Richard of York's battles not in vain . . .

Ann Henderson-Sellers

Rainbows, Halos, and Glories. By Robert Greenler. Pp.240. ISBN 0-521-23605-3. (Cambridge University Press: 1981.) £15, \$24.95.

ACCURATE recollection of the ordered colours of the rainbow by means of the nursery sentence, "Richard Of York Gave Battle In Vain", is a necessary but insufficient basis for understanding in the eyes of Robert Greenler. He wants us also to be moved to wonder at the mysteries of optical phenomena in the sky. His book is reminiscent of a fascinating, extended tutorial with a professor of physics who, fortunately, combines hard scientific research with an almost childlike delight in beautiful things. During his discourse we are prompted to exclaim at magnificence, explain apparent enigmas and reinterpret historical events through computer simulations of atmospheric optics.

The book divides into three sections dealing with rainbows and ice-crystal optics, and then simulation and understanding of historical and modern sky displays, before finally returning to colourful mysteries, myths and mirages. Throughout, facts and frustrations are, like the individual rainbow we each view, enriched by Greenler's personal experiences. For instance, he illustrates the concept of the constant angular size of rainbows by a description of his doomed attempts to photograph the, apparently, miniature bow formed in the spray of his garden hose. The author is clearly "hooked" on his subject; he admits to seeing and searching for rainbows everywhere and has even captured infrared bows on film.

Despite his obvious love of rainbows it is with the optical displays formed by ice-crystals that Greenler is most strongly associated. As a physicist who has spent extended periods in Antarctica and the Arctic his fascination with this topic is understandable, but it is frustrating to realize that many of the sky effects he illustrates in this section are seen only rarely in more populated regions. This is because the huge variety of optical effects discussed depend upon the presence of simple hexagonal ice-crystals while most of us see our ice-crystals as snowflakes. This pinpoints the only real criticism that I can make of the book: it is not focused on a specific readership. As a meteorologist I am frustrated by the fact that the weather which, after all, is creating most of these effects, is mostly ignored. This is a pity because it makes an otherwise outstanding book tricky to use directly in taught courses. Despite the fact that the book is not intended as a textbook, with little additional effort topics could have been related to other disciplines. For instance, the very thin cirrostratus clouds

responsible for the 22° halo, itself generally considered as a forerunner of stormy weather, could also be considered to be a sky phenomenon. I can testify to having used halo occurrence to convince a non-meteorologist that a blue sky could be totally cloud-covered. Despite these reservations I was drawn on by the enthusiasm of the writing. Indeed, I spent some time testing the author's assertion that hexagonal ice-crystals have preferred orientations in the atmosphere, to the extent of spinning and dropping computer cards around my office.

With a flair for detective work which Holmes would have envied, Greenler considers his computer simulation of the famous "Arcs of Lowitz". These composed part of the historic sky display seen and sketched by Tobias Lowitz in St Petersburg in 1790. The accuracy of the simulated curves seems remarkable but Greenler remained dissatisfied. By returning to the written description he has demonstrated that the sketch is not a "snapshot" but a composition of a number of hours of viewing. This revelation solves the outstanding problems

which depended upon knowledge of the solar zenith angle.

The final 50 pages are devoted to colourful optical phenomena in both senses of the word. We are treated to pictures, and explanations, of white and black clouds in the same scene and then yellow, green, blue and red clouds. Such comparatively "every-day" sights pale before the "Specter of the Brocken". This apparition takes the form of a misty giant around whose head are a series of brilliant halos. Many air travellers have seen the same effect, a glory, which simply requires the observer to be in direct sunlight with his anti-solar point projected onto a cloud.

In the opening pages of the book the author states, "I have chosen, knowingly to include myself . . . my delight at seeing . . . my excitement in the process of discovery". Despite my slight unease at such an apparently selfish exercise I shall use and recommend the text. Like the Pied Piper of Hamelin in his rainbow-coloured coat, Greenler charmed me into following and will, I am sure, similarly entrap other readers. It appears that the white rose of the house of York was not lost in vain. □

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Evidence of intent

John Stachel

The Greatest Power on Earth: The Story of Nuclear Fission. By Ronald W. Clark. Pp.342. ISBN 0-283-98715-4. (Sidgwick & Jackson: 1980.) £8.95. To be published in the USA by Harper & Row, \$13.95.

