§3. Plasma Diagnosis for GAMMA10 with VUV Spectroscopy

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Emission lines in the VUV wavelength range are observed for the plasmas in GAMMA 10. The spectrometer has a focal length of 320 mm and is equipped with a holographic toroidal grating with 550 grooves/mm. The reciprocal wavelength dispersion is 1.75 nm/mm. The entrance slit can be alternated between 0.1, 0.25, and 0.5 mm depending on the purpose of the observation. A CCD (charge coupled device) is used as the detector. The pixel size is 14 μm square and the detection area consists of 2048 pixels in the direction of wavelength dispersion times 14 pixels in the perpendicular direction. The wavelength range simultaneously measurable is approximately 25 nm.

Figure 1 shows the spectra measured at the central part of GAMMA 10. The central wavelength is changed shot by shot and the wavelength range from 5 nm to 80 nm is covered with successive four measurements. In the wavelength range longer than 80 nm no emission lines are observed. In each observation the signal is accumulated during the entire discharge time. The wavelength resolution appears generally worse at both the edge regions in each measurement than that at the center. This is because the detector surface is flat while the focusing points of the toroidal grating draw a circle, the so-called Rowland circle.

In Fig. 1 the positions and expected relative intensities of the O II–V and C II–IV emission lines available at the NIST[1)] database are also shown. The lines observed in the region of 10–25 nm are found mainly coming from the O V ions. The detailed identification of the observed emission lines is being carried out.

On the other hand, the preparation of the population-alignment collisional-radiative (PACR) model is also in progress in view of analysing the obtained spectra. Besides the population distribution over the excited levels, the PACR model calculates the population imbalance among magnetic sublevels which could be evoked by anisotropic particle collisions. The eventual objective of this study is to determine the anisotropic electron velocity distribution function in the plasma. The PACR models for the He I, C V, and O V ions have been constructed to date.

The most important part of the PACR model is the atomic data such as the excitation cross section due to electron collisions. Generally, the production of those data is so difficult that the data availability is critical whether the construction of PACR model for a specific ion

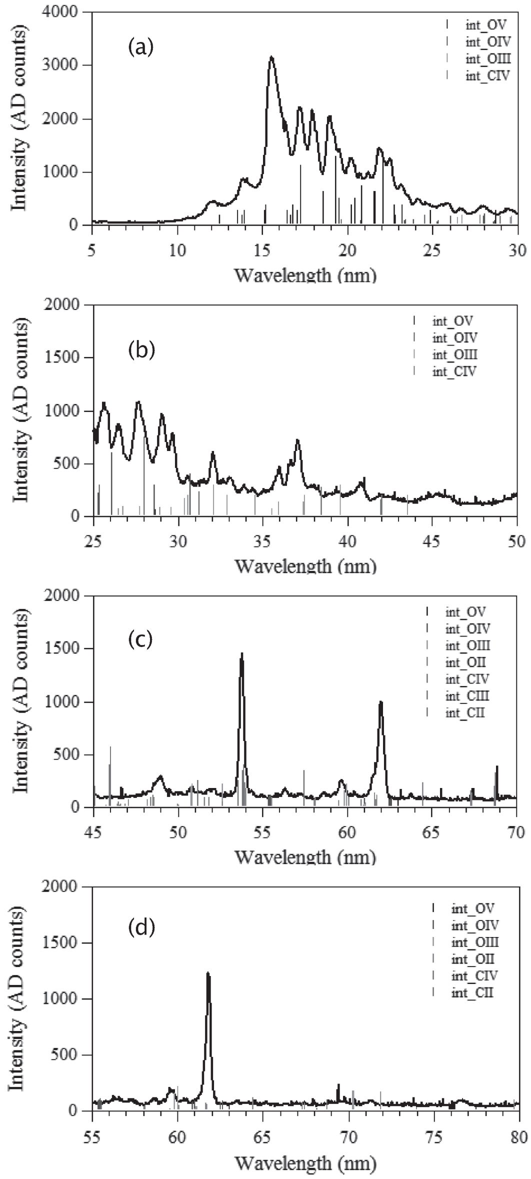

Fig. 1. Spectra measured at the central part of GAMMA 10. The wavelength range of 5–80 nm is scanned with four discharges. The vertical bars indicate various oxygen and carbon lines taken from the NIST[1)] database.

is possible. However, since the release of a computer code named FAC (flexible atomic code)[2)], the situation is being changed. It is rather easy to calculate atomic data required for the PACR model for any ion. We have constructed a PACR model for the O V ion and the results are being examined. It is, however, known that the present FAC code has several problems: the excited level energies calculated with FAC generally have rather large errors and the accuracy of the data for low ionized stage ions are questionable. Nevertheless, employing FAC has great benefit and the continuous improvement is hoped.

1) NIST Atomic Spectra Database, http://physics.nist.gov/PhysRefData/ASD/
2) M. F. Gu, ApJ **582**, 1241 (2003).