Electric Fields Measurements With A Metastable Hydrogen Beam

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When a hydrogen atom prepared in the metastable fine structure quantum state $2s_{1/2}$ is exposed to an external electric field, it may make a transition into $2p_{1/2}$ (separated by the well-known Lamb shift) through Stark mixing. This state is highly unstable and the atom quickly decays to the ground state emitting Lyman-α radiation with an intensity proportional to the square of the electric filed in the weak field limit. Detecting the emitted radiation from a test metastable hydrogen beam injected in a plasma provides a method to non-intrusively measure the local static or fluctuating electric field [1].

Measurements of the Lyman-α intensity follow the theoretical law as long as the field amplitude is not too large. A saturation of the signal has been observed at strong field amplitudes. This was explained through oscillatory and geometrical mechanisms. Profile measurements have been made for a constant electric field between two plates both in vacuum (to allow easy comparison with predictions) and in a plasma [2]. Results with a radio-frequency electric field are presented: for example, we observe a strong enhancement of the signal when the electric field oscillates at the Lamb shift frequency ($\approx$ 1GHz).

References

[1] F. Doveil, A. Lejeune, and L. Chérigier-Kovacic, Phys. Plasmas, **20**, 055701 (2013)
[2] P. Ström, Master of Science in Physics from Uppsala University, internal PIIM report (2013).