

Optical spectrometer for measuring the relative density of the atomic hydrogen and molecular hydrogen in the ABS source

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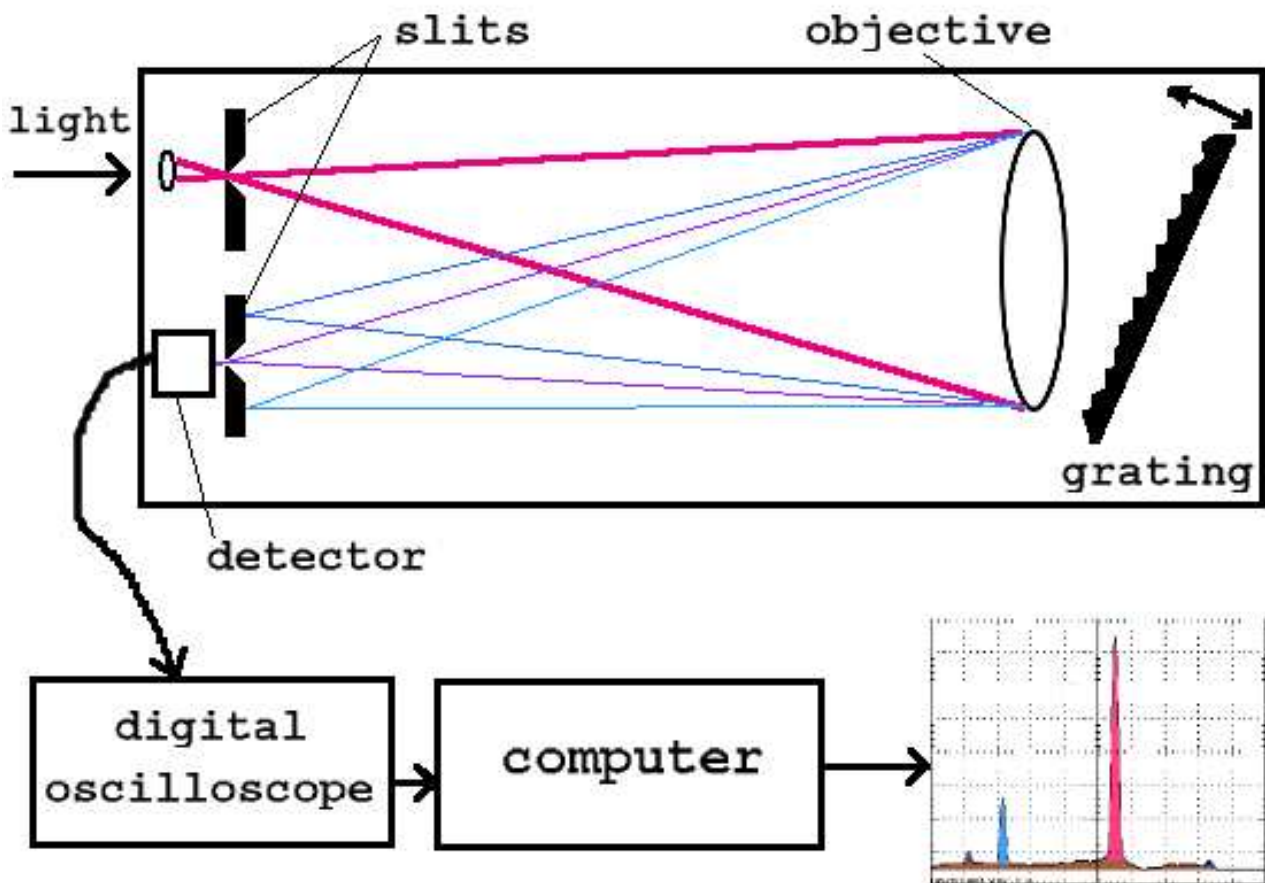
WHAT

