CV of John F. Clauser

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Education:

Baltimore Polytechnic Institute	1959 -1960	High School Diploma, Adv. College Prep.
Caltech	1960 -1964	BS, Physics
Columbia University	1964 -1966	MA, Physics
Columbia University	1966 -1969	PhD, Physics

Employment:

1969 - 1975: Postdoctoral Research Associate, Physics Dept., Univ. of Calif. – Berkeley, and Lawrence Berkeley National Laboratory.
1975 - 1986: Research Physicist, Lawrence Livermore National Laboratory.
1986 - 1987: Senior Scientist, Science Applications International Corp., (SAIC, Emeryville, CA).
1988 - 1989: Consultant, Inventor, (J.F. Clauser & Assoc., Livermore, CA).
1990 - 1997: Research Physicist, Univ. of Calif. – Berkeley, Physics Dept.
1997 - ____: Research Physicist, Consultant, Inventor (J.F. Clauser & Assoc., Walnut Creek, CA).

Selected Awards and Honors:

1982: *The Reality Foundation Prize* ($6000, shared with John S. Bell, CERN). The award citation reads *"The Reality Foundation Prize to John F. Clauser for experimental and theoretical research into quantum foundations, for devising variations of the Bell Inequality which subject local realistic models of nature to experimental tests, for performing experiments which decisively exclude semi-classical models of the radiation field, for carrying out experiments which establish non-locality as a general feature of objective reality."*

2010: The Wolf Foundation Prize in Physics ($100,000, Shared with Alain Aspect and Anton Zeilinger) The award citation reads "*The Prize Committee for Physics has unanimously decided that the 2010 Wolf Prize be jointly awarded to: John F. Clauser, J.F. Clauser & Assoc., Walnut Creek, CA, U.S.A., Alain Aspect, Institut d'Optique, Palaiseau, France, Anton Zeilinger, University of Vienna & Institute for Quantum Optics and Quantum Information, Austrian Academy of Sciences,Vienna, Austria, For their fundamental conceptual and experimental contributions to the foundations of quantum physics, specifically an increasingly sophisticated series of tests of Bell's inequalities or extensions there of using entangled quantum states.*"

2011 The Thomson Reuters Citation Laureate – Physics" for his tests of Bell's Inequalities and quantum entanglement. (for Nobel Prize nomination)

Noteworthy Accomplishments:

1959 -1960: As a high-school student, John built the world's first computer-driven "video games" to win awards at the '59 and '60 National High-school Science Fairs, the U.S. Navy "Science Cruiser" Award, and the "J. J. Chapman Memorial" Award ("Most Proficient Student in Electricity").

1965 - 1969: As a graduate student, with thesis sponsor, Patrick Thaddeus (Columbia), John made the 3rd measurement of the 2.7° cosmic microwave background radiation, and first observed interstellar Carbon-13.

1969: As a graduate student (independently of his thesis work), and with Abner Shimony and Mike Horne, (Boston Univ.) and Richard Holt (Harvard) John proposed the first experimental test of Bell's Theorem. This work introduced the Clauser-Horne-Shimony-Holt (CHSH) inequality as a constraint for hidden-variables theories.

1971: John discovered the basic flaw in John vonNeumann's "Informal Hidden-Variable Argument".

1972: At the UC Berkeley Physics Dept., working with PhD student Stuart Freedman, John carried out the first experimental test of the CHSH-Bell's Theorem predictions. This was the world's first observation of quantum entanglement, and was the first experimental observation of a violation of a Bell inequality.

1974: With Mike Horne (Stonehill College, MA), John first showed that a generalization of Bell's Theorem provides severe constraints for all local realistic theories of nature (a.k.a. objective local theories). This work introduced the Clauser-Horne (CH) inequality as the first fully general experimental requirement set by local

