Supermassive Black Holes DO NOT Evaporate in Hawking's Radiation because Gravitational Mass/Energy Converts into Neutrinos. NOT into Photons

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Abstract Hawking assumed that a Black Hole emits photons, and found that then, the black Hole WILL NOT totally evaporate, in any believable time period.

He found that the life-time of a black hole that is assumed to emit photons is incredibly long. That the emitted Electromagnetic Radiation is too small, by astronomical standards, to evaporate even a solar-size black Hole.

That long time period becomes longer for supermassive black

holes.

Hawking offered no explanation for that.

We observe here that Supernova Models indicate that 99% of the Gravitational Binding energy of a star collapsing into a Neutron star is emitted in the form of Neutrinos' Radiation.

A supernova is the collapse of a star, the size of our sun, into a neutron star.

The supermassive black hole at the center of our milky-way galaxy may have the mass of billion suns.

But for the conversion of binding gravitational energy, the size of the star should make no difference.

Since most of the emission in a supernova is Neutrinos, then gravitational binding energy is made of Neutrinos.

And it is likely that matter, or gravitational energy, that make up a black hole are mainly Neutrinos.

This is supported by experiment: 2018 Neutrino detections in the Antarctica observatory IceCube confirm that black holes emit high energy Neutrinos.

We conclude that Supermassive Black Holes DO NOT Evaporate in Hawking's Radiation because Gravitational

Mass/Energy Converts into Neutrinos. NOT into Photons

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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Contents

1.

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, ν.

A Neutrino beam mixes three types of Neutrinos, ν_e, ν_μ, and ν_τ. The Neutrino is one of the longest living particle, along with electrons, protons, and photons.

Neutrinos are generated for instance

- in the Atmosphere, by $\pi \to \mu + \nu_\mu \to e + 2\nu_e$
- in the Sun Core, by the fusion $4\mathrm{H} \to \mathrm{He} + \nu_e + \gamma$
- in the fusion of protons,
- in the fusion of Boron $^8\mathrm{B}$,
- in the fusion of Beryllium $^7\mathrm{B_e}$
- 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 $\frac{1}{10^{43}}\mathrm{cm}^2$.

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.

2.

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.

2.1 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 misguiding.

2.2 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.

3.

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.

4.

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.

5.

Neutrino's Speed

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

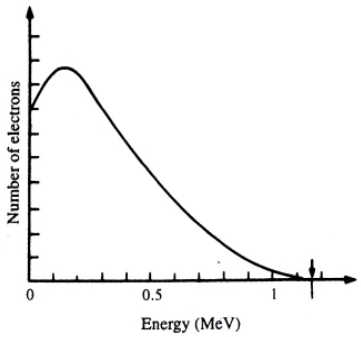
But Light speed is exclusive to the propagation of electromagnetic radiation, and its only carriers are photons.

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].

6.

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

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

with radius

$$r\,,$$

an infinitesimal mass

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

which will add the Gravitational energy

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

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

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

[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

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

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

the Gravitational Binding released is

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

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

$$\tfrac{3}{7}6.7\times 10^{-11}(2.8)^2 10^{60}\,\frac{1}{10^4}=2.25\times 10^{46}\text{Joul}$$

$$=2.25\times 10^{55}\text{erg}$$

The **Nuclear Binding energy** is

$$\begin{pmatrix} 3.2 \underbrace{\text{MeV}}_{1.6\times10^{-11}\text{Joul}} \\ \text{per nucleus} \end{pmatrix} \times \begin{pmatrix} 6\times10^{23} \\ \#\text{ of nuclei/kg} \end{pmatrix} \times \underbrace{M}_{1.4\times2\times10^{30}\text{kg}} = 8.6\times10^{43}\text{Joul},$$

$$= 8.6\times10^{52}\text{erg}.$$

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

$$\tfrac{1}{2}3\underbrace{M_{\text{Sun}}}_{2\times10^{30}}10^{13.6} = 1.2\times10^{44}\text{Joul}$$

$$= 1.2\times10^{53}\text{erg}$$

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.

Since Black Holes are aggregates of Gravitational Energy, Black Holes are aggregates of Neutrinos.

If 99% of the emitted particles are Neutrinos, then 99% of the particles that constitute a black hole are Neutrinos.

In particular, 2018 measurements confirm that black holes emit high energy particles that would be a fourth specie of Neutrinos.

7.

Experiments Indicating that Black Holes Emit High Energy Neutrinos

Two Neutrino detectors are set up in Antarctica:

ANITA = ANtarctic **I**mpulsive **T**ransient **A**ntenna

is a detector hanging from a balloon far above the surface.

It picks up only the most extreme high energy Neutrinos

IceCube

is a buried Neutrino observatory.

Its detectors can trip lower energy particles

By [livescience.com][1],

> ***"In 2018, IceCube tracked a high energy Neutrino back to a blazer, an intense jet of particles coming from an active black hole at the center of a distant galaxy"***

[1] https://www.livescience.com/antarctic-neutrino-mystery-deepens.html

8.

