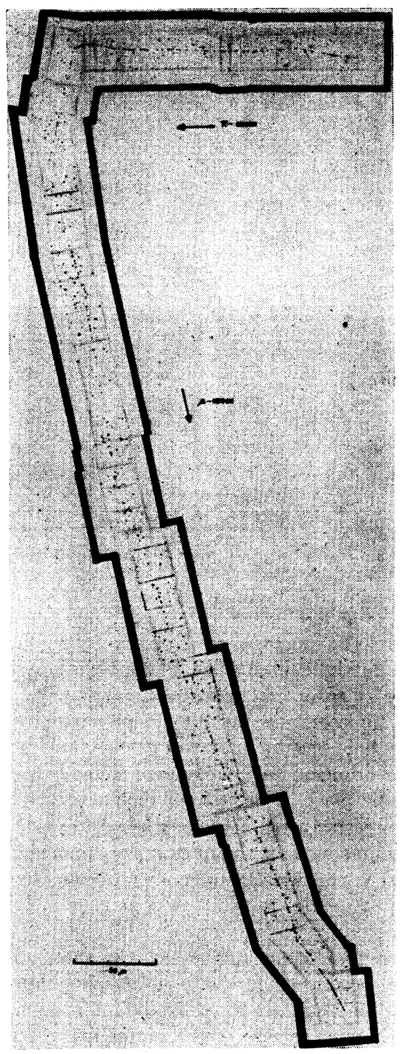

FIG. 2. Mosaic of photomicrographs of tracks of primary and secondary mesons. Leitz 114X, apochromatic objective. Observation by Joan Young.

The differences in the grain counts of the π- and μ-mesons are not great enough to give any positive indication of mass difference. In view of the shortness of the primary track and the statistical uncertainty involved because of the small number of grains, all we can say is that the possibility of a difference in mass cannot be excluded.

The plates were exposed over a six-week period, during which time they were flown 202, 187, 137, and 15 hours above 10,000, 15,000, 18,000, and 20,000 ft. respectively. They were developed for 15 minutes at 68°F in Kodak D-19 diluted with two parts of water to one of developer, with continuous agitation by mechanical means during development and fixing.

The photomicrographs were made by projecting the microscope image through a prism and mirror system onto a flat surface, each track being recorded on a strip of film in a film holder with two slides which could be moved to expose short intervals of the track, brought successively into focus on the top surface of one of the slides. The mosaic was constructed from a series of such strips.

We wish to acknowledge most gratefully the cooperation given by the British Overseas Airways Corporation in carrying the plates and in making available the time-altitude data, the painstaking work of the three observers who did most of the preliminary searching, Misses Joan Young, Shirley Young, and Berverley Mear, and the assistance of Mr. F. Morton in developing the projection scheme.

[1] Lattes, Muirhead, Occhialini, and Powell, Nature 159, 694 (1947).
[2] Lattes, Occhialini, and Powell, Nature 160, 453 (1947).

A Tentative Explanation of the Observed Mass of Mesons and Other Particles

E. G. CULLWICK
Defense Research Board, Department of National Defense, Ottawa, Ontario, Canada
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THE continued experimental discovery of elementary particles whose rest masses appear to have a wide range of values intermediate between those of the electron and the proton evidently calls for some simplifying principle.

The following suggestion, although entirely unorthodox and a reversion to pre-relativistic physics, may possibly be of some interest in this connection.

The following phenomena may be accepted as experimental facts:

(a) the mass of an elementary particle varies with velocity, and the relation $m = m_0[1-(v^2/c^2)]^{-\frac{1}{2}}$ has been verified as describing this variation, at least up to about $v=0.8c$.
(b) energy is directly convertible into mass according to the relation $W=mc^2$.

In relativistic physics, the velocity v in the mass-variation law is measured relative to the observer or, in actual practical experiments, relative to the laboratory. Suppose now that a Newtonian description of all physical phenomena is found to be possible (for example, Ritz's[1] work in electrodynamics and Dewar's tentative hypothesis of non-relativistic radiation[2]). Then velocities relative to the observer are not involved, and v in the mass-variation law (now regarded as empirical) must be measured relative to some specific inertial system.

Let us define this inertial system as the parent body from which an elementary particle is originally ejected. Then if the velocity of the parent body relative to the laboratory is small compared with that of light, there will be no appreciable difference in the mass of the ejected particle as deduced by the two theories. But if the velocity of the parent body is comparable with that of light at the moment a particle is ejected, there will be a difference.

Suppose, for example, that a nucleon (neutron or proton) of high energy, say of the order 10^{10} ev, collides with an atomic nucleus and that as a result it emits one or more electrons (+ or −) in random directions with very high energies, say of the order 10^9 ev. An emitted particle will move with velocity almost equal to that of light *relative* to the incident nucleon. A particle emitted sideways or forewards (if it escapes) will be detected as a high energy electron, but one emitted *backwards* will have a velocity in the laboratory equal to the *difference* between the velocity of the nucleon and the velocity of the electron relative to it. Thus its laboratory velocity will be sensibly less than c, the velocity of light. Its mass, however, according to the hypothesis suggested here, will be of the order 2000 m_0 in *all* reference systems, including that of the laboratory. Depending on its velocity, it will be interpreted by the usual experimental methods as possessing a rest mass somewhere in the range m_0 to 2000 m_0.

