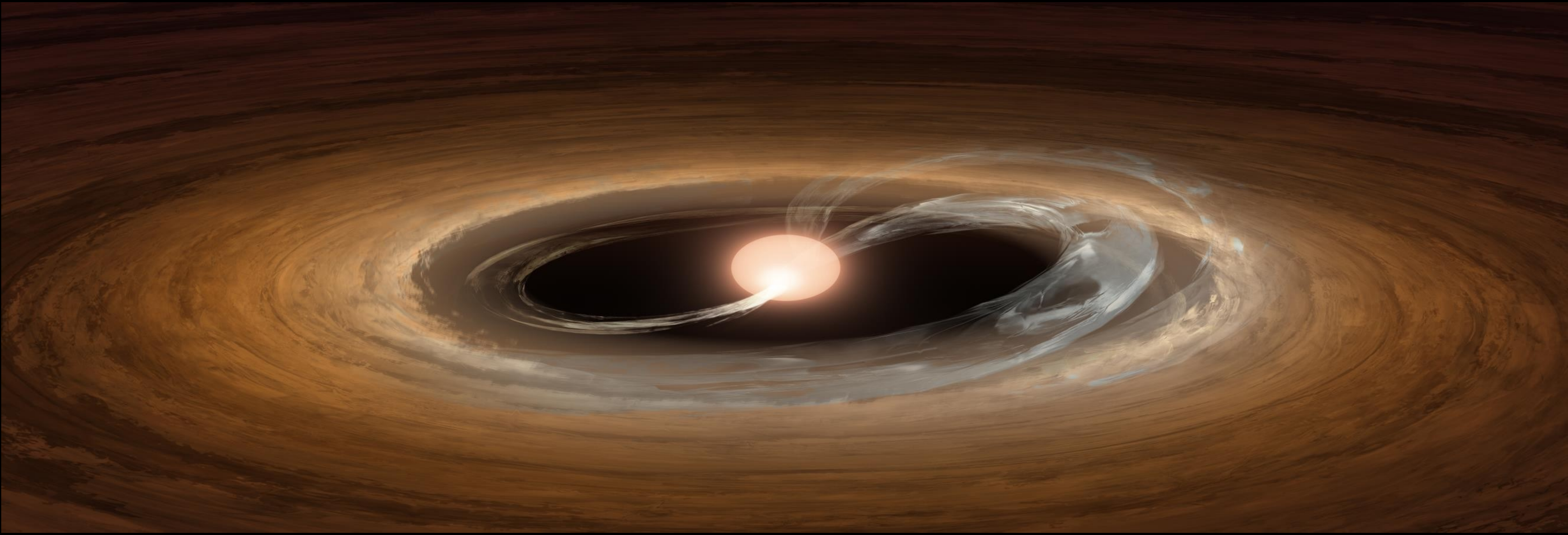
Ionisation by magnetic reconnection events in T Tauri discs



