International Conference on Quantum Gases,
Fundamental Interactions, and Cosmology
Pisa, 26-28 October 2022

Lev Pitaevskii: the Last 30 Years

Sandro Stringari

UNIVERSITÀ DI TRENTO

BEC

CNR-INO
ISTITUTO NAZIONALE DI OTTICA
CONSIGLIO NAZIONALE DELLE RICERCHE

Lev Pitaevskii

Saratov 1933, Rovereto (Trento) 2022

Lev Pitaevskii is worldwide known as

- Outstanding member of the prestigious **Landau's school**
- Coauthor of the last volumes of
  Landau-Lifschitz course on Theoretical Physics
- Author of seminal works on
  - Theory of **Casimir forces**
  - Excitation spectrum of **superfluid helium**
  - Theory of **Plasma Physics**
  - Theory of **dilute Bose gases** (Gross-Pitaevskii theory).

This short presentation focuses on the **Trento period** of Lev's life, which includes the great worldwide development of scientific research in ultracold atomic gases, following the first experimental realization of BEC in 1995.

Landau's group in Moscow, 1956. Are sitting: L. Prozorova, A. Abrikosov, I. Khalatnikov, L. Landau, E. Lifshitz. Are standing: S. Gershtein, Lev, L. Vainshtein, R. Arkhipov, I. Dzyaloshinskii

1988: my first visit to Moscow where I met Lev at the Kapitza Institute

My host in Moscow: Eugene Bashkin

First Lev's visit to Trento

Please Post

First and Last Announcement

The Dipartimento di Fisica dell'Università di Trento will organize an informal workshop on

CLUSTERS OF QUANTUM LIQUIDS

Villa Madruzzo, Trento - Italy
june 5-6, 1989

- The purpose of the workshop is to bring together experimentalists and theorists working in the area of clusters of quantum liquids (mainly helium clusters).

- Possible topics of discussion are: ground state properties, elementary excitations, statistical properties, superfluidity, scattering of atoms and molecules, interaction with electrons, impurities and spectroscopy.

- The workshop will be organized in the form of oral contributions followed by informal discussions.

- Preliminary list of participants : D. Bassi (Trento), M. Casas (Palma de Mallorca), R. Colle (Pisa), F. Dalfovo (Grenoble), J. Dupont-Roc (Paris), A. Fabrocini (Pisa), S. Fantoni (Lecce), H. Haberland (Freiburg), I. Lagaris (Ioannina), P. Leiderer (Konstanz), J. Northby (Kingston), M. Papoular (Grenoble), L. Pitaevskii (Moscow), S. Pieper (Argonne), F. Pobell (Bayreuth), T. Regge (Torino), G. Scoles (Princeton), P. Toennies (Gottingen), J. Treiner (Orsay), G. Viliani (Trento), B. Whaley (Berkeley).

- People whishing to attend the workshop and present a contribution should return the attached form before **may 7, 1989** to : *S. Stringari, Dipartimento di Fisica, Università di Trento, 38050 Povo, Italy (phone number: 461-881529; electronic address: STRINGAR at ITNCISCA; telefax 461-881696)*

