Contribution ID: **108** Type: **Invited Poster**

Demonstration of A Calcium Atomic Beam Optical Clock

With the development of quantum frequency standard at optical frequency [1], the robust and portable optical beam clocks have attracted a lot of attention [2,3]. The calcium atomic beam clock is one promising scheme due to its relatively simple interrogating and detecting schemes, which can be used for time-keeping, satellite navigation and space exploration [4].
Here we demonstrate an optical atomic clock based on spectroscopy of the 1S0-3P1 clock transition of calcium. The scheme of the calcium beam frequency standard is shown in Fig. 1. Only two narrow- linewidth lasers are needed in the calcium beam optical clock system and they are commercially available. The 423 nm laser is locked to the 1S0-1P1 transition which is used as the readout laser. The 657 nm external cavity diode laser (ECDL) laser is used as the interrogation laser and it is locked to a ULE cavity through the Pound-Drever-Hall (PDH) method. The saturated absorption spectrum is used to stabilize the clock laser by feedback the frequency deviation to the AOM1. This stability is evaluated by comparing with the other PDH-locked laser. The experimental results are shown in Fig. 2. The Allan deviation at 1s is ˜1.3E-14.
The work demonstrates a calcium atomic beam optical clock. The short-term stability can be further improved with the use of the Ramsey spectrum. And the long-term downward trend of the stability can be optimized with careful control of temperature and the fluorescence stability of 423 nm laser and so on. Developing a second calcium frequency standard to measure the stability is also needed.

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Track Classification: Molecular, Atomic, Ion and Nuclear Clocks