Spectroscopic models for WEST and ITER edge and divertor plasmas

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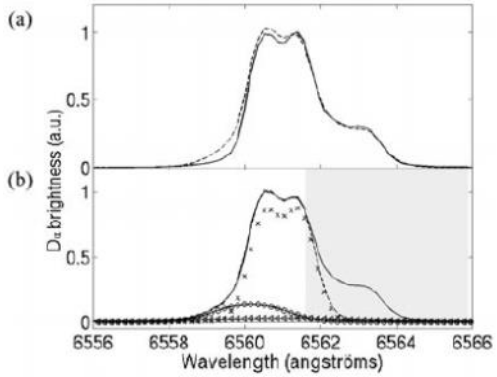
Colloque FR-FCM – Marseille – November 24 & 25, 2016

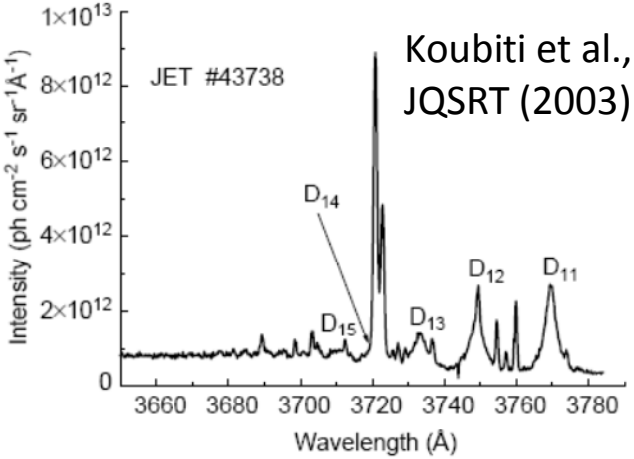
Observation of Balmer lines in tokamak edge and divertor plasmas



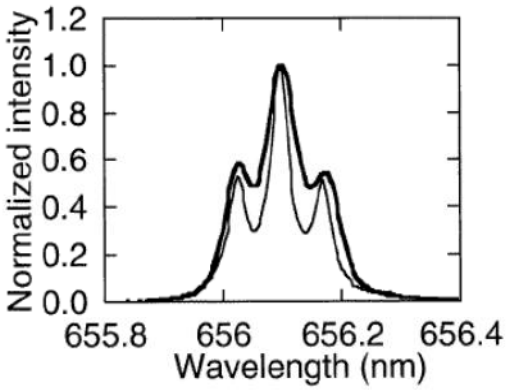
Guirlet et al., PPCF (2001)

Tore Supra

JET

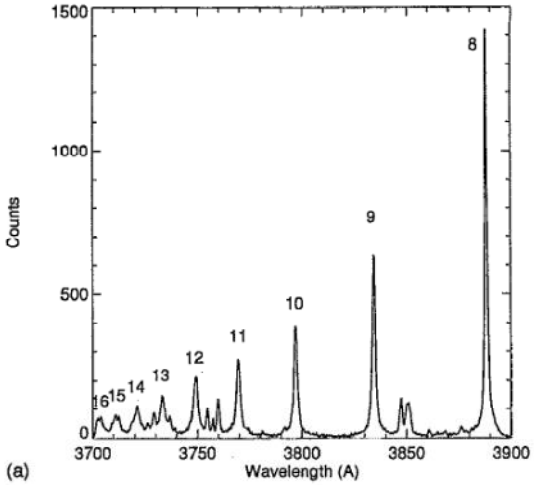


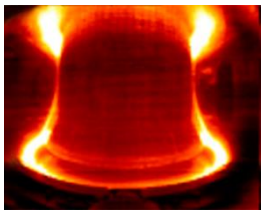
Koubiti et al., JQSRT (2003)



Kubo et al., PPCF (1998)

JT-60U





Alcator C-Mod

Welch et al., PoP (1995)

Low-n lines are Zeeman-Doppler profiles
They provide information on f(v), B
High-n lines: recombination, Stark effect, information on N_e

