

## DAVID VITALI'S CURRICULUM VITAE

### Main steps of the professional career

- Born in Narni (TR, Italy) on 19/5/1964
- 1983-1988: Degree in Physics at the University of Pisa, with votation 110/110 magna cum laude.
- 1988-1992: Ph.D. in Physics at the Scuola Normale Superiore at Pisa. Ph.d obtained the 19/03/1994 with votation 70/70 magna cum laude.
- Gennaio-Giugno 1992: Visiting lecturer at the Università of North Texas, Denton (USA).
- Gennaio-Maggio 1993: INFM grant at the Pisa INFM research unit
- Agosto 1993-Ottobre 2001: Researcher in Physics at the University of Camerino.
- Novembre 2001-today: Associate Professor of Physics of Matter at the University of Camerino, Faculty of Science and Technology

### Main aspects of the research activity

- **Author of 134 papers on International journals with referee** and more than 30 proceedings and contributions to books (both with and without referee, see the attached list)
- **About 3400 citations** in the ISI database (updated at September 2013). Hirsch h-index (h = number of papers with at least h citations) = **32**
- **Invited speaker** at **41** international conferences (see attached list)
- **Guest editor** of the following publications: a) "Proceedings of the 3rd Workshop on Mysteries, Puzzles and Paradoxes in Quantum Mechanics", Zeitschrift fur Naturforschung Section A 56 (1-2), 2001. b) Topical Issue "Mysteries, Puzzles and Paradoxes in Quantum Mechanics IV: Quantum Interference Phenomena", Journal of Optics B: Quantum and Semiclassical Optics, Volume 4, Number 4, August 2002; c) "Quanta of Light, Matter, and Information: A Festschrift in honour of Paolo Tombesi", Fortschritte der Physik, Volume 57, Issue 11-12, 2009.
- **Visiting scientist** at the following universities and research centers: Ecole Normale Supérieure de Paris (1997, 2000, 2002, 2006), University of Queensland, Brisbane (Australia) (1998), University of Oxford (1999), University of Innsbruck (2000, 2005), University of Wien (2005, 2006), University of Bonn (2007), University of Mainz (2007), MIT (Cambridge, MA) (2008), Caltech (2008).
- **Visiting professor** at Universidad Autonoma de Barcelona (2006)
- **Research grant** of three months for Senior Foreign Researchers offered by the City of Paris (France), for research activity at the Ecole Normale Supérieure de Paris. The research period took place on 1/09/2004-15/10/2004 and 1/12/2004-31/01/2005.
- **Referee** of the following international physics journal: "Nature Physics", "Physical Review Letters", "New Journal of Physics", "Physical Review A", "Physical Review D", "Journal of Physics A", "Journal of Physics B", "Europhysics Letters", "European Journal of Physics D", "Journal of Modern Optics", "Physics Letters A", "Journal of the Optical Society of America B", Physica Scripta
- Active participant to the following research programs, funded by the European Commission (EC): a) TMR "Non classical light" (1992-1994); b) RTN "QUEST" (1999-2003); c) RTN "CONQUEST" (2004-2008), d) STREP "QUELE" (2004-2007) d) IP "SCALA" (2005-2009); e) IP "QAP" (2005-2009).

- Active participant to the following research programs, funded by MURST/MIUR: a) PRIN 1997 “Amplification and detection of quantum radiation”; b) FIRB 2001 “Efficient quantum cryprographic scheme under realistic conditions”; c) PRIN 2002 “Quantum coherence phenomena in nonlinear optical media”.
- Active participant to the following research programs, funded by INFN: PRA 1997 “CAT.”, PAIS 2000 “Entanglement and Decoherence”, PAIS 2002 “MEPTRAP”.
- Active participant to the following research programs, funded by Istituto Nazionale di Fisica Nucleare (INFN) “QUCORP”, (Quantum Control of Radiation Pressure Noise) (2004-2005); “SQUALO”, (Reaching the Standard Quantum Limit with optical means) (2008-2009).

