

# Probing stellar feedback and ionising escape with accurate emission line modelling

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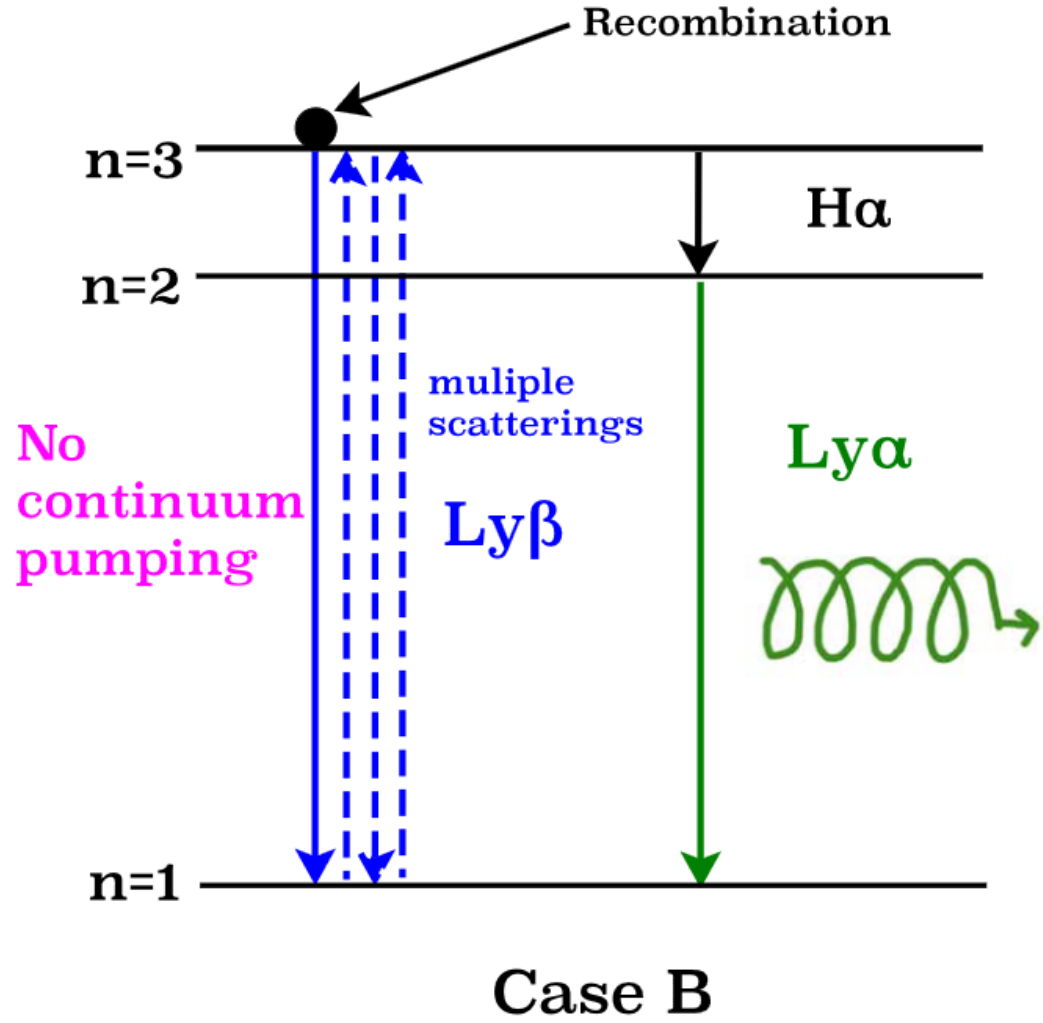
PhD Student @ University of Cambridge

