Prof. Ron Folman – CV
(www.bgu.ac.il/atomchip)

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).
1993-1998 Higgs and super-symmetry searches at CERN – Ph.D. (home institute: Weizmann).
1999-2000 Post-Doc, Innsbruck, Austria.
2000-2003 Researcher at the University of Heidelberg (Marie Curie fellow), Germany.
2003- Ben-Gurion University of the Negev, Israel

Current research activities at Ben-Gurion University

Atom Chips with ultra-cold atoms (2 BEC chambers, 1 MOT chamber): working at the interface between nano science and material science with atoms. Developing more accurate and complex atom optics e.g. for interferometry. Using atoms to gain new insight into quantum optics as well as to probe surface 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, 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 do NMOR for magnetic sensing. We also work with NV centers in diamonds. As with the cold atom projects, we combine fundamental studies and industrial applications. Here is a recent popular account of our work with NVs and superconductors:
http://newscenter.berkeley.edu/2014/03/06/colored-diamonds-are-a-superconductors-best-friend/

A growing body of activity in our lab has to do with searches. These include gravitational waves, a short range fifth force (with Berkeley), axions (new grant submitted with Berkeley), and dark matter (a new grant with an international consortium being submitted). We are also continuing the search for spontaneous collapse mechanisms. In the past, I was involved in the search for the Higgs Boson, super-symmetric particles and even Tachyons and hidden variables.

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. Our unique expertise serves laboratories around the world. For example, an atom chip we designed and fabricated for Heidelberg helped discover a previously

unknown effect in electron transport (featured in Science). Atom chips were also sent to Italy and the UK. An ion chip were sent to Germany. Chips for electron traps were and are fabricated for Germany and the UK. Recently a unique permanent magnet lattice chip was sent to Amsterdam. I am now thinking of trapping anti-matter (either charged or neutral) on atom chips.

Some recent news may be found in: http://www.bgu.ac.il/atomchip/News/Whats_New.htm

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) (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)
17. IARD 2012 (June 2012, Florence)
18. SPIE Quantum Communications and Quantum Imaging X Conference (OP410), San Diego, California, 12-16 August 2012 – invited
19. Laser Physics 2012, Ashtarak, Armenia (9-16/10) – invited.
20. PQE-2013, Plenary – invited.
21. FRISNO-2013, Ein Gedi, Israel (28/2).
22. SPIE-2013, San-Diego, US (Aug, 2013) – invited.
23. Israel-China binational workshop on "Bose Einstein Condensation and Ultra cold Phenomena" Beijing, Oct. 2013 – invited.
24. PQE-2014 – invited.
25. QuantArm2014 – invited.

* Quite a few invited talks declined for lack of time. Most recent invitations: 2014 NSF Workshop on Noninvasive Imaging of Brain Function; SPIE-2014; Materials Research (CCMR) June 2014, South Korea; Nano-materials at the upcoming 2nd Annual World Congress of Advanced Materials-2013 (WCAM-2013); NanoS&T-2014. Industry talks not listed: Last one (declined for lack of time) was Opto-Tech, Tel-Aviv, May 2013. Talks by my students are not listed: e.g. "Cold Atoms-Solid state interfaces" at Nottingham (2013) and in CLEO-2013.

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).
2012 – 'Two-photon spatial coherence in a temporal coherence experiment', Innsbruck (March)
2012 – 'Large momentum splitting of Matter-Waves', Stanford/Berkeley (August)
2012 – 'Spectroscopy and magnetic sensing with NV centers, Krakow, Poland (October)
2012 – 'Large momentum splitting of Matter-Waves', Hebrew University Colloquium (October)
2012 – 'What the 2012 Nobel in physics is about', Open University Colloquium (December)
2013 – 'Coherent SG interferometry', Hannover (April)
2013 – 'Coherent SG interferometry', Bar-Ilan University, Tel Aviv (June)
2013 – 'Coherent SG interferometry', 3 universities in Beijing and Shanghai (September).
2013 – 'Being provocative after 100 years of quantum mechanics' – Miller Institute for Fundamental Science, Berkeley (December 3).
2014 – 'Magic Frequency in light-matter interaction', Berkeley (March)
2014 – 'Coherent SG interferometry', Open University (September).
2014 – Magnetic sensing, NATO for Peace workshop (September)

Publications

Examples of papers by theme:

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

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. B393, 231 (1997)
- The Opal CERN collaboration, 'A Search for Neutral Higgs Bosons in the MSSM and Models with Two Scalar Field Doublets', Euro. Phys. Journal C5, 19 (1998)

