

Georgy Shlyapnikov CV

Personal data

Name Georgy Shlyapnikov
Born July 9, 1948 in Moscow (Russia).
Married wife Nina Shlyapnikova, two daughters, born in 1975, and in 1988.
Address Résidence la Bourdonnière, 2A avenue Edouard Herriot, 91440 Bures sur Yvette, France
Office LPTMS, Campus Université Paris Sud, 100 rue Georges Clemenceau, 91405 Orsay, France
Telephone office : 33-1-69-15-79-46
E-mail shlyapn@lptms.u-psud.fr

Education and scientific degrees

1966 Graduated from the school in Moscow
1966-1972 Student of the Moscow Institute of Physics and Technology (MIPT), Russia
1972 Diploma Thesis "Relaxation and recombination processes in atomic gases and plasmas"
1972-1975 PhD student at the Russian Research Center Kurchatov Institute (RRC KI), Moscow
1975 PhD Thesis "Infra-red radiation and radiative collisions in molecular gases" at RRC KI
1982 Doctor 2 Dissertation (HDR) "Radiative processes in atomic gases" at RRC KI

Employment

1972 - 1975 PhD, RRC Kurchatov Institute
1975 - 1982 Junior researcher, RRC Kurchatov Institute
1982 - 1989 Senior scientist, RRC Kurchatov Institute
1989 - 2003 Laboratory Head, RRC Kurchatov Institute (from 1996 0% time)
1989 - 1996 Visiting fellow, University of Amsterdam, The Netherlands
1996 - 2001 Groupleader, FOM Institute AMOLF, Amsterdam
2000 - 2002 Associate Professor (PAST), University Paris VI - Ecole Normale Sup'erieure, France
2001 - 2003 Main scientist, Groupleader, FOM Institute AMOLF, Amsterdam
2003-present Professor (part time), University of Amsterdam
2003 - present Director of Research at CNRS, LPTMS, Orsay, France
2013-present Group Leader at the Russian Quantum Center, Moscow, Russia

National and International Responsibilities

2005 - present Member of the directoire of IFRAF (Institut Francilien des Atoms Froids), France
2002 - present Member of the Scientific Board for the INFM Research and Development Center on Bose-Einstein Condensation (Trento, Italy)
2005 - 2011 Member of the Editorial Board of Physical Review A
2010 - 2017 Co-editor of European Physics Letters

Awards

1976-1979 Twice Kurchatov Prize of RRC KI for young scientists
1999 Humboldt Prize (Germany)
2000 Kurchatov Prize (Russia, with J.T.M. Walraven, P.O. Fedichev, and D.S. Petrov)
2011 International Bose-Einstein Condensation Prize
2013 European Research Award (Advanced ERC grant)

Research activity

My research activity started in 1969 at the RRC Kurchatov Institute in Moscow, and the early work (1969-1977) was on radiative processes in gases. In 1977 I began collaboration with Yuri Kagan, which determined my interest in collective many-body phenomena. In 1977-1989 we worked on low-temperature physics, in particular on spin-polarized atomic hydrogen. We have constructed a **theory of the decay kinetics of this system (1981-1984), which determined the developments until hydrogen got bose-condensed in 1998**. In 1983 Boris Svistunov, one of my best students (presently a full professor at UMASS in Amherst, USA), joined us and we developed a description of the **influence of Bose-Einstein condensation (BEC) on inelastic and optical processes in dilute gases, including the "effect of 1/6" for 3-body recombination (1985-1988)**, measured 10 years later in rubidium experiments (E.A. Cornell, C.E. Wieman).

