

## CURRICULUM VITAE OF JUAN PABLO PAZ

### PERSONAL DATA

**Name:** Juan Pablo Paz

**Work address:**

- 1 Secretary of Scientific and Technological Articulation (SACT), Ministerio de Ciencia, Tecnología e Innovación de la Nación Argentina, Godoy Cruz 2320, 1425, Buenos Aires, Argentina.
- 2 Departamento de Física, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Pabellón 1, Ciudad Universitaria, 1428 Buenos Aires, Argentina.

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### CURRENT POSITIONS

- SECRETARY OF SCIENTIFIC ARTICULATION, Ministry of Science Technology and Innovation, Argentina
- PLENARY FULL PROFESSOR, Department of Physics, FCEyN, Universidad de Buenos Aires, Argentina
- SUPERIOR RESEARCHER of CONICET (Argentina).
- DIRECTOR of the Instituto de Física de Buenos Aires (IFIBA, UBA-CONICET)

### DEGREES

- PhD in Physics, 1988, Universidad de Buenos Aires. Profesor TITULAR, Departamento de Física, FCEyN-UBA, Argentina
- LICENCIADO en Ciencias Físicas, 1984, Universidad de Buenos Aires.

### AWARDS AND HONORS

- Member of TWAS, 2020
- Distinguished citizen of the City of Buenos Aires, Argentina (prize granted by Buenos Aires legislature in December 2018)
- Simon Associated Fellow of ICTP, Trieste, Italy (2020-2024).
- "INVESTIGADOR DE LA NACIÓN ARGENTINA" (2014), Argentinian Presidential Prize granted to the best scientist of 2014.
- Premio HOUSSAY in Physics (2014), granted by the Ministry of Science of Argentina.

- Premio KONEX 2013 in Physics (Diploma de Honor)
- TWAS prize in Physics, 2012. (The Academy of Sciences of the Developing World).
- BUNGE Y BORN Prize 2010 (granted by Bunge and Born Foundation).
- W. BESSEL PRIZE 2006 (granted by A V Humboldt Foundation, Germany)
- GUGGENHEIM Fellow 2004.
- International Fellow, SANTA FE INSTITUTE, 2001-2003, (granted by SFI) (EEUU)
- Ernesto Galloni Prize (1994) (granted by the Argentinian Academy of Sciences)
- Member of the Latin American Academy of Sciences (ACAL)

### **PREVIOUS RESEARCH POSITIONS**

- Technical Staff Member, Theoretical Division, Los Alamos National Laboratory (2003-2005)
- Postdoctoral Fellow. Theory División. Los Alamos National Laboratory (1991-1994).
- Research Associate, Department of Physics, University of Maryland (1989-1991).
- Doctoral fellowship from CONICET (1986-1989).

### **OTHER POSITIONS**

- Chairman of the Physics Department “Juan José Giambiagi”, FCEyN-UBA, between 1997 and 2002 y then between 2009 and 2011.
- Member of the Directive Council of the Faculty of Natural and Exact Sciences, University of Buenos Aires, between 2001 y 2013
- Coordinator of the “Quantum Group”, Theoretical Division, Los Alamos National Laboratory, LANL (2003, 2004)

### **TEACHING POSITIONS**

- Professor at the Physics Department of the University of Buenos Aires (Assistant Professor since 1994, promoted to Assistant Professor in 1999 and to Full Professor in 2008). Tought the following courses: Física 1 (mechanics), Física 3 (electromagnetism), Mecánica Clásica, Física Teórica 2 (quantum mechanics), Advanced topics in quantum mechanics, Dissipative quantum systems.
- Invited Professor at the Physics Department of the University of Maryland (1990). In charge of the course on Advanced Topics on General Relativity, PHY0879.
- Invited Professor at International Schools (selected list)
  1. LXXII session of the Les Houches Summer School in Physics. July 1999, Les Houches, France.
  2. 84th Schladming Winter School on Theoretical Physics. (2004, Enero), Schladming, Austria.

3. 2nd Scala: (Scalable quantum computers) European Summer School on Quantum Information. 2006 (Julio) Benasque, España.
4. 4th Canadian School on Quantum Information. 2004 (Julio) Waterloo, Canada.
5. Escuela de Ciencias Informáticas (ECI). 2000 (Julio) Buenos Aires.
6. Escuela Latinoamericana de Física (ELAF). 2007 (Agosto) México DF, México.
7. Escuela Brasileira de Informação Cuántica. 2007 (Julio) Parati, Brazil. Topical School on Quantum Open Systems. 2008 (Julio) Nancy, Francia. Escuela Brasileira de Informação Cuántica, 2011 (Agosto) Paraty, Brasil. Escuela sobre “Mecánica cuántica aplicada”, 2012 (Julio) Cuernavaca, México.
8. ICTP-Perimeter Institute International School on Theoretical Physics. Sao Paulo, Brazil (2016).

### **DIRECTION OF RESEARCH PROJECTS**

- General Director of the Group “QUFIBA” (Quantum Foundations and Information @ Buenos Aires <http://www.qufiba.df.uba.ar>). Principal Investigator of several grants supporting Project at QUFIBA (Grants from Agencia Nacional de Promoción Científica y Tecnológica, ANPCyT: PME 2015-0035, PICT 2016, PICT-01014, PICT 0309000. PICT 29856. PICT 01225, PICT 02483. PICT 2014, Grants from CONICET: PIP 2008-2011. PIP 2011-2014, Grants from UBACyT: PID EX-122, PID TW-23, X722, Grant Antorchas for young researchers, 1994, 1995, 1996, 1998.
- Director of the Laboratorio de Iones y Átomos Fríos (LIAF, FCEyN t UBA).
- Principal Investigator. LDRD Grant, Los Alamos National Laboratory: “Cold Atoms quantum simulators”, LANL 2004.

