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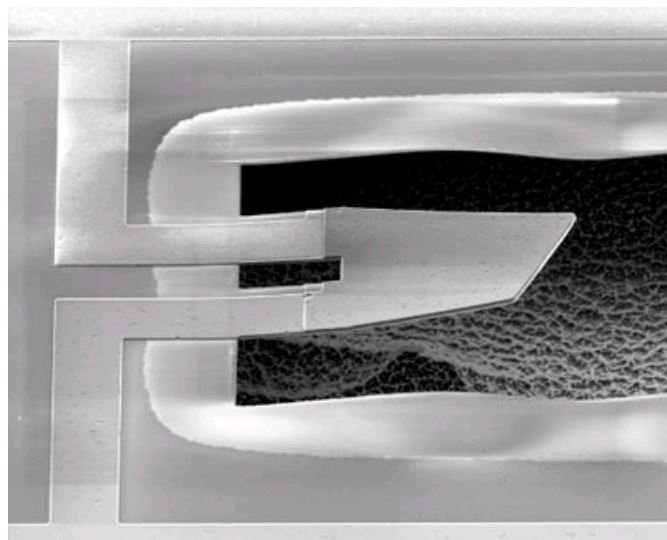
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Quantum effect spotted in a visible object

Mar 18, 2010 [17 comments](#)

Micrograph of the resonator

Physicists in California have observed true quantum behaviour in a macroscopic object big enough to be seen with the naked eye. This is the first time this feat has been achieved and it could shed light on the mysterious boundaries between the classical and quantum worlds.

One of the fundamental principles of quantum mechanics is that objects can be in two states at the same time. This means that an electron can, for instance, be in two places at once. However, these "superposition" states are never seen in classical, macroscopic objects – one example being Schrödinger's famous cat, who clearly could not be both dead and alive. Until now, such states have only been observed in atomic-scale objects and some larger molecules, such as a "buckyball", which is made up of 60 carbon atoms.

Scientists have long wanted to demonstrate superposition in larger objects but a significant challenge here is to eliminate all thermal vibrations in the object, which mask or destroy quantum effects. To achieve this, the object needs to be cooled down to its quantum ground state – at which point the amplitude of vibrations reduces to close to zero.

A quantum drum

Andrew Cleland and colleagues of the University of California, Santa Barbara, have now achieved this for a substantially larger object than in previously experiments – an object so large in fact that it can just about be seen with the naked eye. The object is a mechanical resonator made of aluminium and aluminium nitride, measuring about 40 μm in length and consisting of around a trillion atoms. It is a thin disc, which resonates at about six billion vibrations per second.

In the experiment, Cleland's team reduce the amplitude of the vibrations in the resonator by cooling it down to below 0.1 K. The high frequency of the aluminium resonator was key to the experiment's success, because the temperature to which an object needs to be cooled in order to reach its ground state is proportional to its

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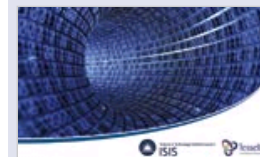
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frequency]. "A regular tuning fork, for example [with significantly lower frequency], would need to be cooled by another factor of a million to reach the same state," Cleland said.

Next, the team measured the quantum state of the resonator by connecting it electrically to a superconducting quantum bit or "qubit". The qubit acts, in fact, like a "quantum thermometer" that can identify just one quantum thermal excitation, or phonon. Once this has been done, the qubit can then be used to excite a single phonon in the resonator. This excitation can be transferred many times between the resonator and qubit.

Dead and alive, at once

In this way the researchers created a superposition state of the resonator where they simultaneously had an excitation in the resonator and no excitation in the resonator, such that when they measured it, the resonator has to "choose" which state it is in. "This is analogous to Schrödinger's cat being dead and alive at the same time," says Cleland.

"Unlike other measuring instruments, [the qubit] allowed us to measure the mechanical resonator while preserving all quantum effects," Cleland told *physicsworld.com*. "Most measuring instruments disturb the mechanical object by heating it up, and so destroy the very quantum effects being sought."

The experiments could have important implications for new quantum technologies, like quantum information processing, and for investigating the boundaries between the quantum and classical worlds – one of the least understood areas in physics.

