

**Prof. Ron Folman – CV**  
**([www.bgu.ac.il/atomchip](http://www.bgu.ac.il/atomchip))**

Born: 1963 – Tel Aviv.

**Academic history**

1983-1988 Undergraduate, self taught (open university) – graduated with excellence (labs and high level courses such as QM were taken at the Hebrew University).

1989-1992 Quark Gluon Plasma (High Energy Physics M.Sc. at Weizmann).

1993-98 Higgs searches at CERN – Ph.D. (home institute: Weizmann).

1999 Post-Doc (Marie Curie fellow) Innsbruck, Austria.

2001 Researcher at the University of Heidelberg, Germany.

2003- Ben-Gurion University of the Negev, Israel

**Current research activities at Ben-Gurion University**

Cold atoms (2 BEC chambers, 1 MOT chamber), AtomChips and BEC: atom-surface interaction for more accurate and complex atom optics and new insight into quantum optics and material science (including novel surfaces with mesoscopic electron systems, molecules, nanomagnets, crystalline materials, super conductors). We study thermal, technical and colored noise, decoherence, vdW and Casimir-Polder forces, electron scattering causing potential corrugations, tunneling and interferometry, photonics, probing surface phenomena with cold atoms, etc.

In addition, we work with hot vapor of atoms for metrology (magnetic sensors and clocks). We manufacture cells with special coating for increased coherence time. We also work with NV centers in diamonds. In both of these projects we combine fundamental studies and industrial applications.

Other lab activities: development of ultra low noise electronics for quantum technology, development of miniaturized cryogenics for superconducting atoms chips, development of Raman lasers for qubit rotations, miniature vapor cells and frequency locks, etc.

My main activity outside the laboratory concerns the nanofabrication facility I designed and built. (it took 5 years of dedicated work!). Here I try and realize my vision of how material engineering and AMO physics can be joined to create better tools for fundamental science as well as technological applications. Specifically I am working on the concept of engineering the classical environment of the quantum system. The facility serves numerous laboratories around the world.

**Conference talks since 2007**

1. Coherent Control of the Fundamental Processes in Optics and X-ray Optics, Nizhny Novgorod, Russia (July 3-9, 2007) Plenary Presentation – invited.
2. Lectures at the school of quantum computing, Ireland (August 2007) - invited

3. Erice conference on noise, information and complexity @ quantum scale (Nov. 2007)
4. Ultra Fast – Ultra Cold processes, Ein-Gedi (Feb. 2008) - invited
5. New frontiers in micro and nano photonics, Florence (Apr. 2008) – invited
6. NanoMed Photonics, Istanbul Oct. 2008  
(<http://www.eng.biu.ac.il/~zalevsz/conference.html>) – invited
7. Zfat Nov. 2008 (<http://star.tau.ac.il/~indo-israel/index.html>) – invited
8. Boston MRS Dec 2008 ([http://www.mrs.org/s\\_mrs/doc.asp?CID=16167&DID=215608](http://www.mrs.org/s_mrs/doc.asp?CID=16167&DID=215608))  
(for lack of time my student replaced me)
9. PQE (Snowbird, 2009 Jan. 4-8) (<http://www.pqeconference.com/>) – invited
10. FRISNO (Ein Gedi, 2009 Feb. 13-16)
11. Second annual Workshop on Integrated Atomic Systems (Seattle, 2009 Feb.18-19)  
(<http://panda.unm.edu/SQuInT/>) – invited
12. PQE - 2010 (SnowBird, 2010 Jan. 3-7)  
(<http://www.pqeconference.com/pqe2010>) – invited as session chair and plenary lecturer
13. PQE - 2011 (SnowBird, 2011 Jan. 2-6)  
(<http://www.pqeconference.com/pqe2011>) – invited as session chair and plenary lecturer
14. OASIS (Tel-Aviv, 2011 March 9)  
(<http://www.oasis.org.il/>) – invited (photonics)
15. OASIS (Tel-Aviv, 2011 March 10)  
(<http://www.oasis.org.il/>) – invited (quantum optics)
16. Nano Technology Conference  
(Bar-Ilan University, 2011 April 14) – invited (quantum optics)

\* Numerous invited talks declined for lack of time. Most recent invitation: SPIE Quantum Communications and Quantum Imaging X Conference (OP410), San Diego, California, 12-16 August 2012