Luba and Lev in Milano

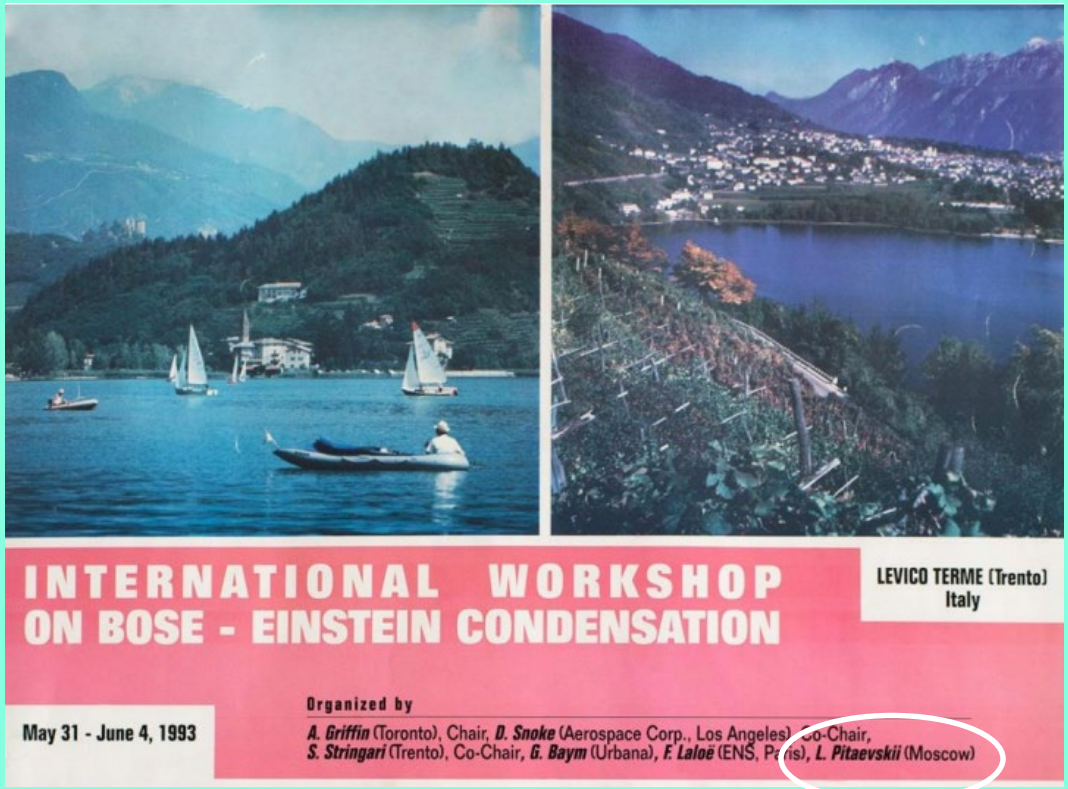
- In the decade 1989 – 1998 Lev visited Trento ina regular way as visiting researcher, also during his 4 year stay in Haifa (Israel)

- In 1998 he became full professor of the University of Trento. He then moved to Trento in a permant way

First Lev's collaborations (before 1995) with Trento concerned

- Superfluidity of Helium clusters
- Ripplons, Rotons and Quantum Evaporation in superfluid Helium
- Generalization of Hohenberg-Mermin-Wagner theorem to T=0
- Effects of disorder in dilute Bose gases

- Scientific Organization of Levico BEC workshop



After the experimental realization of BEC in atomic gases in 1995

Lev started collaborating with the Trento team in the new field of ultracold gases where the **Gross-Pitaevskii equation** emerged as the basic theoretical tool to attack the large variety of theoretical and experimental issues.

Lev's scientific presence in Trento has accompanied the increase of the weight of the Trento team in the international community .

Many collaborations with the **Trento team** as well as with **other labs around the world** (Florence, Innsbruck, ENS Paris, Jila-Colorado, MIT, Barcelona, Institut d'Optique …) on various topics related to

- Thermodynamics and critical temperature of BEC gases
- Casimir-Polder Force
- Spin Orbit Coupled gases
- Momentum distribution and Bragg scattering
- Landau damping in dilute Bose gases
- First and second sound in dilute Bose gases
- Second sound in superfluid Fermi gases
- Interference in momentum space
- Motion of heavy impurities
- Magnetic vortices and vortex pairs
- Soliton vortices (collaboration with Trento experimental team)
- Supersolidity in spin-orbit coupled gases
- Propagation of sound in 2D Bose gases

Some of the most significant Lev's publications written together with the Trento team:

- Rev. Mod. Phys. paper on
  Theory of Bose-Einstein condensation in trapped gases (1999)

- Rev. Mod. Phys. paper on
  Theory of ultracold atomic Fermi gases (2008)

- Book on **Bose-Einstein Condensation and Superfluidity**
  (OUP, 2003 and 2016)

Two examples of
successful international collaborations

The Casimir-Polder force at finite temperature

Date: Wed, 15 Oct 2003 15:30:33 -0600

From: CORNELL Eric <ecornell@jilau1.Colorado.EDU>
To: Lev Pitaevsky <lev@science.unitn.it>
Subject: Casimir-Polder forces

Dear Lev,

My group has been working on characterizing the forces between a rubidium atom and a nearby surface. We have been hoping to make a measurement of the Casimir-Polder force at longer range, so as to be sensitive to corrections induced by thermal radiation.....

- On Sat, 25 Oct 2003
- Lev Pitaevsky wrote:
- Dear Erik,
- I have discussed the Casimir forces calculations with Sandro.
- We both would like to develop these calculations very much.
- We will try to find a young person to be involved. We have already two persons in view. One has just applied for a PhD program ....