### **Invited speaker at the following International conferences**

1. “Fluctuations in Physics and Biology: Stochastic Resonance, Signal Processing and Related Phenomena”, Marciana Marina , Isola d’Elba, June 5-10, 1994
2. “Quantum Computing and Quantum Communications : First NASA International Conference, QCQC '98”, Palm Springs, California, USA, February 17-20, 1998
3. “Quantum decoherence, information and chaos”, Heron Island, Australia, September 21-25, 1998
4. “III Adriatico Research Conference on Quantum Interferometry”. ICTP Trieste, March, 1-5, 1999
5. “6th International Conference on Squeezed States and Uncertainty Relations”, Napoli, May 24-29, 1999.
6. “Entanglement and decoherence”, Gargnano (BS), September 20-25, 1999.
7. “Macroscopic Quantum Coherence and Quantum Computing”, Napoli, June 14-17, 2000
8. “5<sup>th</sup> International Conference on Quantum Communication, Measurement and Computing”, Capri (NA), July 3-8, 2000.
9. “Mysteries, Puzzles and Paradoxes in Quantum Mechanics”, Gargnano (BS), September 17-23, 2000
10. “Mysteries, Puzzles and Paradoxes in Quantum Mechanics”, Gargnano (BS), August 27 – September 1, 2001
11. “International Conference on Experimental Implementations of Quantum Computation”, Sydney, Australia, January 16-19, 2001
12. “Quantum Information Theory Workshop”, Gold Coast, Australia, January 21-25, 2001
13. “Cooling 2002”, Visby, Svezia, June 8-13, 2002
14. “INFN Meeting”, Bari, June 24-28, 2002
15. “8th International Conference on Squeezed States and Uncertainty Relations”, Puebla, Messico, June 9-13, 2003.
16. “International Conference Physics and Control 2003”, Saint Petersburg, Russia, August 20-24, 2003.
17. “Mysteries, Puzzles and Paradoxes in Quantum Mechanics”, Gargnano (BS), September 1-5, 2003
18. “Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons”, Torino, April 26-28, 2004,
19. “Quantum mechanics and quantum computation”, IIASS "E.R. Caianiello", Vietri sul Mare, March 18-20, 2005.
20. “Workshop on Theory and Technology in Quantum Information, Communication, Computation and Cryptography”, ICTP Trieste, June 19-23, 2006.
21. “Laser Physics”, Losanna, July 24-28, 2006
22. “National Congress of the Italian Society of Physics” 2006, Torino September 18-23, 2006

23. "European Conference on Lasers and Electro-Optics and the International Quantum Electronics Conference (CLEO@/Europe-IQEC)", Munich, June 17-22, 2007
24. "3rd International IEEE Scientific Conference on Physics and Control (PhysCon 2007)", Potsdam, September 3-7, 2007
25. "Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons", Torino, May 19-23, 2008
26. "Quantum/Classical Control in Quantum Information", Otranto, September 13-20, 2008.
27. "Open Quantum Systems: Decoherence and Control", Harvard University, Cambridge, MA (USA), November 20-22, 2008.
28. "Cavity Cooling of atoms, molecules and ions", Obergurgl, Tirol, Austria, February 4-8, 2009.
29. "International Conference on Scalable Quantum Computing with Light and Atoms", Cortina d'Ampezzo (BL), February 15-22, 2009
30. "Quantum Control Theory: Probabilistic and Geometrical Aspects", Padova, 28-29 September 2009
31. "QuantumComm 2009: International Conference on Quantum Communication and Quantum Networking", October 26 – 30, 2009 Vico Equense, Italy
32. "10<sup>th</sup> International Conference on Quantum Communication, Measurement and Computing", Brisbane, QLD, Australia, July 19-23, 2010
33. ICTP Workshop on "Nano-Opto-Electro-Mechanical Systems Approaching the Quantum Regime", Sept. 6-10, 2010, Trieste
34. "Congresso Nazionale Società Nazionale di Fisica 2011, L'Aquila 26-30 settembre 2011
35. "Advances in Foundations of Quantum Mechanics and Quantum Information with atoms and photons", Torino, 21-25 Maggio 2012
36. "International School of Physics and Technology of Matter", Otranto 16-22 Settembre 2012
37. "Quantum Science Symposium" Cambridge, Regno Unito, 1-2 Novembre-2012
38. "Quantum Optics VI", Piriápolis, Uruguay, 12-16, Novembre 2012.
39. "Frontiers of Nanomechanics", ICTP Workshop, Sept. 9-13 2013, Trieste
40. "FisMat 2013 - Italian National Conference on Condensed Matter Physics", Sept. 9-13 2013, Milano
41. "iQIT- Integrated Quantum Information Technology", Sept. 23-27 2013, Corfù (Grecia)

