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アルゴン $4s[3/2]^o_2 - 5p[3/2]_2$ スペクトルの飽和吸収分光計測

Saturation spectroscopy of argon $4s[3/2]^o_2 - 5p[3/2]_2$ transition spectrum

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Introduction The measurement of electric field in the sheath and presheath regions is important to understand and to control the ion-surface interaction. However, the measurement method based on laser-induced fluorescence-dip spectroscopy, which has very high sensitivity for electric field requires high operation skill and equipment costs. To reduce these difficulty, we are developing an another Stark spectroscopy system to measure electric field in argon plasma by using saturation spectroscopy. Saturation spectroscopy is a kind of laser absorption spectroscopy and achieves Doppler-free spectral resolution. High frequency resolution of the saturation spectrum is required for a sensitive Stark spectroscopy. In this work, we investigated the line width of the the saturation spectrum of argon $4s[3/2]^o_2 - 5p[3/2]_2$ transition line.

Experiment The experimental apparatus is shown in Fig. 1. The plasma source was a inductively coupled plasma source in a vacuum chamber which was a cylinder of 26 cm diameter. The light sources were a tunable cw diode laser. The frequency of the laser was scanned around the transition (415.859 nm) with the scan speed of 10 MHz/s. A small fraction of the laser beam was picked up for a weak probe beam, and the remain intense beam was used for a pump beam. The probe laser beam and the pump laser beam were injected into the chamber on the same chord of the adjacent of the planner electrode surface with counter direction each other. The probe laser beam was picked up by a beam sampler and detected by an avalanche photo diode. The pump beam was modulated by a optical chopper with 1 kHz. A lock-in amplifier was used to amplify the difference of absorbance between with and without the pump beam.

Results and Discussion At the optimized discharge condition (3 mTorr Ar gas, 50 W RF power), the absorption of probe beam was 2% and the saturation parameter was 0.23. A result of saturation spectrum of $4s[3/2]^o_2 - 5p[3/2]_2$ is shown in Fig. 2 with a solid line. The fitted Lorentzian function is also shown in Fig. 2 with a dotted line. The estimated FWHM of the saturation spectrum is 3 MHz. However, the both side of the saturation peak are more sharp than the fitted Lorentzian function. One of the possible reason is that the line width is determined by the stability of the diode laser rather than the homogeneous line width of the transition.

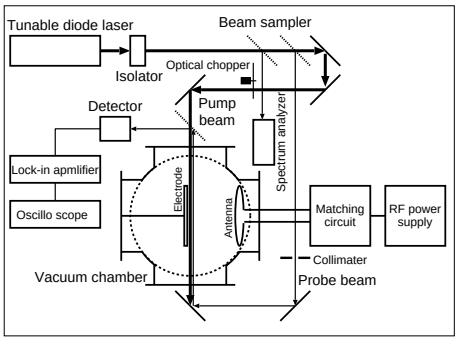

Fig.1: Experimental apparatus.

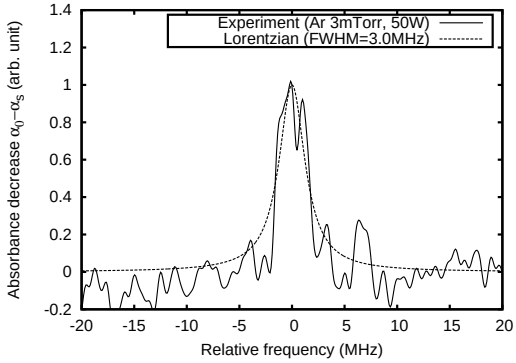

Fig.2: Saturation spectrum of Ar $4s[3/2]^o_2 - 5p[3/2]_2$ transition line and fitted Lorentzian function.

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