Valentin Brunn

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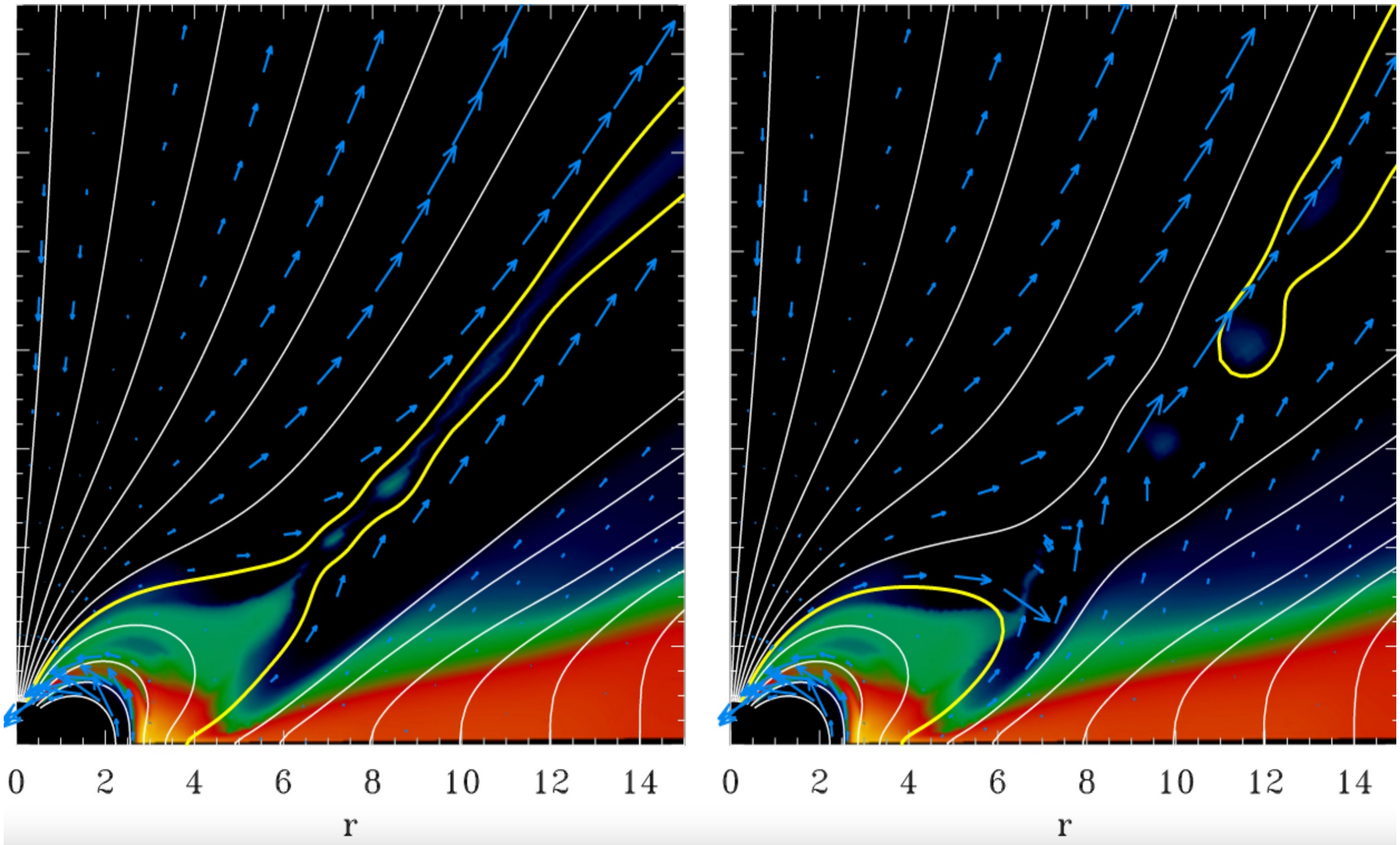
Reconnection regions



Zanni, C., & Ferreira, J. (2013).

Energetic particles are produced by reconnection

They **ionise** the inner disc

Interests of ionisation in circumstellar discs

Source of **heating** of disc and jet
Initiate disc (prebiotic) **chemistry**
Controls **accretion**

Ionisation rate

$$\zeta(N) = 2\pi \int \boldsymbol{j}(\boldsymbol{E},\boldsymbol{N})\big(1+\phi(E)\big)\sigma_{ion}(E)\,dE$$

$$\boldsymbol{j}(\boldsymbol{E},\boldsymbol{N}) = j_0(E_0)\frac{L(E_0,0)}{L(E,N)}$$

Injection model
(magnetic reconnection)