- A compact optical spectrometer to measure the atoms/molecules ratio \bar{A} along the dissociator tube of an atomic beam source for hydrogen
- \bar{A} is evaluated from the ratio of sum of amplitude H_α , H_β and H_γ lines and an integral of recorded hydrogen molecular lines

$$\bar{A} = \frac{I_a}{I_a + I_m}$$

WHY

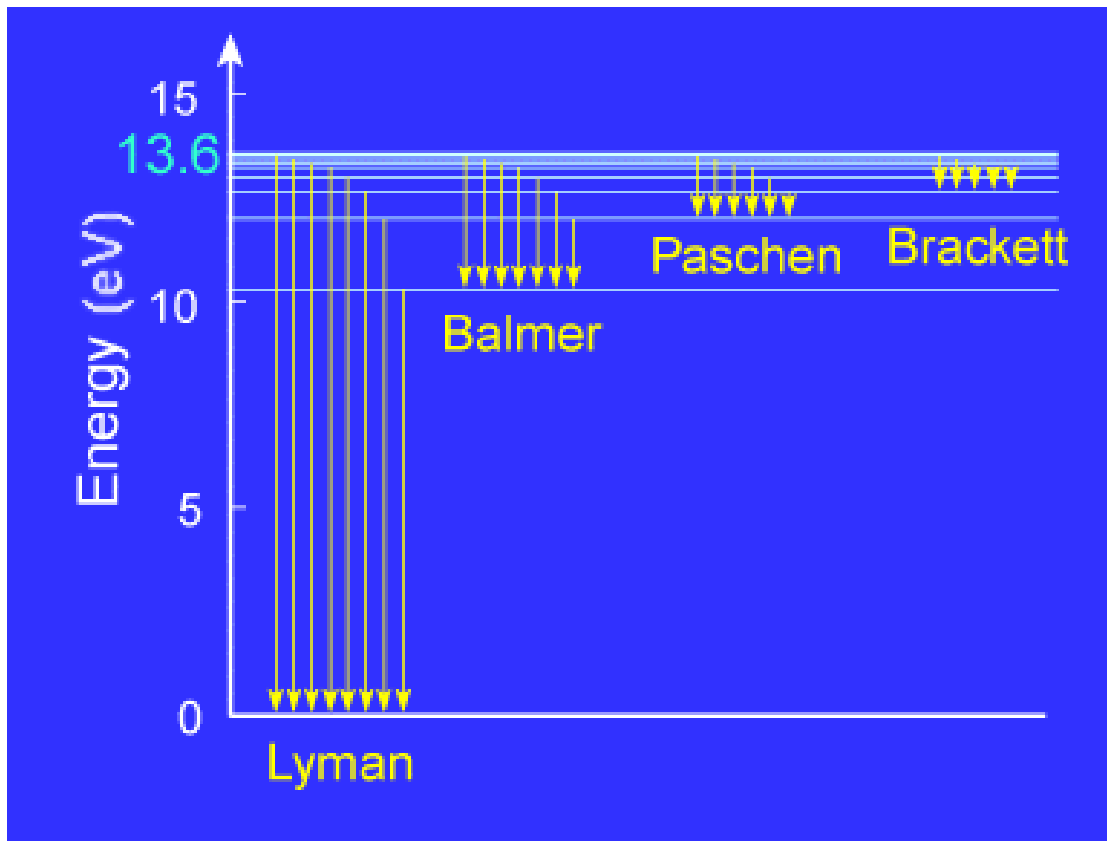
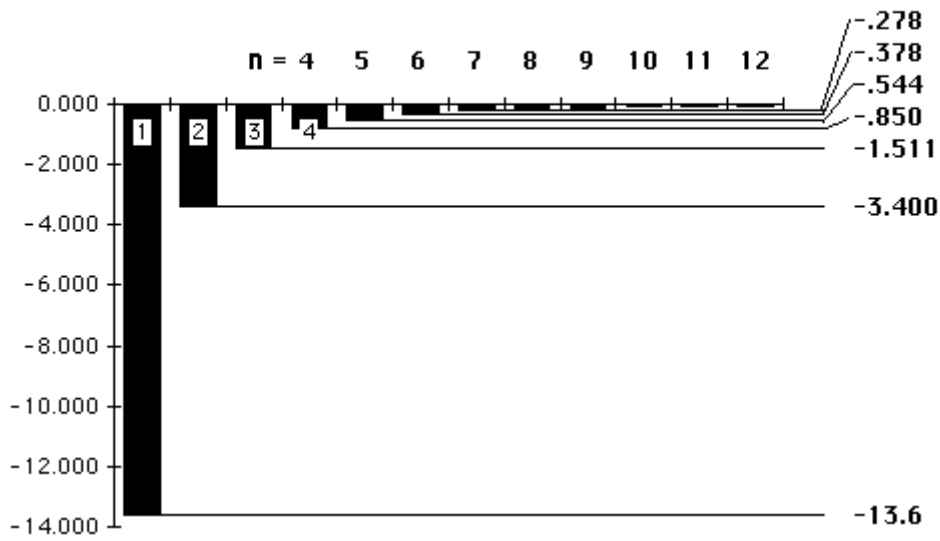
- First approach to optical diagnostic systems for polarized gases in ABSs (Atomic Beam Sources) and cells