The detached plasma regime: spectroscopic diagnostics are required

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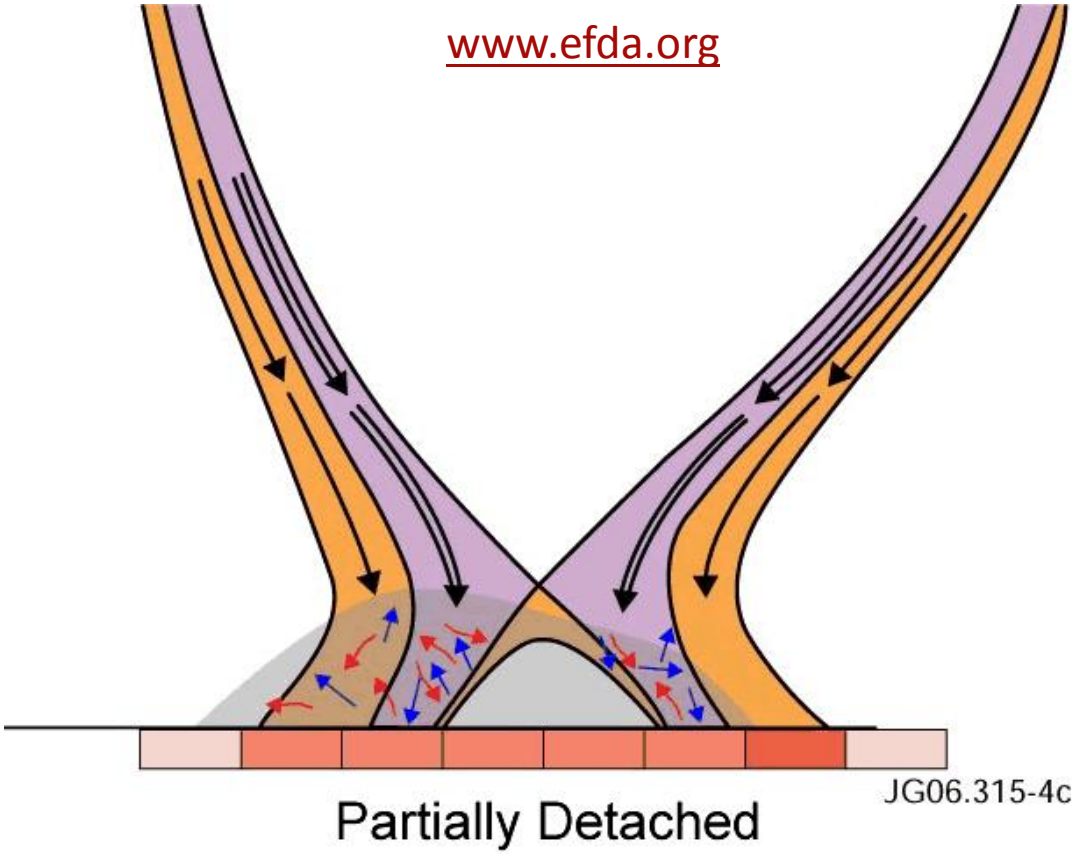
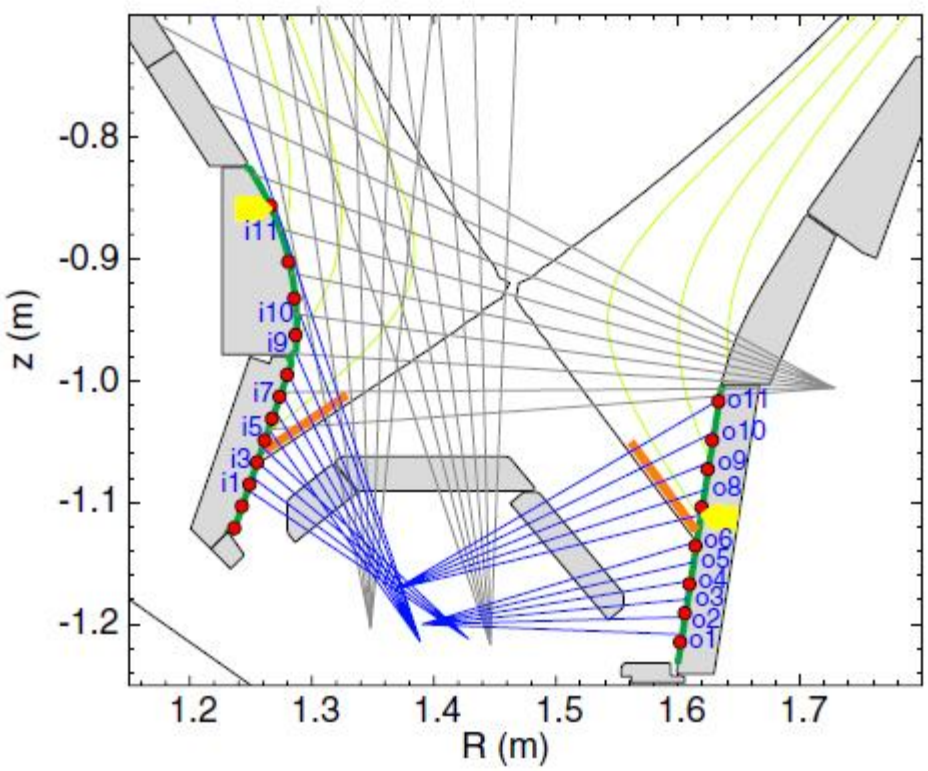