### **Coordination of research programs**

- Coordinator of the node of the University of Camerino associated to the EU FP5-IST-FET IP program "ACQUIRE" , (2000-2003).
- Coordinator of the node of the University of Camerino of the Network of Excellence for Quantum Information Processing and Communication (QUIPROCONE), funded by EU within the FET framework, (2000-2003).
- Local coordinator of the National research program PRIN 2001 "Decoherence control in quantum information processing"
- Coordinator of the National research Program PRIN 2005 "Generation, manipulation and detection of light for quantum communication"
- Coordinator of the node of the University of Camerino of the STREP project within ICT FET Open Call FP7-ICT-2007-C, "Micro- and Nano-Optomechanical Systems for ICT and QIPC" (MINOS) (2008-2011)
- Coordinator of 4 Grants for Young Indian Researchers funded by MIUR (2 in 2007 e 2 in 2008).
- Local coordinator of the National research program PRIN 2011 " Development of ultra low-loss optical interferometers in the ponderomotive regime for quantum noise reduction in

gravitational wave detectors and ultrasensitive detection of weak forces in micro-mechanical systems.”

- Coordinator of the node of the University of Camerino of the FP7-PEOPLE-2011-ITN Project: cQOM - Cavity Quantum Optomechanics (2012-2016)
- Coordinator of the node of the University of Camerino of the ICT FET Open Call FP7-ICT-2011-C project “Interfacing quantum optical, electrical and mechanical systems” (iQUOEMS) (2013-2016)
- Referee of research projects for the Italian Ministry MIUR, for the European Commission within the FP7, for the Israel Science Foundation and for the “Fond Quebecois de la Recherche”.

## ADMINISTRATION AND ORGANIZATION ACTIVITIES

- From 1998 to 2006, Coordinator for the Physics Area, of the Relationships with High Schools.
- May 2006-today: **Coordinator of the License and Master Physics Program of the University of Camerino**
- Member of the **Organizing Committee of the following International conferences:**
  1. “Quantum Communication, Measurement, and Computing”, July Capri, 3-8, 2000
  2. “Entanglement and decoherence”, Gargnano (BS), September 20-25, 1999;
  3. “Mysteries, Puzzles and Paradoxes in Quantum Mechanics”, Gargnano (BS), September 17-23, 2000;
  4. “Mysteries, Puzzles and Paradoxes in Quantum Mechanics”, Gargnano (BS), 27/08/2001-01/09/2001
  5. International Meeting “Foundations of Quantum Information” Università di Camerino, April 16–19, 2004.
  6. International Meeting “Recent Challenges in Novel Quantum Systems” Università di Camerino, July 6–9, 2005.
  7. “International Conference on Scalable Quantum Computing with Light and Atoms”, Cortina d’Ampezzo (BL), February 15-22, 2009

## TEACHING ACTIVITIES

### Supporting teaching activity done as a Researcher of the University of Camerino

- From 1992/93 to 2000/01: “Elements of Theoretical Physics” of the III year of the Degree in Physics
- From 1992/93 to 1993/94: “Elementary Physics” of the I year of the Degree in Biology
- In the academic year 1994/95: “Mathematical Methods for Physics” of the III year of the Degree in Physics
- In the academic year 2001/02: “Differential Equations” of the II year of the Degree in Physics

### Teacher of the following courses at the University of Camerino

- From 1995/96 to today: “Nonlinear Optics” for the Master Degree in Physics (valid also for ph.d students)
- From 2002/03 to today: “Mathematical Methods for Physics”, of the III year of the Degree in Physics
- From 2004/05 to 2006/07: “Statistical Physics”, of the III year of the Degree in Physics

### **Additional teaching activities**

- Supervisor of 7 Master Theses of the Master Degree in Physics of the University of Camerino  
Supervisor of 4 Final Dissertations for the Degree in Physics of the University of Camerino.
- External supervisor of 4 Master Theses of the Master Degree in Physics of the University of Pisa and of 1 4 Master Thesis of the Master Degree in Physics of the University of Milan
- Supervisor of 4 ph.d theses in Physics at the University of Camerino.
- Referee of 7 ph.d theses in Physics, of the University of Palermo (1999), of the University of Salerno (2003, 2007), of the University of Milan (2004, 2005), of the Ecole Normale Supérieure de Paris (2002), and of the Scuola Normale Superiore di Pisa (2009).

