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Development of a Web-Based Educational Environment Using Atmospheric Muon Simulations for Particle Physics Education

University-level particle physics education faces challenges associated with understanding microscopic phenomena that, due to their abstract nature, are often addressed primarily through theoretical and mathematical formulations. Although specialized tools are available for simulating atmospheric particles and processes related to cosmic radiation, such as GEANT4 (Agostinelli et al., 2003) and CORSIKA (Heck et al., 1998), many of these developments have been primarily designed for scientific research and experimental applications, which limits their incorporation into undergraduate educational contexts. Consequently, there remains limited integration between scientific simulation and interactive educational resources specifically designed for university-level particle physics education.

In response to this situation, the present research proposes the development of a web-based educational environment using atmospheric muon simulations, aimed at supporting the conceptual understanding of phenomena related to particle propagation, radiation–matter interactions, and special relativity among undergraduate students in the Physics program at Universidad de Nariño. The proposed environment seeks to adapt scientific simulation capabilities to an educational context through interactive representations of physical variables associated with the behavior of atmospheric muons in a browser-accessible resource.

Methodologically, the research will follow an applied approach with a descriptive and exploratory scope, structured into four phases: a literature review and analysis of scientific, computational, and educational background; integration of simulations based on specialized frameworks; design and implementation of the interactive web environment; and a pilot application with undergraduate students to explore its potential use as a conceptual learning support resource. Technical and pedagogical analysis instruments will be employed, including perception questionnaires and observation records.

As an expected outcome, the study aims to produce a functional prototype of a web-based educational environment capable of adapting scientific simulation tools to university-level particle physics education and providing a preliminary assessment of its usefulness as a conceptual support resource in undergraduate educational contexts.

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