

# Literature

---

## I) Why the quantum? From Einstein-Podolsky-Rosen to Greenberger-Horne-Zeilinger.

### *Prelude: Challenges of quantum theory and the Einstein-Bohr-discussions*

- W. Heisenberg, *Quantentheorie und Philosophie*, Reclam (in german)
- W. Heisenberg, *Physics and Philosophy*, Harper & Row (1958)
- Pais, *Einstein and the quantum theory*, Rev. Mod. Phys. 51, 863 (1979)
- A. Peres: *Quantum Theory, Concepts and Methods*, Kluwer, (1993)
- Paul Arthur Schilpp, *Albert Einstein: Philosopher-Scientist*, Cambridge University Press (1949)
- D. Howard, *Revisiting the Einstein-Bohr-dialogue*,  
[http://www.science20.com/don\\_howard/revisiting\\_einsteinbohr\\_dialogue](http://www.science20.com/don_howard/revisiting_einsteinbohr_dialogue)

### *Entanglement, EPR, Bell, GHZ & Leggett*

- E. Schrödinger, *Die gegenwärtige Situation in der Quantenmechanik*, Naturwissenschaften 23, 52 (1935)
- Einstein, B. Podolsky & N. Rosen, *Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?*, Phys. Rev. 47, 777 (1935)
- N. Bohr, *Can Quantum-Mechanical Description of Physical Reality be Considered Complete?*, Phys. Rev. 48, 696 (1935)
- Peres, *Einstein, Podolsky, Rosen, and Shannon*, arXiv:quant-ph/0310010v1 (2003)
- J. S. Bell, *On the Einstein-Podolsky-Rosen Paradox*, Physics 1, 195 (1964)
- J. S. Bell, *On the Problem of Hidden Variables in Quantum Mechanics*, Rev. Mod. Phys. 38, 447–452 (1966)
- Freedman & Clauser, *Neutron optical tests of nonlinear wave mechanics*, PRL **28**, 938 (1972) [*First Bell experiment*]
- Aspect et al., *Experimental Realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: A New Violation of Bell's Inequalities*, PRL 49, 91 (1982) [*Locality loophole*]
- Weihs et al, *Violation of Bell's Inequality under Strict Einstein Locality Conditions*, PRL **81**, 5039 (1998) [*Locality & randomness loophole*]
- Rowe et al., *Experimental violation of a Bell's inequality with efficient detection*, Nature 409, 791 (2001) [*Detection loophole*]
- Scheidl et al., *Violation of local realism with freedom of choice*, PNAS 107, 19708 (2010) [*Freedom of choice loophole*]
- D.Greenberger, M.A.Horne, A.Shimony, A.Zeilinger, *Bell's Theorem Without Inequalities*, Amer. J. Phys. 58, 1131 (1990)
- J.-W. Pan, D. Bouwmeester, A. Zeilinger, *Experimental test of quantum nonlocality in three-photon Greenberger-Horne-Zeilinger entanglement*, Nature 403, 515 (2000) [*First GHZ experiment*]
- J. Leggett, *Nonlocal Hidden-Variable Theories and Quantum Mechanics: An Incompatibility Theorem*, Found. Phys.33, 1469 (2003)
- S. Gröblacher, T. Paterek, R. Kaltenbaek, C. Brukner, M. Zukowski, M. Aspelmeyer, A. Zeilinger, *An experimental test of non-local realism*, Nature 446, 871 (2007)
- T. Paterek et al., *Experimental Test of Nonlocal Realistic Theories Without the Rotational Symmetry Assumption*, Phys. Rev. Lett. 99, 210406 (2007)

- Branciard et al., *Experimental Falsification of Leggett's Nonlocal Variable Model*, Phys. Rev. Lett. 99, 210407 (2007)

### **Review articles**

- J. F. Clauser and A. Shimony, *Bell's theorem. Experimental tests and implications*, Rep. Prog. Phys. 41, 1881 (1978)
- R. Bertlmann & A. Zeilinger, *Quantum [un]speakables: from Bell to quantum information*, Springer (2002) [includes beautiful overview articles by Aspect, Clauser, Zeilinger, Penrose, etc.]

## **II) Why the classical? Schrödinger's cat and the quantum measurement problem**

### **The quantum measurement problem & macrorealism**

- Leggett A.J., *Testing the limits of quantum mechanics: motivation, state of play, prospects*. J. Phys.: Condens. Matter. 2002; 14:R415.
- J. Leggett, A. Garg, *Quantum mechanics versus macroscopic realism: Is the flux there when nobody looks?* Physical Review Letters 54, 857 (1985)

### **Decoherence**

- W. Zurek, *Decoherence and the transition from quantum to classical*, Physics Today 44, 36 (1991) and arXiv:quant-ph/0306072v1 (2003) [updated version of Physics Today]
- M. Schlosshauer, *Decoherence: and the Quantum-To-Classical Transition*, Springer 2007
- Peres, *When is a quantum measurement*, Annals of the New York Academy of Sciences, 480, 438 (1986)
- Joos E., Zeh H.D., *The Emergence of Classical Properties Through Interaction with the Environment*, Z. Phys. B59, 223-243 (1985).
- A. O. Caldeira and A. J. Leggett, *Influence of damping on quantum interference: An exactly soluble model*, Phys. Rev. A 31, 1059 (1985)
- B. L. Hu, J. P. Paz, and Y. Zhang, *Quantum Brownian motion in a general environment: Exact master equation with nonlocal dissipation and colored noise*, Phys. Rev. D 45, 2843 (1992).
- G. J. Milburn, *Intrinsic decoherence in quantum mechanics*, Phys. Rev. A 44, 5401 (1991).
- L. Hackermüller et al., *Decoherence of Matter Waves by Emission of Thermal Radiation*, Nature 427, 711 (2004)
- J. Myatt et al., *Decoherence of quantum superpositions through coupling to engineered reservoirs*, Nature 403, 269 (2000)

