Diagnostic potential of a simultaneous detection of Lα and VL in eruptive prominences and CMEs

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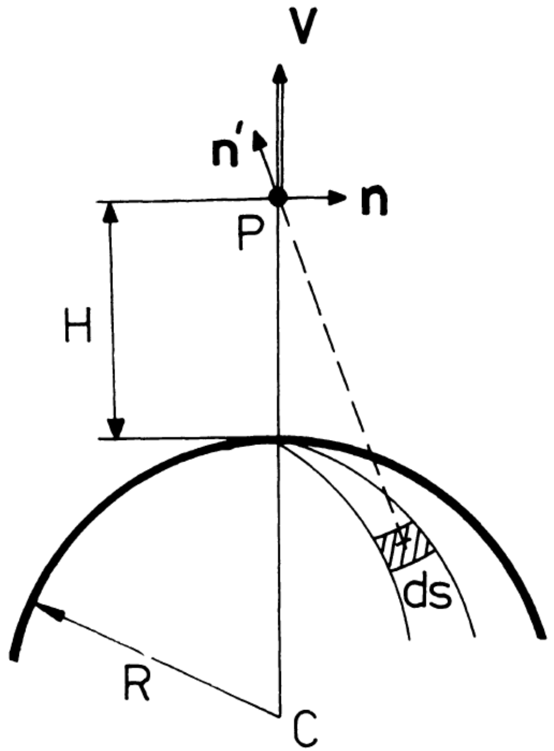
METIS scientific objectives

Origins and acceleration of the solar wind streams

Sources of solar energetic particles

Origin and early propagation of CMEs:

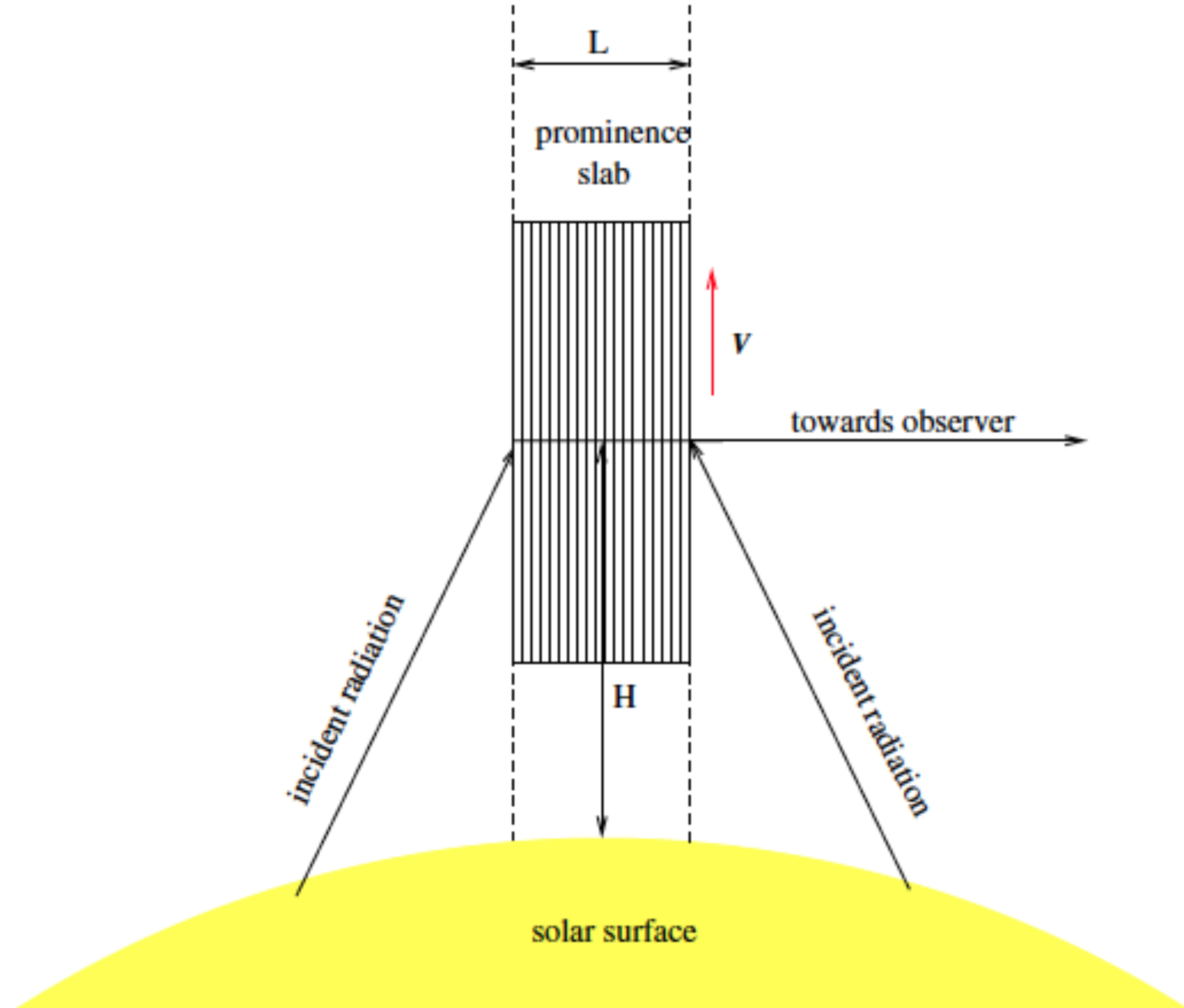
Detection of cool plasmas in the corona – eruptive prominences and CME cores



