QUANTUM PHYSICS WITH ATOMS AND IONS

Lecturers: Roberto Onofrio (8 h) and Luca Salasnich (16 h)

The course gives an introduction to quantum phenomena with atoms and ions which are currently under intensive investigations:
Bose-Einstein condensation, topological quantum states, and ion quantum computers. Both experimental and theoretical methods and techniques will be discussed and analyzed.

Program of the course

1. Bose-Einstein condensation with ultracold alkali-metal atoms (4 h).
2. Experimental trapping techniques for atoms and ions (4 h).
3. Topological quantum states with ultracold atoms (4 h).
4. Two-dimensional systems: topological phase transion of Kosterlitz-Thouless (4 h).
5. Macroscopic quantum tunneling: Josephson effect and Schrodinger-cat states (4 h).
6. Experimental and theoretical methods for optical lattices and ion quantum computers (4 h).

Suggested books:

[b1] L. Salasnich, Quantum Physics of Light and Matter, sections 6.3, 6.6, 7.2-7.8, 8.2-8.4 (Springer, 2017).
[b2] H.T.C. Stoof, K.B. Gubbels, D.B.M. Dickerscheid, Ultracold Quantum Fields, sections 15.3 and 15.4 (Springer, 2009).
[b3] D. McKay, B. De Marco, Cooling in strongly correlated optical

lattices: prospects and challenges, Rep. Prog. Phys. 74, 054401 (2011).

Period: November 2020 - February 2021.

Exam: Seminar of the student on a specific topic of the course.