Silicon Telecommunications Devices

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Abstract

Using light rather than electricity to move data would dramatically reduce computer chips' energy consumption, and the past 20 years have seen remarkable progress in the development of silicon photonics, or optical devices that are made from silicon so they can easily be integrated with electronics on silicon chips. [15]

In their most recent paper they demonstrated that solitons can be manipulated and outlined how to use them for logical operations. Their experiments and models are published in Nature Physics and pave the way to a new field of electronics: Solitonics. [14]

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A team of theoretical physicists has proposed a way to simulate black holes on an electronic chip. Additionally, the technology used to create these lab-made black holes may be useful for quantum technologies. [12]

To carry out this experiment, Chen and Mourou suggest a laser pulse could be sent through a plasma target. [11]

Jeff Steinhauer, a physicist at the Israel Institute of Technology, has published a paper in the journal Nature Physics describing experiments in which he attempted to create a virtual black hole in the lab in order to prove that Stephen Hawking's theory of radiation emanating from black holes is correct —though his experiments are based on sound, rather than light. In his paper, he claims to have observed the quantum effects of Hawking radiation in his lab as part of a virtual black hole—which, if proven to be true, will be the first time it has ever been achieved.

New Research Mathematically Proves Quantum Effects Stop the Formation of Black Holes. By merging two seemingly conflicting theories, Laura Mersini-Houghton, a physics professor at UNC-Chapel Hill in the College of Arts and Sciences, has proven, mathematically, that black holes can never come into being in the first place. The works not only forces scientists to reimagining the fabric of space-time, but also rethink the origins of the universe.

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.

Researchers show that silicon can reproduce physical phenomena exploited by high-end telecommunications devices

The Semiconductor Industry Association has estimated that at current rates of increase, computers' energy requirements will exceed the world's total power output by 2040.

Using light rather than electricity to move data would dramatically reduce computer chips' energy consumption, and the past 20 years have seen remarkable progress in the development of silicon photonics, or optical devices that are made from silicon so they can easily be integrated with electronics on silicon chips.

But existing silicon-photonic devices rely on different physical mechanisms than the high-end optoelectronic components in telecommunications networks do. The telecom devices exploit so-called second-order nonlinearities, which make optical signal processing more efficient and reliable.

In the latest issue of Nature Photonics, MIT researchers present a practical way to introduce second-order nonlinearities into silicon photonics. They also report prototypes of two different silicon devices that exploit those nonlinearities: a modulator, which encodes data onto an optical beam, and a frequency doubler, a component vital to the development of lasers that can be precisely tuned to a range of different frequencies.

In optics, a linear system is one whose outputs are always at the same frequencies as its inputs. So a frequency doubler, for instance, is an inherently nonlinear device.

"We now have the ability to have a second-order nonlinearity in silicon, and this is the first real demonstration of that," says Michael Watts, an associate professor of electrical engineering and computer science at MIT and senior author on the new paper.

"Now you can build a phase modulator that is not dependent on the free-carrier effect in silicon. The benefit there is that the free-carrier effect in silicon always has a phase and amplitude coupling. So whenever you change the carrier concentration, you're changing both the phase and the amplitude of the wave that's passing through it. With second-order nonlinearity, you break that coupling, so you can have a pure phase modulator. That's important for a lot of applications. Certainly in the communications realm that's important."

The first author on the new paper is Erman Timurdogan, who completed his PhD at MIT last year and is now at the silicon-photonics company Analog Photonics. He and Watts are joined by Matthew Byrd, an MIT graduate student in electrical engineering and computer science, and Christopher Poulton, who did his master's in Watts's group and is also now at Analog Photonics.

Dopey solutions

If an electromagnetic wave can be thought of as a pattern of regular up-and-down squiggles, a digital modulator perturbs that pattern in fixed ways to represent strings of zeroes and ones. In a silicon modulator, the path that the light wave takes is defined by a waveguide, which is rather like a rail that runs along the top of the modulator.

Existing silicon modulators are doped, meaning they have had impurities added to them through a standard process used in transistor manufacturing. Some doping materials yield p-type silicon, where the "p" is for "positive," and some yield n-type silicon, where the "n" is for "negative." In the presence of an electric field, free carriers—electrons that are not associated with particular silicon atoms—tend to concentrate in n-type silicon and to dissipate in p-type silicon.

A conventional silicon modulator is half p-type and half n-type silicon; even the waveguide is split right down the middle. On either side of the waveguide are electrodes, and changing the voltage across the modulator alternately concentrates and dissipates free carriers in the waveguide, to modulate an optical signal passing through.

