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Using Ultrahigh Energy Cosmic Rays to Probe New Physics

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Due to the uncertainty principle, higher and higher particle energies are required to probe smaller and smaller physical scales. In the near future, earth-based particle accelerators may be able to achieve the TeV scale but to go beyond this, one must use the cosmic accelerators that nature has provided such as ultrahigh energy cosmic rays. The flux of these particles is expected to be dramatically attenuated by photomeson producing interactions with the cosmic microwave background as first pointed out by Greisen, Zatsepin and Kuzmin in the 1960s (the GZK effect). Yet some particles have been observed at energies above the GZK cutoff, and in particular by the Akeno array, which is in possible contradiction to the attenuation effect. We may indeed be seeing new physics beyond the standard model such as quantum gravity, extra dimensions, or string theory coming into play. For some of these effects, the modified particle energy spectrum can be calculated which leads to a lessening of the GZK effect. Such theoretical studies combined with new experimental data that will soon be available from the Auger array may lead to a revolution in our understanding of fundamental physics.