Absorption lines and gas flows

RASCAS-SPHINX-TRIPLE meeting
5th February 2021
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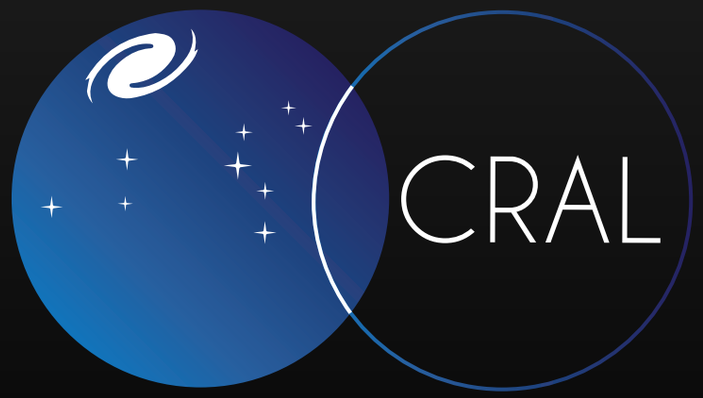
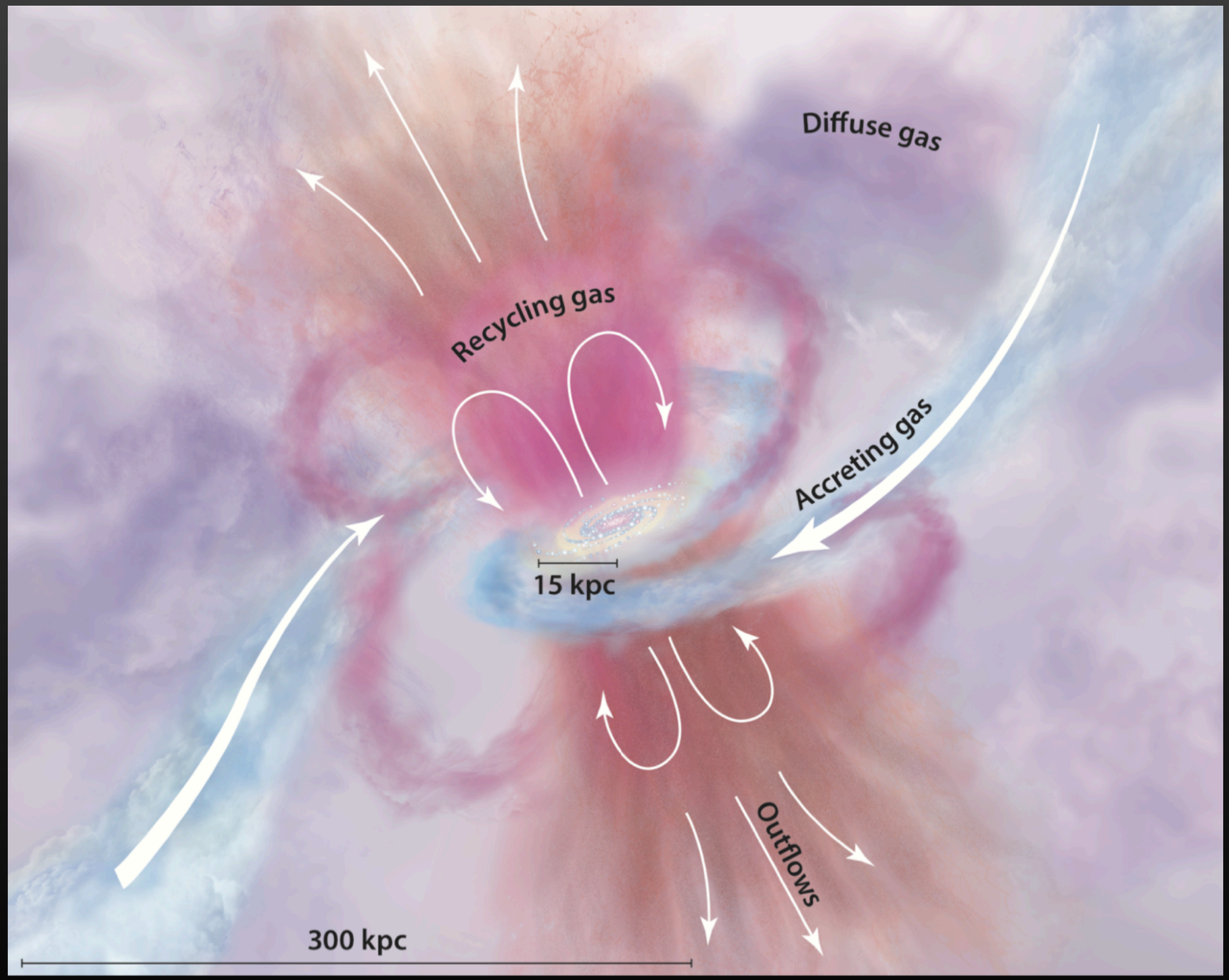
Supervised by
Anne Verhamme and Jérémy Blaizot



