Modelling the EUV coronagraphic observations of the Full Sun Imager on board Solar Orbiter

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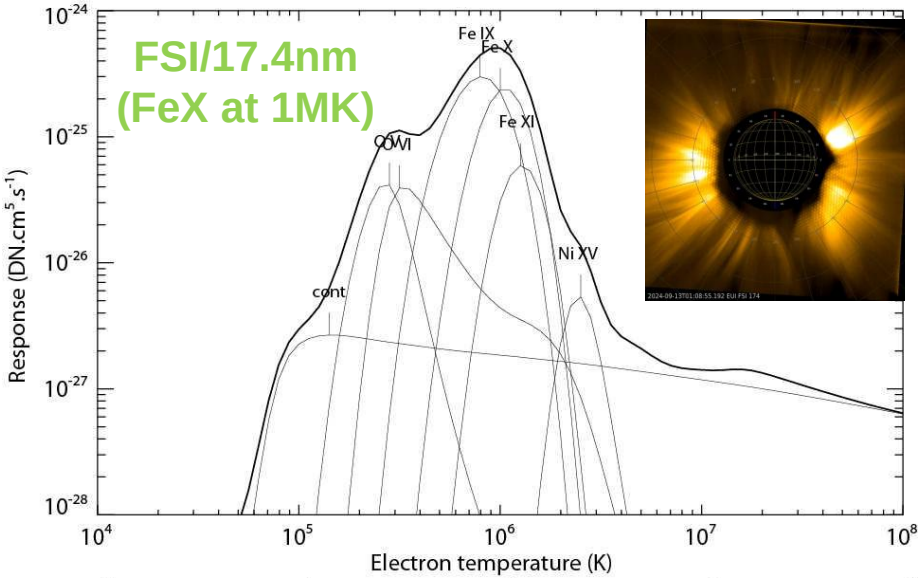
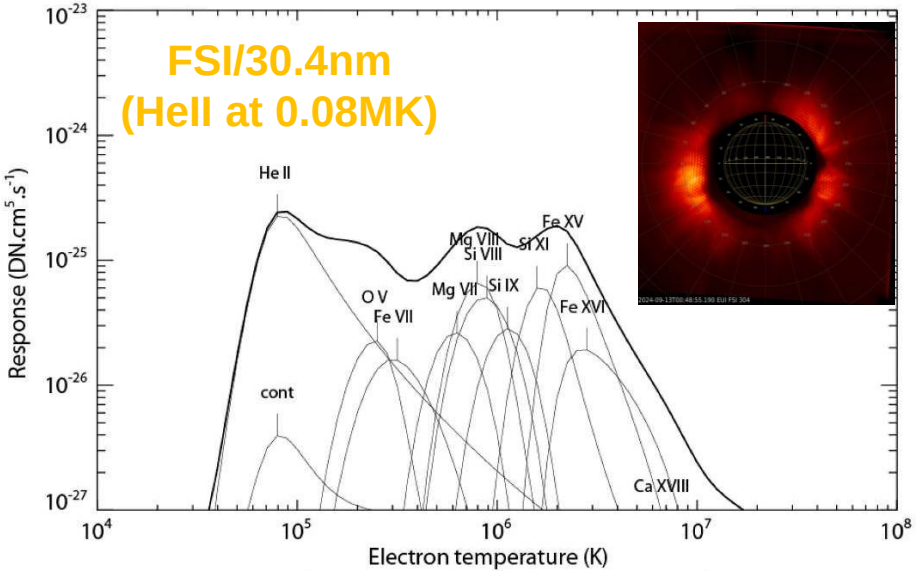
Full Sun Imager (FSI) in coronagraphic mode

- FSI observations : solar corona visible in EUV up to $7R_s$
- Coronagraphic mode : occulting disk, no stray light, signal/noise x30
- Two passbands : **FeX/17.4nm : [17nm : 18nm] with 5 major lines (Fe ions)**
  HeII/30.4nm : [27nm : 34nm] with 9 major lines (Fe, He, Si, Mg ions)





FSI passband : sum of EUV emission lines from ions
➡ Relative intensity contribution? Which emission process?

