Absolute frequency measurement of molecular iodine hyperfine transitions at 554 nm and its application to stabilize a 369 nm laser for Yb+ ions cooling

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We investigate 13 hyperfine structures of transition lines of $^{127}I_2$ near 554 nm, namely, the R(50) 22-0, P(46) 22-0, P(121) 24-0, P(69) 25-1, R(146) 25-0, R(147) 28-1, P(160) 26-0, P(102) 26-1, R(96) 23-0, R(49) 22-0, P(45) 22-0, P(92) 23-0, and R(72) 25-1 transitions, and measure their absolute frequencies with an optical frequency comb. A 369 nm frequency-tripled laser is frequency stabilized by locking the 554 nm harmonic-frequency laser to the R(146) 25-0 a_{15} line of $^{127}I_2$ via modulation transfer spectroscopy. A frequency stability of 5×10^{-12} is observed over a 1000 s integration time. The measurement of the molecular iodine spectroscopy at 554 nm enriches high-precision experimental data, and also enables theoretical predictions. Meanwhile, the 369 nm frequency-tripled laser stabilized by molecular iodine spectroscopy has wide applications in frequency metrology, and quantum information processing based on Yb^+ ions.

The experimental setup is shown in Fig. 1. It consists of the light source, the iodine frequency stabilization, and the optical frequency comb measurement.

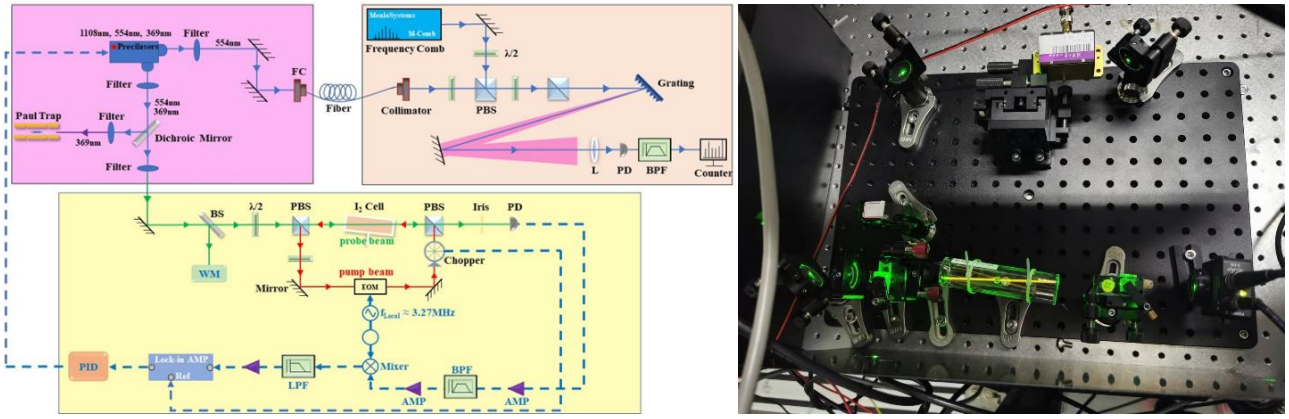

Fig. 1. Experimental setup. FC, fiber coupler; PBS, polarization beam splitter; λ/2, half-wave plate; L, lens; EOM, electro-optic modulator; Lock-in, lock-in amplifier; LPF, low-pass filter; BPF, band-pass filter; PD, photodetector; PID, electronic servo loop.