collision data from other fields (such as plasma physics and astrophysics) has increased. In the subfield of energetic atomic collisions, positively charged ions from small as well as large accelerators with energies from KeV's to hundreds of MeV's are now used to explore the inner region of atoms. In such collisions, hot atoms with inner-shell vacancies are produced. The de-excitation of these hot atoms, with the emission of electrons and photons, is detected with increasingly high resolutions, from which the excited states of these atoms can be identified.

Compared to the impact by electrons, positrons, and photons, energetic ion-atom collisions can cause great distortion of the electronic charge clouds, which not only can change size but can also change shape and rotate. Measurements of excitation, ionization, and charge transfer cross sections, which are illustrated in this book, provide information about the response of the electronic clouds to the changing Coulomb fields of the collision system. When the incident particles are light projectiles, the distortion of the charge cloud is small and the standard perturbation theory (first Born approximation and its variants) has been proved to be able to predict excitation and ionization processes quite well. The situation for charge transfer is different. Identification of charge transfer mechanisms at high energies has shown that the first Born approximation is completely inadequate and that a correct description requires at least a second Born approximation (and its variants). Simple perturbation theory is no longer applicable for collisions with heavier projectiles. In the special case of lower collision velocities, the time evolution of the charge cloud can be approximated as following the molecular orbitals of the collision system. This general model, which was first proposed in the 1930's, has now been used to interpret many experimental data. Recent progress lies in our ability to isolate a few important molecular orbitals for specific collisions and for quantitative predictions.

Although quantum mechanical scattering theory is in principle a well-documented subject, extensive theoretical development is still needed for implementation of the various working models associated with the various collisional mechanisms. This proceedings volume starts with a brief and excellent review of the formal scattering theory by Massey. The chapters that follow survey a coherent selection of interesting topics in energetic ion-atom collisions. Most of these overview chapters are thoughtful and stimulating, and the experimental and theoretical papers complement each other.

The last third of the book contains papers on coherence and correlation in atomic collisions and on new aspects in the study of atomic collisions. The papers on coherence and correlation report progress toward "complete" (in the quantum mechanical sense) experiments where scattering amplitudes and phases are determined in coincidence experiments. The papers on new aspects cover the use of polarized particles in atomic experiments. This third of the book is concerned with highly sophisticated techniques that are expected to be the driving forces in providing detailed information about atomic collisions in the future.

All in all, the book provides a lucid, enjoyable overview of energetic ion-atom collisions. It will be valuable to anyone who is seriously interested in doing research in accelerator-based atomic physics and to researchers in other fields who want to get an overview of the considerable progress that has been made in this field. The book provides less insight into the collisions of atoms with electrons, positrons, and photons because of the limited space allocated to these subjects, and those who would consider them are advised to look elsewhere.

CHII-DONG LIN
Department of Physics,
Kansas State University,
Manhattan 66506

Sedimentary Particles

Coated Grains. TADEUSZ M. PERYT, Ed. Springer-Verlag, New York, 1983. xiv, 655 pp., illus. $58.

Coated grains are sedimentary particles with concentric (usually) layers. Some are less than 0.5 millimeter in diameter, and others are many centimeters in diameter. Most consist of calcium carbonate, but iron-rich or even volcanic-ash coated grains also occur. Some coated grains form chemically in shallow water, others precipitate in vadose zones, and still others are formed by a variety of living organisms.

The laminated nature of most coated grains implies episodic deposition and precipitation, but the diversity of structure and composition of the grains has led to confusing terminology and classifications that ultimately have hindered conclusions concerning their origin. One person's ooid is another's oolith or oolite or pisolith. More seriously, rhodoliths (calcified by red algae) on occasion have been termed oncolites (generally formed by blue-green algae). Travertine coated grains at various times have been considered freshwater ooids, vadose precipitates, or biochemically formed grains, and in fact any of these explanations could apply in the proper circumstances.

In an attempt to bring order to this chaos, Peryt has edited a multiauthored discussion of the types, occurrences, and origins of coated grains. The book is divided into six sections containing a total of 52 chapters. There are more than 60 authors, the majority from Europe, but also from North America, Australia, China, South Africa, Sri Lanka, and Israel. The first section deals with general aspects of coated grains. The next four sections discuss ooids (chemically or biochemically precipitated in the phreatic zone), rhodoids (precipitated by red algae), oncoids (formed by green algae or cyanophytes), and vadoids (chemically precipitated in the vadose zone). The final section deals with occurrences of multiple types of coated grains. Each section begins with one or more unifying reviews discussing general characteristics, classification, ecology, and formation of the type of coated grain under consideration. The rest of the papers in each section deal with specific occurrences in both modern and ancient environments. Most examples come from Europe and North America, but examples from Africa, South America, Australia, and Asia are also discussed.

Despite Peryt's attempt to unify the description and classification of these diverse grains, the book contains a number of problems. One concerns terminology: under the classification proposed by Peryt, where does one place a bryozoa- or foraminifera-coated grain, for example, and why should the term "rhodoid" necessarily replace the commonly used "rhodolith"? In a more constructional sense, many papers read as descriptions and lack adequate conclusions; other papers resemble extended abstracts. The inclusion of such papers detracts from the book, which is unfortunate, for it also contains a number of excellent summary papers, many of which should be used for years as standard references.

One can question the premise that coated grains need a unifying discussion. Because differences in morphology, structure, and origin often outweigh the similarities of these layered grains, many readers probably will only read parts of the book. Readers concerned with rhodoids, or rhodoliths, for example, may