Möbius animation

## Description

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[su_spoiler title="Display QR code and permanent URL" style="fancy" icon="folder-2?]Permanent URL: dual-aspect-monism.cf
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# Dimensions of epistemology and ontology:

## A multidisciplinary dual-aspect monism perspective on psychophysics

*by Christopher B. Germann (PhD, MSc, BSc / Marie Curie Fellow)*

**It is argued that the Möbius band provides a readily communicable conceptual visual metaphor for dual-aspect monism à la [su_tooltip style="bootstrap" position="north" shadow="yes" rounded="yes" title="Explication:" content="The quantum physicist Wolfgang Pauli communicated with depth-psychologist C.G. Jung over several years. They specifically addressed the relationship between mind & matter, i.e., psyche & physis. The resulting hypothesis has been termed the Pauli-Jung conjecture."]Pauli-Jung[/su_tooltip]. The Pauli-Jung conjecture is particularly relevant in the context of modern neuroscience as most contemporary neuroscientists stipulate *prima facie* that the brain produces consciousness. However, this perspective is not conclusively supported by empirical evidence. The monistic dual-aspect perspective provides a parsimonious & elegant solution for the mind-body problem**

**and the hard problem of consciousness (viz., the production problem). The symbolism of the Möbius band is particularly interesting from an embodied and grounded cognition perspective. Specifically, Lakoff's "conceptual metaphor theory" provides a theoretical framework which highlights the importance of metaphorical thinking, i.e., metaphors lie at the very core of human cognition and structure all of human thought at the most fundamental neuronal/cognitive level (e.g., via neuronal Hebbian mechanisms of long-term potentiation which are established in the Piagetian sensorimotor-phase of human development). Besides its theoretical scientific relevance pertaining to fundamental questions concerning epistemology and ontology, the non-dual (Sanskrit:** ??????, **"Advaita") perspective has important and far-reaching moral and ethical ramifications which are crucial for the critically endangered survival of the species [su_tooltip style="bootstrap" position="north" shadow="yes" rounded="yes" title="Latin etymology:" content="Sapi?ns (masculine substantive) = a wise man, sage, philosopher. "]*Hom? sapi?ns sapi?ns*[/su_tooltip] on the 'Earth System'.**

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Figure 1. [su_tooltip style="bootstrap" position="north" shadow="yes" rounded="yes" title="Explication:" content="3D modeling is the process of developing a mathematical representation of any surface of an object in three dimensions via specialized 3D computer graphics software (i.e.,modelling application or modelers). Someone who works with 3D models may be referred to as a 3D artist. 3D models can be created by hand, algorithmically (procedural modeling), or scanned. Their surfaces may be further defined with texture mapping. For instance, the architecture industry uses 3D modelling to demonstrate proposed buildings and landscapes in lieu of traditional, physical architectural models. The process of transforming representations of objects, such as the middle point coordinate of a sphere and a point on its circumference into a polygon representation of a sphere, is called tessellation. This step is used in polygon-based rendering, where objects are broken down from abstract representations (primitives) such as spheres, cones etc., to so-called *meshes*, which are nets of interconnected triangles. Meshes of triangles (instead of e.g. squares) are popular as they have proven to be easy to rasterise (the surface described by each triangle is planar, so the projection is always convex)."]**3D model** [/su_tooltip] of the Möbius band positioned in front of the University of Plymouth (UK).[su_lightbox type="image" src="http://cognitive-liberty.online/wp-content/uploads/moebius-uop2.gif"] [su_lightbox type="image" src="http://cognitive-liberty.online/wp-content/uploads/moebius-uop2.gif"]**Click here** to display an animated version of the algorithmic digital artwork in a lightbox.[/su_lightbox]

According to a dualistic perspective on consciousness, mind & matter are two fundamentally different substances. In Cartesian[1] nomenclature this dichotomy is expressed by the terms *res extensa* vs. *res cogitans*, i.e., the extended substance and the thinking substance.
The majority of contemporary neuroscientists assume that the brain *produces* consciousness (perhaps somewhat analogous to the way the liver secretes bile). However, this is merely a [su_tooltip style="bootstrap" position="north" shadow="yes" rounded="yes" title="Definition" content="A working hypothesis is a hypothesis that is provisionally accepted as a basis for further research in the hope that a tenable theory will be produced, even if the hypothesis ultimately fails."]working hypothesis [/su_tooltip] which has not been conclusively corroborated by empirical evidence. In the neurosciences this enduring problem concerning the exact relationship between the brain and consciousness is known as the "mind-body problem" which is cognitional to "the hard problem of consciousness".