Disc Model

Padovani et al. 2009

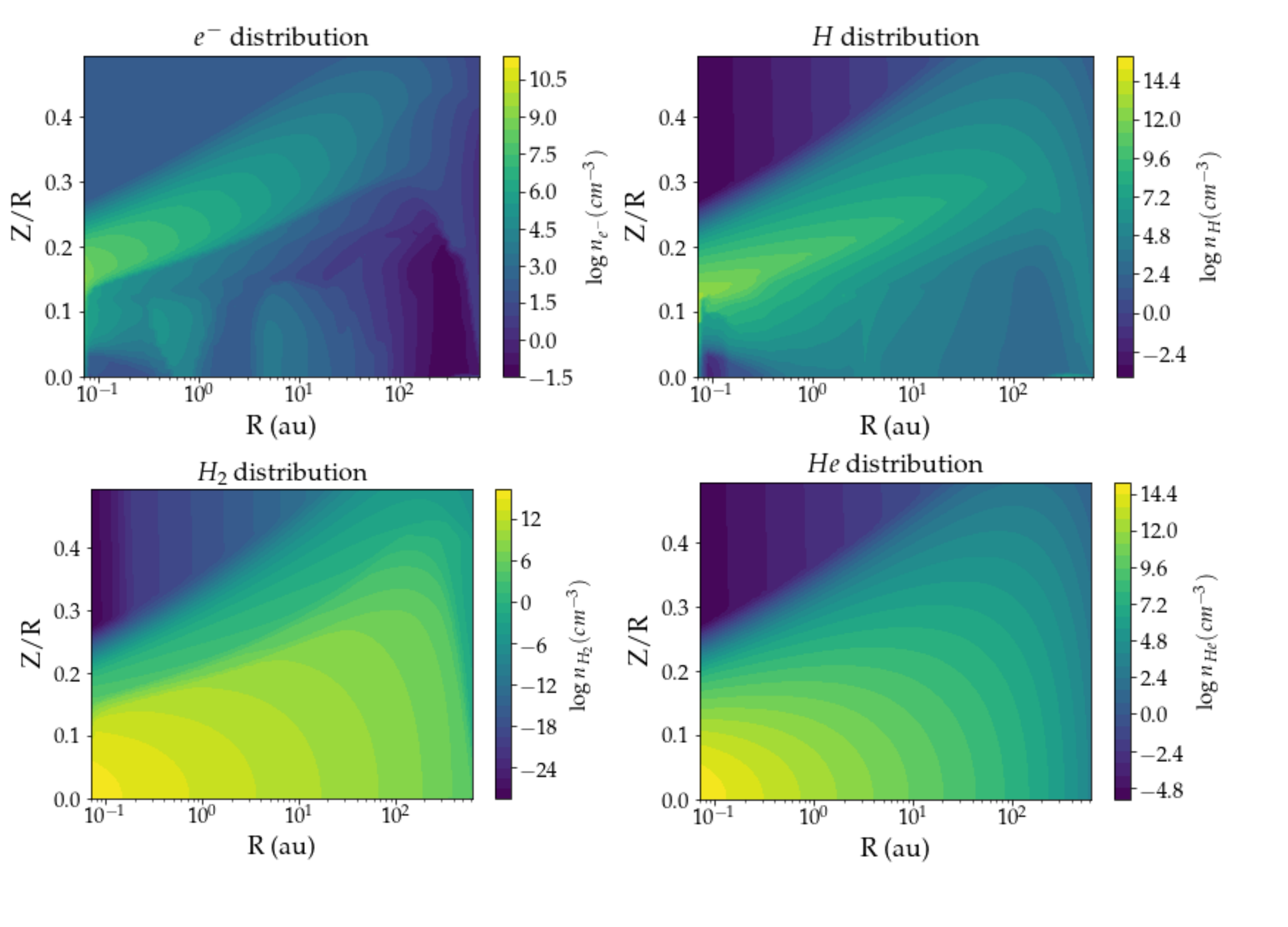
$j(E,N)$: propagated flux