The MIT researchers' device is similar, except that the center of the modulator—including the waveguide that runs along its top—is undoped. When a voltage is applied, the free carriers don't collect in the center of the device; instead, they build up at the boundary between the n-type silicon and the undoped silicon. A corresponding positive charge builds up at the boundary with the p-type silicon, producing an electric field, which is what modulates the optical signal.

Because the free carriers at the center of a conventional silicon modulator can absorb light particles—or photons—traveling through the waveguide, they diminish the strength of the optical signal; modulators that exploit second-order nonlinearities don't face that problem.

Picking up speed

In principle, they can also modulate a signal more rapidly than existing silicon modulators do. That's because it takes more time to move free carriers into and out of the waveguide than it does to concentrate and release them at the boundaries with the undoped silicon. The current paper simply reports the phenomenon of nonlinear modulation, but Timurdogan says that the team has since tested

prototypes of a modulator whose speeds are competitive with those of the nonlinear modulators found in telecom networks.

The frequency doubler that the researchers demonstrated has a similar design, except that the regions of p- and n-doped silicon that flank the central region of undoped silicon are arranged in regularly spaced bands, perpendicular to the waveguide. The distances between the bands are calibrated to a specific wavelength of light, and when a voltage is applied across them, they double the frequency of the optical signal passing through the waveguide, combining pairs of photons into single photons with twice the energy.

Frequency doublers can be used to build extraordinarily precise on-chip optical clocks, optical amplifiers, and sources of terahertz radiation, which has promising security applications.

"Silicon has had a huge renaissance within the optical communication space for a variety of applications," says Jason Orcutt, a researcher in the Physical Sciences Department at IBM's Thomas J. Watson Research Center. "However, there are still remaining application spaces—from microwave photonics to quantum optics—where the lack of second-order nonlinear effects in silicon has prevented progress. This is an important step towards addressing a wider range of applications within the mature silicon-photonics platforms around the world."

"To date, efforts to achieve second-order nonlinear effects in silicon have focused on hard material-science problems," Orcutt adds. "The [MIT] team has been extremely clever by reminding the physics community what we shouldn't have forgotten. Applying a simple electric field creates the same basic crystal polarization vector that other researchers have worked hard to create by far more complicated means." [15]

Towards new IT devices with stable and transformable solitons

Unavoidably, each digital information we send around the globe is prone to be lost. Travelling long ways in wires, the initial signal decays and scatters by colliding with impurities and neighboring electromagnetic fields. Therefore, beyond each bit of your desired message, it is necessary to send other hidden bits of information that check for mistakes and take action in case of losses; while devices become smaller and smaller, this issue becomes more significant. Scientists at the Center for Artificial Low Dimensional Electronic (CALDES), within the Institute for Basic Science (IBS) are aiming to find innovative ways at achieving a more stable transmission of information. One of their research interests focuses on self-reinforcing solitary wave packets called solitons, which are stable no matter the surroundings. In their most recent paper they demonstrated that solitons can be manipulated and outlined how to use them for logical operations. Their experiments and models are published in Nature Physics and pave the way to a new field of electronics: Solitonics.

Physicists know that one possible solution to the issue of signal attenuation or noise because of external interferences can come from a mathematical concept called topology. It is related to properties that are not affected by a change in shape. For example, believe it or not, a ball and a pencil are topologically the same, but different from a donut. This is because, with some imagination, you can mold the ball into the shape of the pencil. However, when you make a hole in the ball, it becomes a totally different topological object. Holes define the topological state, they can move within the material, but their number does not change even under the presence of pushing and pulling forces. A similar concept could be used in IT to protect the flow of information from external interferences and impurities and guarantee its stability over longer distances and time. It sounds like an amazing property but, paradoxically, it is also its own biggest enemy: The transmitted information is too stable, in a way that it is actually too difficult to modify and use. That seemed to be the sad end of the story, until IBS scientists demonstrated a way to manipulate the transmitted signal and possibly apply it to modern electronics.

One of the key components of the physics of topological system is the soliton, an extremely stable solitary wave packet of energy, which travels though some 1D materials without losing its shape and energy, a bit like a tsunami wave. Scientists began to study topological solitons in the 80's, but were deterred by the seemingly impossibility of manipulating them.

Last year, IBS scientists explored the properties of solitons on a double chain of indium atoms placed on the top of a silicon surface and they found that solitons could exist in three forms. "In a topological sense, it is like having a donut with a lot of holes, where each hole can be of three different shapes corresponding to the three types of solitons," explains YEOM Han Woong, the leading author of this study. "Physicists used to work with solitons (holes) of the same type and the operations you could do with them were limited, but now we have a bigger chance to play with them."

