Orbital angular momentum versatile vortex parametric laser

Chiba Univ. [1], MCRC [2], °Roukuya. Mamuti [1], Shungo. Araki[1], Shigeki. Nishida[1]

Katsuhiko. Miamoto[1], Takashige. Omatsu[1,2]

E-mail: omatsu@faculty.chiba-u.jp

Optical vortex, having an annular spatial form and orbital angular momentum owing to its helical wavefront, has been investigated in various research fields, for instance, optical trapping and manipulation [1], material processing [2], super-resolution microscopy [3]. The above-mentioned applications strongly desire tunable optical vortex sources with orbital angular momentum (OAM) and wavelength versatility.

In this presentation, we report on the demonstration of an OAM versatile tunable vortex laser with five OAM states ($\ell = 3 \sim -1$) based on a singly resonant optical parametric oscillator (OPO) formed of a non-critical phase-matching LiB_3O_5 (NCPM-LBO) crystal. Figure 1 shows a schematic diagram of a LBO-OPO and interferometer. The signal (high energy photon) and idler (low energy photon) share the OAM of the pump ($\ell_p = 2$) to establish the OAM conservation law. The topological charge of the signal and idler can be controlled by simply shortening or extending the cavity. The most intriguing fact is that the compact cavity configuration allows us to produce signal and idler with higher ($\ell_s = 3$) and negative ($\ell_i = -1$) OAM states according to the conservation law.

Figure 2 shows the signal and idler spatial forms and self-interference fringes in compact,extended and further extended cavities. The OPO produces five OAM states, i.e. the signal with $\ell_s = 3, 2, 1$ and the idler with $\ell_i = -1, 0, 1$. Also, the wavelength of output can be tuned from 0.74 μm to1.87 μm as shown in the Fig. 3.

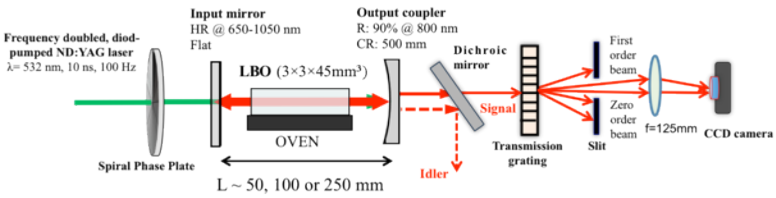

Fig.1 Experimental setup including LBO-OPO and interferometer

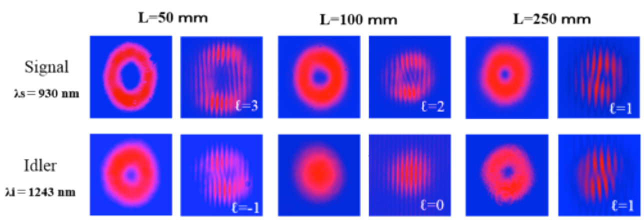

Fig. 2 Spatial profiles and wavefronts of the signal and idler outputs.

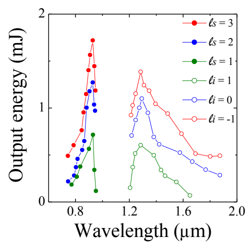

Fig. 3 Tunability of signal and idler outputs.

References

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