### **PhD THESIS DIRECTED**

- Dr. Nahuel Freitas, PhD Thesis FCEyN UBA, 2017. Title: “Quantum thermodynamics and quantum simulations with cold trapped ions”. Dr. Freitas is now a postdoctoral research fellow at the Quantum Optics Group at the Physics Department of the University of Saarbrücke (Germany).
- Dr. Christian Schmiegelow, PhD, FCEyN UBA, 2011. Title: “Quantum information processing with entangled photons”. J.J. GIAMBIAGI Prize to the best PhD Thesis in Argentina during (2011-2012). Dr Schmiegelow was a postdoc at Uni Mainz between 2013 and 2016 and now is the scientific director of LIAF at the Physics Department of UBA.
- Dr. Ariel Bendersky, PhD FCEyN UBA, 2011. Title: “Efficient quantum algorithms for state and process tomography”. Dr. Bendersky was a postdoc at ICFO (Barcelona) between 2012 and 2015. He is now a Professor at the Computer Science Department at UBA.

- Dr. Augusto Roncaglia, PhD FCEyN UBA, 2009. Title: "Dynamics of correlations created in the course of decoherence". PREMIO J.J. Giambiagi to the best PhD Thesis in Argentina during 2008-2009). Dr. Roncaglia was a postdoc at ICFO (Barcelona) between 2009 and 2012. He is now a Professor at the Physics Department of UBA.
- Dr. Cecilia Cormick, PhD Thesis FCEyN UBA, 2009. Title: "Quantum simulators". Dra. Cormick was a postdoc at Univ of Saarbrucke and Univ of Ulm (Germany). She is now a researcher and a professor at the University of Cordoba (Argentina).
- Dr. Cesar Miquel. PhD Thesis FCEyN UBA, 2002. Title: "Quantum computation". Dr. Miquel is the CEO of Logitech, one of the main software firms in Buenos Aires.
- Dra. Diana Monteoliva, PhD FCEyN UBA, 2003. Title: "Decoherence for classically chaotic systems". Dra. Monteoliva is a member of the Scientific Commission of the Province of Buenos Aires (CIC-BA).
- Lic. Milton Aguilar, (in progress, started in 2017)

### **MsC THESIS DIRECTED**

- Lic. Luciana Dávila Romero, Master Thesis defended in FCEyN UBA, June 1996. Title: "Decoherencia y correlaciones iniciales en el movimiento Browniano cuántico".
- Lic. Cesar Miquel, Master Thesis defended in FCEyN UBA, August 1996. Title: "Factorización cuántica con iones fríos" (co-directed with R Perazzo).
- Lic. Hernn Pringe, Master Thesis defended in FCEyN UBA, June 1997. Title: "Códigos cuánticos de corrección de errores".
- Lic. Verónica Cerletti, Master Thesis defended in FCEyN UBA, October 2000. Title: "Cómo buscar una aguja en un pajar usando la mecánica cuántica".
- Lic. Federico Botessi, Master Thesis defended in FCEyN UBA, August 2000. Title: "Dinámica de un sistema de varios espines interactuando con el mismo entorno".
- Lic. Pablo Bianucci, Master Thesis defended in FCEyN UBA, March 2001. Title: "Decoherence for chaotic quantum maps" (co-directed with M. Saraceno).
- Lic. Alejandro Villanueva, Master Thesis defended in FCEyN UBA, September 2002. Title: "Decoherence from vacuum fluctuations" (co-directed with D. Mazzitelli).
- Lic. Graciana Puentes, Master Thesis defended in FCEyN UBA, October 2002. Title: "Optical simulations of quantum maps" (co-directed with M. Sarraceno).
- Lic. Augusto Roncaglia, Master Thesis defended in FCEyN UBA, March 2003. Title: "Quantum algorithms for phase space tomography".
- Lic. Cecilia Lopez, Master Thesis defended in FCEyN UBA, March 2003. Title: "Decoherence in quantum walks".

- Lic. Cecilia Cormick, Master Thesis defended in FCEyN UBA, July 2005. Title: “Discrete Wigner functions for stabilizer states”.
- Lic. Ariel Bendersky, Master Thesis defended in FCEyN UBA, March 2007. Title: “Mutually unbiased basis: theory and applications”.
- Lic. Fernando Pastawski, Master Thesis defended in FAMAFA, UNC, March 2008. Title: “Efficient algorithms for quantum process tomography”.
- Lic. Nahuel Freitas, Master Thesis defended in FCEyN UBA, April 2011. Title: “Dynamics of Gaussian discord between two oscillators coupled with the same environment”.
- Lic. Esteban Martinez, Master Thesis defended in FCEyN UBA, December 2011. Title: “Microscopic derivation of Fourier’s law”.
- Lic. Gabriela Petrunaro, Master Thesis defended in FCEyN UBA, May 2012. Title: “The most general master equation for quantum Brownian motion”.
- Lic. Marcelo Luda, Master Thesis defended in FCEyN UBA, December 2013. Title: “Quantum information processing and key distribution using orbital degrees of freedom of single photons”.
- Lic. Federico Cerisola, Master Thesis defended in FCEyN UBA, March 2015, Title: “Work measurement in quantum systems”.
- Lic. Martin Dresch, Master Thesis defended in March 2016 in FCEyN UBA. Title: “Entanglement Dynamics in driven quantum systems”.