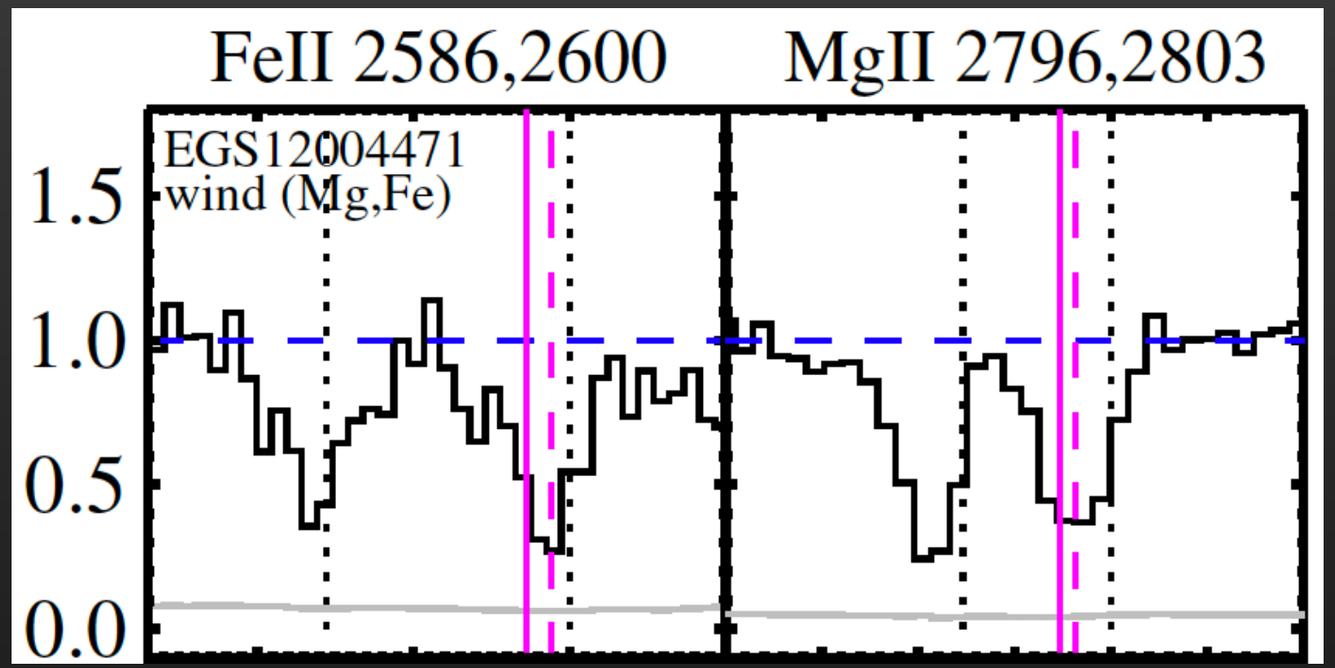
Introduction

Tumlinson+17



Introduction

Rubin+14



Value of the blueshift (v_center)
-> velocity of the outflow

Area of the line (EW)
-> amount of outflow

Open question:
-*Where are down-the-barrel absorption lines produced?*

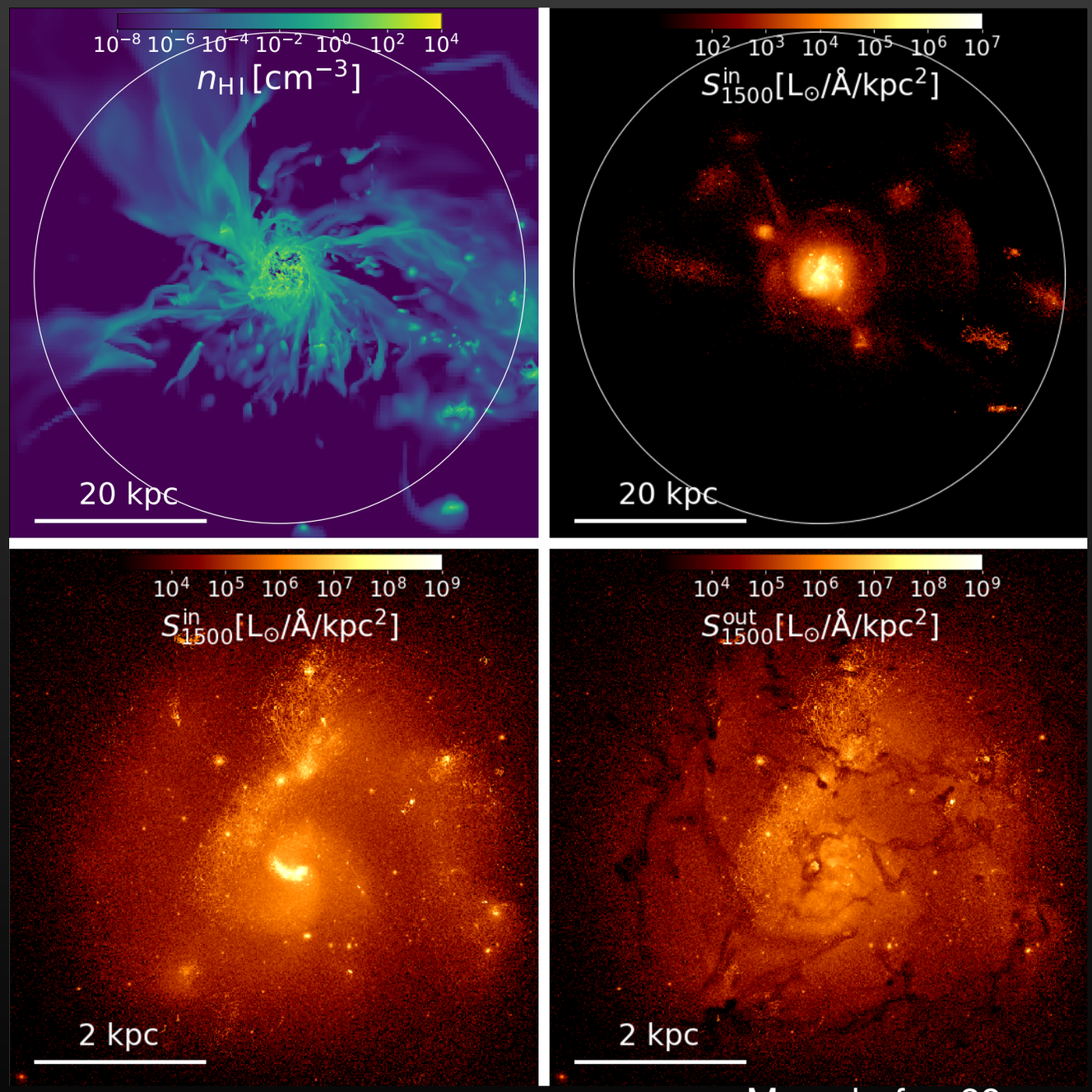
Simulation used in this project

Ramses-RT zoom-in simulation

- Same physics as Sphinx, Rosdahl+18
- Resolution of 14 pc in the ISM and ~220-440pc in the CGM

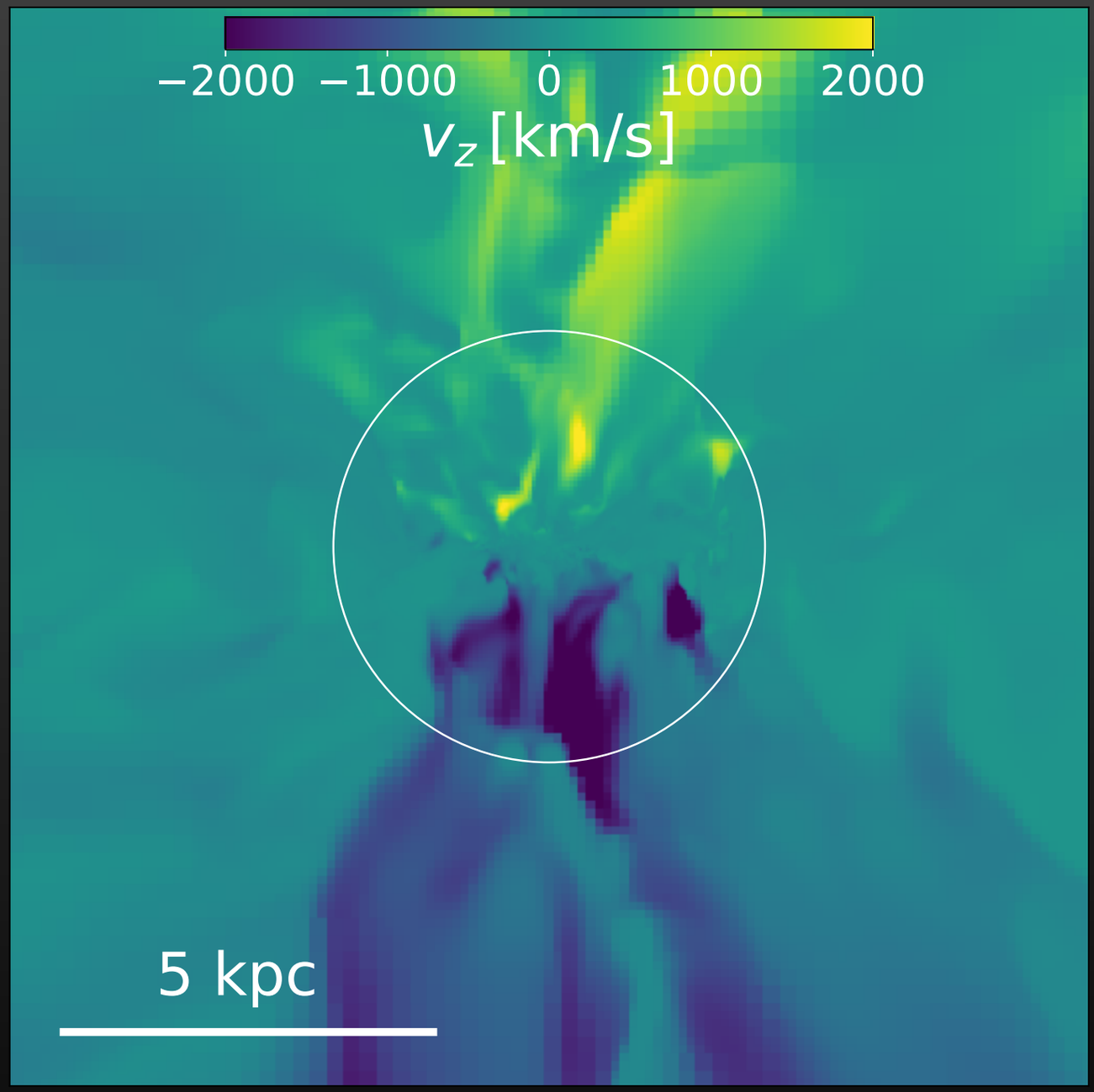
- z = 3
- SFR ~ 1-3 Msun/yr
- Z ~ 0.4 Zsun