### **Examples of oral presentations since 2006 (presentations given by my students are not listed)**

- 2006 – chair of panel discussions on fundamental measurements using trapped atoms, Tel-Aviv University (May 2006)
- 2007 – 'Matter wave interferometry', University of Innsbruck (March, 2007)
- 2007 – 'Nano photonics' – Turkish-Israeli workshop in Bar Ilan University (March 2007)
- 2007 – 5 lecture mini course on quantum mechanics and cold atoms (May 2007, Nicosia).
- 2008 – Innsbruck (March), Florence (April), talks in Israel (e.g. Technion, TAU)
- 2008 – 'Material engineering for atom and ion chips', Berkeley, Stanford, NIST (October).
- 2009 – talks in Israel (HIT - Jan., HUJI - Feb.)
- 2009 – 'Material engineering for quantum optics', Innsbruck (March).
- 2009 – Nottingham Centre for Cold Atoms (July)
- 2010 – 'Is there a future for atom chips?', Innsbruck (March)
- 2011 – 'Effect of colored noise', Innsbruck (March)
- 2011 – 'Where material science meets quantum optics', Southampton Colloquium (October).

## **Publications**

### **More than 50 papers in journals and books** **(not including high energy mega collaboration papers)**

(link to recent papers in: [www.bgu.ac.il/atomchip](http://www.bgu.ac.il/atomchip))

### **Examples of papers by theme:**

#### **Elementary particle Physics**

- R. Folman and A. Shor, ‘Strangeness production in relativistic nuclear collisions’, *Nuc. Phys. A* 568, 917 (1994).
- The Opal CERN collaboration, ‘Search for the Standard Model Higgs boson in e-e+ collisions at 161GeV’, *Phys. Lett. B*393, 231 (1997)

#### **Atom physics**

- R. Folman, P. Krueger, D. Cassettari, B. Hessmo, T. Maier, J. Schmiedmayer, ‘Controlling cold atoms using nanofabricated surfaces: Atom Chips’, *Phys. Rev. Lett.* 84, 4749 (2000).
- R. Folman, P. Krueger, J. Schmiedmayer, J. Denschlag and C. Henkel, ‘Microscopic atom optics’ (Review paper), *Advances in Atomic, Molecular and Optical Physics*, Vol. 48, 263 (2002).
- P. Krueger, X. Luo, M. W. Klein, K. Brugger, A. Haase, S. Wildermuth, S. Groth, I. Bar-Joseph, R. Folman, J. Schmiedmayer, ‘Trapping and manipulating neutral atoms with electrostatic fields’, *Phys. Rev. Lett.* 91, 233201 (2003).
- R. Salem, Y. Japha, J. Chabé, B. Hadad, M. Keil, K. A. Milton, R. Folman, ‘Nanowire atom chip traps for sub-micron atom-surface distances’, *New J. Phys.* 12, 023039 (2010).
- J. Welzel, A. Bautista-Salvador, C. Abarbanel, V. Wineman-Fisher, C. Wunderlich, R. Folman and F. Schmidt-Kaler, ‘Designing spin-spin interactions with one and two dimensional ion crystals in planar micro traps’, *Eur. Phys. J. D* (2011).

#### **The physics of quantum coherence, dephasing and noise**

- R. Folman, J. Schmiedmayer, H. Ritsch and D. Vitali, ‘On the observation of decoherence with a movable mirror’, *Eur. Phys. J. D* 13, 93 (2001).
- E. Andersson, T. Calarco, R. Folman, M. Andersson, B. Hessmo and J. Schmiedmayer, ‘A Multi-Mode Interferometer for Matter-Waves’, *Phys. Rev. Lett.* 88, 100401 (2002).
- C. Henkel, P. Krueger, R. Folman and J. Schmiedmayer, ‘Fundamental limits for coherent manipulation on atom chips’, *Applied Physics B*76, 173 (2003).
- C. Henkel, M. Nest, P. Domokos, R. Folman, ‘Optical discrimination between spatial decoherence and thermalization of a massive object’, *Phys. Rev. A*70, 023810 (2004).

