Black Holes Like Aspirin

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Abstract

When Stephen Hawking postulated in the mid-1970s that black holes leak radiation, slowly dissolving like aspirin in a glass of water, he overturned a core tenet of the Universe. [10]

That's what some physicists have argued for years: That black holes are the ultimate vaults, entities that suck in information and then evaporate without leaving behind any clues as to what they once contained. But new research shows that this perspective may not be correct. [9]

Considering the positive logarithmic values as the measure of entropy and the negative logarithmic values as the measure of information we get the Information – Entropy Theory of Physics, used first as the model of the computer chess program built in the Hungarian Academy of Sciences.

Applying this model to physics we have an understanding of the perturbation theory of the QED and
QCD as the Information measure of Physics. We have an insight to the current research of Quantum Information Science. The generalization of the Weak Interaction shows the arrow of time in the associate research fields of the biophysics and others. We discuss also the event horizon of the Black Holes, closing the information inside.

Black holes dissolving like aspirin: How Hawking changed physics

When Stephen Hawking postulated in the mid-1970s that black holes leak radiation, slowly dissolving like aspirin in a glass of water, he overturned a core tenet of the Universe.

Ever since Albert Einstein published his theory of general relativity in 1915, predicting the existence of black holes, it was thought they devour everything in their vicinity, including light.

Black holes, it was thought, were bottomless pits from which matter and energy could never escape.

But Hawking, sometimes described as the most influential theoretical physicist since Einstein, questioned this, saying that black holes were not really black at all and must emit particles.

In so doing, he touched on a persistent headache for physicists: Einstein's theory, which has withstood every experimental test so far, does not explain the behaviour of particles in the subatomic, "quantum" sphere.

Considered controversial at first, Hawking's black hole theory pointed to a possible bridge between the two mainstay physics theories—general relativity and quantum mechanics.

"Hawking realised that black holes, these objects that are made of gravity, because of quantum mechanics... can actually emit particles," astrophysicist Patrick Sutton of Cardiff University told AFP.

"This was the first case where we had a physical process that links gravity, this classical theory of gravity, with quantum mechanics."

The mechanism was named "Hawking radiation" after the famous scientist who died Wednesday—Einstein's birthday.

And it painted a completely new portrait of black holes.

"Stephen Hawking discovered that when the quantum laws governing the physics of atoms and elementary particles were applied to black holes, the surprising outcome was that black holes actually must emit radiation," physicist Raymond Volkas of the University of Melbourne said via the Australian Science Media Centre.

'Theory of Everything'

Hawking showed that because black holes give off radiation they actually have a temperature. And in losing mass and energy, they would slowly shrink and eventually evaporate—"a real shock" proposition, according to Sutton.

"Hawking's most important scientific legacy is his idea that black holes slowly dissolve like aspirin in a glass of water," said Lisa Harvey-Smith of the University of New South Wales.

But Hawking radiation in turn posed a new problem, the so-called "black hole information paradox".

If a black hole disappears, all the cosmological information from matter and energy that initially went into it will disappear too. But physics predicts that information can never be lost.

Hawking himself had conceded a wager on the point, having initially bet that black hole information will ultimately be lost.

"It is still the focus of theoretical interest, a topic of debate and controversy more than 40 years after his discovery," said British cosmologist Martin Rees.

