99.5% at 780 nm. The finesse of the cavity (including the losses of two faces of the atomic cell) is about $F = 20$. The length of the vapor cell is 7.5 cm. Thus we may obtain that the cavity bandwidth (the half-width at half maximum for the cavity) is about 21 MHz and the OPO efficiency (output coupling over total losses) about 20%. The temperature of the vapor cell can be controlled by a heater. A beam from a grating-stabilized diode laser is injected into a tapered amplifier (TA). The high power output from the TA then passes a standard polarization maintaining single-mode fiber, which is used as the cavity pump beam with an input power of 100 mW. The pump laser beam with the spatial mode filter by the optical fiber is easy to be mode-matched to the TEM_{00} mode of the optical cavity. This atom-cavity system is studied by monitoring the cavity reflection spectra using a scanned F-P cavity. We explore two different input and output configurations of the cavity to detect the different polarizations of the generated Stokes and anti-Stokes fields. One is that the pump field first passes through a polarized beamsplitter (PBS) and is injected into the cavity with horizontal polarization. The vertically-polarized component of the cavity reflection field is reflected by the same PBS, which mainly contains the generated Stokes and anti-Stokes fields with only a little pump field. The total reflected field then passes through an optical isolator and is monitored by a scanned F-P cavity. The other configuration is to use the pump field to inject into the cavity with circular polarization by passing through a $\lambda/4$ waveplate. The output pump field from cavity reflection is reflected by the PBS when passes through the $\lambda/4$ waveplate again. Thus, the total reflected field from the PBS contains the reflected pump field from the cavity and also the generated Stokes and anti-Stokes fields with the same polarization as the pump field inside the cavity.

Figure 3 presents the F-P cavity transmission spectra when the pump beam frequency is set at different positions as indicated in Fig. 2(a) and the pump, Stokes and anti-Stokes fields build up on resonance in the cavity simultaneously. First, as the pump frequency ω_p is tuned to the frequency as indicated by the arrow a, the F-P cavity transmission spectrum is given by Fig. 3(a). The pump beam power is set at 100 mW. The two nearby side peaks (separated from the large middle peak of the pump light by ± 6.8 GHz) are from the generated Stokes and anti-Stokes fields of the ^{87}Rb atoms, which oscillate above thresholds. The central peak and the free-spectral range (FSR) are for the pump beam. The different peak heights (corresponding to the output power) for the Stokes and anti-Stokes fields come from several mechanisms including the cavity detuning, the dependence of gain on the detuning of the pump field, and the variation of intracavity absorption by other atomic transitions (as can be easily seen from Fig. 2). The two outer small peaks on both sides are also the Stokes and anti-Stokes fields due

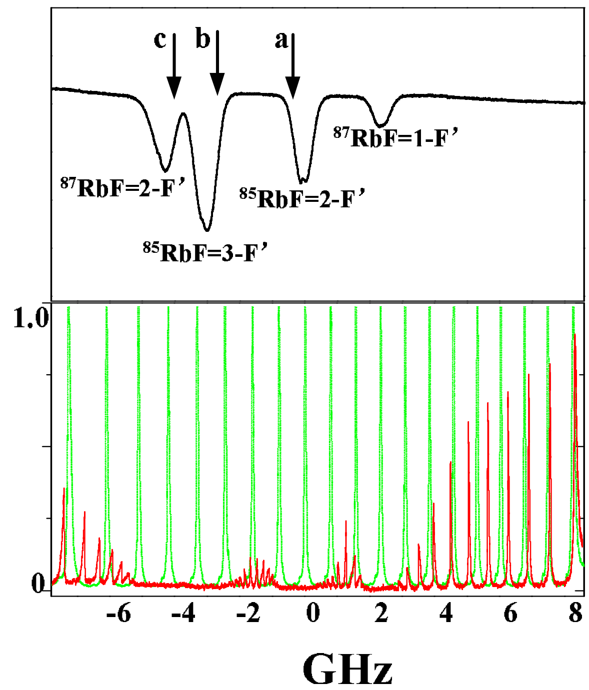

FIG. 2: (a) The saturated absorption spectrum is shown for the frequency reference of the pump light. (b) The weak-field cavity transmission spectrum with atoms inside the cavity (red line). The empty cavity transmission spectrum without atoms (green line).

to the periodicity of the scanned F-P cavity (i.e. FSR). As the pump frequency is tuned to the position marked by arrow b, the F-P cavity transmission spectrum given by Fig. 3(b) presents the generated Stokes field to be on resonance with the cavity and above threshold, where the three-level atomic system is ^{85}Rb atoms with the ground hyperfine state separation of about 3.035 GHz. The anti-Stokes field is absorbed inside the cavity below threshold. When the pump frequency is further tuned to the red side (arrow c), both F-P cavity transmission peaks for the Stokes and anti-Stokes fields appear simultaneously, showing triple-resonant oscillations for the atom-cavity system. Under both different polarization configurations of the cavity input field, we can detect the generated Stokes and anti-Stokes fields with different polarizations above thresholds.

The measurement of the oscillation threshold for the anti-Stokes field (shown in Fig. 3(a)) is presented in Fig.4. The cavity oscillation starts gradually at low input pump power, and saturates at high pump power as expected in a laser-like system. The threshold behaviors for the Stokes and anti-Stokes fields in other cases (for examples Figs. 3(b) and (c)) are similar. The total output powers of the Stokes and anti-Stokes fields can reach more than 1 mW when the pump power is about 100 mW, which indicates that such OPO system with multi-