SHORTLY after the accident at Three Mile Island, a Japanese journalist visited a centre for evacuees from the vicinity of the reactor. As startling as the accident itself was the fact that a reference to Hiroshima drew a blank from those he interviewed; none of them recognized the name. Such ignorance in itself justifies more books on the story of the atomic bomb, which is basically the topic of Clark's book.

Over two-thirds is devoted to the story, from the discovery of atomic fission in late 1938, through the wartime efforts to develop nuclear weapons in Britain, the United States, Germany and Russia, up to the explosion of the first Russian bomb in 1949. A 40-page prologue to the book attempts a potted history of nuclear physics; while the last 40 pages wind up the story with brief accounts of the development of the fusion or hydrogen bomb, the attempts to use fission as an energy source and the growing awareness of radiation perils associated with peaceful and military uses of nuclear power.

The prologue is not too successful. It betrays a shaky acquaintance with the

scientific literature, resulting in numerous small errors and confusions. The placement of emphasis, too, is sometimes curious.

The core of the book demonstrates a wide acquaintance with the atomic bomb literature, both original documents (including some discussed in print for the first time) and later memoirs and analyses. On the whole, it seems a thorough and reliable account, correctly giving greater emphasis to work done in Britain than many American sources. This portion of the book commends itself to those in search of a readable, fairly non-technical account of the scientific, diplomatic and military events leading up to the "Birth of the Bomb" (to use the title of Clark's previous account of Britain's underrated contribution to the early phases of the story). Those in search of a deeper analysis of the potential background to the decision to drop the two bombs on Japan are still advised to consult Martin Sherwin's *A World Destroyed* (Knopf, 1975).

The frequent use of hyperbole is annoying: "In 1905 Einstein erupted into a surprised world" (elsewhere "an astounded scientific world" receives Einstein's 1905 relativity paper); Russian nuclear research is interrupted in 1941 because "German tanks with muffled treads moved through the darkness across the Russian frontier", and so on. There are also a few curious phrases: "The predominance of Jewish nuclear physicists on the Continent — in strong contrast to the situation in Britain —

has long been a subject for discussion"; by whom one wonders?

But the more serious problems of the book begin with its title. It is basically the story of nuclear fission, as its subtitle indicates, yet the title clearly refers to nuclear fusion — a reference reinforced by the exploding hydrogen bomb on the jacket cover. Careful reading of the text makes clear the distinction between fission and fusion, but hasty readers may be left confused.

More important is the question of the distribution of emphasis inherent in the structure of the book. Surely, the critical element in our current nuclear predicament is the combination of the fusion or hydrogen bomb, with its capacity for unlimited growth in explosive power, and a missile technology capable of accurately placing such bombs on target within minutes of launching. But no sense of the crucial nature of this development emerges from the brief concluding section of the book. Indeed, what is the moral of Clark's story? He says all the "right" things about the perils of nuclear weapons, and dangers of nuclear radiation — except for one sentence in his concluding paragraph, which plays into the hands of those currently trying to prepare the public for "limited" nuclear wars. He says,

It would be tragic if a limited nuclear exchange, halted after each side had experienced the agony of one city put to the bomb, were necessary to bring men to their senses and to realize, at last, that there are no victors in nuclear war.

Not only would it be tragic (reminding one of the man being led to his execution who assures the audience that this will certainly teach him a lesson!); it is so unrealistic a prospect, as Lord Mountbatten came to realize, that its contemplation as a pedagogical device seems irresponsible.

Finally, there is the broader question raised by the context in which Clark's account places the story of nuclear weapons. Focusing attention in the opening sections exclusively on the development of nuclear physics fosters the all too prevalent view of science and technology as independently evolving structures. For more direct evidence of this outlook, one need look no further than the opening sentence of Lord Zuckerman's preface:

The keystones of our century's history are those scientific and technological advances — radio, the internal combustion engine, antibiotics — which have determined the pattern of life which half the world now leads, and for which the other half strives . . . ;

or the opening paragraphs of Clark's first chapter. After evoking the political and social turmoil of late 1919, inflation and starvation in Central Europe, civil war in Russia, soldier's soviets in Britain, American rejection of the League, Clark continues:

Yet this record of battery and barricade, which added a bloody touch to the first autumn of

peace, was of infinitely less importance to the future of the human race than three events in the worlds of astronomy and physics.