realism. It also introduced the “CH no-enhancement assumption”, whereupon the CH inequality reduces to the CHSH inequality, and whereupon associated experimental tests also constrain local realism.
1974: At UC Berkeley, John made the first observation of sub-Poissonian statistics for light (via a violation of the Cauchy-Schwarz inequality for classical electromagnetic fields), and thereby, for the first time, demonstrated an unambiguous particle-like character for photons.
1976: At UC Berkeley, John carried out the second published experimental test of the CHSH-Bell's Theorem prediction, thereby refuting the unpublished experimental results of a similar test by Richard Holt and Francis Pipkin (Harvard).
1976: At UC Berkeley, John carried out the first experimental measurement of the circular-polarization correlation of quantum-mechanically entangled photons.
1976: With Abner Shimony and Michael Horne, pointed out the importance of the observer’s freedom of choice (as a criticism of John Bell’s ‘*Theory of Local Beables*’).
1978: With Abner Shimony, John published the first comprehensive review of the experimental and theoretical status of the use of Bell's Theorem for testing local realism.
1975 - 1986: At Lawrence Livermore National Laboratory, with Tom Simonen and Ron Goodman, John designed and built a ruby-laser Thomson scattering plasma diagnostic to measure electron temperature in the 2XIIB magnetic mirror (controlled fusion) experiment. With Grant Logan, he designed and built Langmuir probe arrays to measure the spatial distribution of plasma elecron and ion temperatures and plasma potential in 2XIIB. With Eric Silver and UC Davis PhD student, Bruce Failor, he designed and built x-ray spectrometers and x-ray cameras for the analysis of relativistic *Bremstrahlung* x-ray emission from the TMX-U tandem magnetic mirror experiment.
1975 - 1986: At Lawrence Livermore National Laboratory, as Group Leader for the 2XIIB experiment, John first experimentally demonstrated the scaling limitations imposed by the drift-cyclotron-loss-cone plasma micro-instability in minimum-B magnetic mirror machines.
1975 - 1986: At Lawrence Livermore National Laboratory, John discovered strong electron-temperature gradients in the 2XIIB magnetic mirror machine, parallel to a magnetic field. This discovery was totally unexpected and was a direct refutation of the commonly believed assertion by Lyman Spitzer (Princeton) that a plasma’s electron temperature is always constant along magnetic field lines. It was also pivotal for the subsequent invention by Grant Logan and William Fowler of "electron thermal barriers" that, in turn, were used in the TMX-U experiment at LLNL. That invention subsequently earned Logan and Fowler the James Clark Maxwell Prize.
1975 - 1986: As the leader of a group of computer scientists at Lawrence Livermore National Laboratory, John and his group designed and build the TMX-U experiment's data-acquisition and analysis system.
1984 John invented and built a dramatic new design for a racing sailboat keels. Via John’s work as a consultant to the St. Francis Yacht Club's America's Cup Challenge Syndicate, this keel design was implemented on their revolutionary 12-meter yacht, USA. Virtually all present-day racing sailboat keels are a direct evolution of this design concept.
1985 - 1987: At SAIC John helped develop a 3D imaging system using thermal neutrons for counter-terrorist airline checked-baggage inspection, and wrote the tomography software for this system. Then, to diminish its false-positive rate, he invented dual-energy article-gradient material-specific x-ray imaging. SAIC has subsequently adapted this latter invention for use in inspecting carry-on luggage. Both of these systems are currently used in most international airports. Following the Sept. 11, 2001 attack on the US, their use was mandated for all US international airports. They are now manufactured by Perkin Elmer.
1987 - 1991: John first proposed and patented atom interferometers, as useful ultra-sensitive sensors for inertial and gravity forces, and for petroleum prospecting and well-logging. (US Patents 4,874,942 and 4,992,656, Australian Patent # 637,654, Canadian Patent # 2,033, 341).
1988: John first proposed the use of atom interferometry, in spacecraft for the testing of general relativity.
1992: With UC-Berkeley Physics PhD student Matthias Reinsch, John first deduced the number-theoretical properties of the fractional Talbot effect for finite gratings, first calculated this effect’s spectral resonance properties, and first combined the fractional Talbot effect with the Lau effect to provide a new form of lens-free ultra-short wavelength interferometer, which he named the Talbot-Lau interferometer.
1990 - 1997: At the UC - Berkeley, Physics Dept., with postdoc Shifang Li, John first used Talbot-Lau interferometry to build deBroglie-wave atom interferometers.
1990 - 1997: At the UC - Berkeley, Physics Dept., with postdoc Shifang Li, John adapted Talbot-Lau interferometry to provide the first realization of the "Heisenberg-Microscope" experiment.

1994: John first proposed the use of Talbot-Lau matter-wave interferometry with very massive particles (e.g. “small rocks and live viruses”) as a probe for limits to the validity of quantum theory, as indicated in various attempts to understand the “quantum measurement problem”. Anton Zeilinger’s group at Univ. of Vienna has since carried out such experiments.
1996: With J. Dowling (Redstone Arsenal, AL) John first discovered that Young's N-slit interferometer can be used to find the prime factors of an integer N.
1997: John first proposed the possibility of observing a “Temporal Talbot-Effect”. This effect has since been observed, and further, has been used for factoring integers.
1998: John was granted US Patent 5,812,629, “*Ultrahigh Resolution Interferometric X-ray Imaging*”.
1999 – present: With support from the National Cancer Institute, John has is presently involved in research at his own private lab to develop his US Patent 5,812,629 to provide a clinically useful device (for mammography). To this end, he has observed Talbot-Lau interference with x-rays, and has used it to obtain actual phase-contrast x-ray images. Recently, other workers have also (re)discovered this technique and experiments using it are in progress at various laboratories in Switzerland, Japan and the USA.
2000: As a consultant to the Jet Propulsion Laboratory’s Quantum Computing Technologies Group, John evaluated the use of matter-wave interferometry in earth-orbiting satellites for surveillance and gravity imaging of the earth’s surface.
1999 – present: Via a combination of theoretical and experimental work, John is currently attempting to understand anomalous small-angle x-ray scattering processes that he has observed recently.
1996 – present: In a long term project, John is measuring, mapping, cataloging and attempting to understand and model the oceanographic phenomena known as tidal-current rips. These appear as strong sharp discontinuities in the velocity fields of tidal currents. They occur only in tidal basins that are fed by large rivers (such as San Francisco Bay), and are not understood by oceanographers. Sometimes, they can be very dangerous to shipping traffic.

