Abstract

In this dissertation I present the building of a new optical lattice clock with Sr atoms at Time and Frequency division of *Istituto Nazionale di Ricerca Metrologica* (INRIM) at Turin. This work was possible thanks to the joint collaboration between the BEC-center of *Università di Trento* (UNITN) and the INRIM. The goal of the project is to investigate and implement new experimental techniques that may enhance the metrological performances of the current state-of-the-art optical lattice clocks. Using the know-how offered by experiment with cold atoms, a compact and efficient new atomic source is designed complying with metrological requirements. The atomic source employs a novel design based on *two dimensional magnetic optical trap* (2D-MOT) where it is transversally loaded from a thermal beam of Sr atoms. Atoms trapped in the 2D-MOT region are then moved toward the final MOT by means of a push optical beam. This double loading stage of the MOT offers some metrological advantages like a complete optical control of the cold atomic flux generated from the atomic source, a suppression of hot-background collisions among atoms in final MOT and atoms in thermal beams, and a reduction of black body radiation shift of the oven. During this thesis, a new trapping scheme based on two frequencies 2D-MOT is introduced. This method is used in order to enhance the performance of the atomic flux production of the atomic source. Atomic source and the sideband enhanced 2D-MOT performances were experimental characterized and quantitatively compared with a fully 3D atomic trajectories simulation based on Monte Carlo approach. Finally, the development and the characterization of new lasers sources that address second stage MOT, repumping and clock transitions are presented and their related lasers stabilization techniques are also discussed. During my PhD I spent the first two years at UNITN where I developed preliminary numeric simulations about atomic source performances and I assembled the main components of the experimental apparatus. During the time at UNITN, I had also the opportunity to be involved in the building of a similar apparatus for production of a Bose Einstein condensate. Once it was finally possible to obtained a stable first stage MOT, the entire apparatus was moved from UNITN to INRIM where final characterizations were performed. At INRIM we are now assembling the laser stabilization system for the second MOT stage.