CHAPTER I

HISTORICAL INTRODUCTION

Cosmic rays are nuclear particles from the unknown sources, which come from outside the earth. These particles usually have large energy. Most of them have the energy in the range of billion electron volts. From the observations made to the present time it is found that these particles may come from the sun, the milky way, our own galaxy, and from the extra-terrestrial space.

This kind of particle was first studied by Wilson (1) and independently by Elster and Geitel. In the year 1900 Wilson found that there was the spontaneous ionization of gases, though the gases had been kept in a closed vessel and were not exposed to any known ionizing source. Later investigation was studied by Rutherford, Cook, McLennon and Burton in 1903(2). They showed that the rate of ionization in a closed vessel decreased when it was surrounded by a sufficiently thick layer of absorber.

Gockel sent a balloon up to 4,000 metres above sea level in 1910, and found that the rate of ionization increased with altitude. His results showed that the ionizing rays might come from outside of the earth. The extra-terrestrial origin was confirmed by Hess's experiments in the year 1912-13. He sent a number of balloon flights up to 5,000 metres above sea level and the ionization increased with height. The idea of Hess had been confirmed

by Kolhörster (1914-19), Millikan (1923-24), Hoffmann (1925), Behounek (1926), and at last it was accepted in the year 1926. This new kind of radiation is called cosmic rays.

Some of the most important discoveries can be described in chronological order in the following manner. During the year 1925-26 Hoffmann and Behounek observed the phenomena in the experiments with the ionization chamber under lead absorber. When the rate of ionization was studied as a function of absorber's thickness, the rate, under more than 10 centimetres of lead, decreased in the same manner as γ-rays. Under absorbers of thickness less than 10 centimetres they found that the rate of ionization decreased much faster than that of γ-rays. Nyssowsky in the year 1926 suggested that there might be directional distribution of cosmic rays. Hoffmann had studied a phenomenon which was called burst or stosse in 1927. The magnetic latitude effect was first observed by Clay in 1927. His experiments were made during the voyage between Amsterdam and Batavia, the results were not accepted until 1930. The cosmic ray intensity was found to vary with the atmospheric pressure by Nyssowsky and Tuwim in 1928. This effect was interpreted as the absorption of cosmic rays in air. Bothe and Kolhörster in 1929 observed cosmic rays by using two Geiger-Müller counters placed close above each other, and counted the coincidences between these two counters. In 1929 Skobelzyn found the cosmic ray stars in a photograph from cloud chamber. The first experiment to determine the intensity of cosmic rays under ground was carried out by Regener in the year 1930 in

a mine. The work of Bothe and Kolhörster using counter telescope was extended by Bruno Rossi in 1930, and in 1931 Johnson found that the intensitica of cosmic rays coming from the east and the west directions were not the same. This phenomenon is called the East-West Asymmetry. Blackett and Occhialini in 1933 found the tracks of positrons[1] in cosmic rays in cloud chamber. In this year Lemaitre and Vallarta developed Störmer[2] theory by deriving the equations of allowed cone and forbidden cone. At the same time Rossi discovered soft and hard components of cosmic rays. Bethe and Heitler in the year 1934(3) derived the formula for the cross section of radiation of accelerated electrons. This is very important since it shows that the electronic component in cosmic rays cannot have high energy. Longitude effect was first found by Clay, Alphen and Hoft in 1934. Their experiments were carried out on a voyage along the magnetic equator. In 1935, Yukawa suggested the theory of μ-meson, and it was experimentally discovered by Anderson in cloud chamber. The μ-meson was later found in cosmic rays by photographic method. The results of Street and Woodward in 1935 showed that the soft component of cosmic rays cannot pass through the thickness of 10 centimetres of lead. The hard component is the penetrating particles. In 1937 Bhabha and Heitler

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[1] The positron was first discovered by Anderson in 1932.

[2] Störmer suggested the theory about the year 1900.

found the cascade shower arising from electrons, photons, and photon produced positron-electron pairs. And in the same year Blau and Wambacher found cosmic ray stars in the photographic plate. Bennett in the year 1948 performed an experiment to prove Störmer theory. He found that the particles could be reflected or trapped by the earth's magnetic field. During the International Geophysical Year (IGY) from July 1, 1957 to December 31, 1958, cosmic rays were studied by scientists almost all over the world. It was found that the strong intensity of cosmic rays occurred are caused by solar flares and the appearance of sun spots. Near the end of the IGY, Van Allen announced that there were two dense radiation rings around the earth. From the rocket flight in 1963 O'Brion found that these belts can change their shapes and position due to the solar wind from the sun. And it was found by using satellite Pioneer V that the particles in the streams of plasma from the sun during the solar flares and sun spots are not high energy. Then it seems that the belts behave as if they were high energy accelerators in space for accelerating charged particles driving the particles from time to time to the earth.

In the course of these investigations, it may be summerized in a general manner that cosmic rays can divided into two components. These are the soft of lower energy while the hard component which is of higher energy cannot be easily

absorbed. In the present investigation, the experiments are performed for the first time to observe the soft and hard components of cosmic rays at ground level at the Physics Building, latitude 13°46'(N) by using counter telescope running continuously for a period from July 16, 1963 to September 18, 1963.