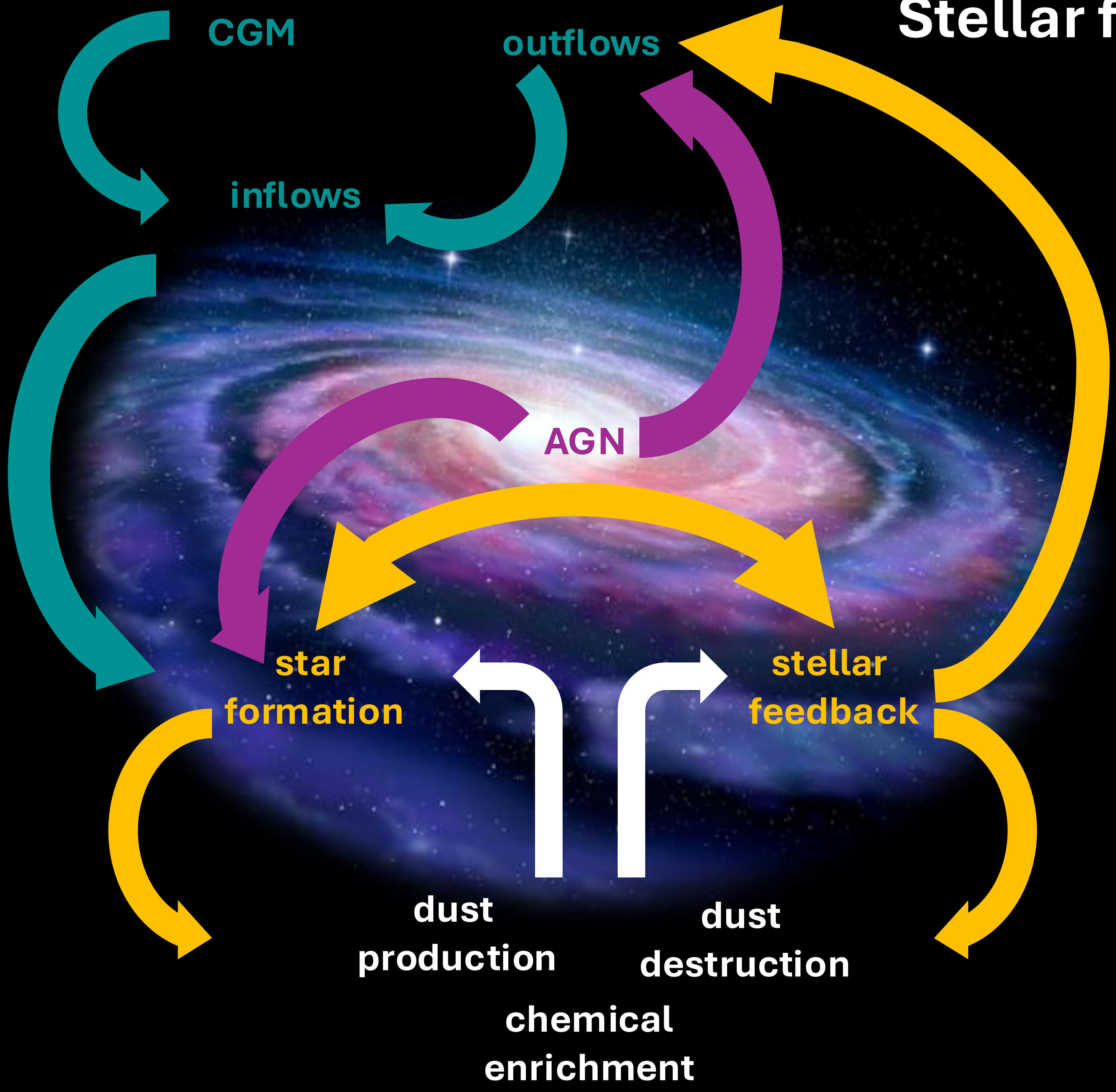
Stellar feedback, population synthesis, and the IMF, across redshifts

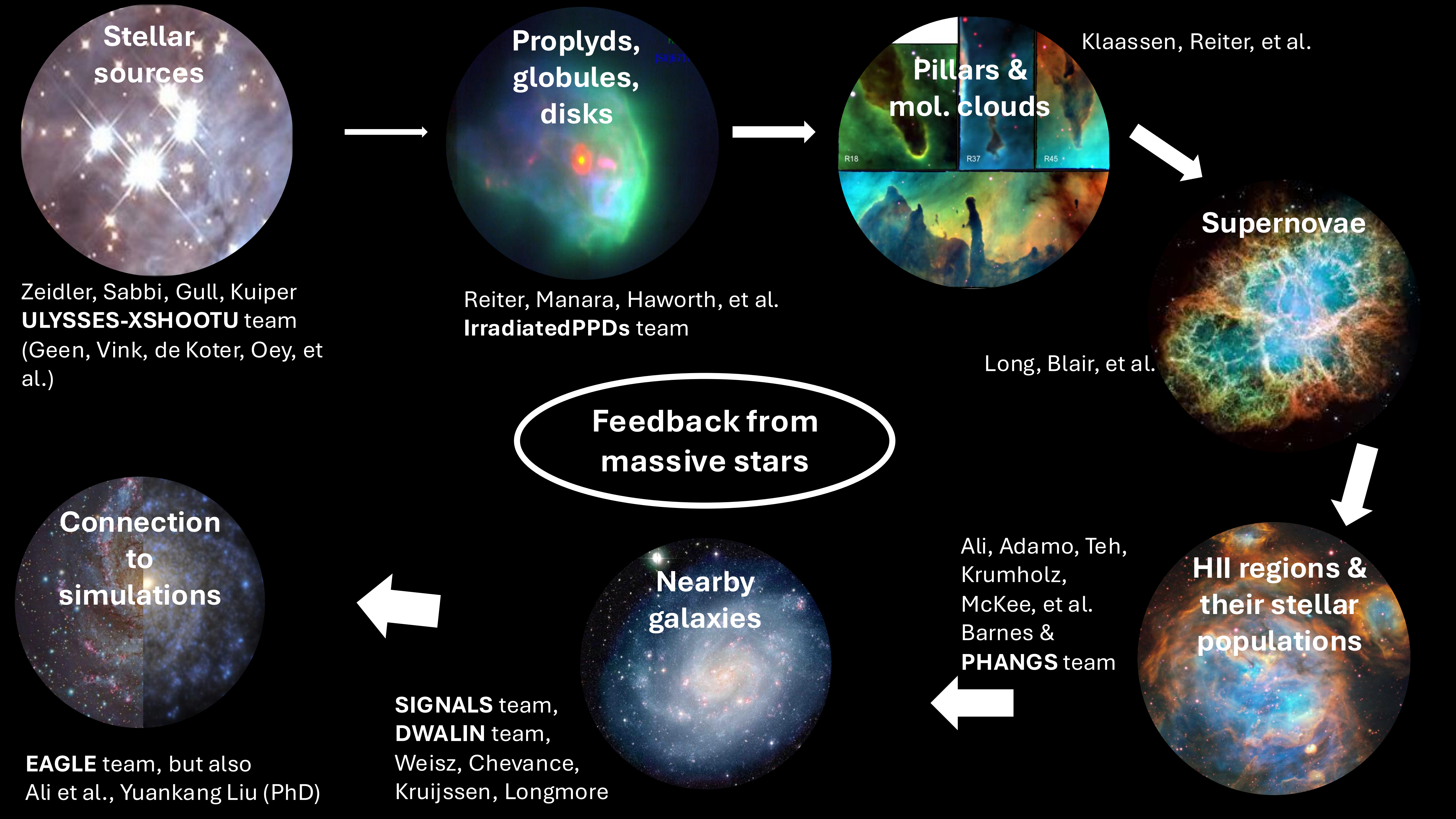
Anna McLeod
Assoc. Prof. @ Durham Uni (UK)
ISM summer school, July 2025



ICC

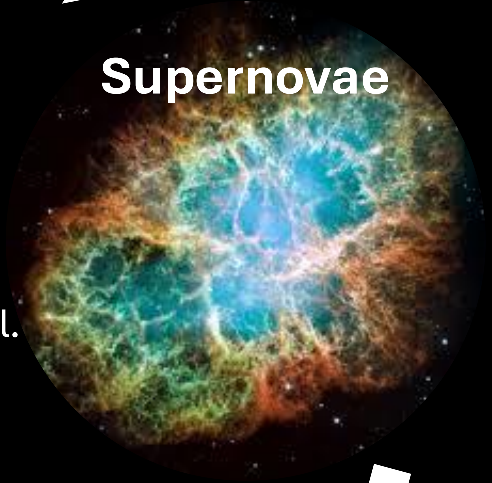
Durham University

Durham Centre for Extragalactic Astronomy


Stellar sources
Zeidler, Sabbi, Gull, Kuiper
ULYSSES-XSHOOTU team
(Geen, Vink, de Koter, Oey, et al.)
Proplyds, globules, disks
Reiter, Manara, Haworth, et al.
IrradiatedPPDs team
Pillars & mol. clouds
R18
R37
R45
Klaassen, Reiter, et al.
Supernovae
Long, Blair, et al.
Feedback from massive stars
HII regions & their stellar populations
Ali, Adamo, Teh, Krumholz, McKee, et al.
Barnes & **PHANGS** team
Nearby galaxies
SIGNALS team,
DWALIN team,
Weisz, Chevance, Kruijssen, Longmore
Connection to simulations
EAGLE team, but also
Ali et al., Yuankang Liu (PhD)

Zeidler, Sabbi, Gull, Kuiper
ULYSSES-XSHOOTU team
(Geen, Vink, de Koter, Oey, et al.)