Modelling of single emission line

Assumptions :

- Collisional plasma, optically thin
- Electroneutrality of plasma
- Local thermodynamic equilibrium

$$I = \frac{h\nu_{2p1s}}{4\pi} \frac{A_{He}}{1+2A_{He}} \int_l \frac{N_{He^+}}{N_{He}} \frac{N_{He^+_{2p}}}{N_{He^+}} N_e A_{2p1s}\, dl$$

Total Intensity in ph/cm2/s/sr:

$$I_d = \frac{h\nu_{21}}{4\pi} \frac{A_{He}}{1+2A_{He}} \int_l P_{1s2p} \frac{N_{He^+}}{N_{He}} N_e\, dl$$

Resonant-scattering

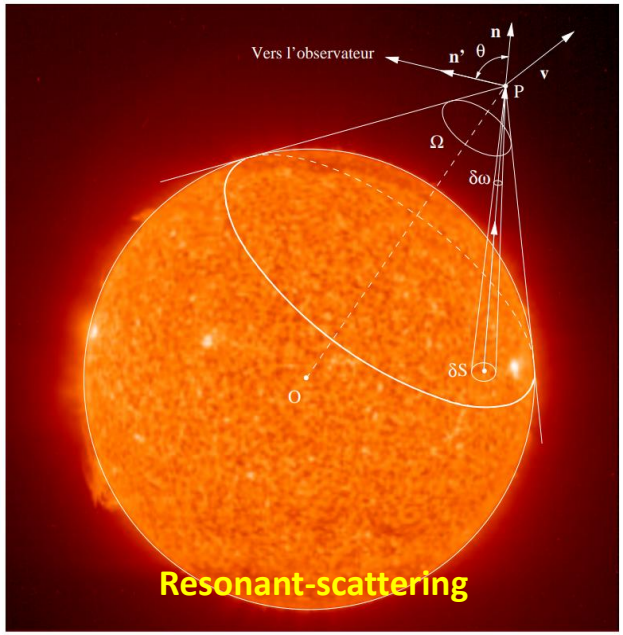
+

$$I_c = \frac{h\nu_{21}}{4\pi} \frac{A_{He}}{1+2A_{He}} \int_l C_{2p}^{eff} \frac{N_{He^+}}{N_{He}} {N_e}^2\, dl$$

Collisional excitation

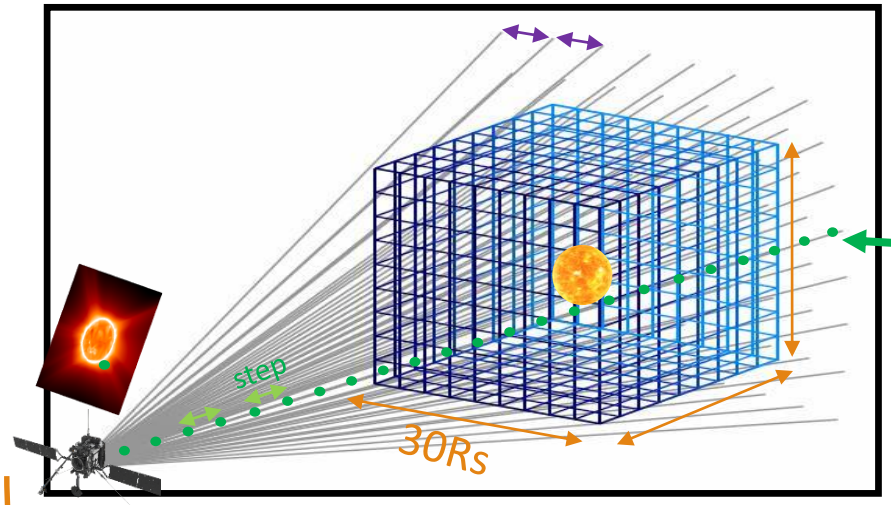
$f(N_e, T_e, \overrightarrow{V_{flow}}, \overrightarrow{V_{local}}, \phi(v))$

$f(N_e^2, T_e)$



Emission processes : main dependance on N_e, T_e, V_{flow}
➡ Simulation of the coronal emission?