"Another long-term prospect is testing the foundations of quantum physics," writes Markus Aspelmeyer of the University of Vienna in a commentary in *Nature*. "For example, superposition states of massive objects may be used to test possible deviations from quantum mechanics, which have been suggested to eliminate the Schrödinger's cat paradox."

This research is published in *Nature*.

About the author

Belle Dumé is a contributing editor to *nanotechweb*.

17 comments

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1

Jarek Duda

Mar 18, 2010 3:58 PM

Physics can be objective!

So maybe in some time they will entangle photon with a cat?

If there is also a person in such isolated system, he will know the state of the cat, while for an outside observer they will be in superposition...

Wait - there are no isolated systems!

Really? What about spatial separation - if they are on a colony a light year away - for at least a year after cat's death, for us they still will be 'in superposition'...

Such looking natural tool to work with situations we don't/cannot have full information about some system is believed to be fundamental - that these subjective descriptions cannot be joined into objective picture (there isn't the perspective of omniscience physics) - because quantum correlations doesn't fulfill Bell inequalities.

But situation changes when we assume determinism, e.g. governed by some Lagrangian (like GR, EM, ... but also QFT) - from our perspective of time it's equivalent with Einstein's block universe - static 4D picture. In this picture the fundamental entities are trajectories - it occurs that even the simplest statistical model for them - uniform distribution, has correlations which doesn't fulfill Bell inequalities, but their relations has 'squares' like QM.

If these trajectories would end in given moment, they would agree with BI - 'the squares' appears because these trajectories doesn't end now, but goes further into the future.

arxiv.org...0910.2724

Deterministic physics can be objective: even if we don't know the state of cat/drum/.../electron, physics still can know it - it can be objectively in just one state.

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2 **modernphysics**
Mar 18, 2010 10:42 PM

Cat Clips and Other Quirky Quantum World Ideas

If you want to see a cute interpretation of the Schrödinger's Cat thought experiment acted out, check some clips from The Quantum Tamers. The new program about quantum physics and possible technologies provides some fun and visual ways to help understand the quantum world. [www.perimeterinstitute...](http://www.perimeterinstitute.org)

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3 **Ragtime**
Mar 19, 2010 9:08 AM
Prague, Czech Republic

Single-particle interference of macroscopic object

Single-particle interference was observed for macroscopic objects before years by Couder group..

[www.physorg.com...news78650511.html](http://www.physorg.com/news78650511.html)

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4 **JULIOBW**
Mar 19, 2010 12:54 PM

Two persons can be in superpositions state, when they are feeling the same emotion, no doubt they are entangled will anybody oposses to this ?

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5 **JULIOBW**
Mar 19, 2010 12:59 PM

Two persons can be in superpositions state, when they are feeling the same emotion, no doubt they are entangled will anybody oposses to this ?

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6 **jagadeesh raghavendra**
Mar 20, 2010 1:53 AM

Classical and Quantum

Superposition of states is the most vexing problem of QM which has repeatedly evaded any classical explanation or understanding.

Attempts to 'see' superposition in action at the classical level has always lead to paradoxical situations like Schrodinger Cat.

After years of studying QM I have come to the conclusion that we can never 'see' superposition in action but only its consequences [or effects] in the Classical World; or

Classical World is the result of Quantum Mechanical Superposition of States.

I maintain this as a Fundamental Principle to be strictly adhered to by anyone who wants to explore the borderlands of Classical-Quantum World.

While Bohr's Correspondence Principle strengthens our faith in the validity of QM, it should be regarded only as a pacifying guarantee that all is not hopelessly wrong.

As many have said elsewhere, our Classical World perceived through our senses is only a pale shadow of Quantum Reality.

Quantum Reality is a state of Potential Possibilities, like all possible solutions of a differential equation and Classical World perceived by us is one of the solutions.

There seems to exist a profound principle that determines which of these solutions is to be selected for presentation to our gross senses. Discovering that principle would be the greatest next step in Fundamental Physics. And that discovery would also forever dissolve the border that separates Math and Physics.

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7 **CharlyAndy**
Mar 20, 2010 1:39 PM

Quote:

Originally posted by JULIOBW

Two persons can be in superpositions state, when they are feeling the same emotion, no doubt they are entangled will anybody oposses to this ?

There is no way to prepare two people in exactly the same emotional state because there is no precise definition of these states.