In this new study, Yeom and his team proved, experimentally, that switching between these solitons is possible. They observed that when two solitons meet, they result in a different soliton, in other words they found that solitons can be transformed, and yet remain immune to the defects of the medium. "So far solitons could only be created or destroyed in pairs, no other manipulations were possible, but we showed that these solitons can be switched from one to another, and even used for logical operations", continues Yeom.

These three types of solitons can also be represented by digits (1, -1 and 2) and the condition without solitons as zero (0), creating a quaternary mathematical system. The four digits can then be used for mathematical computations.

Quaternary digit systems, and multidigit systems in general, have several advantages over the binary (0, 1) system that we are currently using. They allow more operations and information storage in less space and they could bring us a step closer to brain-like devices, which mimic the way information is computed and stored by our neuronal circuits.

Opening a new field of electronics, dubbed solitonics, IBS scientists imagine new generation IT devices that combine silicon and solitons. "We are using solitons travelling in indium atoms on a silicon surface, and we imagine that this structure that could be implemented in current silicon devices, creating hybrid systems," explains KIM Tae-Hwan, first author of this study. [14]

Researchers investigate the potential of metal grids for future electronic components

Scientists from the Helmholtz Zentrum Dresden-Rossendorf (HZDR) have shown how a cobalt grid can be reliably programmed at room temperature. In addition, they have discovered that for every hole ("antidot"), three magnetic states can be configured in a nanometer-scale magnetic perforated grid. The results have been published in the journal Scientific Reports.

Physicist Rantej Bali from the HZDR, together with scientists from Singapore and Australia, designed a special grid structure in a thin layer of cobalt in order to program its magnetic properties. Colleagues from the National University in Singapore produced the grid using a photolithographic process similar to that currently used in chip manufacture. Approximately 250 nanometer-sized holes, so-called antidots, were created at regular intervals with interspaces of only 150 nanometers in the cobalt layer. In order to be able to stably program it, the Singapore experts followed the Dresden design, which specified a metal layer thickness of approximately 50 nanometers.

At these dimensions, the cobalt antidot grid displayed interesting properties. Dr. Bali's team discovered that with the aid of an externally applied magnetic field, three distinct magnetic states around each hole could be configured. The scientists called these states "G", "C" and "Q." Dr. Bali says, "By optimizing the antidot geometry, we were able to show that the spins, or the magnetic moments of the electrons, could be reliably programmed around the holes."

Building blocks for future logic

Since the individually programmable holes are situated in a magnetic metal layer, the grid geometry has potential use in computers that would work with spin-waves instead of the electric current. "Spin-waves are similar to the so-called Mexican waves you see in a football stadium. The wave propagates through the stadium, but the individual fans—in our case, the electrons—stay seated", explains Dr. Bali. Logic chips utilizing such spin waves would use far less power than today's processors, because no electrical current is involved.

Many magnetic states can be realized in the perforated grid so that the spin-waves can, for example, be assigned specific directions. This could allow for a higher processing speed in future logic chips. "Our perforated grids could also operate as components for future circuits working with spin-waves", says Dr. Bali. Doctoral candidate Tobias Schneider is now investigating the dynamics developed by the spin-waves in such perforated grids. Among other aspects, he is participating in the development of special computer programs making possible the complex calculation of the magnetic states in perforated grids. [13]

Black holes on an electronic chip

A team of theoretical physicists has proposed a way to simulate black holes on an electronic chip. Additionally, the technology used to create these lab-made black holes may be useful for quantum technologies. The researchers from the University of Chile, Cedenna, TU Eindhoven, Utrecht University, and FOM will publish their results in Physical Review Letters on 1 February 2017.

Black holes are astronomical objects so dense that nothing – not even light – can escape their gravitational pull once it passes a point of no return called the event horizon. The researchers have discovered how to make such points of no return for spin waves, fluctuations that propagate in magnetic materials, by using the behaviour of these waves when they interact with electric currents.

Spin waves

Magnetic materials have north and south poles. If perturbed, the north and south pole move from one position in the material to another in a wavelike manner. Such a wave is called a spin wave. When an electric current runs through the material, the electrons drag these waves along. When passing such a current through a wire that is thick on one end and thin on the other, the electrons flow faster on the thin end, just like water flows faster through a narrow hose. The flow of electrons on the thin end of the wire can be so fast that the spin waves that are dragged along cannot flow in the opposite direction anymore. The point at which this happens along the wire is a point of no return for the spin waves, analogous to a black hole event horizon.

