scribed techniques for transferring smaller amounts of genetic information is difficult to predict. If, with the development of appropriate selective systems, it should turn out to be regularly possible to introduce bits of chromosome containing one or a few specific genes into host cells, this could turn out to be of major significance.

Year of the ψ

from W. T. Toner

The Lepton-Photon Symposium was held at Stanford University on August 21–27.

It is appropriate that this year's Lepton-Photon Symposium was at Stanford where many of the discoveries which have revitalised high energy physics have been made. Pride of place went to new results from electron-positron annihilation, many of them obtained at the host laboratory.

The spectroscopy of the ψ , as it stood before the symposium, was reviewed in *News and Views* for September 11. Two new states were added at the meeting, to make a total of at least eight. R. Schwitters (SLAC, Stanford) reported data from the SLAC-Berkeley collaboration showing a fourth ψ -like particle of mass 4,400 MeV and width 50 MeV, produced directly in electron-positron annihilation. B. Wiik (DESY, Hamburg) and J. Heintze (Heidelberg) both presented evidence for the decay chain $\psi(3095) \rightarrow \gamma X(2800) \rightarrow \gamma\gamma\gamma$, and Wiik tentatively suggested (on the basis of two events) that X may also decay to proton-antiproton pairs. Spins and parities remain to be determined except for the two lightest ψ s (1^-), but the uncanny resemblance of the level structure to that of positronium (Mills *et al.*, *Phys. Rev. Lett.*, **34**, 1541; 1975) left few to argue against some form of charmonium interpretation (Appelquist *et al.*, *Phys. Rev. Lett.*, **34**, 365; 1975; Eichten *et al.*, *ibid.*, 369).

If 1975 is the year of the ψ , 1976 may well be the year of the lepton. Earlier this year M. Perl (SLAC) had reported on 24 anomalous events of the type $e^+ + e^- \rightarrow \mu^\pm + e^\mp +$ unobserved particles, of which only 5 could be background from conventional processes. G. Feldman (SLAC) discussed the extension of this analysis to cover the whole of the SLAC-Berkeley data, leading to a total of 86 events, of which no more than 22–30 could be from conventional processes. It is possible that these events are due to the production and weak decay of a pair of charmed mesons, but the most

popular explanation (as yet without proof) is that the reaction is $e^+ + e^- \rightarrow U^+ + U^-$ where U is a heavy lepton, a member of the series $e, \mu, \dots$ and decays to $\mu \bar{\nu}_\mu \nu_U \rightarrow \nu_U$ is the neutrino associated with U. The excitation curve suggests a mass of about 1.9 GeV for U.

The most apt comment in the 36 years of our attempts to understand the leptons, is Rabi's "Whoever ordered that?", of the muon. With a third member of the series one might begin to make progress. F. Gilman (SLAC) remarked that the U (if a lepton) has been found where charmed mesons were expected, just as the muon was found where Yukawa's pion was sought. He left unspoken the outrageous thought which occurred to more than one member of the audience: that there might be a connection between the masses of these leptons and hadrons—the pion is not much heavier than the muon, and the charmed mesons (when found) should have masses ~ 2 GeV. H. Harari (Weizmann Institute) presented an imaginative scheme linking leptons to hadrons in another way: the electron to the u and d quarks which are found in ordinary matter, the muon to the s and c quarks to be found in strange and charmed particles respectively, and the U to new t and b quarks, which would make up other families of particles yet to be discovered.

L. Lederman (Columbia University) discussed old and new data on the direct production of the old leptons (muons and electrons) in the strong interactions of protons, a process that should not take place to any appreciable extent, but does (*News and Views*, March 13). The plot seems to be thickening, with reports of enhanced production, relative to pions, at small transverse momentum, which rules out any explanation in terms of large transverse momentum phenomena, and also makes it difficult to explain the effect in terms of any very heavy particle decaying into lepton pairs. There is experimental confusion at low energies, with new data from a Pennsylvania-Stony Brook collaboration showing direct lepton production at energies as low as 10 GeV, in agreement with Leipuner *et al.* (*Phys. Rev. Lett.*, **34**, 103; 1975), but in disagreement with Winter (*Phys. Lett.*, **B57**, 479; 1975) and with Russian data reported to the symposium. The new discoveries at the electron-positron storage rings do not seem to be related to the high-energy direct lepton production in any obvious way, and if direct leptons are indeed produced at low energy, a relation between the two is extremely unlikely. There is no explanation for this phenomenon, nor even any estimate of its likely significance. As his conclusion,

Lederman showed a blank transparency.

The symposium would still have been stimulating without all this excitement. There was, for example, the strong evidence presented by Schwitters for the production of back-to-back jets of particles in electron-positron annihilation at 7.8 GeV, in beautiful agreement with the parton model; there was the report by W. Lee (Columbia University) of the first clear observation of the long sought decay of the $\rho'(1600)$ into two pions; and a great deal more. There was also the 'monopole' event (Price *et al.*, *Phys. Rev. Lett.*, **35**, 487; 1975), which L. Alvarez (Berkeley) argued, most convincingly, was probably caused by the fragmentation of a platinum nucleus in the detector.

There was such euphoria about the new physics that several theorists—Gilman, Harari, C. H. Llewellyn-Smith (Oxford) and J. D. Bjorken (SLAC)—went out of their way to remind us that much of the interpretation rests on plausible assumptions, which remain to be proved. This will require a searching re-examination of the old physics as well as the new. $\square$

More headaches from star formation

from M. G. Edmunds

A RENEWED discussion of the interpretation of observational studies of the radio spectra of molecules in the Orion nebula will probably make star formation theorists reach for their aspirin bottles. The theory of star formation is complex and difficult; the refinements of competing physical processes that can be invoked are almost infinite, and yet even the most simplified models gobble up large amounts of computing time, only to leave the proponents arguing about numerical errors.

The basic model attempts to follow the self-gravitational collapse of a cloud of interstellar medium into a state where it is hot and dense enough for the start of nuclear energy generation and the birth of a star. Any observational constraints on the theories are invaluable since the conditions involved must range over many orders of magnitude in temperature and density as the formation proceeds. The presence of large amounts of finely-divided dust in the dense gas clouds which are the site of star formation means that radiation at optical wavelengths is obscured and the probing of the physical conditions can only be achieved with radio and infrared techniques. One of the happiest hunting grounds for the elusive observational data has been the region of the Orion nebula, which includes both the optically visible region of gas heated