- D. Rohrlich, Y. Neiman, Y. Japha, R. Folman, ‘Interference Swapping in Scattering from a Nonlocal Quantum Target’, *Phys. Rev. Lett.* 96, 173601 (2006).
- Y. Japha, O. Arzouan, Y. Avishai, R. Folman, ‘Using time reversal symmetry for sensitive incoherent matter-wave Sagnac interferometry’, *Phys. Rev. Lett.* 99, 060402 (2007).
- M. Nest, Y. Japha, R. Folman, R. Kosloff, “Dynamic Matter-Wave Pulse Shaping”, *Phys. Rev. A* 81, 043632 (2010).
- S. Machluf, J. Coslovsky, P. G. Petrov, Y. Japha and R. Folman, “Coupling between internal spin dynamics and external degrees of freedom in the presence of colored noise” *Phys. Rev. Lett.* 105, 203002 (2010).

### **Light-matter interaction**

- P. Horak, B.G. Klappauf, A. Haase, R. Folman, J. Schmiedmayer P. Domokos and E.A. Hinds, ‘Towards integrated optical non-destructive single atom detectors’, *Phys. Rev. A* 67, 043806 (2003).
- M. Rosenblit, P. Horak, S. Helsby, R. Folman, ‘Single-atom detection using whispering gallery modes of microdisk resonators’, *Phys. Rev. A* 70, 053808 (2004).
- M. Rosenblit, Y. Japha, P. Horak, and R. Folman, ‘Simultaneous optical trapping and detection of atoms by microdisk resonator’, *Phys. Rev. A* 73, 063805 (2006).
- M. Rosenblit, P. Horak, Y. Japha, R. Folman., ‘Design of microcavity resonators for single-atom detection’, *Journal of Nano Photonics* 1, 011670 (2007).

### **Material science**

- S. Groth, P. Krueger, S. Wildermuth, R. Folman, T. Fernholz, D. Mahalu, I. Bar-Joseph, J. Schmiedmayer, ‘Atom chips: fabrication and thermal properties’, *Appl. Phys. Lett.* 85, 2980 (2004).
- V. Dikovsky, Y. Japha, C. Henkel, R. Folman, ‘Reduction of Magnetic Noise in Atom Chips by Material Optimization’, *Eur. Phys. J. D* Vol. 35 No. 1, 87 (2005).
- S. Aigner, L. Della Pietra, Y. Japha, O. Entin-Wohlman, T. David, R. Salem, R. Folman, J. Schmiedmayer, ‘Long-Range Order in Electronic Transport through Disordered Metal Films’, *Science* 319, 1226 (2008).
- Y. Japha, O. Entin-Wohlman, T. David, R. Salem, S. Aigner, J. Schmiedmayer, R. Folman, ‘Model for Organized Current Patterns in Disordered Conductors’, *Phys. Rev. B* 77, 201407(R) (2008).
- T. David, Y. Japha, V. Dikovsky, R. Salem, C. Henkel, R. Folman, ‘Magnetic interactions of cold atoms with anisotropic conductors’, *Eur. Phys. J. D* 48, 321–332 (2008) – Selected by editors as a highlight paper.
- V. Dikovsky, V. Sokolovsky, Bo Zhang, C. Henkel, and R. Folman, ‘Superconducting atom chips: advantages and challenges’, *Eur. Phys. J. D* 51, 247–259 (2009).
- P. G. Petrov, S. Machluf, S. Younis, R. Macaluso, T. David, B. Hadad, Y. Japha, M. Keil, E. Joselevich, and R. Folman, ‘Trapping cold atoms using surface-grown carbon nanotubes’, *Phys. Rev. A* 79, 043403 (2009). Selected to appear in the *Virtual Journal of Nanoscale Science & Technology* (published by the American Physical Society, <http://www.vjnano.org>) volume 19 issue 15 (13 April, 2009).

- R. Folman, 'Material Science for Quantum Computing on Atom Chips', Quantum Information Processing 10 (6), 995 (2011). [arXiv:1108.3803](https://arxiv.org/abs/1108.3803)

### **Device technology**

- S. Schneider, A. Kasper, Ch. vom Hagen, M. Bartenstein, B. Engeser, T. Schumm, I. Bar-Joseph, R. Folman, L. Feenstra, and J. Schmiedmayer, 'Bose-Einstein Condensation in a simple Microtrap', Phys. Rev. A 67, 023612 (2003).
- A. Waxman, M. Givon, G. Aviv, D. Groswasser, R. Folman, 'Modulation enhancement of a laser diode in an external cavity' Applied Physics B 95, 301-305 (2009).
- D. Groswasser, M. Givon, G. Aviv, Y. Japha, M. Keil and R. Folman, 'Retroreflecting polarization spectroscopy enabling miniaturization', Rev. Sci. Instrum. 80, 093103 (2009).

