Geomagnetic Effects at Low and High Altitudes Due to Cosmic Rays

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Introduction

The cosmic rays measured by means of ionization chambers. These instruments were able to record the total ionization produced by the cosmic rays, but failed to distinguish the direction or energy of the cosmic ray particles. The discovery of Geiger Muller counters and development of coincidence circuits provided a simultaneous recording of counts. The G.M. Counters were used in the form of telescope, the cosmic rays coming in the direction of the telescope produced gas discharges in the counters simultaneously. The cloud chambers, proportional counters and photographic plate techniques have been playing on ever-increasing role in cosmic ray research.

Early work demonstrated the effect of the earth magnetic field on the cosmic radiation and showed that geomagnetic latitude was a more direct parameter of the radiation than was geographical latitude. Although the magnetic field of earth is weak, it extends out for large distances and acts on incoming charged particles for an appreciable length of time.

The field is represented by a dipole of magnetic moment 8.1×10^{18} maxwell meter, situated at the center of the earth with its axis emerging from the earth at the points called the geographical poles. These poles are located at 78.5°N, 69.0°W and 78.5°S, 111.0°E. The following effects well observed:

1. The intensity of the cosmic rays changes with both geomagnetic latitude and longitude. These effects are referred to as the latitude effect and longitude effect.
2. The intensity of cosmic rays changes not only with the inclination between the direction of incidence and the vertical but also with azimuth. The cast-west and north-south asymmetries are most pronounced.

Effect at Low Altitudes

The magnetic latitude effect was first observed by clay (1927). It was further studied by Compton and his coworkers. Seventeen physicts equipped the cosmic ray intensity at sixty nine stations distributed over the whole world. This combined work showed the dependence of cosmic ray intensity upon geomagnetic latitude. The latitude

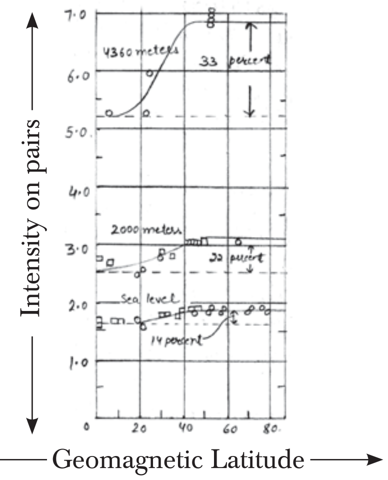

Fig. Compton & milkman is observations of cosmic rays intensities

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effect can be expressed by quantity g, the relative change of intensity between geometric equator and pole i.e.,

$$R = (I_{q0} - I_0)/I_{q0}$$

Cosmic ray intensity as a function of geomagnetic latitude at three attitudes were observed by A.H Compton in 1933.

The intensity was measured by the no. of ion pairs produced by cosmic rays in 1 cm^3 of air at normal temperature and pressure. The measurement showed that the latitude effect became more pronounced as the attitude increased. R is found 33%, 22% and 14% at the attitudes 4360 m, 200 m and sea level respectively.

It was observed by Clay, Alphen and Hooft (1934) that the cosmic ray intensity depends not only upon the geomagnetic latitude but also on the geomagnetic longitude. The intensity is maximum near Peru and minimum near the Philippines. The minimum coincidence with the closest approach to the centre of the equivalent magnetic dipole.

It was found by Rossi and clay and by Johnson and street that the cosmic ray intensity inclined at an angle q to the west from the vertical is larger than the corresponding intensity of the radiation inclined at a same angle to the east from the vertical. The north-south asymmetry was observed by Johnson, Clay and Rossi.

On the northern hemisphere the intensity from the south was found to be larger than from the corresponding direction inclined to the north.

Effects at High Altitudes

The cosmic ray intensity has been measured by Milikan, Neher and Others upto very great heights with instruments carried in aero planes and balloons. The latitude effect extends only upto geomagnetic latitudes of about ±50°. The intensity of the cosmic ray increases very rapidly upto this latitude. It remains constant from 50° the magnetic poles. This independence of intensity upon this latitude is called latitude cut off. Below the latitude cut-off, the latitude effect increases very rapidly with altitude for instance, the intensity above the equator at 7 km height is roughly one half of that at high latitudes.

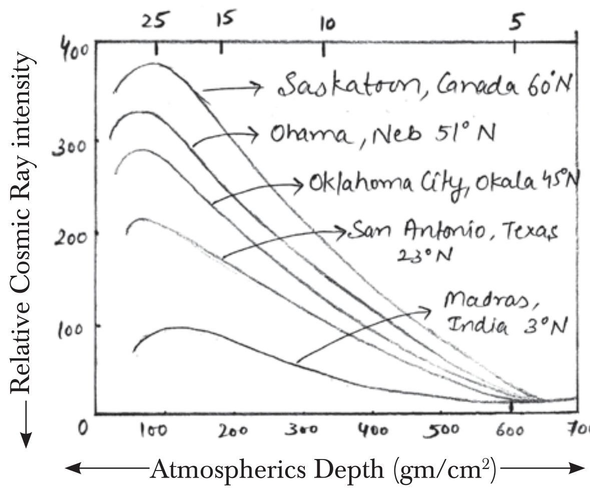

Fig. Variation of Intensity with pressure

The cosmic ray intensity were observed by Bowen, Neher and Milkam (1938) atplaces situated at four geomagnetic latitudes.

1. Saskatoon (Canada) – 60°N
2. Ohama (Nebraska) – 51°N
3. Sam Antonia (Texas)–38°N
4. Madras (India)–3°N

The ionization chambers were carried out by balloons upto 30 km into the atmosphere where the pressure was only 10 gms/cm^2 only. It was found that the cosmic ray intensity increased around 8.5 km and then decreased rapidly as shown in fig. the maximum imization observed at high attitude is not the same at all the geomagnetic latitudes.

The curve at, – 60°N shows that the maximum intensity is about 40 times larger than the intensity

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at sea level. The difference in these two intensities is not so large in the equatorial region.

Conclusion

This shows that intensity of cosmic radiation varied with the geomagnetic latitude. This was interpretated as the effect as the effect due to the earth's magnetic field on the incoming cosmic rays and the cosmic radiations were thought to be consisted of electrons and gamma rays. The intensity of radiation arriving from the west was larger than that from the east.

This led to the conclusion that cosmic radiations are predominantly positive charged particles.

References

Bhabha, H.J., Proc. Ray Soc. A 152, 559 (1935), A 154, 195 (1936), A 164, 257 (1938)

Bhabha, H.J. and W. Heitler, Proc. Roy. Soc., A 159, 432 (1937)

Cranshaw, T.E., "Cosmic Rays", Oxford University Press, 1963.

Rossi Bruno, "Cosmic Rays", MC Graw Hill, Inc. 1964

Montgomery, d.J.X., "Cosmic Ray Physics", Princeton University Press, 1949

Burbidge, G., "The Origin of Losmic Rays", Scientific American, 2015, No 2, 32 (1966)