PROBLEMS IN THE MEASUREMENT OF IONIZATION IN TRACKS IN A CLOUD CHAMBER

W. B. FRETTER
UNIVERSITY OF CALIFORNIA, BERKELEY

The study of the interaction of nuclear particles at high energies gives information on the most elusive, yet the most important problems in the physics of elementary particles. In this study the nature of the particles created in an interaction must be determined. To identify such particles a property characteristic of a given kind of particle must be distinguished; the mass and the charge (including the sign of the charge) are sufficient to distinguish all known particles, although other properties may be used in some cases.

Suppose, for example, it is desired to study the interaction of a proton emerging from the new accelerator in CERN, in Geneva, with another proton in a liquid hydrogen target. In the collision, enough energy is available to create several particles: mesons, hyperons, anti-nucleons and nucleons, and if a full knowledge is to be gained as to the details of the interaction it is essential to identify the reaction products. It is also important to know the energies, momenta, and angular distribution of the products of the interaction.

It is not the purpose of this paper to describe all the methods available for the detection and analysis of the particles emerging from such a nuclear interaction. Rather, I will describe a particular method that has been used, which involves certain statistical problems that have not been solved.

A cloud chamber may be used for detection and identification of the reaction products. If the cloud chamber is in a magnetic field, the deflection of the particle may be measured, giving the sign of the charge and the momentum of the particle. To complete the identification of the particle, the velocity may be measured, which combined with the momentum, a function of the mass and velocity, yields the mass.

Since the operation of the cloud chamber is critical in the statistical problem, a brief outline of the principles on which the operation of this instrument is based is in order. A cloud chamber is a device which makes visible the tracks of charged particles passing through it. It contains a gas such as air or argon or helium, or a mixture of these, plus a vapor such as alcohol. When a charged particle passes through the chamber, leaving a trail of ionized gas behind it, the chamber is suddenly, adiabatically expanded. The resulting drop in temperature of the gas produces supersaturation of the vapor, which condenses preferentially