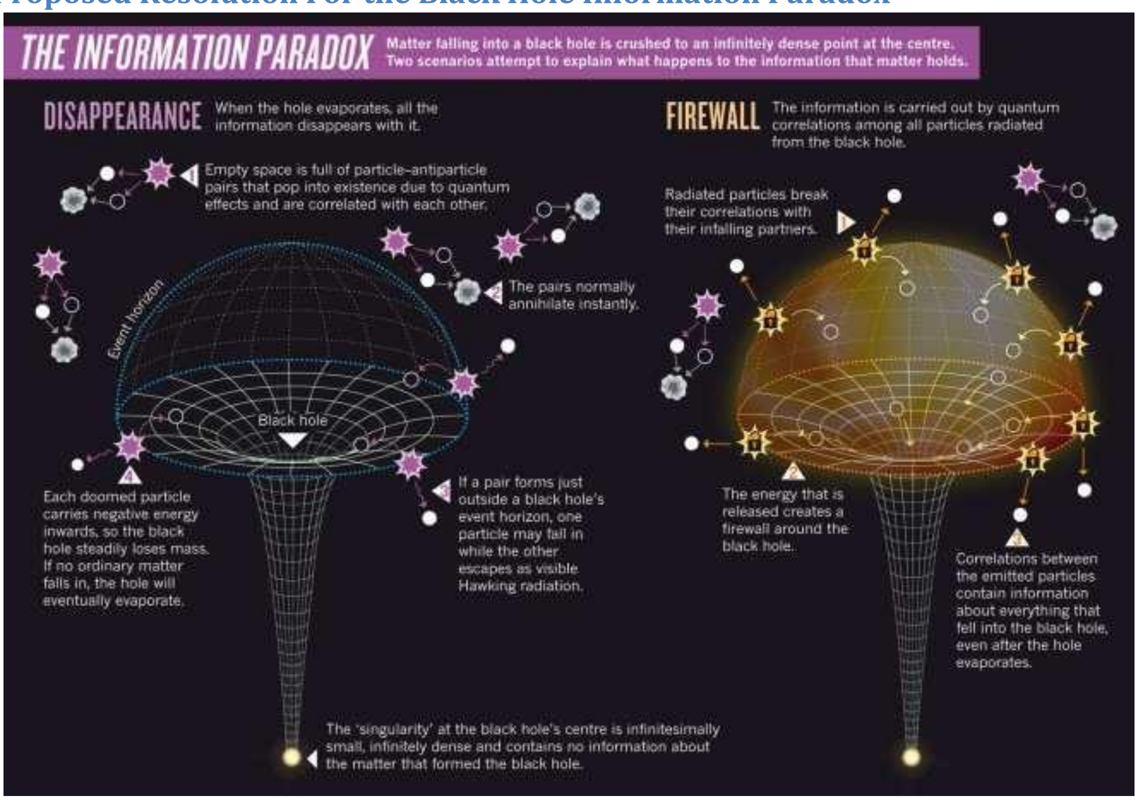
A former collaborator of Hawking, he added, once described the radiation theory as causing "more sleepless nights among theoretical physicists than any paper in history."

Hawking radiation has heavily influenced the ongoing quest for "New Physics", a "Theory of Everything" that can unify general relativity with quantum mechanics.

Besides his deep imprints on theoretical physics, many credit Hawking's popularisation of science, including through his cosmology-themed book "A Brief History of Time", with motivating their own interest and careers.

"His impact on the public understanding of science is almost beyond measure," said Harvey-Smith. [10]

Proposed Resolution For the Black Hole Information Paradox



“According to our work, information isn’t lost once it enters a black hole,” says Dejan Stojkovic, PhD, associate professor of physics at the University at Buffalo. “It doesn’t just disappear.”

Stojkovic's new study, "Radiation from a Collapsing Object is Manifestly Unitary," appeared on March 17 in Physical Review Letters, with UB PhD student Anshul Saini as co-author.

The paper outlines how interactions between particles emitted by a black hole can reveal information about what lies within, such as characteristics of the object that formed the black hole to begin with, and characteristics of the matter and energy drawn inside.

This is an important discovery, Stojkovic says, because even physicists who believed information was not lost in black holes have struggled to show, mathematically, how this happens. His new paper presents explicit calculations demonstrating how information is preserved, he says.

The research marks a significant step toward solving the "information loss paradox," a problem that has plagued physics for almost 40 years, since Stephen Hawking first proposed that black holes could radiate energy and evaporate over time. This posed a huge problem for the field of physics because it meant that information inside a black hole could be permanently lost when the black hole disappeared—a violation of quantum mechanics, which states that information must be conserved.

