“Wave-Packet Reduction” and the Quantum Character of the Actualization of Potentia

Type Web Page

Author Gregg Jaeger

Abstract Werner Heisenberg introduced the notion of quantum potentia in order to accommodate the indeterminism associated with quantum measurement. Potentia captures the capacity of the system to be found to possess a property upon a corresponding sharp measurement in which it is actualized. The specific potentiae of the individual system are represented formally by the complex amplitudes in the measurement bases of the eigenstate in which it is prepared. All predictions for future values of system properties can be made by an experimenter using the probabilities which are the squared moduli of these amplitudes that are the diagonal elements of the density matrix description of the pure ensemble to which the system, so prepared, belongs. Heisenberg considered the change of the ensemble attribution following quantum measurement to be analogous to the classical change in Gibbs’ thermodynamics when measurement of the canonical ensemble enables a microcanonical ensemble description. This analogy, presented by Heisenberg as operating at the epistemic level, is analyzed here. It has led some to claim not only that the change of the state in measurement is classical mechanical, bringing its quantum character into question, but also that Heisenberg held this to be the case. Here, these claims are shown to be incorrect, because the analogy concerns the change of ensemble attribution by the experimenter upon learning the result of the measurement, not the actualization of the potentia responsible for the change of the individual system state which—in Heisenberg’s interpretation of quantum mechanics—is objective in nature and independent of the experimenter’s knowledge.

Date 2017-09-24

Language en

URL https://www.mdpi.com/1099-4300/19/10/513

Accessed 2/28/2022, 11:45:30 AM

Extra Pages: 1-11 Place: Basel, Switzerland Publisher: MDPI Volume: 19

Website Type Published Article or Volume

Website Title Entropy

Date Added 2/28/2022, 11:45:28 AM

Modified 2/28/2022, 3:23:16 PM

Tags:

probability, quantum measurement, potentiality

Notes:

Einsten's EPR Paper

Attachments

- Full Text PDF

Related

- Quantum potentiality revisited

A single quantum cannot be cloned

Type	Journal Article
Author	W. K. Wootters
Author	W. H. Zurek
Date	10/1982
Language	en
Library Catalog	DOI.org (Crossref)
URL	https://sci-hub.se/https://www.nature.com/articles/299802a0
Accessed	11/9/2021, 2:46:05 PM
Volume	299
Pages	802-803
Publication	Nature
DOI	10.1038/299802a0
Issue	5886
Journal Abbr	Nature
ISSN	0028-0836, 1476-4687
Date Added	11/9/2021, 2:46:08 PM
Modified	12/3/2021, 5:32:49 AM

Tags:

Quantum Physics, Quantum Physics - Foundations

Notes:

Additional notes

"If this second photon could be replicated and its precise polarization measured as above, it would be possible to ascertain whether, for example, the first photon had been subjected to a measurement of linear or circular polarization"

KEY linear vs. circular polarization (T.O.I.)

References

"...the amplifying process could be used to ascertain the exact state of a quantum system: in the case of a photon, one could determine its polarization by first producing a beam of identically polarized copies and then measuring the stokes parameters." 1

Photon cloning = plaus. argument for "faster than light" communication 2

It is well known that for certain non-seperably correlated Einstein-Podolsky-Rosen pairs of photons, once an observer has made a polarization measurement (vertical vs. horizontal) on one member of the pair, the other, which may be far away, can be for all purposes of prediction regarded as having the same polarization. 3

Well-established long-range quantum correlations: 6-8

Adiabatic transport of qubits around a black hole

Type Journal Article
Author David Viennot
Author Olivia Moro
Abstract We consider localized qubits evolving around a black hole following a quantum adiabatic dynamics. We develop a geometric structure (based on fibre bundles) permitting to describe the quantum states of a qubit and the spacetime geometry in a single framework. The quantum decoherence induced by the black hole on the qubit is analysed in this framework (the role of the dynamical and geometric phases in this decoherence is treated), especially for the quantum teleportation protocol when one qubit falls to the event horizon. A simple formula to compute the fidelity of the teleportation is derived. The case of a Schwarzschild black hole is analysed.
Date 2017-03-09
Library Catalog arXiv.org
URL http://arxiv.org/abs/1609.01540
Accessed 2/28/2022, 10:13:15 AM
Extra arXiv: 1609.01540
Volume 34
Pages 055005
Publication Classical and Quantum Gravity
DOI 10.1088/1361-6382/aa5b5c
Issue 5
Journal Abbr Class. Quantum Grav.
ISSN 0264-9381, 1361-6382
Date Added 2/28/2022, 10:13:15 AM
Modified 2/28/2022, 10:13:15 AM

Tags:

General Relativity and Quantum Cosmology, Quantum Physics, Mathematical Physics

Attachments

- arXiv Fulltext PDF
- arXiv.org Snapshot

Entangled “Frankenstein” Photons

Type Journal Article
Author David R Schneider
Abstract The H> and V> outputs of a Polarizing Beam Splitter can be combined to restore the original input superposition state, as long as no knowledge is obtained regarding the path taken through the PBS. Using this principle, it should be possible to create entangled photons from the identical H> and V> components of different polarization entangled photons. These “Frankenstein” photons will also be polarization entangled and should violate a Bell Inequality.
Date 2010

Language	en
Library Catalog	Zotero
Pages	6
Date Added	2/28/2022, 8:23:06 AM
Modified	2/28/2022, 9:38:41 AM

Tags:

Polarization, Photons, Entanglement, Analyzer Loop, Frankenstein Photons, Crystallography, Bell state analyzer, Bell states

Notes:

Frankenstein Photons

"The paths that these components traverse must
be made identical as to length, such that the actual path taken cannot be somehow distinguished by timing."