Hawking radiation

Near astronomical black holes, gravitation is so strong that it causes an event horizon for any type of particle. Even photons cannot escape from a black hole once they pass its horizon. In 1974, Stephen Hawking discovered that black holes are not completely black, but emit radiation. Roughly speaking, subtle quantum mechanical effects cause pairs of particles and antiparticles to continuously appear and disappear. If this happens near the horizon of a black hole, one of the particles in the pair is sometimes swallowed by the black hole, leaving the other particle to escape and radiate away. This so-called Hawking radiation is almost impossible to observe in outer space. However, the possibility of simulating the black hole on an electronic chip makes it possible to study this effect in a much simpler way by looking at Hawking radiation of spin waves.

Quantum entanglement, quantum computers, and future research

The particles in the pairs that cause Hawking radiation are quantum mechanically entangled, meaning that their properties are so closely intertwined that they cannot be described by classical physics. Entanglement is one of the key ingredients of quantum technologies such as quantum computers. One of the directions that the researchers are now investigating is how to make devices that use this entanglement and can serve as building blocks for applications based on the quantum entanglement of spin waves. [12]

Possible way to test black hole information paradox in the lab

A pair of researchers, one with National Taiwan University, the other with École Polytechnique in France has come up with a way to test the idea of Hawking radiation and the information paradox in a lab setting. In their paper published in the journal Physical Review Letters, Pisin Chen and Gerard Mourou describe their idea and the likely difficulties that researchers would face in trying to carry out actual experiments.

The information paradox surrounding black holes came about as researchers pondered the problem of physical information being destroyed when it is pulled into a black hole and disappearing later as the black hole dies—this would seem to violate the laws of physics. Back in the 1970s, Stephen Hawking famously postulated the idea that if a pair of entangled photons came to exist near the event horizon and one was pulled into the black hole but the other escaped, then the escaping photon would hold the information, preventing its loss, thus avoiding a paradox. Since that time, physicists have conceived thought experiments to test this idea, but of course, due to the inability to travel to and test a black hole, all remain theoretical. In this new effort, the research pair believe they may have come up with a way to test one of those thought experiments in a lab here on Earth.

The thought experiment consisted of developing a way to mimic the behavior of the photons near the black hole event horizon—perhaps by generating entangled pairs of photons and then using an accelerating mirror to mimic the impact of black hole gravity. In this scenario, one photon would be reflected (representing Hawking radiation) while the other would not—it would keep moving until the mirror finally stopped.

To carry out this experiment, Chen and Mourou suggest a laser pulse could be sent through a plasma target. As it moves, it would create a wake consisting of electrons that could serve as a moving reflecting boundary. To keep the mirror accelerating, they also note, the plasma density would have to be continually increased. The two ran simple tests of the concept, and they now claim that carrying out such an experiment would be extremely difficult, though possible. It could be done, they suggest, using a next-generation particle accelerator called a plasma Wakefield accelerator. [11]

Physicist claims to have observed quantum effects of Hawking radiation in the lab for the first time

For many years, scientists believed that nothing could ever escape from a black hole. But in 1974, Stephen Hawking published a paper suggesting that something could—particles that are now called Hawking radiation. His idea was that if a particle (and its antimatter mate) appeared spontaneously at the edge of a black hole, one of the pair might be pulled into the black hole while the other escaped, taking some of the energy from the black hole with it—which would explain why black holes grow smaller and eventually disappear. Because such emissions are so feeble, no one has been able to measure Hawking radiation, so researchers have instead tried to build virtual black holes in labs to test the theory. One type of virtual black hole was proposed back in 1981 by Bill Unruh with the University of British Columbia—he suggested that an analogue might be created using water instead of light. He imagined a phonon existing at the edge of a waterfall—as the water speeds up, it begins to move faster than the speed of sound, causing it to be trapped. But if the phonon had an entangled mate that eluded the fall by moving away before getting caught up, it could escape. In this new effort, Steinhauer has built a device based on that idea and in so doing, claims he has observed an analogue of Hawking radiation.

The experiment consisted of creating an entangled pair of phonons sitting inside a bit of liquid that had been forced (via laser) to move very fast and then observing the action as one of the pair was pulled away as the liquid began to move faster than the speed of sound, while the other escaped—the fluid was a Bose-Enistein condensate of rubidium-87 atoms. After repeating the experiment 4,600 times Steinhauer became convinced that the particles were entangled, a necessity for a Hawking radiation analogue. His findings do not prove Hawking's theory to be true, of course, but they do appear to add a degree of credence that other researchers have thus far not been able to achieve. [10]

Quantum Effects Stop the Formation of Black Holes

For decades, black holes were thought to form when a massive star collapses under its own gravity to a single point in space – imagine the Earth being squished into a ball the size of a peanut – called a singularity. So the story went, an invisible membrane known as the event horizon surrounds the singularity and crossing this horizon means that you could never cross back. It's the point where a black hole's gravitational pull is so strong that nothing can escape it.