$M_* = 2.3 \cdot 10^9 M_\odot$ $\quad M_{1500} = -18.5$



Mauerhofer+20

How to visualise gas flows?

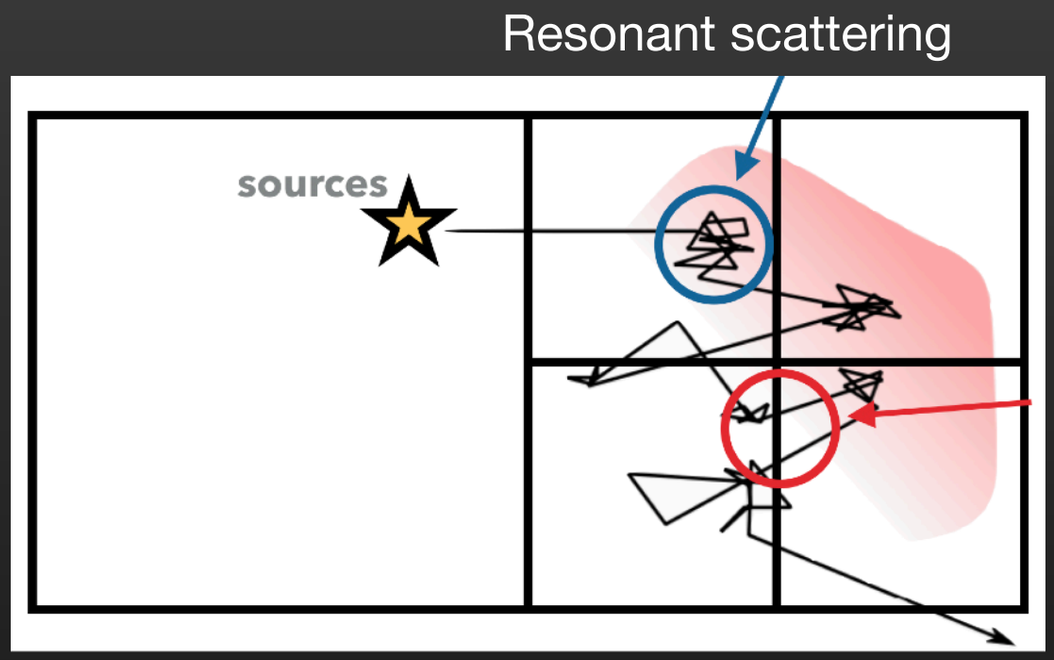


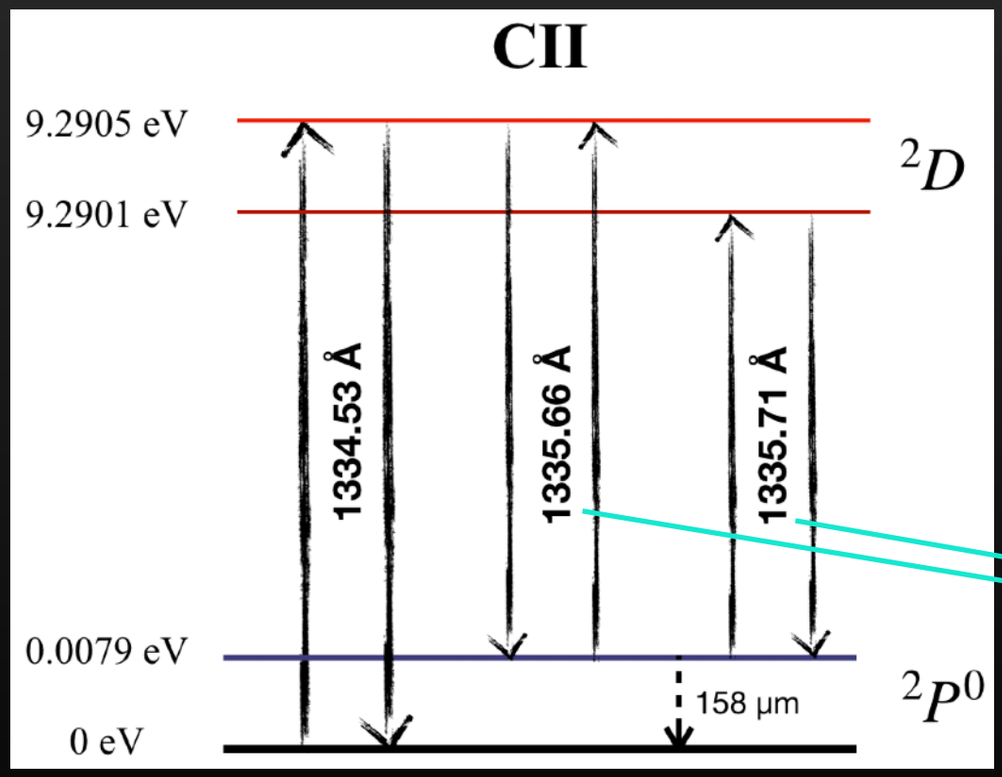
There are ultra-fast outflows, but they account for <0.1% of the mass outflow rates