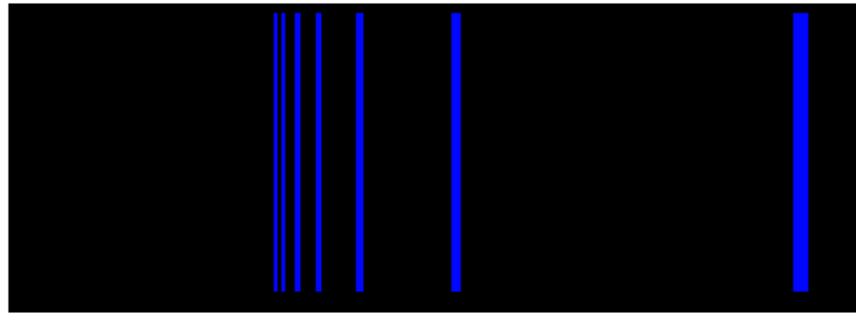
The spectrometer consists of a rotating grating (2500 lines per mm), one achromatic lens, two slits and a sensitive photo-detector connected to a computer. The spectrometer is fed by a 10m optical fiber through which light from ABS discharge tube comes to the spectrometer. Due to the rotation of the grating, the detected ABS spectrum is scanned and the intensity of hydrogen (H_{α} , H_{β} and H_{γ}) spectral line and intensity of hydrogen molecular lines (decay from $(a)^3\Sigma_g$ molecular state to $(b)^3\Sigma_u$ molecular state [*]) are recorded.

[*] A. Rousseau et al., J.Phys. D: Appl. Phys. **27**, 1412 (1994)

Scaled plot of hydrogen levels in eV



Lyman Series



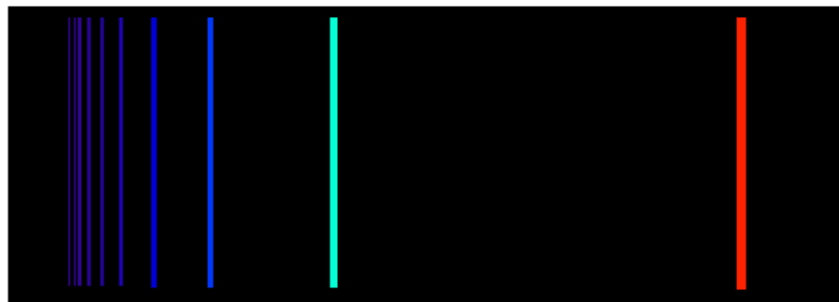
80

100

120

wavelength [nm]

Balmer Series



400

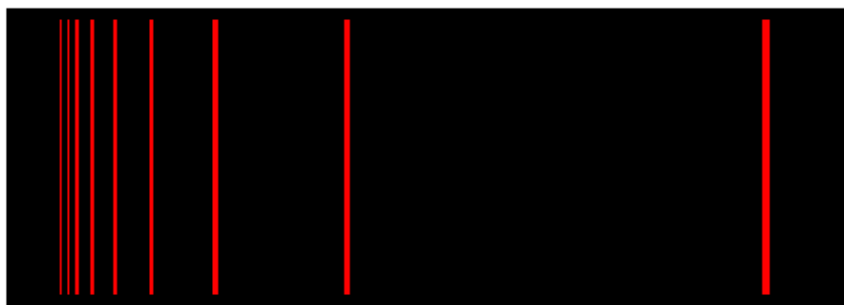
500

600

700

wavelength [nm]