with Sandro Tacchella, Aaron Smith, and Roberto Maiolino

# **PART I**

## **Galaxies are weird**

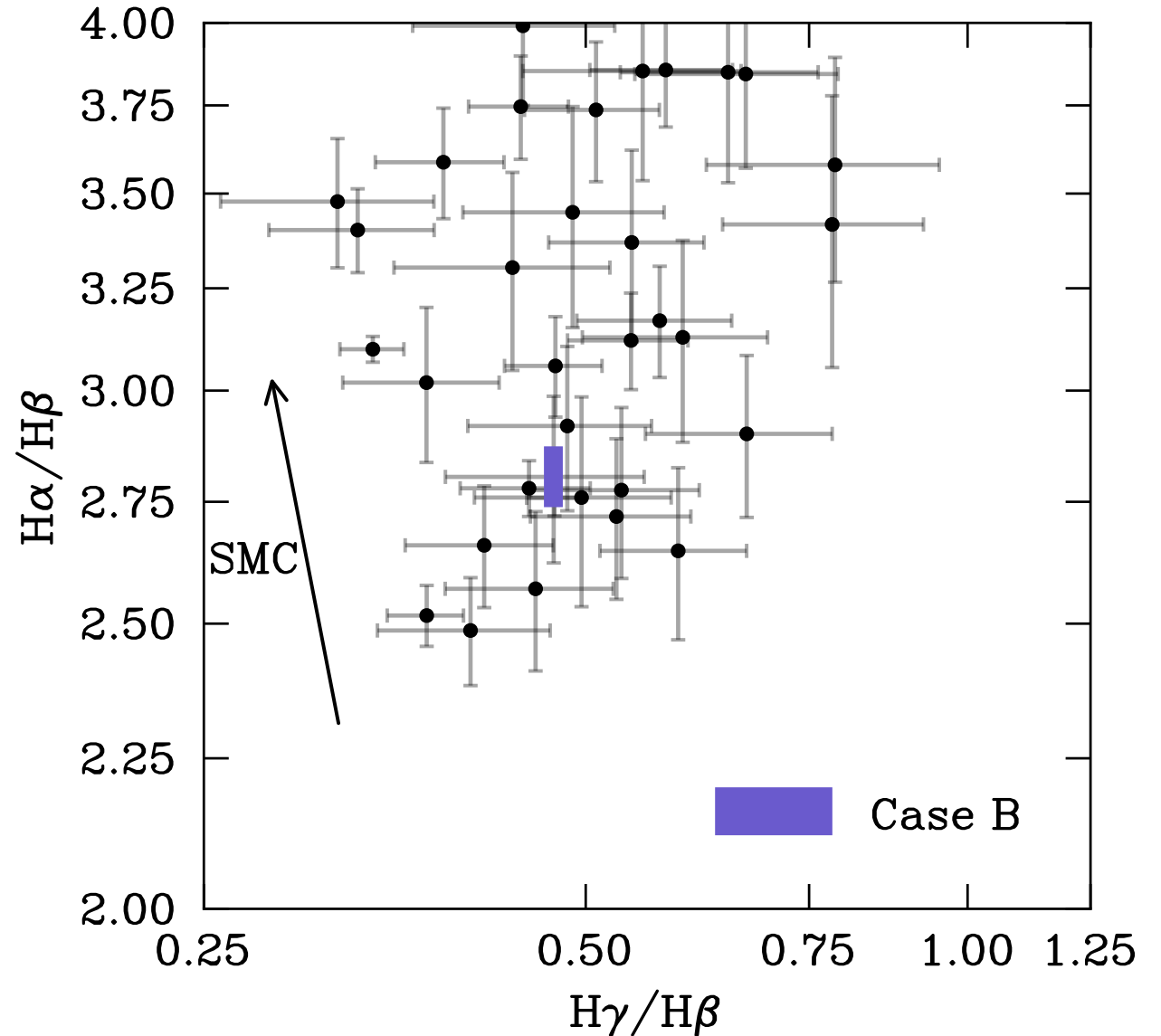
# Case B refresher



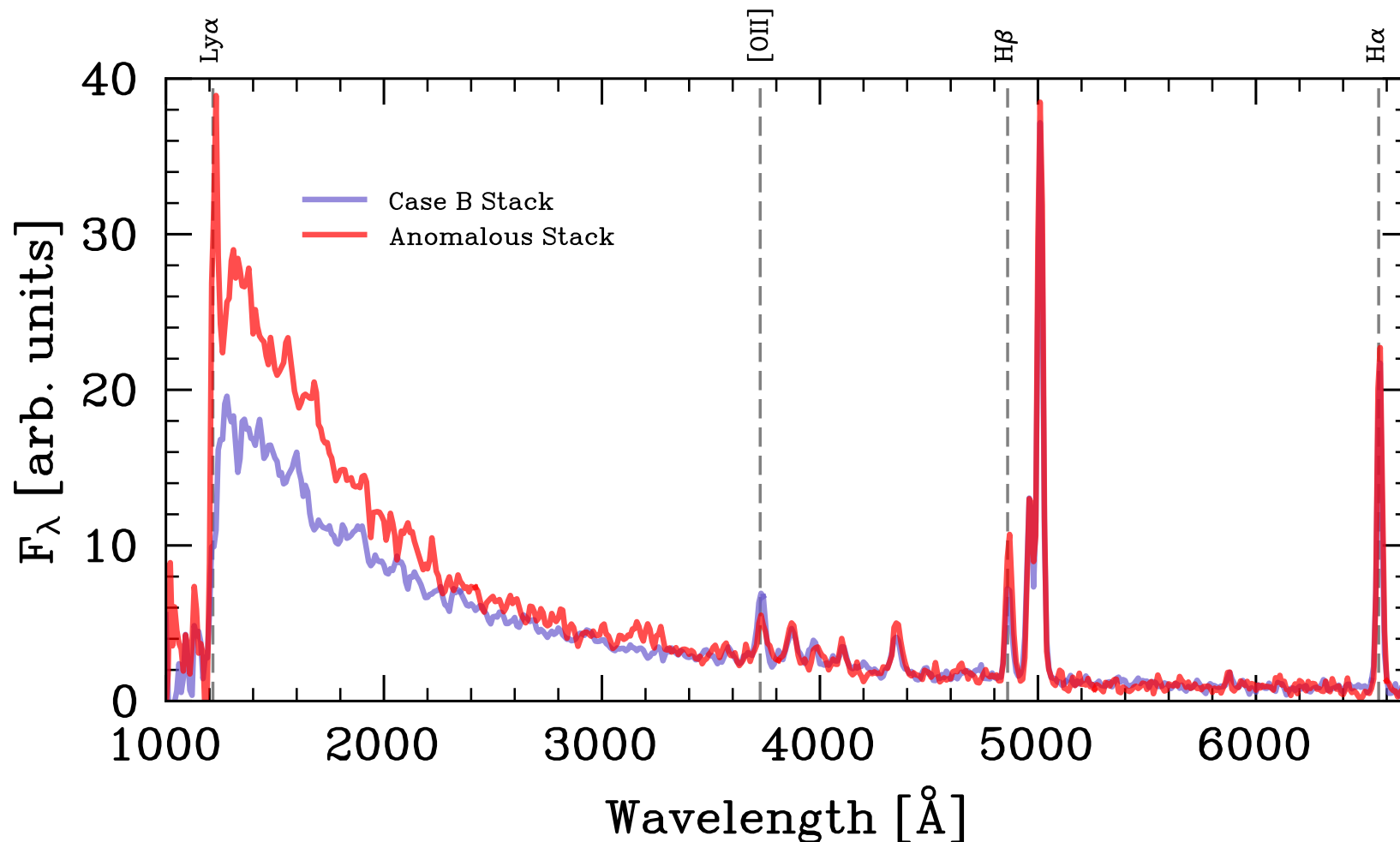
Chakraborty et al. (2021)