Numerical implementation



Integration over the line of sight (LOS)

Physical parameters :

Atomic physics : CHIANTI database

N_e, T_e, $\overrightarrow{V_{flow}}$: MHD simulations

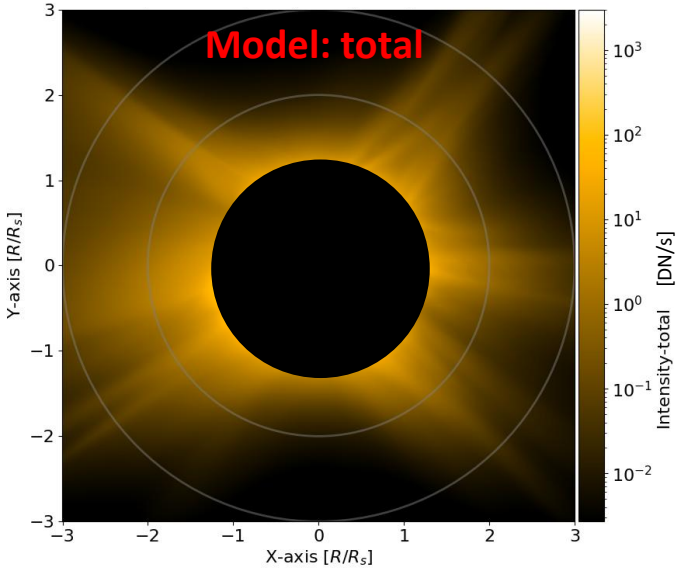
Emission profile $\phi(v)$: observations

Velocity distribution function $g(\overrightarrow{v_{loc}})$: thermal

Local intensity calculation on each point of a LOS

Simulated observation of the Sun in a specific emission line and coronal configuration

FSI passband FeX/17.4nm : simulation of an observation



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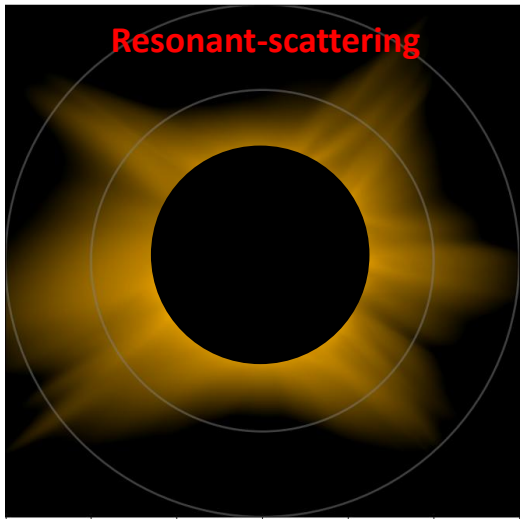

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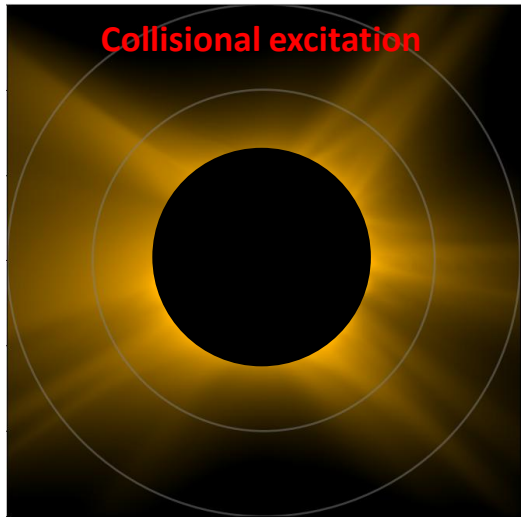
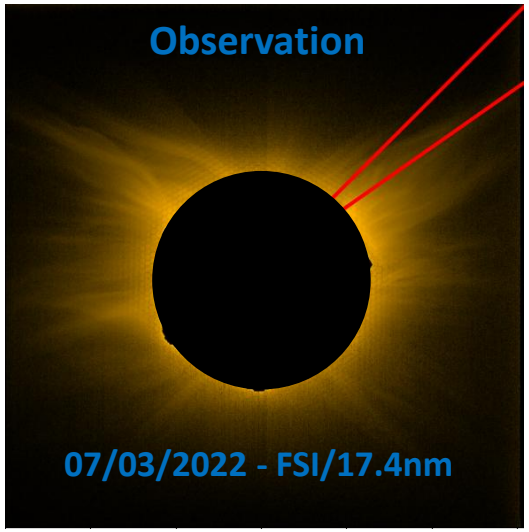