**PUBLISHED PAPERS (scientometric data: h factor 49, more than 10500 citations)**

1. Quantum amplifier in an tunable superconducting circuit N. Del Grosso, F.C. Lombardo, J.P. Paz and P.I. Villar Phys. Rev A (2021) submitted.
2. Classical and quantum correlations in thermal machines. M. Aguilar and J.P. Paz, Phys. Rev A in press (2021)
3. Entanglement in quantum thermal machines. M. Aguilar, N. Freitas and J.P. Paz, Phys. Rev. A 102 062422 (2020)
4. “State dependent squeezing of a trapped ion: new method and applications”, M. Drechsler, M.B. Farías, N. Freitas, C. Schmiegelow and J.P. Paz, Phys. Rev. A 101 052331 (2020).
5. “Entanglement in quantum thermodynamics”, M. Aguilar and J.P. Paz, Phys. Rev. Lett (2019) submitted.
6. “Cooling a quantum oscillator: A useful analogy to understand Laser cooling as a thermodynamical process”, N. Freitas and J.P. Paz, Physical Review A 97 032104 (2018).
7. “Cooling to absolute zero: the unattainability principle”, N. Freitas, R. Gallegos, L. Masanes and J.P. Paz, in “Thermodynamics in the quantum regime”, Fund. Theories Phys, 195, Springer Nature Sw DOI 10.1007/978-3-319-99046-0\_25 (2018).
8. “Fundamental limit for cooling by linear quantum refrigerators”, N. Freitas and J.P. Paz, Phys Rev E 95, 012146 (2017) (commented in Scientific American, 2017).

9. "Using a quantum work meter to test non equilibrium fluctuation theorems", F. Cerisola, Y. Margalit, S. Machluf, A. Roncaglia, J.P. Paz and R. Folman, *Nature Communications* 8, 1241 (2017).
10. "On the origin of the third law of thermodynamics", N. Freitas, A. Masanes and J.P. Paz (2018) to appear in *Lecture Notes in Physics* (Springer, DE).
11. "Quantum work and the informational cost of projective measurements", S. Deffner, J.P. Paz and W.H. Zurek (2016) *Phys Rev E* 94, 010103 (Rapid Comm): arXiv: 1603.06509.
12. "Work measurement as a generalized quantum measurement", A. Roncaglia, F. Cerisola and J.P. Paz, *Phys. Rev. Lett.* 113, 250601 (2014), selected as editor's choice and commented in *Physics APS*.
13. "Measuring work and heat in ultracold quantum gases", G. De Chiara, A.J. Roncaglia and J.P. Paz, *New J. Phys* 17 (2015) 035004.
14. "Comments on General non Markovian Dynamics of open quantum systems", D. Mac Cutcheon, J.P. Paz and A. Roncaglia, *Phys. Rev. Lett* 116 030011 (2015).
15. "Analytic solution for heat flow through a general harmonic network", N. Freitas and J.P. Paz, *Phys. Rev. E* 90, 042128 (2014). Errata *Phys Rev E* 90, 042128 (2014).
16. "Manipulating transverse modes of photons for quantum cryptography", M. Luda, M. Larotonda, J.P. Paz and C. Schmiegelow, *Phys. Rev. A* A89, 042325 (2014)
17. "Heat transport through an ion cristal", N. Freitas, E. Martinez and J.P. Paz, *Physica Scripta* 91, 1 (2015).
18. "Dynamics and thermodynamics of linear quantum open systems", E. Martinez and J.P. Paz, *Phys. Rev. Lett.* 110, 130406 (2013).
19. "Selective and efficient quantum state tomography and its applications to quantum process tomography", A. Bendersky and J.P. Paz, *Physical Review A* 87, 012127 (2013).
20. "Chiral mediated entanglement in an Aharanov Bohm ring", B. Rizzo, L. Arrechea and J.P. Paz, *Phys. Rev. B* 85, 045442 (2012).
21. "Dynamics of Gaussian discord between two oscillators coupled with the same environment", N. Freitas and J.P. Paz, *Phys. Rev. A* 85, 032118 (2012).
22. "Selective and efficient quantum process tomography without ancilla", C. Schmiegelow, A. Bendersky, M. Larotonda and J.P. Paz, *Phys. Rev. Lett.* 107, 100502 (2011).
23. "Selective and efficient quantum process tomography with single photons", C. Schmiegelow, M. Larotonda and J.P. Paz, *Phys. Rev. Lett.* 104, 123601 (2010).
24. "Towards scalable tomography of quantum maps using twirling—based methods and information hierarchies", C. Lopez, A. Bendersky, J.P. Paz and D. Cory, *Phys. Rev. A* 81, 062113 (2010).
25. "Studying the different phases for the dynamics of entanglement in an ion trap", C. Cormick and J.P. Paz, *Phys. Rev. A* 81, 022306 (2010).
26. "Selective and efficient quantum process tomography", A. Bendersky, F. Pastawski, J.P. Paz, *Phys. Rev. A* 80, 032116 (2009).