### **BRIEF DESCRIPTION OF THE RESEARCH ACTIVITY**

My research activity, which began in 1989, spreads across various fields of research. At the beginning I have studied various applications of **nonlinear stochastic systems**, as for example superconducting devices and optical and atomic systems.

Starting from 1993 my research interests focused more and more on the development of new **quantum mechanical devices**, concentrating in particular on **quantum optics** systems and on systems of few trapped atoms and ions.

These new research interests have been stimulated also by the simultaneous impressive development of the field of Quantum Information, which provides a new way of looking at Quantum Physics. In fact, the quantum laws ruling the behaviour of atomic and subatomic particles, also provide a new and efficient way of processing and exchange information. I have worked on some important aspects of **Quantum Information**. I have proposed and studied various proposals for the practical implementation of quantum computers, which could solve some problems (such as prime factoring) much faster than any “classical” computer. I have then also studied various aspects of **Quantum Communication**, either in the case of single photons and in the case of bright optical fields. More recently I have studied a fascinating form of quantum communication, i.e., quantum teleportation, which consists in the transport to a remote distance of all the quantum properties (the exact quantum state) of a physical system. I have also studied quantum cryptography, i.e., how to use photons for encrypted communications and I have collaborated to install and develop the Quantum Optics Lab at the Department of Physics of the University of Camerino.

As witnessed by the good number of citations, some of my papers on the **control and reduction of quantum decoherence** are quite popular. Quantum decoherence is the phenomenon according to which quantum coherence (which is the key ingredient of any quantum information protocol) is destroyed by the interaction with the environment. In my research activity I have developed various decoherence control techniques, especially tailored for atomic and quantum

optical systems. Another field in which I have obtained excellent results is the one concerning **optomechanical devices**, in which radiation pressure couples light with micro- and nano-mechanical oscillators and which can be used in order to implement **sensors of forces, masses, displacements with an incredibly high sensitivity**. These sensors are able to reach the ultimate quantum limits imposed by quantum mechanics and the Heisenberg principle and they can be employed in particular in atomic force microscopes and in gravitational wave detectors.

### **Publications in International journals with referees**

- [1] D. Vitali, P. Grigolini, “Subdynamics, Fokker-Planck equation and exponential decay of relaxation processes”, *Phys. Rev. A* **39**, 1486-1499, (1989) .
- [2] G. Cicogna, D. Vitali, “Generalised symmetries of Fokker-Planck-type equations”, *J. Phys. A: Math. Gen.* **22**, L453-L456, (1989).
- [3] G. Cicogna, D. Vitali, “Classification of the extended symmetries of Fokker-Planck equations”, *J. Phys. A: Math. Gen.* **23**, L85-L88, (1990).
- [4] P. Grigolini, R. Mannella, R. Roncaglia, D. Vitali, “Quantum mechanical dissipation: from the weak to the strong-coupling limit”, *Phys. Rev. A* **41**, 6625-6634 (1990).
- [5] L. Bonci, P. Grigolini, D. Vitali, “Beyond the semiclassical approximation of the discrete nonlinear Schrödinger equation: collapses and revivals as a sign of quantum fluctuations”, *Phys. Rev. A* **42**, 4452-4461 (1990).
- [6] D. Vitali, P. Grigolini, “Nonlinear effects in quantum dissipation”, *Phys. Rev. A* **42**, 7091-7106 (1990).
- [7] L. Bonci, P. Grigolini, R. Mannella, G. Trefan, D. Vitali, “Statistical mechanics of a nonlinear relaxation process: I. Equilibrium properties”, *Phys. Rev. A* **43**, 2624-2631 (1991).
- [8] L. Bonci, P. Grigolini, R. Mannella, D. Vitali, “Statistical mechanics of a nonlinear relaxation process: II. Dynamical properties”, *Phys. Rev. A* **44**, 876-883 (1991) .
- [9] P. Grigolini, V. M. Kenkre, D. Vitali, “Spin relaxation with bistable precession”, *Phys. Rev. A* **44**, 1015-1021 (1991).
- [10] D. Vitali, L. Bonci, R. Mannella, P. Grigolini, “Localization breakdown as a joint effect of nonlinear and quantum dissipation”, *Phys. Rev. A* **45**, 2285-2293 (1992) .
- [11] L. Bonci, R. Roncaglia, D. Vitali, B.J. West, P. Grigolini, “Irreversibility and quantum macroscopic effects of classically chaotic systems”, *Int. J. Mod. Phys. B* **7**, 1175-1205 (1993).
- [12] L. Bonci, P. Grigolini, R. Roncaglia, D. Vitali, “Nonlinear Schrödinger equation and wave function collapse: An unreliable consequence of the semiclassical approximation.”, *Phys. Rev. A* **47**, 3538-3545 (1993).
- [13] D. Vitali, P. Allegrini, P. Grigolini, “Nonlinear quantum mechanical effects: real or artefact of inaccurate approximation?”, *Chem. Phys.* **180**, 297-318 (1994).