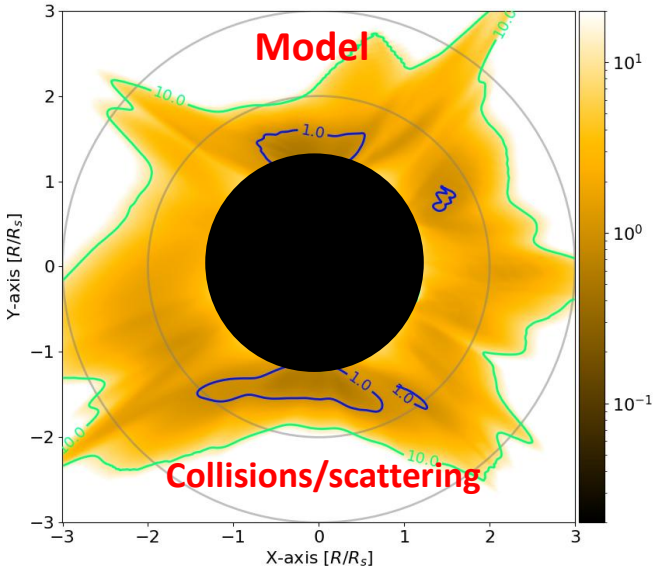


Global morphology

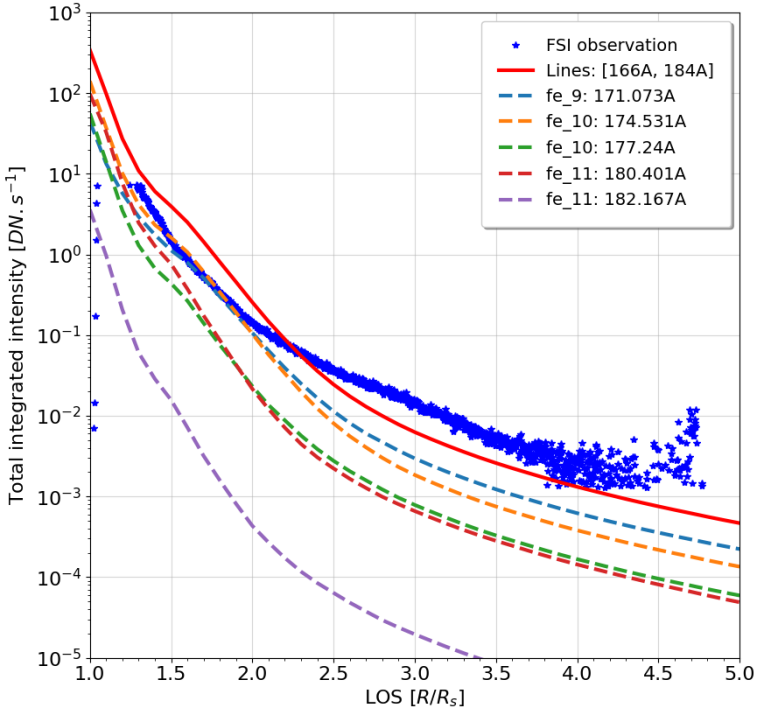
Agreement in streamers and coronal holes

