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Gas Pressure Dependence of Turbulence Characteristics Observed with Multi-channel Spectroscopic Tomography in Linear Cylindrical Plasma

非平衡極限-多チャンネル分光分析トモグラフィで見た直線プラズマ乱流特性のガス圧依存性

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In order to understand plasma turbulence, we perform multi-channel spectroscopic measurement in a linear plasma device, named PANTA. The system consists of four detector arrays installed at four azimuthal angles of 0°, 45°, 90°, 135°, and each detector array has 33 line of sights arranged at 5 mm intervals. This paper presents dependence of characteristics in light emission in blue range (ArII) on argon filling gas pressure. In near future, we are planning to measure the emission in red range (ArI) that has not been taken, and to study local plasma fluctuation and structure by using tomography algorithms.

1. Introduction

In order to realize high-performance fusion plasma, understanding of plasma turbulence that influences magnetically confined plasmas is essential. Plasma turbulence is composed of multi-scale fluctuations that are nonlinearly coupled with each other. Therefore it is required to measure global and local structure of plasma turbulence simultaneously. As a method to satisfy such requirements, for observing the plasma turbulence globally, with fire resolution, we develop a spectroscopic system for tomographic reconstruction of line-integrated light emission in a linear plasma device, named PANTA (Plasma Assembly for Nonlinear Turbulence Analysis) [1]. The system consists of four detector arrays installed at four azimuthal angles of 0°, 45°, 90° and 135°, and each detector array has 33 line of sights arranged at 5 mm intervals. The detector can receive light of blue, red, infrared, and ultraviolet range. This article presents dependence of the spectral characteristics on argon filling gas pressure

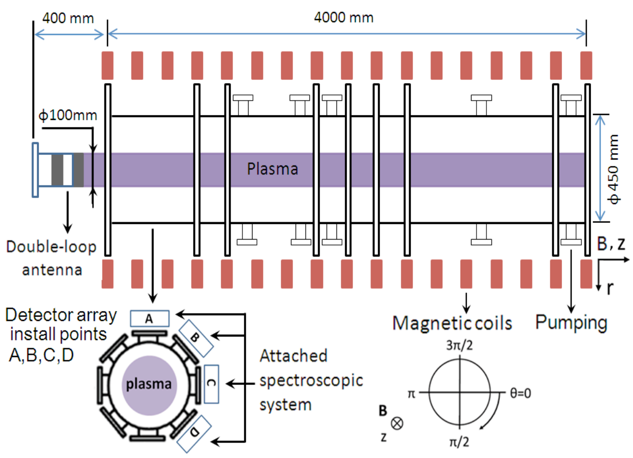

Fig.1 Schematic view of PANTA and the disposition of spectroscopic system

in light emission in blue range.

2. Experimental Device

Figure1 shows schematic views of PANTA and the spectroscopic system[2]. In PANTA, cylindrical linear plasmas are produced by helicon wave. The radius of the plasma is 50 mm. plasma radius is determined by the radius of the double loop antenna of Figure 1. Each detector array covers the whole plasma area completely. Operation parameters are magnetic field of 900 G, radio-frequency power of 2kW, and electron temperature of 3eV. In this experiment, we observe the dependence by changing the neutral gas pressure from 1.0, 2.0 and 3.0mtorr.

3. Experimental Results

Figure2 shows an experimental result of emission profiles when gas pressure is 1.0, 2.0 and 3.0 mTorr. Emission intensity has a maximum in L=-5 mm. It is found that this plasma is radially asymmetry. The absolute intensity and effective radius of the plasma decrease as the gas pressure increases from 1.0 to 3.0mTorr. Figure3 shows the power spectrum of the line-integrated emission at the center of the device calculated by the fast Fourier transform. We can see several coherent fluctuations in every gas pressure consition. In particular, in the case of 3.0 mTorr, harmonic peaks are found with the fundamental frequency at 1.2 kHz, and existence of nonlinear phenomenon with quasi-periodic oscillation is suggested[3]. Here, normalized fluctuation amplitude $\delta I/I$ is evaluated, where I and δI are the emission intensity and its fluctuation amplitude, respenctively. Figure 4 shows normalized fluctuation amplitude dependence on gas pressure 1.0, 2.0 and 3.0 mTorr. The nomalized fluctuation amplitude $\delta I/I$ at the center is 5.43×10^{-3}, 2.82×10^{-3} and 3.13×10^{-3} for 1.0, 2.0 and 3.0 mTorr, respectively. It is found that the nomalized fluctuation amplitude becomes smaller as the gas pressure increases.

4. Sammery

We are investigating gas pressure dependence of turbulece characteristics of line integral data of the emission intensity in PANTA. We are currently developing tomography algorithms for this spectrospopic system in order to know local date of the plasma. By using the algorithms, we are planning to study structure and local plasma fluctuation, and their dependence on the gas pressure. We will report the details of the above-mentioned results and a future plan in this conference.

References

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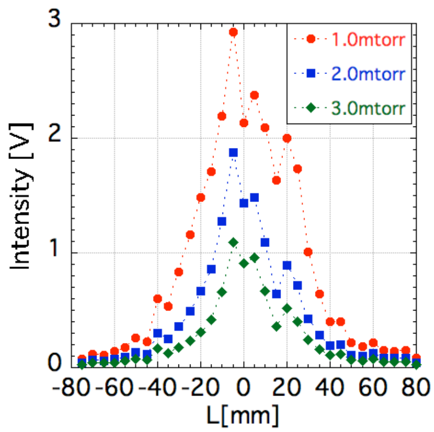

Fig.2 Dependence of emission intensity profile on the gas pressure 0.8, 1.0, 1.5 and 3.0 mTorr

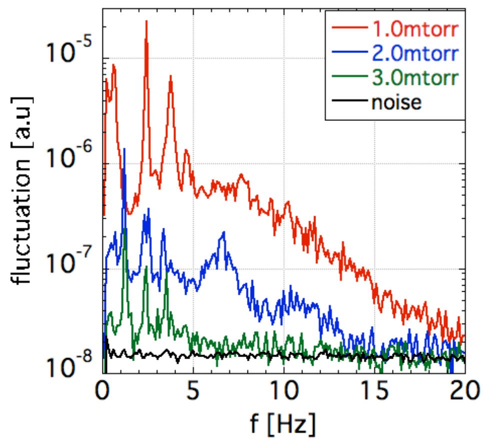

Fig.3 Power spectra of the emission intensity at L= 0 mm

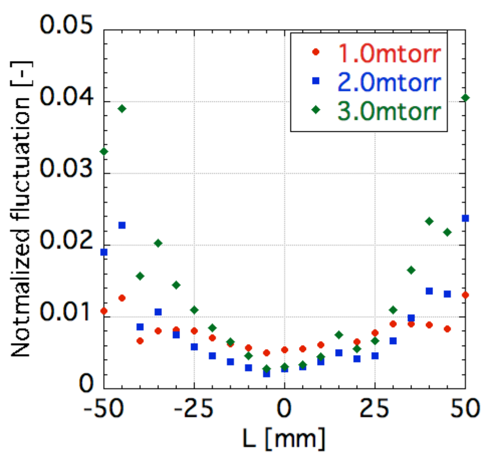

Fig.4 Normalized fluctuation amplitude on gas pressure 0.8, 1.0, 2.0 and 3.0 mTorr