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8 **Imre von Soos**
Mar 20, 2010 2:27 PM

The thoughts I am presenting have been triggered off in the mid 1980's after studying the results of an extensive statistical research about changing the output of a random number generator through mind-power. After ascertaining with test-runs that the non-interfered-with tapes have always presented equal events and odds, and that in the interfered-with ones one or the other dominated, it became a logical proposition that an already run but yet untested tape can be in two states of potential possibilities at the same time.

In a special test the subject was not present at the recorded generations. The tape was later presented to

him to change the result, after which it was replayed for evaluation. Those tapes, which have been interfered with mentally, have demonstrated convincingly the interference. But – and this is of very great significance – if a recording was evaluated first – even if that was done with a second copy – and then the first copy given to the subject to change its content, his efforts were ineffective.

The key question is, why, if the tapes' content could be interfered with – during the running and even posteriorly – through the power of the mind, was this prevented by the fact that it was first replayed by others and evaluated by a machine?

I suggest – with an open question – that the chain of events follow the way they are engraved in the world-line of the events, which is within the space-time structure, meaning that it is in the psychic plane. The engraving happens through consciousness, which is the feed-back link between the physical events and that plane. The apperception of an event on the level of that event is necessary to fix it within the chain, the reality of which will form part of it from that moment on.

It stands to reason that if the mechanical process of the generation would not have been recorded or otherwise monitored originally, it would not have made its mark on the progression of events and would have disappeared irrecoverably. The same would have happened if the tape would have been destroyed before being replayed and monitored. Its content would have existed exclusively on the physical plane, and would not have formed any part of the psycho-physical reality. Only by conscious observation did it become realised – made real – and thus a part of a chain of events. The result of the random number generation and the interference became fixed in space-time – became an event – at the moment of the observation, and not at the time marked at their actual happening. Once the content of the tape was brought into conscious existence through the monitoring of a replay, the mind was up against altering a past event, which it was unable to do. As long as it was not exposed to that effect, the content remained in the present for eternity and open to interference at any time later.

The key is in having placed into the sphere of consciousness, beyond which act there is no return. Like Schrödinger's cat that can be – or rather is – both dead and alive until, through the direct observational experience of one element of consciousness, that is subjective, gets fixed as one or the other in objective reality as the unalterable event on the world-line of that particular existence. Previous to that observation a mind can act decisively on the outcome: posteriorly not.

I must note here that this particular and very famous paradox limps fundamentally, because a cat, as a conscious entity, is continually conscious of its state of being, into which "the wave function continually collapses", gets fixed as an objective reality.

These thoughts might even bring to the interesting conclusion that objective reality is built on subjective structure; that even that part of physical reality that can be expressed in absolutely concrete terms, is of subjective origin. It might even have implications for investigating the boundaries between the quantum and classical worlds.

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9

inthend9

Mar 20, 2010 8:07 PM
Lenexa, United States

Unrelated Comment

Quote:

Originally posted by Imre von Soos

The thoughts I am presenting have been triggered off in the mid 1980's ... It might even have implications for investigating the boundaries between the quantum and classical worlds.

This is a common occurrence. If you flip a coin and only remember the time you get heads, you will believe heads to be more likely. Please provide valid and scientific evidence (numbers, articles) before you proceed to make grand conclusions, or else you will be justifiably ignored.

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10

Jarek Duda

Mar 20, 2010 8:25 PM

Imre, they are very interesting kind of Wheeler's experiments - were they verified, repeated by independent researches?

Generally all the problems of quantum mechanics disappears when we assume 'block universe' picture - static 4D - 'the future is already there':

- verified experimentally Wheeler's experiment literally says it,
- it's strongly suggested by CPT conservation,
- from our perspective of time it's practically equivalent with determinism - like used on all scales Lagrangian theories,

- in this picture time isn't just only evolution parameter, but is additional dimension like in SR,
- while working on GR we rather automatically assume block universe - time dimensions are chosen locally,

...

- and finally if in given moment there is intuitively 'tension from both time directions', correlations no longer should fulfill Bell inequalities, but are with 'squares' like in QM - it's already seen in the simplest stochastic model for trajectories as the fundamental entities - uniform distribution among them (MERW)

So it looks like nonintuitiveness of QM lies in this 'the future is already there' - and so in Bohm's interpretation pilot waves goes into the future, in transactional interpretation waves propagates in both time directions ...