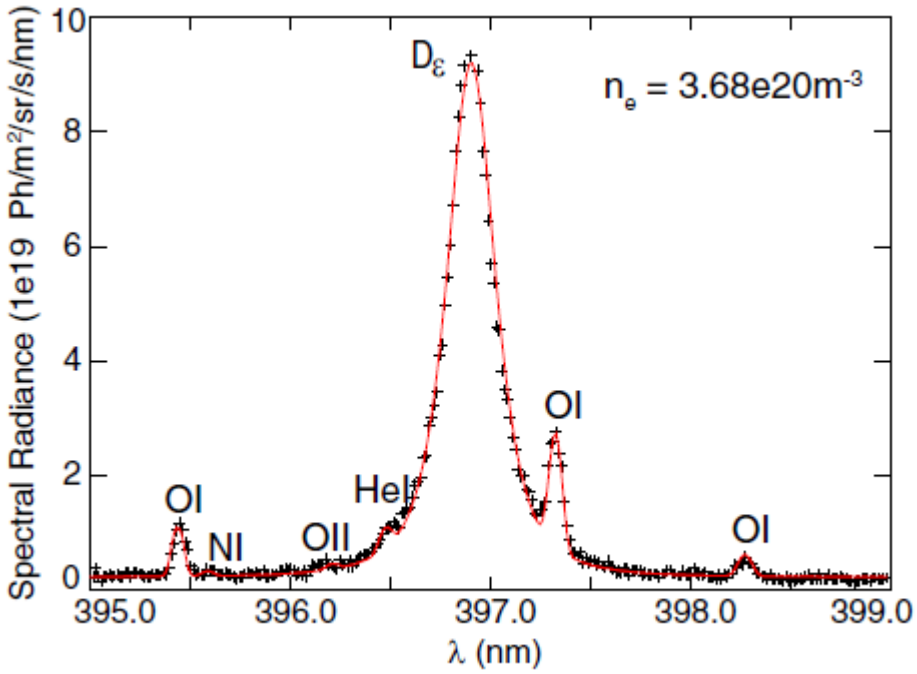
Detached plasma:
a large amount of neutrals
and strong line radiation

Probes can be inefficient
Spectroscopy provides a potential complementary diagnostic tool

Stark broadening of H/D lines

Spectral lines broadened due to Stark effect are sensitive to N_e
Here: density diagnostic in the divertor of ASDEX-Upgrade

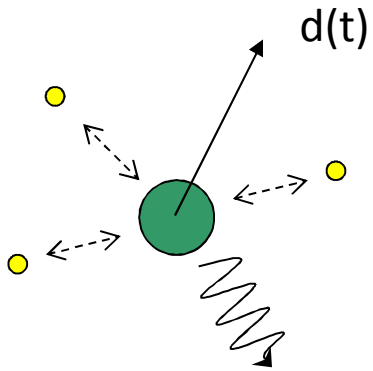




S. Potzel et al., PPCF 56, 025010 (2014)

Accuracy is needed in Stark line shape models

Stark broadening: when emitting a photon,
an atom feels the presence of the charged particles
located at vicinity



