

Probing particle physics from colliders to cosmic rays by very large experiments.

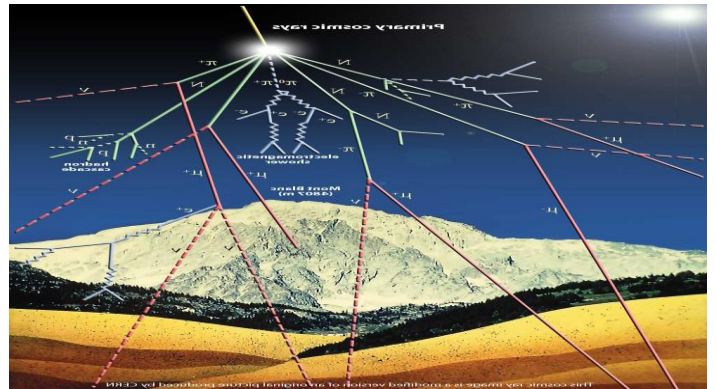
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Abstract

This work explores how modern particle physics investigates the fundamental structure of matter and forces. This is done through a combination of collider-based and cosmic ray experiments, both relying on extremely large-scale scientific infrastructures. Collider experiments, such as those conducted in high-energy particle accelerators at CERN for example, provide controlled environments where particles are accelerated to near-light speeds and made to collide and produce a multijet of very high energetic particles. These collisions recreate basically conditions like those existing just after the Big Bang, enabling precise tests of current theoretical models like the Standard Model of high energy physics and facilitating discoveries such as new particles.

In parallel to that, cosmic ray experiments study naturally occurring high energy particles originating from astrophysical galactic and extragalactic sources. These particles reach energies far beyond those achievable in human-made accelerators, offering a unique window into extremely physical processes occurring in the universe. Large scale observatories can detect secondary particle showers or extragalactic neutrinos produced when cosmic rays interact with Earth's atmosphere or surrounding matter. Such kinds of experiments extend the energy frontier and probe phenomena inaccessible to collider physics in laboratories. The integration of these two complementary approaches provides complementary



insights: colliders deliver precision and repeatability, while cosmic ray studies offer access to ultra-high-energy regimes and astrophysical phenomena.

Both require massive detectors and collaborative international efforts due to the rarity of significant events and the complexity of measurements. Together, these very large experiments bridge particle physics and astrophysics, advancing our understanding of physical fundamental questions such as the nature of dark matter, composition and origin of cosmic rays, and the possible existence of new physical laws beyond current theoretical models.

Biography



Author is a Moroccan university professor affiliated with the Mohammed First University (UMP) in Oujda. He is associated particularly with the Faculty of Sciences (FSO), where he contributes to teaching and scientific research. He has been involved in academic and research activities at the university level, including participation in international scientific collaborations including ATLAS experiment and MoEDAL at CERN (2005-today) in Geneva. HESS experiment in Namibia (2003-2005), HERAB experiment at DESY in Hamburg (2000-2003) and MACRO experiment at Gran-Sasso in Italy (1997-2000). His main field of interest is Particle Physics, Accelerator Physics and Quantum Information. Recently he is working on CLS accelerators combining electron beams and laser light sources. Throughout his career, he has supervised numerous PhD theses both in Morocco and abroad, contributing significantly to the training of researchers and the advancement of scientific research. He has also participated in international collaborations as team leader and scientific events as key speaker. Thanks to the quality and impact of his work, he is considered among the most prestigious researchers in the field of high energy physics. He is the head of the doctoral center at UMP.

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