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# Light and color in the open air—introduction by the feature editors

James A. Lock and Craig F. Bohren

The natural environment is still rich in new observable phenomena despite centuries of scientific observation. Reflecting this fact, the papers in this feature issue of *Applied Optics* report the observation and analysis of both new and well-known naked-eye optical phenomena.

There once was a time when people who were curious about nature, who carefully observed it, and who attempted to understand it were not called scientists. They were called natural philosophers. In our fast-paced modern society and with the reliance on technology in almost every aspect of our daily lives, we easily equate science with the study and the manipulation of the artificial environment that we have created. We easily lose sight of our interaction with the natural environment, leaving the discussion of this interaction to poets and artists, instead of to scientists as well.

The publication of *Applied Optics* is a thrice-monthly celebration of technological optics and optical engineering. This issue, on the other hand, is a celebration of the observation and the analysis of naked-eye optical phenomena seen in the natural world around us by all who take the time to look. In the following pages our celebration takes three forms. First, we use modern analytical and computational methods and new experimental techniques to analyze well-known naked-eye optical phenomena in order to obtain a deeper understanding of them. Second, we report the observation of several exceedingly rare or previously unknown phenomena. The richness of the natural environment is reflected by the fact that, after so many centuries of scientific observation, there are still new phenomena to be seen by the patient and the lucky. Last, we appeal to

recent advances in physiology and psychology to understand the role that the idiosyncrasies of the human visual system play in observations.

The title of this collection of papers on naked-eye optical phenomena was chosen in honor of Marcel Minnaert's contribution to the field<sup>1</sup> and the influence that this contribution has had on those who continue today to view and study these phenomena. In addition to his well-known book,<sup>2</sup> which has been recently reprinted under the new title *Light and Color in the Outdoors*,<sup>3</sup> he wrote a seminal paper on unusual optical phenomena in the natural environment.<sup>4</sup> Various naked-eye optical phenomena cataloged in his book and paper have been analyzed in detail in four previous special issues of the *Journal of the Optical Society of America* and *Applied Optics*.<sup>5</sup> We hope that this feature issue<sup>6</sup> will be for each of us a source of increased appreciation of the natural environment and a reminder of the excitement, wonder, and joy that we experience when we observe it.

It sometimes happens that we interact with the natural environment in ways we neither anticipate nor intend. An example is provided by the odyssey of the paper "Subsuns, Bottlinger's rings, and elliptical halos" that appears in this feature issue. The original version of the paper avoided being consumed by the southern California brush fires of November 1993 by only 400 m. A few months later, the revised version had to be dug out of the rubble produced by the January 1994 Los Angeles earthquake. We wish to thank the authors of this paper for their persistence in pursuing the publication of their work in the face of adversity. We also wish to thank the authors of all the other contributed papers whose dedication to the study of naked-eye optical phenomena made this feature issue a reality. We thank the Optical Society of America for judging this topic to be sufficiently important to warrant the forum and support for it that they have here provided. Finally, we

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2. M. Minnaert, *Light and Color in the Open Air* (Dover, New York, 1954).
3. M. Minnaert, *Light and Color in the Outdoors* (Springer-Verlag, New York, 1993).
4. M. Minnaert, "Unusual or neglected optical phenomena in the landscape," *J. Opt. Soc. Am.* **58**, 297–303 (1968).
5. Three previous collections of papers on atmospheric optics, which are associated with the Topical Meeting on Meteorological Optics, are *J. Opt. Soc. Am.* **69**, 1051–1198 (1979); *J. Opt. Soc. Am.* **73**, 1622–1664 (1983); and *J. Opt. Soc. Am. A* **4**, 558–620 (1987). Another collection of papers on naked-eye optical phenomena in general, which is associated with the Topical Meeting on Light and Color in the Open Air, is *Appl. Opt.* **30**, 3381–3552 (1991).
6. This collection grew out of presentations given at the Optical Society of America Topical Meeting on Light and Color in the Open Air, held at the Pennsylvania State University, University Park, Pa., 16–18 June 1993. This meeting was sponsored in part by the Office of Naval Research. A review of the meeting is given in M. E. Churma, "Halos, fuzzy suns, and swallowtails: light and color in the open air," *Opt. Photon. News* **4**(12), 76, 87 (1993).