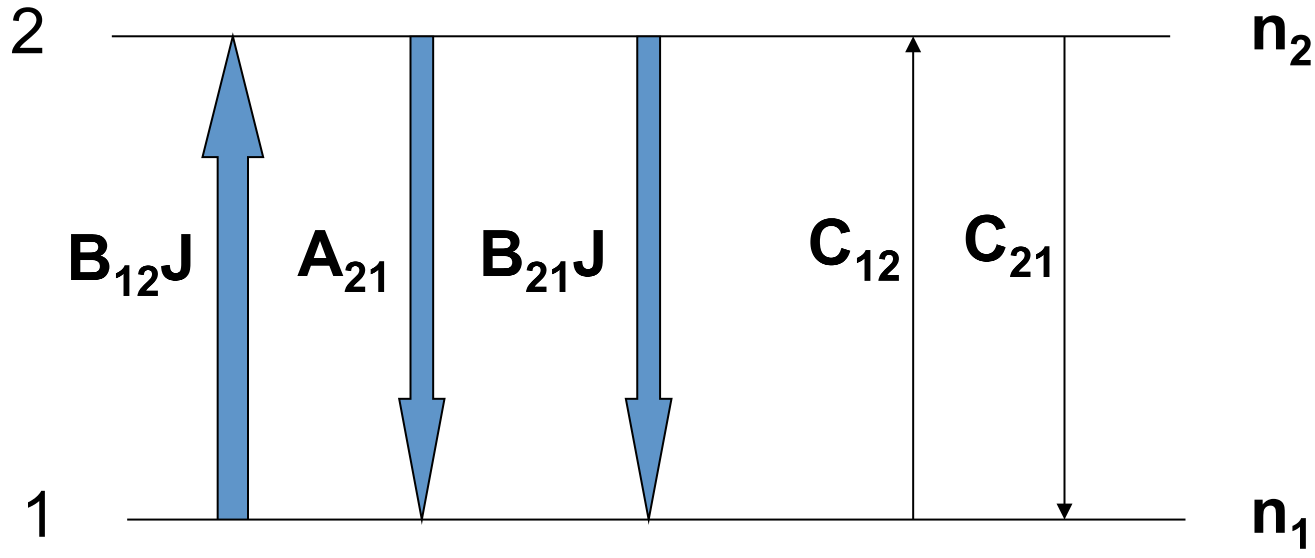
Resonant scattering of incident solar radiation:

Cool plasmas (prominences, CMEs)
Neutrals and low ions in the hot corona

1D-slab prominence model



Radiative and collisional transitions



Lα line formation

$$n_1(B_{12}\bar{J} + C_{12}) = n_2(A_{21} + B_{21}\bar{J} + C_{21})$$

$\bar{J}$ is the *frequency-averaged mean intensity*:

$$\bar{J} = \frac{1}{2}\int_0^\infty \int_{-1}^{1} I(\nu,\mu)\phi(\nu)\mathrm{d}\mu\mathrm{d}\nu$$

