Book Reviews

Progress in the Infrared

Infrared Astronomy with ISO. TH. ENCRENAZ and M. F. KESSLER, Eds. Nova, Commack, NY, 1992. xxviii, 547 pp., illus. $132. Les Houches Series. From a workshop, Les Houches, France, June 1991.

Ten years ago the Infrared Astronomical Satellite (IRAS), a joint project of the United States, the United Kingdom, and the Netherlands, opened our eyes to the infrared sky for the first time by making an all-sky survey at four wavelengths between 12 and 100 micrometers. The helium-cooled 60-centimeter telescope, operating in the cold, black night of space, was able to make observations with a thousand times more sensitivity than ground-based or airborne telescopes. IRAS revealed a great variety of new phenomena that continue to make news today—from protostars and protoplanets to protogalaxies, from the large-scale structure of the solar system and the Milky Way to the large-scale structure of the universe.

The exciting prospects of following up these discoveries with another sensitive space telescope, the European Space Agency's Infrared Space Observatory (ISO), are ably described in this volume of proceedings. The ISO satellite will be launched in 1995 and will operate for 18 months as a general-purpose observatory enabling astronomers from around the world to obtain images and spectra of thousands of individual sources.

The present proceedings will be of interest to specialists in infrared instrumentation, who will find papers on each of the four ISO instruments, and to anyone interested in a snapshot of infrared astronomy on what the editors thought would be the eve of ISO's launch. (The launch, originally scheduled for late 1993, has been delayed until 1995 owing to technical problems.) The first part of the book, describing the ISO mission, the observing procedures, and the instruments, is essential reading for any astronomer interested in submitting a proposal for use of some of the more than 60 percent of the time that will be open to guest observers.

This volume contains useful reviews of some of the many scientific disciplines that ISO will impact. In one of these Crovisier describes what infrared spectroscopy can reveal about the chemical composition of comets and how this primitive material might relate to the interstellar matter out of which our solar system formed. In others, van Dishoeck, Falgarone, and Puget discuss the chemistry, energy balance, and structure of the interstellar medium in considerable physical detail. ISO spectroscopy of molecular hydrogen (17 and 28 micrometers) and ionized carbon (158 micrometers) will be particularly important in advancing our understanding of the thermal balance of the interstellar gas.

Léger and his collaborators describe the remarkable angstrom-sized planar molecules called polycyclic aromatic hydrocarbons (PAHs) that IRAS revealed to be responsible for 10 to 30 percent of the entire infrared emission of our own and other galaxies. PAHs, containing only 50 to 100 atoms, can be heated by the absorption of single ultraviolet photons to radiate short-wavelength (1- to 30-micrometer) radiation far in excess of that expected from their equilibrium temperature of 20 to 30 K. Infrared spectroscopy by ISO will help define the molecular constituents of PAHs, including species such as coronene and ovalene, and determine the physical conditions responsible for their creation and destruction.

Moorwood and Lequeux summarize our present understanding of infrared emission from normal and active galaxies. ISO observations will be of particular importance in understanding whether ultra-luminous infrared galaxies are the precursors of quasars and whether objects like the IRAS source F10214+4724 really are galaxies in formation.

Harwit gives an informative discussion of the evolution of the early universe and the question of galaxy formation. Whether ISO results will bear on these problems remains to be seen, but Harwit and other ISO scientists are planning very deep surveys with ISO cameras to search for the most distant, youngest objects in the universe.

Under the terms of collaborations currently being negotiated with the European Space Agency, the United States and Japan will play minor roles in the ISO project in return for a small amount of guaranteed observing time; U.S. astronomers will also compete for guest-observer time. But what U.S. astronomy really needs in order to advance into this last unexplored spectral region is approval by NASA and Congress of the Space Infrared Telescope Facility (SIRTF). As SIRTF project scientist Michael Werner recounts in these proceedings, SIRTF will combine the twin revolutions of a cryogenic telescope and large arrays of infrared detectors to make an observatory thousands of times more powerful than ISO or any ground-based facility. SIRTF, the highest-priority recommendation of the National Research Council's Decennial Survey ("The Bahcall Report"), will follow up on numerous ISO discoveries and break new ground with its own deep surveys of the infrared sky. This volume describes an important component in the continuing progress of infrared astronomy where each step is thousands of times more capable than its predecessor: IRAS in the 1980s, ISO for the 1990s, and, ultimately, SIRTF in the first years of the next century.

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Future-Oriented Physics

Dynamics of the Standard Model. JOHN F. DONOGHUE, EUGENE GOLOWICH, and BARRY R. HOLSTEIN. Cambridge University Press, New York, 1992. xviii, 540 pp., illus. $100. Cambridge Monographs on Particle Physics, Nuclear Physics and Cosmology, 2.

There has been a revolution in particle physics in the last 20 years, and the rallying cry of the revolution has been the standard model. Created in 1964 principally by Glashow, Weinberg, and Salam and building on contributions from many others, the standard model is an elegant theory that has demonstrated great power in predicting experimental results in high-energy physics. A major part of most high-energy physics experiments now and for the past 15 years has been dedicated to verifying the model, measuring its parameters, or trying, unsuccessfully, to find a chink in its armor.

The standard model provides a simple and coherent framework within which most current experimental results in high-energy physics can be understood. All matter is composed of six quarks and six leptons (plus antiparticles). The weak, electromagnetic, and strong interactions between these fundamental constituents are described by the exchange of gauge bosons: the photon that mediates the electromagnetic interaction, the heavy $W^{\pm}$ and Z^0 that mediate the