Child's Book of Light
ADDENDUM I
August 28, 2016

Only a coincidence?--that today I came across for the first time the life of renowned Italian physicist, Gilberto Bernardini (who coincidentally bore the same surname as my mother's paternal family), on what would have been his 110th birthday. Synchronistical?—that also by chance this week there came to me two books that set me sailing once again through the turbulent seas of Physics. I don't pretend clear grasp of the Quarkian maze of components, classifications, actions, and derived formulas!--no more than decades ago, when Mind was inexplicably was seized to compose *A Child's Book of Light.*

Nonetheless, the recent unanticipated readings reinforced *CBL's* personal driving vision of--for want of better words--"a one-on-one 'solid electromagnetic field universe'!" With whatever names are baptized the unseen, *is* Humankind's understanding of its physical world destined for a monumental revision?... *Are 'neutrinos' their own 'antiparticles? Will 'neutrino' by it or any other name be a final revealed manifestor of an all-pervading elemental force?*

This addendum offers summaries of some recent Physics data. A reader with avid interest would want to (perhaps best, if first) check out pertinent Einsteinian, etc. history and details available in Addendum II. In it and this addendum, parenthetical potential alternate terms and single quotation marks often are supplied at terms involving ambiguity related to concepts approached in "Child's Book of Light."

"IMPLICATIONS OF NEUTRINO MASS," **http://ctp.berkeley.edu/neutrino/neutrino5.html**.

"Neutrinos--the least understood elementary particle known, are everywhere, trillions passing through our bodies every second but so shy we do not see or feel them. Existence of neutrinos was suggested as a 'desperate remedy' to the apparent paradox of energy not appearing conserved in the world of atomic nuclei. The Standard Model of particle physics has *[had]* been able to describe all determined about elementary particles--that neutrinos do *[did]* not have mass, because they all are *[appeared to be]* 'left-handed' and do *[did]* not bump on the mysterious "Higgs boson" which *[it is considered]* filled the entire Universe. However, in 1998 convincing evidence was reported that neutrinos have 'mass', the Standard Model falling after decades of invincibility--evidence coming from experiments deep underground in many thousands of tons of water housed in mines.

"Now that neutrinos do appear to have mass, we have to solve two problems: first, overcome the contradiction between 'left-handedness and mass'; second, understand why the neutrino mass is so small compared with other particle masses, direct measurements indicating electrons are at least 500,000 times more massive than neutrinos. The tiny mass is a puzzle; there must be some deep reason why.

"Neutrino mass is *[so]* extremely tiny--at least million times lighter than the electron, the lightest elementary particle. How to change the Standard Model to explain neutrino mass? Some argue that 'spacetime' has unseen spatial *[regional]* dimensions; others, that the heretofore sacred distinction between matter and 'anti-matter' must be abandoned.

"Basically, there are two approaches for extending the Standard Model to make neutrinos massive: one involves particles called Dirac neutrinos; the other, a completely

different type called the Majorana neutrino. The Dirac neutrino […has] a serious flaw that involves "chirality" *[the direction of constitution; for example, two molecules of the same formula can mimic right and left symmetry, such as the case with LSD and Serotonin--brain 'mistaking' LSD as it shoots across the synaptic cleft in place of the neurotransmitter].*

"Accordingly, 'right-handed' neutrinos have escaped detection so far in that their interactions are at least 26 orders of magnitude weaker than 'ordinary' neutrinos. Dirac's idea of neutrino does work in that neutrino masses can be generated via the Higgs mechanism, but suggests that neutrinos should have masses similar to other particles in the Standard Model. To avoid that problem, strength of neutrino interactions with the Higgs boson must be made at least 12 orders of magnitude weaker than that of the top quark, few physicists accepting such a tiny number as a fundamental constant of nature [!].

"The second way to extend the Standard Model involves particles that are called *Majorana neutrinos,* one advantage being that 'right-handed' neutrinos with extremely weak interactions no longer must be invoked. That, however, means giving up the fundamental distinction between matter and 'antimatter'. As bizarre as this sounds, neutrinos and 'antineutrinos' can be IDENTICAL because they have no electric *[electromagnetic?]* charge."

MAGUEIJO, JOAO, *A BRILLIANT DARKNESS,* NY, NY: Perseus Books/Basic Books, 2009; story of the life, work, and disappearance of Ettore Majorana.

"Twenty-five years before the neutrino was even detected…Ettore [Majorana] …left us a major piece of information about a particle that would play a leading role in the nuclear age." Page xvi. "…Ettore's construction throws us a lifeline in unifying the whole wild managerie of particles we insist on calling fundamental." Page 133.

Majorana discovered "'vanishing energy' and how it revealed a new particle [proposed by Pauli]--pathologically shy, almost impossible to detect--the neutrino…[which] can penetrate several light-years of ordinary matter as if it were traveling through a 'vacuum', without stopping to let itself be known. … A massive burst of neutrinos spills out every time an atomic bomb goes off." Pages 19 and xv.