A Stark broadened line is proportional to the Fourier transform of the atomic dipole autocorrelation function

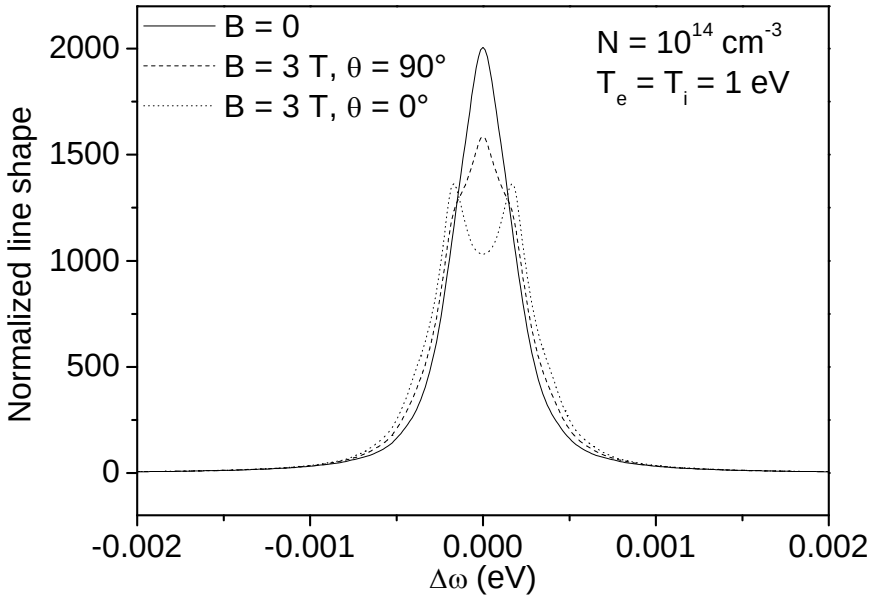
$$I(\omega) \propto \frac{1}{\pi} \mathrm{Re} \int_0^\infty \left\langle \vec{d}(0) \cdot \vec{d}(t) \right\rangle e^{i\omega t} dt$$

There is no general formula applicable to all tokamak edge plasma conditions

A spectroscopic database for WEST and ITER

Tables for the first Balmer lines have been constructed using a line shape code: from Balmer α (656 nm, n = 3 -> 2) to Balmer ε (397 nm, n = 7 -> 2)

* $T_e = T_i = 0.316,\ 1,\ 3.16,\ 10,$ and 31.6 eV;
* $N = (1,\ 2.15,\ 4.64) \times (10^{13},\ 10^{14},\ 10^{15}),$ and 10^{16} cm^{-3};
* $B = 0,\ 1,\ 2,\ 2.5,\ 3,$ and 5 T.