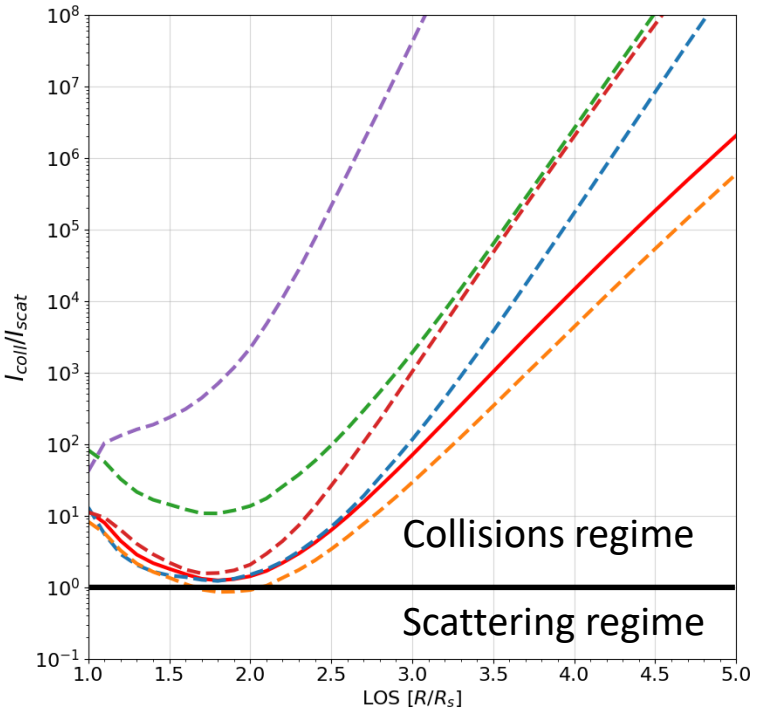
Emission regimes

Scattering dominates only above the poles R < ~1.5 Rs



FSI passband FeX/17.4nm : emission lines and regimes





Emission lines : FeIX line at 17.1nm and FeX at 17.4nm

⇨ *main contributors in the passband*

Intensity evolution : Observed and simulated different

⇨ *non thermal in velocity distribution?*

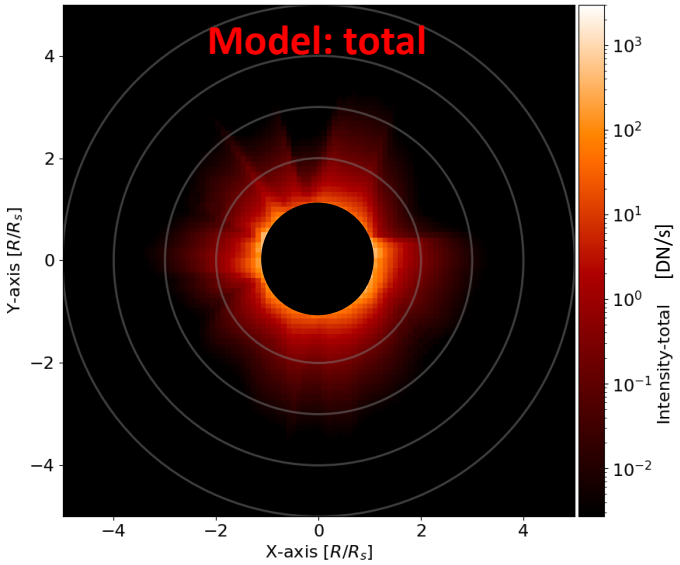
Collisions regime : all lines

⇨ *dominant everywhere*

Scattering contribution : FeX line

⇨ *weak for $1.7R_s < R < 2.1R_s$*

FSI passband HeII/30.4nm : simulation of an observation



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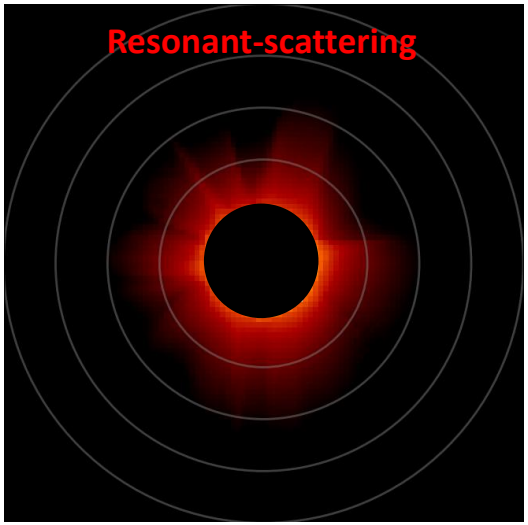