Klaassen, Reiter, et al.



Long, Blair, et al.

, Adamo, Teh,
umholz,
cKee, et al.
Barnes &
PHANGS team

SIGNALS team,
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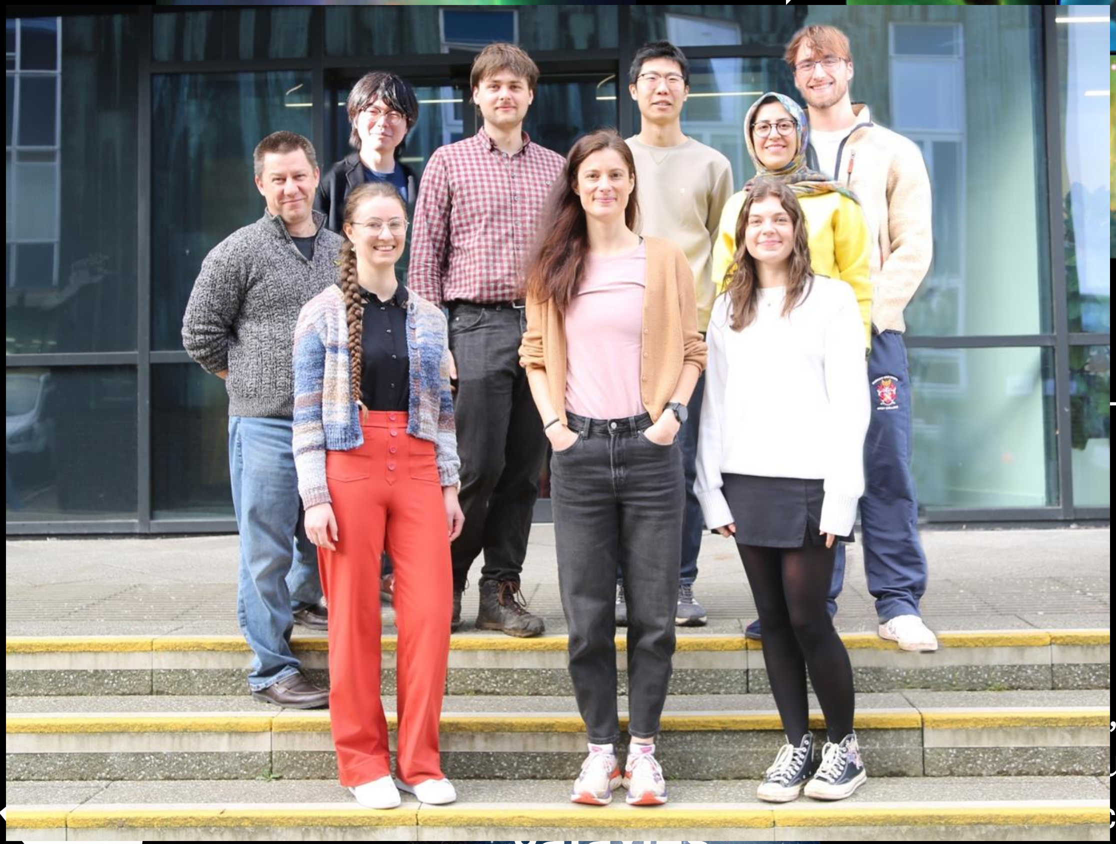

Today’s program

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1. Stellar feedback: a bit of background

