Seeing stars

M.G. Edmunds

Astronomical Optics. By Daniel J. Schroeder. *Academic:1988. Pp.352. \$45, £28.50.*

EXCEPT for the bunsen burner, telescopes are probably the best-known of scientific apparatus. Their design has not fundamentally changed since Newton excited the Royal Society with his model in 1672. The main mirror size has increased by a factor of 200, but most large telescopes rely on the same principle of keeping two mirrors accurately spaced apart and steerable around the sky.

Instead of the spherical and flat optical surfaces used by Newton, modern telescopes use combinations of other conic (or almost-conic) sections. This allows minimization of the inevitable aberration, or blurring, of images of finite size, which was a possibility recognized by James Gregory before Newton built a working telescope but which could not be realized until mirror grinding and polishing had improved. The main part of this useful book is an introduction to the optical design of simple reflecting telescopes — in this context, most large telescope designs are simple optically — together with description of the design of associated instrumentation such as spectrographs and their cameras. The exposition is clear, with careful reference to the different sign conventions used by other authors.

Much optical design these days is done by using ray-tracing computer software packages. The analytical approach described by Schroeder is an essential tool for efficient and sensible use of such programs, although it would have been helpful if a few more illustrations of actual aberrations had been shown. The result of the author's involvement in design of the Hubble Space Telescope is a good description of application of the methods to an extremely highly specified optical system, the goal here being a wavefront error of only one-twentieth of a wavelength with a primary mirror of 2.4 m in size. Such high performance is demanded because of the lack of atmospheric blurring that the Space Telescope will enjoy. But space-based observation is necessarily very much more expensive than that from the ground, and the next generation of large optical telescopes of primary mirror size 8 m or more will, of financial necessity, be Earth-bound.

It is in this area that Schroeder's book could have been taken further. The manufacture, testing and support of large mirrors is the most difficult of the problems facing the builders of the new 'very large' telescopes, yet it is barely mentioned. There is an account of the

diffraction image from several primary mirrors carried on a single mount, but only one telescope, the Columbus 2×8 m, is likely to be built on this principle, and even the pioneering Multiple Mirror Telescope in Arizona is to have its six mirrors replaced by a single, monolithic mirror.

Also offering tantalizing, but as yet unfulfilled, promise is the idea of servo-controlled *adaptive* optics to correct the wavefront aberrations introduced by the atmosphere in real time. Although such methods have been applied in other optical systems, the faintness of astronomical sources introduces its own problems and for some time it may be possible to correct only in the infrared where tolerances are slacker. Nevertheless, improvements in image quality have profound implications for auxiliary instrument design and the ultimate performance of the telescopes. The use (and constraints) of optical fibres

as feeds from telescope foci to spectrographs, which can effectively increase the survey speed of a telescope by one or two orders of magnitude in allowing many objects to be observed simultaneously, is also not given the attention it deserves.

The topics that are covered in this book are covered well. As well as telescope design, the reader is gently guided through the veritable zoo of modern astronomical spectrograph types. This is a text which sets out the general design principles of astronomical optics in a palatable way, although additional knowledge of the limits on quality and size of available optical components will be required by those described in the foreword as the "future practitioners of the magic art of doing it with mirrors". □

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Fruits of industry

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Acidification in Tropical Countries, SCOPE 36. Edited by Henning Rodhe and Rafael Herrera. *Wiley:1988. Pp.405. \$155, £65.*

WE ALL know about so-called acid rain in Europe and North America. But what about the rest of the world? Is there the prospect elsewhere of widespread acidification of soils and water bodies, damage to vegetation, corrosion of buildings and the rest of the unfortunate syndrome? In particular, how far are tropical ecosystems becoming vulnerable to sulphur and nitrogen emissions?

Rodhe and Herrera, Swedish and Venezuelan scientists, respectively, have assembled an impressive array of contributions by experienced observers. As the editors stress, this is not a definitive work. Yet the early findings are sombre enough, as the book makes plain. Although the emission density of sulphur and nitrogen oxides in most tropical areas is still far less than in many temperate-zone industrial countries, several regions are likely to experience pronounced acidification if current trends in population growth, urbanization, industrialization and consumption of fossil or biomass energy continue beyond the turn of the century.

Much of the concern stems from the fact that tropical soils are often naturally acidic, low in cation-exchange capacity and high in aluminium concentration. This leaves them unusually susceptible to acidifying processes of human origin. The situation is exacerbated by a number of further characteristics of tropical environments. Daytime temperature and sunlight intensity are generally high throughout

the year, enhancing the efficiency of many photochemical processes in the atmosphere. Rainfall rates are high, at least seasonally, offering much scope for wet depositions of sulphur and nitrogen compounds. And many tropical winds, such as the trade winds, change little in direction over long periods of time, meaning that areas downwind of a source of air pollution can continuously be subject to high concentrations and deposition of pollutants. Rapid deforestation, now overtaking much of the humid tropics, is a further acidifying mechanism — forest cover is often replaced with bush and grass savannahs, and the subsequent fires, whether natural or anthropogenic, become another source of trace gases in the atmosphere.

The book starts with a consideration of which specific tropical areas are likely to be particularly sensitive to acidification because of their already acid soils. It then goes on to examine the regions in which emissions of sulphur and nitrogen pollutants are likely to increase. Six areas that are undergoing rapid industrialization, and/or have large urban communities with large numbers of motor vehicles are cited — southern China (in which additional acidification is already manifest), south-east Asia (Thailand, peninsular Malaysia, Sumatra and Java), south-western India, West Africa, south-eastern Brazil and northern Venezuela.

The findings described in the book are tentative, and will need to be elaborated with more data and analysis. But this is a timely assessment of an emergent problem that is likely to demand increasing attention from conservationists and environmental scientists. □

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