

**Supernova Models  
indicate that the Neutrino  
is the Quantum of The  
Gravitational Radiation.  
The Origin of Gravitation  
is the Transition between  
the d-quark energy level,  
and the u-quark energy  
level of a Nucleon,**

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**Abstract** *The Quantum of Gravitational Radiation is the Neutrino*, because Supernova Models indicate that 99% of the Gravitational Binding energy of a collapsing star is emitted in the form of Neutrinos' Radiation.

Since radiation is emitted in transition between energy levels, this suggests that *the so called d-quark, and the so called u-quark, that have never been observed, are*

***energy levels of the nucleon.***

An accelerated Nucleon will emit a Graviton=Neutrino if it transitions from a d-quark energy level, to a u-quark energy level in say  $d \rightarrow u + e^- + \bar{\nu}_e$

Namely, ***the origin of Gravitation is the transition between the d-quark energy level, and the u-quark energy level, of the Nucleon.***

Gravitational Radiation is the sum of the emissions from a collection of Nucleons transitioning between their energy levels, when accelerated.

**Keywords** Gravitation, Quantum Gravity, Gravitons, Neutrino's Mass, Neutrinos Oscillations, Helicity, Anti-Neutrino, Photon, Majorana Neutrino, Anti-Neutrino, Neutrino, Supernova, Quantum Gravitational Radiation Cherenkov Radiation, Faster Than Light, Gravitational binding energy, Chandrasekhar limit, Neutron star, Tests of general relativity, Gravitational wave, Neutrino, Neutrino oscillation, Neutrino astronomy, Neutrino detector, Graviton

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# 1.

## Gravitons

The existence of a particle that carries the Gravitational Force, a Graviton, is certain.

Some of its properties can be predicted

### **1.1 Gravitons should be common, and plentiful, to the extent that they already may have been detected**

Gravitons are exchanged in Gravitational Interaction. Thus, there should be many of them flying around. In fact, they might have been detected by now.

### **1.2 Gravitons should have Extremely Small Masses, Much Smaller than Photons' Masses,**

#### **Thus, the Gravitons are Very Difficult to Detect**

Because the gravitational Forces are much weaker than Electrical Forces. Therefore, the carrier of the gravitational forces will be far less energetic. Hence, due to energy-mass equivalence, the Graviton should have extremely small

mass, much smaller than the  $\frac{h\nu}{c^2}$  masses of photons.

### **1.3 Accelerating Matter Emits Gravitons.**

#### **Thus, the Earth, and the Sun Emit gravitons**

Because the effect of the acceleration is to generate the force carriers: The earth in its orbit around the sun emits gravitons towards the sun, and the sun in its orbit emits gravitons towards the earth.

### **1.4 The Earth-Sun Planetary System is Stable due to the Exchange of Gravitons**

Just like the Electron-Proton Atom that is stable due to the exchange of photons between the photon and the proton

### **1.5 Gravitons could be Faster Than Light,**

#### **Thus, Unseen, and Difficult to Detect**

Because Faster than Light motion is allowed by special relativity [Dan]

### **1.6 Gravitons may not Carry Electrical Charge**

Because matter is not electrically charged, and even photons, the carriers of the electromagnetic force, are not electrically charged.

## 2.

# Neutrinos

To account for missing Energy, and Momentum in the balance of Radioactive Interaction, Pauli proposed the emission of electrically neutral, hence, unseen particle, with zero mass. Fermi coined the name Neutrino,  $\nu$ .

A Neutrino beam mixes three types of Neutrinos,  $\nu_e$ ,  $\nu_\mu$ , and  $\nu_\tau$ . The Neutrino is one of the longest living particle, along with electrons, protons, and photons.

Neutrinos are generated for instance

- in the Atmosphere, by  $\pi \rightarrow \mu + \nu_\mu \rightarrow e + 2\nu_e$
- in the Sun Core, by the fusion  $4\text{H} \rightarrow \text{He} + \nu_e + \gamma$
- in the fusion of protons,
- in the fusion of Boron  $^8\text{B}$ ,
- in the fusion of Beryllium  $^7\text{B}_e$
- in Meson decay,
- in Supernova

And they are believed to fill the Universe. But their chance to collide with a particle is very low.