- [14] D. Vitali, L. Tessieri, P. Grigolini, "Wave-function collapse and quantum fluctuation-dissipation process", Phys. Rev. A **50**, 967-976 (1994).
- [15] P. Tombesi, D. Vitali, "Physical realization of an environment with squeezed quantum fluctuations via QND-mediated feedback", Phys. Rev. A **50**, 4253-4257 (1994).
- [16] P. Allegrini, L. Bonci, P. Grigolini, R. Mannella, R. Roncaglia, D. Vitali, "Comment on 'Quantum chaos in the Born-Oppenheimer approximation'", Phys. Rev. Lett. **74**, 1484 (1995).
- [17] D. Vitali, "Proton tunneling in symmetric H-bond: a simple microscopic model", Chem. Phys. **192**, 79-88 (1995).
- [18] P. Tombesi, D. Vitali, "Optical feedback from quantum non-demolition measurements: How to realize a measurement apparatus to observe macroscopic quantum coherence", Appl. Phys. **B60**, S69-S75 (1995).
- [19] L. Tessieri, D. Vitali, P. Grigolini, "Quantum jump as an objective process of nature", Phys. Rev. A. **51**, 4404-4414 (1995).
- [20] P. Tombesi, D. Vitali, "Macroscopic coherence via quantum feedback", Phys. Rev. A. **51**, 4913-4917 (1995)
- [21] D. Vitali, R. Mannella, "Quantum stochastic resonance in the dissipative two-state system", Nuovo Cimento **17D**, 959-967 (1995).
- [22] L. Bonci, P. Grigolini, G. Morabito, L. Tessieri, D. Vitali, "Spontaneous localizations, environment-induced decoherence and individual-system observations", Phys. Lett. A **209**, 129-136 (1995).
- [23] P. Tombesi, D. Vitali, "All-optical model for the generation and the detection of macroscopic quantum coherence", Phys. Rev. Lett. **77**, 411-415 (1996).
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- [25] V. Giovannetti, P. Grigolini, G. Tesi, D. Vitali, "Wave-function collapse and objective randomness", Phys. Lett. A **224**, 31-38 (1996).
- [26] D. Vitali, P. Tombesi, P. Grangier, "Conditional Schrödinger cats generation and detection by quantum nondemolition measurements", Appl. Phys. **B64**, 249-257 (1997).
- [27] D. Vitali, P. Tombesi, "Generation and detection of linear superpositions of classically distinguishable states of a radiation mode", Int. J. Mod. Phys. B **11**, 2119-2140 (1997).
- [28] D. Vitali, P. Tombesi, G.J. Milburn, "Controlling the decoherence of a 'meter' via stroboscopic feedback", Phys. Rev. Lett. **79**, 2442-2445 (1997).
- [29] D. Vitali, P. Tombesi, G.J. Milburn, "Protecting Schrödinger cat states using feedback", J. Mod. Opt. **44**, 2033-2041 (1997).