Next to the dominant intuitive dualistic/dichotomous conception that the brain creates thought/consciousness there are other less widely known viable alternatives to conceptualize the interrelation between mind & matter. One of these alternatives is termed “dual-aspect monism”. According to this view, mind & matter are two different aspects of the *same* underlying substance. William James ( *1842; †1910), the logician/mathematician Lord Bertrand Russel ( *1872; †1970), and the Swiss depth-psychologist C.G. Jung (*1875; †1961), *inter alia,* subscribed to this monistic perspective. Specifically, the œuvre of the great polymath William James (whom many regard as the founding father of American psychology) discusses the topic of mind-matter duality *in extenso*.

> *“Granted that a definite thought, and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass by a process of reasoning from the one phenomenon to the other. They appear together but we do not know why.”* (James, 1890)

James later writes the following:

> *“The instant field of the present is at all times what I call the ‘pure’ experience. It is only virtually or potentially either object or subject as yet. For the time being, it is plain, unqualified actuality, or existence, a simple that. […] Just so, I maintain, does a given undivided portion of experience, taken in one context of associates, play the part of the knower, or a state of mind, or “consciousness”; while in a different context the same undivided bit of experience plays the part of a thing known, of an objective ‘content.’ In a word, in one group it figures as a thought, in another group as a thing. […] Things and thoughts are not fundamentally heterogeneous; they are made of one and the same stuff, stuff which cannot be defined as such but only experienced; and which one can call, if one wishes, the stuff of experience in general. […] ‘Subjects’ knowing ‘things’ known are ‘roles’ played, not ‘ontological facts’.”* (James, 1904)

It is evident that William James can be regarded as a proponent of dual-aspect monism. It is important to emphasize that contemporary cutting-edge scientific findings in the domain of experimental quantum physics are compatible with the monistic axiom.
It is argued that the [su_tooltip style=”bootstrap” position=”north” shadow=”yes” rounded=”yes” title=”Explication:” content=”The Möbius band is eponymously named after the German mathematician August Ferdinand Möbius who described it in 1885, contemporaneously with another German mathematician named Johann Benedict Listing. It is a so called ruled surface with only one side and one boundary and it possesses the mathematical property of non-orientability (viz., a non-orientable manifold). In fact, the Möbius band is the simplest possible non-orientable surface.”]Möbius band [/su_tooltip] provides a readily accessible geometric/mathematical visual metaphor to communicate this monistic view to a broader public. More information and an intuitive *Gedankenexperiment* explaining the peculiar geometry of the Möbius band can be found under the following custom-made website: moebius-band.ga
The monistic perspective symbolized by the Möbius band is not just of scientific/mathematical relevance, but it has far reaching moral and ethical implication because it emphasizes the interconnectedness of existence which is of great importance for the critically endangered survival of the species *Hom? sapi?ns* on this fragile planet some call spaceship earth as ego-centrism lies at the very heart of many serious problems humanity is facing in the 21st century (i.e., myopic destruction of

the ecosystem, immoral war among nations, fierce economic competition/social Darwinism, etc.).
From a neuroscientific perspective, the question how the brain creates consciousness is still an unsolved conundrum and a question of fundamental importance. A genuine reductive materialistic science of consciousness must be able to explain the exact relationship between subjective first-person conscious mental states (*qualia*) and neuronal brain states formed by electrochemical signal transduction (e.g., electrochemical action-potentials, interactions of various endogenous neurotransmitters, quantum processes at the microtubular level within the cytoskeleton of cells, etc. pp.).
In his book "The Astonishing Hypothesis: The Scientific search for the Soul" (published in 1994) Nobel laureate Francis Crick ( *1916; †2004; co-discoverer of the molecular double-helix structure of DNA) hypothesised that *"a person's mental activities are entirely due to the behaviour of nerve cells, glial cells, and the atoms, ions, and molecules that make them up and influence them."*