27. "General theory of measurement with two copies of a quantum state", A. Bendersky, J.P. Paz and M. Terra Cunha, Phys. Rev. Lett. 103, 040404 (2009).
28. "Redundancy of total and quantum correlations in the course of decoherence", J.P. Paz and A. Roncaglia, Phys. Rev. A80, 042111 (2009).
29. "Entanglement dynamics during decoherence", J.P. Paz and A. Roncaglia, Quant. Info. Comp 8, 535 (2009).
30. "Dynamical phases for the evolution of the entanglement between two oscillators coupled with the same environment", J.P. Paz and A.J. Roncaglia, Phys. Rev. A 79, 032102 (2009).
31. "Dynamics of the entanglement between two oscillators in the same environment", J.P. Paz and A. Roncaglia, Phys. Rev. Lett 100, 220401 (2008).
32. "Selective Efficient Estimation of the Parameters of a Quantum Process Iquote", A. Bendersky, F. Pastawski and J.P. Paz, Phys. Rev. Lett. 100, 190403 (2008).
33. "Phase space origin of purity and fidelity decay", D. Monteoliva and J.P. Paz; Phys. Rev. A (2008), submitted (AQ10398).
34. "Decoherence of Bell states by local interactions with a dynamic spin environment", C. Cormick and J.P. Paz, Phys. Rev. A 78, 012357 (2008).
35. "Decoherence induced by a dynamic spin environment: the universal regime", C. Cormick and J.P. Paz, Phys. Rev. A 77, 022317 (2008).
36. "Universal decoherence induced by an environmental quantum phase transition", F.M. Cucchietti, J.P. Paz and S. Fernández-Vidal, Phys. Rev. A 75, 032337 (2007).
37. "Signatures of non-locality in the first-order coherence of the scattered light", P. Cañizares, T. Görler, J.P. Paz, G. Morigi and W. Schleich, Laser Physics 17, 903-907 (2007).
38. "Gaussian decoherence and Gaussian echoes from spin environments", W.H. Zurek, F. Cucchietti and J.P. Paz, Acta Physica Polonica B 38, 1685 (2007).
39. "Interference in the discrete Wigner function", C. Cormick and J.P. Paz, Phys. Rev. A 74 062315 (2006).
40. "Simulating a quantum walk with classical optics", D. Francisco, C. Lemmi, J.P. Paz and S. Ledesma, Phys. Rev. A 74, 052327 (2006).
41. "Optical simulation of the quantum Hadamard operator", D. Francisco, C. Lemmi, J.P. Paz and S. Ledesma, Optics Communications 268, pp 340-345 (2006).
42. "Classicality in the discrete Wigner function", C. Cormick, E. Galvao, D. Gottesmann, J.P. Paz and A. Pittenger, Phys. Rev. A 73, 012301 (2006).
43. "Decoherence from spin environments", F. Cucchietti, J.P. Paz and W.H. Zurek, Phys. Rev. A 72, 052113 (2005).
44. "Decoherence induced by a chaotic environment: a quantum walker with a complex coin", L. Ermann, J.P. Paz and M. Sarraceno, Phys. Rev. A 73, 012302 (2006).
45. "Qubits in phase space: Wigner function approach to quantum error correction and the mean king paradox", J. P. Paz, A. Roncaglia and M. Sarraceno, Phys. Rev. A 72, 012309 (2005).

46. "Quantum algorithms for phase space tomography", J. P. Paz, A. J. Roncaglia and M. Saraceno, Phys. Rev. A 69, 032312 (2004).
47. "Decoherence and recoherence from vacuum fluctuations near a conducting plate", F. D. Mazzitelli, J. P. Paz and A. Villanueva, Phys. Rev. A 68, 062106 (2004).
48. "Optical simulation of quantum algorithms using programmable liquid crystal displays", G. Puentes, C. La Mela, S. Ledesma, C. Lemmi, J. P. Paz and M. Saraceno, Phys. Rev. A 69, 042319 (2004).
49. "Randomness in quantum computation", J. P. Paz, Science 302, 2076-2077 (2003).
50. "Phase-space approach to the study of decoherence in quantum walks", C. C. Lopez and J. P. Paz, Phys. Rev. A 68, 052305 (2003).
51. "Decoherence and the Loschmidt echo", F. M. Cucchietti, D. A. R. Dalvit, J. P. Paz and W. H. Zurek, Phys. Rev. Lett. 91, 210403 (2003).
52. "A Method for Modeling Decoherence on a Quantum Information Processor", G. Teklemariam, E. M. Fortunato, C. C. Lopez, J. Emerson, J. P. Paz, T. F. Havel and D. G. Cory, Phys. Rev. A 67, 062316 (2003).
53. "Testing integrability with a single bit of quantum information", D. Poulin, R. Laflamme, G.J. Milburn and J. P. Paz, Phys. Rev. A 68, 022302 (2003).
54. "A quantum gate array can be programmed to evaluate the expectation value of any operator", J. P. Paz and A. Roncaglia, Phys. Rev. A 68, 052316 (2003).
55. "Interpretation of tomography and spectroscopy as dual forms of quantum computation", C. Miquel, J. P. Paz, M. Saraceno, R. Laflamme, E. Knill and C. Negrevergne, Nature 418, 59-62 (2002).
56. "Quantum computers in phase space", C. Miquel, J. P. Paz and M. Saraceno, Phys. Rev. A 65, 062309 (2002).
57. "Decoherence for classically chaotic quantum maps", P. Bianucci, J. P. Paz and M. Saraceno, Phys. Rev. E 65, 046226 (2002).
58. "Phase-space representation of quantum teleportation", J. P. Paz, Phys. Rev. A 65, 062311 (2002).
59. "Discrete Wigner functions and the phase space representation of quantum computers", P. Bianucci, C. Miquel, J. P. Paz and M. Saraceno, Phys. Lett. A 299, 353-358 (2002).
60. "Decoherence for classically chaotic quantum systems: rate of entropy production and quantum-classical correspondence", D. Monteoliva and J. P. Paz, Phys. Rev. E 64, 05238 (2001).
61. "Environment engineering: protecting the quantum world", J P Paz, Nature 412, 869-870 (2001).
62. "Decoherence and the rate of entropy production for chaotic quantum systems", D. Monteoliva and J. P. Paz, Phys. Rev. Lett. 85 3373, (2000).
63. "Quantum limit of decoherence: Environment induced superselection of energy eigenstates", J. P. Paz and W. H. Zurek, Phys. Rev. Lett. 82, 5181 (1999).
64. "Continuous error correction", J. P. Paz and W. Zurek, Proc. Roy. Soc. London A 454, 355 (1998).



