BOOK REVIEWS

The Jovian Spectacle

Impact Jupiter. The Crash of Comet Shoemaker-Levy 9. DAVID H. LEVY. Plenum, New York, 1995. xiv, 290 pp., illus., + plates. $25.95.

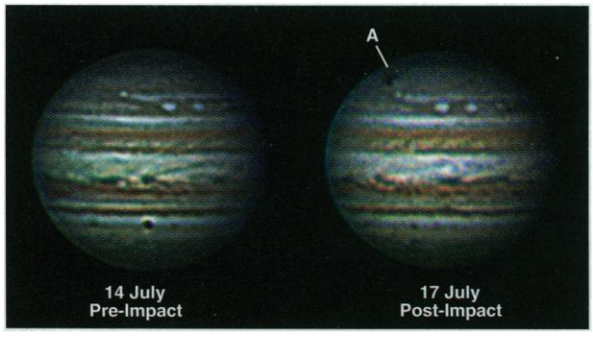
The Great Comet Crash. The Impact of Comet Shoemaker-Levy 9 on Jupiter. JOHN R. SPENCER and JACQUELINE MITTON, Eds. Cambridge University Press, New York, 1995. x, 118 pp., illus. $24.95 or £16.95.

Few celestial events have captured the public imagination as did the impacts of the fragments of Comet Shoemaker-Levy 9 on Jupiter in the summer of 1994. For five days the world watched in awe as 21 cometary fragments bombarded the solar system's largest planet, 478 million miles away. The results, huge dark clouds of cometary debris often larger than the Earth, were easily visible in even backyard telescopes.

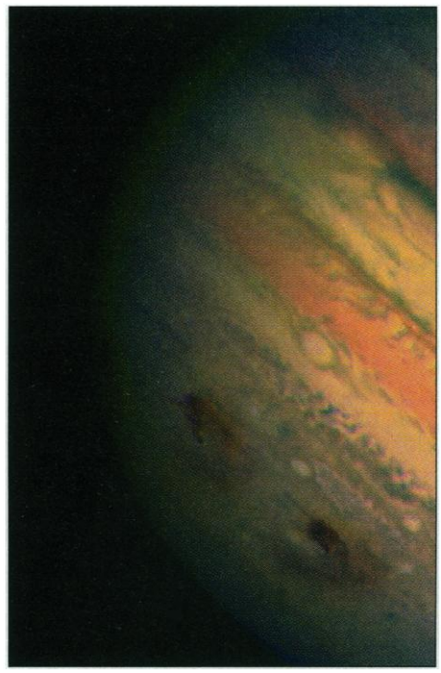
A fortuitous set of circumstances combined to create this global excitement. First of all was the rarity of the event itself, estimated to occur only once every 1000 years. Second was the lead time, 16 months, between the comet's discovery and the impacts, allowing astronomers to apply for observing time on all the major telescopes around the world. Third was the repaired Hubble Space Telescope, which gave by far the sharpest view of much of the impact phenomena. Fourth was the position of the long-delayed Galileo spacecraft, en route to an orbital mission around Jupiter and able to view the impact sites directly (the impacts were all on the night side of Jupiter, away from the Earth-facing hemisphere). Fifth was the recent availability of the World Wide Web for instantaneous dissemination of images and data. And so on.

The tale of Shoemaker-Levy 9 is a remarkable story of scientific organization and cooperation, as observers and theorists shared their results in near real time. An e-mail exploder set up at the University of Maryland kept observers informed of events as they happened, as did a similar exploder for amateur astronomers at the University of Arizona. Images flew around the world on Web sites created for both scientific and public access; the site at NASA's Jet Propulsion Laboratory was deluged with 1.1 million log-ons during the impact week (the current count is 5.4 million).

The cooperation also extended to the analyses of the impacts. No single observer had sufficient data to understand the complex series of events seen in each impact. For most terrestrial observers, the major event was a huge infrared flash, brighter than the entire planet in some cases, which lasted typically 20 minutes. But this was only the fallback of cometary and Jovian debris onto the planet after the initial impact and explosion. The Galileo spacecraft with its direct view provided exciting images of the entry of several of the comet fragments and critical infrared measurements of the evolution of the resulting fireballs, initially 10 kilometers in diameter with a temperature of 7500 degrees Kelvin (hotter than the surface of the sun) for the larger impacts. The Hubble Space Telescope (HST) obtained remarkable time sequences of the hot fireballs rising above the limb of Jupiter, carrying huge debris plumes up into the sunlight. HST also provided detailed images of the immense debris clouds and of waves emanating from the impact sites. From this combined data set a unique understanding of the impacts has emerged.



