# Preliminary Experiment of Sympathetic Cooling a Single $Al^+$ ion by $Ca^+$ ions In a Linear Paul ion Trap

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## Abstract:

Optical frequency standards have been developed rapidly over the world in recent years because of the fast developing technologies such as laser cooling neutral atoms or single trapped ion, the optical frequency comb and the ultra-narrow-linewidth lasers [1-6]. While Sympathetic cooling of trapped ions which could hardly be laser-cooled directly because of the UV optical laser transition laser has become an indispensable tool for quantum information processing and precision optical frequency standards. Until now, one of the most precise frequency standards is a single $^{27}Al^+$ ion standards cooled by $^{25}Mg^+$ ion with an uncertainty of $8.6\times10^{-18}$ which will be proposed as one of the candidates of the future frequency standards for the next definition of the SI second [7]. In this poster ,we will introduce some Preliminary results what we are developing an optical frequency standard based on a single $^{40}Ca^+$-$^{27}Al^+$ ion in our lab. A stainless steel 316 vacuum system of the $^{40}Ca^+$-$^{27}Al^+$ quantum logic optical frequency standard was built up with a pressure level of $3\times10^{-8}$ Pa, where the linear blade ion trap system and a calcium oven and an aluminum oven were fixed in. The 15MHz radio frequency(RF) resonator feeding the RF signal into the trap with a quality factor around 100. Then we use a home-made 423nm frequency SHG laser system and a ultraviolet LED to ionize the calcium atoms instead of electron bombardment to increase the ionization efficiency. And recently, the calcium atoms' fluorescent signal has been detected by PMT photo detection system and ICCD camera as well, After compensating the ions micro-motion carefully, a seven $Ca^+$ ion-chain has been well trapped in the linear-blade type ion trap .A traped $Al^+$ ion has also been detected as a dark ion in the $Ca^+$ chains after heating the Al atom oven to around 1000 $^0$C , which means that the whole ion trap optical frequency standards physics system is in good working condition at our Lab. What is our next main experiment task will be concentrated on the $Ca^+$ Raman sideband cooling to further cool a single $ca^+$ ion into its ground state .This work is supported by National High Technology Research and Development Program "863 "of China.

**Refference:**

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