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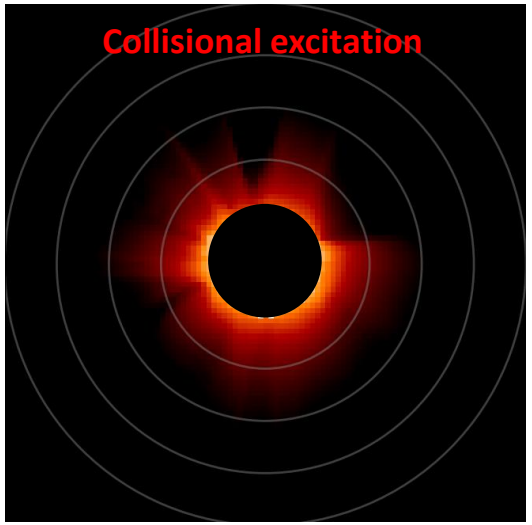
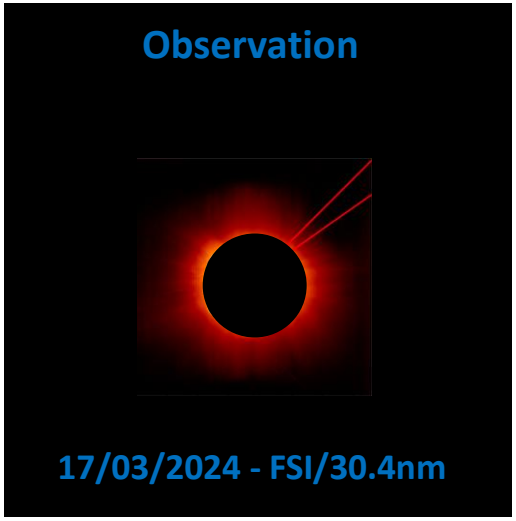