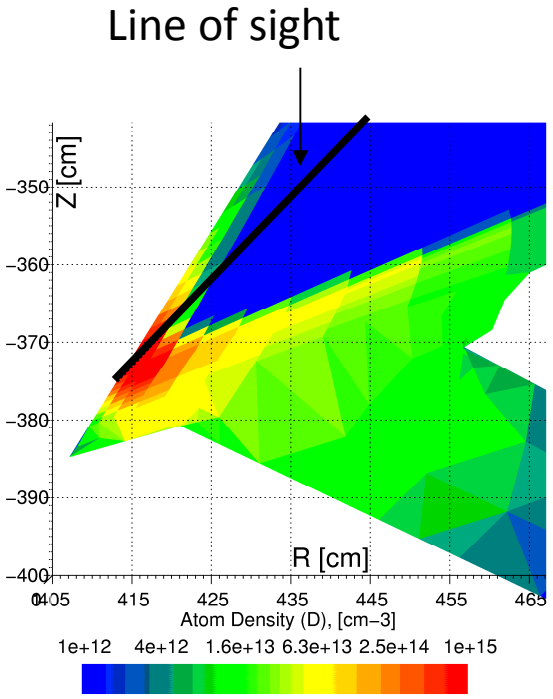


J. Rosato et al., JQSRT 165, 102 (2015)
J. Rosato et al., JQSRT, in press

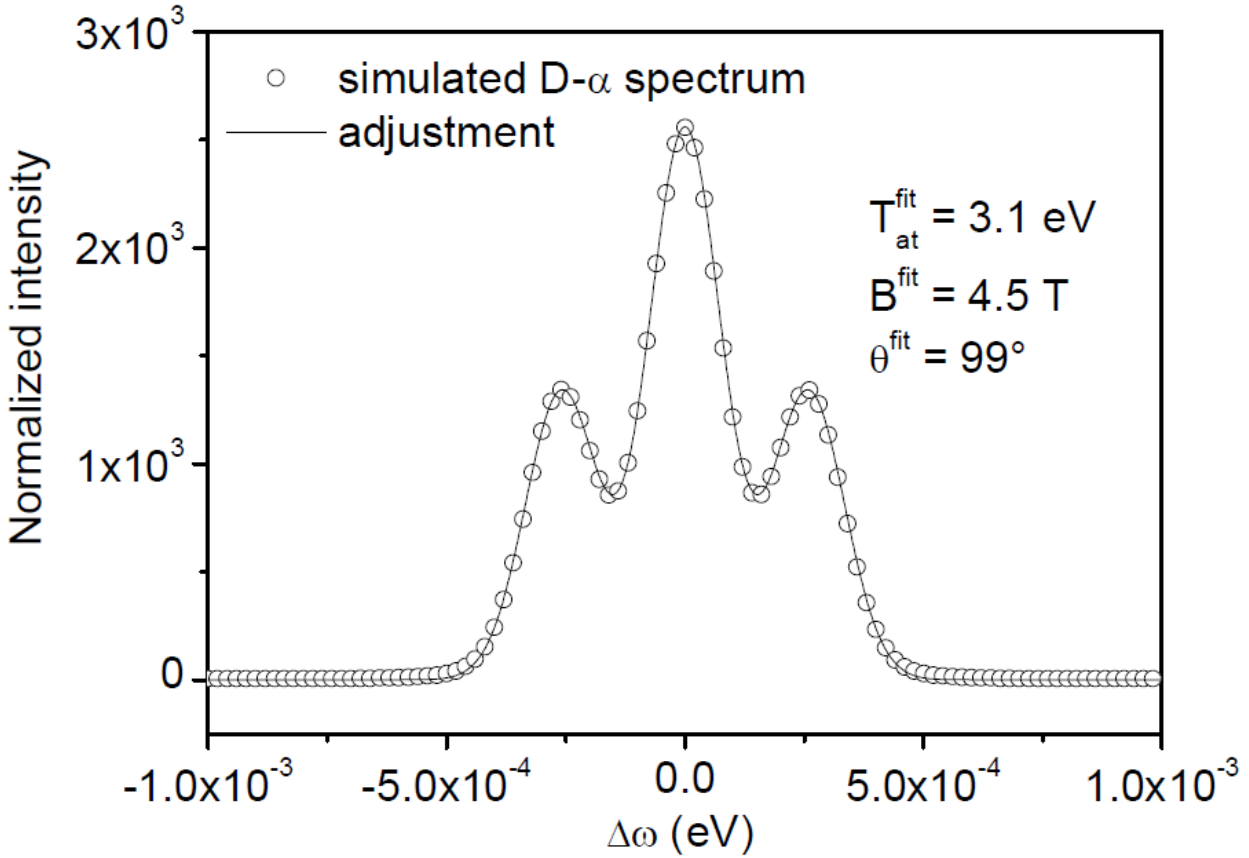
A FORTRAN routine that reads the database is ready for use

Synthetic diagnostics

B2-EIRENE simulation: V. Kotov et al., Contrib. Plasma Phys. (2006)



J. Rosato, V. Kotov, D. Reiter, J. Phys. B (2010)



Information on the densest location has been obtained

Here, the adjustment assumes a Zeeman-Doppler model