Astronomy from the darkroom

David W. Hughes

Colours of the Stars.
By David Malin and Paul Murdin.
Cambridge University Press: 1984.
Pp.198. £13.95, $27.95.
Secrets of the Sun.
By Ronald Giovanelli.
Cambridge University Press: 1984.
Pp.116. £11.95, $19.95.

WE HAVE been told that a picture is worth a thousand words, but how many more words is a colour image worth over black and white? Judging by the multitude of dramatic, beautiful and informative colour photographs in Malin and Murdin's book, the answer must be another thousand at least.

Colours of the Stars is much more than a collection of pictures, however. We are treated to a detailed discussion of the physiology of colour vision and led to bemoan the fact that, at low light levels, the eye effectively switches off its colour system. But photography of the sky can restore the reality of the colourful Universe. Ever since 1883, when Andrew Ainslie Common presented to a Royal Astronomical Society meeting his photograph of the Orion Nebula, the power of photography as an astronomical recording medium has been recognized. Colour didn't arrive until 1959, when William C. Miller used "fast" colour film and exposures of around four hours at the prime focus of the world's largest telescope. The usefulness of being able to record both intensity and colour in one image was immediately apparent.

Malin and Murdin concentrate on two things. First is a clear, practical explanation of the darkroom wizardry that, by colour separation, unsharp masking, photographic amplification, image superimposition and integration printing, can drag the maximum detail out of a photographic plate. Second are the end results. Page follows page of spectacular images of stars, nebulae and galaxies alive with colour. We are not, however, just left to admire their beauty. Colour is the clue to a host of physical and chemical processes: nebulae reflect and emit; forbidden transitions abound; dust scatters both forwards and backwards; each element has its signature; temperature, pressure and velocity can be revealed.

There is much that is new in this book and everything is very clearly explained. The authors' enthusiasm for their subject is apparent throughout and their desire to share this enthusiasm and to help the reader to delve more deeply is furthered by the provision of an impressive reference list.

Moving from countless millions of stars submerged in swirling clouds of gas and dust to one star a mere 150,000,000 km away brings us to the Sun. Instead of recording a point of starlight we can now reveal minute details of sunspots, granulations, fibrils, canopies, plages, spicules, coronal holes, prominences, flares and so on. The common ground between Giovanelli's book and *Colours of the Stars* is the reliance on photography. With the Sun, however, the emphasis is on narrow wavelength bands moving, for example, slowly up the limb of the Hydrogen Alpha line, thus enabling us to sample different layers of the photosphere, produce magnetograms to delve into the magnetic structure and use the Doppler shift to plot out the velocity variations in the convective regions.

The Sun is a very complicated object — the more so, it seems, the more we find out about it — and Giovanelli points towards the five basic "solar problems": the cause of sunspots and their cycle, the structure of the convective zone, the variation of spin with latitude and depth, the mechanism responsible for coronal heating and the cause of flares. But while the book is billed as being intended for non-specialists and non-scientists, and mathematical equations and scientific jargon are taboo, it still does not make our Sun an easy object to understand. The author tries hard to explain what is going on but should have given himself more room. A picture might well be worth a thousand words, but without the picture the words need writing. □

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Spark o' nature's fire

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Electron–Molecule Interactions and their Applications, Vols 1 and 2.
Edited by L.G. Christophorou.
Academic: 1984. Vol. 1 pp.699, $80, £67.
Vol. 2 pp.678, $85, £71.

WE FEW, who risked incredulity if not suspicion at our 1960s belief that the scientific event of the decade — dominated, remember, by twisted helices, parity, lasers and bizarreness — was the experimental establishment of the electron affinities of the halides, will, alas, find here but a one-line entry noting that result. But then we should have been warned, by both title and preface. If chemistry is the interesting part of physics (G.N. Lewis this, I think) then these tomes qualify as chemical, but in fact the authorship is largely North American physicist, accounting no doubt for the particular selection of references (200–450 per chapter).

The editor, a major contributor to studies in the field, has co-authored five of the thirteen articles, four in the second volume in which the stress is on applications of the preceding fundamental studies. He has aimed ultimately at emphasizing the role of slower electrons, which are thus more reactant in nature: more particle, less wave. Elastic scattering of electrons by molecules is dealt with as standard particulate scattering, where scattered intensity is represented as differential (scattering-angle dependent) cross-section, integrable to total scattering cross-section of target species, each dependent on incident energy; the now numerous theoretical analyses are clearly outlined. Reference is included to electron-molecule interactions in the atmosphere of the Earth (causing aurorae) and of other planets. Exciting, ionizing and dissociating collisions, transient electron attachment in resonance interactions and a further variety of electron attachment and detachment processes are analysed in terms of the cross-sections, and inferred potential energy surfaces and molecular mechanisms. The events are complex — consider even the basic processes of electron capture, autoionization, dissociation or stabilization of a simple species AX^- — and the profundity of interpretation presented here represents an impressive scientific achievement.

Volume 2, emphasizing applications, starts with "Electron Transfer Reactions", nearly all in the gas phase. Replacing the physics-versus-chemistry jest by a more relevant contrast of small-molecule versus condensed-phase studies, the tenor of these volumes lies with the former — condensed-phase electron transfer is included but fleetingly. Studies are reported of electron/molecular-cation recombination (dissociative recombination), which also occurs in interstellar space and the upper atmosphere of the Earth. Electron transport in gases, giving an alternative source of scattering cross-section, relates to dielectric use. Electron interactions in liquids are briefly viewed in the light of known electron–gas interactions. Technological applications also related to the fundamental studies arise in laser usage, lamp construction, dielectric applications, and uses of plasmas. Extensions to biology — involving condensed systems — are tenuous. By contrast, the final comprehensive chapter on electron affinities, methods and results, making up a third of Vol. 2, would on its own serve as an invaluable monograph for physical scientists, and is quite admirable.

In general the prose is, let us say, not overburdened with elegance, and some sections have suffered quirky proof-reading. But these are trivial defects in an authoritative, almost encyclopaedic, opus. □

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