Sensitive measurement of sheath electric field by Stark spectroscopy using the Balmer-alpha line of atomic hydrogen

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The measurement of sheath electric field has focused on using high Rydberg states for a long time since they have sensitive Stark effects to weak electric fields. However, Rydberg states are difficult to detect because of their small transition probabilities. In this work, we shifted our approach from Rydberg states to lower-lying energy states. Lower-lying energy states can be detected easily because of large transition probabilities. The less sensitive Stark effects of lower-lying states are compensated by employing saturation spectroscopy which has ultrafine, Doppler-free spectral resolution. We demonstrated the measurement of sheath electric field in an inductively coupled hydrogen plasma by measuring the Stark spectra of the Balmer-alpha line of atomic hydrogen. We realized a sensitive detection limit of 10 V/cm and a fine spatial resolution of 0.2 mm by the developed method. Since the developed method utilizes an economical, maintenance-free diode laser system, it may be useful in various experiments which need the measurements of electric fields in plasmas.

References

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