

Exploring Thermal Hawking Radiation and Temperature in an Analogue Black Hole Setup

"Matters Arising" Comment written by Alexander Johnston, Independent Researcher, Cambridge, UK.

Abstract/Summary

The Letter "Observation of thermal Hawking radiation and its temperature in an analogue black hole" does far more than support Hawking radiation. In a performance worthy of Einstein and Newton, it and related topics also contribute to our understanding of geometry, matter's formation, the Higgs boson, the speed of light, the particles of the two nuclear forces, planet formation, the origin of water, quantum superposition, macro-entanglement, and black holes. Unfortunately, this could lead to the Letter's importance being downplayed. Although scientists are thrilled when a scientific paper unifies subjects, they also have a tendency to be deeply suspicious when a paper attempts to explain so many things. It violates their conviction that science can only progress by taking "baby steps". Though Newton and Einstein proceeded by leaps and bounds, many scientists seem to think history is finished and science can only crawl at a snail's pace now.

Comment

Vector-Tensor-Scalar Geometry, Matter Particles, Higgs Boson, Speed of Light

First, the background of a form of maths I call "vector-tensor-scalar geometry" -

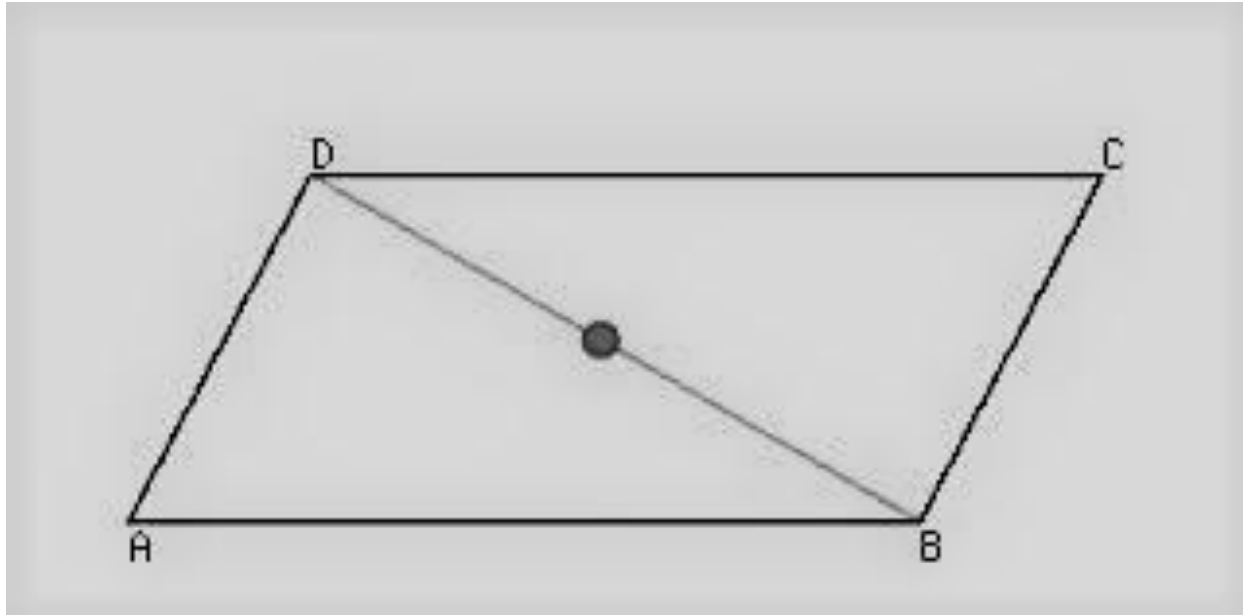


Figure 1 - PARALLELOGRAM WITH DIAGONAL AND CENTRAL SCALAR POINT

A **vector** is a quantity which possesses both magnitude and direction. Two such quantities acting on a point (represented by the central Scalar Higgs boson) may be represented by two adjoining sides of a parallelogram (e.g. CD and AD), so that the resultant diagonal[^] also represents the vectors. The two sides and diagonal thus illustrate the graviton's spin 2 and the photon's spin 1. The resultant diagonal represents the interaction of the sides/vectors ($1 \div 2 =$ the quantum spin of every matter particle: $\frac{1}{2}$). **Tensor** calculus changes the coordinates of the sides and diagonal into the coordinates of a single point on the diagonal. This **scalar** point is associated with particles of spin 0. If the mass^{^^} produced during the $1 \div 2$ interaction happens to be 125 GeV/c², its union with spin 0 produces the Higgs boson.

[^] The resultant diagonal of those two sides can be pictured as a boat being driven in, say, the vertical direction across a river while simultaneously being pushed horizontally by the river's fast-flowing current.