### **Papers outside the accepted paradigm**

- R. Folman, 'A search for hidden variables in the domain of high energy physics', Found. Phys. Lett. 7-2, 199 (1994). Served as the basis for the next paper and cited by Jeffrey Bub (Maryland) in "Interpreting the Quantum World" as "resurrecting" the Bohm-Bub theory.
- The Opal CERN collaboration, 'Test of the exponential decay law at short decay times using tau leptons', Phys. Lett. B368, 244 (1996) - based on R. Folman and D. Lellouch, Opal tech. note 199.
- R. Folman and Z. Vager, 'Empty wave detecting experiments: A comment on auxiliary "hidden" assumptions', Found. Phys. Lett. 8-1, 55 (1995).
- R. Folman and E. Recami, 'On the phenomenology of Tachyon radiation', Found. Phys. Lett. 8-2, 127 (1995).
- R. Folman and Z. Vager, 'Quantum mechanics versus realism', Found. Phys. Lett. 8-4, 345 (1995)
- R. Folman, 'On the possibility of a relativistic correction to the E and B fields around a current-carrying wire', <http://arxiv.org/abs/1109.2586> (2011).
- R. Folman, 'Two-photon spatial coherence in a two-photon temporal coherence experiment', <http://arxiv.org/abs/1201.3111> (2012).

### **Popular papers, e.g.**

- R. Folman and J. Schmiedmayer, 'Mastering the Language of Atoms', News and Views article, Nature 413, 466 (2001).
- R. Folman, 'The AtomChip: Bringing Nanofabrication and Quantum Optics together', <http://www.azonano.com/article.aspx?ArticleID=2904> (2011)
- R. Folman, 'Qubit from the editor', Quantum Information Processing 10 (6), 719 (2011).
- R. Folman and E. Recami, 'Comment on faster than light neutrinos', Physics World (Dec. 2011).

### **Books and chapters**

- *Quantum Information Processing (2003)*, P. Krüger, A. Haase, R. Folman, J. Schmiedmayer, ‘Quantum Information Processing with Neutral Atoms on Atom Chips’, Eds. T. Beth and G. Leuchs, Wiley-VCH,
- *Atom Chips (2011)*, Ron Folman, Philipp Treutlein and Joerg Schmiedmayer, ‘Atom Chip Fabrication’, Eds. Jakob Reichel and Vladan Vuletic, Wiley-VCH.
- *Quantum Information Processing with Neutral Particles (2011)*, a special issue of the journal of Quantum Information Processing (Springer), Eds. Ron Folman and Howard Brandt, Springer. <http://www.springerlink.com/content/1570-0755/10/6/>

### **Proceedings e.g.**

- (from the early days of atom chips) J. Schmiedmayer and R. Folman, “Miniaturizing Atom Optics: From Wires to Atom Chips”, Proceedings of the Cargese 6th Workshop on Atom Optics and Interferometry, Comptes Rendus de l'Academie des Sciences, Volume 2 Issue 4, 551 (Elsevier 2002).
- (from the theoretical work at BGU) M. Rosenblit, P. Horak, R. Folman, “Size effect in waveguide-coupled whispering gallery mode disk resonators”, Proceedings of SPIE, Optical Trapping and Optical Micromanipulation, Volume 5514, 530 (2004); Editor(s): Kishan Dholakia, Gabriel C. Spalding; Michael Rosenblit, Yonathan Japha, Peter Horak, and Ron Folman, “Design of a trapping potential for detecting single atoms by microdisk resonator on a chip”, Proceedings of SPIE, Volume 6195, 62 (2006); Editor(s): D. L. Andrews, J-M. Nunzi, A. Ostendorf.
- (from the experimental work at BGU) I. Gurman, Y. Soreq, R. Shavit, M. Givon, G. Aviv, D. Groswasser and R. Folman, “Dual Frequency Cavity Resonator for Atomic Manipulation and Spectroscopy”, COMCAS-2009.

### **Awards**

- 2003 Award by the Israeli center for Science of Complex Systems
- 2008 Material Research Society graduate award to my student (Tal David) for the discovery that electrically anisotropic materials may suppress room temperature decoherence by orders of magnitude.
- 2009 MSc excellence award to my student Shimon Machluf.
- 2011 Lamb Medal for quantum optics (<http://www.lambmedal.org/>) for applying the field of material science to quantum optics.

### **Service to the community**

Supplying advanced chips for quantum optics to laboratories around the world.