Information Hidden in Particle Interactions:

In the 1970s, Hawking proposed that black holes were capable of radiating particles, and that the energy lost through this process would cause the black holes to shrink and eventually disappear. Hawking further concluded that the particles emitted by a black hole would provide no clues about what lay inside, meaning that any information held within a black hole would be completely lost once the entity evaporated.

Though Hawking later said he was wrong and that information could escape from black holes, the subject of whether and how it's possible to recover information from a black hole has remained a topic of debate. Stojkovic and Saini's new paper helps to clarify the story.

Instead of looking only at the particles a black hole emits, the study also takes into account the subtle interactions between the particles. By doing so, the research finds that it is possible for an observer standing outside of a black hole to recover information about what lies within.

Interactions between particles can range from gravitational attraction to the exchange of mediators like photons between particles. Such "correlations" have long been known to exist, but many scientists discounted them as unimportant in the past. [9]

Considering the chess game as a model of physics

In the chess game there is also the same question, if the information or the material is more important factor of the game? There is also the time factor acting as the Second Law of Thermodynamics, and the arrow of time gives a growing disorder from the starting position.

When I was student of physics at the Lorand Eotvos University of Sciences, I succeeded to earn the master degree in chess, before the master degree in physics. I used my physics knowledge to see the chess game on the basis of Information – Entropy Theory and giving a presentation in the Hungarian Academy of Sciences, proposed a research of chess programming. Accepting my idea there has built the first Hungarian Chess Program "PAPA" which is participated on the 1st World Computer Chess Championship in Stockholm 1974. [1]

The basic theory on which one chess program can be constructed is that there exists a general characteristic of the game of chess, namely the concept of entropy.

This concept has been employed in physics for a long time. In the case of a gas, it is the logarithm of the number of those microscopic states compatible with the macroscopic parameters of the gas.

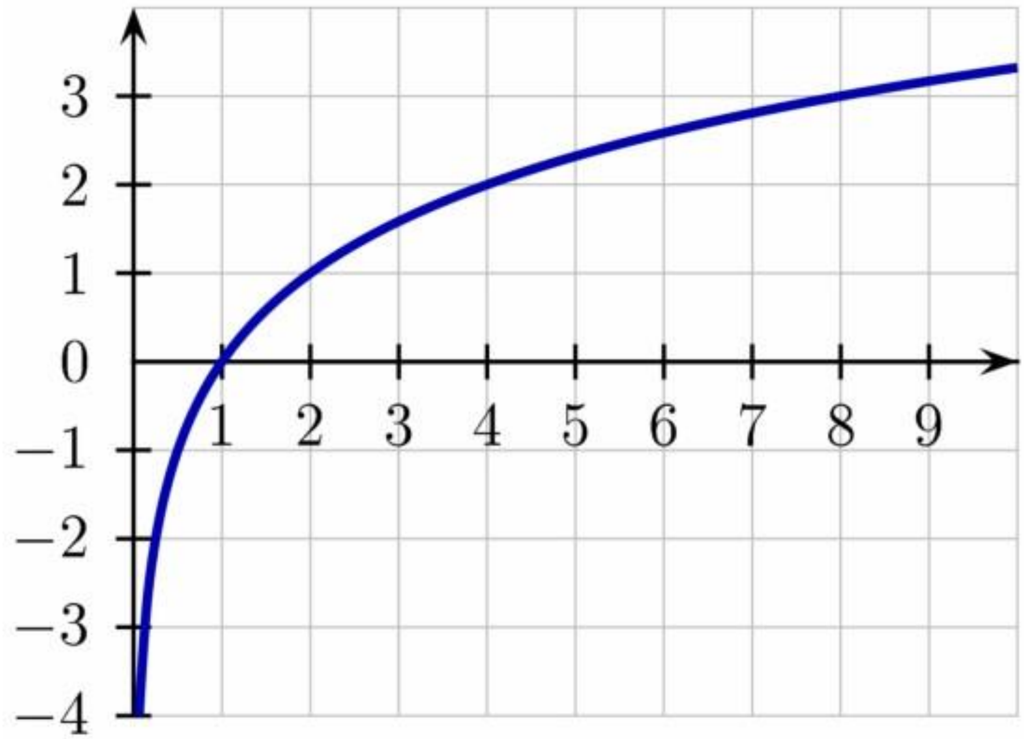
What does this mean in terms of chess? A common characteristic of every piece is that it could move to certain squares, including by capture. In any given position, therefore, the pieces by the rules of the game possess certain states, only one of which will be realized on the next move. The difference of the logarithm of the numbers of such states for Black and White respectively is the "entropy of the position". The task of the computer is then to increase this value for its own benefit.

