Particle Physics in Budapest

At the Conference on Particle Physics held at Budapest, July 4-9, an unusually large amount of new and exciting experimental results was presented.

Certainly an outstanding highlight was the discovery of a very heavy dimuon resonance with mass around 9.5 GeV in the process $p + \text{nucleus} \rightarrow \rightarrow \mu^+\mu^- + \text{anything}$. The experiment had been performed at the Fermi National Accelerator Laboratory with 400 GeV protons by a Columbia-FNAL-Stony Brook collaboration. This new state at 9.5 GeV probably indicates the existence of at least a fifth quark (flavour), just as the previously discovered J/Ψ resonances announced the existence of the fourth quark (flavour) : charm. Due to the limited resolution of the experiment, it is yet an open question whether this enhancement around 9.5 GeV is a single (broad) resonance or — as predicted theoretically — consists of several narrow positronium-like bound states of the new quarks.

Far-reaching new results came from charged current deep inelastic ν and $\bar{\nu}$ interactions. These experiments have been performed at the new CERN-SPS accelerator and at FNAL. A previous experiment (Harvard-Penn-Wisconsin-FNAL collaboration) had claimed to see an anomalous change in certain $\bar{\nu}$ distributions for $\bar{\nu}$ energies beyond 30 GeV. This anomaly has a strong consequence : it had to be interpreted as a manifestation of *right-handed* currents coupling to *new quarks* beyond charm of mass around 5 GeV. In particular the new high statistics ν and $\bar{\nu}$ experiment from CERN (CERN-Heidelberg-Dortmund-Saclay collaboration) has clearly demonstrated now that such an $\bar{\nu}$ anomaly does *not* exist. Moreover all ν and $\bar{\nu}$ results are in nice agreement with the naïve spin 1/2 quark-parton model (possibly adorned with some "asymptotic freedom" corrections). This CERN experiment and the other experiments performed at the big CERN bubble chamber BEBC and at FNAL agree with each other.

Important progress came again from e^+e^- physics : first, a new Ψ resonance with a mass of 3772 MeV has been discovered at the SPEAR e^+e^- colliding beam machine. This state is a particularly interesting member of the J/Ψ family ("charmonium") since it is located just above the threshold for charmed D meson pair production and below the threshold for production of its excited state D*. This peculiar kinematical configuration has made it possible to extract highly accurate and important information on the D meson from the decay of this new Ψ (3772) state.

Second, from the DORIS e^+e^- colliding beam machine came first evidence for the strange member of the charmed pseudoscalar meson family : the F meson. All these results round off beautifully our picture of the rôle of the fourth quark (flavour) : charm.

A large amount of new (indirect) evidence for the heavy lepton τ has accumulated from the DORIS and SPEAR e^+e^- machines. The new results are in nice agreement with the theoretical expectations for such a heavy lepton.

A series of three fairly narrow peaks (at 1498, 1820 and 2130 MeV) has been reported from the e^+e^- colliding beam facility ADONE. The masses are consistent with expectations for higher spin one $\varnothing$ meson excitations. However, the reported widths seem somewhat too narrow, so perhaps there is interesting new physics about to emerge.

Even in the domain of "old" physics (i.e., neither involding charm nor quarks beyond charm) there was interesting and intriguing news : two groups working at the CERN Omega spectrometer have reported the discovery of new heavy baryon-antibaryon resonances at 2020 MeV, 2200 MeV and 2950 MeV with surprisingly narrow widths. They are candidates for the predicted "baryonium" states. Theoretically one expects a somewhat longer lifetime for "baryonium" than for normal mesonic resonances due to the topological peculiarity of baryons as composites of three quarks. The puzzle with the new states is that their widths are considerably smaller than may be expected in such schemes.

In the domain of "theoretical theory" much effort was devoted to a better understanding of quark dynamics in general and the quark confinement problem in particular. Interesting new developments in the field of "supergravity" and in the investigation of non-perturbative solutions of classical and quantum field theories were reported.

A special highlight was certainly the beautiful and inspiring lecture by Prof. Dirac celebrating the 50th anniversary of the Dirac equation at this Budapest Conference.

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