John has published over 300 technical articles in physics journals. He is a member of the American Physical Society, the Optical Society of America, SPIE, the Radiological Society of North America, and United States Sailing Association. He is also an avid sailboat racer.

Selected publications by John F. Clauser on the foundations of quantum mechanics:

J. F. Clauser, 1969, *Proposed Experiment to Test Local Hidden-Variable Theories*, Bul. Amer. Phys. Soc., **14**, 578.
J. F. Clauser, M. A. Horne, A. Shimony, R. A. Holt, 1969, *Proposed Experiment to Test Local Hidden-Variable Theories*, Phys. Rev. Lett., **23**, 880.
J. F. Clauser, 1971, *VonNeumann's Informal Hidden-Variable Argument*, Amer. J. Phys., **39**, 1095.
J. F. Clauser, 1971, *Reply to Dr. Wigner's Objections*, Amer. J. Phys., **39**, 1098.
J. F. Clauser, 1972, *Experimental Limitation to the Validity of Semi-classical Radiation Theories*, Phys. Rev., A **6**, 69.
S. J. Freedman and J. F. Clauser, 1972, *Experimental Test of Local Hidden-Variable Theories*, Phys. Rev. Lett., **28**, 938.
J. F. Clauser, 1972, *Formalism and Reality*, Science **175**, 871 (1972).
J. F. Clauser, 1973, *Experimental Limitations to the Validity of Semiclassical Radiation* Theorie, in *Coherence and Quantum Optics: Proceedings of the Third Rochester Conference on Coherence and Quantum Optics*, *June 21-23*, *1972*, ed. by L. Mandel and E. Wolf (Plenum Press, New York).
J. F. Clauser, 1973, *Localization of Photons* in *Coherence and Quantum Optics: Proceedings of the Third Rochester Conference on Coherence and Quantum Optics*, *June 21-23*, *1972*, ed. by L. Mandel and E. Wolf (Plenum Press, New York).
J. F. Clauser, 1974, *Experimental Distinction Between the Quantum and Classical Field Theoretic Prediction for the Photoelectric Effect*, Phys. Rev. D, **9**, 853.
J. F. Clauser and M. A. Horne, 1974, *Experimental Consequences of Objective Local Theories*, Phys. Rev., D **10**, 526.
J. F. Clauser, 1976, *Philosophical Motivations of Bell's Theorem and the Experimenter's Problem*, invited paper presented at *Thinkshops on Physics - Experimental Quantum Mechanics `Ettore Majorana'*, Erice, Sicily, in *Progress in Scientific Culture*, (#4) 1976, ed. by A. Zichichi (Tipographia "Cartograf", Trapani, Italy, 1977).
J. F. Clauser, 1976, *Experiments Performed at Lawrence Berkeley Laboratory Bearing Relation to Bell's Inequality*, invited paper presented at *Thinkshops on Physics - Experimental Quantum Mechanics `Ettore Majorana'*, Erice, Sicily, in *Progress in Scientific Culture,* **1** (#4) 1976, ed. by A. Zichichi (Tipographia "Cartograf", Trapani, Italy, 1977).
A. Shimony, M. A. Horne, and J. F. Clauser, 1976, *Comment on `The Theory of Local Beables'*, Epistemological Lett. **13**, 1, republished along with comments by J.S. Bell as '*An exchange on local Beables*' in Dialectica, **39**, 97 (1985).
J. F. Clauser, 1976, *Measurement of the Circular-Polarization Correlation in Photons from an Atomic Cascade*, Il *Nuovo Cimento*, **33B**, 740.
J. F. Clauser, 1976, *Experimental Investigation of a Polarization Correlation Anomaly*, Phys. Rev. Lett., 36, 1223.
J. F. Clauser and A. Shimony, 1978, *Bell's Theorem*: *Experimental Tests and Implications*, Rpts. on Progr. in Phys. 41, 1881.
J. F. Clauser, 2002, *Early History of Bell's Theorem*, Chapter 6 in *Quantum [Un]speakables*, ed by R. A. Bertlmann and A. Zeilinger (Springer, Berlin).
J. F. Clauser, 2003, *Early History of Bell's Theorem*, in *Coherence and Quantum Optics VIII*, ed. by Bigelow *et al*. (Kluwer Academic/Plenum Publishers), pp. 19-43.
J. F. Clauser, 2017, *Bell's Theorem, Bell Inequalities, and the "Probability Normalization Loophole"*, Chapter 28 in *Quantum [Un]speakables II*, ed. by R. A. Bertlmann and A. Zeilinger (Springer International Publishing, AG Switzerland).