The excess of mass may be regarded as the storage of part of the energy which has been expended in giving the particle its high velocity relative to its original inertial system, the bombarding nucleon.

If also we suppose the surplus mass to be rather loosely tied to the electron, it seems reasonable to expect that it will be rapidly, or suddenly, converted back into other forms of energy, as it moves comparatively slowly in its new inertial system. One might also suppose that the instability of the particle would be a function of the increment of mass above that value appropriate to its velocity in the new inertial system.

In this hypothesis variable mass appears not as a relativistic effect, but as a result of true conversion of energy into mass according to the relation $W=mc^2$.

[1] W. Hovgaard, "Ritz's electromagnetic theory," J. Math. Phys. 11, 218–254 (1932).
[2] M. J. S. Dewar, "An interpretation of light and its bearing on cosmology," Phil. Mag. 38, 488–494 (1947).

Study of Turbulence by Light Diffraction*

J. C. HUBBARD, J. A. FITZPATRICK, W. J. THALER, LAURA CHENG, AND R. J. BEEBER
The Catholic University of America, Washington, D. C.
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IN the course of experiments on the distortion of progressive ultrasonic waves[1] we have been accustomed to estimate the complexity of the wave form by viewing the spectrum produced by the photographic negative of the acoustic wave system used as an optical grating in a spectrometer of small aperture, or by viewing or photographing the Debye-Sears pattern produced by portions of the sound field itself.

It has been found that turbulence in a fluid, however produced, may conveniently be examined by the same methods. A field of turbulence, instead of a system of sound waves, may be studied by visual or photographic

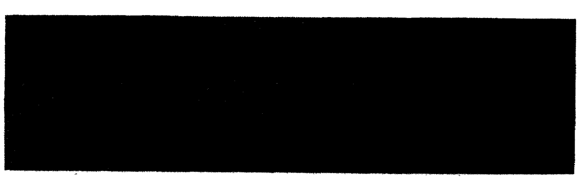
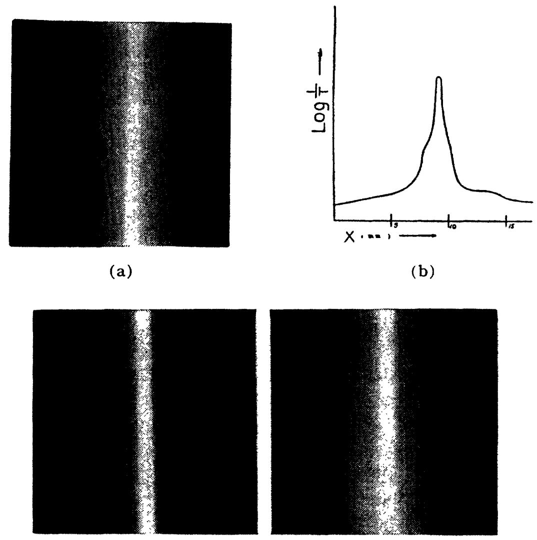


FIG. 1.



(a) (b)

(c)

FIG. 2.

inspection of the spectrum produced as in the Debye-Sears effect, or by the use of a photographic negative of the turbulence as an optical diffraction grating. In the latter method a photographic negative is prepared by allowing collimated light from a spark of 10^{-7}-second duration to enter the turbulent field, afterward being received on a photographic plate. A print from such a negative is given in Fig. 1, showing a jet of CO_2 escaping into air through a nozzle of 2-mm opening, the static pressure being 90 lb./in.^{2}. When used as an optical grating, with the negative masked so that most of the transmitted light passes through the region affected by the jet, and with the axis of the jet in this case perpendicular to the slit, the spectra shown in Fig. 2 are produced; (a) and (b) are, respectively, the diffraction spectrum produced by the full image of the jet, and the photomicrometer trace representing the density of the image of the spectrum (logarithm of the reciprocal of transmission *vs.* distance along axis perpendicular to the slit); (c) shows the diffraction effect when the half of the jet image near the orifice is used. This half contains less of the turbulent structure and more of the line structure, some of which is found to be closely associated with segment dimensions. In the spectrum (d), formed by the half of the jet image farther from the orifice, the continuous part indicates more turbulence and a finer structure (broadening of spectrum limits).

Direct visual observation of the diffraction spectrum of light passed through the jet, as in the Debye-Sears experiment, shows to better advantage the line system in which the intensity and number of lines is a function of pressure. These lines doubtless result in part from the system of sound waves which can be seen to originate in jet structures of sufficient intensity, as photographed by transmitted light from the very short spark.[2] Both methods of observation show the progressive change of turbulence to finer structure, an effect analogous to that previously found for