Crick thus advocated a mechanistic view according to which human beings are in essence complex machines (a view which is representative of the general materialistic *Zeitgeist* which dominates the 21st century). What really matters is matter (cf. Whorfianism). By contrast, the eminent German neuroscientist Cristof Koch (who collaborated with Crick over several years in an attempt to solve the hard problem of consciousness in a materialistic reductionist framework) wrote the following in a 2014 Scientific American article entitled, "Is Consciousness Universal?"

> *"Yet the mental is too radically different for it to arise gradually from the physical. This emergence of subjective feelings from physical stuff appears inconceivable and is at odds with a basic precept of physical thinking, the Ur-conservation law—ex nihilo nihil fit. So if there is nothing there in the first place, adding a little bit more won't make something. If a small brain won't be able to feel pain, why should a large brain be able to feel the godawfulness of a throbbing toothache? Why should adding some neurons give rise to this ineffable feeling? The phenomenal hails from a kingdom other than the physical and is subject to different laws. I see no way for the divide between unconscious and conscious states to be bridged by bigger brains or more complex neurons"* (Koch, 2014)

It is unclear what exactly led to Koch to change his mind on this crucial topic. However, it is clear that he no longer simply *prima facie* assumes that consciousness is produced by the brain (i.e., that it can be explained in purely physical terms).
Furthermore, Nobel laureate Erwin Schrödinger (one of the key figures in modern quantum physics who first introduced the idea of "aperiodic crystals" that contain genetic information, i.e., DNA) wrote in his seminal book what is life:

> *"The only possible alternative is simply to keep the immediate that consciousness is a singular of which the plural is unknown; that there is only one thing and that, which seems to be a plurality, is merely a series of different aspects of this one thing, produced by a deception (the Indian Maya); the same illusion is produced in a gallery of mirrors, and in the same way Gaurisankar and Mt. Everest turned out to be the same peak seen from different valleys…"* (Schrödinger, 1944, p. 89).

Schrödinger is not the only highly influential quantum physicist who postulates the primacy and continuity of consciousness.[2] For instance, Nobel laureate Max Planck (who coined the term "quantum") states in his speech on "*Das Wesen der Materie*" [The Nature of Matter]:

> *„Als Physiker, der sein ganzes Leben der nüchternen Wissenschaft, der Erforschung der Materie widmete, bin ich sicher von dem Verdacht frei, für einen Schwarmgeist gehalten zu werden. Und so sage ich nach meinen Erforschungen des Atoms dieses: Es gibt keine Materie an sich. Alle Materie entsteht und besteht nur durch eine Kraft, welche die Atomteilchen in Schwingung bringt und sie zum winzigsten Sonnensystem des Alls zusammenhält. Da es im ganzen Weltall aber weder eine intelligente Kraft noch eine ewige Kraft gibt—es ist der Menschheit nicht gelungen, das heißersehnte Perpetuum mobile zu erfinden—so müssen wir hinter dieser Kraft einen bewußten intelligenten Geist annehmen. Dieser Geist ist der Urgrund aller Materie."* (Planck, 1944).

*Provisional* translation:

> *"As a man who has devoted his whole life to the most clear headed science, to the study of matter, I can tell you as a result of my research about atoms this much: There is no matter as such. All matter originates and exists only by virtue of a force which brings the particle of an atom to vibration and holds this most minute solar system of the atom together. We must assume behind this force the existence of a conscious and intelligent Mind. This Mind is the matrix of all matter."*