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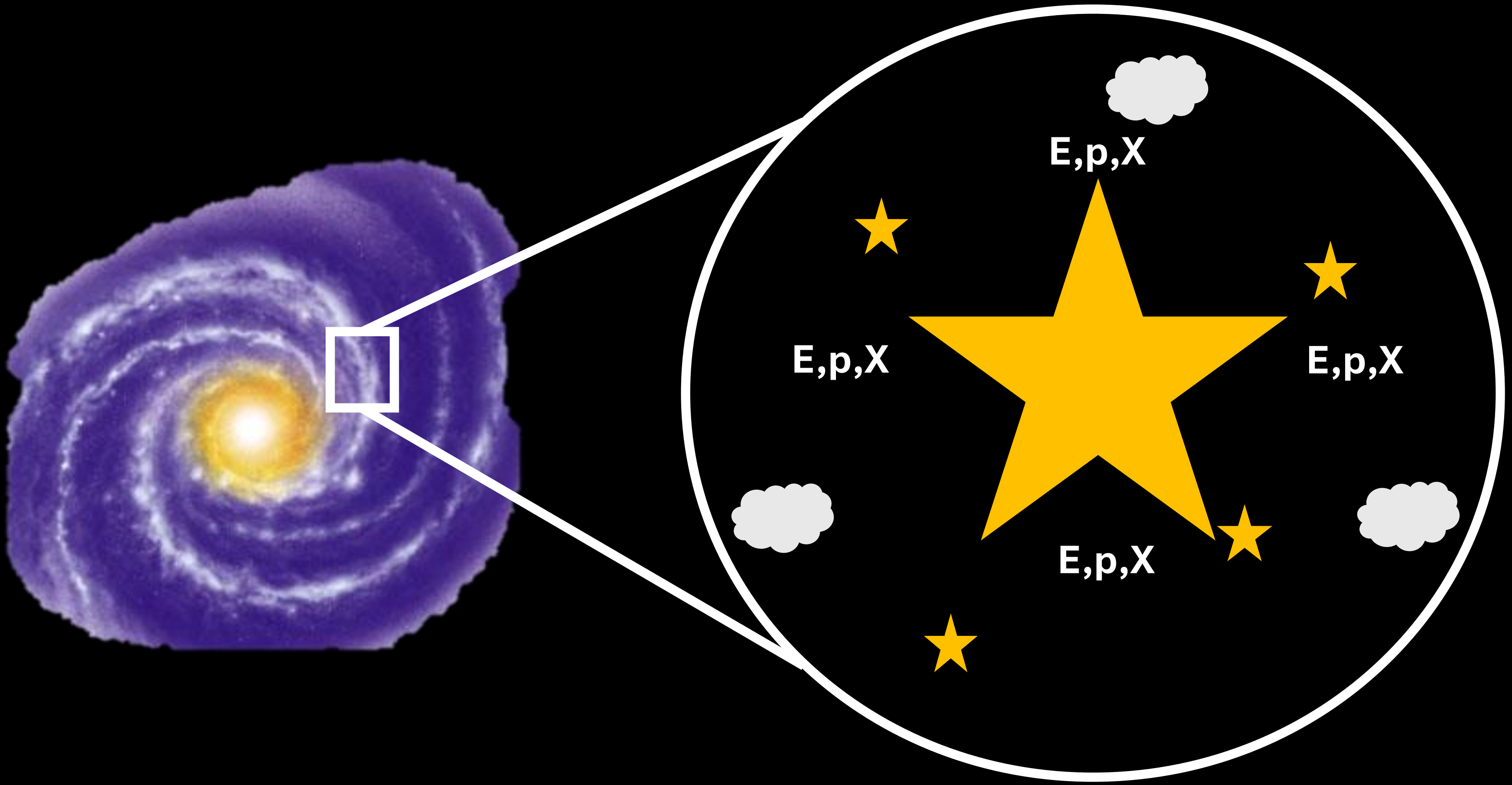
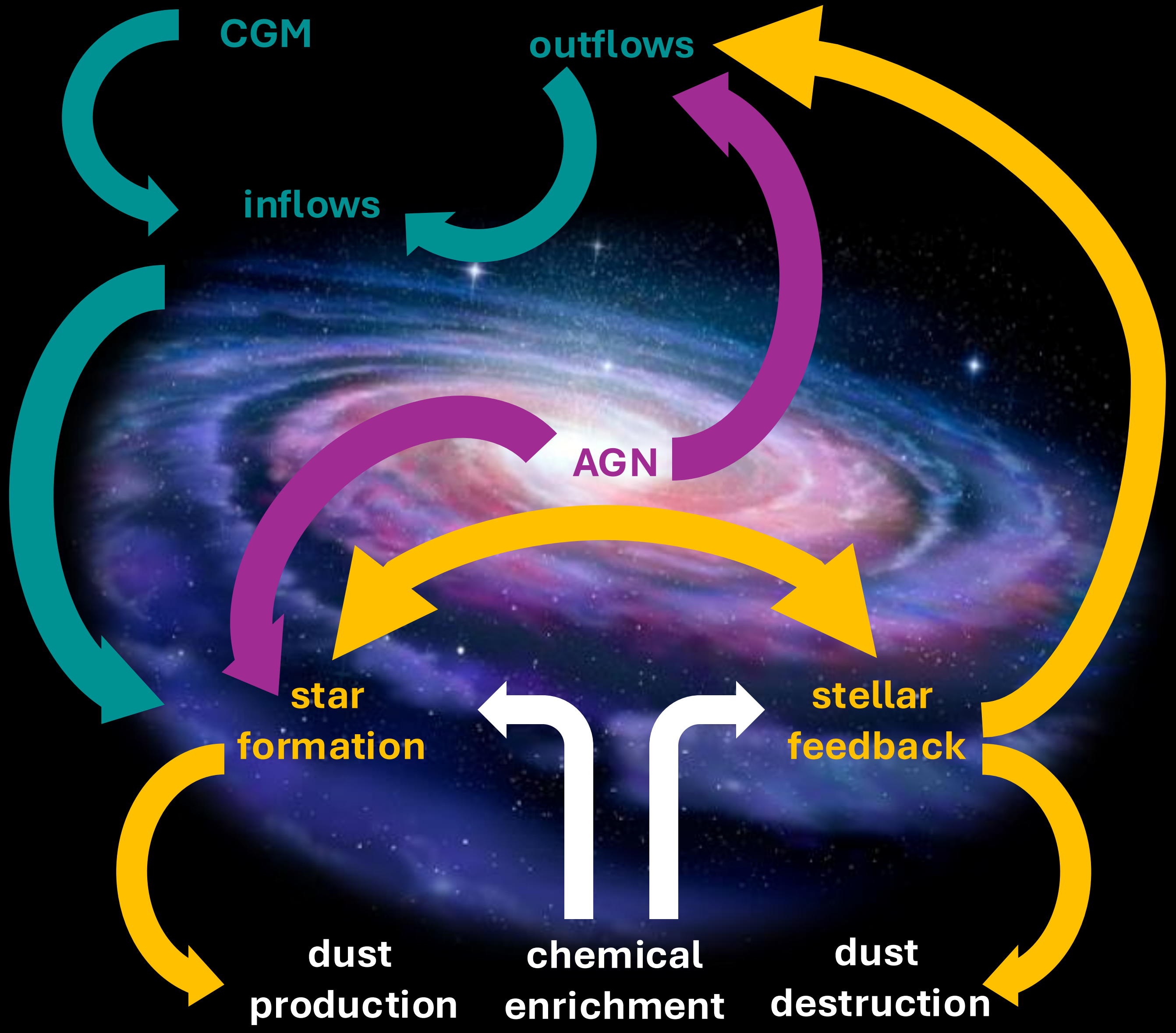
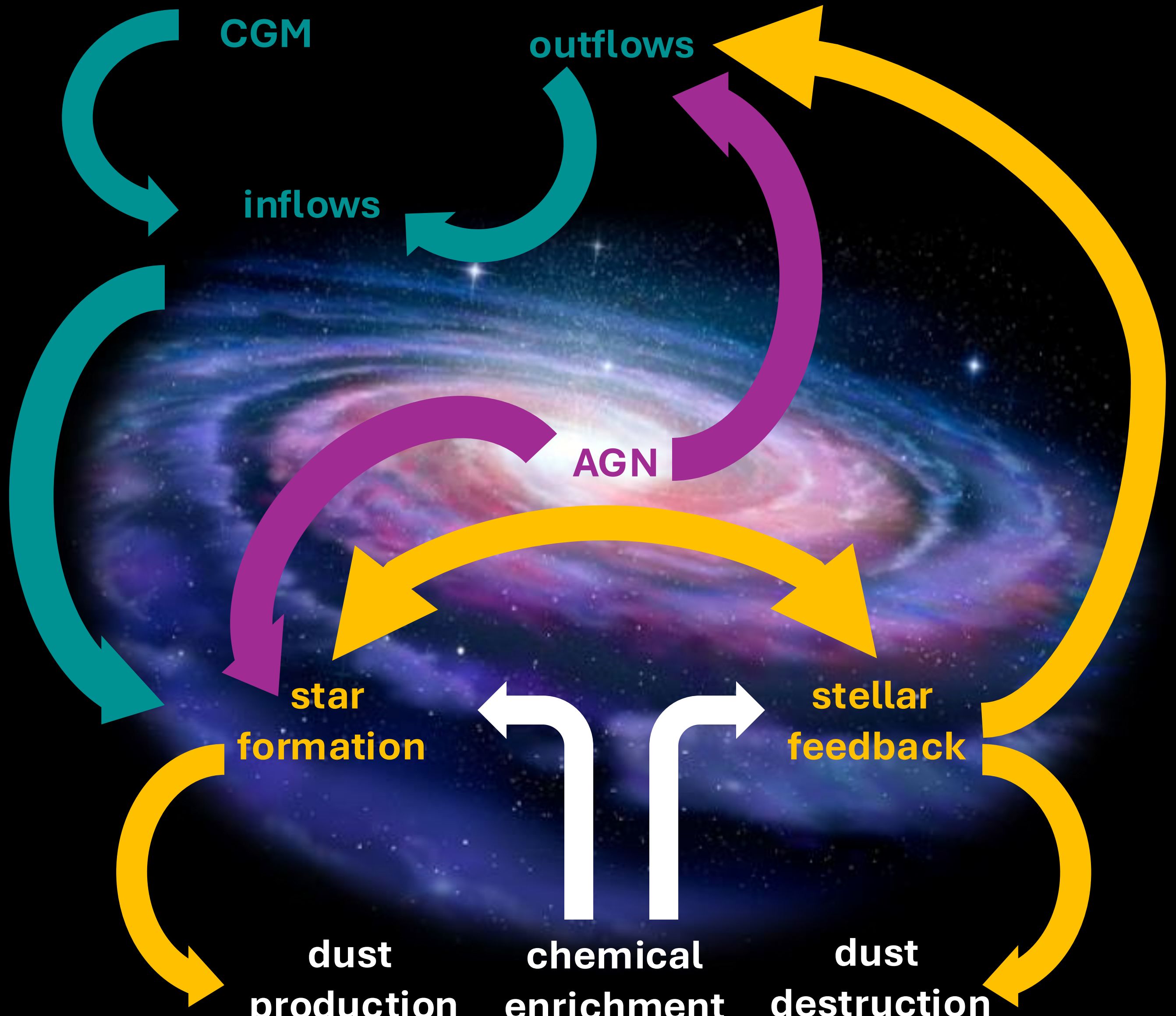
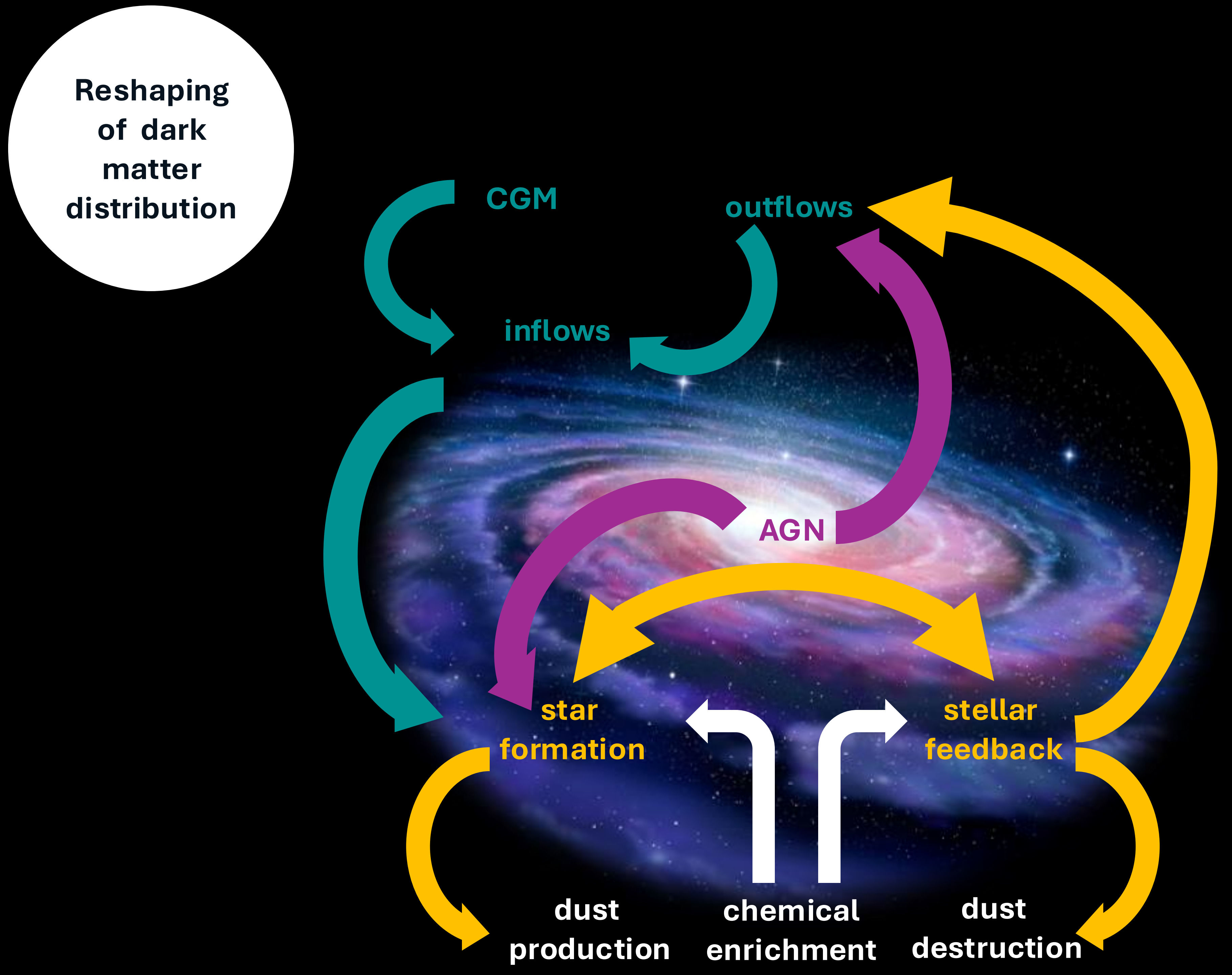
Feedback = deposition of **energy (E), momentum (p),** and **metals (X)** into the surrounding medium by **massive (M > 8 $M_\odot$) stars**



