A REVIEW OF ATOMIC FREQUENCY STANDARDS

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ABSTRACT

Atomic frequency standard are based on a complex mixture of detailed atomic physics and practical engineering. The marketplace has distilled the many possibilities into three commercially successful types - the rubidium gas cell, the cesium beam and the hydrogen maser. The purpose of this paper is to provide an introduction to the subject. A simplified and heuristic approach will be used to develop an understanding of the hyperfine structure of atoms and the principle perturbations which must be accounted for in the design of atomic frequency standards. The interactions of the atoms with magnetic fields (Zeeman effect), electric fields (Stark effect) and the resonant radiation (Doppler effect) explain the dominant systematic frequency offsets and the major sources of environmental sensitivity. The most common methods of building "atomic" spectrometers will be reviewed including methods of state selection, stimulation of the atomic transition and detection of the atomic resonance. The noise processes associated with these methods and the resulting stability for the three frequency standard types are compared to the actual performance.