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Looking at Nature in a new light

Light and Color in the Outdoors
M G J Minnaert 1993 Springer 417pp
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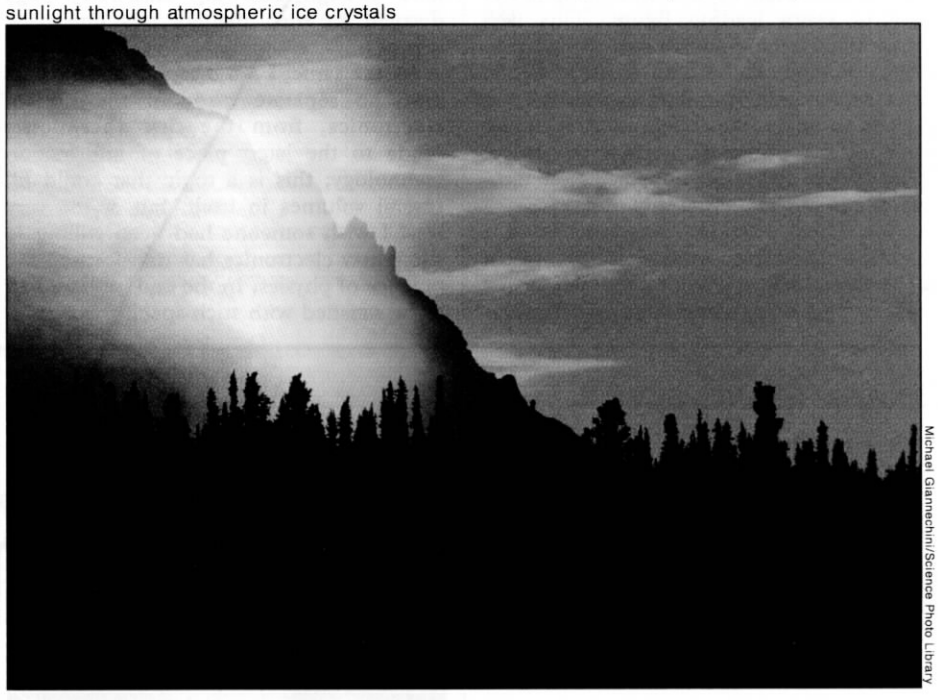
METEOROLOGICAL optics – the play of light in the atmosphere – is now recognized as an area of serious research in physics. The Optical Society of America has held at least three topical meetings on the subject and the proceedings have been reported extensively in its journals. There are excellent popular books – *Rainbows, Halos and Glories* by Robert Greenler (Cambridge University Press) – and semipopular books – *Introduction to Meteorological Optics* by R A R Tricker (Elsevier) – available.

All this activity – only two decades old – stems from the influential book *The Nature of Light and Colour in the Open Air* by the Flemish astronomer Marcel Minnaert, originally published in Dutch in 1937, and then in English in 1940 (reprinted in 1954). Now, to celebrate the centenary of Minnaert's birth, we have the definitive version; a new translation of the fifth and final Dutch edition (1968) by Len Seymour, supplemented with a biography and many new photographs and references to more recent literature.

Minnaert sets out to describe "partly things you can observe in everyday life, and partly things as yet unfamiliar to you, though they may be seen at any moment, if only you will touch your eyes with that magic wand called 'knowing what to look

Trick of the light – a sundog (also called a winter rainbow or parhelion) is caused by refraction of sunlight through atmospheric ice crystals



Michael Giannechini/Science Photo Library

for' ". He avoids "anything that can be found only with the help of instruments ... anything deduced from ... statistical observations" and "theoretical considerations not directly concerning what we see with our eyes". What follows is a virtuoso display of classical optics applied to an enormous variety of phenomena. For example, there are comprehensive treatments of rainbows (caused by refraction and reflection in water-droplets, with diffraction accounting for fine detail), halos (refraction in prismatic ice crystals), and coronas (diffraction by tiny crystals and droplets).

But this is no mere textbook, in which Nature is reduced to a standard set of manifestations of general laws. Minnaert has a keen eye for subtleties and curiosities. Thus we learn about fogbows, dewbows, moonbows, red bows, reflected bows and reflected-light bows. We are told how "herring fishermen notice the approach of shoals ... by their reflection in the clouds (herring blink)", how seawater and leaves shine with chemiluminescence, how the wavelength-dependence of light scattering explains the variety of delicate colours, shadings and changes in the appearance of landscapes at different distances and different times of day.

I read the section about landscapes on a train, and confirmed that their colours are intensified when viewed through a tube, e.g. of rolled-up paper. Now I intend to take up Minnaert's suggestion to use a similar tube as a "nigrometer", looking into a window (black body) to detect the subtle colours of light scattered by intervening air.

Of course there are imperfections. Minnaert misses the chance to explain the bright edges of floating leaves and insects as caustics (focal curves). He could have pointed out the strange numerical coincidence that the two forms of Earth-light on the Moon – namely diffuse reflection from the whole Earth at new moon, and focusing of sunrises and sunsets during an eclipse of the Moon – have approximately the same intensity. He does not explain that the "glory" (the small system of coloured rings surrounding the shadow of an observer's head and cast by the Sun on a bank of mist) and the Brockenspectre (the shadow of an observer cast by the Sun on a bank of mist) are related, and caused largely by the backwards-focusing of waves skimming the surface of mist-drops.

The beautiful translation is also marred by mis-spellings, mistakes in several formulae, and a confusing reference to refraction, rather than diffraction, in the title of the section on supernumerary rainbows. Some of the new colour photographs are unclear or faint (especially those with halos), and the picture of a corona has the peculiar feature, not commented on, that its rings are not concentric. This new edition does not, however, repeat the blunder of an earlier reprint, whose front cover showed a rainbow painted with its colours back to front.

Minnaert writes lyrically, with a passion that sometimes overwhelms him: "The foliage around the crown of a tree becomes a fine fabric, a myriad of dots and dashes between you and the sky. If you look more closely into the crown, you will see that it becomes ever denser, but never opaque; it is always transparent, with openings of light ... Then you see, heavier and heavier, a mass of lighted foliage, blinding and inextricable, except here and there where a single leaf is visible. Then, under this mass, deep through-views of broken, irregular darkness that gradually turns into a series of transparent, green-lit, hazy hollows; and numerous intertwined branches. The beams of sunlight that rain down from above and briefly stroke the shining leaves lose themselves and then become visible again on an emerald sod or knurled roots ..."

He creates natural philosophy at its best. Instead of chatter about two cultures, "relevance" and wealth creation, we have a simple and intense yearning to unify the seen with the thought. Minnaert's book changed my scientific life when I read it a quarter of a century ago. This edition, which is even better, will awaken more people to physics as it can be lived directly. Its publication is a cause for celebration.

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