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B-3(H), paper VI

Nuclear Physics

Soft and Hard cosmic rays :-

Q :- Distinguish between hard and soft cosmic rays and describe the composition of each components.

Ans :- The cosmic rays consists of two different types of radiations, namely the soft and hard components. The portion of cosmic rays which is able to penetrate up to 10 cms, of lead is refered to as soft component while the portion which is able to penetrate even further and is absorbed only with difficulty is known as the hard component. Cosmic rays have been detected under ground and under water at distance equivalent to 1400 meters of water below the earth's surface which speaks of their extreme penetrating power. Such penetrating power particles have billions of ev energy.

The presence of soft component has been detected at great depth below

sea-level which is produced at great by the extremely hard component even at these great depths,

Compositions :- Detailed studies of the penetra-ting and ionising powers of hard and soft components at various latitudes and altitudes have shown that the hard component mainly consists of highly energetic mesons which have mass intermediate between that of electrons and proton and which may be charged and neutral. The hard component is also comprised of a small number of fast protons and a still smaller number of nuclei of heavier atoms; these are primary cosmic ray particles. A few neutrons, electrons and photons of extremely high energy are also present in the hard component. The extreme penetrating power of the hard component is attributed to the presence of mesons in it.

The soft component is essentially comprised of electrons, positrons and photons. A smaller number of slow mesons, neutrons, protons and heavier particles are also believed to be present in this component. The soft component is believed to be presumably secondary in nature.

The electrons in the soft component are believed to be produced in three different ways. First, the charged π-mesons decay in to μ-mesons which in turn emit either +ve or -ve electrons depending upon the sign of the mesons. Secondly, the decay of neutral mesons accompanies the liberation of high energy ray photons, which can produce electron-positron pair on encounter with atomic nuclei. This latter process is known as pair for motion. And thirdly many electrons are produced as a consequence of impact mesons with the orbital electrons of O_2, N_2 atoms in the atmosphere. Electrons during passage through matter (or air) interact with atomic nuclei and produce x-rays. This accounts for the presence of photons in the soft component. These photons can produce electron-positron pair provided their energy is greater than 1 Mev. The production of photons by electrons and the subsequent conversion of photon in to electron-positron pairs result in multiplication of electrons. This multiplication helps in maintaining the concentration of electrons in soft components of cosmic rays.