test', we know these capacities when we see them, but we cannot make explicit what it is we know. This interpersonal recognition is yet another of these marvellous psychological skills. If Davidson is right, our intuitions, which emerged during the evolution of ourselves as social primates, may work for creatures like ourselves but are suspect when applied to different entities like computer models of the mind. The moral of this is not despair, but the need to develop hypotheses that are precise enough to be tested about these intriguing psychological processes. This sort of nonglamorous hypothesis-testing has been the mainstay of not a few cognitive psychologists (such as the work on reasoning and thinking reviewed here by Johnson-Laird and Evans) but it seems that neuroscientists and artificial intelligence researchers are reluctant to take advantage of the gains of their psychologist colleagues. And some philosophers seem wilfully ignorant, as witness the nonsensical chapter by Boden in which she uses Spinoza as the model of scientific psychology preceding artificial intelligence, ignoring three centuries of research.

Noble's intriguing essay comparing Hodgkin–Huxley type models of the nerve impulse to computer models of the mind suggests that without rigorous theories of psychological functioning we may not even be able to interpret the models of lower level processes we already have. The Hodgkin–Huxley model would certainly be of far less interest or use if we had not already a considerable body of theory and data about the higher-level, integrative functioning of the nervous system, within which context the model could be interpreted.

There is no easy short cut to a science of the mind, computer technology and its advances notwithstanding. What is needed in cognitive science is good thinking tempered by careful research unhindered by restrictive models and analogies. After this, modelling might help to clarify some issues. For Johnson-Laird, everyday mental models of the world are acts of constructive imagination, but he emphasizes that it is imagination that is central in these models, not inference. Similarly in science, much of the effort of thought lies in the theoretical imagination, with the kind of inferencing characteristic of formal models playing a secondary role. Cognitive science has had far more than its share of modellers, but precious few thinkers and theorists. If ever there were a task that required good imagination intermingled with hard thought, it is the job of understanding the human brain and mind. □

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Star exhibits

A.C. Fabian

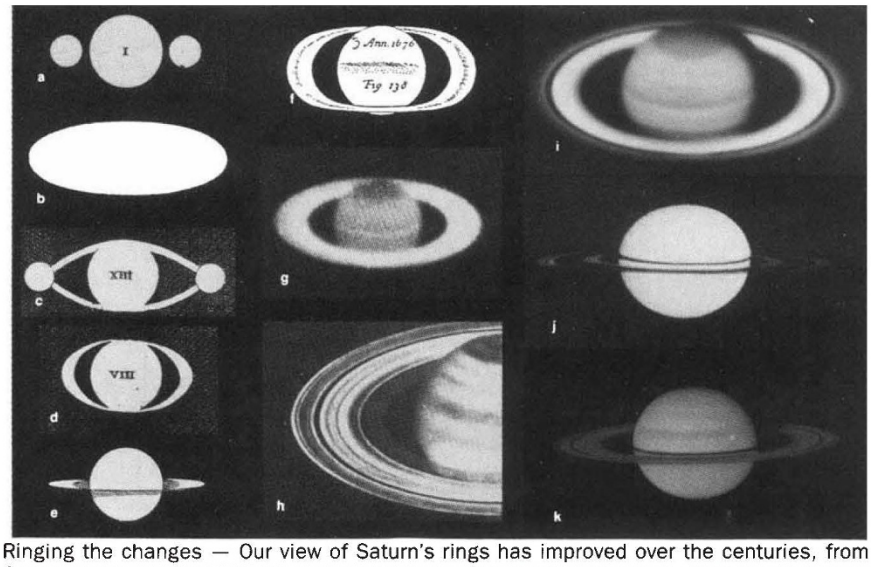
The Astronomer's Universe. Stars, Galaxies and the Cosmos. By Herbert Friedman. *Norton: 1990. Pp. 359. $24.95, £19.95.*

WE ARE taken on a tour of a museum by an amiable guide. In this cabinet we have a red giant, over there we have the Hale telescope and just come and look at the solar flare round the corner. Here we have the eminent Soviet astrophysicist about whom it was said that "fifty per cent of what he does is brilliant but no one can tell which fifty per cent it is", and an extract of a letter from Thomas Edison's associate with his proposal to detect magnetic disturbances from the Sun by using a giant mass of iron ore with wire wound around it — in 1890! This is *The Astronomer's Universe*, and Herbert Friedman of the Washington Naval Research Laboratory is the guide.

The description on the exhibits are rather dull, probably through over-use, although the exhibits are interesting enough. When the guide pauses for an anecdote, particularly if related to his own research experiences in the early days of rocket astronomy, the story takes off and the excitement and the adventure of frontier research shines through. Friedman and the Naval Research Laboratory were involved in early experiments with captured V-2 rockets, flying spectrometers, photographic plates and photon counters from White Sands to altitudes above 100 km in the late 40s and early 50s. They discovered ultraviolet and X-ray emission from the Sun and some hints of a nonsolar X-ray background.

This early work culminated in the *Vanguard* satellite programme, which had a disastrous beginning. Friedman's first *Vanguard* satellite was submersible instead of orbital. His second one was swamped by radiation from the then recently discovered Van Allen belts. Nevertheless, persistence won through and results began to flow in.

One curious aside, made in 1959, notes that the steady-state theory of the Universe, as calculated by Fred Hoyle at that time, predicted a background X-ray flux 100 times higher than Friedman's data allowed. This calculation was presumably forgotten about in 1962 when Hoyle published a paper claiming that the X-ray background just discovered by Giacconi and his co-workers supported a steady-state cosmology.



Ringing the changes — Our view of Saturn's rings has improved over the centuries, from Galileo's drawing in 1610 (*a*) through various sketches and photos to Voyager 1's image in 1980 (*k*). *The New Solar System*, eds J. K. Beatty and A. Chaikin, describes the Solar System as we know it today, thanks to modern astronomy and robotic probes. Published by Cambridge University Press, price is £25, $39.95 (hbk); £13.95, $24.95 (pbk). □

Perhaps the most currently relevant aspect of these tales is the trial-and-error and try-and-try-again nature of the research. Generally it was successful and when it wasn't, it was usually the fault of the apparatus or the rocket. Serendipity played, and still plays, an enormous role. Most cosmic phenomena have been found by chance. Observations lead the subject and theory provides an essential later synthesis. How this era of discovery would have proceeded if it had all gone through the present peer-review system, which is usually overloaded by more than three good proposals to each one accepted, does not bear thinking about. Discoveries often come from an advanced form of playing and playing should not be made accountable. What does bear thinking about is how our present systems stifle enthusiastic trial-and-error research.

I found the tales of the early rocket days made interesting reading and wished that