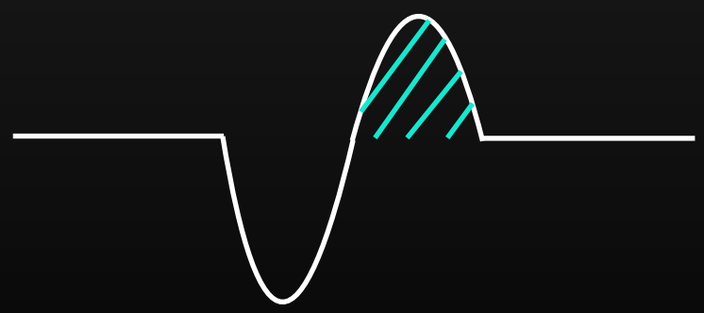
The production of mock absorption lines

KROME , to compute the density of ions

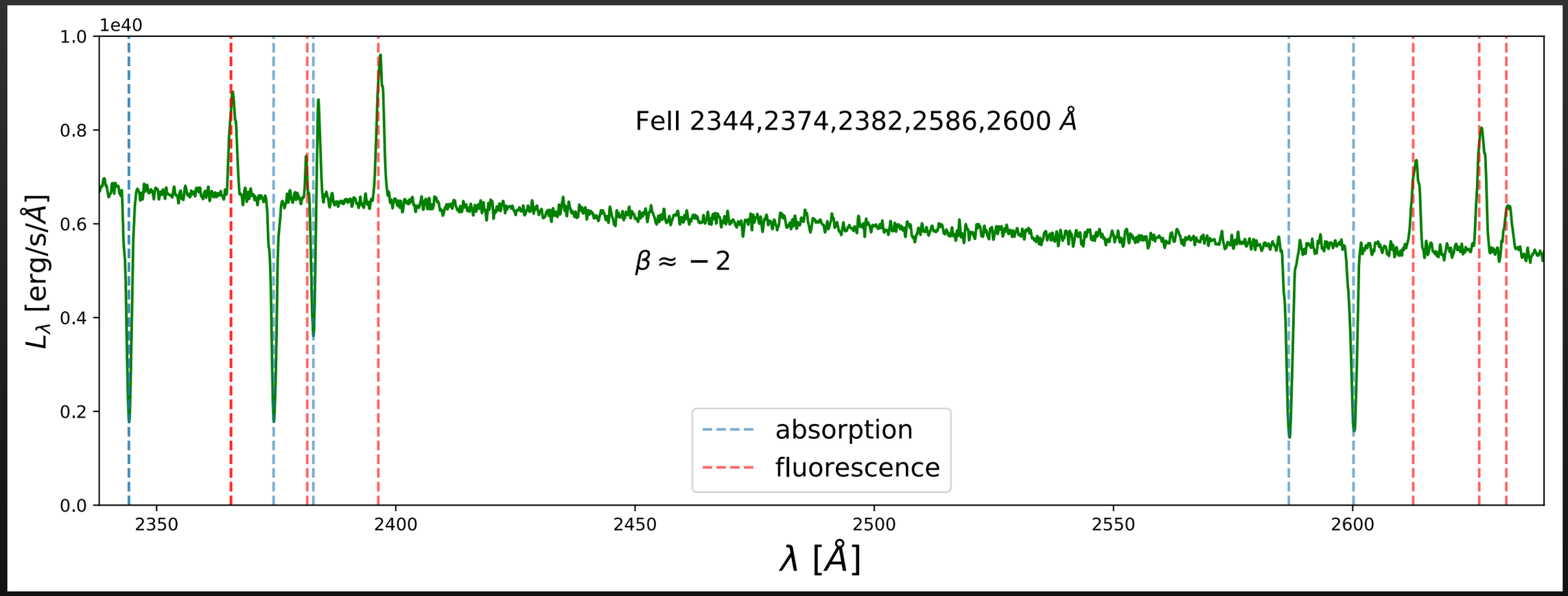
Radiative transfer post-processing with RASCAS
+ peeling-off algorithm



