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A single-laser system for mobile cold atom gravimeter

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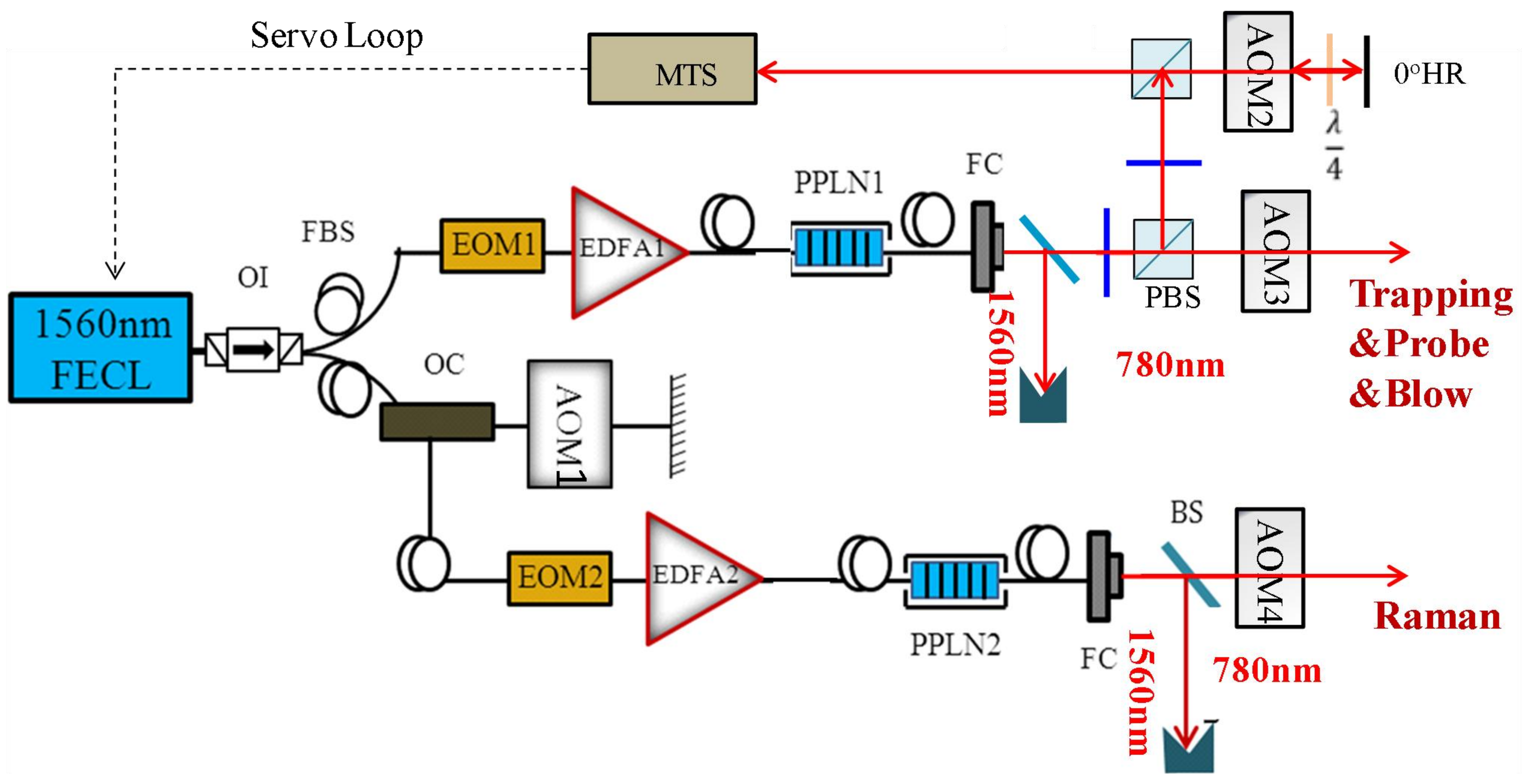
Abstract: A laser system based on a 1560nm fiber laser is described in detail. The output power of trapping laser and Raman laser are 1.1W and 1.9W at 780.2nm, with near-ideal Gaussian mode of TEM_{00}, respectively. Using this compact optical scheme, we achieved the atom gravimeter with interrgoration time 2T=140ms, corresponding to an acceleration sensitivity of 610μGal/√Hz, which is limited by vibration noise. The results of optical frequency locking and power stabilization for laser system meet requirements of high precision mobile gravimeter.