65. "Quantum computation with phase drift errors", C. Miquel, J.P. Paz and W. H. Zurek, Phys. Rev. Lett. 78, 3971 (1997).
66. "Deconstructing decoherence", J. Anglin, J. P. Paz and W. H. Zurek, Phys. Rev. A 55, 4041 (1997).
67. "Decoherence and initial correlations in quantum Brownian motion", L. Davila Romero and J. P. Paz, Phys. Rev. A 55, 4070 (1997).
68. "Perfect quantum error correction code", R. Laflamme, C. Miquel, J. P. Paz and W. H. Zurek, Phys. Rev. Lett. 77, 198 (1996).
69. "Dissipation and decoherence in mean field theory", S. Habib, Y. Kluger, E. Motolla and J. P. Paz, Phys. Rev. Lett. 76, 4660 (1996).
70. "Factoring in a dissipative quantum computer", C. Miquel, J. P. Paz and R. Perazzo, Phys. Rev. A 54, 2605 (1996).
71. "Quantum evolution of disoriented chiral condensates", Y. Kluger, F. Cooper, E. Motolla, J. P. Paz and A. Kovner, Nucl. Phys. A590, 581 (1995).
72. "Decoherence, recoherence and the black hole information paradox", J. Anglin, R. Laflamme, W. Zurek and J. P. Paz, Phys. Rev. D52, 2221 (1995).
73. "Quantum chaos, a decoherent definition", W. H. Zurek and J. P. Paz, Physica D83, 300 (1995).
74. "Non-equilibrium dynamics of disoriented chiral condensates", Y. Kluger, J. P. Paz, F. Cooper and E. Mottolla, Phys. Rev. D 51, 2377 (1995).
75. "Non-equilibrium quantum fields in the large N expansion", F. Cooper, S. Habib, Y. Kluger, E. Motolla, J. P. Paz and P. Anderson. Phys. Rev. D 50, 2848 (1994).
76. "Decoherence, chaos and the second law", W. H. Zurek and J. P. Paz, Phys. Rev. Lett. 72, 2508 (1994). See also the reply to comments by B. Chirikov and G. Casati in W.H. Zurek and J. P. Paz, Phys. Rev. Lett. 75, 351 (1995).
77. "Proposed test for temporal Bell inequalities", J. P. Paz and G. Mahler, Phys. Rev. Lett. 71, 3235 (1993).
78. "Environment--induced decoherence, classicality and the consistency of quantum histories", J. P. Paz and W. H. Zurek, Phys. Rev. D 48, 2728 (1993).
79. "Coherent states via decoherence", W H Zurek, S. Habib and J. P. Paz, Phys Rev Lett 70, 1187 (1993).
80. "Reduction of the wave packet: Preferred observable and decoherence time scale", J. P. Paz, S. Habib and W. H. Zurek, Phys Rev D 47, 488 (1993).
81. "Quantum Brownian motion in a general environment: II nonlinear coupling and perturbative approach", B. L. Hu, J. P. Paz and Y. Zhang, Phys Rev D 47, 1576 (1993).
82. "Quantum Brownian motion in a general environment: exact master equation with non-local dissipation and colored noise", B. L. Hu, J. P. Paz and Y. Zhang, Phys Rev D 45, 2843 (1992).
83. "Decoherence and backreaction in quantum cosmology: multidimensional minisuperspace examples", J. P. Paz and S. Sinha, Phys Rev D 45, 2823 (1992).
84. "Decoherence and backreaction: the origin of the semiclassical Einstein equations", J. P. Paz and S. Sinha, Phys Rev D 44, 1038 (1991).

85. "Anisotropy dissipation in the early universe: finite temperature effects reexamined", J. P. Paz, Phys Rev D 41, 1054 (1990).
86. "Dissipation during the oscillations around a true vacuum", J. P. Paz, Phys Rev D 42, 529 (1990).
87. "Reheating of the Universe and evolution of the inflaton", F. Mazzitelli, J. P. Paz and C. El Hasi, Phys Rev D 40, 955 (1989).
88. "Gaussian and 1/N approximations in semiclassical cosmology", F. Mazzitelli and J. P. Paz, Phys Rev D 39, 2234 (1989).
89. "Quantum effects near multidimensional black holes", V. P. Frolov, F. Mazzitelli and J. P. Paz, Phys Rev D 40, 948 (1989).
90. "Renormalized evolution equations for the backreaction problem with a selfinteracting scalar field", J. P. Paz and F. D. Mazzitelli, Phys Rev D 37, 2170 (1988).
91. "A simple form for the Gaussian equations in curved space time", F. D. Mazzitelli and J. P. Paz, Phys Rev D 37, 3525 (1988).
92. "On the Dirac equation in anisotropic backgrounds", M. A. Castagnino, C. El Hasi, F. Mazzitelli and J. P. Paz, Phys Lett A 128, 125 (1988).
93. "Cauchy data and Hadamard singularities in time dependent backgrounds", F. D. Mazzitelli, J. P. Paz and M. A. Castagnino, Phys Rev D 36, 2994 (1987).
94. "Graviton and topology contributions to selfconsistent cosmology", M. A. Castagnino, J. P. Paz and N. Sanchez, Phys Lett B 193, 13 (1987) (CERN preprint, TH-4691/87).
95. "Fermions between moving boundaries", M. A. Castagnino, F. D. Mazzitelli and J. P. Paz, Phys Lett B 189, 132 (1987).
96. "Hadamard and minimal renormalizations", M. A. Castagnino, E. Gunzig, P. Nardone and J. P. Paz, Phys Rev D 34, 3698 (1986).
97. "De Sitter self-consistent cosmologies for Weinberg-type fields", M. A. Castagnino, D. Harari and J. P. Paz, Class Quantum Grav 3, 569 (1986).
98. "On the instability of the Minkowski space", M. A. Castagnino and J. P. Paz, Phys Lett B 164, 274 (1985).