"Some of the first reported observations of the impact sites at visible wavelengths were made by amateur astronomers in Florida. Don Parker was setting up his 40-cm (16-inch) telescope in the afternoon of 16 July when he got an excited phone call from Jeff Beish, who lived nearby. Broad daylight notwithstanding, Jeff had just seen a black spot on Jupiter at the A impact site. They reported this observation to Brian Marsden at the Central Bureau for Astronomical Telegrams and, just as the Sun was setting, Don Parker was able to obtain the CCD image on the right at 00:11 UT on 17 July. The image on the left shows the planet on 14 July, minus the impact scar. South is at the top in these images, following the convention used by amateur astronomers." [From J. R. Spencer's contribution to *The Great Comet Crash*; Don Parker]



"By the time of the Q impact the black clouds at the nearby G site (left) and the L site (right) were beginning to show their age as the jovian stratospheric winds started to pull them apart. In this [Hubble Space Telescope] view, taken between 20:53 and 20:59 UT on 20 July, the core of the 2.5-day-old G site is breaking into many dark spots and its northern edge has been stretched out by east-blowing winds, and the halo is also becoming distorted. Similar processes are starting to act on the 0.9-day-old site. The halo of fresh Q1 impact site is beginning to rotate into view on the terminator, and a tiny dot between it and the G site marks the Q2 impact." [From J. R. Spencer's contribution to *The Great Comet Crash*; courtesy H. Hammel and HST Comet Team/Nasa]

Two books have now appeared to describe all this to the general public as well as the non-astronomer scientist. David Levy, one of the comet's codiscoverers, paints a wonderfully enjoyable picture of the events surrounding Shoemaker-Levy 9. The book is reminiscent of Watson's *Double Helix*, the tale of a young scientist caught up in the whirlwind of a major discovery. Levy is an amateur astronomer (though his amateur status is seriously in doubt), and he approaches the subject with an almost childlike fascination. He opens his box of toys and shows them to us, sometimes in an almost stream-of-consciousness manner. Throughout, his enjoyment of the wonders of astronomy shines through, and the poetry of his descriptions adds color and depth to the scientific tale.

John Spencer and Jacqueline Mitton have produced a very different but very complementary book composed of chapters by knowledgeable astronomers on each aspect of Shoemaker-Levy 9. Although the book is not a personal narrative in the manner of Levy's book, each scientist recounts his or her participation in the different phases of the story, along with explanations of the key findings. Where the book really shines, though, is in its illustrations, providing a photo album of the newly discovered comet, its evolution as it headed for its catastrophic end, the Galileo and HST impact observations, and the wealth of ground-based infrared and visual imagery. Also included are snapshots of the observers at work, including the University of Chicago team at the South Pole, who braved temperatures of −75 degrees Fahrenheit and blowing snow to view every one of the impacts through the polar night.

The final scientific text on Shoemaker-Levy 9 has yet to be written. The ongoing analysis and synthesis of the data will likely take years. In the meantime, these two books have begun to record both the scientific and the human story. Both books are highly recommended.

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Running Waters

Stream Ecology. Structure and Function of Running Waters. J. DAVID ALLAN. Chapman and Hall, New York, 1995. xii, 388 pp., illus. Paper, $44.95.

For pure love of the environment in which they're working, stream ecologists are an enviable bunch. This should not be surprising—what youngster has not been enthralled by the mysteries of the brook, the lure of the river? Streams and rivers have an organic connection to all that is upstream and hidden from view and to the future, embodied in the sea. Rivers are the bloodstream of the land—a sign of its vitality, too often a reflection of its maladies. These grand integrators transport, harbor, nourish, deposit and erode, connect and disconnect, produce, consume, transform, and assemble all that is organic about the environment. At the same time they host an array of aquatic denizens found nowhere else.

There is a science here too, and J. David Allan's *Stream Ecology* is its new handbook. H. B. Noel Hynes (*The Ecology of Running Waters*, University of Toronto Press, 1970) produced the only indisputable classic in the history of the science some 25 years ago. That book, now out of print, has guided the development of the field for a quarter century. Allan's volume, which should be the second classic, shows us how far we've come.

Eighty-five percent of the material reviewed by Allan has been published since Hynes's effort. Indeed, Allan's book reflects a revolution in stream ecology—a substantial increase in experimental technique, an increasingly holistic perspective, an appreciation for the geographic diversity of streams and rivers worldwide, and a new dedication to redressing the environmental insults hurled in the name of water resource development.

The strength of this book is the even-handed way in which Allan reviews a voluminous literature in search of generality. Allan takes us inside original research papers and builds his book on the evidence provided rather than the claims of the authors. Reading this book is not a travelogue, but a pleasant journey. The route is braided, there are multiple channels downstream, and Allan has left many hints for rewarding thesis projects for the graduate student who is willing to explore a bit.

