NEWS AND VIEWS

Neutral Current in Weak Interactions?

GARGAMELLE was Gargantua's mother. She had a dreadful and Rabelaisian labour before finally bringing her great child into the world. Nowadays Gargamelle is a giant heavy-liquid bubble chamber at CERN. A vast collaboration of physicists from seven European laboratories—Aachen, Brussels, Milan, Ecole Polytechnique, Paris, Orsay and University College, London—has been acting as midwife to the delivery of her most recent result (presented at the conference on neutrino physics held last month in Bonn). In this case the labour has also been long, not because the offspring was caught up in her internal workings, but because the data were embedded in background.

The chamber was exposed to a neutrino beam and to an antineutrino beam. The kind of events which were expected always includes a fast charged muon in the final state, along with strongly-interacting pions, protons and neutrons from the breakup of the struck nucleus. The process of changing the incident neutrino into a charged final muon is called a "charged-current" interaction. But in Gargamelle more than 160 events have been seen which look exactly like charged-current events, except that there is no muon in the final state. It is impossible to prove for any of these events, taken by itself, that it was a neutrino interaction, but no alternative explanation has been found which could account for even one quarter of the number of events seen. A long list of background processes has been investigated (as described by Hasert *et al.* in a forthcoming issue of *Physics Letters*) but none can reproduce the observed properties of the sample of events, either qualitatively or quantitatively. For comparison, about 570 charged-current neutrino events were seen in the same film, showing that the neutrino flux was more or less as expected.

If it is accepted that most of the 160 events were induced by neutrinos, then the most attractive explanation is that they are "neutral current" events, in which the incoming neutrino or antineutrino has scattered inelastically, but kept its identity. The old-established theories of weak interactions forbid this, but a family of new theories, due to Weinberg and others, requires such neutral currents. These new theories not only attempt to explain the weak interactions more fully ; if successful they will establish that the weak interaction and the electromagnetic interaction are two aspects of the same force.

Some properties of the weak interaction are very analogous to electromagnetic interactions at the most fundamental level. Both weak and electromagnetic processes are, for instance, described in terms of currents, a concept of quantum field theory which is remotely related to the everyday electric current. But calculations of weak processes have been very crude because the theory could not be "renormalized". Renormalization is the formal technique which removes infinities and other nonsense properties from the theory of quantum electrodynamics and allows exact calculations to be made for electromagnetic processes. The new theories attempt to renormalize the weak interaction too, but in doing so they predict hitherto unobserved phenomena. In order to cancel out infinite terms from the crude conventional calculation of weak processes, other unconventional infinite terms must be introduced. These terms are not just mathematical tricks. If they are present they will give rise to one or two physically observable properties ; neutral weak currents of the kind Gargamelle has probably discovered, or a new type of heavy lepton like a massive electron or muon. Some theories require both neutral currents and heavy leptons. Groups at CERN and at the National Accelerator Laboratory at Batavia, Illinois, are looking for heavy leptons but no firm claims have yet been made, though a Harvard group at NAL, led by Rubbia, has also reported evidence for neutral currents.

So far only a fraction of the film from Gargamelle has been analysed. But to understand the neutral currents more thoroughly it will be necessary to study them in neutrino interactions on hydrogen, as well as collecting more of the events on heavy nuclei from the present Gargamelle experiment. One of the most readily available devices for studying neutrino-hydrogen interactions is Gargamelle herself, but with a propane filling (C_3H_8) instead of freon (CF_3Br). Gargamelle is better than a pure hydrogen chamber for this work because the propane is a denser liquid, which will detect many of the neutrons and gamma rays in the final state. Because there is pressure at CERN to close down Gargamelle before the propane experiment can take place, to save money for the new accelerator, a brisk debate is in prospect. The supporters of Gargamelle are not expected to go to the same lengths in defending their case as did their sixteenth century predecessors. D. M.

Thermoluminescent Dating

THE various phenomena of luminescence provide useful diagnostic tools for the study of electron states in solids. Among them is thermoluminescence, which has been applied since the late 1940s to the dating of geological minerals and more recently to the dating of archaeological specimens, particularly by M. J. Aitken and his team in Oxford. The same phenomenon is now in common use for dosage measurements in radiology.

Many non-metallic solids are at least feebly luminescent and of these many show the thermoluminescence effect, that is, emission of luminescence on warming in the dark after suitable excitation at ordinary or lower temperatures. In the case of minerals and archaeological samples the excitation is the result of the cumulative effects of exposure to radioactive inclusions in the material or at the original site. In the simplest cases, therefore, warming of such samples in the dark in the laboratory can give a light emission which can be a measure of the total dose of excitation and so, if the excitation is a steady process over the years, an indication of the sample age. By laboratory calibration with standard radioactive sources the time scale can be established.

The most elementary mechanism for the thermoluminescence effect is that which assumes excitation to put electrons into metastable states or electron traps from

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