**(not including numerous high energy mega collaboration papers)

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 65, 285 (2011).
- Anat Daniel, Ruti Agou, Omer Amit, David Groswasser, Yonathan Japha and Ron Folman, Damping of local Rabi oscillations in the presence of thermal motion, arXiv:1208.1396 (2012); Phys. Rev. A 87, 063402 (2013).
- Menachem Givon, Yair Margalit, Amir Waxman, Tal David, David, Groswasser, Yonathan Japha and Ron Folman, Magic frequencies in atom-light interaction for precision probing of the density matrix, arXiv:1306.1151 (2013), Phys. Rev. Lett. 111, 053004 (2013).
  Chosen by PRL editors to be on their exceptional research watch list:
  http://physics.aps.org/synopsis-for/10.1103/PhysRevLett.111.053004?referer=rss
- Shuyu Zhou, Julien Chabe, Ran Salem, Tal David, David Groswasser, Mark Keil, Yonathan Japha, and Ron Folman, Phase space evolution of cold atoms in the presence of a weakly disordered potential, arXiv: 1403.3432 (2014).

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 B76, 173 (2003).
- C. Henkel, M. Nest, P. Domokos, R. Folman, 'Optical discrimination between spatial decoherence and thermalization of a massive object', Phys. Rev. A70, 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).
- Shimon Machluf, Yonathan Japha and Ron Folman, Coherent splitting of matter-waves by an atom chip field gradient beam-splitter, arXiv:1208.2526. Nature Communications 4, 2424 (2013).

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. A70, 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).
- P. Kehayias, M. Mrózek, V.M. Acosta, A. Jarmola, D.S. Rudnicki, R. Folman, W. Gawlik, D. Budker, Microwave saturation spectroscopy of nitrogen-vacancy ensembles in diamond**,** arXiv:1403.2119; Phys. Rev. B 89, 245202 (2014)

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. B77, 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
- A. Waxman, H. Schlussel, D. Groswasser, V.M. Acosta, L.-S. Bouchard, D. Budker, R. Folman, 'Diamond Magnetometry of Superconducting Thin Films', http://arxiv.org/abs/1308.2689 , Phys. Rev. B 89, 054509 (2014).

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).
- V.Y.F. Leung, D.R.M. Pijn, H. Schlatter, L. Torralbo-Campo, A. La Rooij, G.B. Mulder, J. Naber, M.L. Soudijn, A. Tauschinsky, C. Abarbanel, B. Hadad, E. Golan, R. Folman, R.J.C. Spreeuw, Magnetic-film atom chip setup with 10 μm period lattices of magnetic microtraps, arXiv 1311.4512 (2013); Rev. Sci. Instrum. 85, 053102 (2014).

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', J. Phys.: Conf. Ser. 437 012013 (2013), http://iopscience.iop.org/1742-6596/437/1/012013; http://arxiv.org/abs/1109.2586
- R. Folman, 'Two-particle quantum transmission', http://arxiv.org/abs/1201.3111 (2012). (Invited paper) SPIE, Volume 8518, 8518 0H (2012)
- R. Folman, 'Anomalous second order coherence and g^2 complementarity', http://arxiv.org/abs/1305.3083 (2013) (Invited paper SPIE 2013)

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/

* declined to write quite a few chapters or books for lack of time. The last request was received in 2013 from Imperial College Press and World Scientific to write a volume with lecture notes on the Atom Chip.

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.
- 2011 Lamb Medal for quantum optics (http://www.lambmedal.org/) for applying the field of material science to quantum optics.
- 2013 Miller institute for fundamental science - visiting professor award (Berkeley)
- Awards received by my students include: 2008 Material Research Society graduate award (US), given to my student Tal David for the discovery that electrically anisotropic materials may suppress room temperature decoherence by orders of magnitude; 2009, 2012 excellence awards to my students Shimon Machluf and Amir Waxman; 2014, nomination by the thesis referees for a PhD excellence award to Shimon Machluf (still in process). 2014 excellence award for his MSc work on the magic frequency to Yair Margalit.

Service to the community

Founder of the BGU nano-fabrication facility
Supplying advanced chips for quantum optics to laboratories around the world.
Referee for EU programs
Referee for numerous journals
Consultant to foundations (e.g. the German-Israeli Foundation – GIF)
Conference organization committees
Several projects with the industry, e.g., all optical magnetic sensor with Israeli AeroSpace Industries, miniature cold atomic clock with Accubeat, and matter-wave inertial navigation systems with the Israeli government.

Active grants

Several Industry grants
European FP7 consortium on matter-wave interferometry
NATO consortium on NV magnetometry
Israel Science foundation on cold atom interferometry
European Marie-Curie grant for neuron imaging with NV magnetic sensors

Previous grants (last 10 years)

Several Industry grants
European FP7 network on atom chips
Israel Science foundation on cold atoms
European Marie-Curie grant for nano fabrication of atom chips
French government grant for post doctoral fellow
German government grants for atom and ion chips
Israeli-US grant for ion chips