# Anomalous Balmer emitters (ABEs)

- Anomalous Balmer emitters (ABEs) show Balmer line ratios which are inconsistent with Case B and dust
- 26 (52) ABES at  $z > 5.3$  ( $z > 2$ )
- Also seen in other datasets and at low- $z$  (e.g. Scarlata+24)

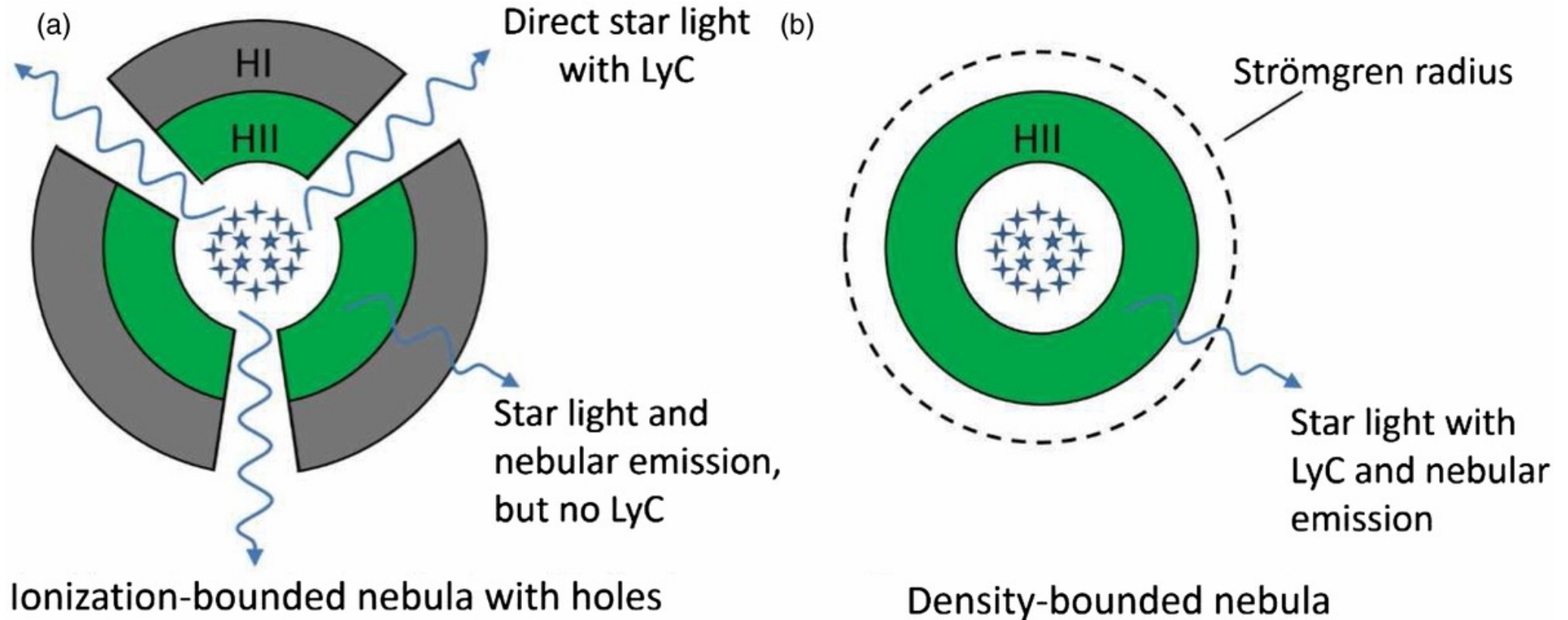


# Anomalous Balmer emitters (ABEs)



- ABEs show higher OIII/OII, have steeper UV slopes, are fainter, and are more preferentially Ly $\alpha$  emitters