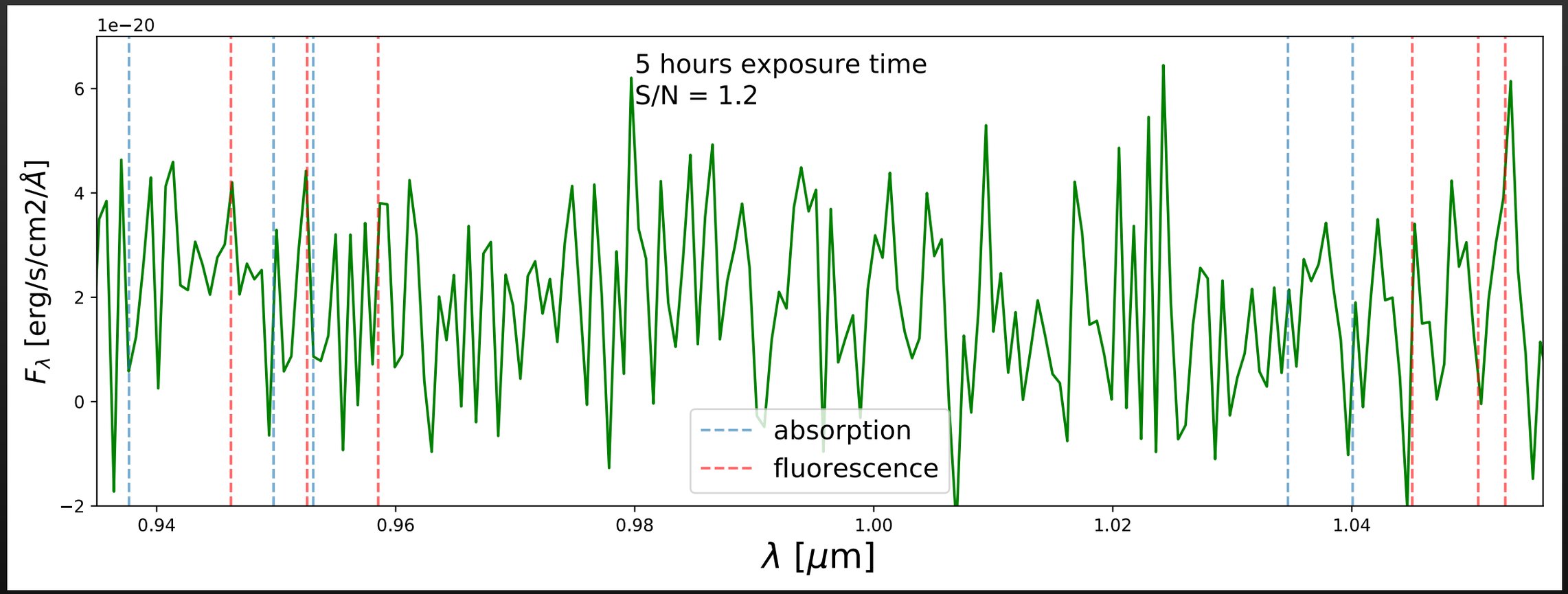




Rest-frame mock observation

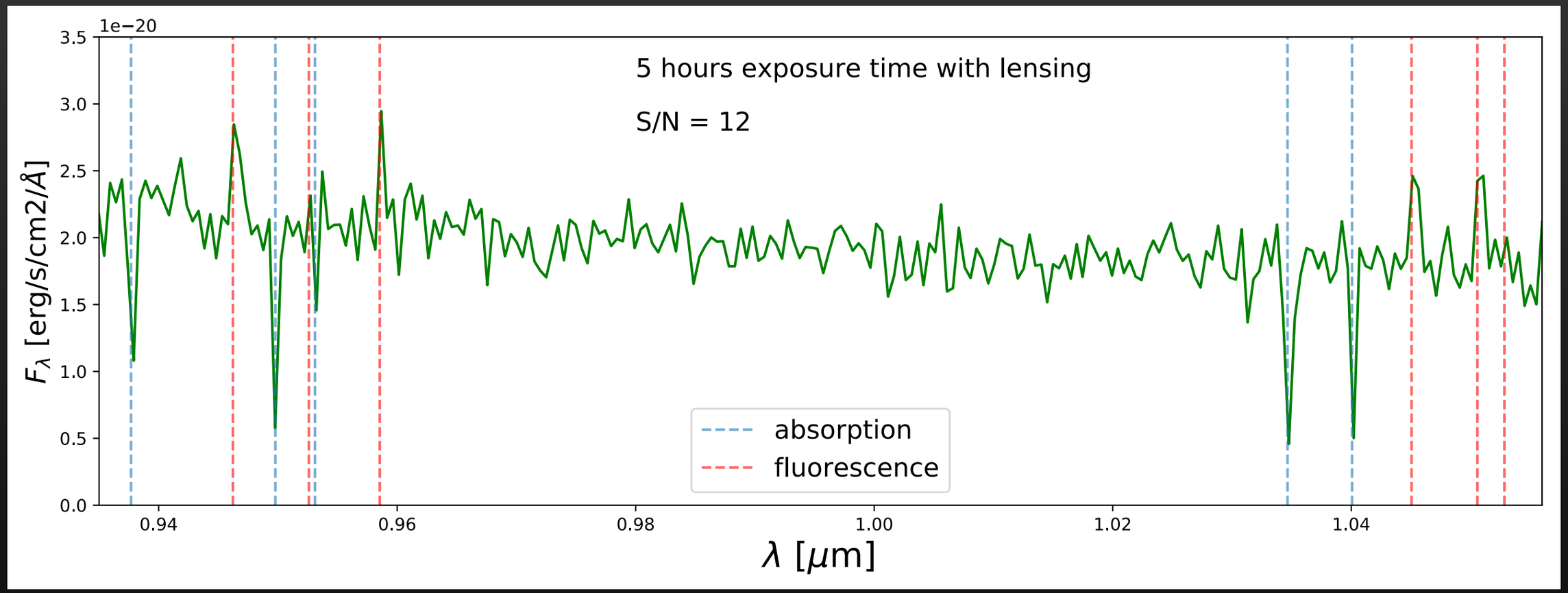


Mock NIRSpec observation

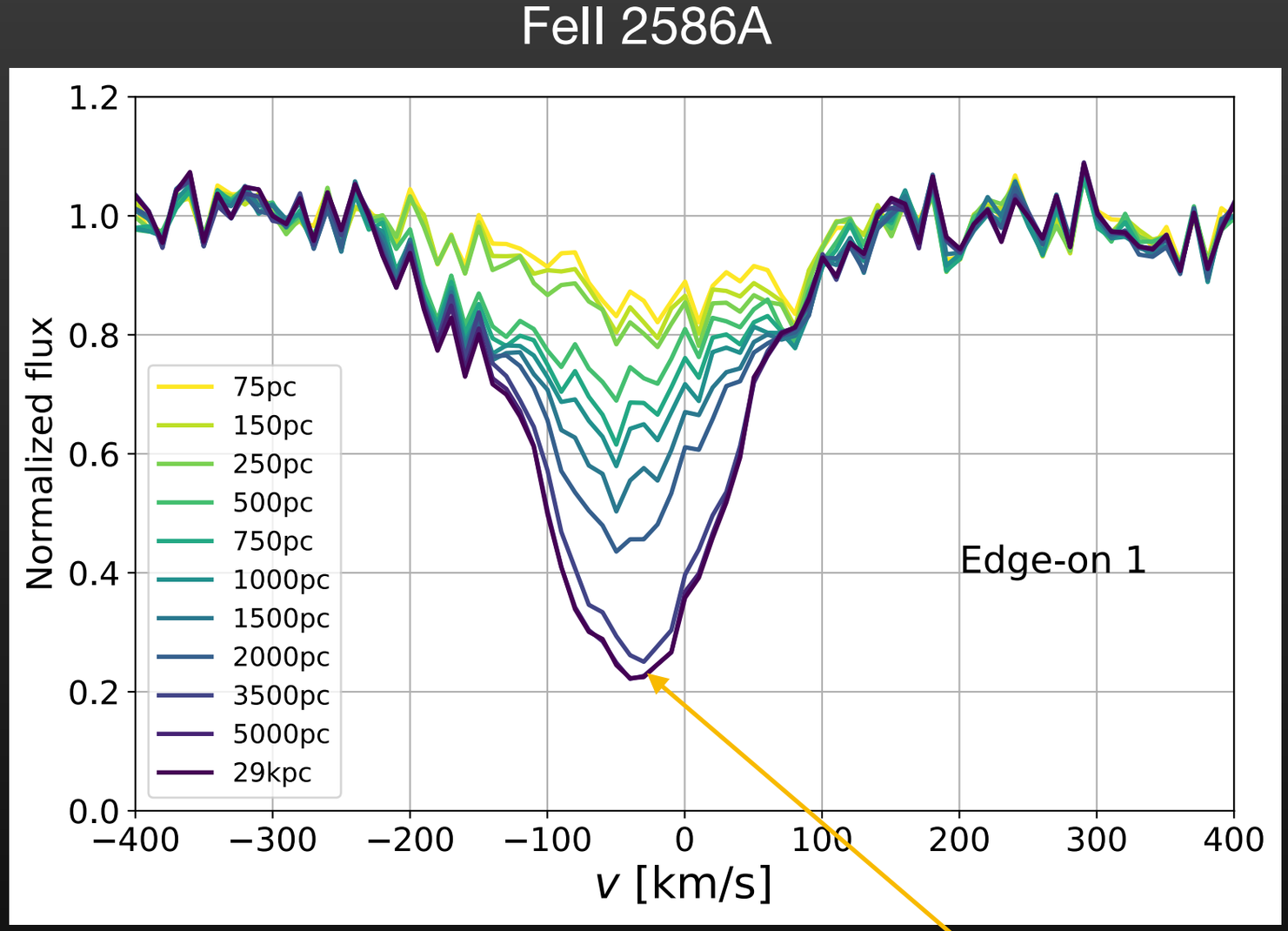


Credit to Pascal Oesch for computing the S/N ratio