ψ(Bell) = HAlice HBob> + VBob VAlice> = HChris HDale> + VChris VDale>

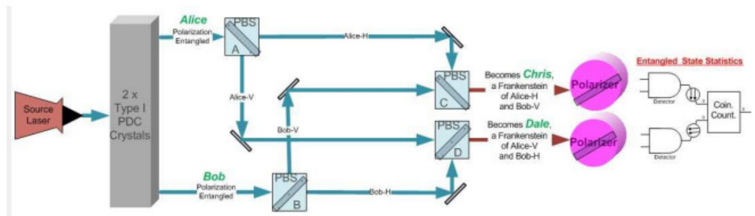


Fig 5. Polarization entangled Alice and Bob are split into H> and V> components, but recombined in a different manner than in Fig. 3. Chris and Dale are composed of one H> and one V> component each. Because the Alice and Bob H> components are identical, as are the Alice and Bob V> components, it does not matter which is combined with which. Path lengths are not shown to scale.

Chris and Dale composed of *half* ***Alice*** and *half* ***Bob***

Analyzer Loop

French, Taylor "...a two-part device" (first part, beam splitter; second, homotopy (reconstruction) reversal

Path knowledge is erased; superposition is circular

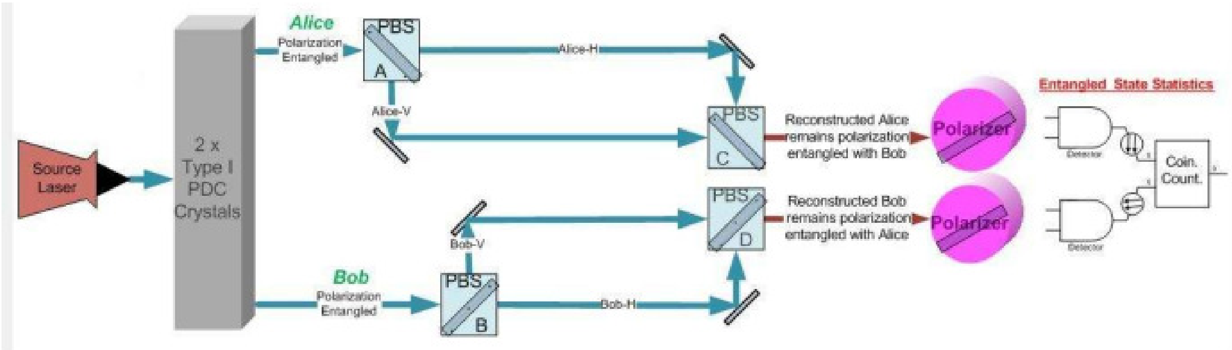
Eberly

Fig. 2: A series of Bell Analyzer Loops lead to violation of Bell Inequalities, per Eberly. An entangled source [*] above has Alice going through Analyzer loops x/y and Theta/~Theta oriented at some angles. Bob goes through loops x/y, Θ/~Θ, and Φ/~Φ. Each loop for Alice and Bob splits them into components which are then recombined into their initial states. Even after such a series of loops, Eberly imagines that the resulting beams remain polarization entangled. This can be tested by checking for a violation of a suitable Bell Inequality. Eberly uses 5 loops in his example, and obtains a Bell inequality by comparing fractions of detections when one channel is blocked in each of several configurations (only one of which is shown here). The detected photons are no longer polarization entangled in this example, because the blocking of a channel reveals the path taken. Here Alice is y-polarized and Bob is Φ-polarized.

7. J.H. Eberly, Bell inequalities and quantum mechanics (2001).

ψ(Bell) = HAlice HBob> + VAlice VBob>

The initial polarization is a superset of the terminal polarization realization event. However, its observation cannot be deduced to have been recombined (focused), or preserved.



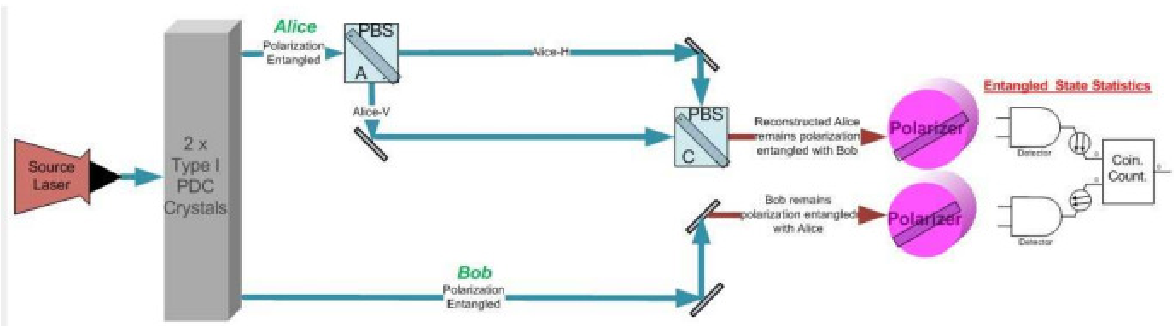
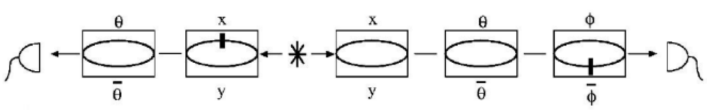


Fig. 3. Polarization entangled Alice is split into H> and V> components, then recombined to her original state. Alice is still entangled with Bob after recombination (in the ideal case).

