PROPOSAL TO SEARCH FOR FRACTIONALLY CHARGED
PARTICLES IN A BUBBLE CHAMBER IN THE O2 BEAM

It has recently been suggested by M. Gell Mann (1) and by G. Zweig that there
may exist particles called the "quark" or "ace" with 1/3 of the electronic charge.
It is proposed to search for them using a bubble chamber in the O2 or O4 beams.
Other particles with charges in the range of about 1/6 to 2/3 of the electronic
charge would also be detected. The proposal is in two parts,
(a) to detect the existence of the quark,
(b) to observe and measure the properties of quarks.

A. DETECTION OF QUARKS

1. Method

The quark is detected by giving a track in a bubble chamber which is 1/9 that
of other beam tracks. Thus if the chamber is operated to give 27 bubbles per cm
then the quark would give a track of 3 bubbles/cm which is easily recognisable.
(the apparent bubble diameter is 1/50 cm). Any bubble chamber, hydrogen or heavy
liquid will do this.

It is proposed to run the PS at about 24 GeV/c. The O2 beam is set to give
a negative beam of about 10 tracks per pulse in the bubble chamber - this will
mean particles of apparent momentum of about 18 to 20 GeV/c will enter the chamber.
These particles would be almost all negative pions and would provide the calibration
tracks with which quarks would be compared. The electrostatic separators
would not be used, so that the possible masses of the quark which would be
observed would vary from zero up to kinematic limit of about 2.3 GeV.

2. Cross Section

Assuming a solid angle of $d\omega = 10^{-4}$ ster, and an apparent momentum bite of
3.6 GeV/c (i.e. $\Delta p/p = \pm 10$ o/o) then for 107 protons interacting in the target
every 5 seconds, the differential cross section to observe one quark in one hour's
running time would be $d^{2}\sigma/d\omega \; dP_{app} = 10^{-36}$ cm$^2$/ster. GeV/c. Assuming that the
quarks produced can be considered to be spread over a solid angle of $\approx 10^{-2}$ ster.
and to have an apparent momentum spread of $\approx 20$ GeV/c, then in one week's running
time with 15 o/o of the PS beam, the minimum detectable total cross section would
be $2 \times 10^{-39}$ cm$^2$. The 80,000 photographs taken could be scanned in one to two weeks.
The time to prepare the beam would be of the order of one hour.

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B. PROPERTIES OF QUARKS

1. Mass

If quarks are detected, then the three 10-metre separators would be used to measure the mass of the quark. The apparent momentum of the 02 beam could be reduced to obtain better mass resolution though this would also reduce the flux of quarks.

2. Properties of Quarks

If quarks are strongly interacting, their interactions and possibly the decay of $A_0$ might be studied.

C. OTHER USES OF THE Experiment

If the bubble chamber used should be a large hydrogen one, then the interactions of the calibration tracks, which are $\approx 18$ GeV/c negative pions, are of interest in the study of certain subjects in high energy physics. The limiting factor in the choice of subject is the momentum spread of $\pm 10$ o/o in the beam. To allow all subjects to be studied an acceptable momentum spread would be $\pm 3/4$ o/o for the 150 cm chamber and $\pm 2$ o/o for the 81 cm chamber.

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(1) M. Gell-Mann, Physics Letters 1st Feb. 1964