N: effective column density

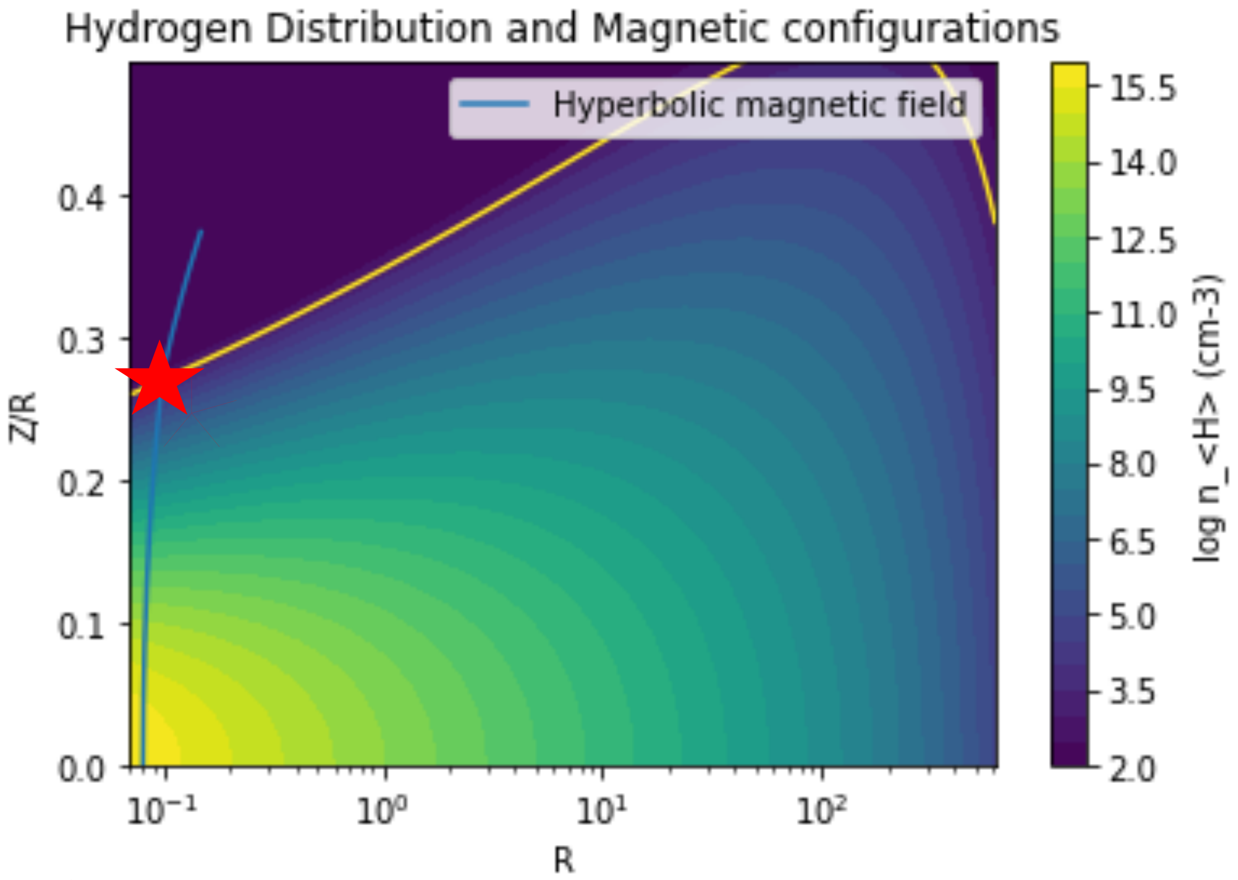
σ_{ion}: ionisation cross section

L: loss fuction

