Set-up for Continuous Superradiance Clock Based on Strontium Atoms

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***Abstract*—We present a setup build for superradiance tests at the clock transition ($^1S_0$-$^3P_0$) in strontium atoms. The apparatus is built for both ^{87}Sr and ^{88}Sr isotopes. Apparatus is designed for pulsed or continuous operation of superradiance active clock.**

Keywords—active optical clock, strontium

I. Introduction

While a pulsed superradiant [1] lasing of atoms on a clock transition in a bad-cavity has been observed experimentally [2-4], the continuous operation is yet to be developed. A continuous active clock based on superradiance phenomena [6] should allow overcoming limitations of passive clocks that come from the clock laser cavity thermal noise and mechanical vibrations [7]. It has been predicted theoretically that even the quasi-continuous operation [8] of such an active clock should lead to the extremely stable phase/frequency output.

Here we present a set-up build for verifying optimal pulsed superradiance conditions and for demonstration of quasi-continuous or continuous operation.

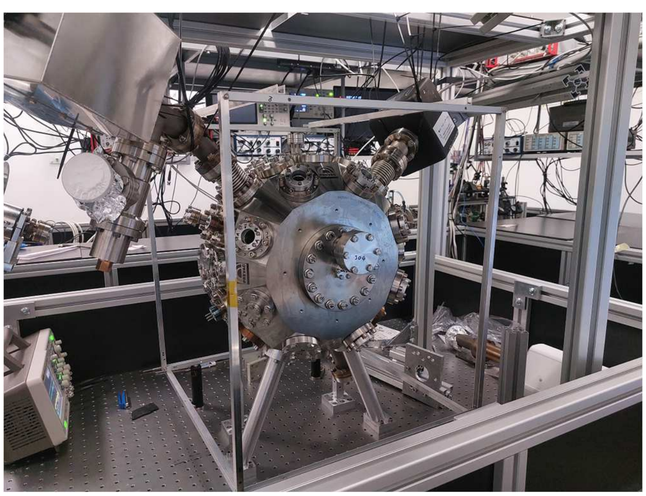

Fig. 1. Vacuum setup for continuous superradiance active clock. The main chamber is made of non-magnetic materials: titanium, aluminum, and glass.

II. Methods

The heart of the apparatus is an optical cavity for superradiance with a spacer made of Zerodur. The cavity is installed inside a vacuum chamber. The chamber is presented in Fig.1. The apparatus is designed for operating with either strontium 88 or strontium 87 isotope. The magnetically induced clock transition in the strontium 88 is extremely narrow (on the order of μHz), which imposes extremely precise control over the magnetic filed. Therefore, the vacuum system is made of non-magnetic materials and the science area is surrounded by two layers of magnetic shields.

During the testing phases of the experiment the main vacuum chamber is connected to a standard strontium oven and a Zeeman slower [9] set-up. In the future the traps will be loaded from the continuous source of cold strontium atoms, as described in reference [10].

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