Using the relations:

$$B_{21}/B_{12} = g_1/g_2 \qquad A_{21}/B_{21} = 2h\nu_0^3/c^2$$

and

$$C_{21}/C_{12} = (n_1/n_2)^* = (g_1/g_2)\exp(h\nu_0/kT)$$

The *source function* is then:

$$S = (1-\epsilon)\bar{J} + \epsilon B(\nu_0)$$

where the photon *destruction probability* is:

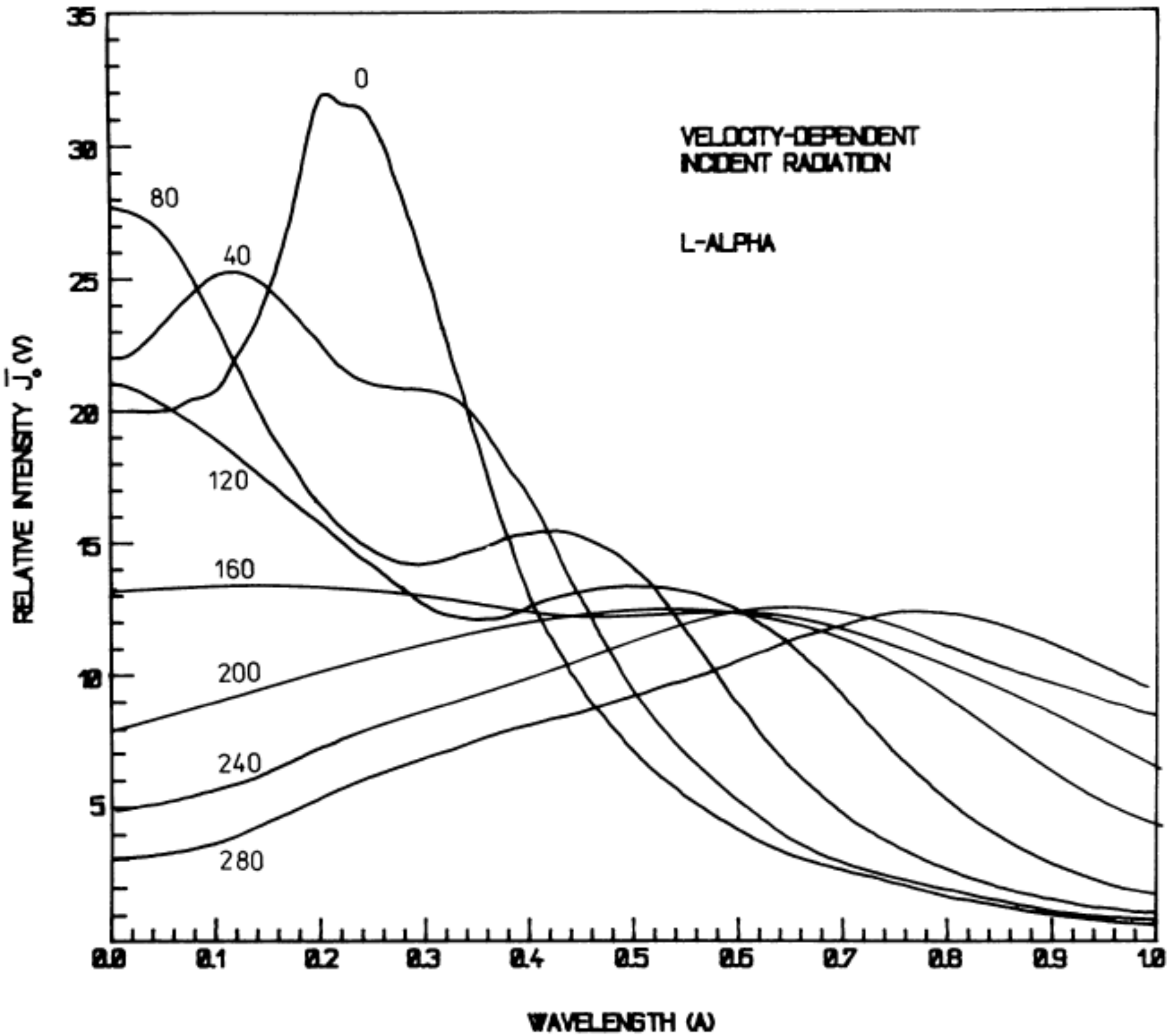
$$\epsilon \approx \frac{C_{21}}{C_{21} + A_{21}}$$