Mock NIRSpec observation



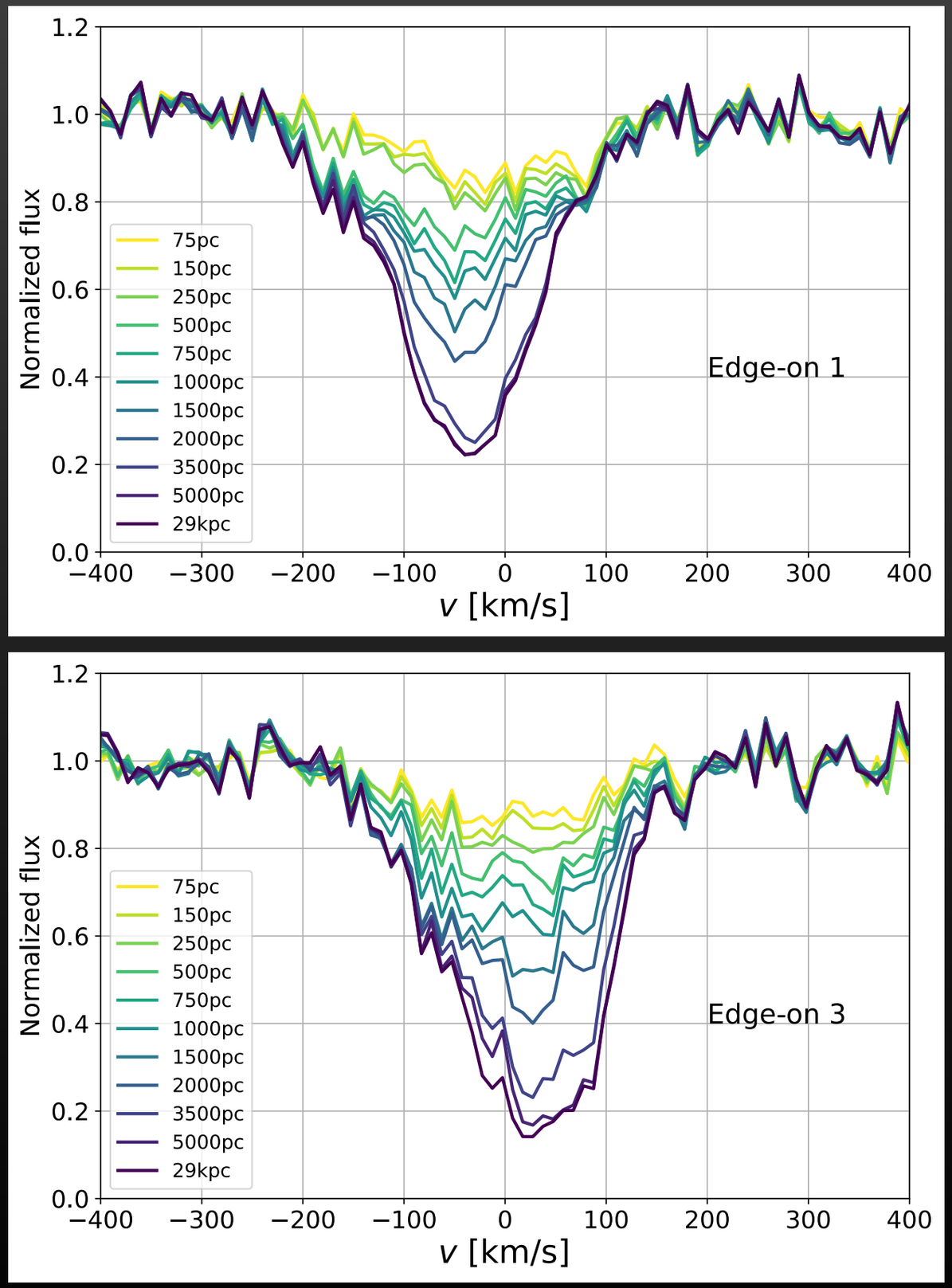
Where are absorption lines produced?

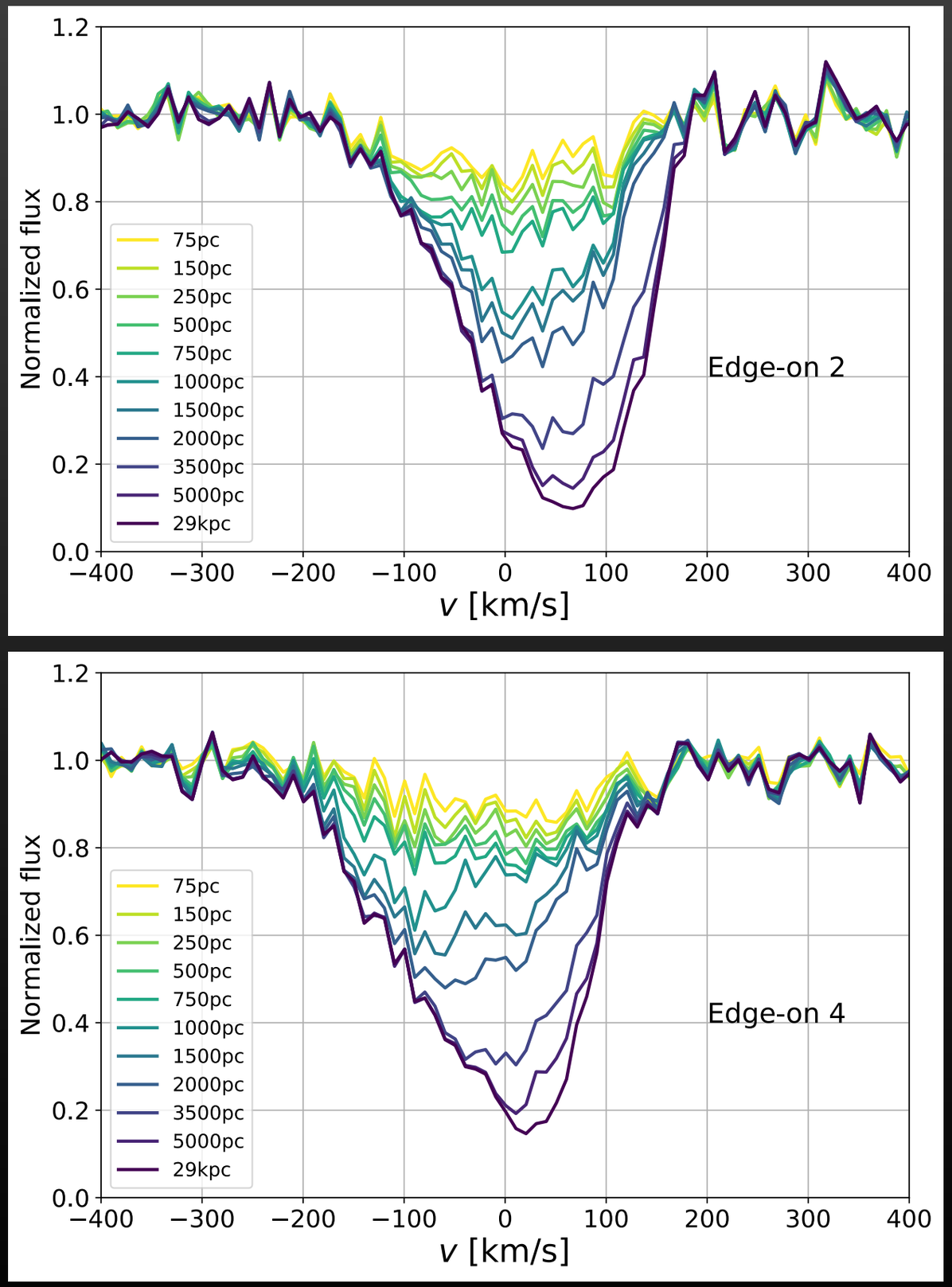


~75% of the line is produced in the ISM

5 and 29 kpc mixed up

Where are absorption lines produced?





