Jeffrey Robbins seems to realize, is Feynman's belief that we don't live in a scientific society. Why else, he asks, would astrology and mysticism thrive? For Feynman, science is a uniquely privileged form of enquiry, and he has no truck with those who associate the term with educational research, psychology or sociology.

However, he reserves his most withering disdain for philosophers, who "should learn to laugh at themselves", he says. This is all good knockabout fun, but one wonders, as he lays into Spinoza's "meaningless chewing around", whether he knew what he was talking about. Feynman's style is impressively direct, but you can't help thinking that some philosophers have much to teach us by paying especially careful attention to the meaning of words and ideas. It would have been fascinating to have heard Feynman justify his views in a head-to-head discussion with a philosopher who was his intellectual match.

Feynman is on surer ground when talking about science and technology, and there are two pieces in this collection that show him at his formidable best. The first is the transcript of his visionary 1959 talk, "There's plenty of room at the bottom", in which he set the agenda for what became known as nanotechnology. In this masterpiece of futurology, he points out in straightforward language what everyone else has come to accept — that the laws of science do not prevent the making of machines at the atomic level. In an aside, he notes that "in the year 2000, when they look back at this age, they will wonder why it was not until the year 1960 that anybody began seriously to move in this direction". It's a safe bet that he'll be proved right on that, too.

The other outstanding piece is his report to the Challenger Space Shuttle inquiry. President Reagan set this up after the 1986 disaster and invited Feynman to join the commission, as its only scientist member. He made a vital contribution to the proceedings by ferreting out the true reason for the disaster (the failure of the O-rings), which he explained in an experiment he dramatically carried out on prime-time television. His report was embarrassingly critical of the US space agency NASA, and he had to fight to have it included, as a minority opinion, as an appendix to the final document. It is a pleasure to read and a monument to Feynman's courage, eloquence and ingenuity.

The Pleasure of Finding Things Out is a delightful reminder of Feynman's prodigious gifts. On the book's inside cover, among the encomia to his talents as a communicator and a scientist, the writer John Gribbin asserts that he "was certainly the greatest physicist, and possibly the greatest scientist, to be born in the twentieth century". Certainly the greatest? Just as Feynman would have wished, I have my doubts. ■

Graham Farmelo is at the Science Museum, South Kensington, London SW7 2DD, UK.

Astronomy's biggest project

Measuring the Universe: The Cosmological Distance Ladder
by Stephen Webb
Springer-Praxis: 1999. 342 pp. £24.50, $44.95 (pbk)

G. Jacoby

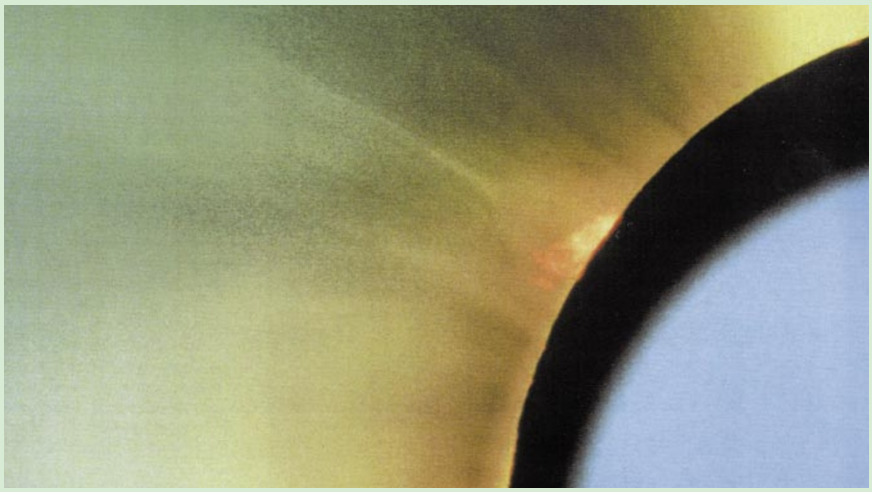
We started thousands of years ago. We are still at it today: we measure distances to stake out property boundaries, to estimate how far ships are from land, and to determine our place in the scheme of the Solar System, the Galaxy and the Universe. It has never been easy, and attempting to measure the size of the largest 'thing' that exists — the entire observable Universe — must be among mankind's most ambitious intellectual quests. Consequently, astronomers require a tremendously broad understanding of the way the Universe works, from the origin of matter and energy to the life cycles of stars. Nevertheless, centuries of effort by many people have come together over the past decade, culminating with observations from the Hubble Space Telescope, so that astronomers can now determine the size and age of the Universe with good accuracy. That story is the subject of this book.

