The Hunt for Cosmic Bullets

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Abstract. The Earth is exposed to a permanent rain of cosmic particles from outer space which we call cosmic rays. Most of the particles are fully ionized atomic nuclei, moving with relativistic energies. The bulk of them with energies up to 1017 eV originate within our Milky Way. Some particles have a thousand times higher energies, i.e., around 1020 eV. Such high energy cosmic rays are often referred to as cosmic bullets. They travel through the universe with an energy that is a million times bigger than in the largest particle accelerator on earth. With almost the speed of light, they collide like bullets with the atmosphere, before falling apart into a cascade of secondary particles.

To clarify the origin of the highest-energy particles, their properties like energy, arrival direction and the particle type (photons, protons, atomic nuclei) have to be measured. The highest-energy cosmic rays are extremely rare. At earth one particle is registered in an area of 100 square kilometers in a hundred years. Measurement of such particles requires a huge measurement device that is operated for a long time.

The Pierre Auger Observatory, located on a vast, high plain in western Argentina, is the world's largest cosmic ray observatory. The objectives of the Observatory are to probe the origin and characteristics of cosmic rays above 1017 eV and to study the interactions of these, the most energetic particles observed in nature. The Auger design features an array of 1660 water Cherenkov particle detector stations spread over 3000 km2 overlooked by 24 air fluorescence telescopes. In addition, three high elevation fluorescence telescopes overlook a 23.5 km2, 61-detector in filled array with 750 m spacing. The Observatory has been in successful operation since completion in 2008.

In this contribution an overview of the history of cosmic rays research, cosmic ray basics and design of modern experiments aimed at measuring ultra high energy cosmic ray properties will be discussed.