## **BOOKS**

- "La física cuántica", Editorial Siglo XXI, Colección Ciencia Que Ladra (2017), ISBN 9789876297264

## **BOOK CHAPTERS**

- "Environment induced Decoherence and the transition from quantum to classical", J. P. Paz and W. H. Zurek, (2000). In "Coherent matter waves, Les Houches Session LXXII", edited by R. Kaiser, C. Westbrook and F. David, EDP Sciences, Springer Verlag (Berlin) (2001) 533-614.
- "Using qubits to learn about it", J. P. Paz (2002) in "Science and ultimate reality", a book edited to honor J. A. Wheeler. Cambridge University Press (2004).

Authors of the chapters of this book were selected by an international committee and awarded with a prize of ten thousand dollars by the Templeton Foundation and the Metanexus Institute.

- "Environment-induced decoherence and the transition from quantum to classical", J. P. Paz and W. H. Zurek, LECTURE NOTES IN PHYSICS; 2002; v.587, p.77-148

### **PAPERS FOR GENERAL PUBLIC**

- "Del átomo a la bomba (una breve historia para entender mejor la obra Copenhague)", J. P. Paz, Teatro (Revista del Complejo Teatral de Buenos Aires), Nro. 64, 40-44 (2002).
- "Einstein contra la mecánica cuántica: el azar y la ignorancia", J. P. Paz (2007); publicado en "El Universo de Einstein" editado por A. Gangui (EUDEBA).
- "Dos cazadores galardonados", J. P. Paz, Ciencia Hoy, 107, 25-27 (2012)
- "La física en la próxima década", J. P. Paz, Ciencia Hoy, 125, 39-43 (2013).

### **CONFERENCE PROCEEDINGS**

- "Quantum Golems", J.P. Paz, Published in "Interdisciplinary aspects of human-machine coexistence and cooperation", V. Malik et al editors, Czech Tech Univ Press ISBN 80-01-03275-2, (Prague, 2005).
- "La decoherencia y el principio de correspondencia para sistemas clásicamente caóticos", J. P. Paz, in Anales de la Academia Nacional de Ciencias Exactas, Físicas y Naturales, Buenos Aires, V47, (1995).
- "Why we don't need 'Quantum Planetary Dynamics'?", W. H. Zurek and J. P. Paz, in Proceedings of the Fourth Drexel Meeting on Quantum Nonintegrability, ed. by D. H. Feng et al., Plenum, (1995).
- "Decoherence, chaos, the quantum and the classical", W. H. Zurek and J. P. Paz, in Il Nuovo Cimento B110 (1995), 611; also in Proceedings of the FMP93 Symposium, Cologne, October 1993. ed. By P. Busch, World Sc. (Singapore, 1994).
- "Quantum coherence, classical limit and temporal Bell inequalities", J P Paz, in "Perspectives in neutrinos, atomic physics and gravitation", Proceedings del 28th Rencontre de Moriond, ed. By C.T Van Tran and O. Fackler, Editions Frontieres (1993).
- "Minisuperspace as a quantum open system", B.L. Hu, S. Sinha and J. P. Paz, in "Directions in General Relativity", ed. by B.L. Hu et al., Cambridge Univ Press (1993), 145-165.
- "Decoherence in Brownian motion", J. P. Paz in "Physical Origins of Time Asymmetry", ed. by J. J. Halliwell et al., Cambridge Univ. Press (1993).

- "Quantum origin of noise and fluctuations in cosmology", B. L. Hu, J. P. Paz and Y. Zhang, in *The Origin of Structure in the Universe*, ed. by E. Gunzig and P. Nardone, NATO ASI Series, Kluwer Acad. Pub. (1993), 227-252.
- "Decoherence and backreaction in quantum cosmology", J. P. Paz and S. Sinha, in *Proceedings of the VII Simposio Latino Americano de Relatividad y Gravitación*, (SILARG VII), ed. by M. Rosebaum et al., World Sc., Singapur, (1991).
- "Causality in finite temperature quantum field theory", J. P. Paz, in "Thermal Field Theories and Applications", ed. by Ezawa et al, (1991) North Holland, *Proceedings of the Second Workshop on Thermal Field Theories*, Tsukuba, Japan, (1990).
- "Non-equilibrium quantum fields in cosmology", J. P. Paz, in "Thermal Field Theories and Applications", ed. por Ezawa et al, (1991) North Holland, *Proceedings of the Second Workshop on Thermal Field Theories*, Tsukuba, Japan, (1990).
- "The back-reaction problem for self interacting scalar fields: one loop and gaussian approximations", J. P. Paz and F. D. Mazzitelli, in *Proceedings of the VI Simposio Latino Americano de Relatividad y Gravitación*, (SILARG VI), ed. by M. Novello, World Sc. Pub, Singapur, (1988).
- "Some quantum effects in cosmological models", M. A. Castagnino and J. P. Paz, in "Quantum Mechanics of Fundamental Systems", ed. by C. Teitelboim, Plenum New York, (1988), chap 11.
- "Semiclassical cosmological models", M. A. Castagnino, D. Harari and J. P. Paz, in *Procc of the Fourth Marcel Grossmann Meeting on General Relativity*, ed. by R. Ruffini, Elsevier Sc Pub, (1986), 1095.
- "De Sitter self consistent cosmology with adiabatic regularization", J. P. Paz, D. Harari and M. A. Castagnino en *Proceedings of the V Simposio Latino Americano de Relatividad y Gravitación* (SILARG V), ed. by O. Bressan et al., World Sc., Singapur, (1985).