Our brain is extremely powerful computer which operates on correlations - searches for them everywhere and build higher and higher structures from them.

For the whole life I've train mine for full rationality - for practically every thought I can track logical reason-result relations which lead me to it - it's very useful for a scientist, but disadvantage is that this way I'm

killing its natural intuitions.

From the other side, there are very emotionally sensitive persons, who for example can feel that cell phone will ring in a moment - probably EM waves used to initiate the connection causes some very subtle change in neuron behavior and these correlations are somehow caught by the brain.

Brain is rather constructed to work in standard reason-result way accordingly to our thermodynamical arrow of time, but maybe some very sensitive and well trained brain could also catch correlations (presented as intuition) from backward reason-result chains like in Wheeler's experiment? But I think that even if it's possible - these times should be extremely short?

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11

steppe **probabilities**

Mar 21, 2010 5:56 AM
Canada

The survival (or not) of the cat seems to include the concept of probabilities. This reminds me of an encounter with probabilities which seems similar to what Imre describes. A roulette wheel has 38 slots and the bet/payout balance is set for the house to win. So, each number should come up (appear) once in every 38 spins, however this only happens on a macroscopic scale. In 10,000 spins each number will appear very close to one in 38 times. On a small scale numbers often come in groupings. When I tried to devise a "system" to "beat the odds" I spent a lot of time observing and found a wheel where prime numbers didn't appear for quite a while then; appeared a number of times in a row. As long as I didn't bet on this it kept recurring. When I started to play and bet on all the primes right after one appeared I won for a while but, since I was apparently unbalancing the odds by beating the house the prime numbers started to break up and appear more intermittently and more randomly, causing me to lose my advantage. On other wheels I would watch for a pattern and, whenever I would spot one, I would refrain from betting for a progressively longer time in each instance, because I wasn't recording precise data. Every time it was the same. The groupings stayed consistent until I bet on them and won - then they went random and I lost. Much like Imre's changing of a sequence which had been seen and interacted with something outside the immediate system.

I would advise caution in testing because other data indicated a strong draw to bet my winnings as if the system was acting on me to restore the odds by losing and paying back the imbalance. Namely, the house winning me more than my winning from the house. I decided to gamble no more and won't even accept a lottery ticket in a gift. My friends have been so informed.

Another on probabilities. Suppose a researcher gathers data until two different hypotheses seem to fit. The researcher decides which is more probable then, tests it. If it doesn't pass then the researcher may test the other and find that it passes muster. Was the first more probable or; did it just seem more probable? When the unlikely happens - was it truly unlikely or, did it just seem unlikely?

Since unlikely things appear to happen does that mean that our way of calculating probabilities need amending; perhaps by looking into ways in which the system that is being judged for probabilities interacts with other systems that it "appears" unconnected to?

Perhaps there's a connectedness which we have yet to discover and which Imre has labelled the psychic plane.

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12 **The_Quantum_Rangers**

Mar 21, 2010 8:59 AM

Is it really material/atomic structure in two places at once?

I think Feynman would have been skeptical, and maybe commented thus: It may be that structure has separated into two spacial arena's, one of space and one of Time?

Could be that the experiment shows the uncoupling of matter from SPACETIME!
very cool indeed.

p.v

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13 **The_Quantum_Rangers**

Mar 21, 2010 9:12 AM

Is it really structure in two places in one instant? Could be that under the extreme conditions, matter excludes itself from spacetime?

In macro scales matter is automatically fused into two places, thus Spacetime. But in the Quantum realms it appears no fusion takes place, thus electrons can be in single space and a single time at any multiple location or any number of moments?

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14

Imre von Soos

Mar 21, 2010 5:45 PM

My contribution did not want to discuss the possibility of psychokinesis, which was not the subject anyway, but used a part of an experiment done by others, suggesting that a purely mechanically prepared tape can be, after mentally interfering with its recorded content, in two states of potential possibilities at the same time; and further, that, if that content is mechanically evaluated and disclosed, it cannot be interfered with it any more.

