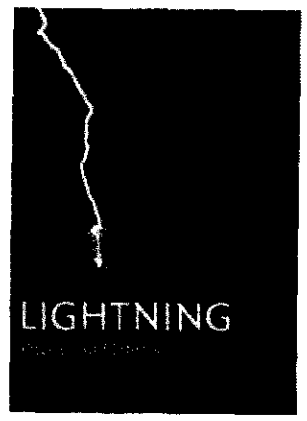
Lightning: Physics and Effects

Vladimir A. Rakov and
Martin A. Uman
Cambridge U. Press, New York, 2003. $200.00 (687 pp.).
ISBN 0-521-58327-6



Lightning is a gigantic spark discharge—an impressive natural phenomenon that is an object of aesthetic delight and scientific curiosity. But lightning also causes a lot of problems. It kills hundreds of people worldwide each year, with more than 100 deaths annually in the US, and it causes—fortunately only rarely—terrible airplane accidents with dozens of fatalities. Lightning strikes result in forest fires, ignite explosives, lead to transmission line and power system failures, and disturb the operations of electronic devices that control important systems. The annual cost in the US of the power failures alone is more than $1 billion. Clearly, humankind's interest in lightning and its effects will never disappear. So the publication of a new book with a great deal of information on lightning and lightning protection is an event. *Lightning: Physics and Effects*, by Vladimir A. Rakov and Martin A. Uman, is such a book.

The modern scientific study of lightning and its effects began about 100 years ago, and the field has developed exponentially since. Scientists now have available an immense quantity of facts that need to be collected, systematized, generalized, and presented in a convenient package. Probably the first steps in this direction were taken by Uman in his book *Lightning* (McGraw-Hill, 1969). Uman's *The Lightning Discharge* (Academic Press, 1987) updated his earlier work. The new book by Rakov and Uman, who have both made numerous contributions to the field, represents the current state of the art. It has much greater topic coverage and much more information than other books on lightning, including Uman's previous two efforts. In view of the rapid pace of progress in the field, even the two-volume collection *Lightning* edited by Rudolf H. Golde (Academic Press, 1977)—a standout among serious books treating the topic—can't compete with Rakov and Uman's offering. The more than 6000 references indicate the scope and completeness of the new book. All of those references have article titles, which significantly increases the value of the reference lists.

A short review cannot possibly address every topic that is discussed in the book. Among other things, the authors cover thundercloud formation and discuss hypotheses on lightning inception inside a cloud. They also consider upward-directed lightning emitted from high grounded structures, such as towers, skyscrapers, and so forth, that lie under thunderclouds. Rakov and Uman present numerous streak photographs of lightning leaders, the faint discharges that, after they touch Earth, are followed by the main stage of a lightning discharge—the so-called return stroke. The authors offer experimental data on electric fields generated by thunderclouds and leaders as well as data on return-stroke currents. Those currents, which grow at a rate of about 10^{11} A/s and can reach an impressive 100 kA, are responsible for lightning's damages and disturbances.

The book includes a chapter devoted to triggered lightning. Such lightning is excited by a small rocket that, while flying under a thundercloud, pulls a thin grounded wire. Lightning initiates when the rocket reaches an altitude of 200–300 m. Such experiments give especially valuable information because one can prepare them with an exact knowledge of where and when the lightning will strike. That kind of foreknowledge is impossible in natural conditions.

Lightning: Physics and Effects considers the influence of lightning on electromagnetic wave propagation and on broadcasting, the hazards lightning poses to people and animals, and the generation of nitrogen oxide during thunderstorms. The book also discusses some topics, not mentioned in other books, that have recently attracted attention. Those include lightning in the middle and upper atmosphere and on other planets. Aviation specialists will find much of value on interactions of lightning with aircraft and spacecraft, and engineers will find a great amount of data on the protection of terrestrial objects.

As extensive as its coverage is, the book does leave out some things I would like to have seen. It includes very little data concerning corona ion clouds above tall structures or corona ion layers above Earth's surface: Both coronas are excited by a thundercloud's electric field. Coronas can influence whether upward-directed lightning is initiated and can effect the location of downward-directed flashes.

Lightning: Physics and Effects tells the reader what was done and by whom rather than focusing on physical phenomena. Another relatively recent book, *Lightning Physics and Lightning Protection*, by E. M. Bazelyan and me (IOP, 2000), concentrates on physical mechanisms. Rakov and Uman's encyclopedic work will be extremely useful for specialists as a rich source of factual and bibliographic information, but it won't serve as a textbook. Students and others looking for a guide to help them become acquainted with the subject should look for a book that emphasizes the physics and clearly distinguishes what we understand from what we don't.

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