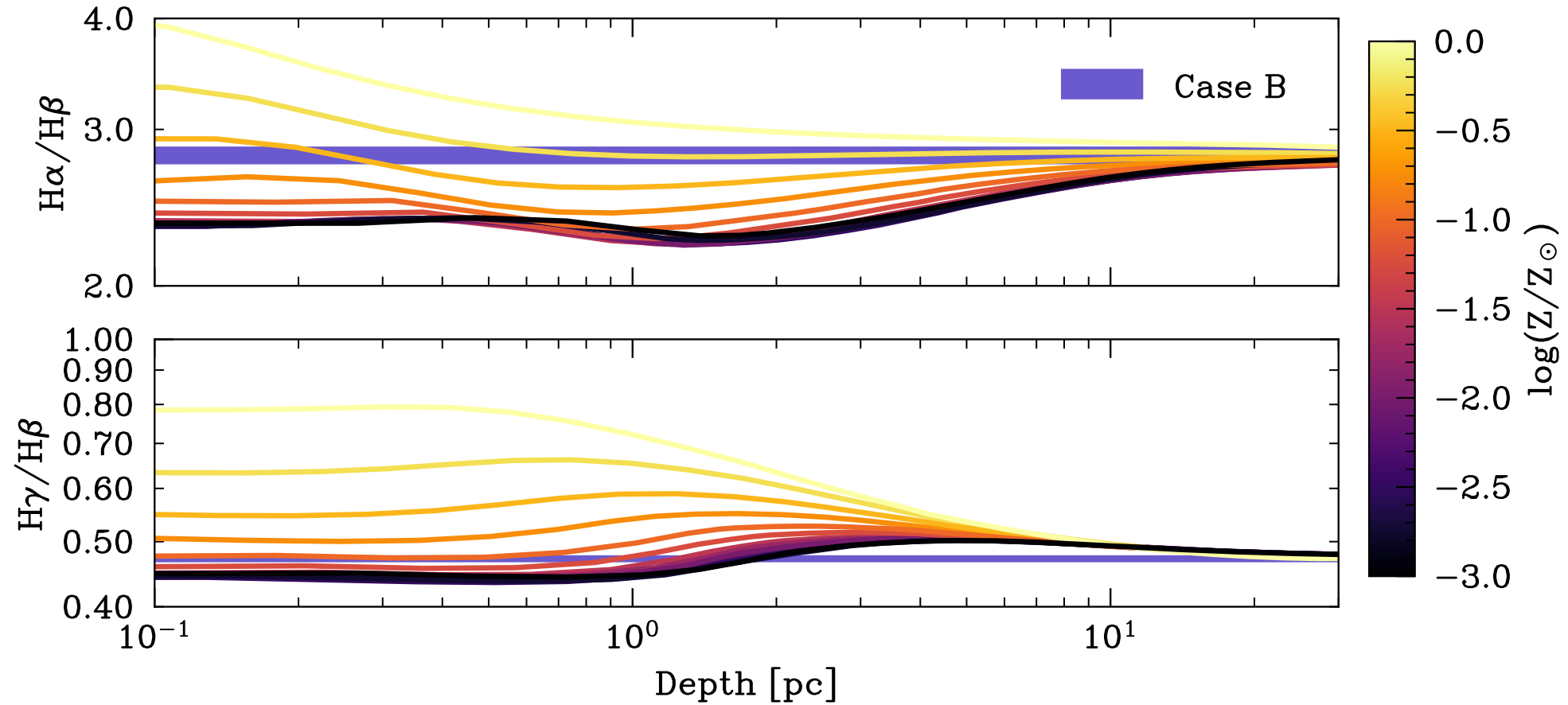
# Density-bounded nebulae



Zackrisson et al. (2013)

- Density-bounded nebulae naturally explain ABE features
- Boosts higher ionisation lines at a given ionisation parameter

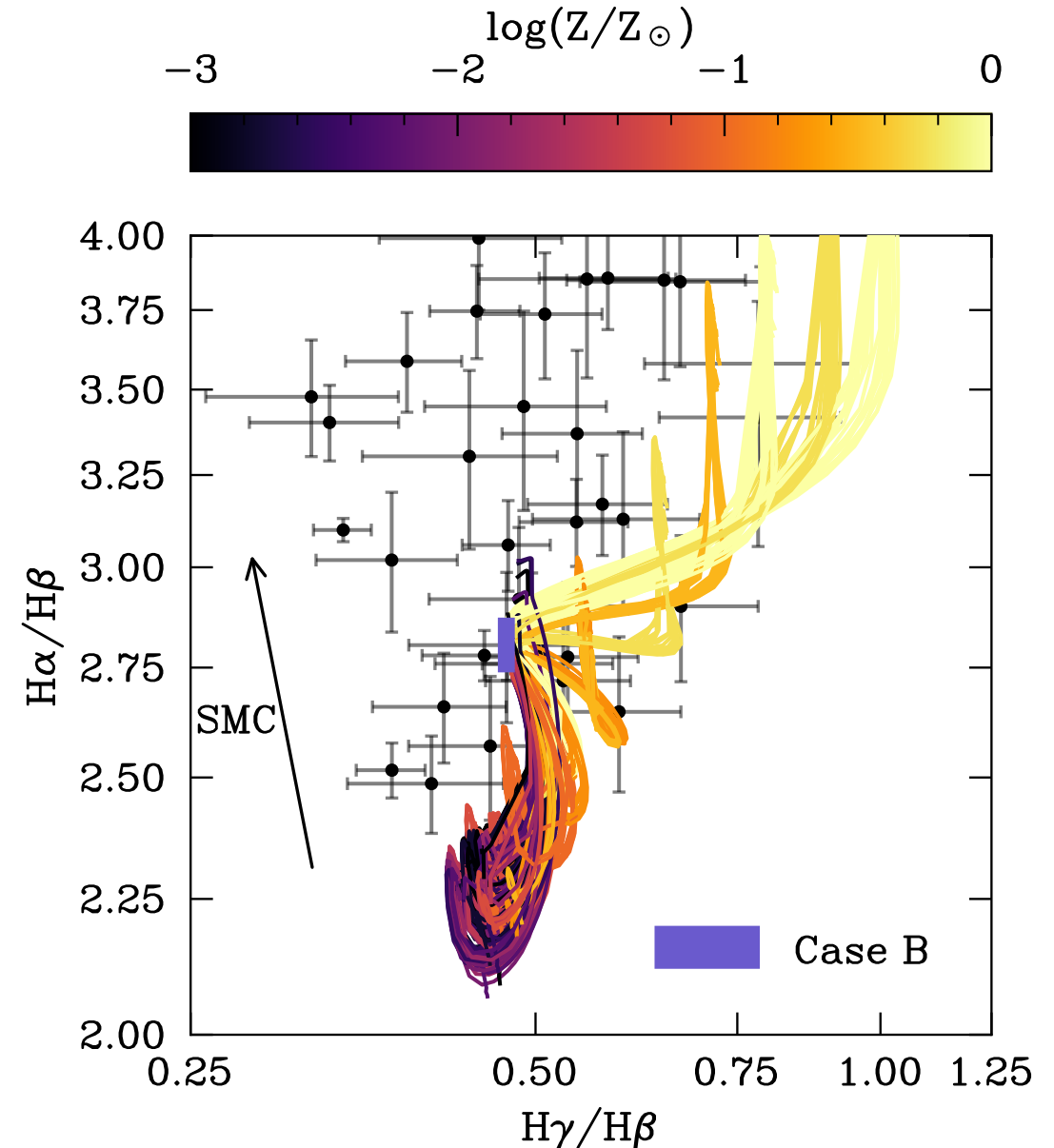
# Density-bounded emission from ABEs



- Metallicity dependence due to the amount of Lyman line pumping from stellar SEDs