Hawking Radiation

According to Hawking, [Hawking]

The radiation named after him is

1) Thermal radiation, that is, electromagnetic energy, which particles are photons.

   Thus, Contradicting the fact that Gravitational Energy converts into Neutrinos. NOT into Photons.

   Hawking was unaware of the conversion of Gravitational Energy into Neutrinos

2) Speculative.

   Never been detected,

3) Relevant to small Black Holes that may have already disappeared

And

4) Irrelevant to the evaporation of supermassive, and ultramassive Black Holes at the centers of galaxies.

At the beginning of [Hawking], he wrote

"...Even though quantum effects may be small locally, they may still add up to produce a significant effect over

$$\textit{the life time of the Universe} \approx 10^{17}\,\text{seconds}$$ [2]

.....

It seems that any black hole will create and emit particles such as neutrinos or photons at just the rate that one would expect if the black hole was a body with temperature[3] *of*

$$\left(\frac{\kappa}{2\pi}\right)\left(\frac{\hbar}{2k}\right) \approx \frac{1}{10^6}\frac{M_{Sun}}{M_{BlackHole}}\ \text{Kelvin}$$

where

κ *is the surface gravity of the black hole.*

As a black hole emits this thermal radiation, one would expect it to loose mass.

This, in turn, will increase the surface gravity, and so increase the rate of emission.

The black hole would therefore have a finite life of the order of

[2] He means the assumed life-time till 1974.

[3] He means Absolute Temperature where Zero Celsius = 273 Kelvin

$$10^{71}\left(\frac{M_{BlackHole}}{M_{Sun}}\right)^3 \text{ seconds}.$$

For a black hole of a solar mass, this is much longer than the age of the Universe

There might, however, be much smaller black holes which were formed by fluctuations in the early Universe.

Any such black hole of mass less than

$$10^{15} \text{ grams}$$

would have evaporated by now.

Near the end of its life, the rate of emission would be very high, and about

$$10^{30} \text{ erg}$$

would be released in the last 0.1 second.

This is fairly small explosion by astronomical standards but it is equivalent to about

1 Million 1 Megaton hydrogen bombs.

To see how this thermal radiation arises, consider (for simplicity) a massless Hermetian scalar field

$$\phi$$

which obeys the covariant wave equation....."

9.

Hawking Radiation is Photons, Instead of Neutrinos

Hawking wrote

> *...It seems that any black hole will create and emit particles such as neutrinos or photons at just the rate that one would expect if the black hole was a body with temperature[4] of*
>
> $$\left(\frac{\kappa}{2\pi}\right)\left(\frac{\hbar}{2k}\right) \approx \frac{1}{10^6}\frac{M_{Sun}}{M_{BlackHole}} \text{ Kelvin}$$
>
> *where*
>
> κ *is the surface gravity of the black hole.*
>
> *As a black hole emits this thermal radiation,...*

Thermal Radiation is known

in Electromagnetics, as Electromagnetic Radiation

in Atomic Physics, as Photons,

in Planck's Quantum Theory, as Black Body Radiation

It is Never Ever Neutrinos!

Recall that Neutrinos are generated for instance

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

Neutrinos, along with photons, electrons, and protons, are true elementary particles, rather than transients in experiments.

Even the ignorance of Neutrinos in 1974 does not justify including Neutrinos in thermal radiation, by Hawking.

In [Dan1], and in [Dan2], we elaborate on the fact that in a Super Nova, most of the Gravitational mass or binding gravitational energy converts into Neutrinos

Neutrino energy, is not electromagnetic.

Thus, Neutrinos are non-photonic signals, of their own energy.

Supernova Models establish that about 1% of the

[4] He means Absolute Temperature where Zero Celsius = 273 Kelvin

gravitational binding is released as nuclear binding energy, supernova shell kinetic energy, and electromagnetic radiation.

The rest, 99% of the Gravitational Binding Energy of a collapsing star, is emitted in the form of Neutrinos' Radiation, and is carried away by the radiated Neutrinos.

10.

Hawking Radiation is an Assumption

Hawking radiation is based on a plausibility argument:

The uncertainty relation

$$(\Delta E)(\Delta t) \geq \frac{1}{2}\hbar$$

may allow, but DOES NOT mandate the creation of a pair of virtual photons

one virtual photon emitted with energy $h\nu$,

and

one virtual photon absorbed with energy $-h\nu$

Hawking Radiation existence follows from his deep (?!) observation that

$$-1+1=0 \ldots$$

The Hawking Radiation is an assumption that cannot be confirmed.

11.