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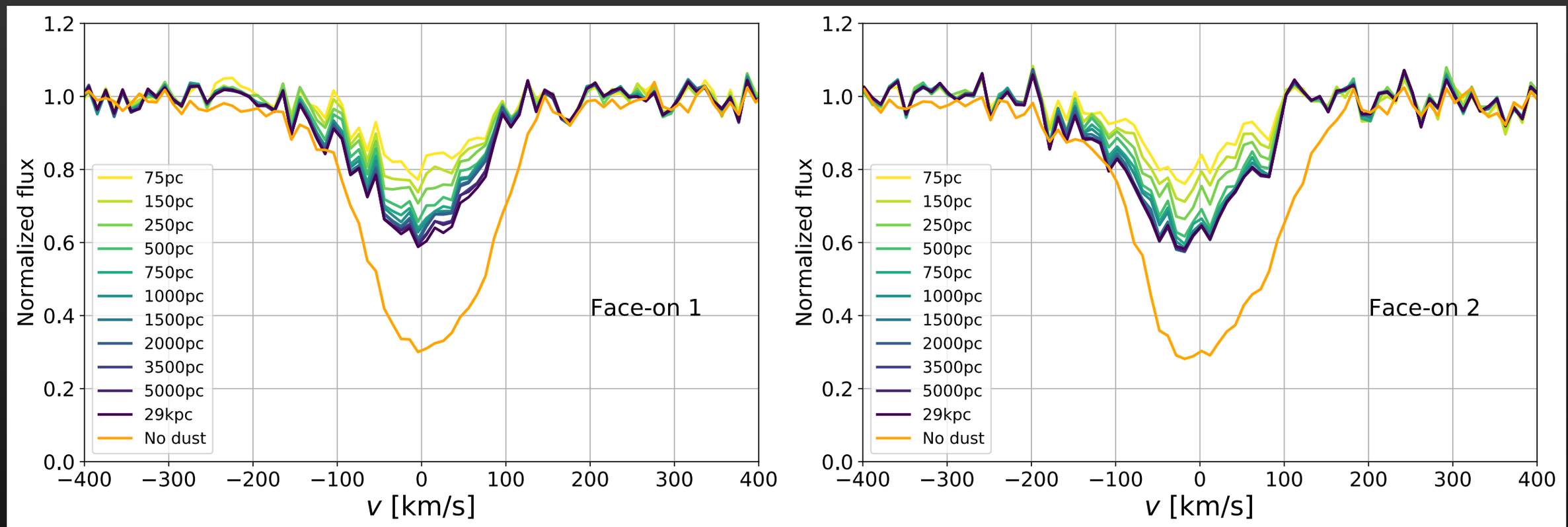
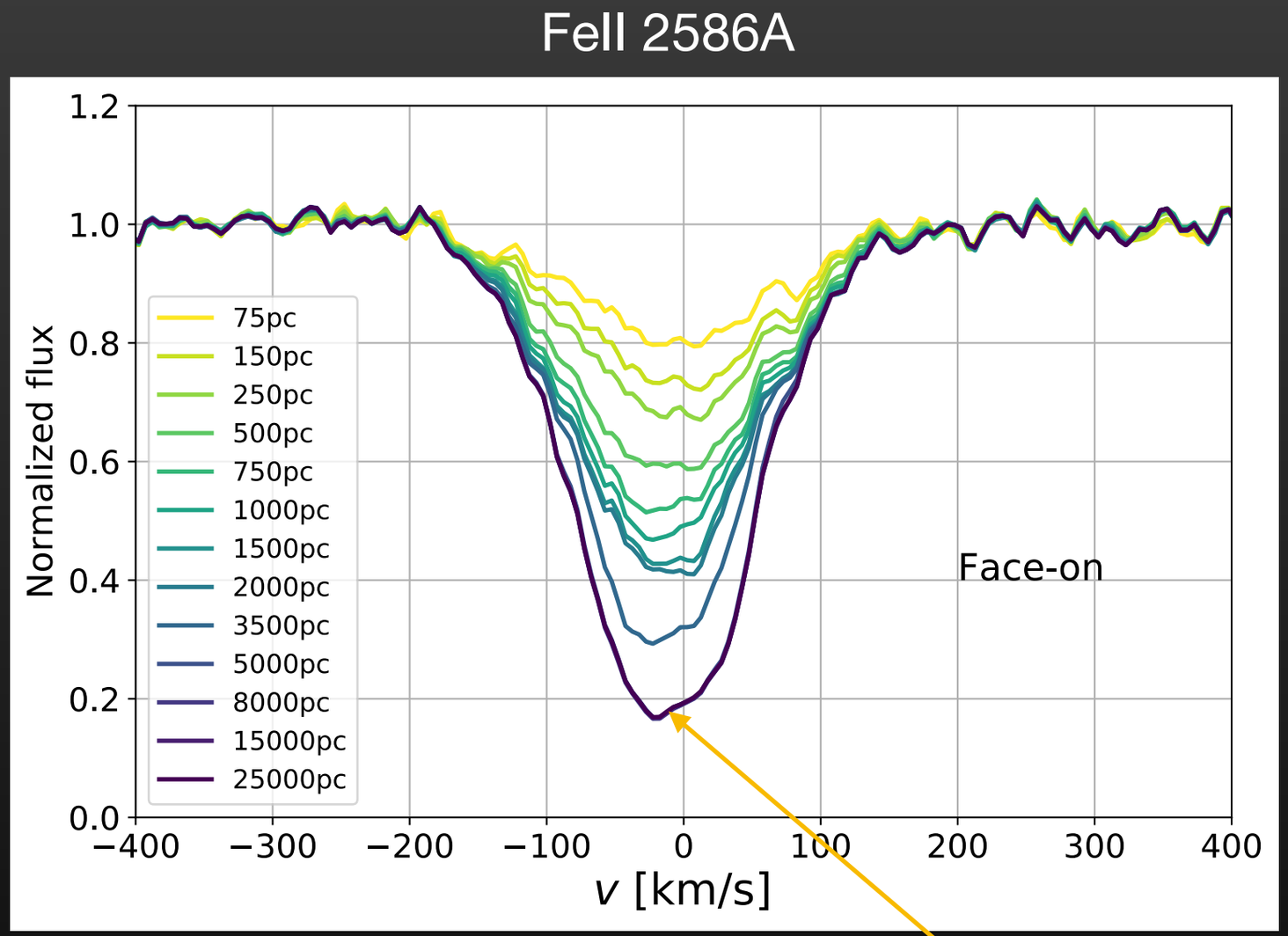


Less neutral gas in face-on directions?