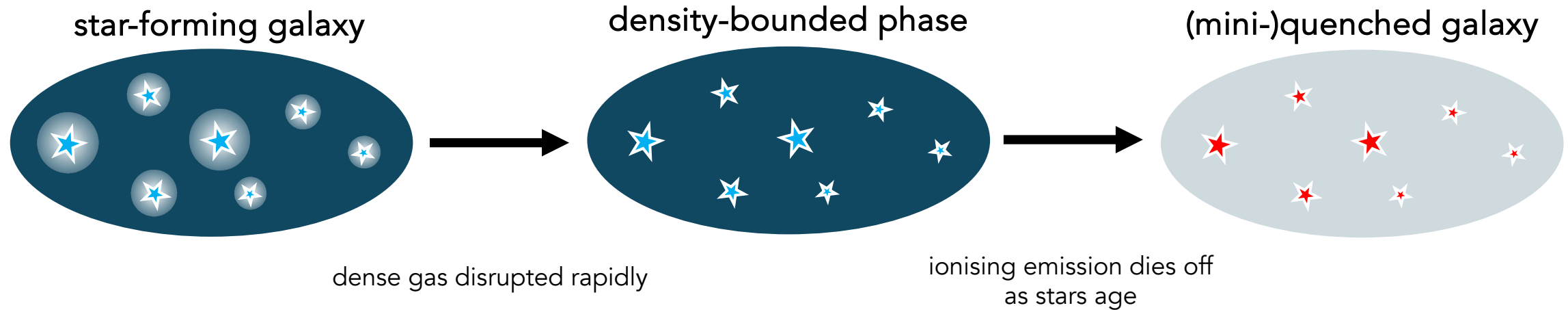
# Density-bounded emission from ABEs

- Density-bounded emission successfully reproduces all observed ABEs
- Consider how density-bounded emission may impact your observations!





# Physical interpretation of ABEs



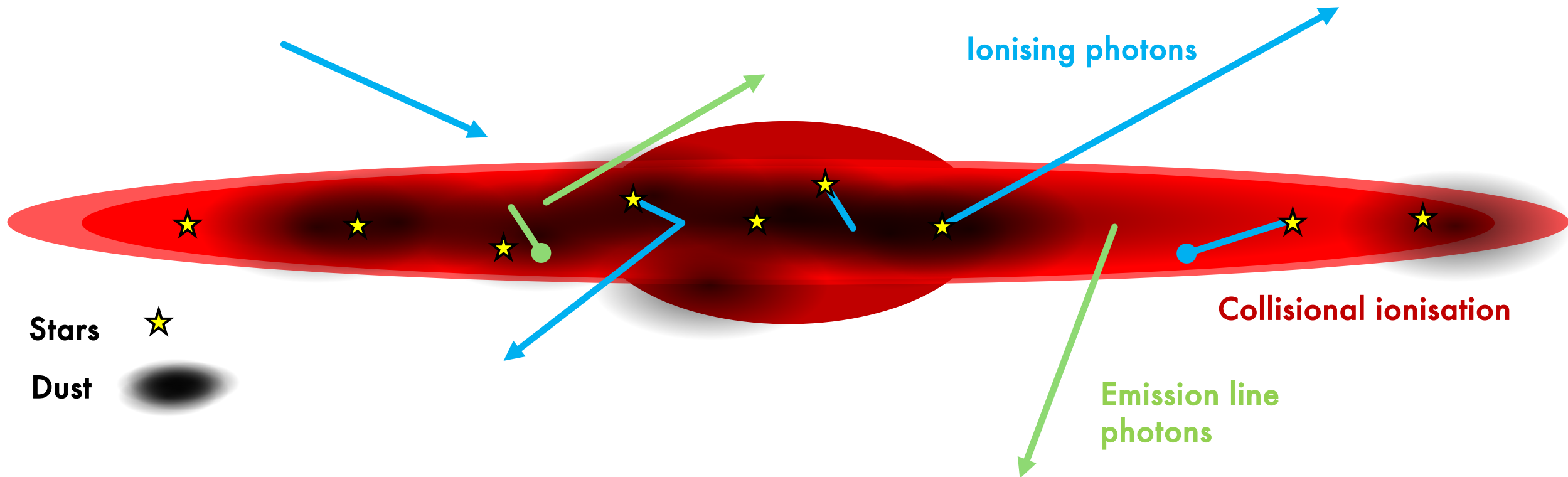
- ABEs may be rapidly quenching galaxies
- Interpretation limited by modelling only simple geometries