Paschen Series



1000

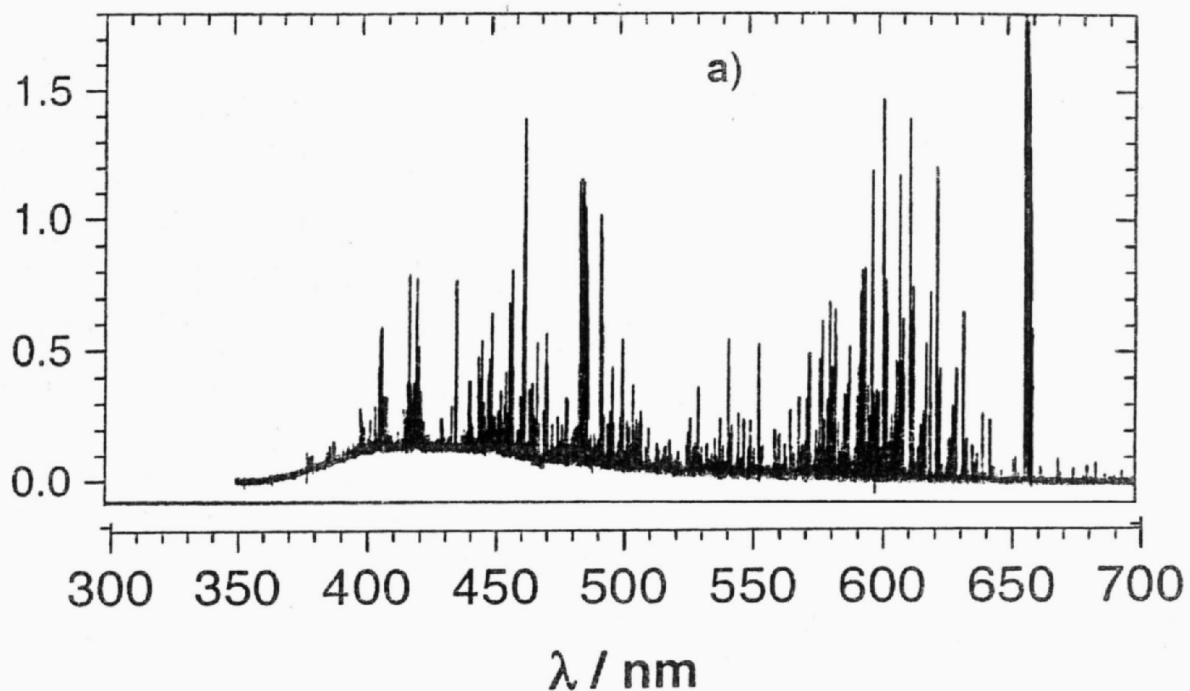
1500

2000

wavelength [nm]