ϕ: secondary electrons



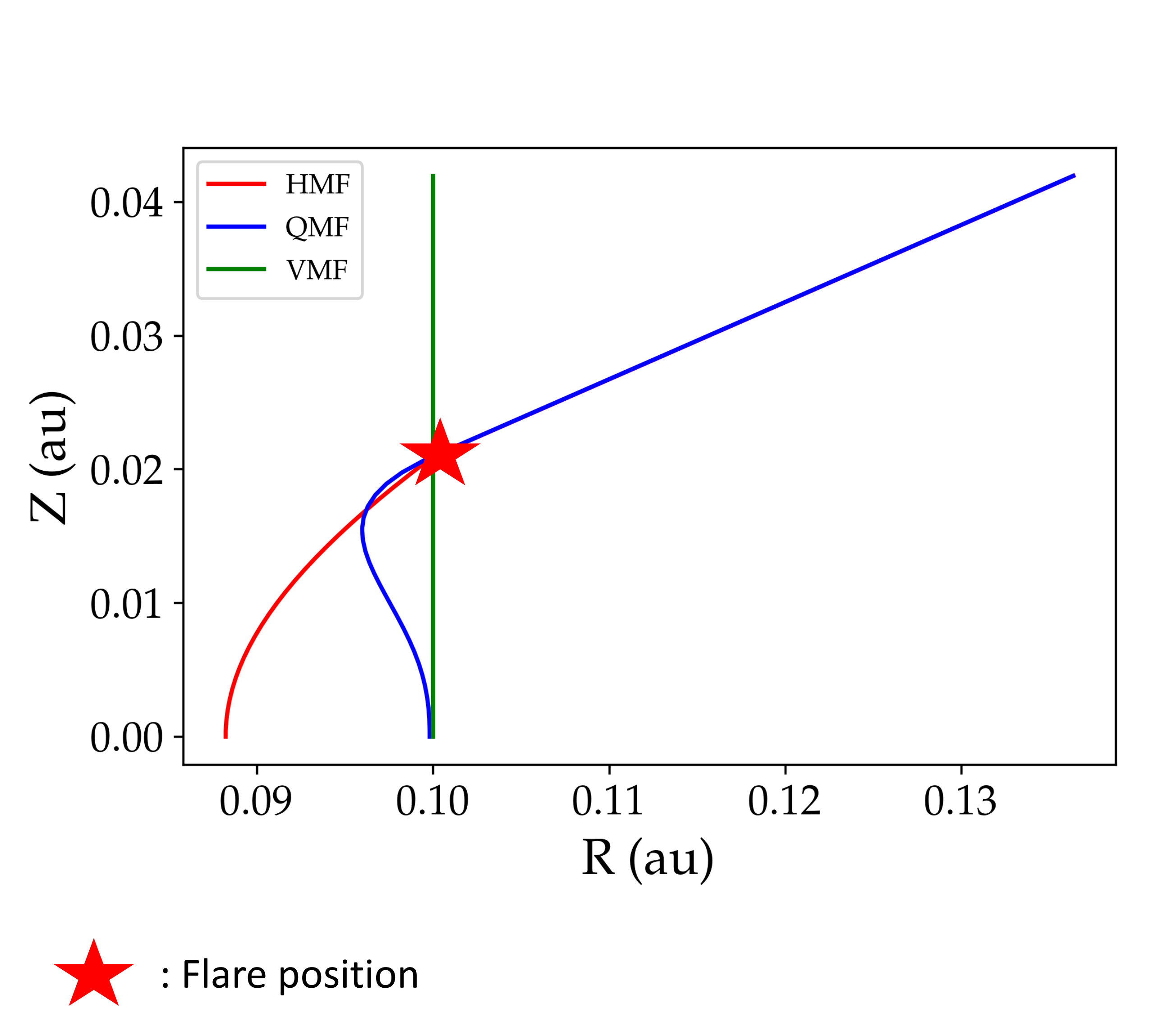
Composition: H^+, **H**, **H_2** and **He**