### **INVITED TALKS, COLLOQUIA, etc**

Dr. Paz is regularly invited to give plenary talks at international conferences and colloquia at various Universities and Research Institutions. The list of such talks is not presented here. As an example, in 2017 and 2018 he gave invited talks at the following Universities: Univ of Innsbruck, Univ of Vienna, Technical Univ of Vienna, Univ of Oxford, ICTP (twice), College de France (twice), Ecole Normal Superieure Paris, Univ of Paris 7, Univ of Harvrard, Univ of Saarbrucke, Univ of Ulm, Univ of California at Santa Barbara,

## **SUMMARY OF DR. JUAN PABLO PAZ SCIENTIFIC TRAJECTORY**

### **SHORT CITATION:**

Dr Paz is a leader in quantum information. He made major contribution to the theory of quantum open systems and to the study of the process of decoherence. He contributed to the theory of quantum error correction and to design new quantum algorithms for physics simulations. He played a key role to establish a strong experimental basis for quantum technologies in Argentina. As a Director of the Physics Dep of UBA he played a key role to position it as a leading institution in the region. Since December 10, 2019 he is the vice Minister of Science of Argentina.

### **MAIN TEXT**

Juan Pablo Paz was borned in the city of Buenos Aires, Argentina, on April 5 1959. He received the degree of Licenciado in Physics (1984) and the PhD in Physics (1989) from the University of Buenos Aires (UBA). He is currently Plenary Full Professor in the Physics Department (DF) of the School of Natural and Exact Sciences (FCEyN) of UBA. He is also a Superior Investigator of the Argentinian National Research Council (CONICET) and is the Director of the Institute for Physics in Buenos Aires (UBA & CONICET).

He not only has an outstanding career as a teacher and a scientist in Argentina but also has a distinguished career abroad. In Argentina he occupied, since 1994, the positions of Assistant Professor (until 1997), Associate Professor (until 2009) and Full Professor (until 2018) at UBA, where he is now Plenary Full Professor, the highest possible position in such University. He has also occupied all the positions as a researcher of CONICET (from Assistant to Superior Investigator). Outside Argentina he worked in internationally recognized institutions. He was a Postdoctoral Associate in the Physics Department of the University of Maryland (1989-1991) and a Director Funded Postdoctoral Fellow at the Theoretical Division of Los Alamos National Laboratory (LANL) between 1991 and 1994. Later, between 2003 and 2006, he took a leave of absence from his positions in Argentina and returned to LANL where he was a Technical Staff Member at the Theoretical Division and played a major role as Coordinator of the Quantum Group.

Juan Pablo Paz played a very significant role in the Argentinian scientific system. He was the Director of the Physics Department of FCEyN UBA between 1997 and 2003 and later between 2009 and 2011. His activities as Director were recognized as outstanding by external review committees and contributed to transform the Physics Department into an internationally recognized institution. He was also the founder, and is currently the Director, of the Institute for Physics at Buenos Aires (IFIBA, UBA CONICET).

Dr Paz's scientific research focus on the study of quantum information and quantum foundations, with particular interest in quantum computation. His studies on the nature of

the process of decoherence contributed to the understanding of the role of this process in explaining the emergence of the classical world out of a fundamental substrate which is described by quantum mechanical laws. Noticeably, in order to perform a systematic study of decoherence, Juan Pablo made major contributions to the theory of quantum open systems (obtaining, for the first time, the exact master equation for the most general type of quantum Brownian motion, which is now known as the Hu-Paz-Zhang master equation). These studies also contributed to understand the limitations imposed by the process of decoherence, which is induced by the interaction with any type of external environment, on quantum information processing devices. In fact, he is one of the pioneers in the field of quantum information where he not only contributed to characterize decoherence but also to fight against it. Thus, in 1996, he participated in the development of the theory of quantum error correcting codes, which are essential for quantum computation. He is one of the co-discoverers of the, now famous, five qubit “perfect” quantum error correcting code. Also, he developed new methods to perform tasks which are essential for quantum information processing such as the so-called quantum process tomography (and other algorithms for physics simulations). He also contributed to the development of the emerging field of “quantum thermodynamics”. In this area he helped to understand the nature of the exchange of heat and work in the atomic scale studying not only the limitations but also the opportunities brought by quantum mechanics to the design of engines and refrigerators operating at the atomic scale, which is dominated by fluctuations (quantum or thermal). His recent papers on the nature of the measurement of quantum work, on the thermodynamics of linear quantum open systems and on the fundamental limits for cooling of driven quantum systems are internationally recognized.