III. Bell Analyzer Loops and Entangled Particle Pairs

Eberly [7] has applied the above to polarization entangled photon pairs. A diagram from the reference:



Tags: Polarization

Main result

i.) A photon with an unknown polarization

- decomposition into H> and V> components
  - re-combinable to restore unknown states

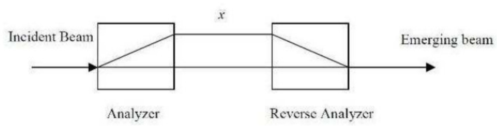
ii.) Entangled photons

- recombination to restore state

iii.) Entangled photons, cont'd.

    - re-arrangement
    - re-combination to create photon
    - ***hybrid*** of Alice and Bob

  Analyzer loop

    - 

Tags: Polarization, Photons, Entanglement

Violations of Bell's Intuition

a.) entanglement of particles who have never interacted

b.) entanglement of particles after they were detected ***(delayed choice)***

c.) >2 entangled photons

d.) hyperentanglement (multiple degrees of freedom)

e.) entanglement of particles from fully dependent sources

[1-5]
Tags: Polarization, Photons, Entanglement

Attachments

- Schneider - Entangled “Frankenstein” Photons.pdf

  Tags:

  Polarization, Entanglement, Quantum Information

Related

- Experimental Nonlocality Proof of Quantum Teleportation and Entanglement Swapping

---

Experimental Nonlocality Proof of Quantum Teleportation and Entanglement Swapping

Type	Journal Article
Author	Thomas Jennewein
Author	Gregor Weihs
Author	Jian-Wei Pan
Author	Anton Zeilinger
Abstract	Quantum teleportation strikingly underlines the peculiar features of the quantum world. We present an experimental proof of its quantum nature, teleporting an entangled photon with such high quality that the nonlocal quantum correlations with its original partner photon are preserved. This procedure is also known as entanglement swapping. The nonlocality is confirmed by observing a

violation of Bell's inequality by 4.5 standard deviations. Thus, by demonstrating quantum nonlocality for photons that never interacted, our results directly confirm the quantum nature of teleportation.

Date	December 18, 2001
Library Catalog	APS
URL	https://link.aps.org/doi/10.1103/PhysRevLett.88.017903
Accessed	2/28/2022, 9:14:57 AM
Extra	Publisher: American Physical Society
Volume	88
Pages	017903
Publication	Physical Review Letters
DOI	10.1103/PhysRevLett.88.017903
Issue	1
Journal Abbr	Phys. Rev. Lett.
Date Added	2/28/2022, 9:14:59 AM
Modified	2/28/2022, 9:38:36 AM

Tags:

Quantum Physics - Foundations, Bell's inequality, Quantum teleportation, Bell state analyzer, Bell states

Notes:

CHSH Inequality

"quantum mechanical prediction" $S = |E(\phi_0', \phi_3') - E(\phi_0', \phi_3'')| + |E(\phi_0'', \phi_3') + E(\phi_0'', \phi_3'')| \leq 2,$

Quantum state teleportation

[1] C. H. Bennett, G. Brassard, C. Cr´epeau, R. Jozsa, A. Peres, and W. K.Wootters, Phys. Rev. Lett. 70, 1895 (1993).

system becomes new original

initial particle erased (no-cloning theorem) [2]

V. Buzek and M. Hillery, Physical Review A 54, 1844 (1996).

Entanglement swapping [3]:

0-1,2-3 starting pair

"subjects photons 1 and 2 to a Bell-state
measurement by which photons 0 and 3 also become entangled."

Peres [4]

reduction of teleportation efficiency does not influence fidelity

[7] teleportation efficiency measures the fraction of cases

loss of a photon in our case leads outside the
two-state Hilbert space used and thus reduces the efficiency and not the fidelity

in which the procedure is successful and the fidelity characterizes the quality of the teleported state in the successful cases.

M. Zukowski, A. Zeilinger, M. A. Horne, and A. K. Ekert, Phys. Re ˙ v. Lett. 71, 4287 (1993).

Tags: Quantum Information, Quantum teleportation

Bibliography

[1] C. H. Bennett, G. Brassard, C. Cr´epeau, R. Jozsa, A. Peres, and W. K.Wootters, Phys. Rev. Lett. 70, 1895 (1993).
[2] V. Buzek and M. Hillery, Physical Review A 54, 1844 (1996).
[3] M. Zukowski, A. Zeilinger, M. A. Horne, and A. K. Ekert, Phys. Re ˙ v. Lett. 71, 4287 (1993).
[4] A. Peres, Journal of Modern Optics 47, 139 (2000).
[5] J.-W. Pan, D. Bouwmeester, H. Weinfurter, and A. Zeilinger, Phys. Rev. Lett. 80, 3891 (1998).
[6] J. Bell, Physics 1, 195 (1964).
[7] D. Bouwmeester, J.-W. Pan, H. Weinfurter, and A. Zeilinger, J. Mod. Opt. 47, 279 (2000).

[8] J. Calsamiglia and N. L¨utkenhaus, Appl. Phys. B 72, 67 (2001).
[9] K. Mattle, H. Weinfurter, P. G. Kwiat, and A. Zeilinger, Phys. Rev. Lett. 76, 4656 (1996).

[10] P. G. Kwiat, K. Mattle, H. Weinfurter, A. Zeilinger, A. Sergienko, and Y. Shih, Phys. Rev. Lett. 75, 4337 (1995). Type 2 down conversion

[11] M. Zukowski, Phys. Rev. A 61, 022109 (2000).
6

Measurements

[10] pumped by UV laser pulses at a wavelength of 394 nm, a pulse width of ≈ 200 fs, a repetition rate of 76 MHz, and an average
power of 370 mW. The entangled photons had a wavelength of 788 nm. The registered event rate of photon pairs was about 2000 per second before the Bell-state analyzer (Alice) ant
3
the polarizing beam splitter (Bob). The rate of obtaining a four-fold photon event for the teleportation was about 0.0065 per second. Each single correlation measurement for one setting of the polarizers lasted 16000 seconds. The polarization alignment of the optical fibers performed before each measurement proved to be stable within 1◦
for 24 h.