Stephen Webb lucidly presents the scientific basis for deriving distances to the Sun, the Moon, the planets, nearby and distant stars, and to the nearby and the most distant galaxies, despite the necessity of dealing in complex concepts such as relativity, curved space–time and vacuum pressure. His discussion extends from the basic astronomy of the Solar System up to and beyond the Big Bang, the inflationary period and the resulting cosmic microwave background.

The author adopts a conservative, and perhaps the only, story-telling strategy by beginning with the ancient astronomers and working chronologically to larger distances. I especially appreciated the descriptions of the roles of many of the less celebrated players in the game.

One is tempted to compare *Measuring the Universe* with *The Cosmological Distance Ladder* (1985) by Michael Rowan-Robinson, which is now somewhat dated. Because Webb aims at a broader, less professional audience, his book includes less mathematics and fewer references and data tables than Rowan-Robinson's, and so does not completely displace that book. But Webb is more fun to read, relating many fascinating little tales. There is Fritz Zwicky's definition of a 'sphere' (all extragalactic books require a Zwicky story), the rationale for how the days of the week are named and ordered (which, amazingly, depends on the distance scale!), the story of how mathematics cost Tycho Brahe his nose, and how Giordano Bruno's astronomical beliefs led to his burning at the stake. And, with a bit of poetic licence, Webb uses *Star Trek*'s Starship *Enterprise* to view the Solar System from a distance, and has malevolent aliens destroy the Sun to illustrate the travelling time of light (we still see the Sun 8.3 minutes after its destruction).

The mathematics is well aimed at the target audience of beginning science students. Many excellent numerical examples are used to illustrate how today's common observational techniques are applied. Historical and modern references are listed after each chapter; while the bibliography is not complete, it



Solar spectacle

If it's the showier aspects of astronomy that you're after, you can't go far wrong with comets, meteor showers and eclipses. All three astronomical wonders are explained and illustrated in *Cosmic Phenomena* by Gabriele Vanin (Firefly, $35). The photograph above was taken in Kazakhstan during the 1981 solar eclipse, and shows a bright prominence, together with delicate coronal polar plumes.

samples the breadth of the literature. Also, there are questions for the student; some are easy while others have no answer.

While Webb is nearly objective in reporting the current state of the distance scale, a lot of the public interest in this topic stems from the controversy surrounding it. But Webb gives only limited space to the human element that has fuelled the nearly religious fervour of the distance-scale debate for the past 25 years. His emphasis is probably appropriate, considering the target audience and the availability of Dennis Overbye's *Lonely Hearts of the Cosmos* (Little Brown, 1991). For those seeking an exposé of cosmologists' lives, this is not the book; but, for those interested in an understandable and enjoyable textbook that describes how astronomers measure real distances to real objects that are far away, *Measuring the Universe* hits the mark. ■

G. Jacoby is at the Kitt Peak National Observatory, 950 North Cherry Avenue, PO Box 26732, Tucson, Arizona 85726-6732, USA.

Synchronizing situations

Fast Oscillations in Cortical Circuits
by Roger D. Traub, John G. R. Jefferys and Miles A. Whittington
MIT Press: 1999. 324 pp. $57.50, £34.95

Dietmar Plenz

The dynamics of groups of nerve cells pose a major challenge in understanding brain function. In that context, *Fast Oscillations in Cortical Circuits* is a refreshing approach to unravelling one of the most intriguing phenomena displayed by the mammalian brain: the γ oscillation. This brain activity, during which neurons synchronize their firing at a rate of approximately 40 Hz, has been found during a vast variety of behavioural states, ranging from REM (rapid eye-movement) sleep to attentive behaviour in human and animal studies.

Traub, Jefferys and Whittington use a combination of neuronal modelling and electrophysiological experiments to outline their ideas on how γ oscillations are generated. This book is not for the novice. Its main focus resides at the minuscule level at which changes in the membrane potential occur in single neurons from a hippocampal slice. The authors show how these changes can be represented by compartmental modelling of neuronal networks. However, the authors also link these cellular-level descriptions to more complex phenomena such as epilepsy, opiate function and memory formation.