Stellar feedback is a **multi-scale, multi-temporal, multi-phase,** and **multi-wavelength** phenomenon




CGM
outflows
inflows
AGN
star formation
stellar feedback
dust production
chemical enrichment
dust destruction



Reshaping of dark matter distribution
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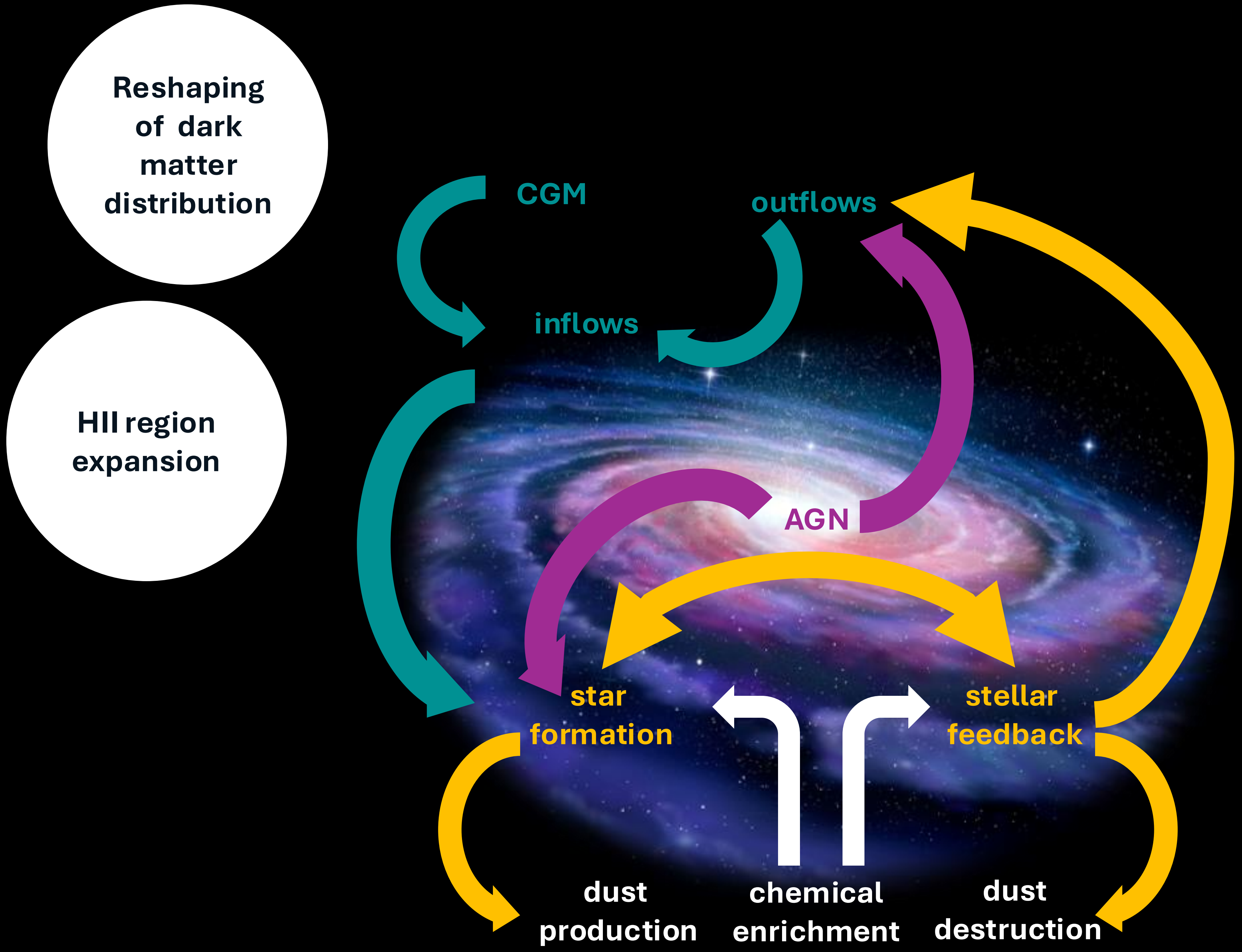

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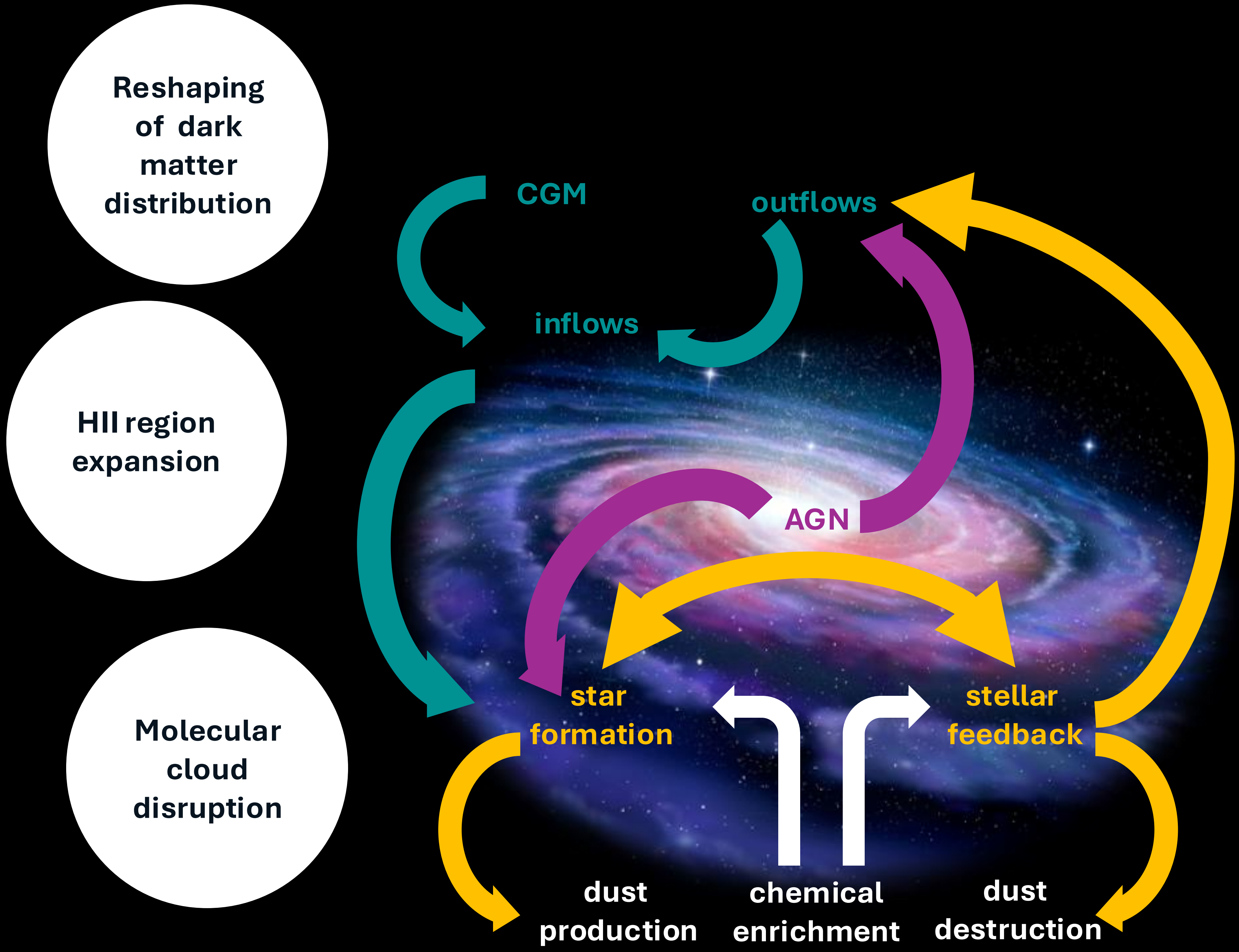
Reshaping of dark matter distribution
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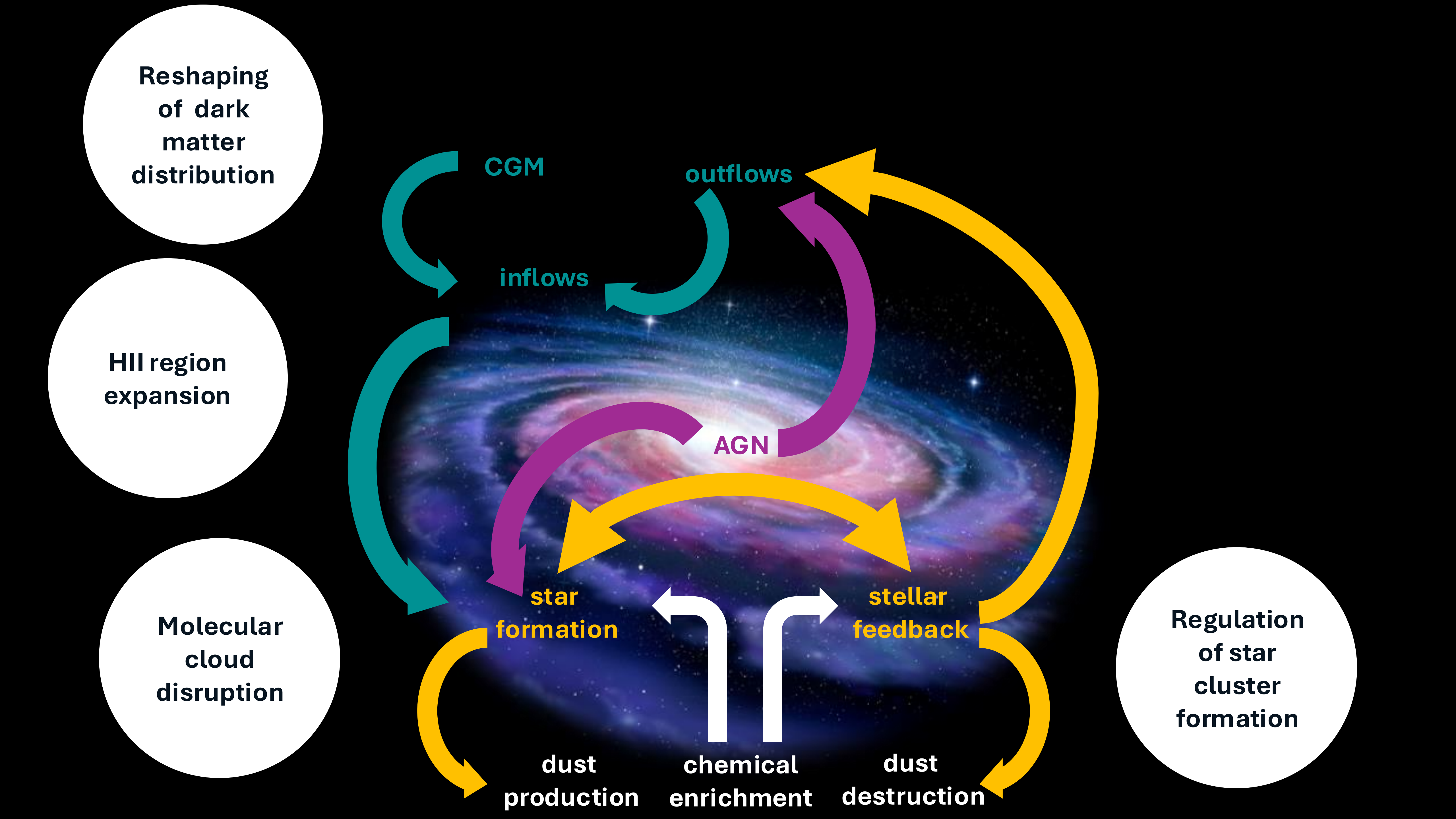

