VACUUM TECHNIQUES IN THE SERVICE OF QUANTUM TIME AND FREQUENCY STANDARDS

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Vacuum techniques and vacuum apparatus are widely used in quantum time and frequency standards. A physical package of atomic clocks, typically consisting of an ultra-high vacuum chamber with vacuum instrumentation, a laser, detection and control system. The subject of the speech will be the presentation of several types of atomic clocks (old-type caesium atomic clock with thermal atomic beams [1], newer-type caesium clocks with laser-cooled atoms, the so-called caesium fountains [2,3], optical clock with a single ytterbium ion [4]) in terms of the vacuum solutions used in them.

During the seminar presentation, the concept of an optical nuclear clock will also be presented, which is the use of the ground and the first excited states of the nucleus of the thorium isotope 229 to the electromagnetic resonance transition in order to measure time and frequency. Vacuum systems for trapping and obtaining the isomeric state in 229Th ions and a highly complex laser system for generating electromagnetic radiation with a frequency corresponding to the isomeric transition will be presented [5,6,7]. This frequency multiplied by the quantum Planck constant gives the energy of the isomeric state (EIS), the latest value of which in the literature is EIS = 8.28 (0.17) eV, which corresponds to the electromagnetic wavelength in the vacuum ultraviolet range λIS = 149.7 (3.1) nm [8].

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