Leonardo Masi

Curriculum Vitae

Personal information

Date of birth October 14, 1991.

Place of birth

Address

Cityzenship

Present position Research fellowship at CNR-INO, Via Nello Carrara, 1 - 50019 Sesto Fiorentino (FI) - Toscana, starting from 07/01/2020.

Education

2016 - 2019 **PhD in Physics and Astronomy**,
Dipartimento di Fisica e Astronomia, Università degli Studi di Firenze, Firenze, Italy.

PhD thesis: *Realization of a beat-note optical lattice for interferometry with Bose-Einstein condensates*

Supervisor: Prof. M. Fattori

Graduation date: April 2, 2020.

2013 - 2016 **Master degree in Physical and Astrophysical Sciences, (curriculum: Physics of Matter)**,
Università degli Studi di Firenze, Firenze, Italy.

Final Score: 110/110 cum laude.

Master thesis: *From Rabi to Josephson dynamics with a Bose-Einstein condensate in a double-well potential*

Advisors: Prof. M. Fattori, Prof. G. Modugno.

Graduation date: April 27, 2016.

2010 - 2013 **Bachelor degree in Physics and Astrophysics**,
Università degli Studi di Firenze, Firenze, Italy.

Final Score: 110/110 cum laude

Bachelor's thesis: *Energy and temperature of Bose-Einstein condensates with tunable interaction*

Advisors: Prof. G. Modugno

Graduation date: December 12, 2013.

2005 - 2010 **Scientific High School degree**,
Liceo Scientifico Bertrand Russell – Isaac Newton, Scandicci (FI), Italy.

Final Score: 100/100 cum laude

Conferences and awards

20/07/2020

2017 IQIS 2017, Florence (Italy). Poster presentation: *Crossing Over from Attractive to Repulsive Interactions in a Tunneling Bosonic Josephson Junction.*

2018 WE Heraeus-Seminar: Quantum Gases and Quantum Coherence, Bad Honnef (Germany). Poster presentation: *Self-bound quantum droplets in atomic mixtures in free space.* **Best poster award**

2018 FOMO 2018: Frontiers in Matter Wave Optics 2018, Summer School and Conference, Chania (Crete). Poster presentation: *Self-bound quantum droplets in atomic mixtures in free space.* **Best poster award**

2019 ECAMP 13th: 13th European Conference on Atoms Molecules and Photons Florence (Italy). Poster presentation: *A novel optical lattice for interferometry with trapped atoms.*

2019 YAO 2019: Young atom opticians, Hamburg (Germany). Poster presentation: *A novel large spacing optical lattice for interferometry with trapped atoms.*

2020 Quantum Optics 2020, Obergurgl (Austria). Poster presentation: *Atom interferometry with a large spacing beat-note opticallattice.*

Research experience

2013 **Energy of Bose Eistein Condensates** - LENS (*European Laboratory for Non-linear Spectroscopy*) and University of Florence , Florence (Italy).

Supervisor: prof. Giovanni Modugno
In this work I experimentally observed the phenomenon of Bose-Einstein condensation in potassium-39 samples with tunable interaction. I measured the condensed fraction and the expansion energy of the cloud for different values of the interaction strength and I compared the results with the theory of interacting Bose gas.

2016-present **Trapped atom interferometry** - LENS (*European Laboratory for Non-linear Spectroscopy*) and University of Florence, Florence (Italy).

Supervisor: prof. Marco Fattori
In this project we study the dynamics of a Bose Einstein Condensate (BEC) in a double well optical potential. This system realizes a spatial Josephson Junction and, thanks to the exquisite control of tunneling and interactions, it can be used for the realization of a Mach-Zehnder interferometer with trapped atoms. Using non interacting clouds we can perform the linear beam splitter operation, while interactions could be used to create many-body quantum-entangled states, improving the phase resolution of the device beyond the shot noise limit. I participated to the whole experimental work, I designed a new system of magnetic coils that produce a very stable magnetic field and I carried out a detailed theoretycal analysis on the different models that can be used to describe the dynamics of the system in different regimes of interaction. In order to increase the stability of the system I developed a novel optical potential provided by the beating between two optical lattices with different wavelengths. I have complitely designed and assembled the setup for the stabilization of the intensity and the frequency of the laser sources, exploiting a technique that allows to lock the two frequencies to the same optical cavity. Finally, we study spatial Bloch oscillations in presence of an external force observing a long coherence time and a good agreement with theoretical predictions. The novel lattice offers interesting perspectives for the realization of high-sensitivity and highly compact double-well interferometers.

2017-2019 **Experimental studies on quantum droplets in atomic mixtures** - LENS (*European Laboratory for Non-linear Spectroscopy*) and University of Florence, Florence (Italy).

Supervisor: prof. Marco Fattori
We worked on the experimental observation and characterization of the quantum droplet phase in a mixture of hyperfine states of potassium-39. I participated to the whole experimental work and to the data analysis. My specific contributions were the building up of the electronic staff for a time-averaged optical potential used to compensate gravity without confining the atoms and optimization of the absorption imaging sequence for dense atomic clouds. I also performed numerical simulations which allowed us to better understand the future perspectives of our work. After an experimental characterization of the time evolution and the

equilibrium properties of quantum droplets in free space, we study the collisional dynamics between two droplets. The results can provide informations about the excitation spectrum and the energy scales of this new phase of matter.

Scientific publications

Masi L., et al., *Spatial Bloch oscillation with a large spacing beat-note optical lattice*, In preparation.

G. Ferioli, G. Semeghini, S. Terradas-Briansó, L. Masi, M. Fattori, and M. Modugno, *Dynamical formation of quantum droplets in a 39K mixture*, Phys. Rev. Research 2, 013269, 2020.

Ferioli G., Semeghini G., Masi L., et al., *Collisions of Self-Bound Quantum Droplets*, Phys. Rev. Lett. 122, 090401 (2019).

Semeghini G., Ferioli G., Masi L., Mazzinghi C., et al., *Self-bound quantum droplets of atomic mixtures in free space*, Phys. Rev. Lett. 120, 235301 (2018).

Spagnolli G., Semeghini G., Masi L., et al., *Crossing over from attractive to repulsive interactions in a tunneling bosonic Josephson Junction*, Phys. Rev. Lett. 118, 230403 (2017).

Languages

Italian **Native**.

English **Good**.

Computer Skills

Operating systems Mac OS, Linux, Windows.

Software LaTex, MS Office, Origin, SolidWorks.

Programming languages C/C++, Mathematica, Matlab, Fortran.

Work Experiences

2009 - 2016 Trainer of Martial arts for children in a private gym.

2010 - 2016 Long lasting experience in private tutoring sessions for high school students (Mathematics and Physics).

Hobbies

Sports, I practiced Martial arts (Karate) at agonistic levels taking parts to competitions at national and international levels. Currently, I am contouning to train in this martial arts at amateur levels..

References

Prof. Marco Fattori,
Universitá Degli Studi di Firenze, Florence, Italy.

email fattori@lens.unifi.it

website `http://quantumgases.lens.unifi.it/exp/k2`

Prof. Giovanni Modugno,
Universitá Degli Studi di Firenze, Florence, Italy.

email modugno@lens.unifi.it

website `http://quantumgases.lens.unifi.it/exp/k1`

20/07/2020