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空間位相変調器を用いた波長可変光渦光源の開発と吸収分光法への応用
Development of a Tunable Laguerre-Gaussian Laser by using a Spatial Light Modulator and its Application to Laser Absorption Spectroscopy

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Laguerre-Gaussian (LG) modes are the solutions of the Helmholtz wave equation in cylindrical coordinates. Figure 1 shows the phase plane of a LG beam. The phase plane is twisted around its axis of travel. The number of twists in one wavelength is called the topological charge *m*. Since the axis is a phase singularity, the intensity of LG beam has a ring-like shape. Recently, the LG beam is intensively studied in the field of singular optics, high resolution microscopy, and optical tweezers, etc. The three-dimensional phase structure may be a valuable feature for plasma spectroscopy. An atom moving in a plane wave does not feel the Doppler effect in the direction perpendicular to the wave vector, on the other side, the motion in the LG beam induces the Doppler effect in all the three dimensional directions [1]. We aim to develop a three dimensional Doppler spectroscopy method using the LG beam. In this study, we have developed a tunable LG laser using a spatial light modulator (SLM).

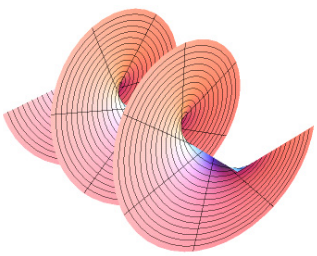

Fig. 1 Phase plane of LG laser.

Figure 2 shows the schematic diagram of the LG beam spectroscopy system. A Gaussian mode beam is obtained from an extended cavity diode laser (ECDL) tuned at 696 nm. In order to prevent the perturbation by the optical feedback from the back scattered light, a double stage optical isolator (60dB isolation) is placed in front of the ECDL. The elliptical beam shape of the ECDL is circularized using an anamorphic prism pair. The Gaussian mode beam is coupled to a polarization maintaining fiber (PMF). The PMF purifies the beam shape. The collimated output beam of the PMF illuminates the SLM. The Gaussian mode beam is converted to LG mode beam by a computer generated hologram (CGH) drawn on the SLM by a personal computer (PC). The order of the LG beam is controlled by changing the CGH. The generated LG beam is introduced into a test plasma, and the spatial distribution of the absorption spectrum will be recorded by a CCD camera. Figure 3(a) shows the CGH calculated to generate $m = \pm 1$ mode LG beam. Figure 3(b) shows $m = 0$ and ± 1 mode LG beam generated by the CGH. The generated LG beam is applied for the absorption spectroscopy of the test plasma. The detail of the LG beam source and preliminary results of the absorption spectroscopy using the LG beam will be presented.

[1]L.Allen, M. Babiker, W.L. Power, Optics Communications **112** (1994) 141.

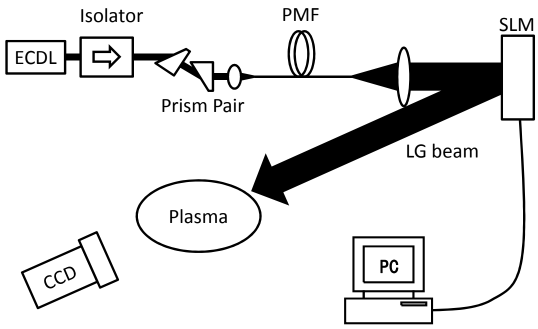

Fig. 2 Setup for LG laser spectroscopy.

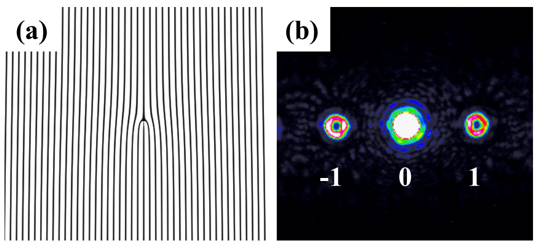

Fig. 3 (a) Computer generated hologram, (b) m = 0 and ± 1 mode LG beam generated by the CGH.