Although the nature of the work of Dr Paz is mostly theoretical, it is remarkable that along his career he showed a special interest not only to interact with experimentalists but also to help in building new experimental facilities in Argentina. In fact, he is the Director of the most active group working in quantum information in Argentina, which combines both theoretical and experimental activities. Since 2008 Dr Paz played a key role in building two experimental groups which are now fully operational and are performing high quality research in areas related with quantum information science. Thus, in 2008, Juan Pablo led an effort to build the first Argentinian laboratory that was able to perform quantum information processing tasks with entangled photon pairs. The laboratory, now led by Dr Miguel Larotonda, is able to produce, characterize and manipulate entangled photons to be used in various experiments aimed at quantum key distribution and other related areas. Remarkably, the first two papers published as a result of the lab activities appeared in PRL (in 2009 and 2011) containing the first experimental implementations of a set of new quantum algorithms for process tomography developed by the theory part of Juan Pablo’s group (and were the core of Christian Schmiegelow’s PhD Thesis, supervised by Dr Paz). More recently, starting in 2015 Juan Pablo Paz led a new adventure: the project known as LIAF, the acronym for the Spanish words for Laboratory for Cold Atoms and Ions. This laboratory became fully operational in February of 2019 and is an important milestone for Argentinian

science. Thus, it is the first and only laboratory which is able to trap, cool and manipulate ion crystals (with single or multiple ions) in Latin America. The laboratory is now finishing the first set of experiments aimed at various areas related with quantum technologies (quantum metrology, quantum simulators, etc) and is currently directed by Christian Schmiegelow, one of Dr Paz's former PhD students and a recognized leader in cold ion physics.

Juan Pablo Paz published nearly 100 papers in international journals (more than 20 of which appeared in the most prestigious journals such as Physical Review Letters, Nature and Science. He also published more than 20 papers as chapters of books, various essays for the general public and a popular book (published in spanish) about quantum theory and quantum information. He was the director of 20 MsC and 8 PhD Thesis (his students received various prizes in recognition of the quality of their PhD Thesis and occupy important positions at various argentinian universities).

His research papers are regularly cited in the scientific literature and some of them became classical papers. According to Google Scholar, his papers received more than 9650 citations and his H-factor is 46. He is regularly invited to deliver plenary lectures in international conference and colloquia in prestigious institutions. As an example, during the last three years he was invited to visit and give talks at UCSB (USA), College de France (France), ENS (Paris, France), ICTP (Trieste), Univ Harvard (USA), LANL (USA), Univ of Oxford (UK), Univ Innsbruck (Austria), Univ Ulm (Germany), Univ Saarbruecke (Germany), Univ Paris VII (France), UNM (USA), etc.

Dr Paz is a member of the Academy of Sciences of Latin America (ACAL) and received many prizes in an outside of Argentina. Among them, it is worth mentioning the Argentinian Academy of Sciences award for young scientists (1995), the Guggenheim Fellowship (2005), the Bessel Prize (granted by the A Humboldt Foundation in 2008), the Bunge and Börn Foundation Prize in 2010 (the most prestigious prize awarded by any argentinian foundation), the TWAS Prize in Physics (2012), the Konex Prize (2013), the Bernardo Houssay Prize (2014) and the "Distinción Investigador de la Nación Argentina" granted by the President of Argentina in 2015 to recognize the most distinguished scientist of that year. He was declared "distinguished citizen" of the city of Buenos Aires in 2018.

### **FIVE IMPORTANT PUBLICATIONS**

"Quantum Brownian motion in a general environment: exact master equation with non-local dissipation and colored noise", B L Hu, J P Paz and Y Zhang, Phys Rev D 45, 2843 (1992). Citations: 1100.

"Coherent states via decoherence", W.H. Zurek, S. Habib and J.P. Paz, Phys. Rev. Lett 70, 1187 (1993). Citations: 800.

"Decoherence, chaos and the second law", W.H. Zurek and J.P. Paz, Phys. Rev. Lett 72, 2508 (1994). Citations: 560.

"Perfect quantum error correction code", R. Laflamme, C. Miquel, J. P. Paz and W. H. Zurek, Phys. Rev. Lett. 77, 198 (1996). Citations: 1025.

"Tomography and Spectroscopy as Dual Forms of Quantum Computation", C. Miquel, J.P. Paz, M. Saraceno, E. Knill, R. Laflamme and C. Negrevergne, Nature 418, 6893, 59 (2002). Citations: 125.

"Dynamics of the entanglement between two oscillators in the same environment", J.P. Paz and A. Roncaglia, Phys. Rev. Lett 100, 220401 (2008). Citations: 320.

"Selective and efficient quantum process tomography", A. Bendersky, F. Pastawski and J.P. Paz, Phys. Rev. Lett 100, 190403 (2008). Citations: 110.

"Selective and efficient quantum process tomography without ancilla", C.T. Schmiegelow, A. Bendersky, M. Larotonda and J.P. Paz, Phys. Rev. Lett 107, 100502 (2011). Citations: 40.

"Dynamics and thermodynamics of linear quantum open systems", E. Martinez and J.P. Paz, Phys. Rev. Lett. 110, 130406 (2013). Citations: 80.

"Fundamental limits for cooling of linear quantum refrigerators", Nahuel Freitas and J.P. Paz, Physical Review E 95 012146 (2017)). Citations: 35.

"Using a Quantum Work Meter to test Non Equilibrium Fluctuation Theorems", F. Cerisola, Y. Margalit, S. Machluf, A. Roncaglia, J.P. Paz & R. Folman, Nature Communications 8 1241 (2017). Citations: 55.

"Work measurement as a generalized quantum measurement", A. Roncaglia, F. Cerisola and J.P. Paz, Phys. Rev. Lett. 113, 250601 (2014), Citations: 145.