The central mechanism proposed to explain γ oscillations is based on the dynamics of networks of mutually coupled inhibitory interneurons. At the start of the decade, computational studies unravelled the conditions under which such networks display and sustain synchronized oscillatory activity. If the membranes of the interneurons depolarize (become activated) homogeneously and their synaptic connections hyperpolarize (become inhibitory) simultaneously, synchronized firing can occur at an oscillation period that is shorter than the duration of inhibition. In the case of hippocampal basket cells coupled through hyperpolarizing $GABA_A$ synapses, such synchronization occurs in the γ frequency range.

Traub, Jefferys and Whittington's central hypothesis is that the homogeneous depolarization necessary for the interneuron network to oscillate is brought about by the action of a single class of neurotransmitter receptor — the metabotropic glutamate receptor. Despite this uni-causal viewpoint, which is by no means universally espoused, the beauty of this book arises from the fact that such hypotheses are clearly formulated, logically argued, then tested by experiments and computational modelling.

The activities of complex neural networks are not always based on complicated rules. Using pharmacological manipulations, the authors skilfully demonstrate the straightforward relationship between the frequency of the γ oscillation and the time course and amplitude of activity at $GABA_A$ synapses. Furthermore, they use a two-site stimulation protocol in the CA1 region of a hippocampus slice as an *in vitro* model for long-range synchronization, and show how interneuron spike doublets are involved in this.

Overall, the book is succinct and informative, and leads the reader through difficult uncharted waters. Unfortunately, the data provided deal exclusively with the hippocampus, and it remains to be shown whether the authors' hypothesis holds true for the neocortex in general. Furthermore, the proposed role of metabotropic glutamate receptors in the generation of γ oscillations naturally invites a thorough review of the various subtypes of glutamate receptor to be found in the neuronal membrane. Finally, some parts of the book are heavy going. Facts are too often presented without being integrated into the authors' context and arguments.

Nevertheless, the interdisciplinary work summarized in the book is exactly the type of research necessary to fill the gap between mechanism and phenomenon in one of the fastest-moving fields in neuroscience. ■

Dietmar Plenz is in the Unit of Neural Network Physiology, Laboratory of Systems Neuroscience, National Institute of Mental Health, Bldg 36 2D-30, Bethesda, Maryland 20892-4075, USA.

Diversity in the world of bugs

Ecology of Insects: Concepts and Applications
by Martin R. Speight, Mark D. Hunter and Allan D. Watt
Blackwell Science: 1999. 350 pp. $55, £26.50

Alison F. Hunter

There is considerable disagreement over whether the total number of insect species is closer to 2 million or 10 million. What is agreed upon is that insects outnumber all other species combined. With an adaptable body plan, complex life histories and diverse feeding modes, insects have successfully radiated into every terrestrial nook and cranny. Ants forage in the desert at close to their lethal temperature of 55 °C, apparently by accumulating heat-shock proteins before leaving cool tunnels. Some moths have a leisurely 13-year life cycle in the Arctic, growing only during the brief summer weeks.

Insects also engage in an extremely diverse range of ecological roles. Bark beetles consume wood by associating with cellulose-digesting fungi, while innumerable species consume more easily digestible insect tissues. Many insects pollinate plants, help decompose organic material and prey on pests.

Given this range, anyone writing a text on the ecology of insects requires considerable audacity to pull it off. Speight, Hunter and Watt provide solid coverage of current ideas. They discuss controversial issues ('talking trees' — the possibility that trees communicate about herbivory using volatile chemicals — overcompensation for herbivory and estimation of the number of insect species, among others) without getting bogged down by details of the debates, providing an even-handed, to-the-point treatment of issues.

It would be easy to write a text that would leave readers bewildered by masses of both ecological and entomological jargon. The authors, however, have taken great pains to explain terminology so that no great prior knowledge of entomology or ecology is required. The material is suitable for students of 18 years and up.

This is a fine volume with few defects. But the mosquito larva in Fig. 9.16 is upside-down, several of the figures are poorly labelled, and it is generally difficult to comprehend the figures from their captions alone. The specialities of the authors, on forest Lepidoptera and other economically important groups, are evident in the choices of examples, but the bias is not overwhelming. ■

Alison F. Hunter is in the Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana 46556, USA.