invaluable to readers interested in developing a confocal microscope or getting the most out of an off-the-shelf instrument. The first and third chapters are mainly concerned with a comprehensive survey of the theory of confocal imaging by the master himself: Tony Wilson. This is supplemented in chapter 5 by a sophisticated treatment of spatial filtering at the confocal pupils. Stephen Hawking was warned, when preparing his popular book *A Brief History of Time* (Bantam, 1988), that every equation halves the readership. If true, this bodes very ill for the popularity of this book, which has 106 equations in Wilson's two chapters alone! Nevertheless, the nontechnical reader who persists with these chapters and takes the derivation of the equations on trust will be rewarded by a thorough knowledge of the principles of confocal microscopy.

Chapter 2, 4, 6 and 7 are concerned mainly with the theory and practice of three-dimensional image representation and optical sectioning in confocal microscopy. Although the first seven chapters describe many of the latest advances and are essential reading for any serious confocal microscopist, it is the second part of the book that, for me, contains a vision of the future. Chapters 8 and 15 discuss the latest developments in phase contrast and interference techniques for the confocal microscope and chapters 9 and 14 discuss the theory and application of Nipkow disc instruments. These confocal microscopes are often considered the poor cousins of stage scanning and mirror scanning instruments but their feature of multiple scanning probes may eventually prove a decisive advantage for high-speed, three-dimensional scanning of living tissue. Taken together, advances in these areas could lead to instruments capable of recording in great detail the full four dimensional space/time structure of the early living embryo using noninvasive optical contrasting techniques. Further speculation on the direction of future developments in cell biology is to be found in chapter 11, whereas the remaining chapters discuss the latest confocal techniques in other major areas of application, including semiconductor metrology and ophthalmology.

In considering the book's potential market, it is easier to say what the book is not rather than what it is. It is certainly not intended as a 'Which Confocal Microscope?' buyer's guide and it is unfortunate for those seeking such advice that Wilson considers it invidious to compare products. Nor is it a practical guide to using confocal microscopes: although much practical advice can be gleaned from it I would suggest (though I hope not invidiously) that biologists will probably find more in the recent *Handbook of Biological Confocal Microscopy* (Plenum, 1990) edited by James Pawley. Aristotle is reputed to have said that 'When a thing has been said once it is hard to say it differently', and it is true that these two books have much in common. Yet I think that Wilson's book, giving a more thorough and cohesive treatment of the principles of confocal microscopy, will appeal more to designers and developers, whereas users might favour Pawley's book. I am not sure whether either book qualifies as a *vade mecum* but I suspect that the true aficionado of confocal microscopy will not wander far without his or her copy of Wilson. □

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Inscrutable matter

John L. Friedman

Black Holes and the Universe. By Igor Novikov. *Cambridge University Press: 1990. Pp.176. Hbk £25, $39.50; pbk £8.95, $14.95.*

By 1784, it was already clear to the English physicist John Michell that there might be stars large and dense enough that, to escape their surface, one must exceed the speed of light. "Since their light could not arrive at us . . . we could have no information from sight. Yet, if any other luminous bodies should happen to revolve around them, we might still perhaps from the motions of these revolving bodies infer the existence of the central ones with some degree of probability". Objects from the familiar world of newtonian physics, Michell's black stars are curious but easily understood. More difficult to grasp is their modern incarnation, the black holes of general relativity. Novikov has written, for the scientifically literate layman, an entertaining, and unusually detailed introduction to these realistic black holes and the universe that they apparently pervade.

If gravity were really newtonian, the stellar corpses that Novikov describes would be denser than other stars and dimmer, but neither black nor holes. Light could travel outward from their surface before falling back, and it would be possible to observe them. In fact, with a sufficiently powerful spacecraft, one could visit them and return. But in the real universe, the gravity of a star dense enough to trap its own light has strength to bend inward the path of all its matter. Nucleons, electrons, neutrinos and light fall to a centre, their extent collapsing to the circumference of a speck. Inside the speck, density and curvature are too high for present physics to describe. Outside the speck space is empty, remembering in its mathematically precise curvature only the mass and rotation of a vanished star. Because the space between speck and horizon is empty, and because any matter crossing the horizon falls inward, 'black hole' is a plausible metaphor. Novikov quotes the poet Marina Katys: "a gulf against the shores of space and time".

Novikov is the latest in a sequence of experts in the field to portray without mathematics the remarkable role that general relativity has come to play in astonomy. The famous co-author (with Y.B. Zel'dovich) of an indispensable text in relativistic astrophysics has given us a more complete picture of black-hole astrophysics than one finds in the similar short books by Robert Wald (*Space, Time, and Gravity: The Theory of the Big Bang and Black Holes*, University of Chicago Press, 1977) and Stephen Hawking (*A Brief History of Time: From the Big Bang to Black Holes*, Bantam, 1988). His discussion of black holes may be less accessible than Hawking's, but Novikov's own pioneering contributions (including the first published prediction with Zel'dovich and Doroshkevich of the 3K cosmic microwave background radiation) more often involve the big bang than black holes. With Marina Katys' poetry, a Soviet song, and his own anecdotes, Novikov leads us to his truer love. He has a talent for telling stories of scientific discovery, and his portrayal of the young science of physical cosmology is a drama of unexpected brilliance and blindness. □

Mary Evans

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John Michell — contemplating the existence of black stars.

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