# **PART II**

## **Modelling weird galaxies**

# Monte Carlo radiative transfer with COLT

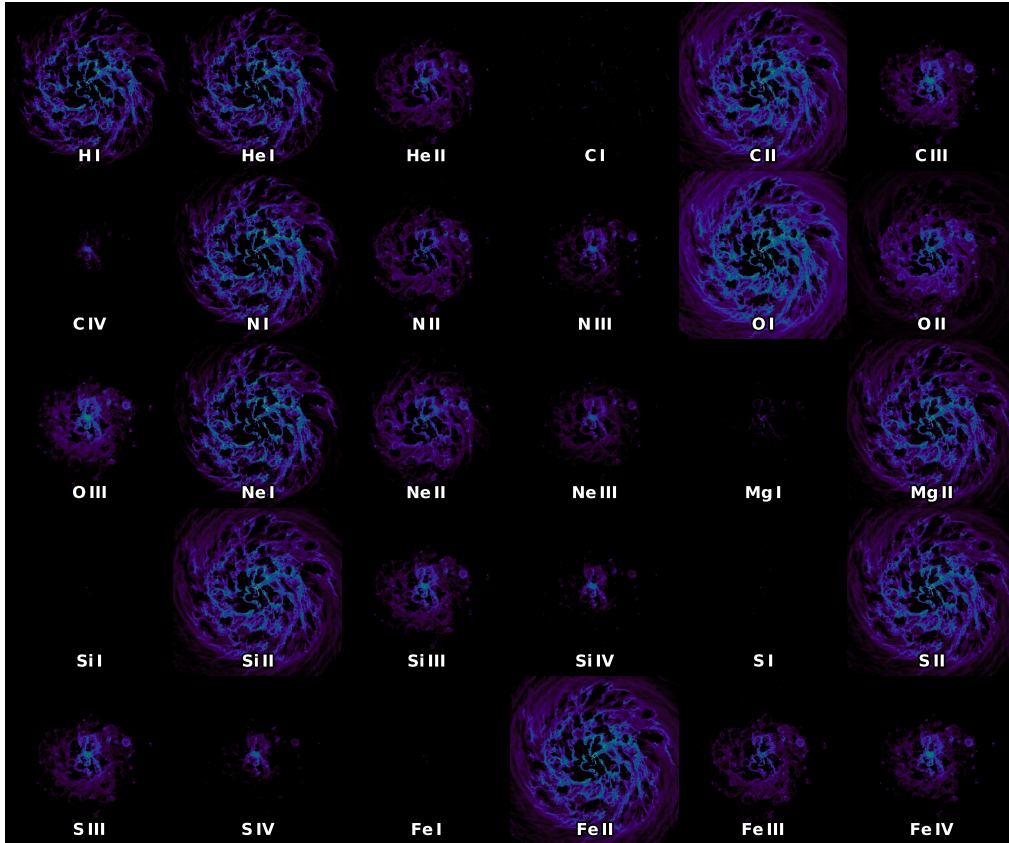
(Smith et al. 2015)



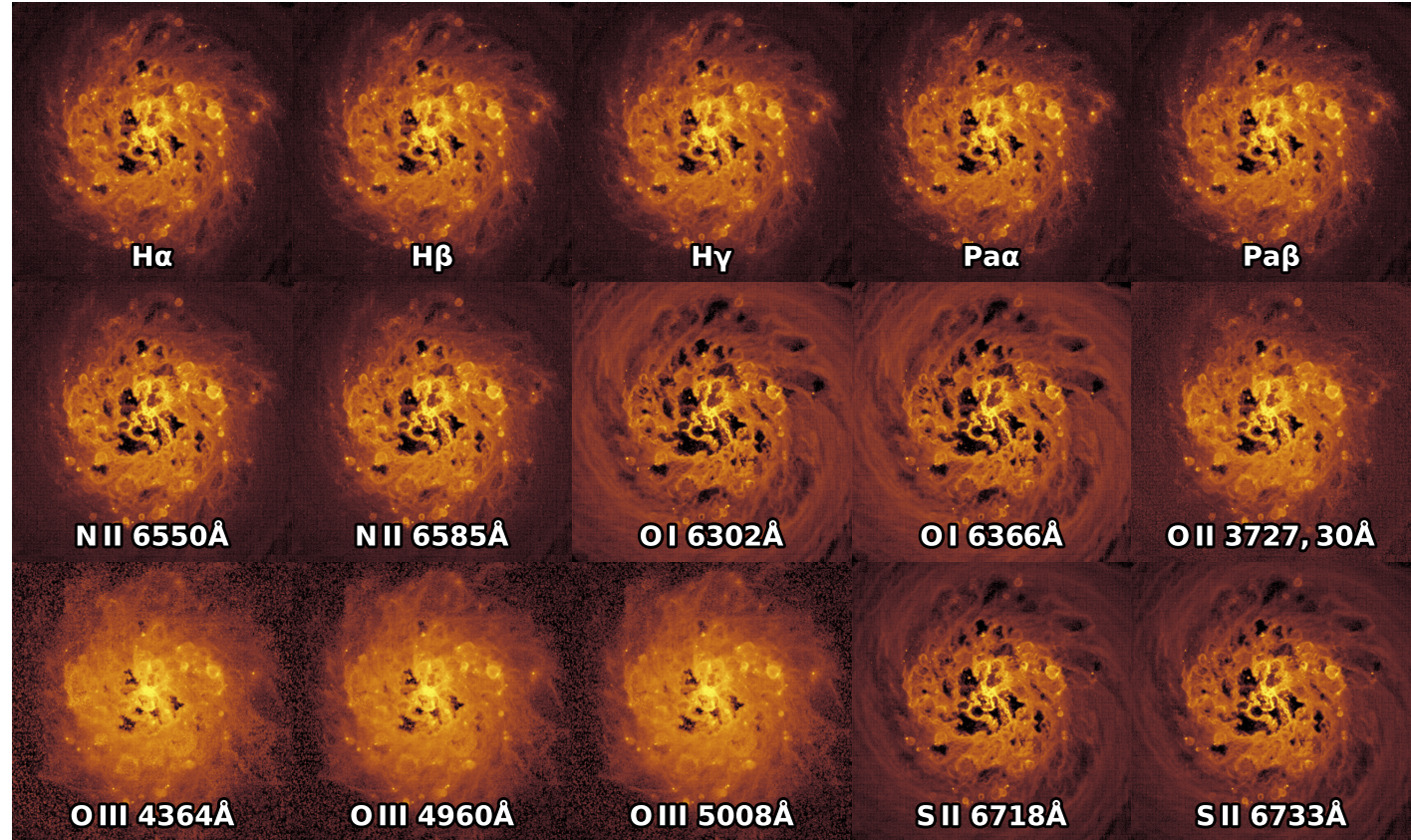
- Calculate ionisation states
- Create mock emission line and (nebular + stellar) continuum maps

