Major components of Cosmic rays at the top of the atmosphere

Cosmic Rays at sea level:

They consist of several different types of nuclear particles

Most abundant are electrically charged muons which penetrate large amounts of shielding.

Next most abundant are neutral particles called neutrons

... Reactors produce neutrons too

There are electrons and protons too – however less abundant than muons and neutrons.

About 300 particles traverse our bodies each second and they deposit some energy in our body and may cause some damage to body cells.

How does the cosmic ray intensity increase with altitude?

In 1913-14 Victor Hess first studied this with ion chambers in a balloon – his results are shown in figure:
Effect of Earth's magnetic field on cosmic rays:

Magnetic field of the earth's dipole can deflect charged cosmic rays as they enter the field. Positive particles deflect one way and negative particles the other way. This leads to a predictable asymmetry for particles coming from easterly direction as compared to particles coming from the westerly direction – East West Effect

Arthur Compton first measured this effect and proved that most of the cosmic rays are positively charged.

Later it was shown that they were mostly protons.
Computer simulated cosmic ray tracks in the galaxy:
Two views

Solar Wind: Archemdian Spirals

Solar Wind and modification of Earth's magnetic field
Magnetopause and magnetoail are shown.

Cosmic ray trajectories in the Earth's magnetic field
Most of the cosmic rays trapped in Van-Allen Belt are Solar Cosmic Rays
They are of relatively low energies.
They are mostly protons and/or electrons
If a space vehicle spends time in a Van-Allen belt region then the space vehicle gets a lot of low energy radiation – so much so that instruments have to be turned off and astronauts have to be protected against radiation – by staying inside the space shuttle.
How much damage does a charged cosmic ray particle do?

How much energy does it deposit and how can you understand its magnitude?

If a trillion (1000,000,000,000) cosmic rays traverse an object per second then they would deposit 3.2 watts of energy!

Another way of saying this: Astronauts inside the shuttle would, in one week, get a dose of radiation of about 210 milli-Rems which is what a person receives at ground level in one year. This is due to passing through the radiation belts.
100,000 COSMIC RAYS WILL HIT YOU IN THE NEXT HOUR!
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A negatively charged particle would be deflected into the paper
The moving charged particle deflects in the magnetic field and emerges from the field region in a different direction. It is bent in the magnetic field. The deflection is smaller for faster moving particles.

Dots represent uniform magnetic field pointing upwards in the region indicated by circle. Outside there is no magnetic field.
Circles represent Magnetic clouds with differently oriented magnetic fields.

Line represents the trajectory of a charged particle. Note that information about initial direction of the charged particle is lost.
Computer simulated cosmic ray tracks in the galaxy: Two views

Fig. 4.10. Trajectories of particles with energies of $5 \times 10^{17}$ eV in the galactic magnetic field with a regular field in the halo. The lower figure shows the projection on the $xy$ plane parallel to the plane of the disc and the upper figure the projection on the $xz$ plane.
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Solar Wind and modification of Earth's magnetic field Magnetopause and mangetotail are shown.
Cosmic ray trajectories in the Earth's magnetic field
Distant sources of cosmic rays

Charged cosmic ray

Gamma Ray not deflected by magnetic fields – points to source
Magnetic Field of the Earth and trapping of Cosmic rays in Van-Allen belts.
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