The non-deterministic nature of the photon pair production implies an equal probability for producing two photon pairs in separate modes (one photon each in modes 0, 1, 2, 3) or two pairs in the same mode (two photons each in modes 0 and 1 or in modes 2 and 3). The latter can lead to coincidences in Alice's detectors behind her beam splitter. We exclude these cases by only accepting events where Bob registers a photon each in mode 0 and mode 3. It was shown by Zukowski [11], that despite these effects of the non-deterministic photon source experiments of our kind still constitute valid demonstrations of nonlocality in quantum teleportation.

Attachments

- APS Snapshot
- Submitted Version

Related

- Entangled "Frankenstein" Photons

Mesoscopic systems in the quantum realm: fundamental science and applications

Type	Journal Article
Author	Mukunda P Das
Date	2010-12-16
Short Title	Mesoscopic systems in the quantum realm
Library Catalog	DOI.org (Crossref)
URL	https://iopscience.iop.org/article/10.1088/2043-6262/1/4/043001
Accessed	2/18/2022, 5:04:45 PM

Volume	1
Pages	043001
Publication	Advances in Natural Sciences: Nanoscience and Nanotechnology
DOI	10.1088/2043-6262/1/4/043001
Issue	4
Journal Abbr	Adv. Nat. Sci: Nanosci. Nanotechnol.
ISSN	2043-6262
Date Added	2/18/2022, 5:04:46 PM
Modified	2/18/2022, 5:05:34 PM

Tags:

Mesoscopic, nanoscale, nanotechnology

Notes:

Additional Theories

Kubo - Linear Response

Kubo's linear response theory represents the first full quantum-mechanical formalism in modern kinetics [32]. It connects the irreversible processes prescribed for the non-equilibrium state to the thermal fluctuations observed in equilibrium. Kubo's formula is more popularly known, in fact, as the fluctuation dissipation theorem (FDT).

The Kubo theory is completely general and encompasses not only bulk quantum systems but also meso/nanosystems equally. In principle, the study of transport does not limit us to those non-equilibrium states lying sufficiently close to equilibrium. Still, computation of linear kinetic coefficients is easiest to carry out, since the final expression involves purely equilibrium expectation values of the relevant dynamical variables, a much simpler procedure than extracting any corresponding far-from-equilibrium quantities.

In the context of mesoscopic systems, the Kubo formulation dates back to the 1980 s with Fisher and Lee and others [33], who derived the Landauer formula in the non-interacting (independent particle) limit of the Kubo formula. Our derivation of conductance [31] from the Kubo formula also produces the Landauer formula as a natural outcome, but the transmission function includes an inelastic part (as demanded by the physics of dissipation) and not purely elastic as in independent-particle approaches. In detail, transmission is a much more complicated concept and invokes many-body scattering, in which elastic and inelastic processes work together.

An analogous microscopic analysis of mesoscopic transport has been made by Soree and Magnus [34], who derived conductance quantization purely using the method of non-equilibrium statistical operators and without any mismatched-reservoir phenomenology. In a different language, Di Ventra and Vignale [27] show that the Landauer formula is incomplete, being devoid of essential many-body effects. There has been use and misuse of the Landauer formula in many papers over time. We have critically examined a few examples in a recent viewpoint paper [35].

Keldyesh - non-equilibrium green function (NEGF)

A rigorous, microscopic and completely general theory of quantum transport can be based on the NEGF formalism developed by Keldysh [36] and Kadanoff and Baym [37]. It has been applied to device problems since then (for applications of NEGF see [38]). This method allows one to systematically solve the interactions within the electron propagator (Green function) under fully non-equilibrium conditions. Therefore, in principle, all scattering mechanisms arising out of many-body correlations can be taken into account *systematically*, in a well-controlled way, in the evaluation of the current.

When a system is driven out of equilibrium by an applied bias, a standard quasi-equilibrium perturbation theory to a finite order is not suitable to describe the transport properties; for the system response can be strongly nonlinear. The resultant net flux of current, sustained by the external bias, is evidence that the system is not in equilibrium. In particular, equilibrium-state theory is incapable of describing real exchanges of energy between electronic and phonon-bath subsystems, and therefore has no means of capturing the physics of heating and dissipation. This is obvious, since in equilibrium there cannot be a steady net flux of energy out of the electron system into the vibrational degrees of freedom.

In its current popularly accepted form, the so-called NEGF formalism does not drastically differ from an equilibrium theory. The principal technical difference is that all time-dependent functions are defined for time-arguments located on a Keldysh contour (in the complex time-plane) [36]. The advantage of the current versions of the NEGF is that one can systematically improve approximations by taking into account various physical processes. The disadvantage (though this is true only for the popularly adopted form and *not* for the genuine NEGF method) is that the Ward identities are not guaranteed, and so neither is microscopic conservation.

We cannot review here such a broad and rather technical field. Useful descriptions of the NEGF theory can be found in Haug and Jauho [39] and Langreth [40]. We shall discuss some salient issues of this theory in the forthcoming 16th Vietnam School of Physics in Hanoi.