Mauro Antezza PhD Defense, Trento, 13 Oct 2006

Thermal dependence of the Casimir-Polder-Lifshitz force and its effect on ultracold gases

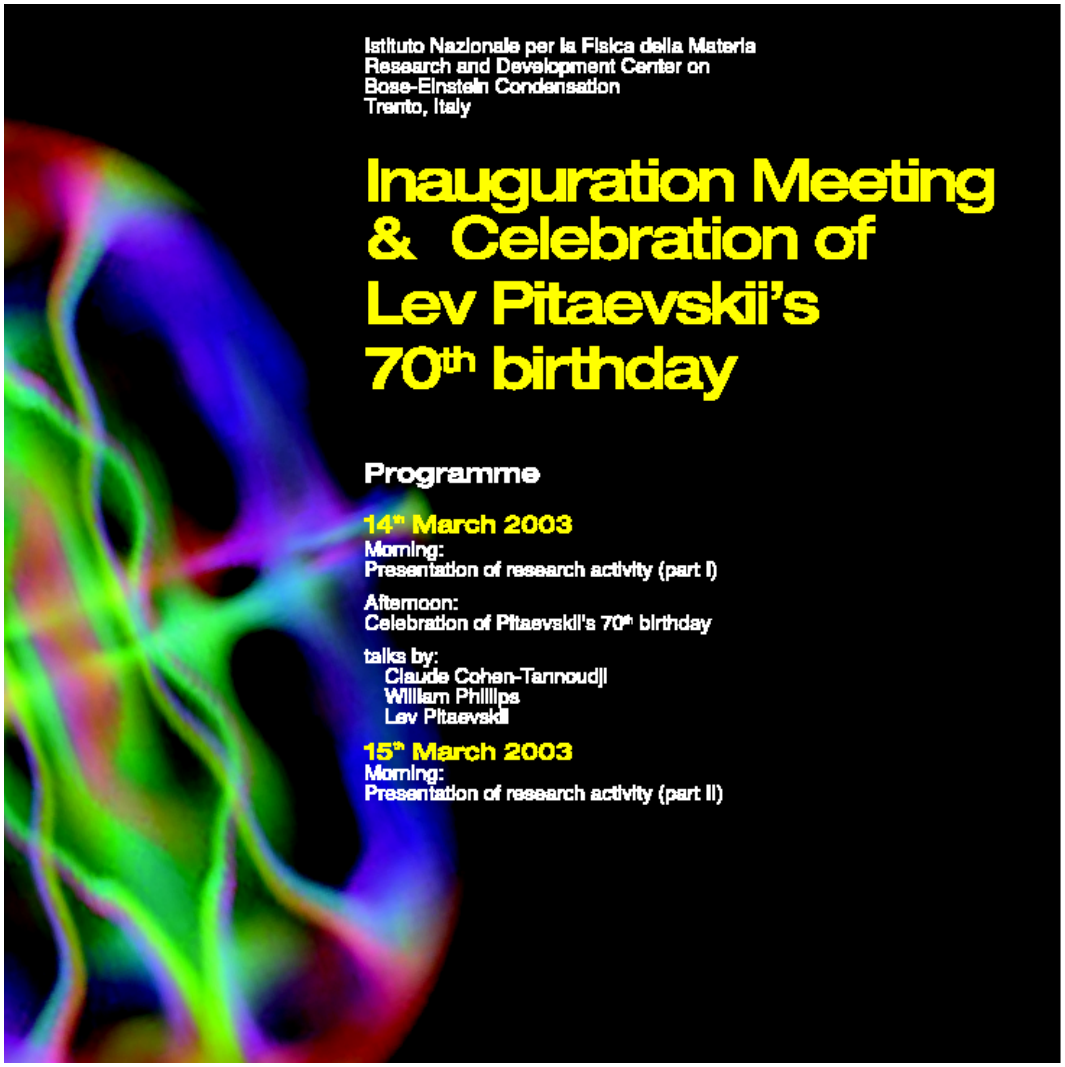
Obrecht, Wild, Antezza, Pitaevskii, Stringari, Cornell, PRL 98, 063201 (2007)

Measurement of **second sound and superfluid density** in a strongly interacting Fermi gas (Innsbruck-Trento collaboration)