"Conservation of mass-energy is one of the most sacrosanct principles of modern science…." Page 19. "[B]y the early 1930's, nuclear physics had pretty much fallen into place except for one tricky detail: the spectrum of beta decay.… The matter that concerned all…was simple: *Energy was disappearing."*

[*Beta decay, single and double* *(as explained):* Ordinary beta decay is a common kind of radioactivity: an atomic nucleus changes into a different element--a neighbor on the periodic table with lower mass--by emitting a beta particle–an electron or positron–plus a neutrino or an antineutrino. For example, carbon-14 transforms to nitrogen-14 when one of its neutrons turns into a 'proton', emitting an electron and an 'antineutrino'. It was beta decay that led to the proposal that there must be a particle like the neutrino, since an electron alone could not account for all the energy lost in the decay. (Berkeley lab--http://newscenter.lbl.gov/2012/05/16/majorana-demonstrator/)]

"When a mother nucleus transmutes into a lighter nucleus in beta decay, if the difference in mass is multiplied by the square of the speed of light (per $E=mc^2$), the amount of energy obtained is energy that *should* be carried away by each electron making up beta

radiation. But the electron invariably had less energy. *Much less.** (*Yes, people were not stupid then, and they did check all the details. We're talking about a million times more energy 'disappearing' than could be accounted for….)" Page 26.

"…[O]ur principle of conservation was wrong…was the opinion of Niels Bohr…May 1930," who went so far as to state that the facts "may force us to renounce the very idea of energy balance [?]." Page 27. "We…now are appealing to String theory, supersymmetry, and other complex constructions containing infinite towers of particles that don't fit the observed world any better than Ettore's infinite dimensional wave function." Page 133. "There is no arrow of time for a Majorana neutrino, because it contains within itself both directions…." Page 179.

ROVELLI, CARLO, *SEVEN BRIEF LESSONS ON PHYSICS,* Carnell, Simon and Segre, Erica, Translators, NY, NY: Riverhead Books, 2016:

"…[T]he gravitational field is *not* [?] *diffused through* space; the gravitational field *is that [region?]* space *itself*—the idea of [Einstein's] general theory of relativity. Newton's 'space', through which things move, and the 'gravitational field' are one and the same thing. … Planets circle around the sun, and things fall because 'space' *[appears that it]* curves [*because the field's force compresses]* around them. … When a large star has burned up all of its combustible substance (hydrogen), it goes out. What remains no longer is supported by the heat of the combustion and collapses under its own weight [?--*What remains no longer is supported by its opposing heat of combustion and collapses under the pressure*]…." Pages 8, 10.

It took Planck to "treat energy as if it were made up of…packets of energy," and "it was to be Einstein who…came to understand that the 'packets of energy' were real…[and] wrote..: In accordance with [this] assumption.., the energy of *[manifesting as?]* a light ray spreading out from a point source is not continuously distributed over an increasing 'space' but consists of a finite number of 'energy quanta' which are localized at points in 'space', which move without dividing, and which can only be produced and absorbed as complete units." [*the energy of a light ray…consists of a finite number of 'energy quanta'..localized at points in space, which move without dividing…produced and absorbed as complete units, but can be changed in direction by the state of the surrounding field.*] Pages 14, 15.

"There is no such thing as a real void…. … We have arrived very far from the mechanical world of Newton. … Quantum mechanics and experiments with particles [describe] the world [as] a continuous, restless swarming [*meshing of]*--a set of vibrations…." Page 33.

"The Standard Model …has never been taken entirely seriously by physicists. … [Its] equations…make predictions…absurdly convoluted…necessary to… [a] convoluted and baroque procedure given the technical term 'renormalization.'" As the great "Paul Dirac, architect of quantum mechanics…repeatedly expressed, 'we have not yet solved the problem.'" Pages 34, 35.

THE FOLLOWING IS EXTRACTED FROM *WIKIPEDIA, "Cosmological Constant."* (Again, emphases added**.) This best is considered in conjunction with related Addendum II, which can clarify and expand some of the following.)**

The “cosmological constant” (CC” denoted by Greek capital letter lambda, Λ; originally introduced by Einstein in 1917 is the value of the energy density of the vacuum of ‘space’. From 1929 to early 1990s, most research assumed the CC to be zero; but later developments have shown that some 68 percent of the mass–energy density of the universe can be attributed to “dark energy,” with the CC being the simplest conceivably possible form of dark energy. The CC has the same effect as an intrinsic energy density of the vacuum.

Einstein’s inclusion of the CC term in his field equations for general relativity was to have his equations allow for a static universe wherein gravity would not cause a dynamic equilibrium of contraction. Einstein abandoned the static theory following the [*perceived*] expansion findings of Edwin Hubble--which, however, happened to be consistent with a cosmological solution to the *original* general relativity equations found by mathematician Friedmann’s work on the Einstein equations of general relativity. Einstein later reputedly referred to [his] failure to accept the validation of his own equations predicting the expansion of the universe in theory, before observation of the cosmological red shift.