Graphene

"very peculiar electronic properties due to its zero energy gaps at special points in the Brillouin zone"

Open and Closed Systems

Closed system: equilibrium

phenomenological + microscopic methods

molecular - discrete; energy gaps

nano - discrete; quasi-continuous bands

bulk limit - continuous spectra

bands may be:

1. completely filled w/ electrons **(insulated)**
2. partially filled **(metallic)**
3. completely empty **(insulated)** *(de facto)*

If the number of electrons contributed by the constituent atoms is less than the number of possible states in the band, then the highest *occupied* electron state lies well inside the permitted energy spread of the band. (electrically conductive~)

case study: fullerene

60 bonded carbon atoms on the surface of a sphere. *ab-initio* methods (density functional theory (DFT)) calculate electronic, geometrical and vibrational properties of assembly. excellent agreement (see for example [13]). Next consider a fullerene molecule contacted with a pair of gold electrodes subject to a low bias. The fullerene molecule in this new environment will be conducting with a considerable amount of electric current, which arises from the non-equilibrium dynamical condition [14]. A conventional static DFT is unsuitable to provide the correct answer to this problem.

Open Systems: interacting

Table 1. The average CO distance (R_{CO}) as well as the average values of the vertical excitation (ω_1), the highest occupied molecular orbital (HOMO) and the lowest-unoccupied molecular orbital (LUMO) energies, which are obtained from the equilibrated MD trajectories. Energies are given in eV and distances in Å.

R_{CO} HOMOLUMO

Acetone in gas	1.222	4.382	−6.744	−0.443
Acetone in solvent	1.233	4.593	−7.124	−0.634
Change Δ	0.011	0.211	−0.380	−0.191

Role of Quantum Mechanics

localized electronic states become delocalized upon increasing overlap of wave function as system size reaches bulk limit (fig. 1)

Quantum confinement

De Broglie wavelength of particles comparable to size of container system. Small sizes implies strong confinement (fig. 2)

"complete confinement" - quasi-zero-dimensional system

excitons - jointly bound electron-hole pairs (3D particle in a shrinking box)

calculation of carrier density:

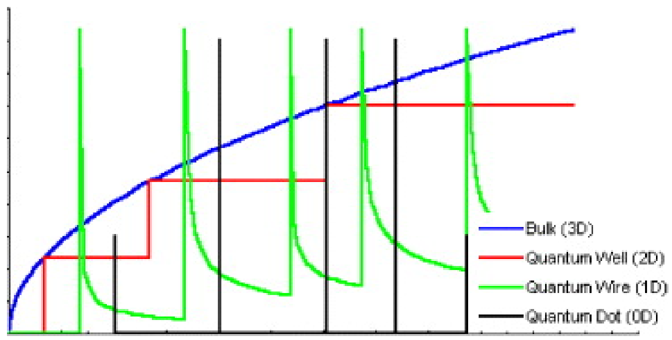
Given in figure 2 are the densities of electronic states in all space dimensions from three to zero. Those are: in 3D, (for each sub-band) in 2D, (for each sub-band) in 1D and $\rho(E)$ as a set of discrete δ-function spikes in

The following equations show the non-interacting wave function and energy of electrons:

$$\psi_{n_x,n_y,n_z} = \sqrt{\frac{8}{L_x L_y L_z}} \sin\left(\frac{n_x \pi x}{L_x}\right) \sin\left(\frac{n_y \pi y}{L_y}\right) \sin\left(\frac{n_z \pi z}{L_z}\right),$$

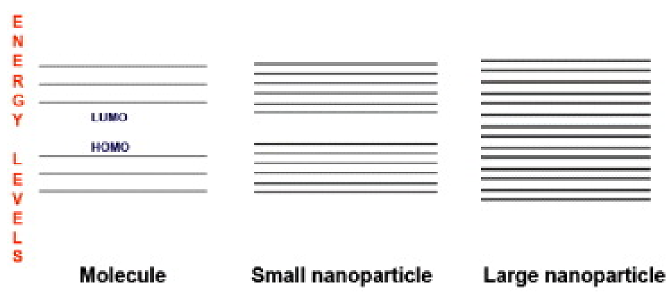
$$E_{n_x,n_y,n_z} = \frac{\hbar^2 \pi^2}{2m} \left[\left(\frac{n_x}{L_x}\right)^2 + \left(\frac{n_y}{L_y}\right)^2 + \left(\frac{n_z}{L_z}\right)^2 \right].$$

0D.



Zoom In Zoom Out Reset image size

Figure 2 Matter in spatial dimensions (from 3 to 0) and their corresponding density of states. Zero dimension is called a quantum dot, one dimension a quantum wire and two dimensions is known as a 2D electron gas.



Zoom In Zoom Out Reset image size

Figure 1 Energy levels with increase of size. In large nanoparticles the energy levels become dense to form quasi-continuum bands.

Special Nano and Mesoscopic properties

In vacuo: isolated from environment (bath); **dissipation,** or **friction** (irreversible transfer)

Einstein, annus 3. [1905]

Rate of quantum state spatial decay specified by coherence length (intermediate) [dephasing/decoherence] result of interaction with environment

Special topic formulae

Bardeen Formula

Quantum tunneling - hopping of single charges

finite-width potential energy barrier (islands)

local occupancy

applications [29]; cf. metallic transport (delocalized particle states)

Landauer Formula

[30] L/R thermodynamic equilibrium; local, dissimilar chemical potentials from/to single-particle state electrons injected/collected both ends

adiabatic, 3D macroscopic connection

absence of scattering, formula for states in a single sub-band: $G=2e^2/h$, where:

e and h are the quantum of electronic charge and Planck's constant, respectively. With N conducting sub-bands the right hand side of the formula is multiplied by N since each band is an independently open channel conducting in parallel with the rest. This phenomenon is known as **quantized ballistic conductance.**

scattering in a ballistic system

takes place at+ within interfaces with reservoir leads: inner system itself free of impurities (assumption). single-particle nature of the Landauer formula deals only with elastic scattering. Using a one-body potential scattering theory, the conductance formula is modified to read $G=(2e^2/h)T$, where T is the transmission function or factor [30]. The function T is the probability that a single electron will traverse the ballistic wire. As a probability, its eigenvalues are bounded between 0 to 1. Where the transmission factor is zero, the system does not conduct, while for unity transmission factors the system is ideally ballistic.

conceptual deficiencies

How can a system with ballistic (i.e. strictly elastic) transport have finite conductance without any dissipation of energy?