Every chess player knows that the more mobility his pieces have and the more constrained are his opponent's, the better his position. For example, checkmate is the best possible state for the attacker, and the chess program playing according to the above principle without the prior notion of checkmate will automatically attempt it if possible.

Entropy is a principle of statistical physics and therefore is only applicable in statistical contexts. The number of microstates of a confined gas is very large and therefore the statistical approach is valid. In chess, however, the number of pieces, a macroscopic parameter, is very small and therefore in this context the "value" of a position cannot be an exact function of entropy. For example, it is possible to checkmate with a total force of a single pawn despite the fact that the opponent has many pieces and various positions available.

Examples of sacrificial combinations further demonstrate this consideration. Therefore we also need specific information about any given position. For example, entropy could be maximized by White giving check, but if the checking piece is then taken, the move was a bad one. The logarithm of the number of variations which have been examined in this way gives the amount of information. In the endgame it is rather inaccurate. Because of the small number of pieces the above noted inadequacy of the statistical principle becomes evident and we need to compute much more information to fill the gap.

We can think about the positive logarithmic values as the measure of entropy and the negative logarithmic values as the measure of information.



Shortly speaking:

- The evaluation of any position is based on the entropy + information.
- The entropy is the logarithm of the possible legal moves of the position.
- The information is simply the depth of the search, since it is the logarithm of the exponential growing number of possible positions, $\log e^x = x$.

E = entropy

I = information

D = depth of search

M = legal moves in any position, M_w for white moves and M_b for black moves

$E = \log M_w - \log M_b = \log M$

And since $\log e^x = x$, $I = D$

We get information + entropy, the value V of any position in the search tree of the current chess position:

$V(D, M) = I + E = D + \log M$

This naturally gives better values for a deeper search with greater mobility. [2]

Using this model in physics

Viewing the confined gas where the statistical entropy not needs the information addition is not the only physical system. There are for example quantum mechanical systems where the information is a very important qualification. The perturbation theory needs higher order calculations in QED or QCD giving more information on the system as in the chess games happens, where the entropy is not enough to describe the state of the matter. The variation calculation of chess is the same as the perturbation calculation of physics to gain information, where the numbers of particles are small for statistical entropy to describe the system. The role of the Feynman graphs are the same as the chess variations of a given position that is the depth of the variations tree, the Information is the same as the order of the Feynman graphs giving the Information of the micro system.

Quantum Information Science

Quantum information science is an area of study based on the idea that information science depends on quantum effects in physics. It includes theoretical issues in computational models as well as more experimental topics in quantum physics including what can and cannot be done with quantum information.

Quantum Computing Research

Quantum computing has been an intense research field since Richard Feynman in 1981 challenged the scientific community to build computers based on quantum mechanics. For decades, the pursuit remained firmly in the theoretical realm.

To understand the quantum world, researchers have developed lab-scale tools to manipulate microscopic objects without disturbing them. The 2012 Nobel Prize in Physics recognizes two of these quantum researchers: David Wineland, of the National Institute of Standards and Technology and the University of Colorado in Boulder, and Serge Haroche, of the Collège de France and the Ecole Normale Supérieure in Paris. Two of their papers, published in 1995 and ‘96 in Physical Review Letters, exemplify their contributions. The one by Wineland and collaborators showed how to use atomic states to make a quantum logic gate, the first step toward a superfast quantum computer. The other, by Haroche and his colleagues, demonstrated one of the strange predictions of quantum mechanics—that measuring a quantum system can pull the measuring device into a weird quantum state which then dissipates over time.

