

Sergei Bashinsky

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Outstanding analytical and research skills. Consistent record of ground-breaking achievements in a variety of fields. Discoveries at the forefront of physics that influenced understanding and the direction of studies of the universe on the largest and sub-proton scales. Experience with patent application. Experience with leading and managing a team.

EDUCATION

Massachusetts Institute of Technology (MIT)

Cambridge, MA

Ph.D. in Physics, 2001

Cosmology and Physics of the Early Universe, Center for Astrophysics and Space Research
Theoretical Particle Physics, Center for Theoretical Physics

1999–2001
1995–1999

Moscow Institute of Physics and Technology (MIPT)

Dolgoprudnyi, Moscow region, Russia

B.S. *summa cum laude* in Physics, 1995

Department of General and Applied Physics
Specialized in Particle Theory at the Institute for Theoretical and Experimental Physics

1991–1995
1994–1995

EXPERIENCE, SCIENCE

Princeton University

Princeton, NJ

R. H. Dicke Postdoctoral Fellowship
(Honorific postdoctoral fellowship at the Princeton Physics Department awarded to one person in theory and one in experiment among contenders from all physics fields.)

2001–2004

- Created a formalism for inhomogeneous cosmological evolution that, unlike traditional approaches, manifestly reveals which large-scale observables are affected by which local properties of cosmic matter. Its equations are simpler than the traditional ones and yield solutions for realistic systems, which previously could not be described analytically.
- Continued to develop a novel for cosmology formalism of plane-parallel Green's functions, initiated in my Ph.D. thesis research with E. Bertschinger at MIT.
- Applying both formalisms, discovered a clean and the only non-degenerate signature of streaming relic neutrinos, **the second most abundant particle in the universe**. The signature is an additive shift of the CMB peaks. In 2015 it was observed by ESA's Planck satellite [Follin et al., Phys.Rev.Lett. 115 (2015) 9, 091301] in agreement with the theoretically calculated prediction. In 2018 it was also detected [Baumann et al] in the baryon acoustic oscillations, imprinting the perturbations in the photon-baryon plasma at CMB decoupling on the power spectrum of galaxies.
- First correctly identified microphysics behind the intermediate-scale angular spectrum of the Cosmic Microwave Background (no resonant "radiation driving" at small scales; about six times stronger than believed suppression of the spectrum by dark matter at large scales).
- First calculated analytically the coupled evolution of the relic neutrinos and primordial gravitational waves.
- Proved new conservation laws for dynamics on ultra-large scales.
- In collaboration with C. Hirata and U. Seljak, worked on a book on cosmological evolution, gravitation, and the CMB.
- Participated in regular intra-group and Princeton-area discussions, journal clubs, and seminars.

Los Alamos National Laboratory (LANL)

Los Alamos, NM

Research Associate, Elementary Particles and Field Theory Group

2005–2008

- Co-investigator in a LANL Grand Challenge project "Dark Energy and the Cosmic Web." Explored the prospects and optimal strategy for observations to probe the properties of dark energy.
- Participated in a 5-person project on the formation of dark matter halos. Advocated and performed the analysis of simulation box effects, reversing the project main result in favor of now frequently cited approximate "universality."
- Initiated a 3-person project that explored cosmological constraints on models of neutrino mass and interactions. Numerically calculated the expected constraints for a satellite Planck and for a ground experiment ACT.
- First suggested in a paper definitive methods to distinguish dark energy from its possible alternative—modified gravity. The results are nontrivial and are now accepted.

- Discovered the first stable mechanism for dark energy density growth, which is somewhat preferred by observations and can “restart” the Big Bang. This study stopped at LANL due to administrative actions. The mechanism was later described by independent researchers [Creminelli et al., JHEP 0612 (2006) 080], attracting attention (200+ citations).
- One of the three co-applicants for a LANL grant “Precision Cosmology and the Neutrino Sector,” following my postdoctoral proposal. The application was selected among 5% of LANL proposals to be funded. Granted \$1 M.
- Led weekly Los Alamos Cosmology Discussion Group meetings, 2007–2008. Invited LANL and external speakers and chaired the discussions.

SELECTED VISITS

International Centre for Theoretical Physics (ICTP)	Trieste, Italy
High Energy, Cosmology and Astroparticle Physics Section, 1-year visitor and research fellow	2004–2005
Canadian Institute for Theoretical Astrophysics (CITA)	Toronto, Canada
1-month research visitor	2000
Brookhaven National Laboratory (BNL)	Upton, NY
RIKEN-BNL Research Center, 1-month research visitor	1998
Les Houches Centre for Physics	Les Houches, France
LXVIII Summer School “Probing the Standard Model of Electroweak Interactions,” 6 weeks	1997

Participation and talks at **international conferences** in Canada, France, Germany, Italy, Switzerland, USA.

