PREFACE

A new field of research in high energy physics was begun soon after the discovery of CRs by Victor Hess, and studies are still continuing with constantly improving direct and indirect techniques. But, despite extensive theoretical and experimental efforts, the fundamental questions like their origin, and acceleration mechanism are still under consideration. The mass composition of primary CRs over the whole primary energy spectrum would unfold some of the models related to the origin, acceleration and propagation of primary CRs. But it is very formidable from both the experimental and theoretical points of view to know the exact mass composition of CRs in the very-high-energy (VHE) to ultra-high-energy (UHE) region from their fluxes.

Important information on primary CRs with energies more than 10^{14} eV can be known only through indirect methods. A CR particle coming from its accelerator site interacts with atmospheric nuclei and produces a bunch of secondary particles which consists of three categories of particles; electromagnetic, muonic and hadronic components. In addition, there are fluorescence and Cherenkov photons, and very weakly interacting neutrinos and very fast muons. There is also radio emission from the propagation of lighter charged particles in an EAS. Any detection of an EAS by means of ground based detector-system equipped with particle detectors supplies directly information on arrival times and densities of cascade particles. Suitable lateral density functions (LDFs) are used to describe the lateral density distributions of the electromagnetic and muonic components of an EAS initiated by protons and other nuclei. Then analyzing directly accessible density, arrival time data of secondary particles of an EAS, the basic EAS observables can be obtained.

In the following chapters (Chapter 3 - Chapter 7), we have introduced quite a few relatively new CR mass sensitive air shower observables applying some relatively new EAS data analysis methods. Moreover, the practical realization of some of these proposed methods on real experiments are described in the thesis. In some cases, our results obtained on the CR mass composition from these analyses are compared with published EAS results by the NBU and KASCADE experiments.