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A Brief History of Time

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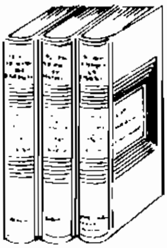
PROFESSIONAL READING



A book reviewer occupies a position of special responsibility and trust. He is to summarize, set in context, describe strengths, and point out weaknesses. As a surrogate for us all, he assumes a heavy obligation which it is his duty to discharge with reason and consistency.

Admiral H.G. Rickover

Frank C. Mahncke

Hawking, Stephen W. *A Brief History of Time*. New York: Bantam Books, 1988. 198 pp. $18.95

One of the magnificent characteristics of the human intellect is its ability to engage in an open-ended quest for understanding of the universe not for gain but for knowledge alone. This is the life and work of Stephen Hawking, professor of mathematics at Cambridge University and inheritor of Issac Newton's chair (This is appropriate, for Hawking is widely regarded as the most profound physicist of the 20th century).

Although Hawking's body is cruelly crippled by amyotrophic lateral sclerosis, his mind is at the very edge of human understanding of the physical origin of the universe. His research in fundamental physics is directed at that deceptively simple question, How did the universe form and why is it like it is? In this short but important book, his objective is to give to the average reader a qualitative grasp of the physical ideas that hold the answer to that question.

Forswearing all equations save Einstein's—for his editor told him that each equation would halve the book's sales—Hawking leads us through the wondrous world of physics and ideas about the formation, state, and fate of the universe. He begins with the first-cause concept so central to the history of Western science: "Within the universe, you always explained one event as being caused by some earlier event, but the existence of the universe itself could be explained in this way only if it had some beginning." Thus the question becomes, What was the beginning?

In searching for the answer to that question, Hawking's intellect and the work of experimental physicists have pushed the edge of our knowledge back to the smallest fraction of time between the big bang and the formation of the laws of physics as we now understand them. From space and time universe as we can imagine, is the domain of modern physics. It is filled with black holes, strings, virtual mass, quarks, and curved spaces, each of which leads Hawking to show us the most intriguing ideas.

Consider black holes. The remains of a collapsed star, a black hole is a chunk of matter so dense that its gravitational field will pull into it anything that comes near. Passing light is bent towards it and no light can escape. Thus no information or sense of it can reach us, yet we know it is there.

If the universe began with a big bang from which all interchangeable matter and energy were flung out to form the universe, will the universe eventually reverse its direction and fall back into a big crunch? Hawking describes the search for the mass needed to generate the gravitational force necessary to overcome the present outward movement of all the universe. How indeed can a universe be expanding equally in all directions with the farthest parts departing most rapidly? Think of a balloon. As you blow it up, every point on its surface moves away from every other point no matter from where on the balloon's surface you observe.

Why does time move in the direction we observe? Because entropy moves it in that direction. Increasing entropy is increasing disorder. For the layman and parent, proof of the universality of entropy lies in the simple observation of a teenager's room. That the arrows of time and entropy are parallel is demonstrated by the falling teacup. We see it fall and break, but we cannot see it assemble itself and leap from the floor to the table. When it comes to imaginary time, only a physicist of Hawking's expository skill can enable us to accept the reality of that concept.

Ere we think that modern man has imposed order on the universe, consider the computer memory. Vast order is put into it, but the act of putting order there requires electrical energy. Hawking demonstrates that "this energy is dissipated as heat, and increases the amount of disorder in the universe. One can show that this disorder is always greater than the increase in the order of the memory itself." Thus this review, written on a computer, has increased the disorder of the universe.

At the microscopic end of all this is the wonderful world of the quark, that apparently fundamental subatomic particle from which are constructed neutrons and protons. They in turn are surrounded by the laws of chance, more commonly known as electrons. The electron is an ephemeral thing: sometimes seeming a particle of no mass, sometimes a wave, sometimes a shell bound by the laws of chance, sometimes a packet of energy existing everywhere and nowhere. Hawking is at ease with these seeming contradictions and shows us how each is equally useful and leads to a better understanding of the larger concepts.

One of the unique aspects of subatomic physics is that each subatomic particle is first postulated as a necessary condition to satisfy higher level observations and then found by clever experiments. For readers of this review, it is worth noting that one of the first crucial experiments in modern physics, the determination of the invariance of the speed of light, was done by Albert Michelson of naval and Nobel fame.

Ultimately, Hawking ties all this together in the two great themes of modern physics: the search for an understanding of the origin and fate of the universe, and the search for a grand unified theory. The latter, which has attracted but eluded physicists throughout the 20th century seeks to link the four fundamental forces of physics: gravity, which causes Newton's apple to fall and the planets to remain in orbit; the electromagnetic force, which governs all that we know as electricity and magnetism; the weak nuclear force, which gives rise to radioactivity; and the strong nuclear force, which binds the atomic nucleus. Gravity is the problem; though apparently simple, it does not seem to yield to the laws of quantum theory. Hawking poses and dissects the question, Can we get there or is the search confined to one of better and better approximations?

Physicists seem closer to understanding the origin of the universe than its ultimate fate. There are several promising theories to account for how that dense and homogeneous cauldron of energy and mass at the big bang clumped itself into the bits of discontinuity that have become the galaxies, suns and planets. If we can get our minds into that initial microsecond after the big bang, we will have come close to the mind of God. Physics, as Hawking describes it, may ultimately tell us how it began and where it goes. Religion and philosophy tell us how to comport ourselves along the way.

Reading Hawking is like his search for the grand unified theory of physics: it requires great imagination, and a complete understanding seems near but always elusive. Along the way, one deals with the most extraordinary and challenging ideas and concepts. For these alone, the trip is worth the intellectual exercise.

Gleick, James. *Chaos: Making A New Science*. New York: Penguin Books, 1987. 352pp. $8.95

In the spring of 1919, legend has it, two veteran sergeant-majors from the Austro-Hungarian army met in a Viennese cafe. After tearful embraces, they began to reminisce. Recalling their glory days, they waxed nostalgic about the shined