LETTERS TO PROGRESS IN PHYSICS

A Brief Note on "Un-Particle" Physics

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The possibility of a hidden sector of particle physics that lies beyond the energy range of the Standard Model has been recently advocated by many authors. A bizarre implication of this conjecture is the emergence of a continuous spectrum of massless fields with non-integral scaling dimensions called "un-particles". The purpose of this Letter is to show that the idea of "un-particles" was considered in at least two previous independent publications, prior to its first claimed disclosure.

The Standard Model (SM) is a highly successful theoretical framework that describes the relationships among all known elementary particles and the attributes of three of the four forces that act on these particles — electromagnetism, the strong force and the weak force. SM covers an energy range upper limited by the weak interaction scale of approx. 300 GeV. Despite the remarkable success of SM, it seems likely that a much deeper understanding of nature will be achieved as physicists continue to probe the fundamental constituents of matter at increasingly higher energies. Both theory and experiments strongly indicate that new phenomena await discovery beyond the SM range and reaching into the Terascale region. The Large Hadron Collider (LHC) at CERN is based on high energy proton beams and is scheduled to begin operation later this year. Moreover, further exploiting the Terascale physics will be possible in the near future with a new accelerator known as the International Linear Collider (ILC). It is believed that running both LHC and ILC will provide clues on how to go about solving many of the open questions challenging the current SM.

The possibility of a yet-unseen sector that lies in the Terascale range and is weakly coupled to SM has been recently advocated by many authors [1–6]. A bizarre implication of this conjecture is the emergence of a continuous spectrum of massless states with non-integral scaling dimensions called "un-particles". In classical physics, the energy, linear momentum and mass of a free point particle are linked through the relativistic connection ($c = 1$):

$$E^2 = p^2 + m^2. \tag{1}$$

Quantum mechanics converts (1) into a dispersion relation for the corresponding quantum waves, with the mass m fixing the low frequency cut-off ($\hbar = 1$):

$$\omega^2 = k^2 + m^2. \tag{2}$$

Unlike (1) or (2), un-particles are conjectured to emerge as streams of fractional objects, something that has never been either imagined or seen before. A possible signal of un-particles at either LHC or ILC may show up as "missing" energy in certain decay channels [1–6].

The purpose of this Letter is to set the record straight and point out that the idea of "un-particles", first claimed in [1, 2], was previously considered elsewhere. To the best of our knowledge, there are at least two publications where a similar or identical concept was introduced and discussed:

1. In 2005, Prof. F. Smarandache has launched the term *un-matter* as part of his novel mathematical framework of Neutrosophy and Fuzzy Logic [7, 8];
2. In 2006, the author has formulated the concept of *fractional number of field quanta* in connection with the development of quantum field theory using complex dynamics [9].

It is unfortunate that neither one of [1–6] have referenced these contributions.

Submitted on March 23, 2008
Accepted on April 07, 2008

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