In 1989-1995 I was sharing my time between RRC Kurchatov Institute and the University of Amsterdam and

started collaboration with Jook Walraven on both low-temperature physics and quantum gases. **We found that spin polarization strongly suppresses the collisional ionization decay of metastable triplet helium and allows the achievement of BEC.** This idea was implemented in experiments in 2001 (A.Aspect/C.Westbrook ; C.Cohen-Tannoudji/M.Leduc), which opened a new branch of research in the physics of cold atoms: "Quantum gases of metastable atoms". Remarkable studies of BEC in trapped gases introduced condensates evolving under variations of the harmonic confinement or the interaction strength, and together with Yu. Kagan and E. Surkov I **developed a scaling theory for these condensates.**

In 1996-2003 I was running a theory group in the FOM Institute AMOLF in Amsterdam. Aside from successful joint work with Jook Walraven and the group members Dimitri Petrov (PhD at that time) and Mikhail Baranov (regular visitor) on various issues in ultracold trapped gases, I established collaboration with Maciej Lewenstein and Luis Santos at the University of Hannover (Germany). It initiated theoretical studies of dipolar quantum gases and we have shown that **pancake dipolar condensates may have a roton-maxon excitation spectrum similar to that in liquid helium**, thus opening a search for novel quantum states. The started collaboration with Dimitri Gangardt stimulated my interest in exactly solvable models and our **theory of local correlations in 1D Bose gases showed a strong decrease of inelastic decay processes in the strongly interacting Tonks-Girardeau regime.**

Since October 2003, I am running a group in Orsay, France. The studies include most of the branches of quantum gases, and I was lucky to collaborate with bright theorists Dimitri Petrov, Dimitri Gangardt (presently a permanent scientist at the University of Birmingham, UK), and David Papoular (PhD, presently a postdoc in Trento, Italy), as well as with distinguished experimental groups of Jean Dalibard and Christophe Salomon at ENS in Paris and that of Alain Aspect in the Institut d'Optique in Palaiseau. Together with D. Petrov and C. Salomon we studied strongly interacting two-component Fermi gases which represent a remarkable object bringing in analogies with superconductors and neutron matter, and on the repulsive side of a Feshbach resonance one has the formation of weakly bound molecules (dimers). **We have found the exact solution for the elastic dimer-dimer interaction and predicted a strong suppression of their collisional relaxation. This provided a route to molecular BEC (JILA, Innsbruck, MIT, ENS, etc.) of these highly excited and presently the largest diatomic molecules in the world (with the size $\sim 3000 \text{ \AA}$).** In 2009 the creation of almost quantum degenerate clouds of ground-state polar molecules (D.S. Jin/J Ye) stimulated my work on ultracold dipoles. In collaboration with Nigel Cooper we showed that single-component microwave-dressed fermionic polar molecules in the 2D geometry may acquire an **attractive dipole-dipole interaction leading to superfluid p-wave pairing** at temperatures of the order of tens of nanokelvins. The emerging state is the **topological p_x+ip_y phase** promising for topologically protected quantum computing and it is collisionally stable on the scale of seconds at commonly achieved densities. The work with the group of L. Santos predicts an **interlayer superfluidity and describes a novel type of crossover from fermionic superfluidity to BEC of interlayer dimers in bilayer systems of dipoles.**

For quantum gases in disordered potentials the key issue was to observe and study Anderson localization of neutral atoms and to reveal how it is influenced by the interparticle interaction. In 2008 I established collaboration with Boris Altshuler and Igor Aleiner (Columbia University, USA) who are recognised experts on disordered systems, and our work of 2010 was dedicated to 1D disordered finite temperature bosons. It is accepted that there are no phase transitions in 1D systems at a finite temperature, because long-range correlations are destroyed by thermal fluctuations. We showed that the **1D gas of weakly interacting bosons in the presence of disorder can undergo a finite temperature phase transition between two distinct states: fluid and insulator.** None of these states has long-range spatial correlations, but this is a true albeit non-conventional phase transition as transport properties are singular at the transition point. In the fluid phase the mass transport is possible, whereas in the insulator phase it is blocked even at finite temperatures. Together with B.L. Altshuler and V.P. Michal, we considered weakly interacting bosons in the quasiperiodic potential representing a superposition of a deep lattice and a shallow incommensurate lattice. We described the interaction-induced localization-delocalization transition at finite temperatures and **revealed an anomalous "freezing with heating" phenomenon** in which an increase in temperature leads to fluid-insulator transition, thus favoring the insulator state. Together with X. Deng, L. Santos, and B.L. Altshuler we then considered dipolar excitations propagating via dipole-induced exchange among immobile molecules randomly spaced in a lattice and showed that all **eigenstates are extended, but can be non-ergodic. Our work predicts a novel ergodic-nonergodic transition which can be realized by changing the filling factor.**

On the side of atomic physics, together with D. Papoular and J. Dalibard we **investigated a possibility to**

control the scattering length for the interaction between cold bosonic atoms by using a microwave field, and our results yield optimistic prospects for experiments.