Streams interdigitate with the land, but stream ecology has not interdigitated well with the larger field of ecology. Few devotees of streams venture beyond their boundaries, and almost no ecologists trained in other areas venture in. Streams have been a research arena fostering detailed, elegant studies of predator-prey dynamics, competition, control of community structure, and a host of conservation issues. Seldom is this work cited in the general textbooks of ecology or used to bolster development of ideas generated in more cumbersome systems such as tropical forests or grasslands. Allan's book provides the generalist with easy access to this wealth of information by casting his chapters on biotic interactions and community structure in the broad framework of theoretical ecology.

Ecosystem-level topics, such as productivity, nutrient cycling, and ecosystem energetics do not fare as well. These topics are treated largely as stream phenomena and remain mired in an isolated disciplinary pool. But it is too much to expect Allan to anneal everything—workers in thus subarea need to work harder to facilitate such a synthesis.

There is no question that David Allan has provided an unusually lucid and judicious reassessment of the state of stream ecology. There is also no question that there is an energetic, creative mass of stream ecologists who will gladly receive and build on this message. There is a question, however, whether a habitat-based approach to ecology is appropriate at this stage of the science. Just as streams ramify with the larger landscape and thereby blur boundaries, so might disciplines aspire to erase the effects of spatial peculiarity and seek a stronger conceptual integration. If this second classic in the history of stream ecology is successful, we may not need a third.

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Books Received

Affine Analysis of Image Sequences. Larry S. Shapiro. Cambridge University Press, New York, 1995. xiv, 210 pp., illus. $49.95. Distinguished Dissertations in Computer Science.

Air Pollution and Community Health. A Critical Review and Data Sourcebook. Frederick W. Lipfert. Van Nostrand Reinhold, New York, 1994. xiv, 556 pp., illus. $74.95.

Biotechnology of Ectomycorrhizae. Molecular Approaches. Vilberto Stocchi, Paola Bonfante, and Marco Nuti, Eds. Plenum, New York, 1995. viii, 251 pp., illus. $85. From a symposium, Urbino, Italy, Nov. 1994.

Biothols, Part B: Glutathione and Thioredoxin. Thiols in Signal Transduction and Gene Regulation. Lester Packer, Ed. Academic Press, San Diego, 1995. xxx, 382 pp., illus. $80. Methods in Enzymology, vol. 252.

Cardiac Growth and Regeneration. William C. Claycomb and Paolo Di Nardo, Eds. New York Academy of Sciences, New York, 1995. xiv, 525 pp., illus. $135. Annals of the New York Academy of Sciences, vol. 752. From a workshop, Viterbo, Italy, June 1994.

Combined Vaccines and Simultaneous Administration. Current Issues and Perspectives. Jim C. Williams *et al.*, Eds. New York Academy of Sciences, New York, 1995. xvi, 404 pp., illus. $140. Annals of the New York Academy of Sciences, vol. 754. From a conference, Bethesda, MD, July 1993.

Disease in Evolution. Global Changes and Emergence of Infectious Diseases. Mary E. Wilson, Richard Levins, and Andrew Spielman, Eds. New York Academy of Sciences, New York, 1994. xx, 503 pp., illus. $145. Annals of the New York Academy of Sciences, vol. 740. From a conference, Woods Hole, MA, Nov. 1993.

Diversity of Interacting Receptors. Leo G. Abood and Abel Lajtha, Eds. New York Academy of Sciences, New York, 1995. x, 534 pp., illus. $145. Annals of the New York Academy of Sciences, vol. 757. From a conference, Washington, DC, May 1994.

Elementary Linear Programming with Applications. Bernard Kolman and Robert E. Beck. 2nd ed. Academic Press, San Diego, 1995. xxii, 449 pp., illus. $59.95. Computer Science and Scientific Computing.

Enzyme Engineering XII. Marie-Dominique Legoy and Daniel Thomas, Eds. New York Academy of Sciences, New York, 1995. xiv, 506 pp., illus. $140. Annals of the New York Academy of Sciences, vol. 750. From a conference, Deauville, France, Sept. 1993.

Fraud and Fallible Judgement. Varieties of Deception in the Social and Behavioral Sciences. Nathaniel J. Pallone and James J. Hennessy, Eds. Transaction, New Brunswick, NJ, 1995. x, 190 pp. Paper, $19.95. Reprinted largely from *Society*, vol. 31, no. 3 (1994).

Fundamental Problems in Quantum Theory. A Conference Held in Honor of Professor John A. Wheeler. Daniel M. Greenberger and Anton Zeilinger, Eds. New York Academy of Sciences, New York, 1995. xiv, 908 pp., illus. $190. Annals of the New York Academy of Sciences, vol. 755. From a conference, Baltimore, June 1994.

A Guide to Wildflowers in Winter. Herbaceous Plants of Northeastern North America. Carol Levine. Yale