Reshaping of dark matter distribution
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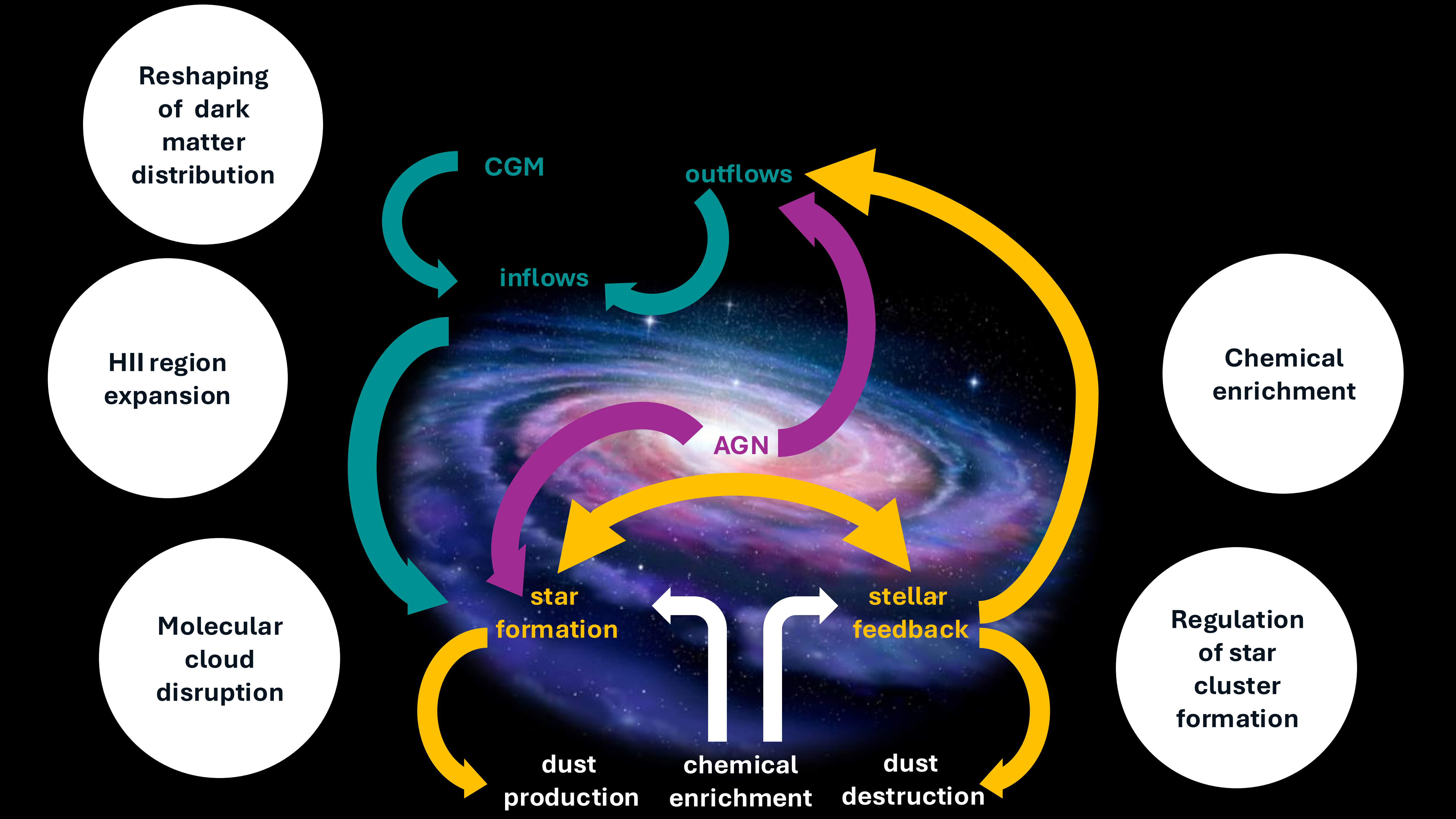
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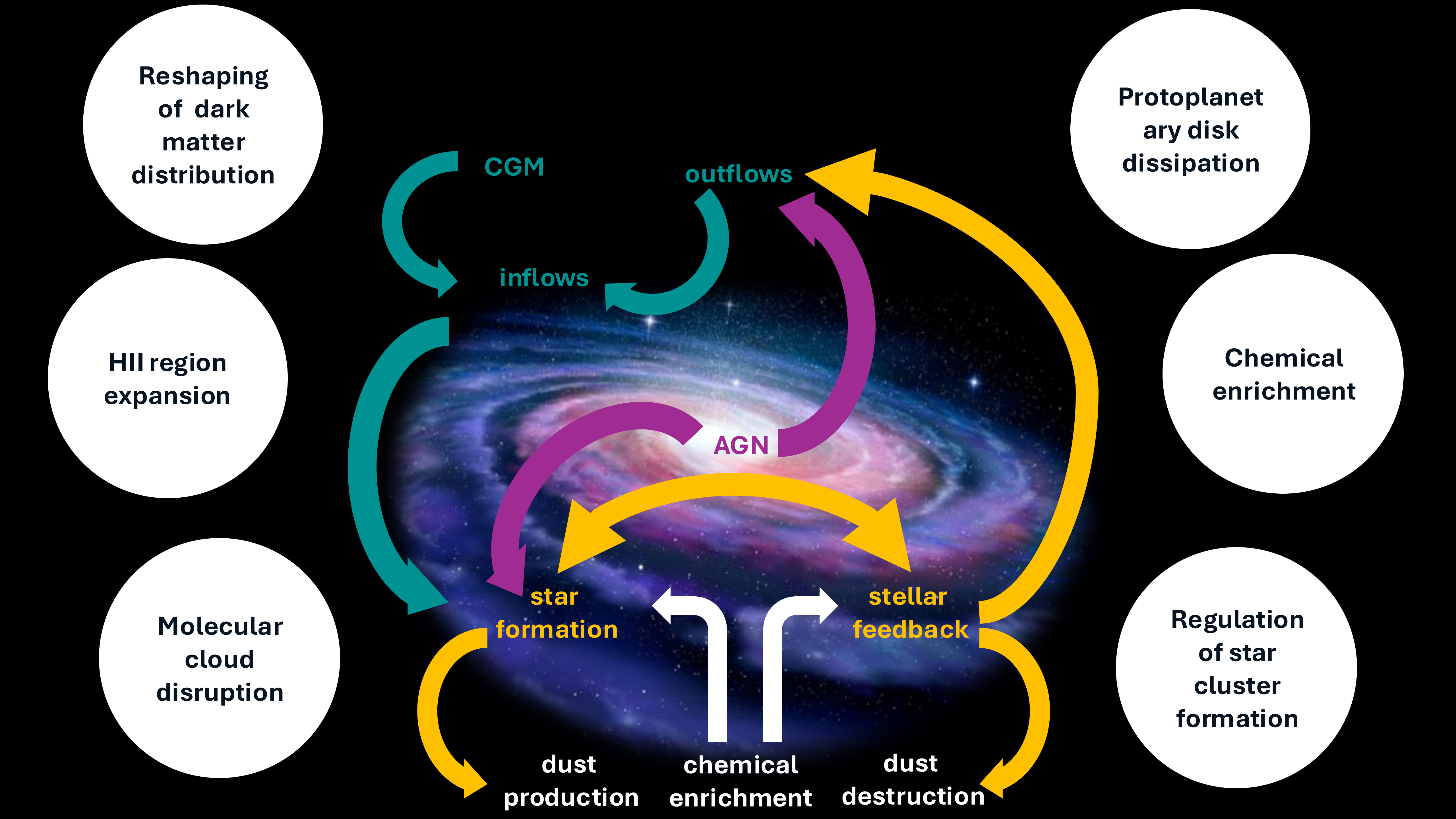
Reshaping of dark matter distribution
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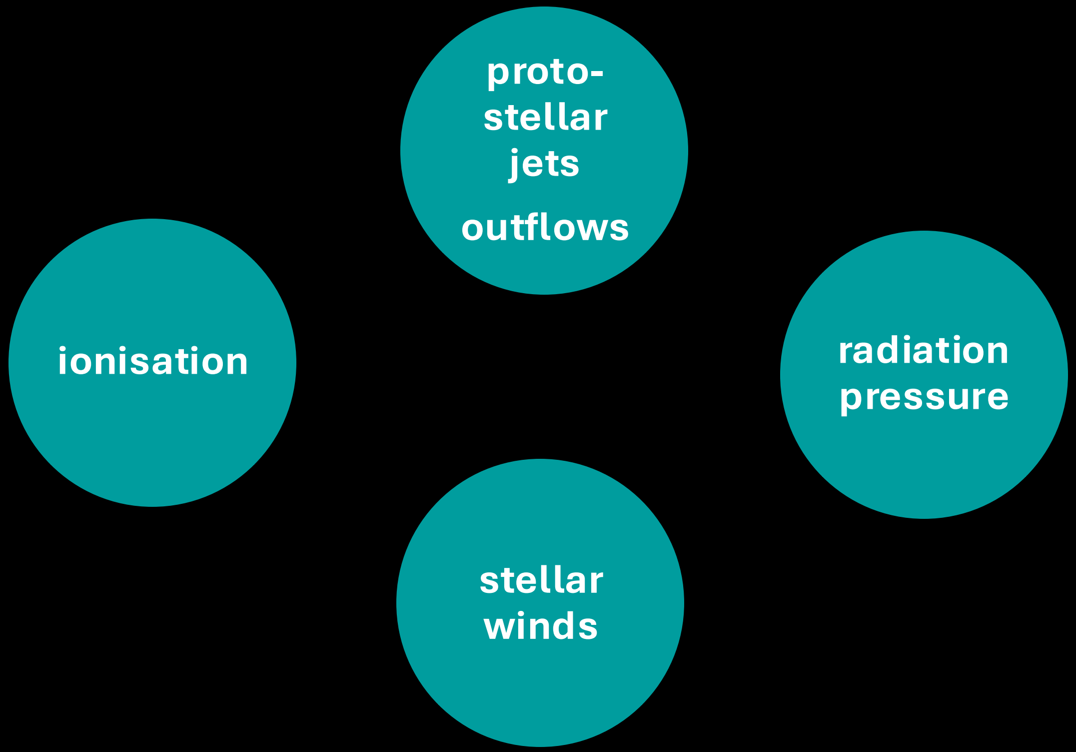
Protoplanetary disk dissipation
Chemical enrichment
Regulation of star cluster formation