-> In part, but also due to dust and scattering effects

A timestep with more neutral “outflows”



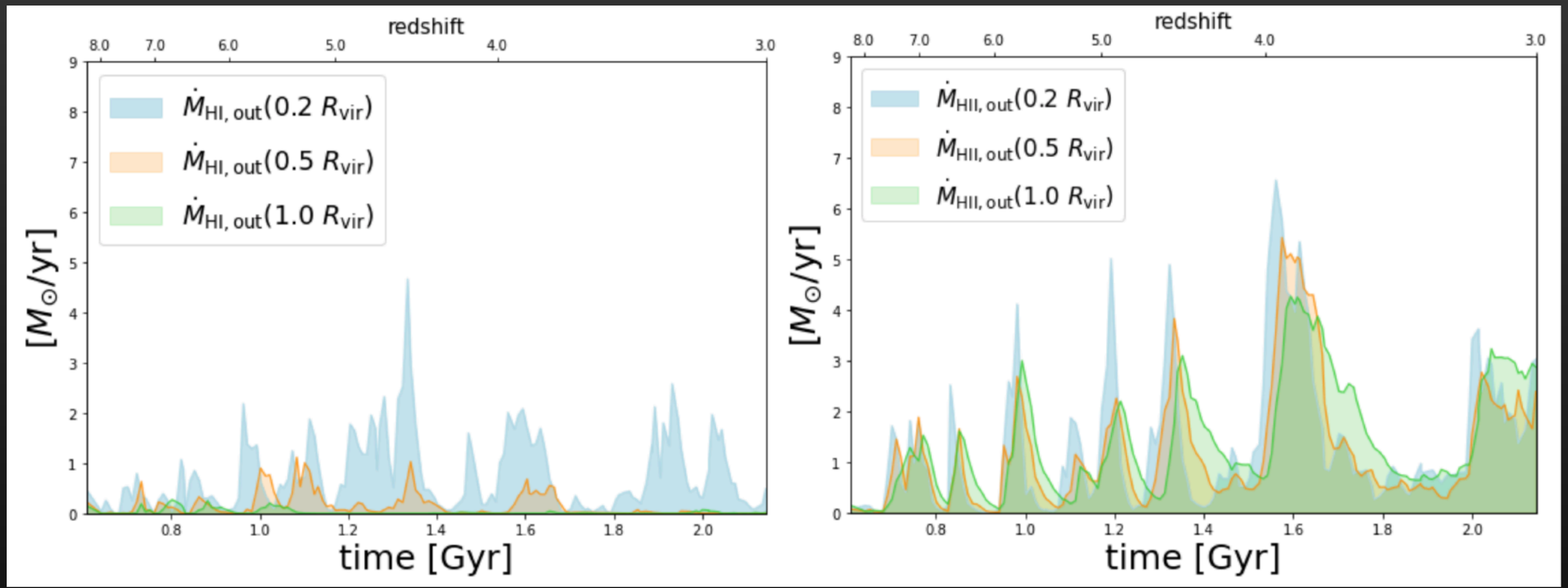
- The “outflow” is actually due to a satellite passing by
- The line is not affected by this gas

5, 8, 15 and 25kpc all the same

What about ionized gas?

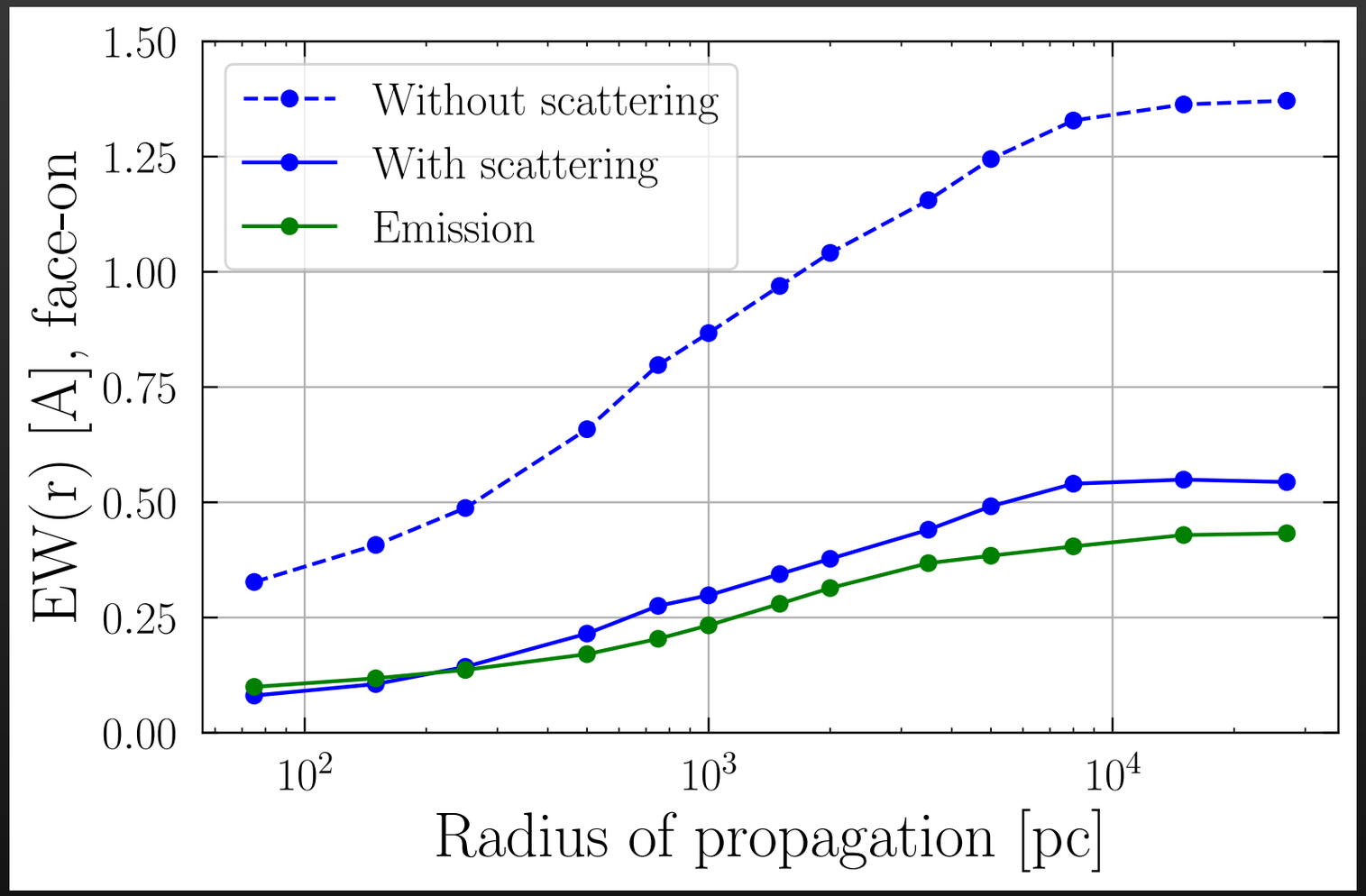
Neutral outflows

Ionized outflows



Is the non-effect of the CGM on low-ionization state absorption lines due to a lack of neutral outflows?

A tracer of ionized gas: CIV 1548A



- Scattering fills the absorption and creates p-cygni profiles. The “fluorescence”here is the EW of the emission part of this profile.

Summary

- Absorption lines are produced in the first ~5 kpc around stars

- There are hints of global trends between gas flows and absorption lines:
  inflowing gas <-> redshifted lines / neutral outflows <-> wider lines.

- But no quantitatively robust correlations between mass outflow rates or gas velocity and absorption line velocity shift/equivalent width.

- Complex scattering effects drastically modify lines such as CIV 1548A or SiIV 1393A.