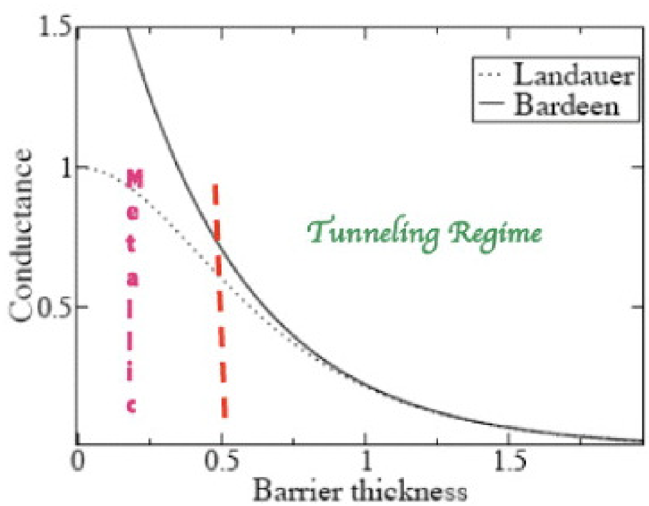
The two quite distinct modalities of conduction, tunnelling and metallic charge flow , as outlined above, are applied interchangeably in Landauer picture. No physical distinction is made between them. This begs the question as to when and how a Bardeen-like *insulating barrier* (as subsumed in the zero-transmission limit of the Landauer model) is able to morph into an ideal ballistic conductor whose states extend right across the structure—as for a metal.

the simple inclusion of passive reservoirs and leads, and even of additional phenomenological voltage probes, cannot save an exclusively single-particle treatment of physics at the nano/meso level [27, 28, 31].

Büttiker [30] introduced into the ballistic system, in a fully phenomenological way, additional probes with adjustable chemical potentials: places for the carriers to instantaneously relax and lose their coherent phase memory.

3.4. Anderson localization and mesoscopics

In the late 1970s P W Anderson and co-workers (popularly known as *The Gang of Four*) established that in a non-interacting, elastically disordered system there is an insulator–metal transition only in 3D, while all oth low-dimensional systems must be insulators. In the language of 'one-body scattering theory' many have concluded that the quantum-coherent discrete conductance for a 1D system, as predicted (among others) Landauer's transport theory, and amply experimentally confirmed, is a contradiction to The Gang of Four's insulator result. See for example, Anderson in '50 years of Anderson localisation' published in *IJMPB* **24** (20 1501. In this area 'weak localization and mesoscopics' have some commonality in popular literature (See fo example, M. Büttiker and M. Moskalets in the above reference p. 1555).



Zoom In Zoom Out Reset image size

Figure 4 Conductance (normalized to e^2/h as barrier (rectangular) thickness (in Å) varies see [29]).

Surface-to-volume Ratio

Smaller systems have higher ratios, implying a strong thermodynamic "driving force". Processes that minimize free energy are sped up.

Chemical reactivity of a porous material: catalytic exhaust converter

Size-dependent properties

1. chemical
    1. reactivity
    2. catalysis
2. mechanical
    1. adhesion
    2. capillary force
3. electrical
    1. tunneling
    2. dipole layers
4. thermal
    1. melting temperature
5. optical
    1. light absorption
    2. light scattering
6. magnetic
    1. super-paramagnetic effect

Three Fundamentals

Diffusive Transport (cf. Bressloff)

1. [8] wave scattering in chaotic cavities

Quantization Phenomena

1. interference
2. quantum size
    1. quantum well confinement (sub-bands)
    2. electron binding (quantum dot)
3. charging effects
    1. Coulomb blockade
    2. Kondo effect (quantum dot)

Physical decoherence

1. Nico van Kampen - inelastic scattering

Universals/generics:

conductance quantization, quantization of charge, universal conductance fluctuations, etc.

Notable effects

Brillouin zone

Aharonov-Bohm

Fermi wavelength (electron density)

Thoulless length

Avogadro's number

Kohn-Sham density functional theory (single particle orbitals)

Hartree-like mean-field interacting quasi-particles (Fermi Golden Rule Formula of conductivity)

$W_{nm} \sim [\psi_n^* \nabla \psi_m - \nabla \psi_n^* \psi_m]$. Here ψ's are Kohn–Sham *effectively single-particle* wave functions.

(the Fermi-liquid, or quasi-particle, theory of Landau).

Limits:

In terms of these lengths and L (being the system length),

- Ballistic limit $\lambda_F < L \ll l_e, l_{in}$,
- Diffusive limit $\lambda_F \ll l_e \ll L < L_T$,
- Macroscopic limit $\lambda_F \ll l_e \ll L_T \ll L$.

