Probing the hidden nature of the universe by high energy physics simulations of Big Bang nucleosynthesis and AGN

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A major challenge in cosmology and astrophysics is explaining the origin of elements. The study focuses on identifying nucleosynthesis in the early universe using the Geant4 simulation toolkit, specifically Hadron Physics package, to model nuclear processes fundamental to Big Bang Nucleosynthesis (BBN). Alpha particles colliding with Galactic material initiated nucleosynthesis, producing new particles subsequently incorporated into the surrounding medium. Successive interactions with additional alpha particles advanced further synthesis. The research identifies the nuclear reactions involved in the synthesis of all elements, along with their initiation energy, initiation temperature, and Q-values. The investigation found elements up to Z=238 in nucleosynthesis. Furthermore, it can be concluded that initiation energy and temperature increase nearly linear with the atomic number, up to Z=108 and transitioning to exponential growth beyond Z=108 up to Z=238, explaining the current elemental limit at Z=118. Notably, nuclear synthesis reactions exhibit negative Q-values, indicating they are endothermic. The presence of negative Q-value nuclear synthesis aligns with the energy-absorbing nature of black holes and suggests a novel mechanism for the generation of elements in these extreme zones. Furthermore, the study proposes that relativistic jets could carry signatures of newly formed elements synthesized in such energetic environments, aligning with temperatures. This provides new insight into the astrophysical role of black holes in cosmic element formation. This suggests that the energy and temperature patterns observed in these nuclear reactions are quite similar to what scientists believe happened during the Big Bang, providing a possible explanation for the role of negative Q-value reactions in initiating it. The study discusses how energy-to-matter conversion contributes to universal expansion, while matter-to-energy conversion underpins compression, linking Q-values to cosmological dynamics. These insights provide a novel interpretation of the Universe's evolution through phases of Inflation, Expansion, Steady State, Compression, and eventual Collapse, governed by the thermodynamics of nuclear synthesis.

Keywords: *Nucleosynthesis, Relativistic Jets, AGN, Energy-Matter Transformation, Physics of the Cosmos*