Mandelbrot's set, and physiology—Penrose proposes a new model of the mind that conjoins 20th-century biology, which is largely mechanistic, with contemporary physics, which is paradoxical (e.g., matter turning into energy or a particle passing simultaneously through two slits). Penrose's description of the mind's operation includes intuition, taste, and judgment, attributes which proponents of strong AI like to disregard.

Penrose has acknowledged that Moravec's *Mind Children* is stimulating and suggestive—as science fiction. However, when theoretical physicists and mathematicians speculate about a masterful set of equations that will unite subatomic quantum physics and large-scale relativity into a "theory of everything" (or T.O.E.), laymen are finding it increasingly difficult to tell the science fiction from the science. That may explain why the strong AI argument is enjoying such a vogue.

THE FIFTH ESSENCE: The Search for Dark Matter in the Universe. *By Lawrence M. Krauss. Basic. 342 pp. $21.95*

Sir Isaac Newton found that the amount of force that planets exert on one another depends on their mass and their distance from each other. This "pull," in turn, determines the speed and course of planets. The same principle applies to galaxies—or did. In 1933, the astronomer Fritz Zwicky established that galaxies move at speeds that should tear them apart, based on what we can observe.

Krauss, a professor of physics and astronomy at Yale University, demonstrates that for galaxies to hold together as they do, there must be a lot more mass to them than meets the eye. From the available evidence, he argues that "*more than 90 percent* of the entire mass within the visible universe is made of material that is invisible to telescopes." The new Hubble space telescope, by possibly determining at what rate the universe is expanding, may be able to suggest where and how much invisible or missing mass there is. But even without this evidence, Newton's universal theory of gravitation, Einstein's theory of relativity, and the "Big Bang" theory all support the idea of the existence of "dark matter." If dark matter doesn't exist, then these established theories will also have to be reconsidered.

What, then, is dark matter? And why not, Krauss asks, assume "that this dark matter is made of the same stuff we are"—that is, of familiar neutrons and protons? Because if it were composed only of these "normal" subatomic particles, galaxies would be much larger than they actually are. So the search is on for the other constituents. One candidate that meets theoretical muster is weakly interacting massive particles (WIMPs). But how do you test something like a WIMP, which is so elusive that it could pass through the molecules of a "solid" rock 100,000 times the size of the Earth and still not interact once with anything? Krauss proposes that one could build a 10-cm cube detector, and in one hour 10^{12} of them will have passed through, statistically enough for one to interact with the detector. He predicts that "there is a real possibility that this darkness will reveal its identity within our lifetimes."

Krauss cautions that the "discovery" of dark matter is "not necessarily as 'deep' as those associated with the development of relativity or quantum mechanics." Yet, he adds, it is "mind-boggling that within less than a quarter-century we have come within striking distance of the answer" to the question man has been asking for millennia: What is the universe made of?