Origin of the Bekenstein-Hawking entropy, Einstein-Hilbert action, and a dark matter particle that should be detected in the next 2-5 years

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This talk is based on the 3 papers cited below. The following results are obtained in Ref. [1] and a paper under review.

Starting with the simplest imaginable picture, and interpreting our universe as the product of two spaces with topological singularities, we obtain the following results: 4-dimensional spacetime with one time coordinate; spin 1/2 fermion and spin zero boson fields defined on this spacetime; path-integral quantization of these fields; gauge fields and a fundamental gauge theory which is necessarily SO(N); correct couplings of matter fields to the gauge fields; a gravitational vierbein; correct couplings of matter fields to gravity; Lorentz invariance; supersymmetry at some energy scale; elimination of the usual enormous cosmological constant; the Einstein-Hilbert action for gravity; the Bekenstein-Hawking entropy of black holes; and a new set of particles, including a new dark matter WIMP which should be detectable in the near future.

This dark matter candidate is consistent with all current experiments, and observable in the near or foreseeable future through a wide variety of direct, indirect, and collider detection experiments. To review the conclusions of Refs. [2] and [3]: This particle is unique in that it has (i) precisely defined couplings and (ii) a well-defined mass of about 72 GeV, providing specific cross-sections and other experimental signatures as targets for clean experimental tests – for example, in direct detection experiments which should be fully functional within the next few years, including XENONnT, LZ, and PandaX. The cross-section for collider detection at LHC energies is small – roughly 1 femtobarn – but observation may ultimately be achievable at the high-luminosity LHC, and should certainly be within reach of the even more powerful colliders now being planned. It is possible that the present dark matter candidate has already been observed via indirect detection: Several analyses of gamma rays from the Galactic center, observed by Fermi-LAT, and of antiprotons, observed by AMS-02, have shown consistency with the interpretation that these result from annihilation of dark matter particles having approximately the same mass and annihilation cross-section as the present candidate.

[1] Roland E. Allen, arXiv:1101.0586 [hep-th].

[2] Reagan Thornberry et al., EPL (Europhysics Letters) 134, 49001 (2021).

[3] Caden LaFontaine et al. Universe 7, 270 (2021).