Stellar feedback is an umbrella term



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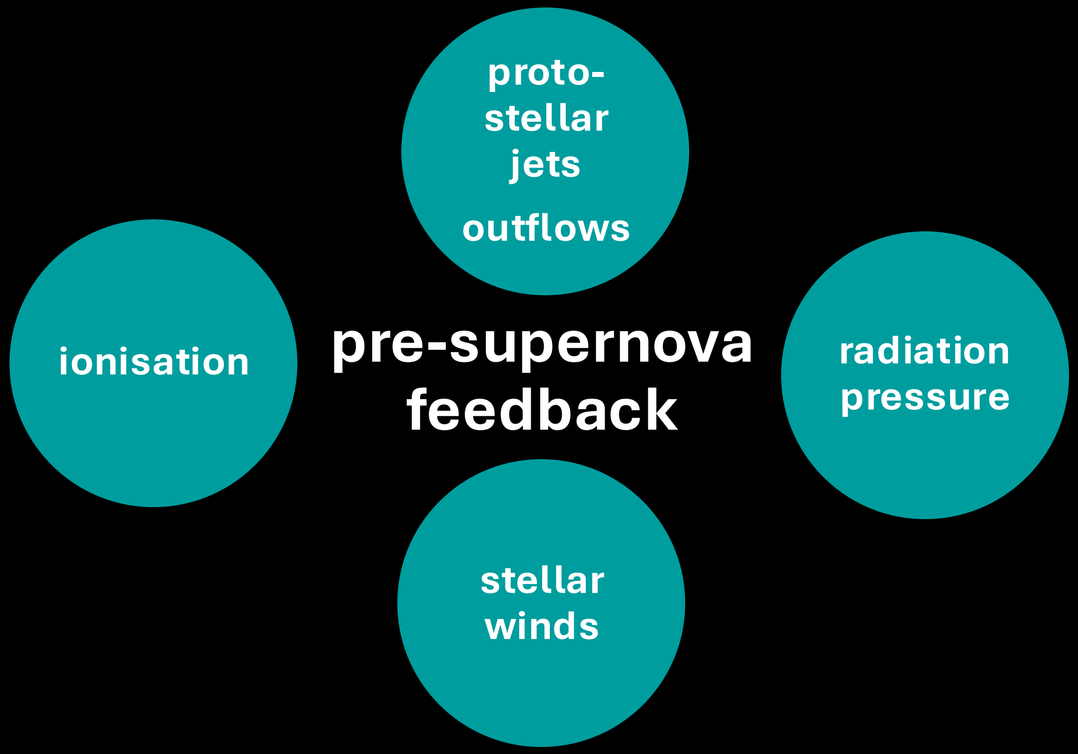

