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# The Optimization of Cold Atom Microwave Clocks

The cold atom microwave clocks play important roles in the field of primary frequency standards, space exploration, satellite navigation, time keeping and fundamental physics, in which the microwave local oscillator drives the transitions between two well-defined cold atomic states using a Ramsey microwave interrogation sequence. Through decades of both theoretical and experimental exploration, many scientific experiments and engineering tests have been initially performed. However, there is still a vast optimization space to improve the performance for atom fountain clock and integrating sphere cold atom clock.

In this paper, after a simple review, we will mainly present the most recent original research progresses for the optimization of atom fountain clock and integrating sphere cold atom clock to improve their frequency stability, including optical path, physical structure, operation time sequence, etc.

The first part focuses on the 87Rb atom fountain clock to solve the problem of the laser frequency stability and limited free evolution time. As shown in Fig.1(a), an ECDL and a DFB laser are applied to build the optical path, whose laser frequency are stabilized by modulation transfer spectrum and saturated absorption spectrum respectively. The designed optical lattice along the gravity in physical structure will be discussed in detail.

The second part emphases on the 133Cs integrating sphere cold atom clock to solve the problem of the laser frequency stability and limited cold atom number in Ramsey interrogation. The experimental scheme of optical path is shown in Fig.1(b) and a new integrated multifunctional microwave cavity in physical structure is proposed, which will be discussed in detail.

The cold atom microwave clocks with the presented optimization are expected to open a range of exciting possibilities for higher frequency stability and better operation ability. The future development of cold atom microwave clocks is also discussed.

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