Brief Report

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Brief Report

Significance and Source of the Sun Goddess Cosmic Ray

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Abstract

We show that the Standard Model of particle physics allows the recently observed 244 EeV ($= 244 \times 10^{18}$ eV) cosmic ray — the Sun Goddess particle — to be a proton with the active galaxy 2MASX J16574719+1832247, redshift z = 0.054 as its source. The Standard Model Theory is preferred over conventional theory by a Bayes Factor K = 490, which in Jefferys' Table is a ''decisive" preference. Further, the Standard Model Theory has now been confirmed by direct observation of the Cosmic Background Radiation (CBR).

Keywords: UHECR; standard model; particle physics

The recently observed 244 EeV cosmic ray has created a stir because, coming from direction of the Local Void, it has no obvious source [1]. As the Telescope Array Collaboration, the discoverers of the particle, correctly pointed out [10], standard theory of the propagation of ultrahigh energy cosmic rays (UHECR) do not allow such particles, be they protons or other nuclei, to travel more than 30 Mpc.

Standard propagation theory, however, assumes that the Cosmic Background Radiation (CBR) is composed of electromagnetic radiation. The Standard Model of particle physics, confirmed by all experiments to date, states [5] that electromagnetism is *not* a fundamental field, but rather is composed of two fundamental gauge fields $U(1)$ and $SU(2)_L$. Tipler [11] has shown that quantum field theory and general relativity require that the universe must begin with only the $SU(2)_L$ field present. Tipler has since argued that if the CBR were still mainly just $SU(2)_L$, it would provide a natural explanation for the nature of the Dark Matter (it would be an oscillation of the Standard Model Higgs field) and such a Dark Matter would automatically resolve the Hubble Tension [13]. A CBR composed mainly of an $SU(2)_L$ field would mean that UHECR with energies above the GZK ([3],[15]) cutoff (50 EeV) could propagate a factor of 150 further through the CBR, since 90% of the cross-section for pion production in the collision between a UHE proton and a CBR photon is due to a quark spin flip, and an $SU(2)_L$ particle cannot generate a quark spin flip. The UHE proton mean-free path with traditional electromagnetic CBR photons would only be 3 Mpc ([6] p. 340) whereas an $SU(2)_L$ CBR would allow a UHE proton mean-free path of 450 Mpc ([11], p. 947). It is important to point out that since the energy loss due to pion creation is approximately 10% per event, the UHE protons could potentially come from distances of over 4 Gpc if the CBR is mainly $SU(2)_L$. For the purposes of this study, however, we restrict ourselves to finding sources near the mean-free path length ℓ. Even though it is possible for UHE protons to come from distances much greater than the mean free path, this realistic restriction will demonstrate how well this theory can explain the anomalous measurements.

The Telescope Array Collaboration noted that active galaxy PKS 1717+177 was within 2.5° of the calculated proton direction, but they dismissed this as a possible source since it is at a redshift z= 0.137. There is a closer source for a proton than PKS 1717+177, namely 2MASX J16574719+1832247, redshift z = 0.054 (= 230 Mpc with $H_0 = 70$ km/s-Mpc), a Linear-Type located AGN located 2.8° from the proton arrival direction. If the CBR is $SU(2)_L$ rather then electromagnetic, then both of these are possible sources for the 244 EeV particle to be a proton. We have earlier suggested the AGN MCG +08.11.011,

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with a redshift of 0.020, and located 3° from the observed direction, as the source of 320 EeV "Oh My God" particle [14], in the same paper that we suggested sources for all unidentified Pierre Auger UHECR.. D. W. Piasecki [7] has given the likely sources of all the unidentified northern hemisphere UHECR.

The Bayes Factor K comparing two theories T_1 and T_2 is defined to be the ratio $K \equiv P(D|T_1)/P(D|T_2)$, where $P(D|T_i)$ is the probability of the data given the theory T_i. Let T_1 be the theory that the CBR is mainly an $SU(2)_L$, and T_2 is the conventional theory that the CBR is composed of photons. Then since the Beer-Lambert Law says the probability that a particle will propagate a distance x from the source is $e^{-x/\ell}$, we have $K = e^{-x/\ell_1 + x/\ell_2}$, where x = 230 Mpc, and we bias in favor of T_2 by choosing the obvious $\ell_1 = 450$ Mpc, and $\ell_2 = 30$ Mpc (1 ℓ for T_1 and 10 ℓ for T_2), we get K = 490 (unbiased gives $K = 10^{32}$). Jeffreys claims ([4], p. 396) $K > 100$ is "decisive" evidence in favor of T_1 against T_2.

If the CBR is missing the $U(1)$ field, it could couple only to electrons with left-handed helicity (this the meaning of the subscript "L" in $SU(2)_L$), the Sunyaev-Zel'dovich (SZ) effect would be half of the value predicted by standard CBR theory ([11], pp. 949-950). This has been observed by both WMAP [2] and by PLANCK ([8], [9]). Finally, the $SU(2)_L$ nature of the CBR has now been observed directly in experiment [12]. UHECR researchers should take these facts into account.

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