Historic X-rays and the Big Bang

David W. Hughes

Glimpsing an Invisible Universe: The Emergence of X-Ray Astronomy.
By Richard F. Hirsh.
Cambridge University Press: 1983. Pp.186. £20, $39.50.
The Moment of Creation: Big Bang Physics from before the First Millisecond to the Present Universe.
By James S. Trefil.
Charles Scribner's Sons: 1983. Pp.234. $15.95.

ASTRONOMICAL frontiers have crumbled dramatically over the past few decades. For example, books on X-ray astronomy and Big Bang physics could not have been written 30 years ago; today they are being produced in profusion.

X-ray astronomy started in the late 1950s, the first X-ray star other than the Sun being detected in 1962. The X-ray universe is one of explosive high temperatures, intense gravitational fields, esoteric concepts such as rotating neutron stars and black holes, and rapid time variations all "visible" only through the aid of sophisticated instrumentation carried above our absorbing atmosphere. Richard F. Hirsh, a scientific historian, has written an account of the growth of X-ray astronomy, the book having blossomed from his dissertation written for the University of Wisconsin.

Hirsh's story makes fascinating reading as we follow the tumultuous growth of this speciality. One paper on X-ray astronomy was published in 1962. Only ten years later the annual rate had risen to 311. And Hirsh found that while there were only four X-ray astronomers in 1962, in 1972 the number was 170. In percentage terms X-ray studies in the field of astronomy leapt from 0.8 to 11.2 in ten years. This is an enormous increase over such a short time and obviously depends on considerable government support and funding, a migration into astronomy of physicists and engineers, and a host of technological innovations. Why did it happen? Hirsh points the finger at the "Pearl Harbor" of the technological war, Sputnik 1.

Once into X-ray astronomy, scientists found the discoveries coming thick and fast. The emissions from the solar corona gave astronomers the first glimpse of the high-energy universe. Some predicted then that non-solar sources would be feeble and undetectable. Others were undaunted, kept an open mind and were rewarded by the detection of Scorpius X 1 on 18 June 1962. The size of the diffuse X-ray flux helped hasten the decline of the Continuous Creation theory.

By 1971 the "glimpsing" phase of X-ray studies characterized by brief rocket observations was replaced by the survey phase and the Uhuru satellite. Many X-ray sources were seen to be binary systems consisting of a compact object (neutron star or black hole) orbiting large companions with matter transferring between the two. But in the late 1970s the funding for X-ray astronomy decreased. X-ray astronomers lost their favoured position, and became just one of many pressure groups scrambling for money.

Hirsh has written an intriguing book which provides a clear picture of the way a branch of science can evolve — or stumble along — in the United States. I didn't realize that recent history could be so enthralling, and my hope is that Hirsh turns his attention to other astronomical fields and produces more splendid works.

Turning to James Trefil's book on the Big Bang (which started at time $t = 0$), do you believe that the interval between time $t = 500{,}000$ years and the present "is the least interesting time for scientists"? And do you believe that gauge theories "swept through the community of physicists bringing with them an entirely new way of looking at natural phenomena"? I don't. And Trefil didn't convince me otherwise, but he made an excellent attempt.

Trefil divides the Big Bang into time intervals — the first 500,000 years, 3 minutes, 1 millisecond and 10^{-35} second. Between 3 minutes and 500,000 years there were just the ions of hydrogen, deuterium and helium plus electrons. At 3 minutes the temperature was 10^9 K and there were six times more protons than neutrons. Earlier than 10^{-3} seconds we are in the hands of the theoreticians.

Why is the isotropic background radiation isotropic? How were galaxies produced? Why is the mass of the universe close to the value needed to stop its expansion? Where has the antimatter gone? Where are the relic particles? Trefil has a gift for tackling such questions for the layman and for explaining extremely complex phenomena. This is a good book and will encourage many to delve deeper into the first 500,000 years. For myself though, I'm going to stick with the present. □

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Hard particles

Nigel Calder

Quarks: The Stuff of Matter.
By Harald Fritzsch.
Allen Lane/Basic Books: 1983. Pp.300. £12.95, $19.
The Cosmic Onion: Quarks and the Nature of the Universe.
By Frank Close.
Heinemann Educational: 1983. Pp.182. Hbk £12; pbk £5.95.

IN my copy of *War and Peace,* a thoughtful publisher provides a large bookmark on which the names and relationships of Tolstoy's principal characters are set out, together with the patronymics and diminutives. Russian names are confusing. Authors of allegedly "popular" books on scientific subjects often add a glossary at the back, in the belief that this will make a jargon-laden text intelligible. Both books under review have glossaries. In a Russian novel the personal names are embedded in simple phrases having to do with love, anger and everyday human actions. In books and magazines on science, on the other hand, the jargon can accumulate until each sentence is like a motorway pile-up, in which all hope of comprehension lies smashed.

The publishers of *Quarks: The Stuff of Matter* say that it is for the general reader, and written "without recourse to technical jargon". Opening the book at random I came across these sentences: "Quantum chromodynamics, our theory of the strong interaction, is an example of a non-Abelean gauge theory. This theory uses the relevant gauge group SU(3), under which all colour transformations can be subsumed". The key terms are not even to be found in the glossary. An unfortunate recurrent misprint in this book adds the *myon* and the *myonneutrino* to the already bewildering menagerie of elementary species. Muscular particles, by the sound of them.

The publishers of *The Cosmic Onion: Quarks and the Nature of the Universe* tell us that the author is well known for his ability to popularize the advanced ideas of physics for a general audience, and that this book describes the current ideas "without mathematics". This promise is broken in a mild way by page 16, where we read: $p \times r = h$. Thereafter more and more formulae appear, until by page 111 the text has degenerated into a matrix representation of $W^+ + e^- = \nu^0$.

Two accomplished physicists have undoubtedly laboured hard, and in a restricted sense both have done well. A physics undergraduate who persevered with either book could learn a lot. But then an undergraduate hardly needs cartoon creatures to represent the varieties of quarks, as in Frank Close's book, or jokey poems, as in Harald Fritzsch's. I could not recommend either book to a biologist, never mind a lawyer or a politician.

These books are replete with the wonders of the Eightfold Way, quarks, gluons, charm, the electroweak force, Grand Unification, and the rest. In subject matter there is little to choose between them, and both books refer to the exciting discovery of the W particle announced in January 1983. The general public ought to share the physicists' excitement; cultural considerations apart, Leon Lederman points out