### **Death due to "New Physics"**

- Bialynicki-Birula, Mycielski, *Nonlinear wave mechanics*, Ann. Phys. 100, 62 (1976) [Nonlinear Schrödinger equation]
- Gähler, Klein, Zeilinger, *Neutron optical tests of nonlinear wave mechanics* Phys. Rev. A 23, 1611–1617 (1981) [experimental falsification of Bialnicki Birula]
- Sinha, Couteau, Jennewein, Laflamme, Weihs, *Ruling Out Multi-Order Interference in Quantum Mechanics*, Science 329, 418 (2010) [experimental test of validity of Born rule]
- Karolyhazy (1960s), e.g. "Gravitation and quantum mechanics of macroscopic objects" Nuovo Cimento 42, 390 (1966) [Gravity-induced collapse]
- Diosi (1980s), e.g. *Quantum stochastic processes as models for state vector*

- *Reduction*, J. Phys. A: Math. Gen. 21, 2885 (1988) [*Gravity-induced collapse*]
- Penrose (1980s), e.g. *Gravitational Collapse: The Role of General Relativity*, Gen. Rel. Grav. 34, 1141 (2002) [*review on continuous spontaneous localisation ala Ghirardi-Rimini-Weber-Pearl*]
- Adler SL, Bassi A. : *Physics. Is quantum theory exact?* , Science. 2009; 325(5938):275-6. [*review on continuous spontaneous localisation ala Ghirardi-Rimini-Weber-Pearl*]
- W. Marshall, C. Simon, R. Penrose, D. Bouwmeester, *Towards Quantum Superpositions of a Mirror*, PRL 91, 130401 (2003) [*proposed optomechanical test for Penrose proposal*]
- Nimmrichter S, Hammerer K, Asenbaum P, Ritsch H, Arndt M.: *Master equation for the motion of a polarizable particle in a multimode cavity*. *New Journal of Physics*. 2010;12(8):083003 [*proposed matter-wave test for extensions of quantum theory*]
- O. Romero-Isart et al., *Large Quantum Superpositions and Interference of Massive Nanometer-Sized Objects*, PRL 107, 020405 (2011) [*proposed optomechanical test for extensions of quantum theory*]

### III) Quantum Optomechanics: towards quantum experiments with massive mechanical objects

#### Reviews

- M. Aspelmeyer, S. Gröblacher, K. Hammerer, N. Kiesel, *Quantum optomechanics - throwing a glance*, JOSA B 27, A189 (2010)
- Kippenberg TJ, Vahala KJ., *Cavity optomechanics: back-action at the mesoscale*. Science. 2008;321(5893):1172-6. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/18755966>.
- Marquardt F, Girvin SM., *Optomechanics*. Physics. 2009;2:40. Available at: <http://arxiv.org/abs/0905.0566> [Accessed March 22, 2011].
- Aspelmeyer & Schwab, *Focus on Mechanical Systems at the Quantum Limit*, New J. Phys. 10 095001 (2008)

#### Some recent results

- Vogel M, Mooser C, Karrai K, Wartburton RJ.: *Optically tunable mechanics of microlevers*. Applied Physics Letters. 2003;83(7):1337-1339.
- Sheard B, Gray M, Mow-Lowry C, McClelland D, Whitcomb S.: *Observation and characterization of an optical spring*. Physical Review A. 2004;69(5):1-4. Available at: <http://link.aps.org/doi/10.1103/PhysRevA.69.051801> [Accessed November 26, 2010].
- Kippenberg TJ, Rokhsari H, Carmon T, Scherer A, Vahala KJ., *Analysis of Radiation-Pressure Induced Mechanical Oscillation of an Optical Microcavity*. Phys. Rev. Lett. 2005;95:33901.
- Metzger CH, Karrai K., *Cavity cooling of a microcantilever*. Nature. 2004;432:1002-1005.
- Gigan, S. et al.: *Self-cooling of a micromirror by radiation pressure*, Nature 444, 67–70 (2006)
- Arcizet O, Cohadon PF, Briant T, Pinard M, Heidmann A.: *Radiation-pressure cooling and optomechanical instability of a micromirror*. Nature. 2006;444:71-74.
- Gröblacher et al.: *Observation of strong coupling between a micromechanical resonator and an optical cavity field*; Nature 460, 724-727 (2009)
- O'Connell AD, Hofheinz M, Ansmann M, et al.: *Quantum ground state and single-phonon control of a mechanical resonator*. Nature. 2010;464:697-703.

- Teufel JD, Donner T, Li D, et al.: *Sideband cooling of micromechanical motion to the quantum ground state*. Nature. 2011; 475(7356):359-363. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21734657> [Accessed July 16, 2011].
- Chan et al.: *Laser cooling of a nanomechanical oscillator into its quantum ground state*, arXiv:1106.3614v1 [quant-ph], 18 Jun 2011)

### ***Mechanics for sensing***

- Rugar et al., *Single spin detection by magnetic resonance force microscopy*, Nature 430, 329 (2004) MRFM

### ***Mechanics for quantum information***

- Cleland A, Geller M.: *Superconducting Qubit Storage and Entanglement with Nanomechanical Resonators*. Physical Review Letters. 2004;93(7):1-4.
- Rabl P, Kolkowitz SJ, Koppens FHL, et al. : *A quantum spin transducer based on nanoelectromechanical resonator arrays*. Nat Phys. 2010;6(8):602-608.
- Stannigel K, Rabl P, Sørensen A, Zoller P, Lukin M. : *Optomechanical Transducers for Long-Distance Quantum Communication*. Physical Review Letters. 2010;105(22).