The Trapped Ion Frequency Standard: Current Status and Future Prospects

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The promise of ion traps for the development of ultra-stable frequency standards has been recognized since 1969. It is however only recently that trapped ion frequency standards have demonstrated operational performance surpassing the stability of hydrogen masers in averaging intervals longer than 10^4 seconds.[1] The progress in the field of trapped ion standards is made possible because of the application of the linear ion traps, and the availability of practical sources of coherent radiation in the ultraviolet region of the spectrum. The former innovation has helped increase the number of ions, as well as reduce the second order Doppler shift of the clock transition, thus improving the overall stability of the standard., The availability of semiconductor laser based light sources for optically pumping the active ion has further improved the prospect of improved stability by increasing the signal to noise ratio,[2] These two approaches may now be combined in a novel configuration for the development of a small ultra-stable frequency standard for space applications.

In this talk the physics of the trapped ion frequency standards will be first reviewed. The advantage of the linear ion trap developed at JPL will then be discussed. Next there will be a discussion of the use of semiconductor lasers together will ytterbium ions for the development of an ultra-stable standard. This will be followed by a description of the shuttling *method* to design a small spacecraft standard based on the. linear trap and the semiconductor laser sources. The talk will conclude by a description of the expected performance of the spacecraft linear trapped ion frequency standard.

1, 3. D. Prestage, R. L. Tjoelker, G. J. Dick, and L. Maleki, "Ultra-stable Hg^+ trapped ion frequency standard," J. Mod. Optics 39, p. 221, 1992.

2. A. Williams, D. J. Seidel, and L. Maleki, "Generation of 369.4 nm radiation by efficient doubling of a diode laser," OSA Proc. Adv. Solid-State Las., **15**, p. 250, 1993.