- [30] S. Mancini, D. Vitali, P. Tombesi, "Optomechanical cooling of a macroscopic oscillator by homodyne feedback", *Phys. Rev. Lett.* **80**, 688-691 (1998).
- [31] D. Vitali, P. Tombesi, G.J. Milburn, "Quantum state protection in cavities", *Phys. Rev. A* **57**, 4930-4944 (1998).
- [32] D. Vitali, P. Grigolini, "Chaos, thermodynamics and quantum mechanics: an application to celestial dynamics", *Phys. Lett. A.* **249**, 248-258 (1998).
- [33] D. Vitali, P. Tombesi, "Using parity kicks for decoherence control", *Phys. Rev. A* **59**, 4178-4186 (1999).
- [34] V. Giovannetti, P. Tombesi, D. Vitali, "Non-Markovian quantum feedback from homodyne measurements: The effect of a non-zero feedback delay time", *Phys. Rev. A* **60**, 1549-1561 (1999).
- [35] F. De Martini, M. Fortunato, P. Tombesi, D. Vitali, "Generating entangled superpositions of macroscopically distinguishable states within a parametric oscillator", *Phys. Rev. A* **60**, 1636-1651 (1999).
- [36] M. Fortunato, J.M. Raimond, P. Tombesi, D. Vitali, "Autofeedback scheme for preservation of macroscopic coherence in microwave cavities", *Phys. Rev. A* **60**, 1687-1697 (1999).
- [37] D. Vitali, P. Tombesi, "Decoherence control for optical qubits", in "Quantum Computing and Quantum Communications", C.P. Williams editore, Lecture Notes in Computer Science, vol. 1509, Springer, Berlin 1999, pag. 402-412.
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- [43] D. Vitali, M. Fortunato, P. Tombesi, F. De Martini, "Generating entangled Schrödinger cat states within a parametric oscillator" *Fortschritte der Physik*, **48**, 437-446 (2000).
- [44] V. Giovannetti, D. Vitali, P. Tombesi, and A. Ekert, "Scalable quantum computation with cavity QED systems", *Phys. Rev. A* **62**, 032306 (2000).
- [45] V. Giovannetti, P. Tombesi, and D. Vitali, "Implementing scalable quantum computation with cavities:", *J. Mod. Opt.* **47**, 2187-2197 (2000).



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- [58] D. Vitali, S. Mancini, L. Ribichini, P. Tombesi "Mirror quiescence and high-sensitivity position measurements with feedback", *Phys. Rev. A* **65**, 063803 (2002); *Phys. Rev. A* **69**, 029901(E) (2004).
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- [60] D. Vitali, "Decoupling methods for heating and decoherence control", *J. Opt. B: Quantum Semiclass. Opt.* **4**, S337-S344 (2002).
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- [64] S. Pirandola, D. Vitali, P. Tombesi, “Trapping and cooling single atoms with far-off-resonance intracavity doughnut modes”, *Phys. Rev. A* **67**, 023404 (2003).
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- [66] S. Zippilli, D. Vitali, P. Tombesi, J. M. Raimond, “Scheme for decoherence control in microwave cavities”, *Phys. Rev. A* **67**, 052101 (2003).
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- [68] S. Mancini, D. Vitali, P. Tombesi, V. Giovannetti, “Bringing quantum strangeness to the macroscopic world”, *Fortschr. Phys.* **51**, 504–509 (2003).
- [69] C. Ottaviani, D. Vitali, M. Artoni, F. Cataliotti, P. Tombesi, “Polarization qubit phase gate in driven atomic media”, *Phys. Rev. Lett.* **90**, 197902 (2003).
- [70] S. Mancini, V. Giovanetti, D. Vitali, P. Tombesi, “Entanglement from ponderomotive interaction”, *Opt. Spectrosc.* **94**, 711-716 (2003).
- [71] S. Pirandola, S. Mancini, D. Vitali, P. Tombesi, “Continuous variable entanglement by radiation pressure” *J. Opt. B: Quantum Semiclass. Opt.* **5**, S523-S529 (2003).
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