Chapter I

INTRODUCTION

When primary cosmic rays interact with the nuclei of gas on top of the atmosphere, many particles and radiations are produced. Some of these particles and radiations in turn produce other particles and radiations by means of nuclear collision, decay, bremsstrahlung and pair production. The particles and radiations produced by primary cosmic rays and in succession are called secondary cosmic rays. They rain down through the atmosphere and produce many kinds of interaction.[1] Some charged secondary particles are rapidly absorbed by the atmosphere by means of ionization, excitation, knock on process, bremsstrahlung and nuclear interaction. These charged particles are secondary nucleon, pions and protons. Most of the secondary neutrons evaporate from gas nuclei and most of them are absorbed by ^{14}N in the atmosphere to produce ^{15}N or ^{14}C.[2]

The interactions of the secondary cosmic rays already explained are called showers which are the common events in

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[1] Detail of interaction of cosmic rays in the atmosphere can be found in K. O'Brien, "Cosmic-Ray Propagation in the Atmosphere," Il Nuovo Cimento, 3A(1971), 521-547.

[2] Robert B. Leighton, The Principles of Modern Physics, (New York: McGraw-Hill Book Co., 1959), pp. 688-689.

the medium of cosmic rays. Showers can be classified into two types.

1. Showers produced by the soft component of secondary cosmic rays: this component comprises of electrons and photons. When electrons and photons incident upon the medium (e.g. lead) from the atmosphere, they multiply into showers and reach the maximum development at thickness of several radiation lengths of the medium. Then they will be exponentially absorbed.

2. Showers produced by the hard component of secondary cosmic rays: at sea level, the most abundant of cosmic rays is muon. This is due to the pion decays and the property of muon that produces very few interactions. Most muons traverse the absorber without interaction. Some muons produce high energy electrons and photons by electromagnetic interaction. These secondary electrons and photons will multiply into showers. These showers will increase and have a maximum at the average range of showers in the absorber. Then they decrease slowly. This type of showers can also be produced by protons and neutrons, however these particles are very rare at sea level comparing to muons.

Besides electrons and photons, many kinds of particles are produced from showers. The particles from lead absorber were first investigated by Rossi in 1933. He used Geiger-Muller counters and found two types of showers. Many workers after him used different techniques e.g. mass spectrographs,

cloud chambers and nuclear emulsions. Of all these techniques, neclear emulsion is the cheapest and very powerful to study the particles with very short lifetime e.g. pions (lifetime 10^{-10}-10^{-7} sec.). Many kinds of absorbers, e.g. lead, iron, copper, were used at different altitudes.

The experiment that was done at the Physics Building I, Chulalongkorn University, Bangkok, was to investigate what particles were produced under lead absorbers at sea level.