In contemporary cognitive psychology/neuroscience, novel models of cognition are being developed which challenge the Newtonian deterministic paradigm (viz., local realism). The field of "quantum cognition" is a highly interdisciplinary research domain which utilized various axioms derived from quantum mechanics in order to account for mental phenomena (e.g., concerning reasoning, memory, language, etc.) which appear paradoxical and irrational in the classical deterministic/material Newtonian framework. These quantum models of cognition challenge *prima vista* taken-for-granted assumptions in the cognitive and behavioural sciences. For instance the Kolmorogovian/Boolean commutativity axiom P(A?B)=P(B?A) which forms the basis of the vast majority of contemporary modelling approaches (e.g., Bayes' theorem). According to quantum cognition, observation can actively interfere with the properties of the system which is measured (cf. the measurement problem in quantum physics). Naïve & local realism might soon reach its vertex and a Kuhnian paradigm-shift (viz., a phase transition) might follow.
The time is ripe to consider alternative epistemological and ontological assumptions in order to re-evaluate our most basic scientific assumptions in novel light. The Möbius band as as a conceptual visual metaphor for dual-aspect monism a la Pauli-Jung could be seen as a conceptual contribution in this novel direction of scientific inquiry and exploration into the interplay of *psyche & physis*.

# Further References

Smith, C. U. M.. (2009). The 'hard problem' and the quantum physicists. Part 2: Modern times. Brain and Cognition

, 71(2), 54–63.

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“This is the second part of a review of the work of quantum physicists on the ‘hard part’ of the problem of mind. after an introduction which sets the scene and a brief review of contemporary work on the neural correlates of consciousness (ncc) the work of four prominent modern investigators is examined: j.c. eccles/friedrich beck; henry stapp; stuart hameroff/roger penrose; david bohm. with the exception of david bohm, all attempt to show where in the brain’s microstructure quantum affects could make themselves felt. it is reluctantly concluded that none have neurobiological plausibility. they are all instances, to paraphrase t.h. huxley, of a beautiful hypothesis destroyed by ugly facts. david bohm does not attempt to fit his new quantum physics to contemporary neurobiology but instead asks for a radical rethink of our conventional scientific paradigm. he suggests that we should look towards developing a ‘pan-experientialism’ or ‘dual-aspect monism’ where consciousness goes ‘all the way down’ and that the ‘hard problem’ is not soluble within the framework of ideas provided by ‘classical’ natural science.”
Polkinghorne, J.. (2009). Mind and Matter: A Physicist’s View. Philosophical Investigations, 32(2), 105–112.

Plain numerical DOI: 10.1111/j.1467-9205.2008.01365.x
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“Physics explores a universe of wonderful order, expressed in terms of beautiful mathematical equations. mathematics itself is understood to be the exploration of a realm of noetic reality. science describes matter in terms of concepts with mind-like qualities. the psychosomatic nature of human persons is best understood in terms of a dual-aspect monism, in which matter and mind are complementary aspects of a unitary being. the new science of complexity theory, with its dualities of parts/whole and energy/information, offers modest resources for the speculative exploration of this idea. the intrinsic unpredictabilities present in nature afford the metaphysical opportunity to consider dissipative systems as exhibiting top2013down causality.”
Atmanspacher, H.. (2012). Dual-aspect monism a? la Pauli and Jung perforates the completeness of physics. In Journal of Consciousness Studies (pp. 5–21)

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“Dual-aspect monism and neutral monism offer interesting alternatives to mainstream positions concerning the mind-matter problem. both assume a domain underlying the mind-matter distinction, but they also differ in definitive ways. in the twentieth century, variants of both positions have been advanced by a number of protagonists. one of these variants, the dual-aspect monism due towolfgang pauli and carl gustav jung, will be described and commented on in detail. as a unique feature in the pauli-jung conception, the duality of mental and material aspects is specified in terms of a complementarity. this sounds innocent, but entails a number of peculiarities distinguishing their conjecture from other approaches.”
Atmanspacher, H.. (2012). Dual-aspect monism a? la Pauli and Jung perforates the completeness of physics. In AIP Conference Proceedings (pp. 5–21)

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“In the mid 19th century, the physicist wolfgang pauli and the psychologist carl gustav jung developed a philosophical position for the mind-matter problem that is today called dual-aspect monism. they conjectured a picture in which the mental and the material arise as two complementary aspects of one underlying psychophysically neutral reality to which they cannot be reduced and to which direct empirical access is impossible. this picture suggests structural, persistent,re-producible mind-matter correlations by splitting the underlying reality into aspects. in addition, it suggests induced, occasional, evasive mind-matter correlations above and below, respectively, those stable baseline correlations. these correlations, and the way they arise, suggest that the domain of the physical is not completely independent of the domain of the mental, and both are not independent from the assumed reality underlying them. some ideas are presented of how these relationships might be conceived.”
Benovsky, J.. (2016). Dual-Aspect Monism. Philosophical Investigations, 39(4), 335–352.