★ : Location of the flare

Flare occur at the **disc edge**

Magnetic Configurations

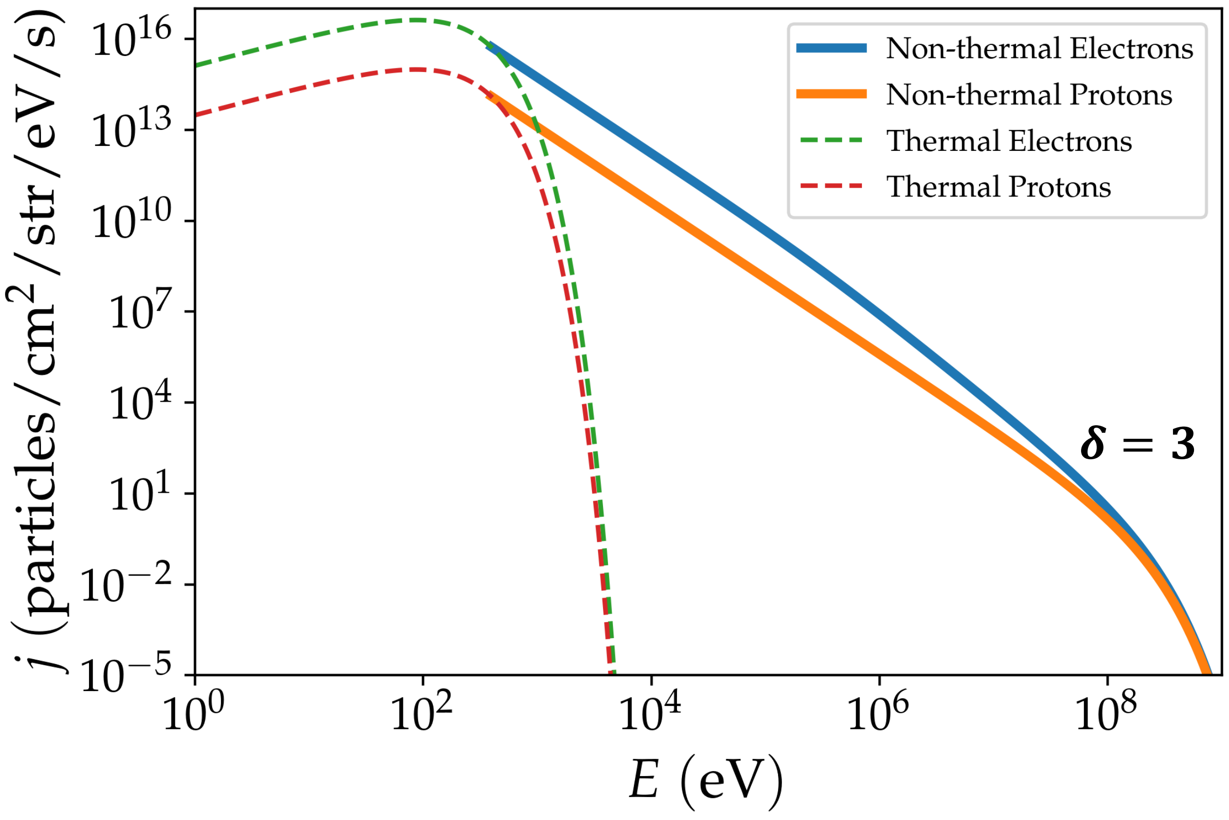


Vertical : Reference

Hyperbolic : Standard disc

Quartic : Differential accretion in the disc

Particle Injection

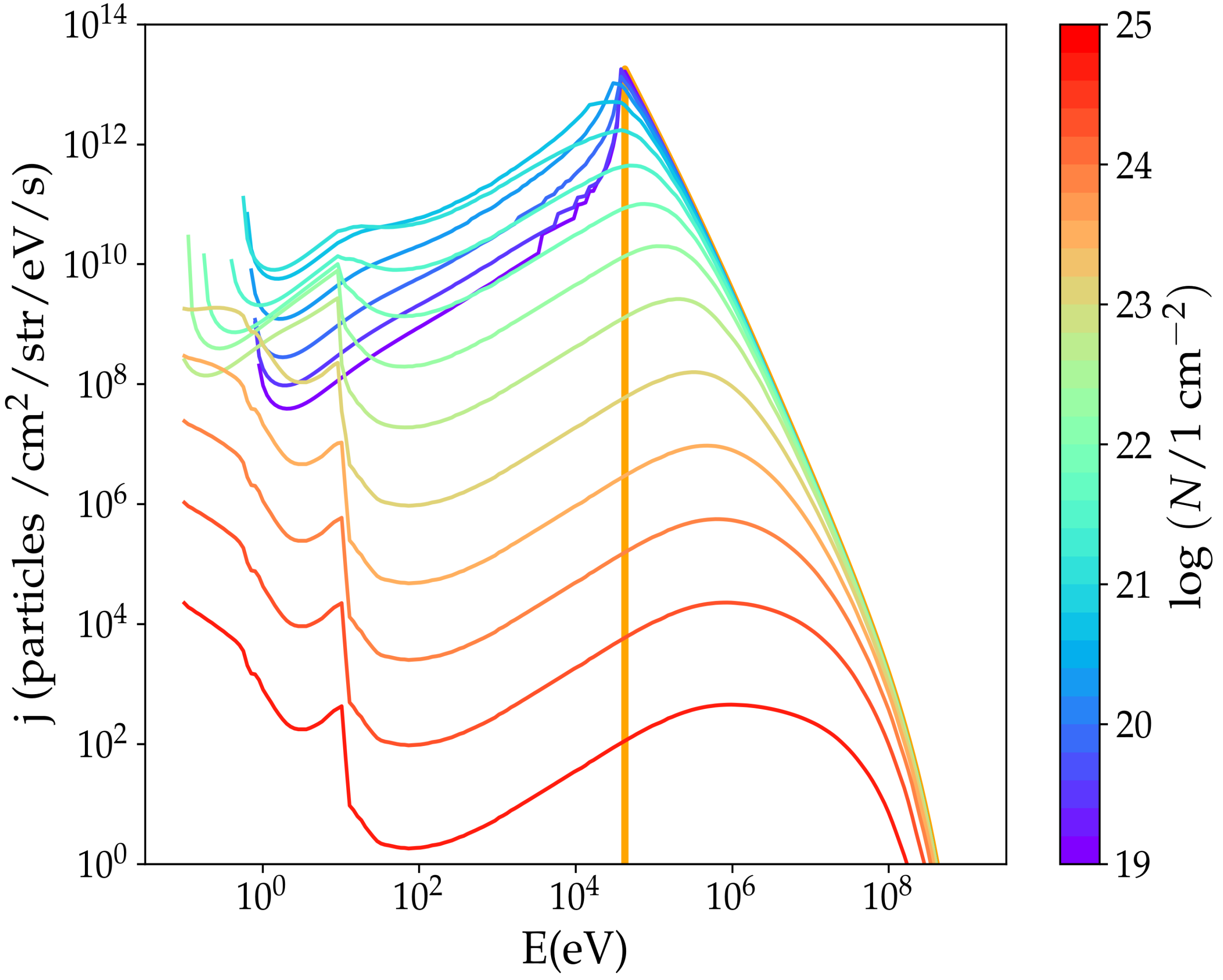


Power law spectrum as in **solar flares**