In fact, adding the CC to Einstein's equations does not lead to a static universe at equilibrium because the equilibrium is unstable: if the universe expands slightly, then the expansion releases vacuum energy, which causes yet more expansion. Likewise, a universe that contracts slightly will continue contracting. Empirically, the onslaught of CC data in the past decades strongly suggests that our universe has a positive cosmological constant. The explanation of this small but positive value is an outstanding theoretical challenge.

Some early generalizations of Einstein's gravitational theory (aka classical unified field theories) either introduced a CC on theoretical grounds or found that it arose naturally from the mathematics. For example, Sir Arthur Stanley Eddington claimed that the CC version of the vacuum field equation expressed the "epistemological" property that the universe is "self-gauging", and Erwin Schrödinger's pure-affine theory using a simple variational principle produced the field equation with a cosmological term.

A major outstanding problem is that most quantum field theories predict a huge value for the quantum ‘vacuum’. A common assumption is that the quantum vacuum is equivalent to the cosmological constant [!]. Although no theory exists that supports this assumption, arguments can be made in its favor. Such arguments are usually based on dimensional analysis and effective field theory. If the universe is described by an effective local quantum field theory down to the Planck scale, the CC would be*…[smaller than expected quantity]* by a factor of 10^{-120}. This discrepancy has been called "the worst theoretical prediction in the history of physics!" This is the *cosmological constant problem*, the worst problem of fine-tuning in physics; there is no known natural way to derive the tiny cosmological constant used in cosmology from particle physics.

If right handed neutrinos exist, they could be responsible for several phenomena that have no explanation within the Standard Model, including neutrino oscillations, the baryon asymmetry of the universe, dark matter and dark radiation. [This article continues with some theoretical possibilities relative to the CC, *e.g.* the “anthropic principle;” potential “multiple universes;” and “cyclic model;”and states that “some supersymmetric theories require a cosmological constant that is exactly zero, which further complicates things.”]

REWRITING THE STANDARD MODEL, http://newscenter.lbl.gov/2012/05/16/majorana-demonstrator.

"Mass is essential to oscillation among the three neutrino flavors, but no one knows the precise mass of any of the flavors or why it's so small. Neutrinoless double-beta decay offers a unique window on that question. If [the project] MAJORANA can go beyond showing that neutrinoless double-beta decay exists, to showing how often it occurs, it may be able to establish the mass scale of neutrinos directly.

"The key is their handedness, or helicity (which refers to how their linear momentum and quantum spin are aligned). If neutrinos and antineutrinos are *[were to be]* two distinct particles, each could be either right-handed or left-handed, for a total of four quantum states. If neutrinos and antineutrinos are just one particle, however, it has only two states of handedness. In fact only two states, left-handed neutrinos and right-handed antineutrinos, have ever been observed.

"A diagram of neutrinoless double-beta decay shows a right-handed antineutrino emitted when a neutron decays (also emitting an electron). The antineutrino flips its handedness and is absorbed by a second neutron, which also decays (and emits a second electron). Only a single antiparticle/particle is involved. How fast it can flip its handedness depends on its mass: the more massive, the easier the flip, and the more often this kind of decay will occur.

"In neutrinoless double-beta decay, a single particle would be emitted as one neutron changes to a proton. This right-handed antineutrino would be absorbed as a left-handed neutrino by a second neutron causing it, too, to change to a proton. Two electrons account for the total difference in energy between the nuclei.

"But there's a catch, says physicist Poon. 'The fascinating thing about neutrinoless double-beta decay is that it would violate one of the basic principles of the Standard Model, in which all interactions supposedly conserve lepton number. Electrons and neutrinos are both leptons, so if an interaction produces two electrons, that's a plus two. In the usual kind of double–beta decay, two antineutrinos are also emitted – antiparticles with minus lepton numbers, which is a minus two. Lepton number is conserved at zero.' Not so with neutrinoless double-beta decay, however, which raises the lepton number from zero to two. 'The Standard Model leaves many outstanding questions, and we know it needs revision', Poon says, 'but we cannot write a new theory until we know if neutrinos are their own antiparticles, or how we're going to accommodate the loss of lepton number conservation if they are, and a number of other questions, including neutrino mass.'

"In the race to answer these questions, the MAJORANA Collaboration is competing with another important germanium experiment, the GERDA experiment at the underground Gran Sasso National Laboratory in Italy. But it's a competition with a twist: GERDA has a different shielding concept, using liquid argon and water, 'and between us we'll find out which has the lower background,' says Poon. 'We may join forces to build the final one-ton detector.' Germanium-76 is not the only element that can undergo double-beta decay. Other detectors use isotopes of tellurium, xenon, neodymium, or other elements. Poon says, 'It's important to establish that any instance of neutrinoless double-beta decay really reflects the property of the neutrino. If the process is seen in more than one element, that's very strong evidence that the neutrino is indeed its own antiparticle.'"