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**Methods for the preparation of Rydberg atoms for quantum
precision measurement**

量子精密测量中里德堡原子制备方法

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part

1. Structure and drafting rules for standardization documents" Drafting. Please note that some of the contents of this document may involve patents. The issuing organization of this document does not assume the responsibility for identifying patents. This document was proposed and coordinated by the National Technical Committee on Quantum Computing and Measurement Standardization (SAC/TC578). This document was drafted by: China Institute of Metrology, Shenzhen Institute of Metrology Technology Innovation Institute, Chinese Academy of Sciences Institute of Precision Measurement Science and Technology Innovation, Shanxi University, China Electronics Information Industry Group Co., Ltd., Beijing Radio Measurement Institute, China University of Science and Technology of China, Zhijiang Laboratory, Huazhong University of Science and Technology, Guoyi Quantum (Hefei) Technology Co., Ltd., and Shenzhen Institute of Standards and Technology. The main drafters of this document are. Song Zhenfei, Liu Hongping, Li Wenwen, Zhang Linjie, Wang Zengbin, Feng Zhigang, Li Guilan, Rui Jun, Dong Ying, Hu Zhongkun, Wan Chuangqi, Wang Yiqun, Jin Shujuan, and Wang Liu. Rydberg atom preparation method for quantum

precision measurement

1 Scope

China's national methods for preparing Rydberg atoms for quantum precision measurement. A Rydberg atom is one whose outer electron has been excited to a very high principal quantum number, so that it orbits far from the nucleus - the atom becomes enormous by atomic standards, and its properties scale dramatically: its polarisability rises as the seventh power of the quantum number, which makes it exquisitely sensitive to electric fields. That sensitivity is the point. A vapour cell of Rydberg atoms is a radiofrequency field sensor whose calibration derives from atomic constants rather than from a reference antenna, which makes it a primary standard: it measures field strength absolutely, over a bandwidth from megahertz to terahertz, in a probe that is dielectric and does not perturb the field it measures. Preparing the atoms reproducibly is the precondition, which is what these methods specify.

This document describes the method of preparing Rydberg atoms, giving the preparation principle, instruments, preparation steps, preparation validity test and Instructions for preparing the report. This document is applicable to the preparation of Rydberg atoms in areas such as quantum precision measurement.

2 Normative references

This document has no normative references.

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 groundstate When an atom is in its lowest energy level, the quantum state of electrons moving in the orbit closest to the nucleus.

3.2 excited state A quantum state in which an atom is in a higher energy level relative to its ground state (3.1).

3.3 Rydberg state A quantum state with a high principal quantum number n (typical value $n \geq 10$).

3.4 Rydberg atom An atom in a Rydberg state (3.3).

4 Preparation principle

The preparation of Rydberg atoms mainly involves exciting atoms from the ground state to the Rydberg state, which requires that the absorbed photon energy is equal to the atomic ground state and the Rydberg state. The commonly used preparation methods can be

divided into single-photon absorption excitation method, two-photon absorption excitation method and There are three methods. emission method and three-photon absorption excitation method. The energy level diagram is shown in Figure 1.

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