$$j_0(E\ ) \sim n_e E^{-\delta} e^{-\frac{E}{100\ MeV}}$$

n_e: non thermal electron density

δ: Power law index



CSDA gives the **propagated flux**

$$j(E,N) = j_0(E_0)\,\frac{\bar{L}(E_0,0)}{\bar{L}(E,N)}$$

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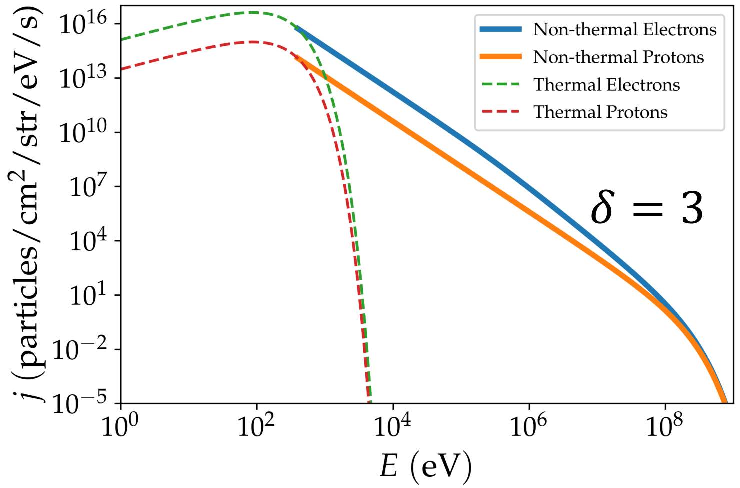