Their Cross Section, the effective target area that they

present to other particles, is as small as  $\frac{1}{10^{43}} \text{cm}^2$ .

Thus, millions of them are believed to pass through the earth in a fraction of a second, with out interaction with any particles, as if the earth was transparent to them.



### 3.

## Neutrino's Mass, and Class

Popular literature refers to the “illusive Neutrino”.

A far more illusive Quark is never described as “illusive”, although Quarks, assumed to exist only in pairs or triplets, have never been observed separately, in any interaction that involves them.

While Neutrinos have very small cross section, and their observations are infrequent, the illusiveness of the Neutrino indicates its unclear nature, due to imprecise definition, and erroneous classification.

### 3.1 The Neutrino's Mass equals $\frac{\text{Neutrino's Energy}}{c^2}$

The neutrino was proposed to balance energy, and momentum in radioactive emission. As such it was defined as a “particle”.

Its energy is very small, hardly detectable, less than 2eV, and the question arose whether its mass might be zero.

Due to the equivalence of mass and energy, the Neutrino

has a mass that equals  $\frac{\text{Neutrino's Energy}}{c^2}$ .

**However small the Neutrino's Energy might be,**  
**it cannot be zero, or else,**  
**there would have been no need to propose the**  
**Neutrino.**

The persistence of the question whether the Neutrino has mass, shows that the word “particle” was misleading.

### **3.2 The Neutrino defines its own class**

The Neutrino was classified as a Lepton, namely a low energy particle, that is similar to the electron.

But having no charge, the Neutrino is as similar to the electron as the photon is.

**Being defined as an energy particle,**  
**the Neutrino is a quantum of energy,**  
**and being charge-less,**  
**the Neutrino is similar to the Photon.**

Thus,

**the Neutrino does not belong with the electron.**

**But it is unlikely to belong with the photon either.**

The photon is a quantum of thermal energy,  
 or, alternatively, electromagnetic energy.

**The Neutrino is a Quantum of Nuclear Binding**  
**Energy,**

**which will be shown to be  
Gravitational Binding Energy.**

In the Particle Data Group booklet,

**the Neutrino should be in the  
GAUGE AND HIGGS BOSONS classification.**

## 4.

## Neutrinos Oscillations, and Mass

Neutrino oscillations between the three types of Neutrinos were suggested to explain the problem of missing neutrinos in Solar radiation.

Then, the claim that Neutrino's mass depended on the solution of the Neutrino's Solar Problem, helped to attract attention to the Solar Problem,

But as we pointed out in 2.2, due to the equivalence of mass and energy, the Neutrino has a mass,  $\frac{\text{Neutrino's Energy}}{c^2}$ .

Thus,

**conditioning the existence of Neutrino's Mass  
on the solution of the Neutrino Solar Problem  
was misguided.**

Moreover,

**the argument that links Neutrino's Oscillations to  
Neutrino's Mass, is erroneous.**

Such an argument is found in [Schutz, p.131]

*"...mass-less particles travel at the speed of light,*

*and...particles moving at the speed of light experience no lapse of time: time stands still for them, and if they had an internal clock it would not advance at all. No dynamical process, like oscillation from one type of Neutrino to another, could happen; Nothing at all could change for a mass-less neutrino..."*

**First**, there are no mass-less particles. Any particle has mass and energy. Even the photon that travels at light speed has mass  $\frac{E}{c^2}$ .

**Second**, the observed time interval of a particle moving at speed  $v$  is

$$\frac{\Delta t}{\sqrt{1 - \frac{v^2}{c^2}}}.$$

At light speed,

$$v = c,$$

and we have meaningless division by zero. Thus, the formula cannot be used to draw any conclusions about particles moving at light speed.

## 5.

# Helicity, Anti-Neutrino, and Majorana Neutrino

Just like the photon, the Neutrino may be spiraling along its propagation axis, with left handed Helicity, or with right handed Helicity.

Years ago, following through Dirac derivation of his wave equation that predicts the anti-electron, Majorana confirmed that unlike the electron which has an anti-electron, the different helicities do not distinguish between a particle, and an antiparticle. That is, the Neutrino is his own antiparticle.

For some Astrophysicists it is an open question whether the Neutrino is his own antiparticle, a Majorana Neutrino, or if the Neutrino's Helicity distinguishes between a particle and an antiparticle, a Dirac Neutrino.

