Grassmann, Kotelnikov, and Ball. (He does not, however, incorporate the similar and often-cited works of Study [1903] and Von Mises [1924].)

All in all, volume 2 complements volume 1 nicely but does not at all "close the book" on the subject of screw theory. The work is written in a way that leaves readers with research areas to investigate, questions to ponder, and issues to resolve for themselves. (In fact, in some passages, such as 11.50 and 12.70, Phillips acknowledges some vagueness in his accounts of the subject matter.) These volumes present themselves as powerful learning tools that should bring the novice mechanism student to the forefront or send the experienced researcher back to assess his or her own foundation.

We would like to suggest that the cylindric joint noted to exist at A in figure 13.07 be done away with. This joint is not necessary because it is colinear with the revolute existing at B, and, furthermore, the two joints acting together confuse the explanation given in the figure caption. This is because the reader may be led to believe erroneously that the force acting on the line AP is the force acting in the cylindric joint. But this is a minor criticism of what is otherwise an excellent treatise.

Unfortunately, the vast majority of researchers today studying the kinematics and statics of mechanisms and robot manipulators have failed completely to recognize the power of the tools afforded to them with screw theory. The study of kinematics and statics without screw theory is analogous to the study of heat engines without the laws of thermodynamics or of electricity without Kirchoff's laws.

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The Universe Updated

The Astronomer's Universe. Stars, Galaxies, and Cosmos. HERBERT FRIEDMAN. Norton, New York, 1990. xxii, 359 pp., illus. $24.95. Commonwealth Fund Book Program.

In 1975 Herbert Friedman published a book for the National Geographic Society entitled *The Amazing Universe,* in which he described for a lay audience the wonders revealed by modern astronomy and astrophysics. His latest book, *The Astronomer's Universe: Stars, Galaxies and Cosmos,* seems in part to be another look, 15 years later. Indeed, the six chapters that make up the last two-thirds of the volume deal with the same topics as the six chapters of the 1975 book: the sun, stars, neutron stars and black holes, galaxies, cosmology, and life in the universe. But they reflect the remarkable changes that have occurred in our understanding. Friedman describes Supernova 1987A and the detection of its neutrinos; exotic close binary pairs of stars including SS433; gravitational lenses; the problem of dark matter in the universe; and inflationary universes and GUTs. For all these he points out their significance for the frontiers of our knowledge of the universe.

Friedman precedes these chapters with a section on The Tools of Astronomy, introducing devices ranging from radio telescopes and new-technology optical ones to x-ray and gamma-ray detectors and the Hubble Space Telescope. (In his section on the HST, written before its launch, he describes in considerable detail the care with which the mirror was figured and mounted; this now has an ironic ring.) This part of the book is a useful account of the many recent technological advances that have had major effects on the way astronomical research is conducted these days.

The intended audience for this book is not clear to me. Lewis Thomas's foreword, for the Commonwealth Fund, which sponsored it, indicates that the goal is to broaden public understanding of astronomy by presenting the subject in an accessible way. Part of the time Friedman does this well, using basic vocabulary, analogies, and visualization. But he is not consistent; often he uses technical terms with no definition or explanation—as in the case of a reference to piezoelectric transducers or a description of photinos as "the supersymmetric partners of photons of light." There is a glossary, but it does not help here either, since neither "transducer" nor "photino" is to be found in it. Some of these topics are discussed later on; but this gives the book a rather disorganized feel. If a lay audience is intended, I think Friedman has been less successful here than in his 1975 book; if he is writing for readers who are scientifically more sophisticated, he should say so.

Friedman is at his best describing the rocket and x-ray work with which he has himself been associated, as in his discussions of the Sun and the Crab Nebula. In other areas he is sometimes careless or misleading with his facts, as when he says that most stars evolve "along" the main sequence (they don't) or when he refers to the Sun "reaching its supergiant stage" (it will only become a red giant). His historical material is not always correct or consistent either; in some cases he states one thing in his introductory chapter and makes a contradictory statement in a later chapter, as in describing Bessel's measurements of stellar parallax. Historical dates are in error on several occasions.

Despite these shortcomings and some careless proofreading, there is a lot of fascinating material here, and the book is fairly easy to read if one has some prior acquaintance with the vocabulary of astronomy and modern physics. Readers of this journal should find it of interest; but it is not a book for the scientifically naive general reader.

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Earthquakes

The Mechanics of Earthquakes and Faulting. CHRISTOPHER H. SCHOLZ. Cambridge University Press, New York, 1990. xii, 439 pp., illus., $79.50.

Earthquakes are fascinating—clues to inner workings of the earth, sources of primordial fear, and the root of complex engineering, social, and political problems for rapidly growing societies. Research into the mechanics of faulting and earthquake generation is splintered among a number of earth science disciplines—seismology, geodesy, structural and surficial geology, geomorphology, rock mechanics, and geochemistry. Christopher Scholz's goal in *The Mechanics of Earthquakes and Faulting* is to review our present understanding of earthquake and faulting processes based on work contributed by specialists from all of these disciplines. In so doing he hopes to partly remove communication barriers between the various groups of scientists. He does an admirable job on both counts.

The text proceeds in a logical fashion, from the basic physics of rock friction and crack propagation, through the nature of the fault zone, the mechanics of earthquakes, seismotectonics, and finally earthquake hazards and prediction. Scholz has done research not only in his primary field of rock mechanics but also in seismology, and he has some experience in geodesy and structural geology. This breadth is evident in his writing. The physical basis for understanding earthquakes is developed from the perspective of rock mechanics, with focus on the physics of friction and experimental results. A preferred mechanical model of faulting is proposed in which earthquake generation is confined between the upper and lower stability transition between stick-slip and stable sliding. The model is rooted in velocity-dependent friction laws, which are consistent with many experimental and earthquake phenomena. This fault model forms the