On Quantum Non-Locality, Special Relativity, And Counterfactual Reasoning

Type	Book Section
Editor	Jürgen Renn
Editor	Lindy Divarci
Editor	Petra Schröter
Editor	Abhay Ashtekar
Editor	Robert S. Cohen
Editor	Don Howard
Editor	Sahotra Sarkar
Editor	Abner Shimony
Author	Abner Shimony
Author	Howard Stein

Date	2003
Language	en
Library Catalog	DOI.org (Crossref)
URL	http://link.springer.com/10.1007/978-94-010-0111-3_25
Accessed	2/28/2022, 12:51:10 PM
Extra	DOI: 10.1007/978-94-010-0111-3_25
Place	Dordrecht
Publisher	Springer Netherlands
ISBN	978-1-4020-1285-3 978-94-010-0111-3
Pages	499-521
Book Title	Revisiting the Foundations of Relativistic Physics
Date Added	2/28/2022, 12:51:10 PM
Modified	2/28/2022, 12:51:10 PM

Proceedings of the 8th International Symposium on Foundations of Quantum Mechanics in the Light of New Technology: ISQM--Tokyo '05: Advanced Research Laboratory, Hitachi, Ltd., Hatoyama, Saitama, Japan, 22-25 August 2005

Type	Book
Editor	Sachio Ishioka
Editor	K. Fujikawa
Date	2006
Short Title	Proceedings of the 8th International Symposium on Foundations of Quantum Mechanics in the Light of New Technology
Library Catalog	Library of Congress ISBN
Call Number	QC173.96 .I576 2005
Extra	Meeting Name: International Symposium Foundations of Quantum Mechanics in the Light of New Technology
Place	Hackensack, N.J
Publisher	World Scientific
ISBN	978-981-256-858-8
# of Pages	319
Date Added	2/28/2022, 12:55:07 PM
Modified	2/28/2022, 12:55:07 PM

Tags:

Congresses, Physics, Quantum theory

QCDOC: A 10-teraflops scale computer for lattice QCD

Type	Journal Article
Author	D. Chen

Author N.H. Christ
Author C. Cristian
Author Z. Dong
Author A. Gara
Author K. Garg
Author B. Joo
Author C. Kim
Author L. Levkova
Author X. Liao
Author R.D. Mawhinney
Author S. Ohta
Author T. Wettig
Date 3/2001
Language en
Short Title QCDOC
Library Catalog DOI.org (Crossref)
URL https://linkinghub.elsevier.com/retrieve/pii/S0920563201010143
Accessed 2/1/2022, 3:37:15 PM
Volume 94
Pages 825-832
Publication Nuclear Physics B - Proceedings Supplements
DOI 10.1016/S0920-5632(01)01014-3
Issue 1-3
Journal Abbr Nuclear Physics B - Proceedings Supplements
ISSN 09205632
Date Added 2/1/2022, 3:37:16 PM
Modified 2/1/2022, 3:37:16 PM

Attachments

- Chen et al. - 2001 - QCDOC A 10-teraflops scale computer for lattice Q.pdf

---

Quantum communication with ultrafast time-bin qubits

Type Journal Article
Author Frédéric Bouchard
Author Duncan England
Author Philip J. Bustard
Author Khabat Heshami
Author Benjamin Sussman
Abstract The photonic temporal degree of freedom is one of the most promising platforms for quantum communication over fiber networks and free-space channels. In particular, time-bin states of photons are robust to environmental disturbances, support high-rate communication, and can be used in high-dimensional schemes. However, the detection of photonic time-bin states remains a challenging task, particularly for the case of photons that are in a superposition of different time-

bins. Here, we experimentally demonstrate the feasibility of picosecond time-bin states of light, known as ultrafast time-bins, for applications in quantum communications. With the ability to measure time-bin superpositions with excellent phase stability, we enable the use of temporal states in efficient quantum key distribution protocols such as the BB84 protocol.

Date	2021-06-17
Library Catalog	arXiv.org
URL	http://arxiv.org/abs/2106.09833
Accessed	3/3/2022, 5:44:06 AM
Extra	arXiv: 2106.09833
Publication	arXiv:2106.09833 [physics, physics:quant-ph]
Date Added	3/3/2022, 5:44:06 AM
Modified	3/3/2022, 5:44:06 AM

Tags:

Quantum Physics, Physics - Optics

Notes:

Comment: 8 pages, 6 figures

Attachments

- arXiv Fulltext PDF
- arXiv.org Snapshot

Quantum mechanics of many-electron systems

Type	Journal Article
Author	Paul Adrien Maurice Dirac
Author	Ralph Howard Fowler

Abstract The general theory of quantum mechanics is now almost complete, the imperfections that still remain being in connection with the exact fitting in of the theory with relativity ideas. These give rise to difficulties only when high-speed particles are involved, and are therefore of no importance in the consideration of atomic and molecular structure and ordinary chemical reactions, in which it is, indeed, usually sufficiently accurate if one neglects relativity variation of mass with velocity and assumes only Coulomb forces between the various electrons and atomic nuclei. The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that the exact application of these laws leads to equations much too complicated to be soluble. It there fore becomes desirable that approximate practical methods of applying quantum mechanics should be developed, which can lead to an explanation of the main features of complex atomic systems without too much computation. Already before the arrival of quantum mechanics there existed a theory of atomic structure, based on Bohr's ideas of quantised orbits, which was fairly successful in a wide field. To get agreement with experiment it was found necessary to introduce the spin of the electron, giving a doubling in the number of orbits of an electron in an atom. With the help of this spin and Pauli's exclusion principle, a satisfactory theory of multiplet terms was obtained when one made the additional assumption that the electrons in an atom all set themselves with their spins parallel or

antiparallel. If s denoted the magnitude of the resultant spin angular momentum, this s was combined vectorially with the resultant orbital angular momentum l to give a multiplet of multiplicity 2s + 1. The fact that one had to make this additional assumption was, however, a serious disadvantage, as no theoretical reasons to support it could be given. It seemed to show that there were large forces coupling the spin vectors of the electrons in an atom, much larger forces than could be accounted for as due to the interaction of the magnetic moments of the electrons. The position was thus that there was empirical evidence in favour of these large forces, but that their theoretical nature was quite unknown.