Selected publications by John F. Clauser on atom interferometry and Talbot-Lau Interferometry:

J. F. Clauser, 1987,88, *Ultra-High Sensitivity Accelerometers and Gyroscopes Using Neutral-Atom Matter-*Wave *Interferometry*, Physica, **B** 151, 262 (1988), presented at the *International Workshop on Matter - Wave Interferometry in the Light of Schrodinger's Wave Mechanics*, Vienna, 14-16 Sept. 1987.
J.F. Clauser, 1989, 1991, US Patents # 4,874,942 (filed 1987, issued 1989) and # 4,992,656 (filed 1989, issued 1991), *Rotation*, *Acceleration*, *and Gravity Sensors*, *Using Quantum-Mechanical Matter-Wave Interferometry with Neutral Atoms and Molecules*.
J. F. Clauser, 1988, *Ultra-Sensitive Inertial Sensors via Neutral Atom Interferometry*, *in Relativistic Gravitational Experiments in Space*, NASA Conference Publ. 3046, R. Hellings editor, presented at the *NASA Workshop on Relativistic Gravitational Experiments in Space*, Annapolis MD, 28-30 June 1988.
J. F. Clauser, 1993, Australian Patent # 637,654 (filed 1989, issued 1993), *Atom Interferometry Gyroscopes*, *Accelerometers and Gravity Gradiometers*.
J. F. Clauser, 1996, Canadian Patent # 2,033,341 (filed 1991, issued 1996), *Atom Interferometry Gyroscopes, Accelerometers and Gravity Gradiometers*.
J. F. Clauser and M. W. Reinsch, 1992, *New theoretical and experimental results in Fresnel optics with applications to matter-wave and x-ray interferometry*, Appl. Phys. B, **54**, 380 (1992), presented at *The WE Heraeus Seminar on Optics and Interferometry with Atoms*, 10-12 June, 1992, Insel Reichenau, Konstanz, Germany, as part of an invited talk,: *Separated - Beam and Talbot - vonLau Interferometry with Potassium*.
J. F. Clauser, 1995, *Results of* atom *interferometry experiments with potassium*, in *Proceedings of the International Symposium on Fundamental Problems in Quantum Physics* (ISFPQP - Oviedo, Spain, 29 Aug. - 3 Sept., 1993), (Kluwer, Great Britain, 1995).
J. F. Clauser and S. Li, 1994, *Talbot-vonLau atom interferometry with slow cold potassium*, Phys. Rev., A **49**, R2213.
J. F. Clauser and S. Li, 1994, "*Heisenberg microscope*" *decoherence atom interferometry*, Phys. Rev., A **50**, 2430.
J. F. Clauser and S. Li, 1994, *Matter-Wave/Atom Interferometry*, in *New Techniques and Analysis in Optical Measurements*, presented at *Interferometry '94* (16-20 May, 1994, Warsaw), *Proceedings of SPIE*, Vol. 2340, 2-13.
J. F. Clauser and J. Dowling, 1996, *Factoring integers with Young's N-slit interferometer*, Phys. Rev. A 53, 4587.
J. F. Clauser, 1997, *deBroglie-wave interference of small rocks & live viruses*, Chapter 1 in *Experimental Metaphysics: Quantum Mechanical Studies for Abner Shimony*, ed. by R. S. Cohen et al. (Kluwer Academic Publishers, Great Britain, 1997), pp. 1-11.
J. F. Clauser, 1998, *Ultrahigh Resolution Interferometric X-ray Imaging*, U. S. Patent 5,812,629 (filed 1997, issued 1998).
J. F. Clauser, and S. Li, 1997, *Generalized Talbot-Lau Atom* Interferometry, Chapter 3 in *Atom Interferometry*, ed. by P. Berman (Academic Press, San Diego, 1997), pp. 121-151.
J.F. Clauser, 2000, *Surveilance and Gravity-Imaging of the Earth's Surface, and Satellite Gravity Gradiometry with Atom Interferometers.* (Jet Propulsion Laboratory Quantum Computing Technologies Group report).
J. F. Clauser, 2015, *Origins of the Talbot-Lau Interferometer*, keynote address at "X-and Neutron Phase Imaging (XNPIG)", SPIE conference XN101, 8-11 Sept. 2015, National Institutes of Health, Bethesda, MD.

List of publications in other areas available on request.