Non-LTE numerical code

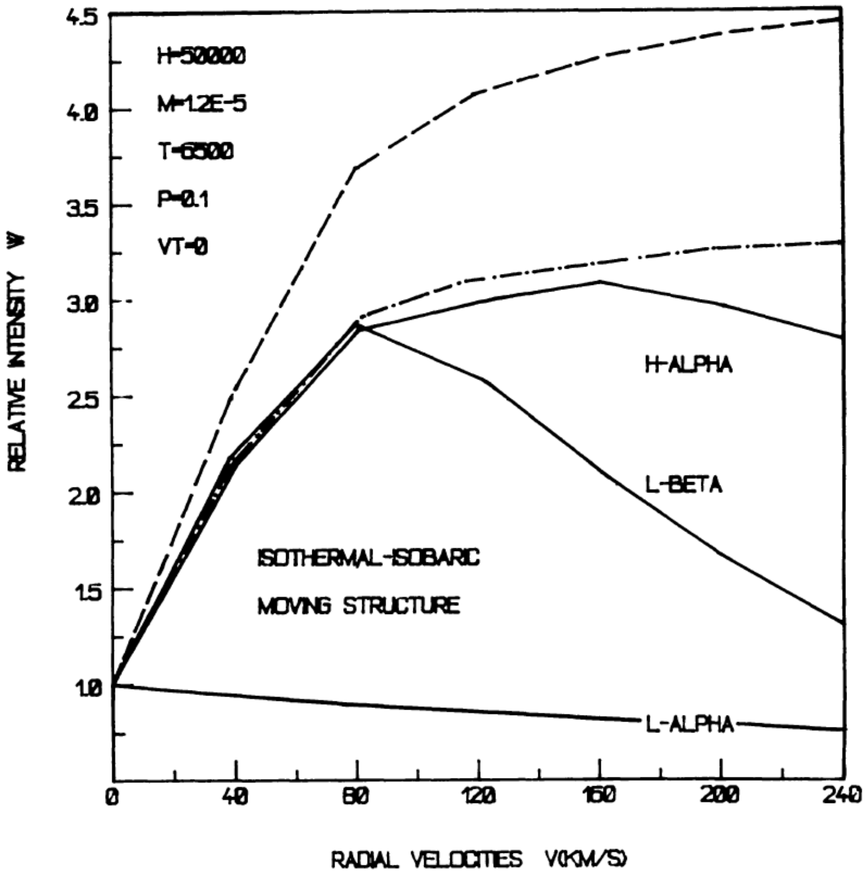
- 1D-slab geometry (extendable to 2D/3D)
- isothermal-isobaric slabs (simple generalization)
- height-velocity dependent boundary conditions
- multilevel hydrogen atom with continuum (ionization)
- coupled transfer + statistical-equilibrium solved
  (including the photoionization by external radiation)
- fast numerical solution using the ALI techniques
- partial redistribution scattering in hydrogen Lyman lines

VL intensity is computed using the resulting electron density and the LOS thickness *L* (Thompson scattering)

Velocity-dependent incident radiation field



Doppler brightening and dimming in hydrogen lines



Full line: 3-level atom with continuum – full solution
Dot-dash: approximate solution
Dashed line: 2-level atom without continuum

Heinzel and Rompolt (1987)

L [km]	T [K]	p	V [km/s]	E(La)	E(Ha)	N_1	N_e
0.10E+04	0.60E+04	0.10E-01	0.30E+03	0.14E+04	0.24E+04	0.36E+18	0.39E+18

$N_1 \approx N_{HI}$

$N_e \approx N_p$ (neglecting the helium ionization)