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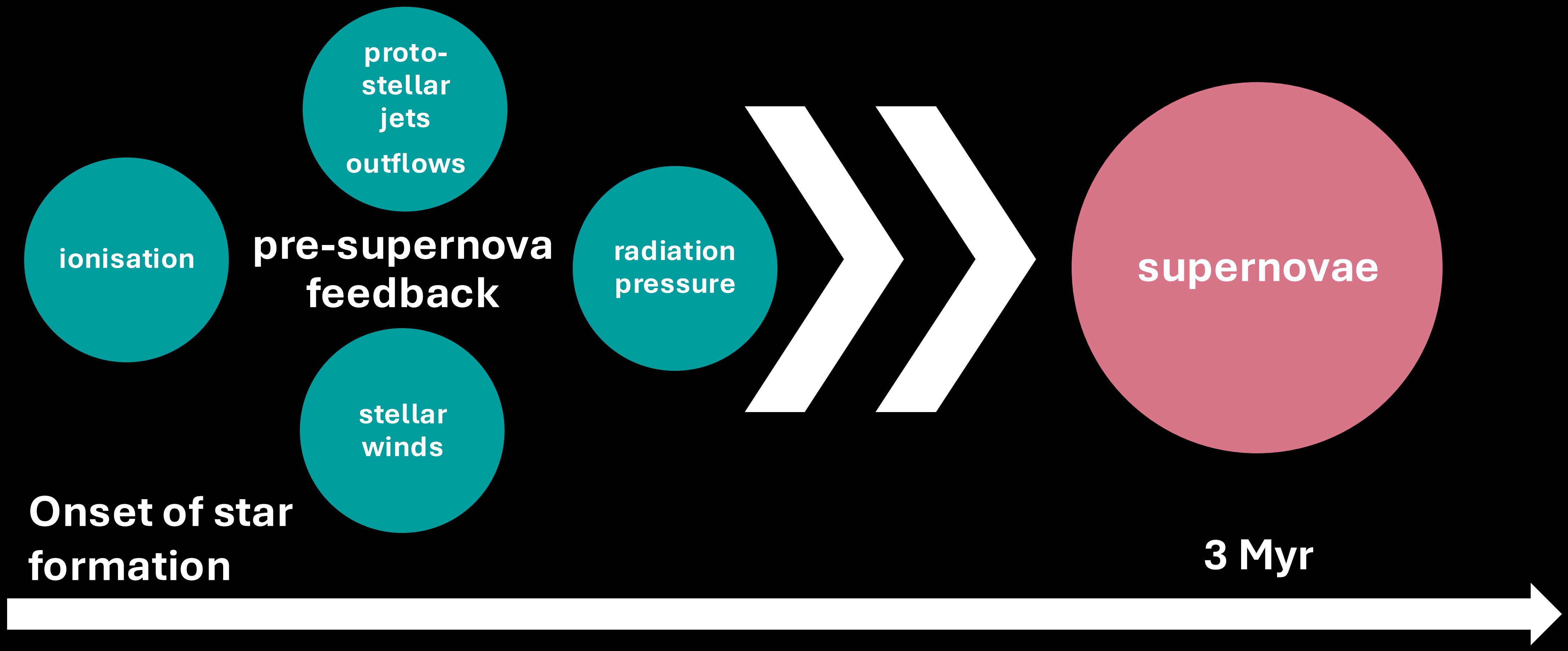
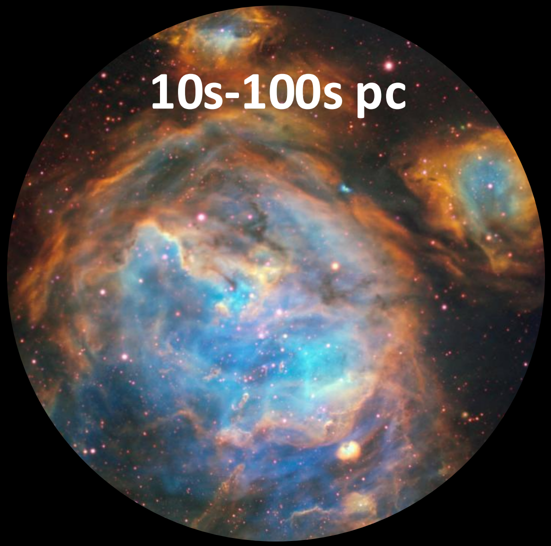
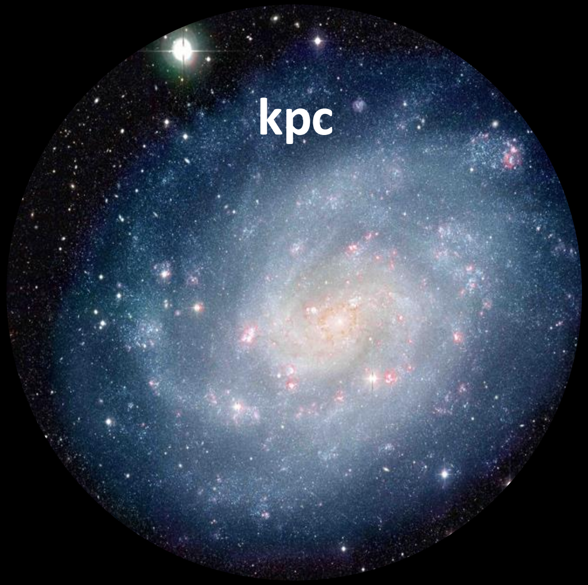


Stellar feedback is an umbrella term

see Krumholz+14, Geen+23 (incl. McLeod), Chevance, Krumholz, McLeod+23, Lucas+20, Haid+18

Stellar feedback affects the environment from **sub-pc** to **kpc scales**





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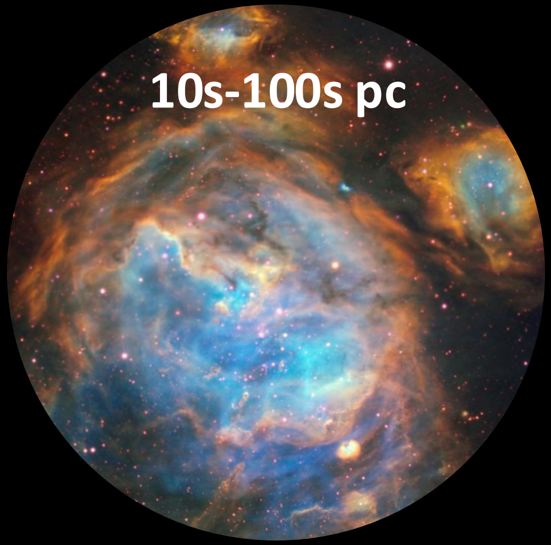

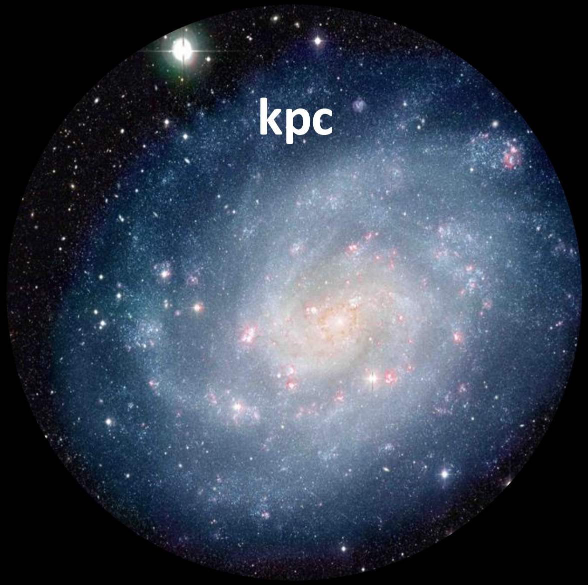

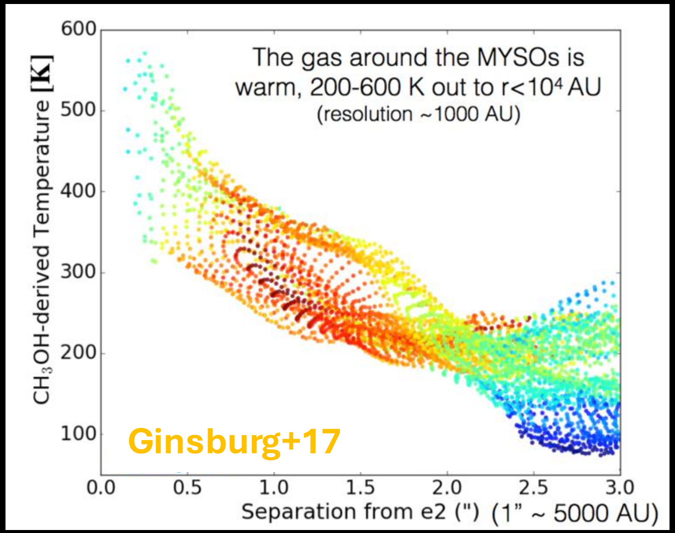

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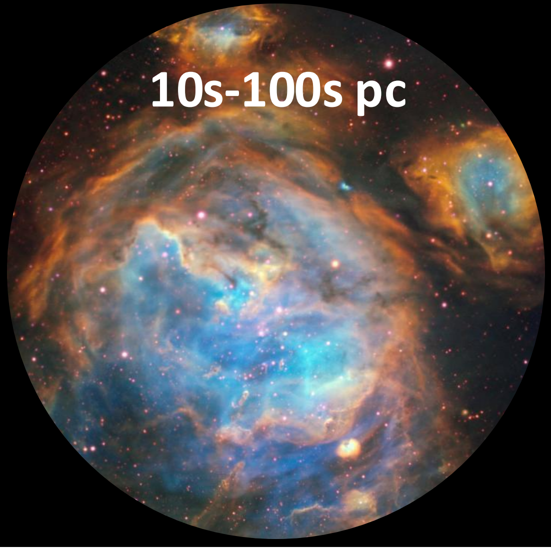

