

energy examples of a broad spread of hadron energy accompanied by a very isolated muon.

Based on what was seen at lower collision energies, only about one such event was expected. Picking up eight was suspiciously interesting, but at the time none of the other three PETRA experiments had anything to report.

The PETRA machine was not able to remain in this high energy region for long, and the matter remained closed for a while. Then the JADE collaboration presented a new analysis of the high energy data, concentrating on the search for isolated muons or electrons. Five examples were found of an isolated muon accompanied by a

broad hadron signal, consistent with the Mark J findings. No such effect was seen with electrons.

The CELLO group found only one example of an isolated muon accompanying a broad spread of hadrons, consistent with what they saw at lower collision energies. The group concluded that the data 'do not support the observations of the Mark J and JADE collaborations of an excess of muon events of this type'.

At a meeting in Santa Monica earlier this year, physicists looked at the possibilities of quarks and leptons heavier than those already known (or, in the case of the 'top' quark, firmly anticipated). Any such particles would have immediate

consequences for the cosy interpretation of modern particle physics in terms of just three 'families', each containing two (known) quarks and a lepton.

Harald Fritzsch admitted that the interpretation of the Mark J and JADE signals was 'unclear'. He hinted that PETRA could have been falling just short of an important new threshold, so that experiments had 'just a short look through the peephole before the slide came down'.

The new TRISTAN electron-positron collider at the Japanese KEK Laboratory should certainly enlarge any such peephole.

Physics monitor

Hadron spectroscopy 1987

With much particle physics research using particle beams to probe the behaviour of the quark constituents deep inside nucleons and other strongly interacting particles (hadrons), it is easy to overlook the progress being made through hadron spectroscopy — the search for and classification of rare particles — and the way it has increased our understanding of quark physics.

One way of remedying this was to attend the stimulating and encouraging Hadron 87 meeting held earlier this year at the Japanese KEK Laboratory, where Jonathan Rosner from Chicago's Enrico Fer-

mi Institute gave the concluding talk.

'Questions that were asked as long as twenty or more years ago are actually being answered,' he observed, thanks to the patient efforts of experimentalists and theorists. We need to be more bold in sharing these pleasures with students, for the study of new spectroscopies... builds on the old'.

A comparison of the 1974 and 1987 classifications of mesons (composed of a quark and an anti-quark) underlined the progress made in recent years. Many conventional spectroscopy labels (radial and angular momentum excitations — as in atomic physics) are needed, while candidates have been found for a variety of exotic states.

Jon Rosner — answering questions from twenty or more years ago.



Complementing the particle spectra are the results on proton-anti-proton annihilation at rest from the ASTERIX experiment at CERN's LEAR Low Energy Antiproton Ring.

'Glueballs' are particles built up of gluons (the transmitters of the inter-quark force) rather than quarks. A good test of a glueball candidate is to see if it can be formed in photon-photon collisions (a by-product of electron-positron annihilation) as glueballs do not carry electric charge. Rosner reeled off a list of glueball possibilities — the ι 1460 (a 'good candidate'), many scalar particles (spin zero, positive parity), all resonances above 1 GeV (apart from the f_2 prime 1525) seen in final states of a neutral kaon pair and a pion or a pion and an eta (because of the photon-photon criterion), the θ/f_2 1720 (interesting for its possible links with the 'Pomeron' mediating elastic scattering) etc. Some states, such as the eta prime 958, could have a small gluonic component.

Baryon (three quark) states abound, but Rosner covered also the Skyrme model, used with some success in the analysis of meson-baryon scattering, providing an alternative approach to quark models, with similar though not identical results. New experiments could shed further light.

Other variations of hadronic matter are the 'hybrid' states containing gluons in addition to quarks, and exotic states with configurations other than the habitual quark-antiquark (meson) and three quark (baryon) forms.

Rosner also looked at the possibility of hadron 'molecules', where the allowable stable configurations of complicated structures is a challenge for lattice gauge theories.

Spectroscopy has certainly blossomed

for heavy quarks beyond strangeness, unknown before 1974. The physics of 'charmonium' (bound pairs of charm quarks and antiquarks) is now a subject of special study. While not yet as well explored as the charm quark, the b quark provides another spectroscopy dimension. The mixing of B mesons (containing b quarks) gives an indication of where the sixth ('top') quark might be found one day.

As well as the top quark, Rosner included in possible future spectroscopies a variety of theoretically admissible quarks and leptons.

He concluded that hadron spectroscopy has a bright future, with results possible from machines existing, entering service, shortly to enter service, or still on the drawing board.

Electronic postcards

Over 200 specialists gathered at Asilomar State Beach in California earlier this year for a Conference on Computing in High Energy Physics.

The organizers decided to restrict presentations to topics often talked about in corridors but rarely covered in open session. The theme was thus 'the computing environment' and all but two review talks dealt with software issues. There were 35 speakers during the 4½ days of presentations, with another 30 topics covered during the 3 hour poster session. In addition, lively panel discussions were held in the evenings.

A highly topical area was computer networking. Reports from Hugh Montgomery (Fermilab) on the US perspective and Brian Carpenter (CERN) on the European

scene showed that the long sought goal of network unification and standardization is still many years away. Meanwhile the various ad hoc networks (BITNET/EARN, DECnets, X.25 based networks, etc.) continue to grow and be heavily used by the particle physics community.

Another area of growing interest is the use of supercomputers. Although these machines have successfully handled lattice gauge calculations and some aspects of accelerator modeling, they have yet to make their mark across the experimental scene. There were two very different illustrations of recent progress. Kenichi Miura (Fujitsu) showed one method to vectorize particle generation in the Stanford (SLAC) EGS simulation package, with significant benefits (although his lead brick geometry was very simple), while David Levinthal, taking another approach, achieved high levels of vectorization in track finding code for his Fermilab experiment.

The most colourful part of the conference was the graphics session. 3-D colour event displays from the UA1 experiment at the CERN collider were presented by Jean-Pierre Vialle (LAPP-Annecy) while Ralph Nelson (SLAC) presented 3-D colour showers from the EGS simulation program. However it was clear that particle physics is only beginning to learn how to exploit the latest 3-D colour graphics terminals and workstations.

Three sessions covered various aspects of program development and management and the computing environment for physics analysis. New words such as PAW, IDA, GEP, TANAGRA, ADAMO, and SASD were explained. With interactive computing readily avail-