I suggested that "the chain of events follow the way they are engraved in the world-line of the events, which is within the space-time structure, meaning that it is in the psychic plane. The engraving happens through consciousness, which is the feed-back link between the physical events and that plane. The apperception of an event on the level of that event is necessary to fix it within the chain [make the wave function collapse], the reality of which will form part of it from that moment on." That is why I consider that the Schroedinger paradox limps; the cat is a conscious entity.

The mind-over-matter concept is for me a reality.

Rationality does not kill natural intuition. It is necessary in judging both sensory and supersensory (intuitive) inputs.

Regarding space, time and matter: "The spatio-temporal correlations of events, are conceptual fundamentals of material manifestations. Only through their concept may movement, change, and spatial, chronological and causal order be perceived and defined. Without movement there exists only a static state without content, devoid of space-time, energy, matter and gravity, which are thus co-emergent, co-existent, interdependent, interacting and co-evolving constituents of a dynamic universal process." (v. Soos 1995) continued

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15

Imre von Soos

Mar 21, 2010 5:47 PM

Regarding psychic plane and quantum theory:

"What is needed is a relativistic theory, – wrote David Bohm – to give up altogether the notion that the world is constituted of basic objects or building blocks. Rather one has to view the world in terms of universal flux of events and processes.

"But let me emphasize that to have an approach of wholeness doesn't mean that we are going to be able to capture the whole of existence within our concepts and knowledge. Rather it means first that we understand this totality as an unbroken and seamless whole in which relatively autonomous objects and forms emerge. And secondly it means that in so far as wholeness is comprehended with the aid of the implicate order, the relationship between the various parts or sub wholes are ultimately internal. Wholeness is seen as primary while the parts are secondary, in the sense that what they are and what they do can be understood only in the light of the whole. And perhaps I should also add here that in each sub whole there is a certain quality that does not come from the parts, but helps organize the parts. . . . The quantum theory implies that ultimately the relationship of the parts and whole of matter in general is understood in a similar way. This approach of wholeness could help to end the far-reaching and pervasive fragmentation that arises out of the mechanistic world view.

"In this flow, mind and matter are not separate substances. Rather they are different aspects of one whole and unbroken movement. . . . The ability of form to be active is the most characteristic feature of mind, and we have something that is mind-like already with the electron."

By introducing into the Schroedinger equation a wavelike information field called the superquantum potential, Bohm established a theoretical instance within physics, demonstrating, that science can remain rational and coherent while involving the realms of the underlying principles, what he called the implicate order.

Erwin Schroedinger supports Bohm's thoughts: "Let us now return to our ultimate particles and to small organizations of particles as atoms or small molecules. The old idea about them was that their individuality was based on the identity of matter in them...The new idea is that what is permanent in these ultimate particles or small aggregates is their shape and organization. Hence this life of yours which you are living is not merely a piece of the entire existence, but is, in a certain sense, the whole; only this whole is not so constituted that it can be surveyed in one single glance. This as we know, is what the Brahmins express in the sacred, mystic formula which is yet so simple and so clear: "Tat tvam asi.", this is you...and not merely "someday" but today, every day she is bringing you forth, not once, but thousands upon thousands of times, just as every day she engulfs you a thousand times over, for eternally and always there is only now, and the same now; the present is the only thing that has no end."

And neither has it a beginning, and is thus the womb of the infinite becoming that is manifested in substance, accident and mode – structure, event and process; in the movement, change, and the spatial, chronological and causal order of energy and matter, while matter itself is not a conglomeration of "things" but consists of by its underlying principle ordered "processes" in interwoven and interdependent system-relationships of energy-quantums.

Albert Einstein, David Bohm, Erwin Schroedinger, Werner Heisenberg, Carl Gustav Jung, are of the small number, but intellectually most pungent sages of science, who implicate the underlying principles of all phenomena they contemplate, not, however, in the form of the extraneous anthropomorphous creation of the theomorphous western man, but as an all-inherent and all-transcendent Reality.

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16

fiziks

Mar 22, 2010 12:13 PM

And here I thought Shroedinger's cat was just a band.

www.notethrower.com...index.php

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17

steppe

Mar 22, 2010 10:57 PM
Canada

Pixel

I haven't heard of the band and will think of checking to see if they have any CDs out.

However, in two of the science fiction novels by popular author Robert Heinlein; who has a science degree; Schroedinger's Cat is a feline named Pixel.

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