More disturbing than Clark's particular choice of three events (about which more could be said) is the very idea of singling out some group of scientific and technological developments and setting them in apposition to the symptoms of vast social, economic and political upheavals in evaluating their "importance to the future of the human race". I think the evidence exists, in Clark's book and elsewhere, to sustain Raymond Williams' recent judgement:

In the case of nuclear weapons, nothing is more evident than that they were consciously sought and developed, and have continued to be consciously sought and developed. It is true that, as so often in modern technological innovations, much of the basic research had been done for quite other reasons, without foreseeing this particular result. But again as in many other comparable cases, the crucial moment of passage from scientific knowledge to technical invention, and then from technical invention to a systematic technology, depended on conscious selection and investment by an existing social order, for known and foreseen purposes (*New Left Review* 124, Nov-Dec. 1980, p.365).

Until we grasp this element of *intention* in the process of research and development in modern technology, as Williams puts it elsewhere, I fear that efforts to organize movements to control the uses of that technology will be hampered by the feeling that such developments really are inevitable. And in the case of nuclear weapons, I am not certain how much time we have left to learn the lesson. □

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More pie in the sky

Paul Davies

Gravity, Black Holes, and the Universe. By Iain Nicolson. Pp.264. ISBN 0-7153-7849-X/0-470-027111-6. (David & Charles/Halsted: 1981.) £10.95, \$24.95.

BOOKS on black holes and the Universe range from postdoctoral research treatises to the wildest distortions of science fiction and the occult. Since the explosion of interest in astronomy in general and black holes in particular, which began during the 1960s, the market has been flooded with literature on matters cosmic. How can the discerning reader tell where to go for both reliable and entertaining treatment?

Having spent many years myself on cosmological and astrophysical research, I do not envy the task of the professional writer who has to attempt to master the technical literature of a difficult and developing subject, and distil out the

features that the scientific community considers to be well established. Still more demanding is the task of grading the various conjectural topics, some of which can be bizarre, into degrees of seriousness.

Take one example: travel through a black hole. Certain solutions of Einstein's field equations display the weird property that they can be continued into regions of space and time that are forever inaccessible to us unless we fall into a black hole. These "other" spacetimes (infinite in number) are sometimes called other universes. Do they exist?

In the sense that certain idealized model spacetimes admit other universes, then the subject is a serious one, and schematic representations of these universes appear in textbooks and mathematical monographs. In spite of this, the models concerned are not supposed to apply to the real world, because they involve certain simplifications (for example, the absence of matter) that manifestly fail in reality. The prevailing opinion is that a more realistic model would not display these other universes, and that an observer who falls into a black hole will not, after all, emerge in a hitherto unknown spacetime, but will crash to oblivion in a region of unlimited tidal stress.

A writer may cover his subject thoroughly yet still miss such subtleties and proclaim that modern physics definitely predicts the existence of other universes. Certainly a glance at a textbook could give that impression. Iain Nicolson is to be congratulated that on this, and many other contentious and delicate issues, he has not only got the facts right, but has conveyed the correct degree of scepticism or reliability appropriate to each conjectural topic.

There is much more to this book than black holes, however. The author takes us gently through Kepler's laws, newtonian mechanics and special relativity, before getting on to the equivalence principle, curved spacetime and the general theory of relativity. He also applies his thoughts to the expanding Universe, and the intriguing topic of its ultimate fate.

The book is nicely illustrated with line drawings and photographs, and has a short bibliography. Although certain advanced topics, such as quantum aspects of black holes, are courageously included (and skilfully handled), the book should still appeal to general readers having only a nodding acquaintance with physics and astronomy.

My initial reaction to this book was to wonder where yet another treatment of this trendy subject could possibly fit in to an already crowded market. The answer is that it is one of the few books that maintains a reliable scientific perspective and a careful treatment, yet covers most of the "fun" topics in detail. □

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