Date	April 6, 1929
Library Catalog	royalsocietypublishing.org (Atypon)
URL	https://royalsocietypublishing.org/doi/10.1098/rspa.1929.0094
Accessed	2/4/2022, 3:12:28 PM
Extra	Publisher: Royal Society
Volume	123
Pages	714-733
Publication	Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character
DOI	10.1098/rspa.1929.0094
Issue	792
Date Added	2/4/2022, 3:12:28 PM
Modified	2/4/2022, 3:12:34 PM

Notes:

Shimony often referred to potentialities as forming a ‘network’ (cf. e.g. [**14**], p. 309).

Shimony A. 1990 Some comments and reflections. In *Sixty-two years of uncertainty* (ed. AI Miller), pp. 309–310. New York, NY: Plenum Press.

Attachments

- Full Text PDF

QUANTUM NON-LOCALITY USING TRIPARTITE ENTANGLEMENT WITH NON-ORTHOGONAL STATES

Type	Conference Paper
Author	J. V. Corbett
Author	D. Home
Date	06/2006
Language	en
Library Catalog	DOI.org (Crossref)
URL	http://www.worldscientific.com/doi/abs/10.1142/9789812773210_0009
Accessed	2/28/2022, 12:53:36 PM
Place	Hatoyama, Saitama, Japan
Publisher	WORLD SCIENTIFIC

ISBN 978-981-256-858-8 978-981-277-321-0

Pages 38-41

Proceedings Title Foundations of Quantum Mechanics in the Light of New Technology

Conference Name Proceedings of the 8th International Symposium

DOI 10.1142/9789812773210_0009

Date Added 2/28/2022, 12:53:36 PM

Modified 2/28/2022, 12:53:36 PM

Quantum potentiality revisited

Type Journal Article

Author Gregg Jaeger

Abstract Heisenberg offered an interpretation of the quantum state which made use of a quantitative version of an earlier notion, , of Aristotle by both referring to it using its Latin name, potentia , and identifying its qualitative aspect with . The relationship between this use and Aristotle's notion was not made by Heisenberg in full detail, beyond noting their common character: that of signifying the system's objective capacity to be found later to possess a property in actuality. For such actualization, Heisenberg required measurement to have taken place, an interaction with external systems that disrupts the otherwise independent, natural evolution of the quantum system. The notion of state actualization was later taken up by others, including Shimony, in the search for a law-like measurement process. Yet, the relation of quantum potentiality to Aristotle's original notion has been viewed as mainly terminological, even by those who used it thus. Here, I reconsider the relation of Heisenberg's notion to Aristotle's and show that it can be explicated in greater specificity than Heisenberg did. This is accomplished through the careful consideration of the role of potentia in physical causation and explanation, and done in order to provide a fuller understanding of this aspect of Heisenberg's approach to quantum mechanics. Most importantly, it is pointed out that Heisenberg's requirement of an external intervention during measurement that disrupts the otherwise independent, natural evolution of the quantum system is in accord with Aristotle's characterization of spontaneous causation. Thus, the need for a teleological understanding of the actualization of potentia, an often assumed requirement that has left this fundamental notion neglected, is seen to be spurious. This article is part of the themed issue ‘Second quantum revolution: foundational questions’.

Date 2017-11-13

Language en

Library Catalog DOI.org (Crossref)

URL https://royalsocietypublishing.org/doi/10.1098/rsta.2016.0390

Accessed 2/28/2022, 11:59:52 AM

Volume 375

Pages 20160390

Publication Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences

DOI 10.1098/rsta.2016.0390

Issue 2106

Journal Abbr Phil. Trans. R. Soc. A.

ISSN 1364-503X, 1471-2962

Date Added 2/28/2022, 11:59:53 AM

Modified 2/28/2022, 11:59:53 AM

Attachments

- Full Text

Related

- “Wave-Packet Reduction” and the Quantum Character of the Actualization of Potentia

---

The Search for a Naturalistic World View

Type	Book
Author	Abner Shimony
Date	1993-02-26
Library Catalog	DOI.org (Crossref)
URL	https://www.cambridge.org/core/product/identifier/9781139172196/type/book
Accessed	2/28/2022, 12:57:22 PM
Extra	DOI: 10.1017/CBO9781139172196
Publisher	Cambridge University Press
ISBN	978-0-521-37745-4 978-0-521-37353-1 978-1-139-17219-6
Edition	1
Date Added	2/28/2022, 12:57:22 PM
Modified	2/28/2022, 12:57:22 PM

Topological field theory of time-reversal invariant insulators

Type	Journal Article
Author	Xiao-Liang Qi
Author	Taylor L. Hughes
Author	Shou-Cheng Zhang
Date	2008-11-24
Language	en
Library Catalog	DOI.org (Crossref)
URL	https://link.aps.org/doi/10.1103/PhysRevB.78.195424
Accessed	2/28/2022, 2:00:40 PM
Volume	78
Pages	195424
Publication	Physical Review B
DOI	10.1103/PhysRevB.78.195424
Issue	19
Journal Abbr	Phys. Rev. B
ISSN	1098-0121, 1550-235X
Date Added	2/28/2022, 2:00:41 PM
Modified	2/28/2022, 2:00:41 PM

Attachments

- Submitted Version