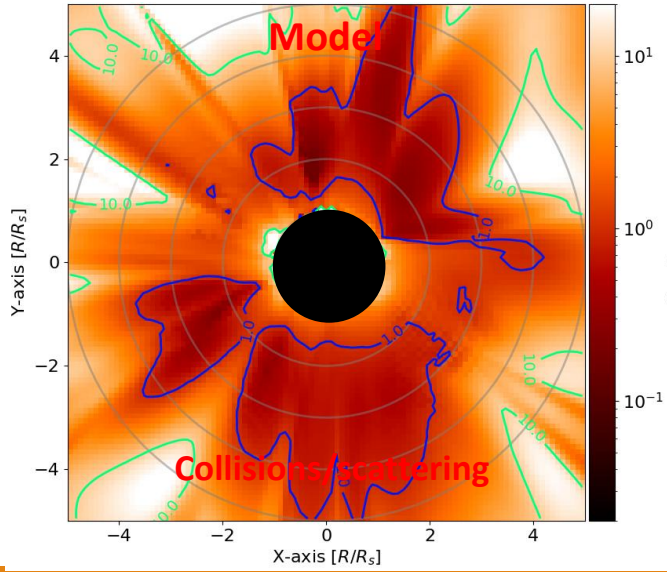
Global morphology

Agreement in streamers and coronal holes

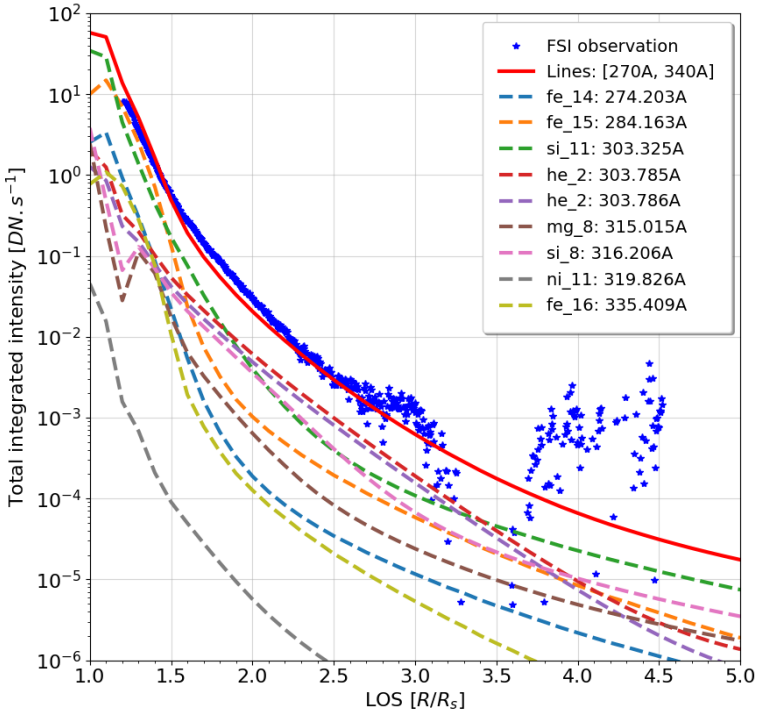
Emission regimes

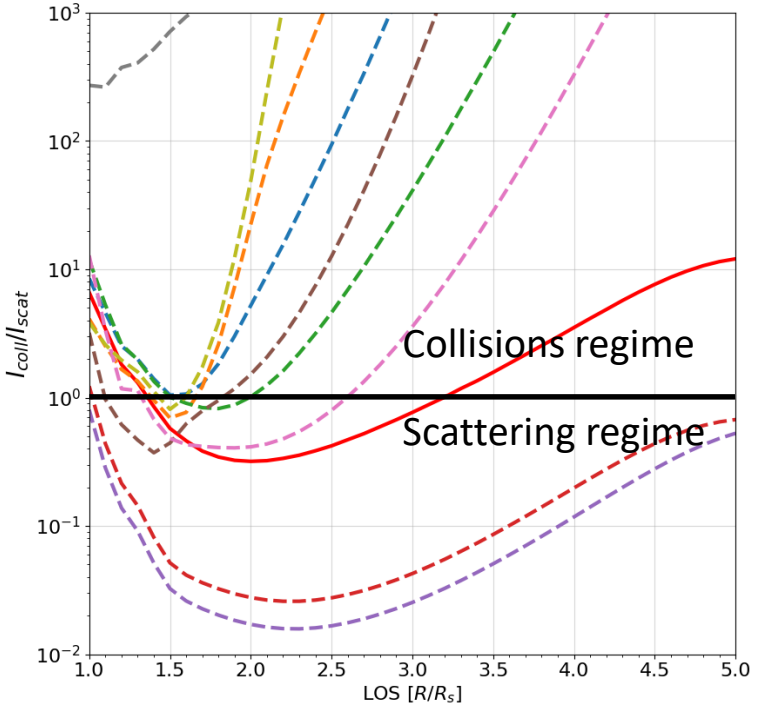
Scattering dominates everywhere

< ~3.5 Rs and collisions elsewhere



FSI passband HeII/30.4nm : emission lines and regimes





Emission lines : SiXI line at 30.3nm and HeII at 30.4nm

⇨ *main contributors in the passband*

Intensity evolution : Observed and simulated same

⇨ *thermal processes only*

Collisions regime : all lines except HeII

⇨ *dominant* for $R < 1.4R_s$ & $R > 3.3R_s$

Scattering regime : HeII lines

⇨ *dominant* for $1.4R_s < R < 3.3R_s$

Conclusion

Modelling the EUV coronagraphic observations of the Full Sun Imager

- FSI observations : larger field of view, calibrated data to make new plasma diagnostics of the solar corona

- Two passands in EUV : sum of EUV emission lines from ions by collisional excitation & resonant scattering

- Fe^{9+}/17.4nm : total intensity emitted by collisional excitation from FeIX line at 17.1nm and FeX line at 17.4nm

- He^{+}/30.4nm : total intensity emitted by collisional excitation from all lines except HeII lines for $R < 1.4R_s$ and $R > 3.3R_s$ & resonant-scattering from HeII lines at 30.4nm for $1.4R_s < R < 3.3R_s$

Preliminary work for computing helium abundance map in the solar corona

Thank you!