My work on the theory of quantum fluids/gases was awarded by the Humboldt Prize (Germany) in 1999, by the Kurchatov Prize (Russia) in 2000, and by the International Bose-Einstein condensation Prize in 2011. In 2013 I got the European Research Award (Advanced ERC grant).

Publications/Citations/Invited Talks/Supervisions

My publication list includes 153 papers. They got more than 11800 citations, with more than 79 citations per paper and H-index of 51. 33 articles have more than 100 citations. The list of invited talks at international meetings includes 233 talks. 30 papers are published and 113 invited talks are given in the last 10 years. During my research career I successfully supervised 12 PhD students and 14 postdocs and was/am a principal investigator or coordinator of 14 research grants.

10-Year Track-Record

Significant publications [= number of citations, ISI data, Maerch 16, 2019

Strongly interacting Fermi gases

- A.K. Fedorov, S.I. Matveenko, V.I. Yudson, and G.V. Shlyapnikov, *Novel p-wave superfluids of fermionic polar molecules*, Scientific Reports, **6**, 27448 (2016). [14]
- Zhen-Kai Lu and G.V. Shlyapnikov, *Fermi liquid of two-dimensional polar molecules*, Phys. Rev. A **85**, 023614 (2012). [24]

Low-dimensional quantum gases

- Zhen-Kai Lu, Yun Li, D.S. Petrov, and G.V. Shlyapnikov, *Stable dilute supersolid of two-dimensional dipolar bosons*, Phys. Rev. Lett. **115**, 075303 (2015). [23]
- V.P. Michal, B.L. Altshuler, and G.V. Shlyapnikov, *Delocalization of weakly interacting bosons in a 1D quasiperiodic potential*, Phys. Rev. Lett. **113**, 045304 (2014). [21]

Dipolar quantum gases

- N.R. Cooper and G.V. Shlyapnikov, *Stable topological phase of fermionic polar molecules*, Phys. Rev. Lett. **103**, 155302 (2009). [134]
- A. Pikovski, M. Klawunn, G.V. Shlyapnikov, and L. Santos, *Interlayer superfluidity in bilayer systems of fermionic polar molecules*, Phys. Rev. Lett. **105**, 215302 (2010). [78]

Quantum gases in disorder

- I.L. Aleiner, B.L. Altshuler, and G.V. Shlyapnikov, *Finite temperature phase transition for one-dimensional disordered bosons*, Nature Physics **6**, 900 (2010). [119]
- X. Deng, B.L. Altshuler, G.V. Shlyapnikov, and L. Santos, *Quantum Levy flights and multifractality of dipolar excitations in a random system*, Phys. Rev. Lett. **117**, 020401 (2016). [18]

Atom-atom and atom-light interactions

- D.J. Papoular, G.V. Shlyapnikov, and J. Dalibard, *Microwave-induced Feshbach resonances*, Phys. Rev. A **81**, 041603 (2010). [56]
- Yong Zeng, Peng Xu, Xiaodong He, Yangyang Liu, Min Liu, Jin Wang, D. J. Papoular, G. V. Shlyapnikov, and Mingsheng Zhan, *Entangling two individual atoms of different isotopes via Rydberg blockade*, Phys. Rev. Lett. **119**, 160502 (2017). [14]

Book Chapters

- D.S. Petrov, C. Salomon, and G.V. Shlyapnikov, *Molecular Regimes in Ultracold Fermi Gases*, Chapter of the book *Cold Molecules: Theory, Experiment, Applications* edited by R.V. Krems, W.C. Stwalley, and B. Friedrich, CRS Press, Boca Raton, 2009.
- D.S. Petrov, C. Salomon, and G.V. Shlyapnikov, *Molecular Regimes in Ultracold Fermi Gases*, Proceedinds of the International School *Enrico Fermi*, Chapter CLXIV, edited by M. Inguscio, W.