Invited talks in the world’s leading scientific institutions, including **BNL, Caltech, CITA, Fermilab, ICTP, LANL, MIT, Princeton University, Princeton Institute for Advanced Studies.**

TEACHING EXPERIENCE

- **International Centre for Theoretical Physics (ICTP)**
ICTP Diploma Programme: Two lectures on *General Relativity* 2005
- **Princeton University**
Assistance in a graduate course *Introduction to Theoretical Cosmology*: 2003
Several lectures and texts on Cosmological Dynamics, Cosmic Microwave Background, Cosmological Inflation, and Gravitodynamics in General Relativity.
- **MIT**
Teaching assistant assignments:
Weekly seminars in *Relativistic Quantum Field Theory II*; Fall 1998
Coaching students, grading, and writing solutions in *Quantum Theory, Quantum Physics, Electromagnetic Theory I and II*. 1995–2000

HIGHLIGHTS OF SCIENTIFIC RESULTS

- Discovered the first non-degenerate signature of the relic streaming neutrinos.
It exposes to probing **40% of the early universe** that was composed of the neutrinos, invisible directly.
- In particular, this result is cited as the motivation to start constraining the neutrino density by NASA’s WMAP satellite collaboration (Astrophys.J.Suppl.170:377, 2007) and with ESA’s Planck satellite (*The Scientific Programme of Planck (Bluebook)*, <http://www.cosmos.esa.int/web/planck/publications>).
- Developed, starting with Ph.D. thesis with E. Bertschinger, a Green’s function method to analyze cosmological evolution. Green’s functions are now applied to baryonic oscillations—one of the primary cosmological probes.
- Discovered a sharp feature in the CMB correlation function at 1.2° that is a distinctive objective evidence of the acoustic waves in the early universe and is the single most sensitive probe of the universe geometry.
- Discovered that the phase of the relic gravitational waves should be locked to zero unless superluminality exists.
- Established and first described in a paper key general nontrivial and now accepted results on distinguishing dark energy from modified gravity.
- First constructed gauge-invariant operators for quark and gluon orbital angular momentum distributions, which were required for **completing theoretical description of proton spin**. (Graduate project at MIT with Prof. R. L. Jaffe.)
- 14 papers and 6 published conference proceedings that received over 600 citations by scientific articles.
- Results are described and cited by several modern textbooks, including *Cosmology* (2008) by the Nobel Prize laureate Steven Weinberg.

EXPERIENCE, IT DEVELOPMENT

Startup MiKey

Moscow, Russia

supported by System Integration of Business

Founder and Principal Manager

2009–2010

- Invented a new method of typing without moving fingers. Received funding to investigate the idea.
- Supervised a team of two developers and a designer. Managed and fully participated in development cycles. In addition to internal quality assurance, organized and conducted testing by independent users.
- Created four conceptually distinct implementations of the original method. Considerably improved typing speed (by 4 times), accuracy, and user experience.
- Developed a training course to facilitate user's mastering of the new typing method.
- Arranged and conducted medical tests of a prototype at a clinical hospital.
- Prepared and submitted a US patent application with Harness, Dickey & Pierce, an IP law firm.

COMPUTER EXPERIENCE

C++, C, Matlab, Fortran, Adobe Air, HTML, CSS, Visual Studio, Eclipse, SVN, JIRA, MS Office, Expression Web, Mathematica, Latex.

Operating Systems: Windows, Linux/Unix.

GRANTS AND AWARDS

Private grant to explore my original results on identifying probability-related wave functions of physically realistic bosonic and fermionic fields with gauge and gravitational interaction, closed UV- finite evolution, and inflationary past as objective entities that emerge in the generic static structure, Moscow, 2012–2016.

Exploratory Research grant (successful co-applicant): *Precision Cosmology and the Neutrino Sector*, LANL, 2008.

Directed Research grant (recipient): *Dark Energy and the Cosmic Web*, LANL, 2007–2008.

R. H. Dicke Postdoctoral Fellowship, Princeton University, 2001–2004.

George Soros International Science Foundation Fellowship, 1994–1995.

Lenin Highest Honor Stipend, MIPT, 1994–1995.

Placed 1st, 2nd, and 1st in the inter-departmental MIPT Physics Competition in each eligible year, 1992–1994.

Gold Medal, XXII International Physics Olympiad, Havana, 1991.