Hawking Radiation May Evaporate Only Small Black Holes

According to Hawking

> *...The black hole would therefore have a finite life of the order of*
>
> $$10^{71}\left(\frac{M_{BlackHole}}{M_{Sun}}\right)^3 \text{ seconds}.$$
>
> *For a black hole of a solar mass, this is much longer than the age of the Universe*
>
> *There might, however, be much smaller black holes which were formed by fluctuations in the early Universe.*
>
> *Any such black hole of mass less than*
>
> $$10^{15} \text{ grams}$$
>
> *would have evaporated by now.*

That is, to evaporate by now, through Hawking Radiation, the Black hole life time,

$$10^{71}\left(\frac{M_{BlackHole}}{M_{Sun}}\right)^3 \text{ seconds},$$

would have to be of the order of the universe age

$$10^{17} \text{ seconds}.$$

Therefore,

$$10^{54}\left(\frac{M_{BlackHole}}{M_{Sun}}\right)^3 =1,$$

$$10^{18}\,\frac{M_{BlackHole}}{M_{Sun}} =1,$$

$$M_{BlackHole}=\frac{M_{Sun}}{10^{18}}\approx\frac{2\cdot 10^{33}\text{grams}}{10^{18}}=2\cdot 10^{15}\text{grams},$$

If the black hole is denser than the earth by a factor ϑ,

$$\frac{M_{BlackHole}}{M_{earth}}\approx\vartheta\frac{V_{BlackHole}}{V_{earth}}=\vartheta\left(\frac{R_{BlackHole}}{R_{earth}}\right)^3$$

$$\frac{2\cdot 10^{15}}{6\cdot 10^{27}}\approx\vartheta\left(\frac{R_{BlackHole}}{6\cdot 10^{6}meter}\right)^3$$

$$\left(\frac{2\cdot 10^{15}}{6\cdot 10^{27}}\right)^{1/3}\approx\vartheta^{1/3}\,\frac{R_{BlackHole}}{6\cdot 10^{6}meter}$$

$$\frac{0.7}{10^{4}}\approx\vartheta^{1/3}\,\frac{R_{BlackHole}}{6\cdot 10^{6}meter}$$

$$R_{BlackHole} \approx \frac{400}{\vartheta^{1/3}} meter$$

For ϑ the order of 10^3, this black hole has radius of about 40 meter

For ϑ the order of 10^6, this black hole has radius of about 4 meter

For ϑ the order of 10^9, this black hole has radius smaller than 0.4 meter

As Hawking notes,

> *Near the end of its life, the rate of emission would be very high, and about*
>
> $$10^{30} \text{ erg}$$
>
> *would be released in the last*
>
> *0.1 second.*
>
> *This is fairly small explosion by astronomical standards*

By Astronomical standards, the evaporation of such black hole will not be noticed.

12.

Hawking Radiation Cannot Evaporate Supermassive Black Holes at the Centers of Galaxies.

Observational evidence indicates that nearly all large galaxies have a supermassive Black holes at their centers.

Our Milky Way Galaxy has a Supermassive black hole with mass

$$M_{BlackHole} \approx 10^8 M_{Sun}.$$

Supermassive black holes with mass

$$M_{BlackHole} \approx 10^{10} M_{Sun}.$$

were observed too.

According to Hawking,

> *...The black hole would therefore have a finite life of the order of*

$$10^{71}\left(\frac{M_{BlackHole}}{M_{Sun}}\right)^3 \text{ seconds}.$$

Therefore, the milky-way black hole has life-time of the order of

$$10^{71}\left(10^8\right)^3 = 10^{95}\text{seconds},$$

way longer than the universe age of the order of

$$10^{17} \text{ seconds}.$$

That is, according to Hawking, the milky-way black hole will last

$$\frac{10^{95}}{10^{17}} = 10^{78}$$

times the age of the universe.

Consequently, the chance that the milky-way black hole will evaporate, through photon emission, in any believable time period, is zero.

13.

Supermassive Black Holes DO NOT Evaporate in Hawking's Radiation because Gravitational Mass/Energy Converts into Neutrinos. NOT into Photons

Since mass and binding gravitational energy in super nova collapse evaporate mostly into Neutrinos, it may be that the binding gravitational energy in black holes cannot not be fully convertible into photons.

Then, the mass-energy equation

$$E_{Gravitational} = mc_{\nu}^2$$

will apply, [Dan2], with

$$c_{\nu} = \text{average speed of Neutrinos}$$

We observed here that Supernova Models indicate that 99% of the Gravitational Binding energy of a star collapsing into a Neutron star is emitted in the form of Neutrinos' Radiation.

A supernova is the collapse of a star, the size of our sun, into a neutron star.

The black hole at the center of our milky-way galaxy may have mass of billion suns.

But for the conversion of Binding Gravitational Energy, the size of the star should make no difference.

Since most of the emission in a supernova is Neutrinos, then gravitational binding energy is made of Neutrinos.

And it is likely that matter, or gravitational energy, that make up a black hole are mainly Neutrinos.

We conclude that

Supermassive Black Holes

DO NOT Evaporate in Hawking's Radiation

because

Gravitational Mass/Energy Converts into Neutrinos.

NOT into Photons

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