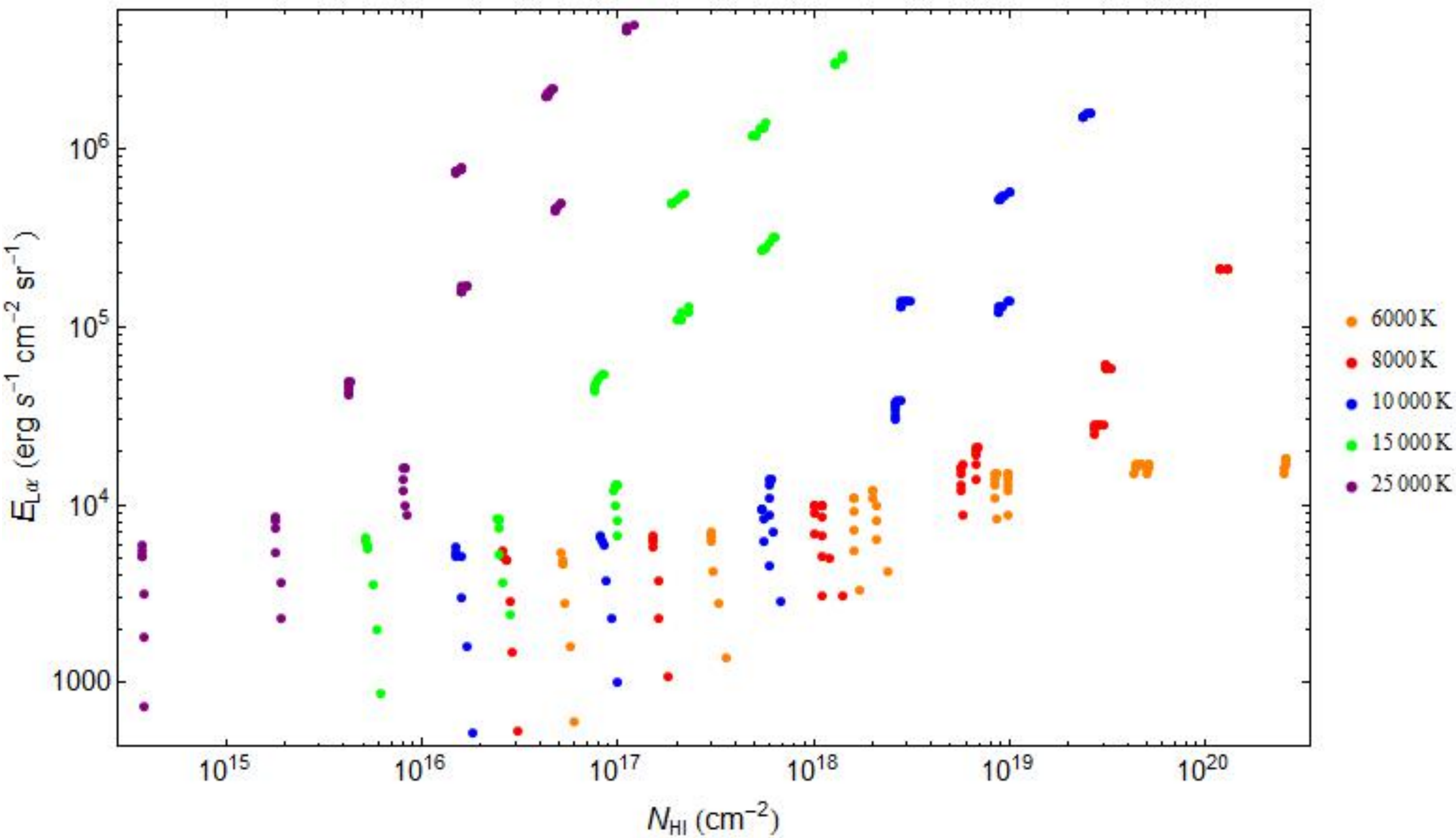
hydrogen ionization degree:

$i = N_p / (N_{HI} + N_p)$

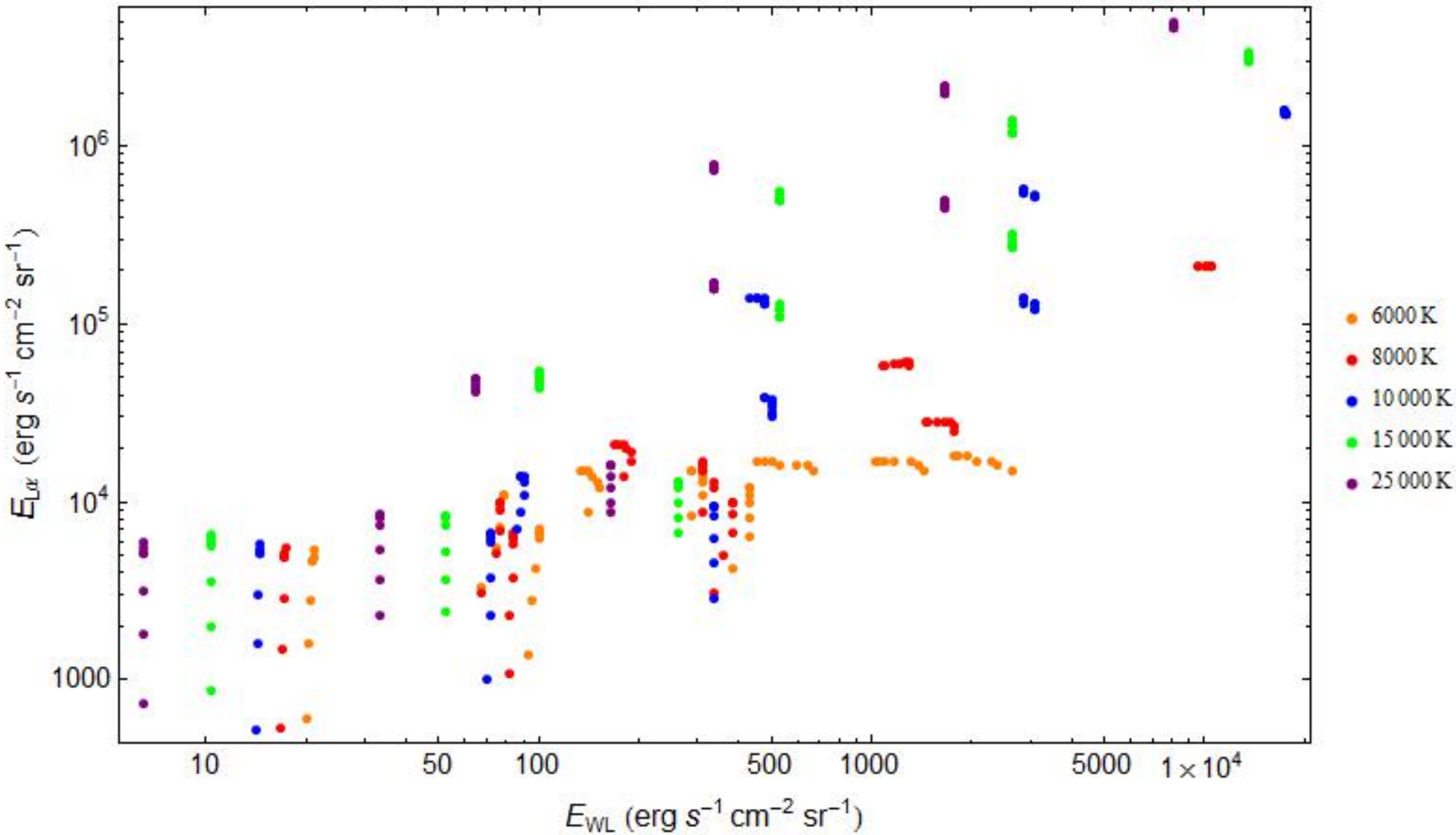
i provides an important diagnostics on prominence/CME **heating**

$(N_{HI} + N_p)\, m_H$ is the **column mass** along the LOS

Lα intensity vs. N_{HI}



Lα vs. white-light intensity



Future prospects:

extended grid of non-LTE models

diagnostics strategies and inversions

include helium ionization in modeling (Labrosse and Gouttebroze)

2D/3D geometry of moving structures

study of heating/cooling processes

determination of total mass of the prominence/CME

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