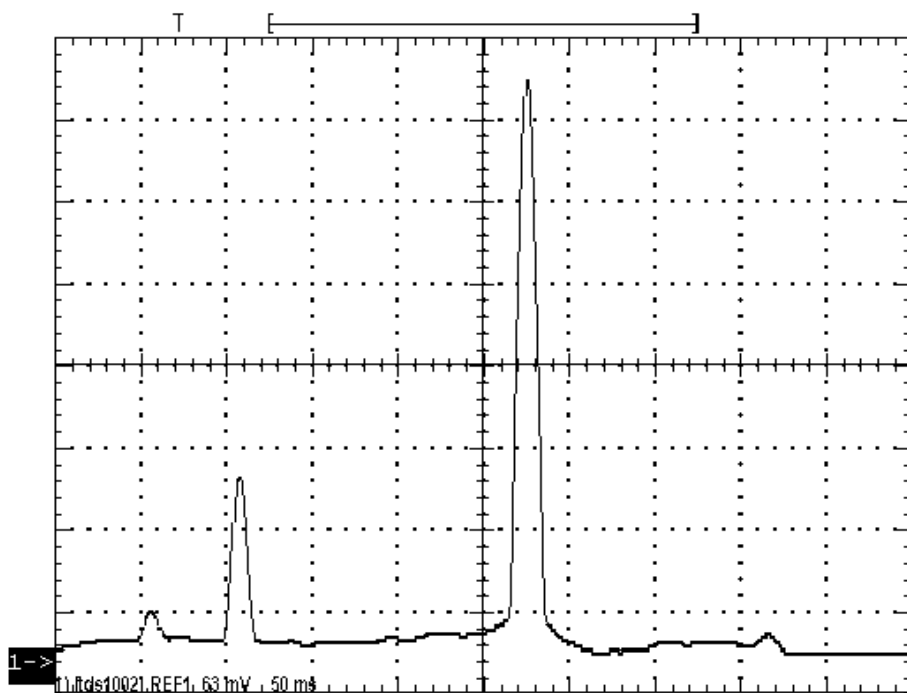


Hydrogen spectrum from glow discharge tube

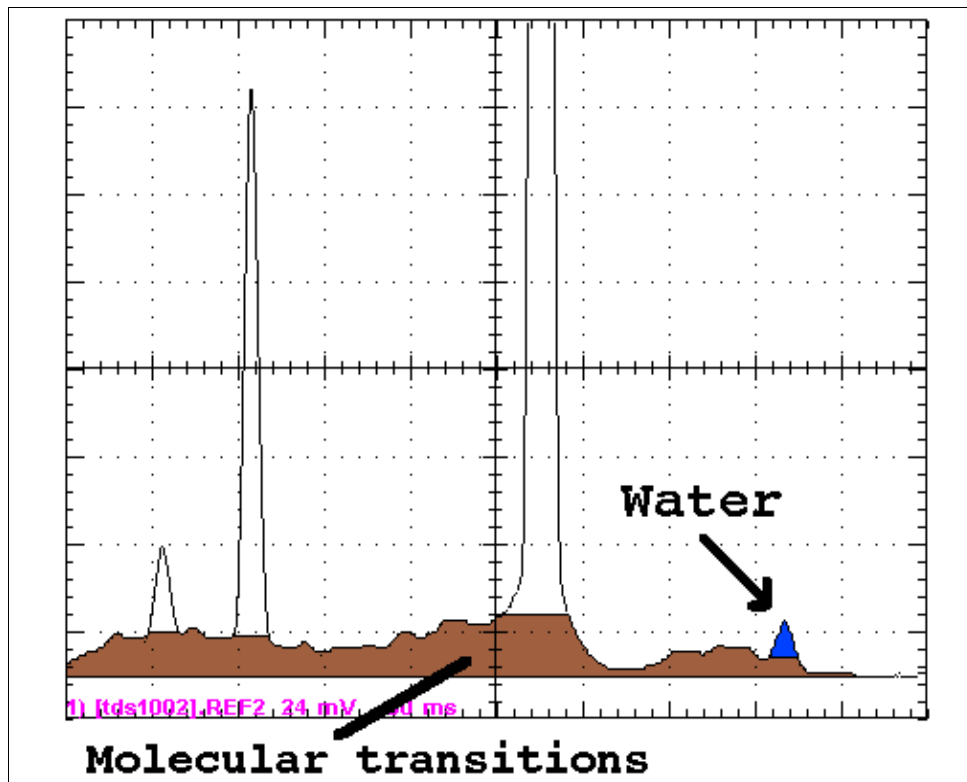
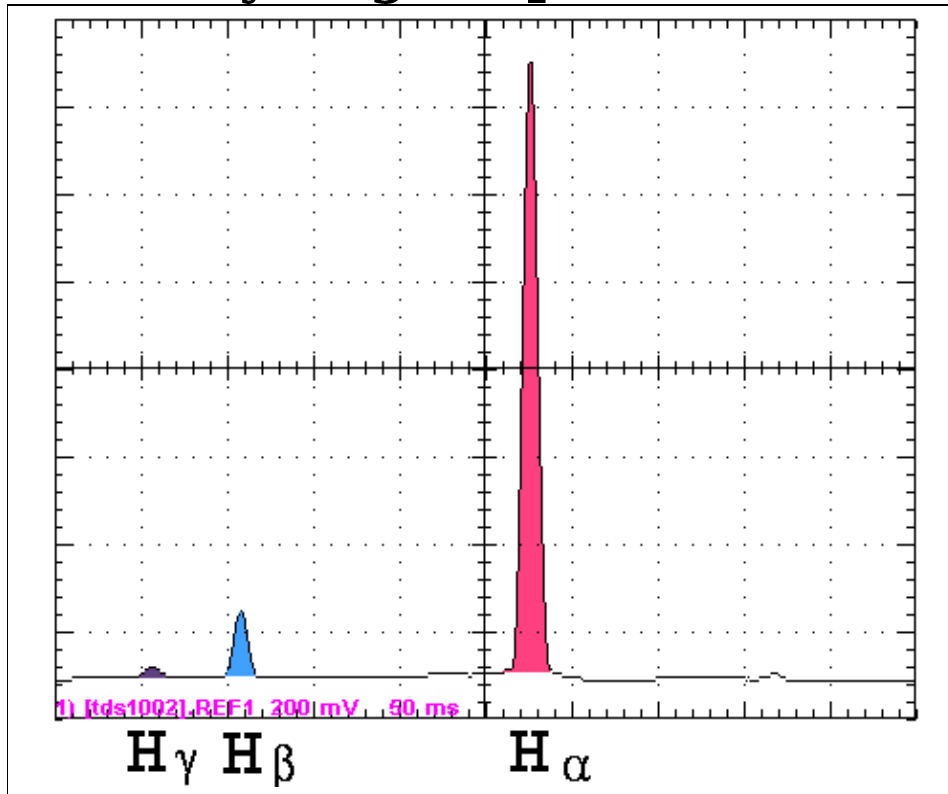


