SUMMARY AND FUTURE OUTLOOK

In this volume, we have reported the development of a spark chamber magnet spectrograph and some results obtained on the low momentum muon flux and charge-ratio. In its present form, this spectrograph was rudimentary in construction. The geometrical factor was 0.31 cm^2 sterad and, consequently, the count rate of the system was 7.8 events/hour. The lack of sophistication, owing to severe technical and financial limitations, restricted its range of momentum detection to ~2 GeV/c. The vertical muon momentum spectrum obtained with this set-up is in agreement with the measurements of other workers. However, towards the momentum region > 1.2 GeV/c, the present spectrum becomes slightly steeper as compared with the others'. The spectrum calculated after Barrett et al. agrees well with our measurements. The observed charge-ratio is 1.10 $\pm$0.06.

There are three possible ways of increasing the range and improving the performance of this spectrograph; (i) by increasing the magnetic field line-integral, so that the scattering to deflection ratio improves, (ii) by increasing the width of the chamber, and (iii) by improving the quality of the track and the recording system.

We have pushed the magnetic field about as far as possible. The only possibility is to fill-up the pole-gap with magnetic material. In that case the scattering becomes considerably large and the purpose of increasing the field will be lost. A superconducting magnet is the obvious solution.

By increasing the width of the gap of spark chamber, the angular resolution of the spectrograph is improved. As mentioned in (Sec. III, Part A) , the single gap width can not be increased too much because of high voltage requirements. However, the lever arm of the chambers can be increased by using two chambers for recording the incoming track and two for recording the deflected track. If each of them is 10 cm wide, then with a seperation of 10 cm between the two chambers, an effective gap width of 30 cm can be obtained. The problem of high voltage requirements is also solved in this manner. But tracks in such a set-up can not be recorded directly by a single camera. An elaborate mirror arrangement is required for folding the optical path from chambers to camera.

Though the quality of the track depends on the gas purity, still it can be improved by reducing the delay in the electronics circuits. If, in place of slow GM-counters, faster scintillators are used, the situation can be improved considerably. There are additional advantages of using scintillation counters- a clear cut distinction can be made between muon, electron and proton. We can then repose greater confidence in the value of charge-ratio. An alternate technique for such measurements is ionization calorimeter.

These days, magnetic spectrographs capable of measurements in the TeV region are being developed to study the hadron-hadron interactions and the composition of primary cosmic-rays in the energy region $> 10^{12}$ eV. But the author believes that the lower energy region (<5 GeV) still needs more studies- both theoretical as well as experimental. For example, little information exists about the charge-mixing in hadron-nucleus collisions in the lower energy region. A more elaborate and careful study of the charge-ratio of muons will throw revealing light on this parameter.

The spark chamber technique, per se , holds good future. Its application in the study of the role of cosmic-rays in the atmospheric phenomena has been envisaged. The elegance and comparative simplicity of operation will make this technique favourite for many more studies of this nature.