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DOI URL
directSciHub download

Pothos, E. M., & Busemeyer, J. R.. (2013). Can quantum probability provide a new direction for cognitive modeling?. Behavioral and Brain Sciences, 36(03), 255–274.

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“Classical (bayesian) probability (cp) theory has led to an influential research tradition for modeling cognitive processes. cognitive scientists have been trained to work with cp principles for so long that it

is hard even to imagine alternative ways to formalize probabilities. however, in physics, quantum probability (qp) theory has been the dominant probabilistic approach for nearly 100 years. could qp theory provide us with any advantages in cognitive modeling as well? note first that both cp and qp theory share the fundamental assumption that it is possible to model cognition on the basis of formal, probabilistic principles. but why consider a qp approach? the answers are that (1) there are many well-established empirical findings (e.g., from the influential tversky, kahneman research tradition) that are hard to reconcile with cp principles; and (2) these same findings have natural and straightforward explanations with quantum principles. in qp theory, probabilistic assessment is often strongly context- and order-dependent, individual states can be superposition states (that are impossible to associate with specific values), and composite systems can be entangled (they cannot be decomposed into their subsystems). all these characteristics appear perplexing from a classical perspective. however, our thesis is that they provide a more accurate and powerful account of certain cognitive processes. we first introduce qp theory and illustrate its application with psychological examples. we then review empirical findings that motivate the use of quantum theory in cognitive theory, but also discuss ways in which qp and cp theories converge. finally, we consider the implications of a qp theory approach to cognition for human rationality."
Stuart, H.. (1998). Quantum computation in brain microtubules? The Penrose–Hameroff 'Orch OR' model of consciousness. Philosophical Transactions of the Royal Society of London. Series A: Mathematical, Physical and Engineering Sciences, 356(1743), 1869–1896.

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"Potential features of quantum computation could explain enigmatic aspects of consciousness. the penrose-hameroff model (orchestrated objective reduction: `orch or') suggests that quantum superposition and a form of quantum computation occur in microtubules (cylindrical protein lattices of the cell cytoskeleton within the brain's neurons). microtubules couple to and regulate neural-level synaptic functions, and they may be ideal quantum computers because of dynamical lattice structure, quantum-level subunit states and intermittent isolation from environmental interactions. in addition to its biological setting, the orch or proposal differs in an essential way from technologically envisioned quantum computers in which collapse, or reduction to classical output states, is caused by environmental decoherence (hence introducing randomness). in the orch or proposal, reduction of microtubule quantum superposition to classical output states occurs by an objective factor roger penrose's quantum gravity threshold stemming from instability in planck-scale separations (superpositions) in spacetime geometry. output states following penrose's objective reduction are neither totally deterministic nor random, but influenced by a non-computable factor ingrained in fundamental spacetime. taking a modern panpsychist view in which protoconscious experience and platonic values are embedded in planck-scale spin networks, the orch or model portrays consciousness as brain activities linked to fundamental ripples in spacetime geometry."
Yearsley, J. M., & Pothos, E. M.. (2014). Challenging the classical notion of time in cognition: A quantum perspective. Proceedings of the Royal Society B: Biological Sciences