The reason black holes are so bizarre is that it pits two fundamental theories of the universe against each other. Einstein's theory of gravity predicts the formation of black holes but a fundamental law of quantum theory states that no information from the universe can ever disappear. Efforts to combine these two theories lead to mathematical nonsense, and became known as the information loss paradox.

In 1974, Stephen Hawking used quantum mechanics to show that black holes emit radiation. Since then, scientists have detected fingerprints in the cosmos that are consistent with this radiation, identifying an ever-increasing list of the universe's black holes.

But now Mersini-Houghton describes an entirely new scenario. She and Hawking both agree that as a star collapses under its own gravity, it produces Hawking radiation. However, in her new work, Mersini-Houghton shows that by giving off this radiation, the star also sheds mass. So much so that as it shrinks it no longer has the density to become a black hole.

Before a black hole can form, the dying star swells one last time and then explodes. A singularity never forms and neither does an event horizon. The take home message of her work is clear: there is no such thing as a black hole.

Many physicists and astronomers believe that our universe originated from a singularity that began expanding with the Big Bang. However, if singularities do not exist, then physicists have to rethink their ideas of the Big Bang and whether it ever happened.

"Physicists have been trying to merge these two theories – Einstein's theory of gravity and quantum mechanics – for decades, but this scenario brings these two theories together, into harmony," said Mersini-Houghton. "And that's a big deal." [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.

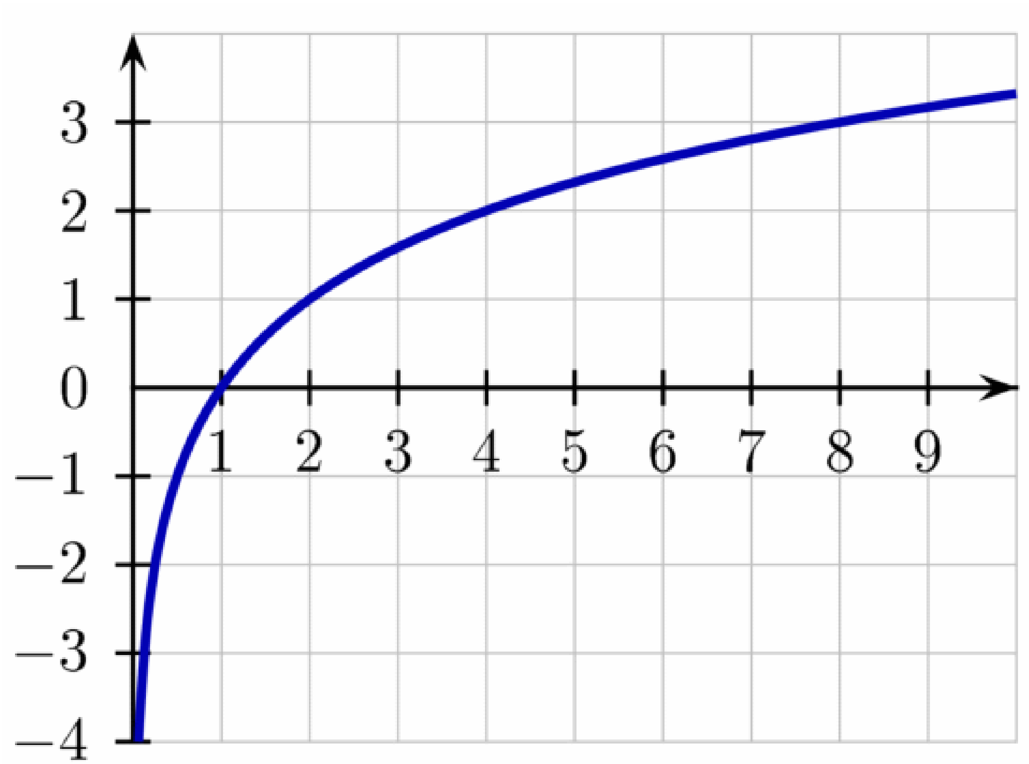
What does this mean in terms of chess? A common characteristic of every piece is that it could move to certain squares, including by capture. In any given position, therefore, the pieces by the rules of the game possess certain states, only one of which will be realized on the next move. The difference 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 full-scale 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

New Research Mathematically Proves Quantum Effects Stop the Formation of Black Holes.

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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