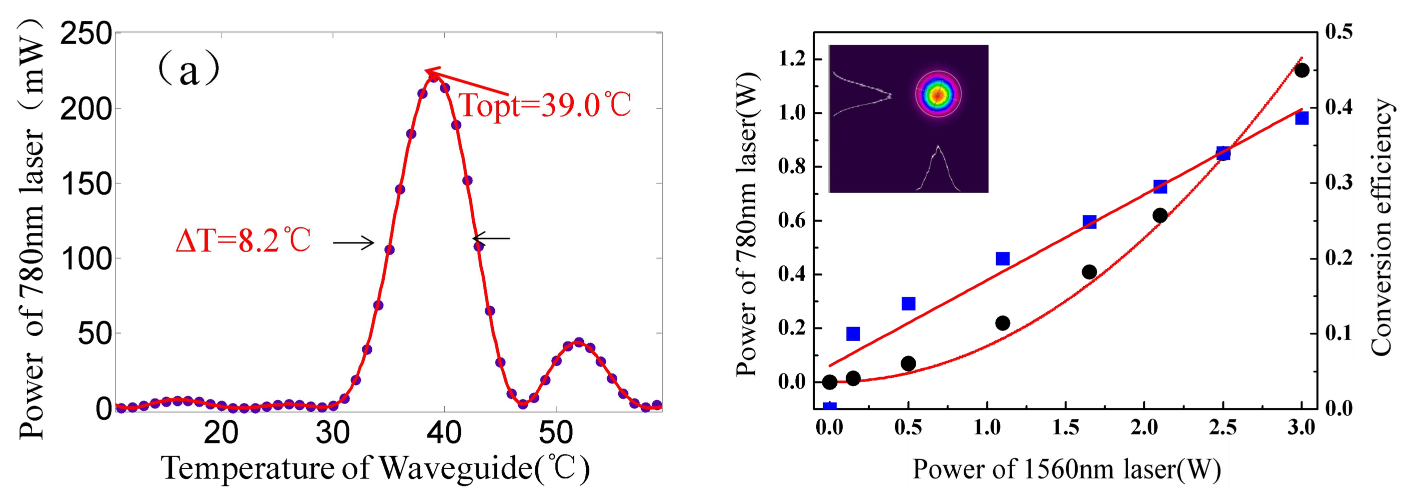
I. Laser system



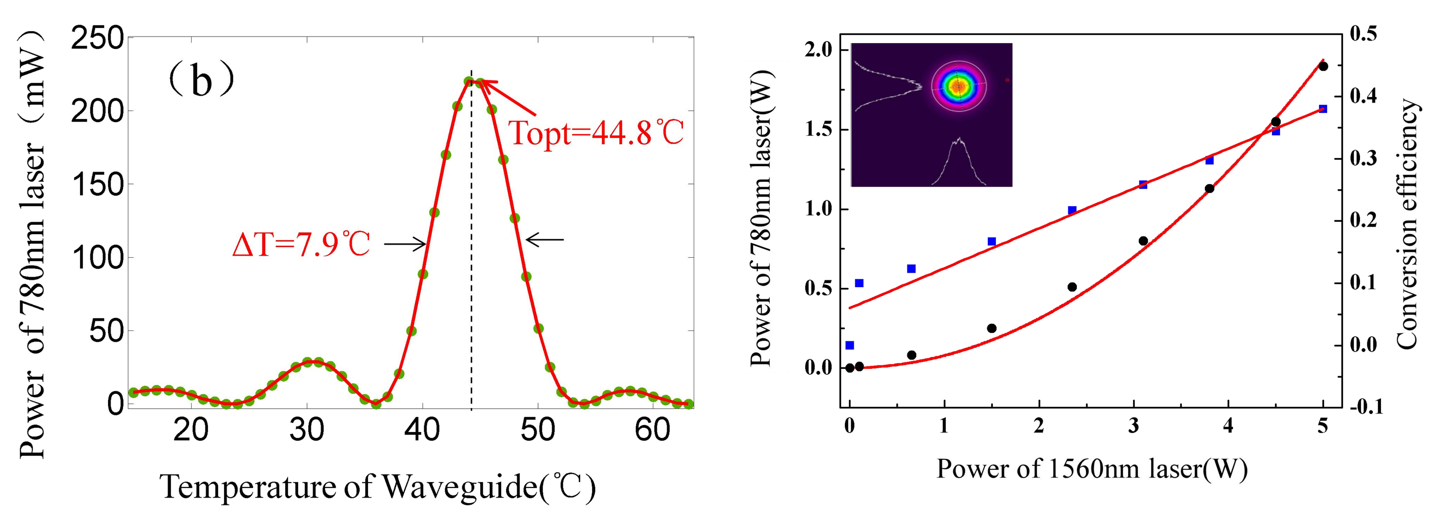
The schematic diagram of cold atom interference gravimeter

Based on single 1560nm fiber laser, a compact laser system for cold atom gravity is built. The Raman laser and trapping laser is modulated by EOM.