# Monte Carlo radiative transfer with COLT

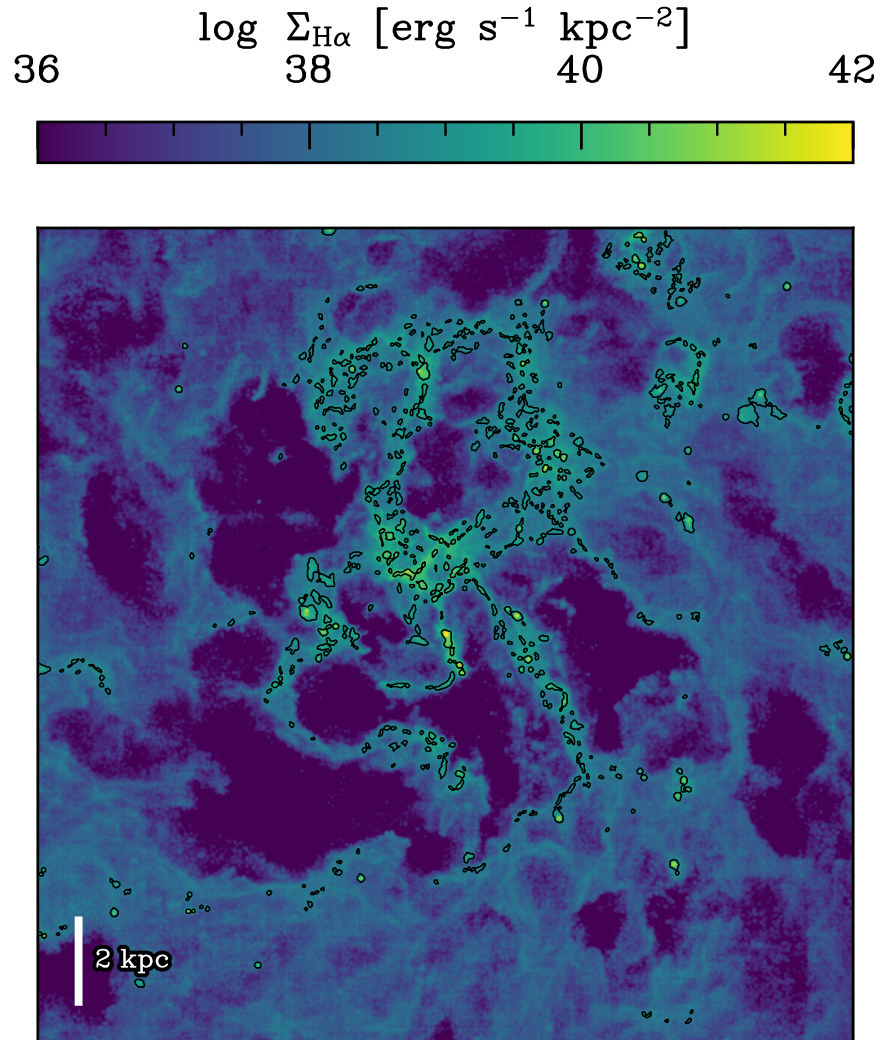
Ionisation states



Emission line maps

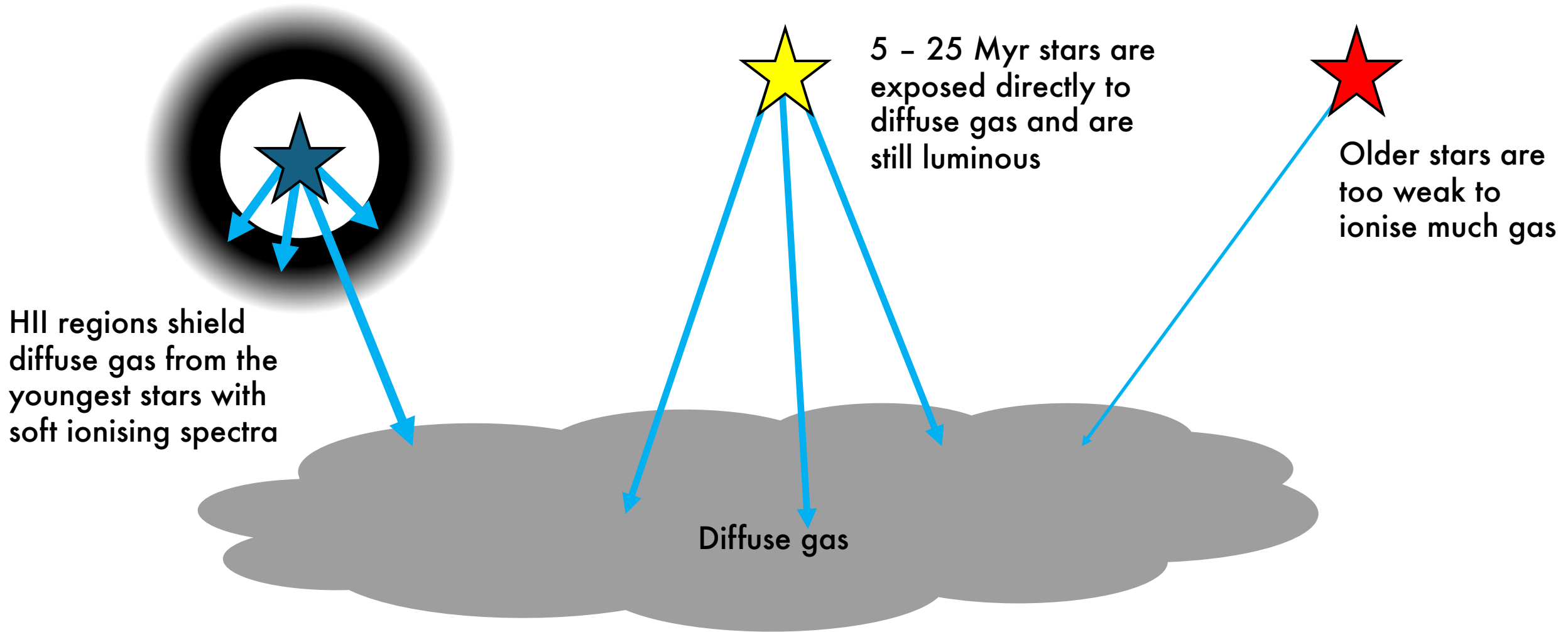


# Diffuse ionised gas (DIG) in local galaxies

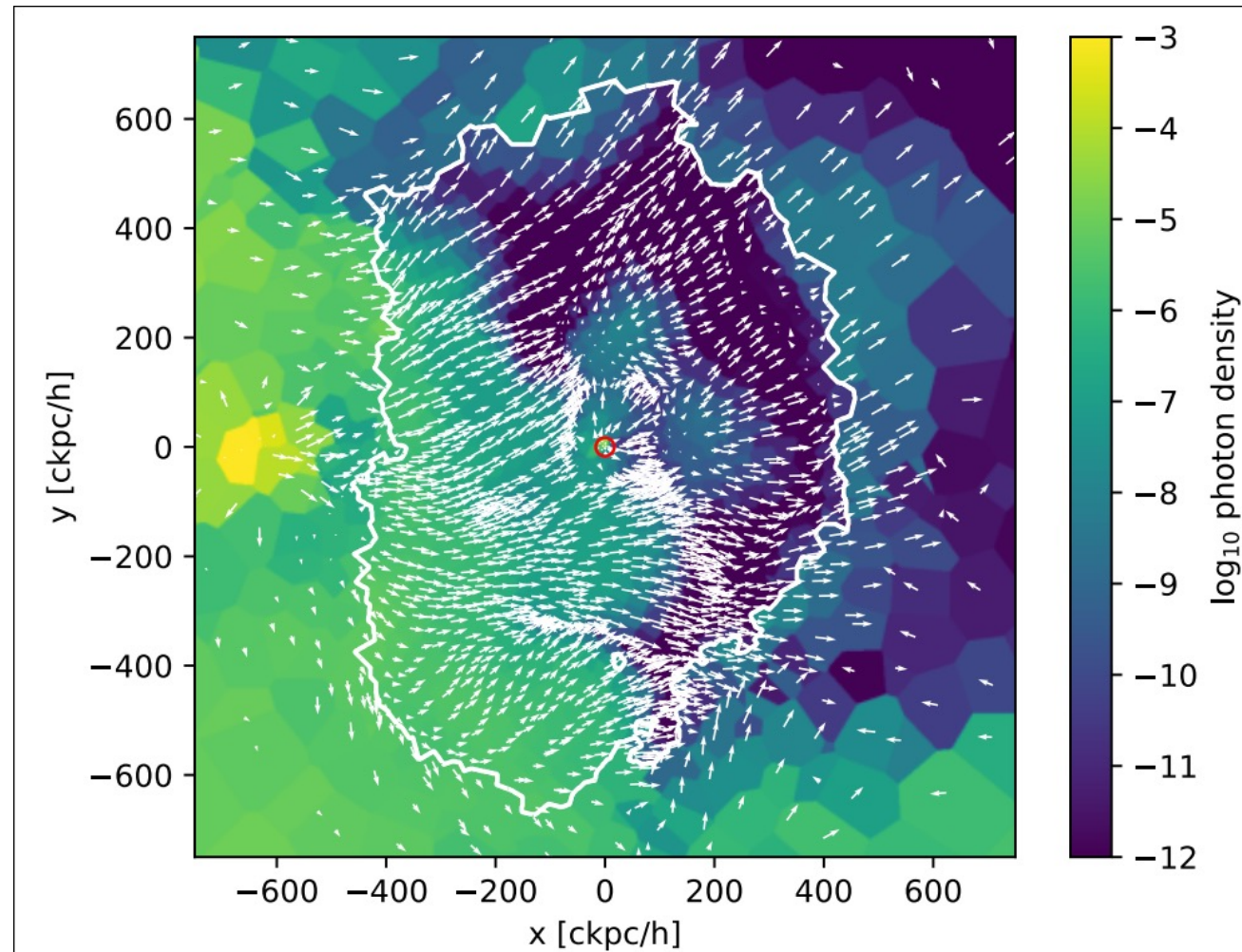


- The DIG shows high  $\text{OIII}/\text{H}\beta$
- Inconsistent with leaking radiation from young stars
- Contribution from post-AGB stars?

# Diffuse ionised gas (DIG) in local galaxies



# Emission during the EoR with THESAN Zoom



- To study the high-redshift universe, COLT is combined with zoom-in re-simulations of galaxies extracted from THESAN

# Conclusions

- We have identified a population of anomalous Balmer emitters (ABEs) during the EoR, which display Balmer line ratios inconsistent with Case B
- ABEs appear to be density-bounded LyC leakers, potentially during the rapid downturn of a star-formation burst
- Modelling ionisation and emission on whole-galaxy scales is required to understand the origin of peculiar line emission