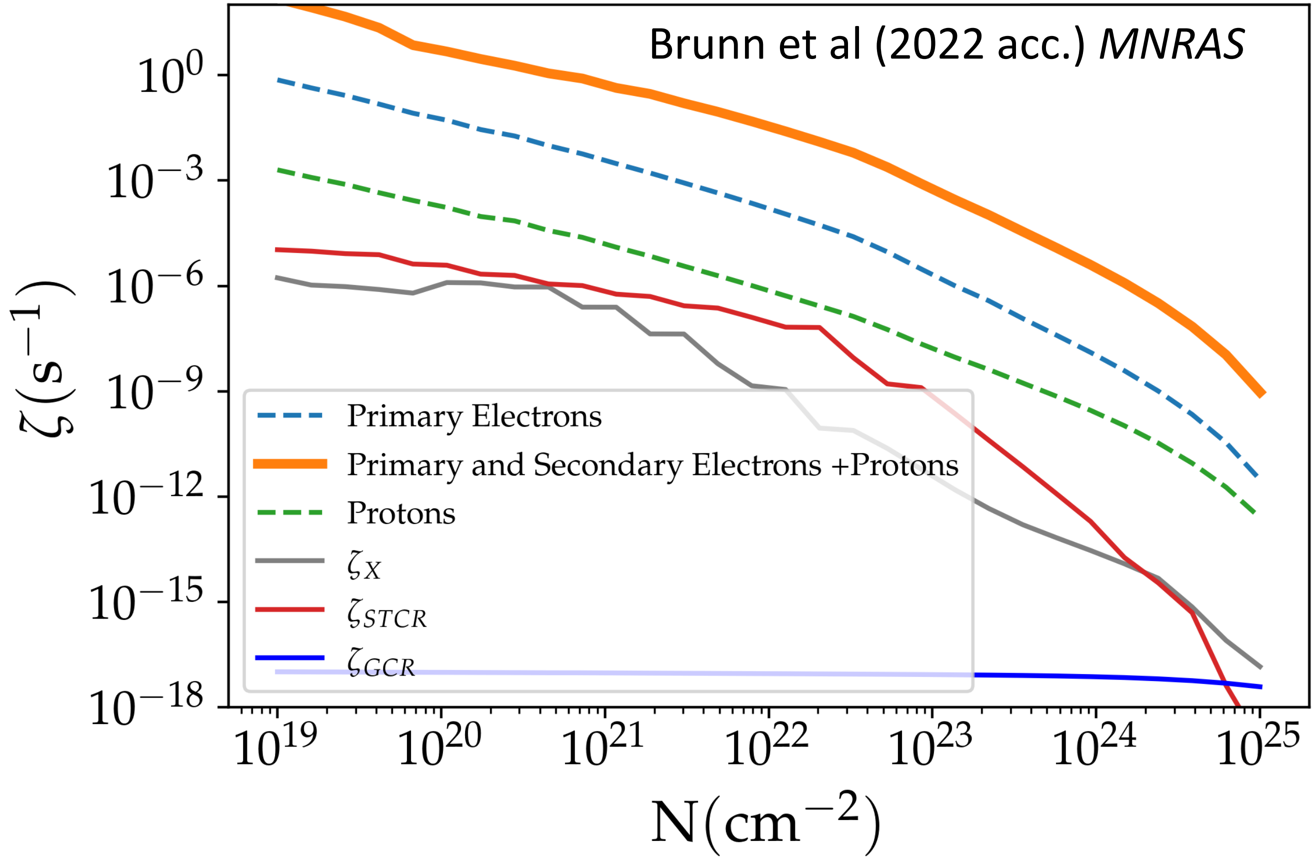

Reference case :

Temperature: **1 MK**

Location: $\boldsymbol{R} =$ **0.1 au,** above the disc

Magnetic configuration: **Vertical**

Power-law index of injection spectrum: **3**

Toward a more Predictive Model

Ionisation rate are overestimated due to very **localised results**

Need of a **spatial** and **time averaged** model

Monte-Carlo Analysis

Luminosity distribution

Duration distribution

PMS Observations (Getman 2021)

Waiting time distribution

Solar Observations (Aschwanden 2010)

Position of occurence

Simulations

Thank you so much !

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