A. The generation of laser sources



trapping laser

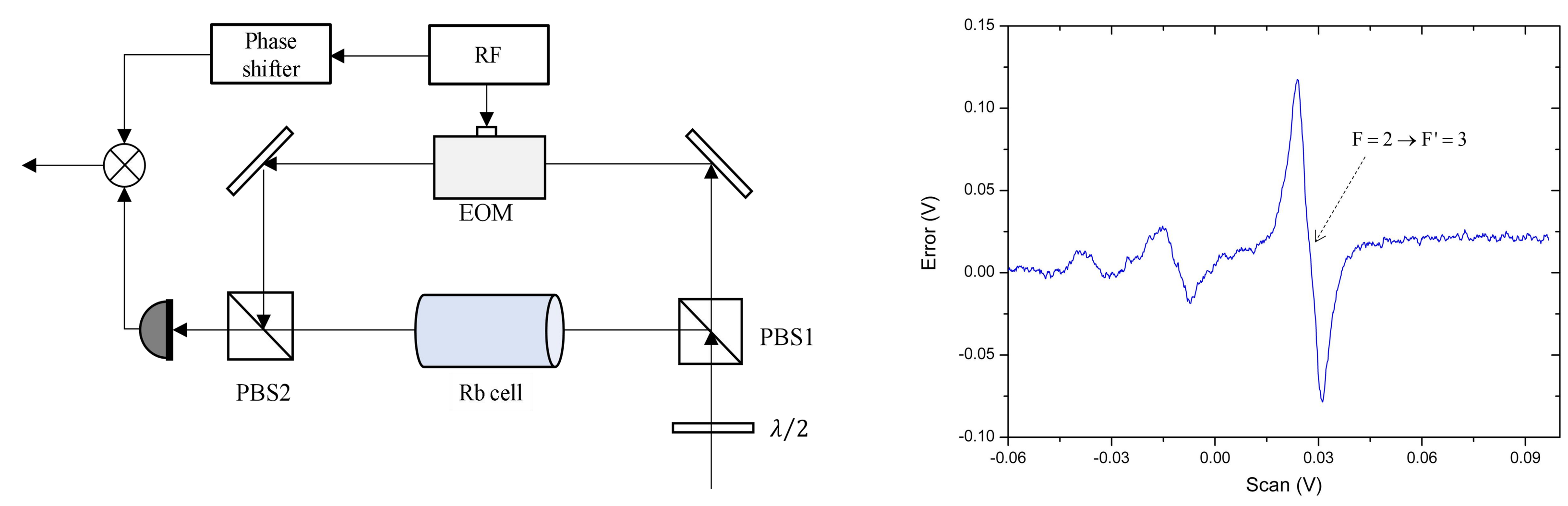


Raman laser

The frequency-doubling of PPLN waveguide

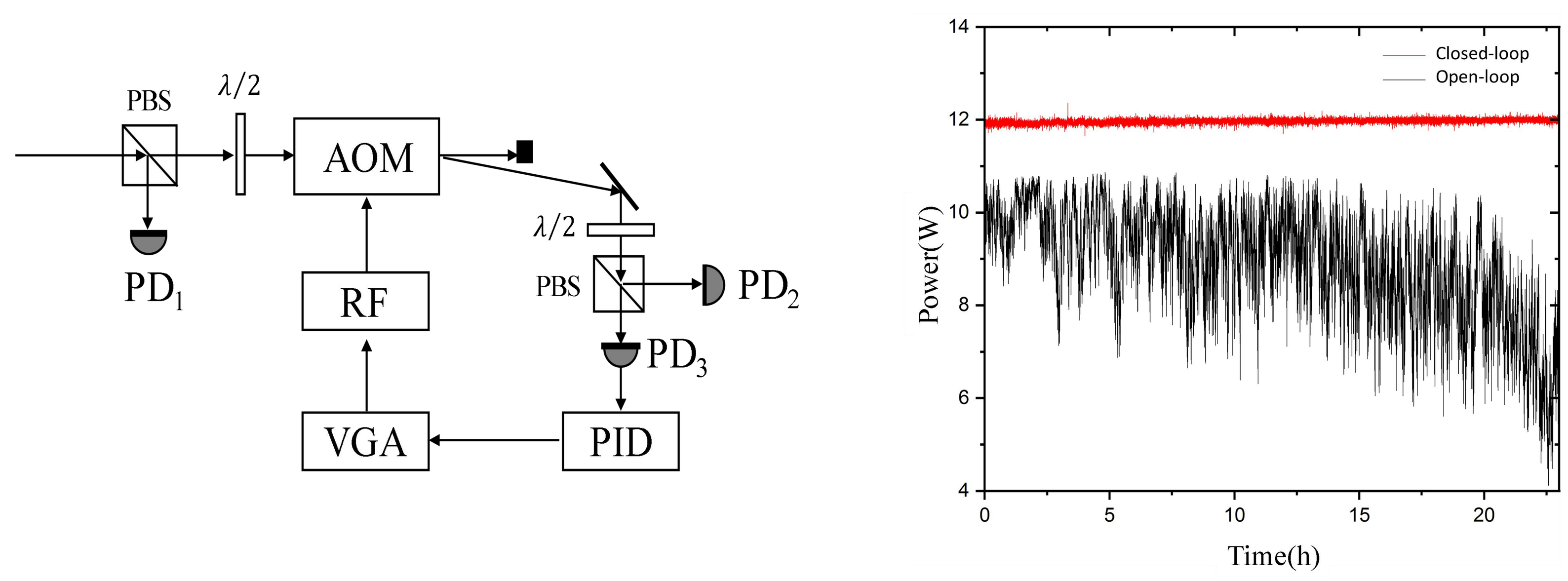
The 780nm laser for cold atom gravimeter is obtained based on frequency-doubling technology. The trapping laser and Raman laser are 1.1W and 1.9W, typically. The temperature tuning curves and conversion efficiency of both QPM waveguides are measured.

B. Laser stabilization



Laser frequency stabilization

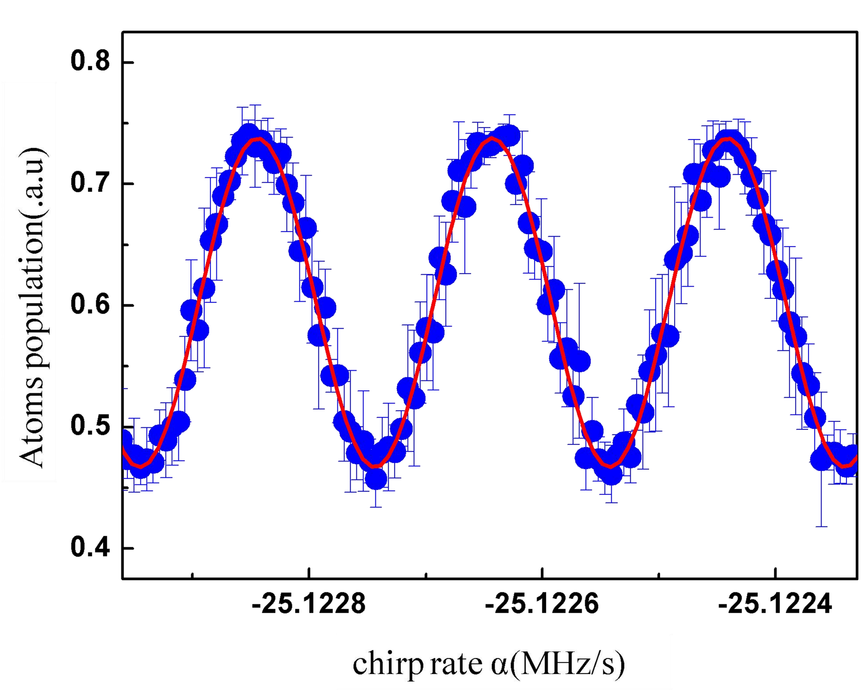
The laser frequency is locked to transition $5S_{1/2}$, F=2→$5P_{3/2}$, F'=3 by MTS. The contribution of error in gravity measurement is less than 1μGal.



Power stabilization

The power fluctuation is 0.34% after optical power stabilization based on AOM.

II. Atom interference



Interferometry fringe at T=70ms

The 120-point fringe phase-uncertainty is 22mrad, indicating to a sensitivity of 610μGal/√Hz.

conclusion

With miniaturization and integration of laser paths, a portable laser system for atom gravimeter is built. The laser parameters are stable during transport measurement. An acceleration sensitivity of 610μGal/√Hz is due to vibration noise.Moreover, there are also some aspects of this laser system need to be optimized and improved. The accurate temperature control of whole laser system can further improve the anti-environmental disturbance; and the precise measurement and evaluation of phase shift introduced by modulated sideband are required.