Ketterle, and C. Salomon, IOS Press, Amsterdam, 2007.

Invitations (plenary) to international conferences and advanced schools

- Annual Meeting of the German Physical Society, Berlin, Germany, March 4-9, 2005
- 16-th Biennial Congress of the Australian Institute of Physics, Canberra, Australia, February 1-4, 2005
- DPG meeting on condensed matter, Dresden, Germany, March 27, 2006
- International conference on recent progress in many-body theory, Barcelona, Spain, July 15-20, 2007
- International conference "Quantum correlations and thermodynamics", Prague, Czech Republic, July 27-31, 2008
- International workshop "Condensed matter physics with cold atoms", Beijing, China, October 7 – 28, 2009
- Physics FOM conference, Veldhoven, The Netherlands, January 19-20, 2010
- International conference on atomic physics ICAP-2010, Cairns, Australia, July 25-30, 2010
- Gordon conference on Atomic Physics, West Dover, USA, 26-30 June, 2011
- International conference on atomic physics ICAP-2012, Paris, France, July 23-27, 2012.
- International school *Enrico Fermi* on Fermi gases, Varenna, Italy, June 21-30, 2006
- International summer school on the physics of nano-devices, Trieste, Italy, July 15-21, 2006
- International winter school on condensed matter and quantum information, Jerusalem, Israel, December 26, 2007 – January 4, 2008
- International ICAP Summer School, Paris, France, July 16-21, 2011
- International conference of the Humboldt Foundation, Bonn, Germany, October 9-11, 2013.
- International conference "Frontiers of Quantum and Mesoscopic Thermodynamics, Prague, Czech Republic, July 27-28, 2015.
- International conference "Frontiers of Nanoscience", Trieste, Italy, August 24-September 1, 2015.
- International conference "Aspects and Applications of Many-Body Localization", Santa Barbara, USA, November 16-20, 2015.

Awards

- 2011: International Bose-Einstein Condensation Prize
- 2013: European Research Award (ERC advanced grant)

Organized international conferences/workshops/schools

- European Research Conference on Bose-Einstein Condensation, September 2005, San Feliu de Guixols, Spain [G.V. Shlyapnikov (chairman), M. Inguscio (vice-chairman)].
- International Workshop "Quantum Gases", April-July 2007, Paris, Inst. Henri Poincare [Y. Castin, Tin-Lun Ho, A.J. Leggett, and G.V. Shlyapnikov (co-directors)].
- International Summer School "Many-Body Physics with Cold Atoms", June-July 2010, Les Houches [C. Salomon and G.V. Shlyapnikov (co-directors)].
- International Conference "Frontiers of ultracold atoms and molecules", January 2011, Goa, India [B. Das, M. Kiselev, R. Pai, and G.V. Shlyapnikov (co-chairs)].
- International Workshop "Fermions. From Cold Atoms to Neutron Stars", March-May 2011, Seattle, USA [A. Bulgac, M. Forbes, A. Gezerlis, T-L. Ho, G.V. Shlyapnikov, and M. Zwierlein (co-directors)].
- International workshop "Quantum transport", July 4-14 2011, Benasque, Spain [F. Sols and G.V. Shlyapnikov (co-directors)].
- First African School on Quantum Gases, January 21-30, 2012, Chlef, Algeria [G.V. Shlyapnikov scientific co-director].
- International workshop "Disordered Quantum Systems", April-July, 2012, Paris, France [B.L. Altshuler, B. Doucot, M. Mezard, and G.V. Shlyapnikov (co-directors)].
- International conference "Frontiers of ultracold quantum gases", November 26, 2012, Paris, France, F. Gerbier, R. Kaiser, M. Leduc, and G.V. Shlyapnikov (co-directors)
- International workshop "Disordered quantum systems. From electrons to cold atoms", May 19-21, 2014, Orsay, France, B.L. Altshuler, V.P. Michal, and G.V. Shlyapnikov (co-directors).