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“All mental representations change with time. a baseline intuition is that mental representations have specific values at different time points, which may be more or less accessible, depending on noise, forgetting processes, etc. we present a radical alternative, motivated by recent research using the mathematics from quantum theory for cognitive modelling. such cognitive models raise the possibility that certain possibilities or events may be incompatible, so that perfect knowledge of one necessitates uncertainty for the others. in the context of time-dependence, in physics, this issue is explored with the so-called temporal bell (tb) or leggett-garg inequalities. we consider in detail the theoretical and empirical challenges involved in exploring the tb inequalities in the context of cognitive systems. one interesting conclusion is that we believe the study of the tb inequalities to be empirically more constrained in psychology than in physics. specifically, we show how the tb inequalities, as applied to cognitive systems, can be derived from two simple assumptions: cognitive realism and cognitive completeness. we discuss possible implications of putative violations of the tb inequalities for cognitive models and our understanding of time in cognition in general. overall, this paper provides a surprising, novel direction in relation to how time should be conceptualized in cognition.”
Groeblacher, S., Paterek, T., Kaltenbaek, R., Brukner, C., Zukowski, M., Aspelmeyer, M., & Zeilinger, A.. (2007). An experimental test of non-local realism. Nature

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“Most working scientists hold fast to the concept of ‘realism’ – a viewpoint according to which an external reality exists independent of observation. but quantum physics has shattered some of our cornerstone beliefs. according to bell’s theorem, any theory that is based on the joint assumption of realism and locality (meaning that local events cannot be affected by actions in space-like separated regions) is at variance with certain quantum predictions. experiments with entangled pairs of particles have amply confirmed these quantum predictions, thus rendering local realistic theories untenable. maintaining realism as a fundamental concept would therefore necessitate the introduction of ‘spooky’ actions that defy locality. here we show by both theory and experiment that a broad and rather reasonable class of such non-local realistic theories is incompatible with experimentally observable quantum correlations. in the experiment, we measure previously untested correlations between two entangled photons, and show that these correlations violate an inequality proposed by leggett for non-local realistic theories. our result suggests that giving up the concept of locality is not sufficient to be consistent with quantum experiments, unless certain intuitive features of realism are abandoned.”
Hensen, B., Bernien, H., Dréau, A. E., Reiserer, A., Kalb, N., Blok, M. S., … Hanson, R.. (2015). Experimental loophole-free violation of a Bell inequality using entangled electron spins separated by 1.3 km. Nature

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“For more than 80 years, the counterintuitive predictions of quantum theory have stimulated debate about the nature of reality. in his seminal work, john bell proved that no theory of nature that obeys locality and realism can reproduce all the predictions of quantum theory. bell showed that in any local realist theory the correlations between distant measurements satisfy an inequality and, moreover, that this inequality can be violated according to quantum theory. this provided a recipe for experimental tests of the fundamental principles underlying the laws of nature. in the past decades, numerous ingenious bell inequality tests have been reported. however, because of experimental limitations, all experiments to date required additional assumptions to obtain a contradiction with local realism, resulting in loopholes. here we report on a bell experiment that is free of any such additional assumption and thus directly tests the principles underlying bell’s inequality. we employ an event-ready scheme that enables the generation of high-fidelity entanglement between distant electron spins. efficient spin readout avoids the fair sampling assumption (detection loophole), while the use of fast random basis selection and readout combined with a spatial separation of 1.3 km ensure the required locality conditions. we perform 245 trials testing the chsh-bell inequality $s leq 2$ and find $s = 2.42 pm 0.20$. a null hypothesis test yields a probability of $p = 0.039$ that a local-realist model for space-like separated sites produces data with a violation at least as large as observed, even when allowing for memory in the devices. this result rules out large classes of local realist theories, and paves the way for implementing device-independent quantum-secure communication and randomness certification.”
Wiseman, H.. (2015). Quantum physics: Death by experiment for local realism. Nature

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“The world is made up of real stuff, existing in space and changing only through local interactions — this local-realism hypothesis is about the most intuitive scientific postulate imaginable. but quantum mechanics implies that it is false, as has been known for more than 50 years1. however, brilliantly successful though quantum mechanics has been, it is still only a theory, and no definitive experiment has disproved the local-realism hypothesis — until now. on page 682 of this issue [doi: 10.1038/nature15759], hensen et al.2 report the first violation of a constraint called a bell inequality, under conditions that prevent alternative explanations of the experimental data. their findings therefore rigorously reject local realism, for the first time… a bell inequality is a mathematical relationship regarding the statistics of measurement outcomes obtained by two or more parties. under certain physical conditions relating to the timing of events, a violation of a bell inequality proves that local realism — a hypothesis satisfied in all of science except quantum mechanics — is false.”
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