

On the single-state selection for H-maser and its signal application for fountain atomic standard

Aleynikov M. S.¹, Boyko A. I.¹

¹Time and Frequency Department, National Research Institute for Physical-Technical and RadioTechnical Measurements FSUE VNIIFTRI, Moscow Region, Russia

Email: alejnikov@vniiftri.ru

It is well known one of the way to ensure a presence only operating atoms in the H-maser's storage bulb is a method associated with Majorana transition¹. To implement this method a magnetic field created by two coaxial identical coils, that are placed at the region between state selection magnets², is used. Moreover the magnetic fields that created by each of the coils lie approximately in the atomic beam axis and are opposite directed to each other. With this shape of the total field in mind it is extremely important to know transverse (in regard to the beam axis) coordinates of the region where the field change its sign, and the magnitude of the field gradient in this region. In the paper the dependences of H-maser's selection state system quality factor on the value of the magnetic field gradient and on the transverse coordinate of its zero value are calculated and examined. The extreme values of this parameters when a single-state selection does not work are defined. On the other hand the hydrogen beam intensity is a principal value for Power Spectral Density of the H-maser's output signal³, and thus in the second part of the paper a principal circuit for using the output signal to form interrogation waveform (a synthesizer) for Rb atomic fountain is discussed, quantity of the Dick effect^{4,5} is calculated. In conclusion it is shown that achievable fountain's stability due to a technical noise of such RF synthesizer can reach $6 \cdot 10^{-14} / \sqrt{\tau}$.

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² M. S. Aleynikov, A. I. Boyko, "Active H-maser with increased power of the output signal", IFCS-EFTF Proceedings, p. 245-248, 2013.

³ J. Vanier, C. Audoin, "The Quantum Physics of Atomic Frequency Standards", IOP Publishing Ltd, Bristol and Philadelphia, vol. 2, p. 1082-1102, 1989.

⁴ G. J. Dick, "Local oscillator induced instabilities in trapped ion frequency standards", PTI Proceedings, Redondo Beach, CA, p. 133-147, 1987.

⁵ G. J. Dick, J. D. Prestage, C. A. Greenhall, and L. Maleki, "Local oscillator induced degradation of medium-term stability in passive atomic frequency standards", PTI Proceedings, Vienna, VA, pp. 487-508, 1990.