optical transition (a) $^3 \Sigma_g^-$ - (b) $^3 \Sigma_u^-$ state of hydrogen molecules
(J. Phys. D:Appl Phys. 33 (2002))

Hydrogen spectrum from Ferrara RF discharge tube



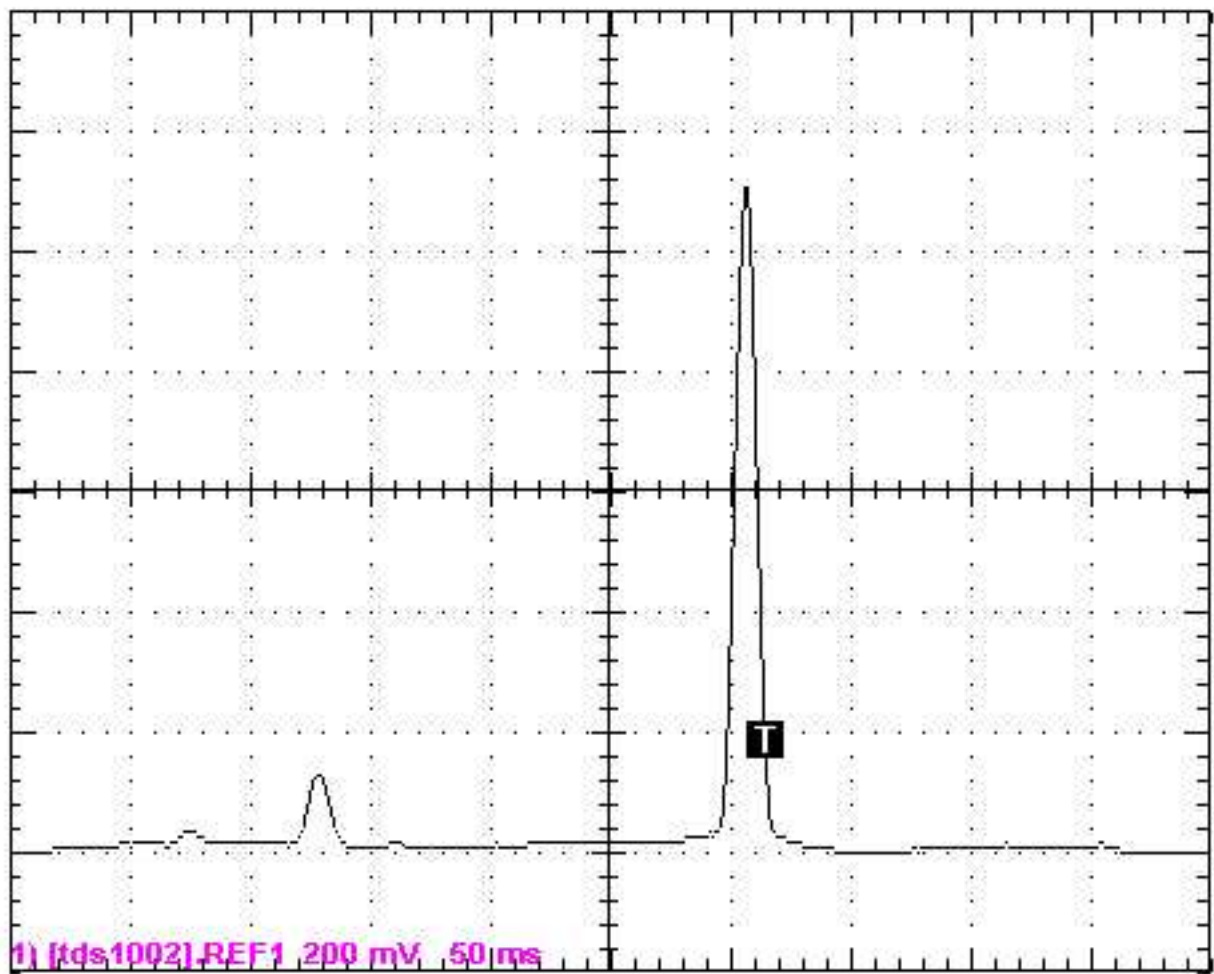
Hydrogen spectrum



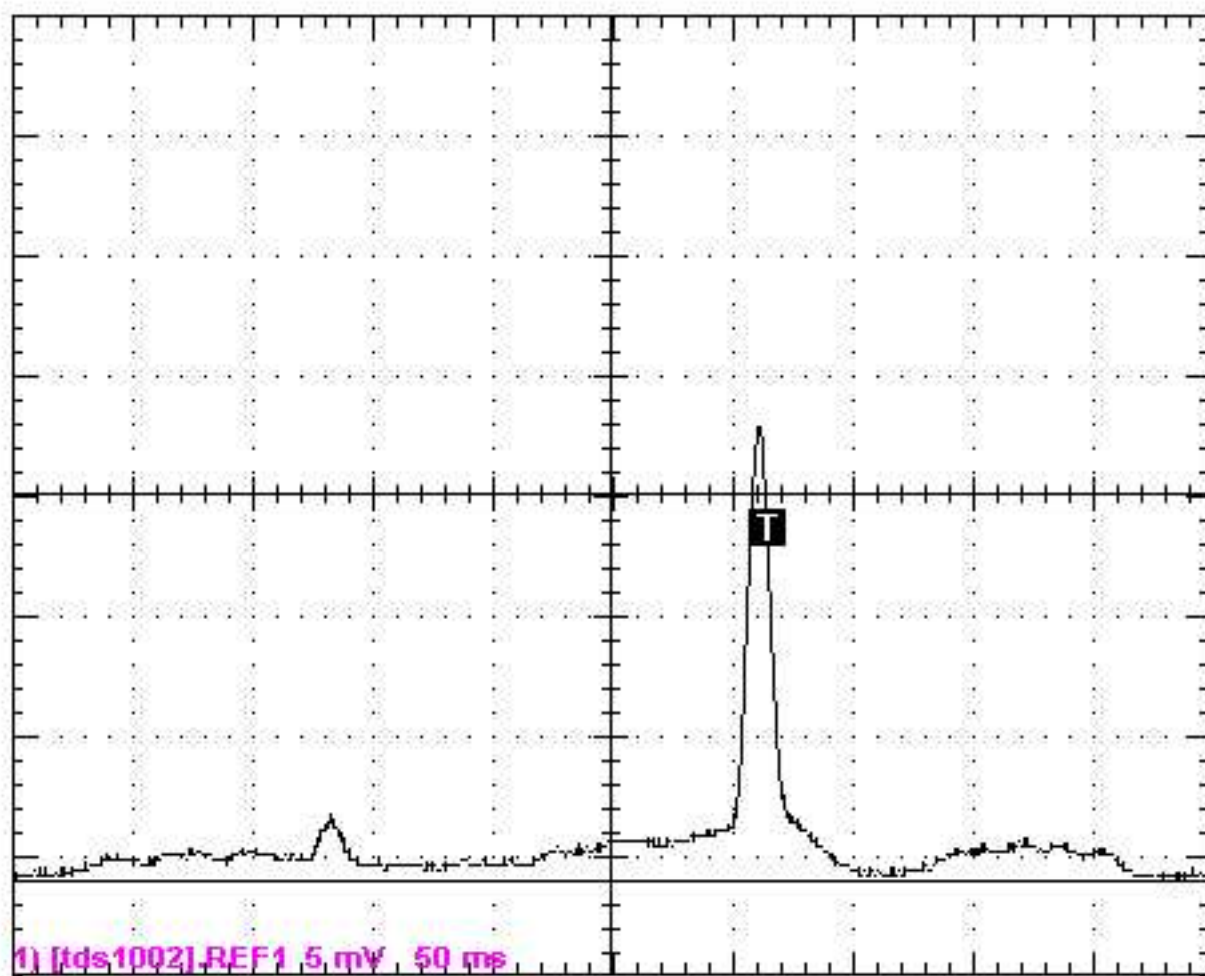
pressure ~ 1 mbar

RF: frequency 124 MHz, power 25 W

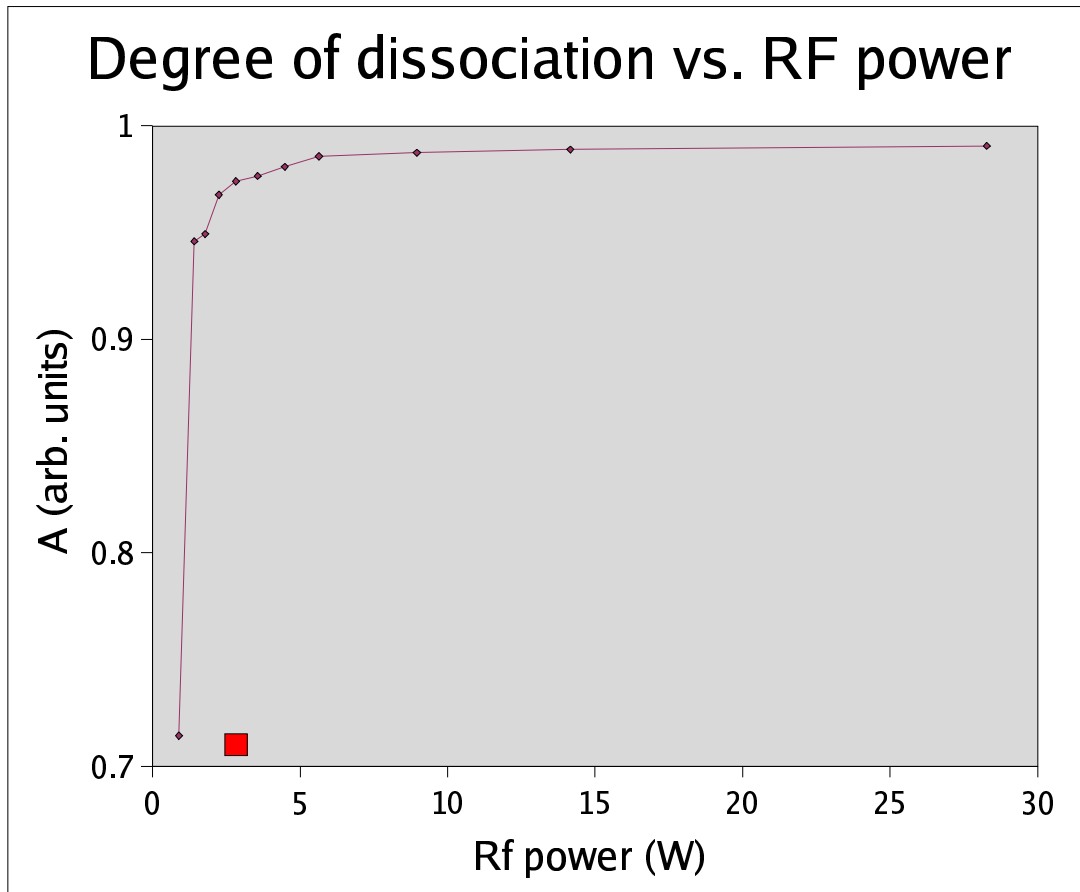
Hydrogen spectrum from the discharge tube
(closed cell, RF: 124 MHz power 30 W, pressure ~1 mbar)



Hydrogen spectrum from the discharge tube
(closed cell, RF: 124 MHz power 5 W, pressure ~1 mbar)



Preliminary results



(closed cell, 124 MHz, pressure ~1 mbar)

- This point is taken after continue discharge during 9 hours

Conclusions

- **A simple grating spectrometer with acceptable spectral resolution and sensitivity has been constructed**
- **Detected emission spectra of light from the discharge tube shows well-resolved Balmer lines of atomic hydrogen together with various lines and bands corresponding to molecular hydrogen and water**
- **The ratio of the intensity of the atomic hydrogen Balmer lines to the intensity of molecular hydrogen spectral bands opens the way to monitor and measure the dissociation rate directly in the ABS discharge tube**