method to reconstruct trees, so the difference may be an artefact of that method. The authors do not discuss the location of the root of the tree.

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Comparing the papers of Smith et al. and MacClure et al. highlights the advantage of a thoroughly tested tree as a basis for analysis. And, as Smith et al. remark, "The reconstruction of the phylogenetic history of HIV-1 and HIV-2 is an important component for the understanding of the epidemiology of the spreading disease, AIDS."

The shifting centre

Virginia Trimble

**European** and American astrophysicists have been in the habit of supposing that their Japanese colleagues are thinking and doing more or less the same things they are, but perhaps a year or so later. At a recent conference it was made abundantly clear that this supposition is badly out of date and that the centre of astronomical research is no longer unambiguously in the mid-Atlantic. A major part of the varied programme consisted of new, wholly or partly Japanese results in the areas of neutrino astronomy, X- and y-rays, the microwave background and data-processing technology.

The solar neutrino problem is almost as old as many of the conference participants. From 1968-69 onwards, the unique CL-experiment operated by Raymond J. Davis Jr and co-workers has persisted in detecting only about one-third as many neutrinos with energies above 8.14 MeV as the standard solar models predict. Most of us ceased to doubt the essential correctness of the experiment many years ago.

Confirmation is nevertheless very welcome. The Kamiokande II experiment, though designed primarily for other purposes, records the energy and incident rate from the direction of the Sun is about 0.1 event per day, whereas the standard solar model predicts 0.3. Allowing for the statistical uncertainty the authors do not discuss the location of the root of the tree.

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according to Tadashi Kifune (University of Tokyo), reporting for a Japanese–Australian–New Zealand collaboration. Their Cerenkov light detector saw a modest increase above background in the direction of the supernova during the January X-ray flare. If real, it corresponds to a luminosity of about $3 \times 10^8$ erg s$^{-1}$ above 3 TeV, persisting for only a couple of days.

The search for spatial and/or spectral lumpiness of the relic 3-K microwave background radiation is also about 20 years old. The most persuasive spectral data so far come from a February 1987 rocket flight mounted jointly by Nagoya University and University of California, Berkeley. Analyses of the data have continued since initial theoretical discussions found that the excess 480- and 710-μm radiation could be attributed either to inverse Compton scattering of longer wavelength photons or to thermal emission from dust heated by pregalactic starlight.

Toshio Matsumoto (Nagoya University) showed the observed fluxes as a function of ecliptic latitude. For the 100–200 μm range, there is a correlation with interstellar hydrogen density and with zodiacal emission (interplanetary dust), as seen by the Infrared Astronomy Satellite. At wavelengths longer than 400 μm, the fluxes are essentially isotropic, with possible fluctuations on a scale of degrees. The residual excess emission, according to Matsumoto, is then best fitted by dust emission at 3.7 × (1+z) to $4.4 \times (1+z)$ K, where z is the redshift at which the dust was heated, and the exact temperature depends on how the dust absorption coefficient varies with wavelength. The necessary energy input is sizable in any model, amounting to about 10 per cent of the $(1+z)^2$ eV cm$^{-2}$ contained in the total microwave background.

Finally, several of the contributed papers and posters touched upon issues of modern technology and data-processing techniques. For instance, Tsuneaki Daishido and colleagues from Waseda University, Nobeyama Radio Astronomy Observatory and Sony Corporation’s Information Systems Research Center reported on a technique for rapid processing of radio signals from arrays of antennae.

Their prototype processor, intended to look for transient radio sources, is capable of 2.7 billion (10$^8$) operations per second and has been used for studying solar radio bursts. I ought to be able to tell you more about it, as the authors provided a seven-page, 1988 reprint, complete with extensive circuit diagrams. As I examined the pages, Satio Hayakawa (Nagoya University) remarked that Americans have been complaining that Japanese researchers do not send state-of-the-art information promptly. He suggested the alternative interpretation that they are sending, but we are not receiving very well. This must be true, for I cannot tell you even the name of the journal that published this forward-looking paper — in Japanese.


Quantum optics

**Noise-driven phase for lasers**

*Peter Knight*

Phase transitions between different output states are common for lasers. The most important is that between ordinary fluorescent behaviour of the laser medium and coherent amplifying laser action. Another occurs at the onset of chaotic fluctuations in the output field at higher powers. J.H. Hannay and D. Field suggest elsewhere in this issue (*Nature* 333, 540–542; 1988) that a third transition can be driven by noise fluctuations of the output electric field. They liken this transition to the Curie–Weiss transition in a ferromagnetic material, in which cooperative interactions between individual atomic magnetic dipoles makes the whole ensemble very sensitive to small thermal fluctuations.

The laser is often regarded as a nonlinear oscillator driven by an external pump mechanism which attempts to maximize the excitation of the atoms forming the source of radiation. The excited atoms form a fluctuating polarization which in turn creates the laser electric field. If the pump rate is insufficient to overcome the relaxation of the atoms and field, the electric field dies away. The decaying transient fields from each atom are randomly phased and add to form mere noise with a zero mean amplitude.

When the pump rate is raised sufficiently to overcome the losses in the laser cavity, gain is possible and a steady-state electric-field amplitude can be maintained. The critical pump rate here defines a first threshold, which is that necessary to provide sufficient excitation to balance the losses.

A second threshold occurs (Haken, H. *Phys. Lett.* A53, 77; 1975) when, for very high levels of pumping, the evolution of the laser electric field becomes completely chaotic, an effect seen in many nonlinear systems. The phase transition discussed by Hannay and Field in this issue is distinguished from both of these through its reliance on fluctuations in the atomic polarization of the laser. Their results indicate that small changes in the laser parameters can lead to very large changes in the average intensity of the laser output.

The method used by Hannay and Field is a straightforward extension of the theory used by Haken and H. Risken (see Haken, H. *Laser Theory.* 2nd edn, Springer, Berlin, 1984) to describe the transition from noise to order in passing through the first threshold. In this standard approach, ‘Langevin’ equations, which model the fluctuations of the polarization, inversion (the degree of excitation of the atoms) and the laser electric field about their mean values, are used to define a ‘Fokker–Planck’ equation which describes how the probability distribution of the electric-field strength evolves. This distribution is governed by the size of the electric-field loss and gain in the laser. As a function of electric field, the probability distribution behaves rather like a potential well which can have a single minimum (a in the figure) when the laser is below threshold, or a double minimum when it is above threshold.

The evolution of the laser electric field behaves rather like a ball rolling in this potential and below threshold will roll to the bottom of the well. Above the threshold, the well bifurcates (b in the figure): two minima symmetrically displaced from zero represent the positive and negative stable equilibria of the ball. Spontaneous symmetry breaking allows...