But in Physics, the problem has been long resolved:

**The Particle Data Group booklet  
lists only the Neutrino,  
just as it lists only the photon.  
Each being its own anti-particle.**

Just like the photon, the Neutrino is a mixture of both left handed Helicity, and right handed Helicity Neutrinos, and is considered its own anti-particle.

## 6.

# Neutrino's Speed

Neutrinos were assumed to propagate at the highest possible speed, which was believed to be light speed.

But Light speed is exclusive to the propagation of electromagnetic radiation, and its only carriers are photons.

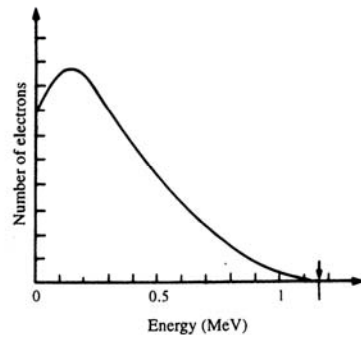
Like the photon, the Neutrino is a charge-less quantum of radiation but the Neutrinos' Radiation is not electromagnetic Radiation.

Unlike Photons' Radiation that is generated in the Atomic shells,

**Neutrinos' Radiation is generated in the Nucleonic Shells, commonly known as Quarks.**

**The different kinetic energies that electrons carry out of the radioactive interaction, imply different kinetic energies and velocities of the Neutrinos.**





The energy distribution of the electrons emitted in the beta decay of bismuth 210. The kinetic energy of these electrons is between zero and 1.17 MeV.

Neutrinos' Observatories detect Neutrinos' Speeds on the order of light speed, and Faster Than Light, as evidenced by the emission of Cherenkov Radiation [Dan].

# 7.

## Supernova Models indicate that the Neutrino is the Quantum of Gravitational Radiation

The Quantum of Gravitational Radiation is the Neutrino, because Supernova Models establish that 99% of the Gravitational Binding energy of a collapsing star is emitted in the form of Neutrinos' Radiation.

This fact seems to be well-known. By [Close, p139],

*“...most of the energy produced in a supernova is radiated away in the form of an immense burst of neutrinos...”*

By [Bahcall, p.428],

*“Most of the binding energy that is released when a neutron star is formed is believed to be emitted in the form of neutrinos”*

However, we could not find any believable substantiation to this claim, and we work it out in the following:

By [Swihart, p.120], to build a Star of constant density

$$\rho,$$

with mass

$$M,$$

and radius

$$R,$$

we will add to mass

$$m(r) = \frac{4\pi}{3} r^3 \rho,$$

with radius

$$r,$$

an infinitesimal mass

$$dm(r) = 4\pi r^2 \rho dr,$$

which will add the Gravitational energy

$$-G \frac{m(r)dm(r)}{r} = -G \frac{16\pi^2}{3} \rho^2 r^4 dr.$$

Therefore, the total Gravitational energy of the Star is the  
Integration Sum

$$-G \int_{m=0}^{m=M} \frac{m(r)}{r} dm(r) = -G \frac{16\pi^2}{3} \rho^2 \int_{r=0}^{r=R} r^4 dr = -\frac{3}{5} G \frac{M^2}{R}.$$

[Landau-Lifshitz, pp.327-331], supply the analysis for the  
Supernova creation of a neutron star, and conclude (p.330-  
331) with the following:

*“The conversion of the whole mass  $M$  from the  
electron-nucleus state to the neutron state requires  
an expenditure of energy...to counterbalance the*

*binding energy of the nuclei.*

*In the process, energy is released because of the contraction of the body...This gain of energy is*

$$\frac{3}{7}GM^2\left(\frac{1}{R_{\text{Neutron Star}}} - \frac{1}{R_{\text{electron-nucleus Star}}}\right)$$

The second term in the formula is negligible compared with the first, and

**the Gravitational Binding released is**

$$\frac{3}{7}GM^2\frac{1}{R_{\text{Neutron Star}}}.$$

Computing with the Chandrasekhar Limit,

$$M = 1.4M_{\text{Sun}} = 1.4 \times 2 \times 10^{30} \text{ kg},$$

and with

$$R_{\text{Neutron Star}} = 10\text{km} = 10^4\text{m},$$

the **Gravitational Binding** is

$$\begin{aligned} \frac{3}{7}6.7 \times 10^{-11}(2.8)^2 10^{60} \frac{1}{10^4} &= 2.25 \times 10^{46} \text{ Joul} \\ &= 2.25 \times 10^{55} \text{ erg} \end{aligned}$$