IBM scientists believe they’re on the cusp of building systems that will take computing to a whole new level. On Feb 28, 2012 the IBM team presented major advances in quantum computing device performance at the annual American Physical Society meeting. Using a variety of techniques in the IBM laboratories, scientists have established three new records for retaining the integrity of quantum mechanical properties in quantum bits, or qubits, and reducing errors in elementary computations. These breakthrough results are very close to the minimum requirements for a fullscale quantum computing system as determined by the world-wide research community. [3]

Quantum computing in neural networks is one of the most interesting research fields today. [4] The biological constructions of the brain are capable to memorize, associate and logically thinking by changing their quantum states. The machine learning of Artificial Intelligence will be one of the mainstreams of the Quantum Computing, when it will be available. Probably the main challenge will be to simulate the brain biologic capability to create new quantum states for logical reasoning, since we don't know nowadays how it is work exactly in the brain. [8]

The General Weak Interaction

The Weak Interactions T-asymmetry is in conjunction with the T-asymmetry of the Second Law of Thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes for example the Hydrogen fusion. The arrow of time by the Second Law of Thermodynamics shows the increasing entropy and decreasing information by the Weak Interaction, changing the temperature dependent diffraction patterns. A good example of this is the neutron decay, creating more particles with less known information about them. [5]

The neutrino oscillation of the Weak Interaction shows that it is a general electric dipole change and it is possible to any other temperature dependent entropy and information changing diffraction pattern of atoms, molecules and even complicated biological living structures.

We can generalize the weak interaction on all of the decaying matter constructions, even on the biological too. This gives the limited lifetime for the biological constructions also by the arrow of time. There should be a new research space of the Quantum Information Science the 'general neutrino oscillation' for the greater then subatomic matter structures as an electric dipole change.

There is also connection between statistical physics and evolutionary biology, since the arrow of time is working in the biological evolution also. [6]

The Fluctuation Theorem says that there is a probability that entropy will flow in a direction opposite to that dictated by the Second Law of Thermodynamics. In this case the Information is growing that is the matter formulas are emerging from the chaos. So the Weak Interaction has two directions, samples for one direction is the Neutron decay, and Hydrogen fusion is the opposite direction.

Black Holes revisited

The Black Holes are the counter example, where the matter is so highly concentrated that the entropy is very low and the information is high but closed inside the event horizon.

The problem is with the Black hole that it is not a logical physical state of the matter by the diffraction theory, because we cannot find a temperature where this kind of diffraction patterns could exist. [5]

Also the accelerating charges of the electric current say that the charge distribution maintains the accelerating force and this viewpoint of the relativity does not make possible an acceleration that can cause a Black Hole. The ever growing acceleration simply resolved in the spin. [7]

The spin is one of the most generic properties of the Universe, not only the elementary particles are spinning, but also the Sun, Earth, etc. We can say that the spin is the resolution of the constantly accelerating matter solving the problem of the relativity and the accelerating Universe. The gravity is the magnetic effect of the accelerating matter, the attracting force between the same charges; working by the electromagnetic oscillations, because of this is their universal force. Since this effect is relatively weak, there is no way for the gravitation force to compress the matter to a Black Hole.

Conclusions

“These correlations were often ignored in related calculations since they were thought to be small and not capable of making a significant difference,” Stojkovic says. “Our explicit calculations show that though the correlations start off very small, they grow in time and become large enough to change the outcome.” [9]

My opinion is that information and matter are two sides of the same thing in physics, because the matter is the diffraction pattern of the electromagnetic waves, giving the temperature dependent different structures of the matter, the information about them arrives by the electromagnetic waves and also the entropy or uncertainty as the measure of disorder. [7]

The Fluctuation Theory gives a probability for Information grow and Entropy decrease seemingly proportionally with the gravitational effect of the accelerating Universe, against the arrow of time by the Second Law of Thermodynamics. The information and entropy are the negative and positive sides of the logarithmic curve, describing together the state of the matter.

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