03aE14P

フェムト秒レーザーを用いたアルゴン原子のエネルギー準位制御

Energy levels regulation of argon atom using femto-second laser

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LIF spectroscopy using a narrow-bandwidth tunable laser, e.g., tunable diode laser, is capable of directly measuring the velocity distribution function. High precision measurement of the flow velocity field of slow neutral particles less than 10 m/s in an electron cyclotron resonance plasma is possible [1]. The usability of LIF spectroscopy is well recognized in the plasma research area, and this method has been widely introduced in plasma. However, the conventional LIF method strongly depends on population of the target particles which are generated by collisional excitation. Realization of a LIF system free from the experimental conditions is desirable.

We are developing an active-LIF spectroscopy system using a femto-second (FS) laser. It is expected that this system is capable of changing the population of target particles by its strong electric field.

We are experimentally investigating the interaction between the FS laser and an argon plasma by measuring the increment of plasma emission spectrum with a CCD spectrometer. Furthermore, simultaneous injection of the FS laser and a Ti:Sapphire (TiS) laser which is a narrow-bandwidth tunable laser is carried out to examine the improvement of controlled performance.

A schematic diagram of optical system is shown in Fig.1. The FS laser pulses with the wavelength of 780±20nm, repetition rate of 80 MHz and pulse width 70 fs is used, and the laser intensity of FS laser is 10^6 W/cm^2. The TiS laser with the wavelength tuned to the resonance absorption line of argon is also injected into the plasma. The emission light (wavelength range of 200 nm to 1,100 nm) is collected by a lens, and detected by a CCD spectrometer through an optical fiber cable.

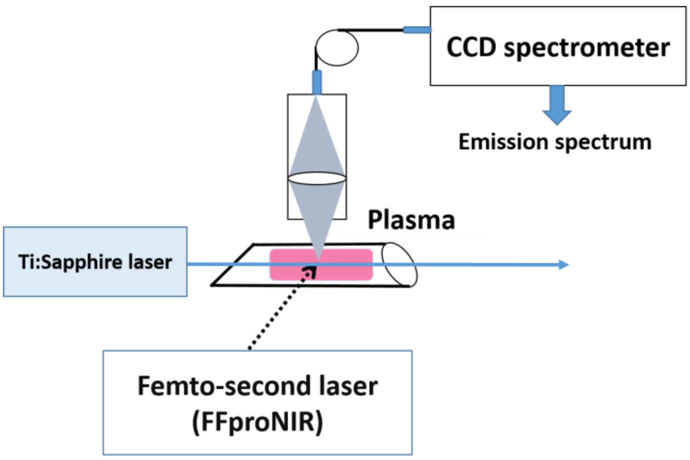

Fig. 1 Schematic diagram of the optical system.

Figure 2 shows the variation of emission spectrum, which is obtained by subtracting the emission spectrum without the lasers. The wavelength of TiS laser is set to 811.7542 nm. As seen in the Fig.2, some significant increments in the emission spectrum can be found. This indicates that the population of each energy levels is changed through the interaction with the lasers. Furthermore, there is a possibility that stimulated emission takes place at wavelength of 811.7542nm. Stimulated emission may improve the signal–to-noise ratio of LIF spectroscopy. The detailed results will be given in the poster session.

This work was supported by JSPS KAKENHI Grant number 23244112

[1] M. Aramaki et al., Rev. Sci. Instrum. **80** (2009) 053505

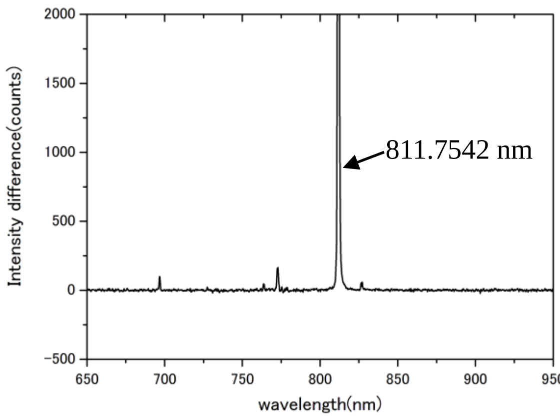

Fig2. Increment of emission spectrum with the application of lasers