**The Nuclear Binding energy** is

$$\begin{aligned} \left( \begin{array}{c} 3.2 \text{ MeV} \\ 1.6 \times 10^{-11} \text{ Joul} \\ \text{per nucleus} \end{array} \right) \times \left( \begin{array}{c} 6 \times 10^{23} \\ \# \text{ of nuclei/kg} \end{array} \right) \times \frac{M}{1.4 \times 2 \times 10^{30} \text{ kg}} &= 8.6 \times 10^{43} \text{ Joul}, \\ &= 8.6 \times 10^{52} \text{ erg}. \end{aligned}$$

This is less than 0.5% of the gravitational binding.

By [Kundt, p.40],

*“Supernova shells tend to have masses...of order  $3M_{\text{Sun}}$  -inferred from the times at which their spectra changes from optically thick (photospheric) to optically thin (nebular), usually between 6 and 18 weeks after launch- and radial velocities ranging from several  $10^5$  m/sec up to several  $10^7$  m/sec, with a quadratic mean near  $10^{6.8}$  m/sec.”*

Their **kinetic Energy** is of order

$$\begin{aligned} \frac{1}{2} 3 \underbrace{M_{\text{Sun}}}_{2 \times 10^{30}} 10^{13.6} &= 1.2 \times 10^{44} \text{ Joul} \\ &= 1.2 \times 10^{53} \text{ erg} \end{aligned}$$

This is a little over 0.5% of the gravitational binding

By [Kundt],

**Radio waves, optical, and X-ray radiation**

average

$$3 \times 10^{40} \text{ Joul} = 3 \times 10^{49} \text{ erg}$$

This is negligible compared with the gravitational binding.

In conclusion, about 1% of the gravitational binding is released as nuclear binding energy, supernova shell kinetic energy, and electromagnetic radiation.

Consequently, 99% of the Gravitational Binding Energy is carried away by the radiated Neutrinos.

Thus,

**Gravitational Radiation is made of Neutrinos,  
and the Quantum of Gravitational Radiation  
is the Neutrino.**

## 8.

## The Origin of Gravitation

Einstein was aware of the fact that his General Relativity does not give a clue as to what the quantum of Gravitational Radiation may be.

Using the CGS system that is devoid of the electric permittivity  $\epsilon_0$ , and the magnetic permeability  $\mu_0$ , he did

not know the exclusiveness of light speed  $c = \frac{1}{\sqrt{\epsilon_0\mu_0}}$  to

electromagnetics, and did not realize that the only radiation quantum that may move at precisely light speed is the quantum of thermal radiation, the photon.

But assuming that gravitons will be generated similarly to photons by the same Atomic Spectroscopy mechanism, he wrote in [Einstein, p.209],

*“...due to the inner-atomic movement of electrons, atoms would have to radiate not only electromagnetic but also gravitational energy, even if only in tiny amounts.”*

By Newton, the source of Gravitation is Mass.

By Rutherford, Mass resides the Nucleus.

And Gravity may reflect Quantum Processes in the Nucleus.

Modifying the first line of Einstein's writing we have

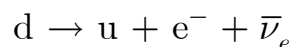
*“...due to the inner-nuclear movement of quarks, atoms would have to radiate not only electromagnetic but also gravitational energy, even if only in tiny amounts.”*

This modified statement points to the Origin of Gravitation:  
The Quantum of Gravitational Radiation is the Neutrino, because Supernova Models indicate that 99% of the Gravitational Binding energy of a collapsing star is emitted in the form of Neutrinos' Radiation.

*Since radiation is emitted in the transition between energy levels, this suggests that the so called d-quark, and the so called u-quark, that have never been observed, are two energy levels of the nucleon.*

Then,

*An accelerated Nucleon will emit a Graviton=Neutrino when it transitions from a d-quark energy level, to a u-quark energy level in the interaction*



Namely,



*the origin of Gravitation  
is the transition between the d-quark energy level,  
and the u-quark energy level, of the Nucleon.*

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