On the roof of IBK Institute

Sidorenkov, Tey, Grimm, How, Pitaevskii and Stringari, Nature **498**, 78 (2013)

Celebrations and Awards



Istituto Nazionale per la Fisica della Materia
Research and Development Center on
Bose-Einstein Condensation
Trento, Italy

Inauguration Meeting & Celebration of Lev Pitaevskii's 70th birthday

Programme

14th March 2003
Morning:
Presentation of research activity (part I)

Afternoon:
Celebration of Pitaevskii's 70th birthday

talks by:
- Claude Cohen-Tannoudji
- William Phillips
- Lev Pitaevskii

15th March 2003
Morning:
Presentation of research activity (part II)

‘Aquila di San Venceslao’
Trento Award
to Lev Pitaevskii (2003)

PhD Honoris Causa
Université Montpellier
2012

PhD Honoris Causa University of Innsbruck (2013)

Celebration of 80° Birthday Anniversary (2013)

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Editorial: To the 85th Birthday of Lev Petrovich Pitaevskii

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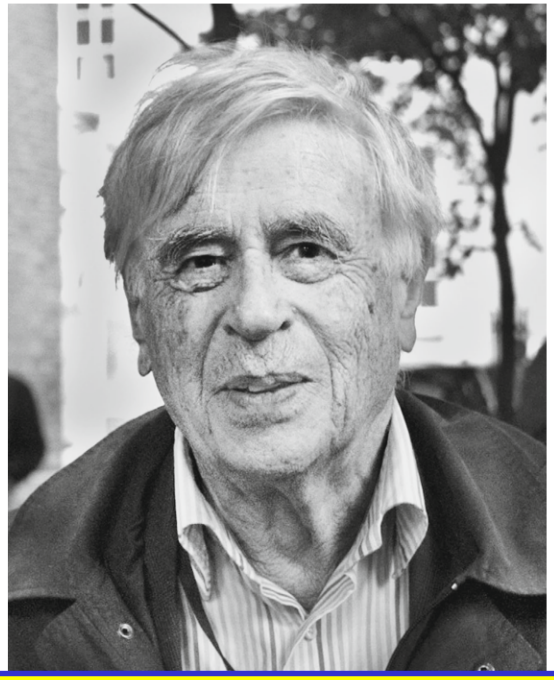


85° Birthday Anniversary (2018)

This issue of JETP is dedicated to the 85th birthday of Lev Petrovich Pitaevskii, an outstanding theoretical physicist and the full member of the Russian Academy of Sciences. Pitaevskii has made major contributions to modern theoretical physics. His research interests cover a remarkably wide range: from the work, which have become classic, on the spectrum of superfluid helium and on fundamental problems in quantum statistics and physics of metals, to the ionosphere and plasma physics, and then, recently, back to the properties of quantum fluids at ultra-low temperatures. JETP is privileged to have first published a number of fundamental works by Pitaevskii, which have since then become parts of textbooks.

The contributions to this issue of JETP are written by Pitaevskii's friends, students, and colleagues. Not surprisingly in view of his outstanding versatility, the contributions touch upon nearly all of the subjects traditionally covered by our journal. We join the authors in celebrating Lev Petrovich Pitaevskii's birthday and wishing him good health and further success in his research.

Other Awards given to Lev in the last years

- 1997 Eugene Feenberg Medal in Many-Body Physics
- 2008 Landau Gold Medal (Russian Academy of Sciences)
- 2013 PhD Honoris Causa (Texas AM University)
- 2018 Pomeranchuck Prize (awarded to LP and Giorgio Parisi)
- 2018 Enrico Fermi Prize (Italian Physical Society, awarded to Federico Capasso, LP and Erio Tosatti)
- 2019 BEC Senior Award
- 2021 Lars Onsager Prize

MY SCIENTIFIC LIFE.

L.P. Pitaevskii

I began my contact with Landau being a student of a university at Saratov (USSR). I passed 8 exams of the "Theoretical minimum" and, after official exams, was accepted as a PhD student to Landau's Department of Theoretical Physics at the Institute for Physical Problems in Moscow, where P.L. Kapitza was the Director. My supervisor was E.M. Lifshitz.