^^ The mass, m , is derived from Einstein's formula equating mass with energy: $E=mc^2$. Solving the equation for m results in $m=E/c^2$: mass equals 125 giga electron volts divided by the speed of light squared.) 125 GeV/c² united with spin 0 means the central scalar point of the Higgs boson is related to the vector of the graviton's spin 2, and the Higgs field is therefore united with the gravitational field - together with the latter's constant interaction with the electromagnetic field. Squaring the speed of light results in a very large number since that velocity is 300,000 kilometres per second, but this speed refers to the shock wave which excites photons. The photons themselves are relatively fixed in position and have a speed assigned the value zero. Whereas 125 giga electron volts divided by the speed of light squared gives a small result if the shock wave's speed is squared, any mathematical operation involving zero can be regarded as an operation not performed and dividing 125 by 0 - the speed of the photons - squared does not change the Higgs boson's mass from the experimentally verified 125 giga electron volts. 125 GeV/c² united with spin 0 means the central scalar point of the Higgs boson is related to the vector of the graviton, and the Higgs field (the boson is an excitation of this field) is therefore united with the supposedly unrelated gravitational field (together with the latter's constant interaction with the electromagnetic field).

The Particles of the Two Nuclear Forces

It must be remembered that referring to space alone is incomplete. Living in space-time, it's necessary to add some sentences about the time factor. The photon must interact with the graviton to produce the mass of the weak nuclear force's W and Z bosons. To produce their quantum spin, the photon's spin 1 needs to react with the graviton's spin 2. That is, the photon's turning through one complete revolution needs to be combined with the graviton's being turned through two half-revolutions.^ Incorporating the time factor as a reversal of time in the middle of the interaction: a gravitonic half revolution is subtracted from the photonic full revolution then the graviton's time-reversal adds a half revolution ($1-\frac{1}{2}+\frac{1}{2}$ = the spin 1 of W and Z bosons). The strong nuclear force's gluon's quantum spin of 1 could arise in the same way as the spin 1 of weak-force bosons.

^ Professor Stephen Hawking writes,

"What the spin of a particle really tells us is what the particle looks like from different directions." (2)

Spin 1 is like an arrow-tip pointing, say, up. A photon has to be turned round a full revolution of 360 degrees to look the same.

Spin 2 is like an arrow with 2 tips - 1 pointing up, 1 down. A graviton has to be turned half a revolution (180 degrees) to look the same.

Spin 0 is like a ball of arrows having no spaces. A Higgs boson looks like a dot: the same from every direction.

Spin 1 / 2 is like a Mobius strip. A particle of matter has to be turned through two complete revolutions to look the same, and you must travel around a Mobius strip twice to reach the starting point.

Planet Formation, Origin of Water

Vector-tensor-scalar geometry agrees with Dr. Lydia Hallis that Earth's water came from the solar nebula. Referring to protoplanetary disks (PPD's), the geometry concludes that the quantum spin of matter particles is established when gravitational and electromagnetic waves interact. Like a scanner reading a barcode, the spin is "imprinted" on the waves scanning a PPD and cause Earth to be built up layer by layer, incorporating water into its minerals as its size increases. This scan means the mass of planets etc formed from a PPD can exceed the PPD's mass. (Most planetary systems seem to outweigh the protoplanetary disks in which they formed, leaving astronomers to re-evaluate planet-formation theories [3])

Quantum Superposition, Macroscopic Entanglement, and Black Holes

Quantum superposition means any two (or more) quantum states - e.g. of photon and presently hypothetical graviton - can be added together, and the result will be another valid quantum state: Higgs boson (as well as the Higgs field), or the weak nuclear force's bosons, or matter particles. Planetary systems and black holes are two examples of valid macro-superposition. "Physicists now believe that entanglement between particles exists everywhere, all the time, and have recently found shocking evidence that it affects the wider, 'macroscopic' world that we inhabit". (4) Caslav Brukner, working with Vlatko Vedral and two other Imperial College researchers, has uncovered a radical twist. They have shown that moments of time can become entangled too. (5) The interacting gravity

and electromagnetism produce mass e.g. they can form a Higgs boson or the weak nuclear force's bosons as well as matter. On a cosmic level - When gravitational and electromagnetic waves scan a protoplanetary disk, the info in the disk is recorded or imprinted in the waves. When they scan "empty" space-time, the opposite interaction to $1/2$ occurs and the info pertaining to the graviton's spin of 2 ($2/1$) is imprinted since gravity is space-time according to General Relativity - it says gravity is just another term for the curvature of space-time. The mass produced has the spin inherent in a body of gravitational waves, and could be an additional method to supernovas for producing black holes.

References

- (1) "Observation of thermal Hawking radiation and its temperature in an analogue black hole" by Juan Ramón Muñoz de Nova, Katrine Golubkov, Victor I. Kolobov & Jeff Steinhauer: *Nature* **569**, 688–691 (2019)
- (2) "A Brief History of Time" by Stephen Hawking (Bantam Press, 1988): pp.66-67
- (3) AstroNews: Astronomy, February 2019, p. 17
- (4) "The Weirdest Link": New Scientist, vol. 181, issue 2440 - 27 March 2004, page 32 - online at <http://www.biophysica.com/QUANTUM.HTM>
- (5) "Quantum Entanglement in Time" by Caslav Brukner, Samuel Taylor, Sancho Cheung, Vlatko Vedral (Submitted on 18 Feb 2004) - <http://www.arxiv.org/abs/quant-ph/0402127>