The Relationship between Zenith Angle Dependence of Cosmic Ray and Geomagnetic Activity

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INTRODUCTION

What are cosmic rays?
- Radiation coming from space.
- 90% of them are protons.
- Primary cosmic rays are converted to secondary cosmic rays like muons.

Previous research about anisotropy
- "East-West Effect"
- "Zenith angle dependence: $\cos^2\theta$"

Our objective
- To find the time-dependence of cosmic ray anisotropy in effect of space weather condition.
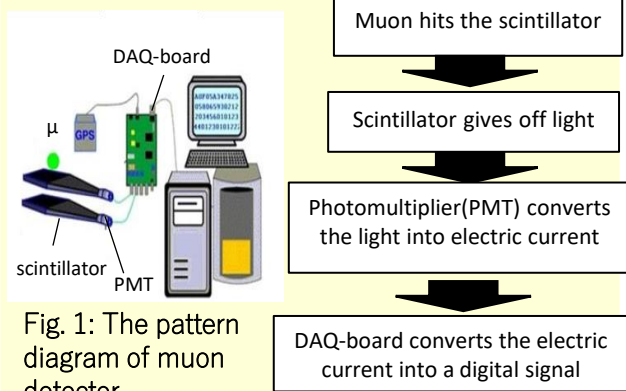
Geomagnetic activity
- K index is the index representing the geomagnetic activity which is one of the space weather condition.
- The larger the K index, the more active geomagnetism.

HYPOTHESES

1. Zenith angle dependence of cosmic ray follows the relation of empirical $\cos^2\theta$.
2. The higher the K index, the greater the deviation from the $\cos^2\theta$ relation.

METHODOLOGY

I. Use the "Cosmic Ray Muon Detector"
II. Set a pair of scintillator plates 90 cm apart from each other.
III. Observe flux using 2-fold coincidence at zenith angles of 0, 15, 30, 45, 60 degrees facing the South.

Muon hits the scintillator

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Scintillator gives off light

↓

Photomultiplier(PMT) converts the light into electric current

↓

DAQ-board converts the electric current into a digital signal

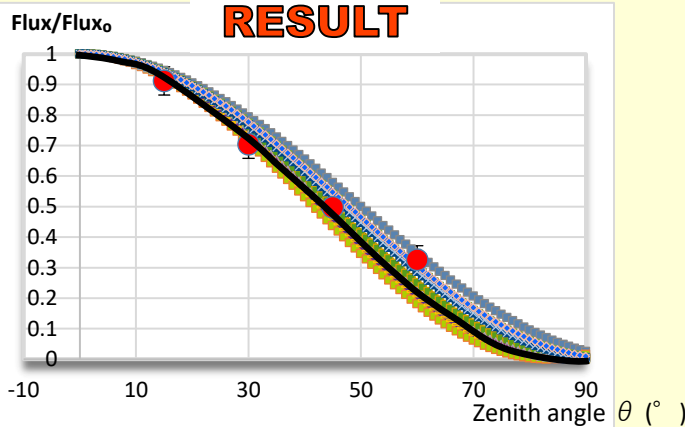Fig. 1: The pattern diagram of muon detector

RESULT

Fig. 2: The zenith angle dependence of the flux

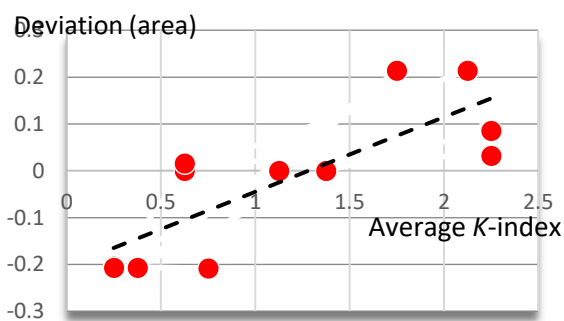- The zenith angle dependence of the flux approximately follows $\cos^2\theta$ graph with some deviation.

Fig. 3: deviation from $\cos^2\theta$ vs. K index

- There is a positive correlation between the flux deviation from $\cos^2\theta$ and the K index of geomagnetism.

DISCUSSION

- The larger the K index is, the larger the deviation becomes because cosmic ray is affected by geomagnetic activity.
- The geomagnetic disturbance may cause the deviation from the normal zenith angle dependence of cosmic ray.

CONCLUSION

1. The zenith angle dependence of cosmic ray flux was consistent with the empirical relation ($\cos^2\theta$).
2. The deviation from the $\cos^2\theta$ relation increases when geomagnetism is more active or the K index is larger.