From the very beginning I wanted to work on the theory of superfluidity. My first published paper was devoted to a simple derivation of the Feynman equation for the superfluid ^{4}He. After I made works on interaction of excitations with a quantized vortex line and on properties of this line near the transition point. I discussed the problem with V.L. Ginzburg, who made similar calculations and we published a joint article. I continue to work on this problem and constructed a system of equation for dynamic of the superfluid near transition point. This paper was a predecessor of future works on dynamic scaling. I also investigated threshold phenomena in the helium spectrum. This permitted to explain a plateau in the spectrum, observed in neutron experiments.

During the same period I worked with Igor Dzyaloshinskii on the problem of generalization of Casimir and Lifshitz results of forces of interaction for the case of bodies separated by an absorbing dielectric. We solved this problem using quantum field theory methods. I consider this problem as the most difficult between my works. The point is, that it was far not obvious that the problem can be solved, that is the forces in such situation can be expressed in terms of observable electromagnetic properties of the bodies.

After defense of my thesis I worked for a short period in a research center near Moscow and soon was invited by Prof. Kapitza back to Institute for Physical Problems to work in plasma physics, which was at this period a field of his interest. I made several articles in plasma physics in collaboration with Alex Gurevich. Particularly I would like to note our work on dissipationless shock waves. Our method was later developed in numerous mathematical papers.

I continued to work on superfluidity and in 1961 solved a problem of structure and oscillations of a vortex line in a dilute Bose gas. To solve this problem I formulated an equation, described a inhomogeneous and time-depending condensate. In the same year a similar paper was published by Eugene Gross and the corresponding theory often is called as Gross-Pitaevskii (GP) theory.

I also invested much time to finish in collaboration with Eugene Lifshitz and Vladimir Berestetzkii the Landau-Lifshitz Course of Theoretical Physics.

When conditions for scientific work became intolerable for me, I moved for 4 years in the TECHNION in Haifa, Israil. At the same period I began my fruitful collaboration with Sandro Stringari. In 1995 an important event happened in physics. The Bose-Einstein condensation was achieved in experiments. I began to work on this problem, partially because the conditions were suitable for application of the GP-theory. Several important results were obtained and predictions were made. I will mention only a small number. We investigated structure of a boundary of BEC in a trap. A hidden symmetry of two-dimensional condensate in a trap was revealed. Interference of condensates in momentum space and shift of the transition point in a trap were predicted. Was calculated a shift of frequencies of oscillations due to the non-meanfield corrections etc.
At 1998 I moved to Italy to work at University of Trento. Thus Italy became my second homeland.

I continue to work in BEC and also investigate different systems of interests, for example gases with artificial spin-orbit coupling.

11/09 2018

St. Feliu BEC Conference (Sept 2019)
BEC Senior Award: LP and SS
BEC Junior Award: Francesca Ferlaino

Lev and Luba

Lev and Luba
Saratov, 1953

Luba and Lev
50th wedding anniversary
Regole di Malosco, Trento, 2006

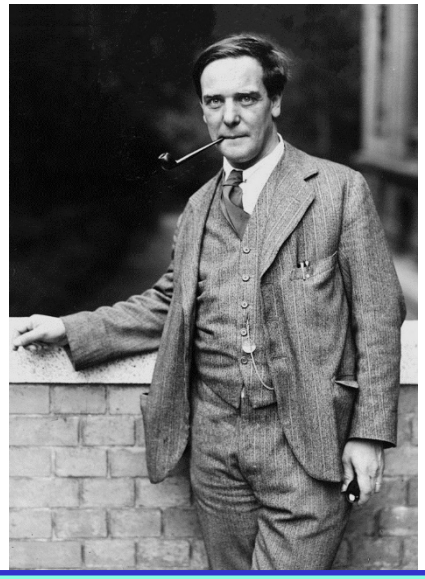
Snow fall in front of Lev's apartment (Trento, 2010)

My second visit to Moscow (2008)

Dinner in Lev and Luba's apartment in Moscow (2008)

Zina Lifschitz and Luba
(Zina's apartment, Moscow 2008)

Visiting the
Kapitza museum
(2008)



Pyotr Kapitza (1894-1984)
Nobel Prize 1972

Collection of taps in Kapitza museum

Portrait of Pyotr Kapitza

Lev

Drum with portraits of Kapitza friends (gift for his 80° anniversary, 1974)

Lev portrait

Due to the profound and longstanding role played by Lev in the scientific life of the Trento BEC Center and the corresponding worldwide recognition, we plan to rename our Center as

Pitaevskii Center on Bose-Einstein Condensation