Explanation of The GZK Limit Based on the WSM Model of SRT

Michael Harney © 2011
e-mail: mharney1268@yahoo.com

It has been calculated by Greisen, Zatsepin and Kuz'min that the interaction between cosmic rays and CMBR photons would result in pion production through the Δ-resonance at cosmic ray energies above 5 x 10^{19} eV [1][2]. Thus, the maximum cosmic ray energy that we should measure for relativistic cosmic ray protons that reach Earth is 5 x 10^{19} eV, but some cosmic ray observatories have measured 10^{20} eV, including the measured energy of 3 x 10^{20} eV for the OMG particle by the Fly's Eye at Dugway Proving Grounds in 1991 [3][4].

One explanation for the violation of the GZK limit is that the relativistic effects at the center of mass collision are different than what is predicted by the standard SRT model. A version of SRT has been developed based on the wave structure of matter (WSM) that, unknown to the authors at the time of development (2007), yields results that explain the GZK-limit violation while still keeping the energy threshold for pion-production of proton-photon collisions at the standard model level of 5 x 10^{19} eV [5].

The WSM hypothesizes that a particle is a combination of an in-wave and out-wave and that the superposition of these waves at *r* = 0 (wave center of the particle) produces the measured effects of the particle [6]. The in-wave, which has a fixed frequency based on a standing wave model [7] and travels at the speed of light, appears Doppler-shifted and higher in frequency by the particle moving relative to the in-wave's stationary reference frame:

$$\omega_{Cin} = \omega_{in}\,(1 + v/c) \qquad \textbf{1}$$

Where ω_{in} = the frequency of the in-wave as seen by a stationary observer and ω_{Cin} is the Doppler shifted frequency of the in-wave as seen by the moving particle at its wave center. A blue-shifted photon in the WSM is modeled as a geometric resonance between ω_{in} and ω_{Cin} :

$$\omega_{Fin} = (\omega_{in}\,\omega_{Cin})^{1/2} \qquad \textbf{2}$$

Where ω_{Fin} is the frequency of the CMBR photon as seen by the cosmic ray proton moving relative to the CMBR [5]. Incorporating equations 1 and 2, we arrive at:

$$\omega_{Fin} = [\omega_{in}^2(1 + v/c)]^{1/2} = \omega_{in}(1 + v/c)^{1/2} \qquad \mathbf{3}$$

which is quite different than the relativistic Doppler shift formula that is used for observing a photon resonance between the out-wave of the moving object (such as a receding galaxy) and the stationary observer. If one takes v/c = 0.92 for a high-energy cosmic ray proton and applies eq. 3 to find the frequency shift ratio, the increase in photon frequency with respect to the stationary CMBR according to WSM is $\omega_{Fin}/\omega_{in} = (1 + 0.92)^{1/2} = 1.38$.

According to WSM, the standard SRT model for relativistic Dopper shift of the CMBR photons is valid only for an observer seeing a photon resonance with an out-wave from the moving particle (which is the typical case where the relativistic Doppler shift is applied, as in receding galaxies, etc.), but not for the particle's Doppler shifted, in-wave resonance which is more accurately described by eq. 3. If we do incorrectly apply the relativistic Doppler shift to the CMBR photons as follows:

$$\omega_{Fout} = \omega_{Fin}[(1 + v/c) / (1 - v/c)]^{1/2} \qquad \mathbf{4}$$

Where ω_{Fout} is the out-wave but is misinterpreted as the CMBR photon frequency as seen by the relativistic proton, we come up with a frequency shift (again, assuming v/c = 0.92) of $\omega_{Fin}/\omega_{in} = 4.9$. The frequency-shift ratio of what we expect to see for particle-photon interactions ($\omega_{Fin}/\omega_{in} = 4.9$) from incorrect application of the relativistic Doppler shift and what WSM predicts ($\omega_{Fin}/\omega_{in} = 1.38$) shows the same ratio for measured energies of particles over the GZK limit (4.9/1.38 = 3.6), where the expected energy threshold is 5×10^{19} eV and the measured cosmic ray energies are almost 4 times higher (2×10^{20} eV). Thus, the relativistic proton frame of reference sees a Doppler shifted CMBR photon at a lower frequency than what is predicted by the relativistic Doppler shift formula by a factor of 4 and the result is that the energy threshold for pion production is not reached. Much higher energy protons are required to initiate pion production, resulting in the confusion of the GZK limit which is actually correct for proton-photon collisions but inaccurately calculates the wrong CMBR photon frequency in the relativistic proton's reference frame. As most experiments involving relativistic effects of particles are measured in a laboratory setting where energy is applied external to the reference frame of the particle (such as through external magnetic fields in particle accelerators), the effects of the relativistic Doppler shift are only seen from an external standpoint where it does accurately apply to out-waves, but not to the particle's in-waves or its reference frame (wave-center).

The in-wave and out-wave concept of particles also explains the electromagnetic field, where a moving electron produces a Doppler-shifted out-wave that in its direction of motion produces a higher wave frequency (ω_{in} (1 + v/c)) or compressed out-wave as seen by an observer, with this out-wave acting as a space disturbance that accurately models a static magnetic field (see Figure 1). The Doppler-shifted out-wave that is produced leaving away from the direction of motion of the electron has a lower wave frequency (ω_{in} (1 – v/c)) that is rarefied with respect to the stationary wave. The compressed and rarefied waves complement each other spatially, just as the north and south poles of a magnetic field do. The faster the electron velocity, the higher the electric current and the stronger the magnetic field and the compression and rarefaction of the out-waves leaving the electron. The result is a stronger attraction between the two out-waves. The necessarily combined nature of the in and out-waves explains the lack of evidence for magnetic monopoles.

Magnetic Field Between Two Electrons Moving in the Opposite Direction -
Compression and rarefaction of out-waves creates complementary zones of attraction

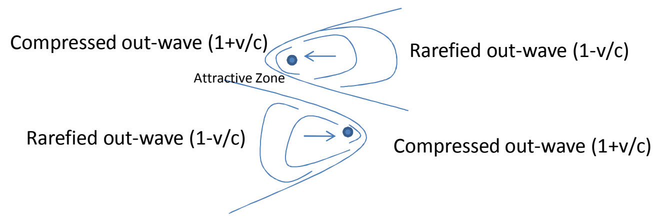

Figure 1

References:

1. Greisen, Kenneth (1966). "End to the Cosmic-Ray Spectrum?". *Physical Review Letters* **16** (17): 748–750. Bibcode 1966PhRvL..16..748G. doi:10.1103/PhysRevLett.16.748.

2. Zatsepin, G. T.; Kuz'min, V. A. (1966). "Upper Limit of the Spectrum of Cosmic Rays". *Journal of Experimental and Theoretical Physics Letters* **4**: 78–80. Bibcode 1966JETPL...4...78Z. http://www.jetpletters.ac.ru/ps/1624/article_24846.pdf.

3. J. Linsley (1963). "Evidence for a Primary Cosmic-Ray Particle with Energy 10^{20} eV". *Physical Review Letters* **10**: 146. Bibcode 1963PhRvL..10..146L. doi:10.1103/PhysRevLett.10.146.

4. Open Questions in Physics. German Electron-Synchrotron. A Research Centre of the Helmholtz Association. Updated March 2006 by JCB. Original by John Baez.

5. Weber and Harney, “Derivation of the Relativistic Lorentz Transformation Using the Wave Structure of Matter”, http://www.wsminfo.org/articles/doppler_shift_2007_july.htm

6. Harney, “The Derivation of a Unified Field Theory from a Model of Spherical Quantum Waves”, http://www.signaldisplay.com/Unified_Field_Theory.pdf

7. Harney, “The Gravitational Force as Defined By DeBroglie Waves”, http://www.signaldisplay.com/debroglie.html