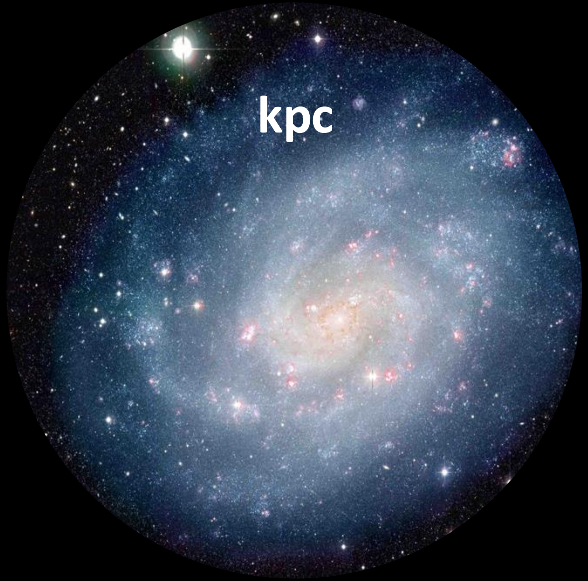

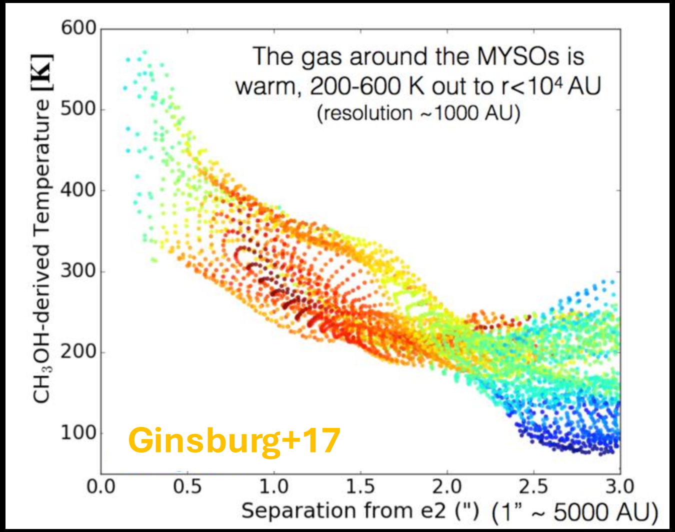

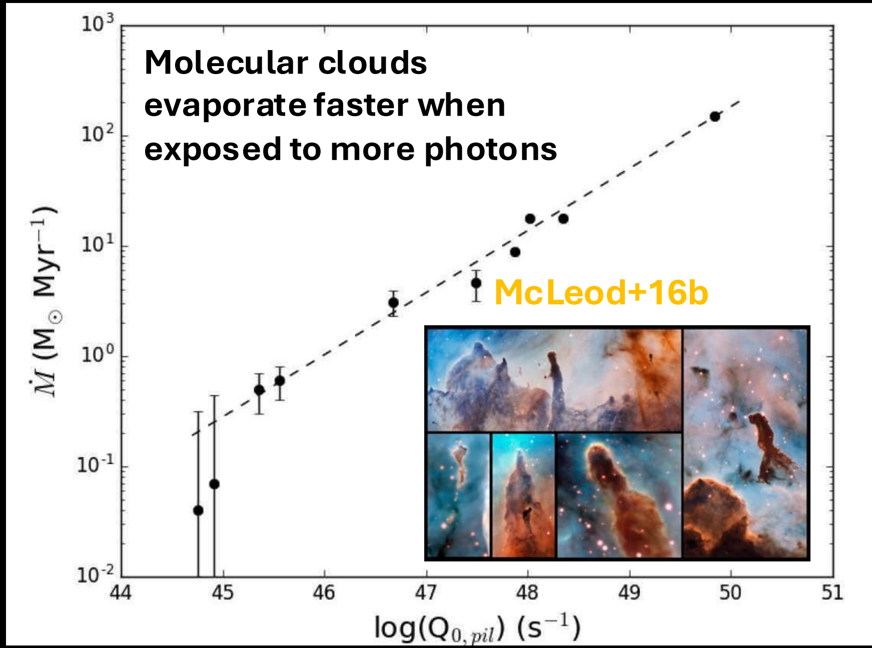

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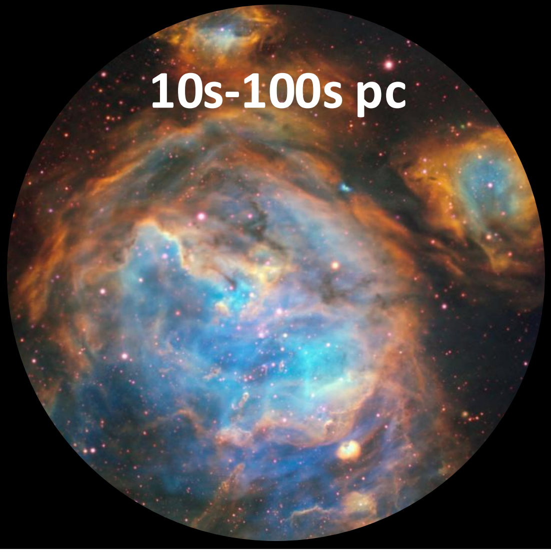
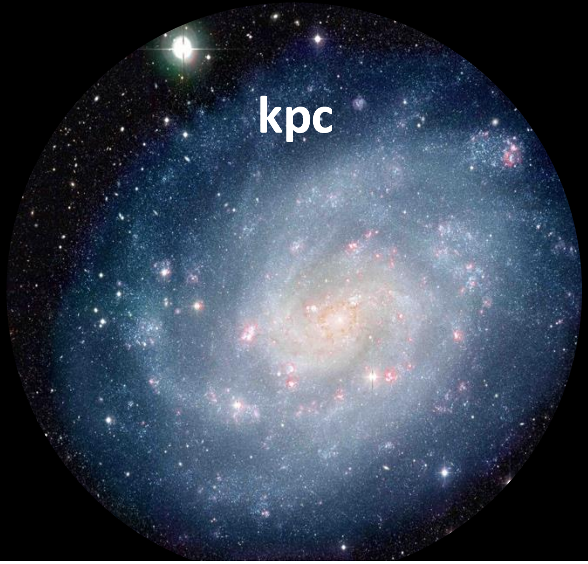
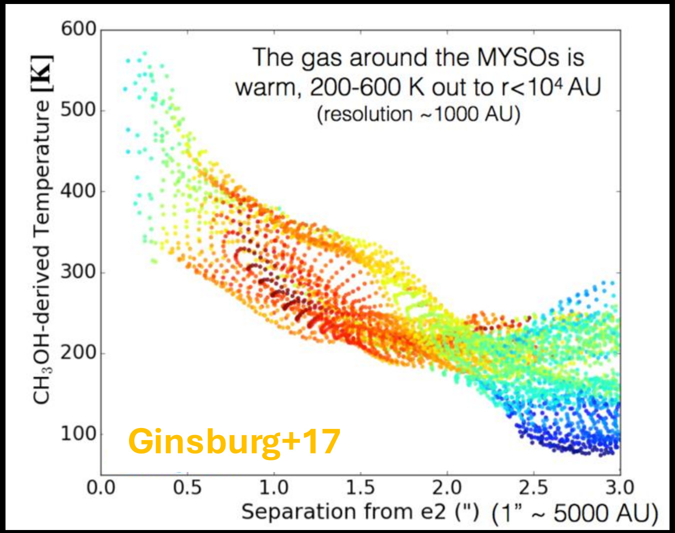
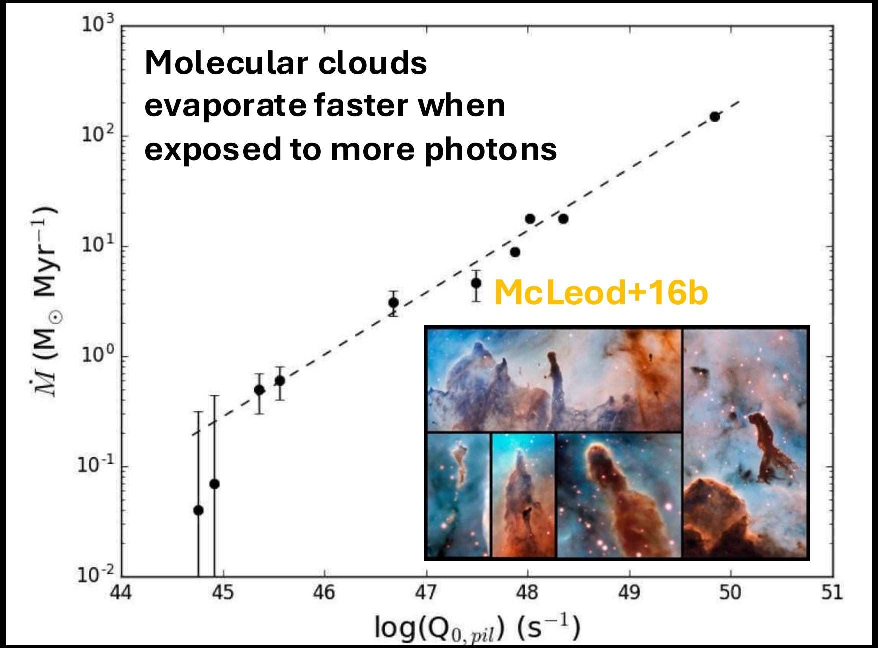
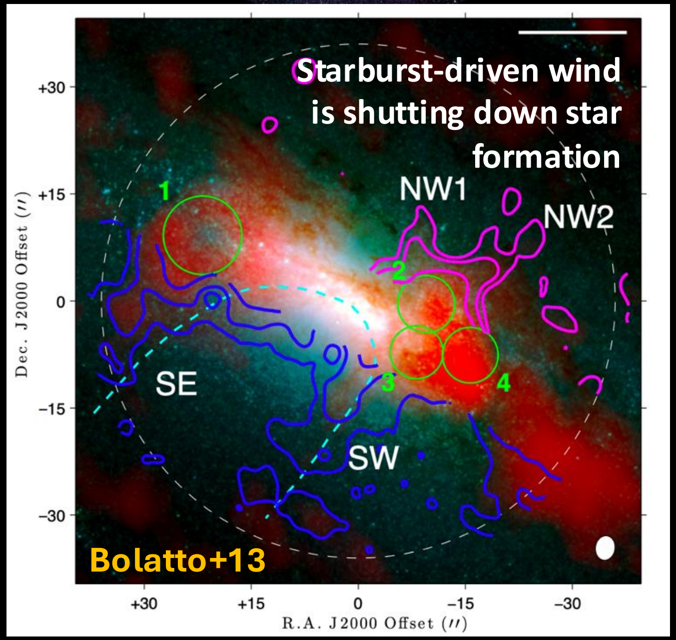


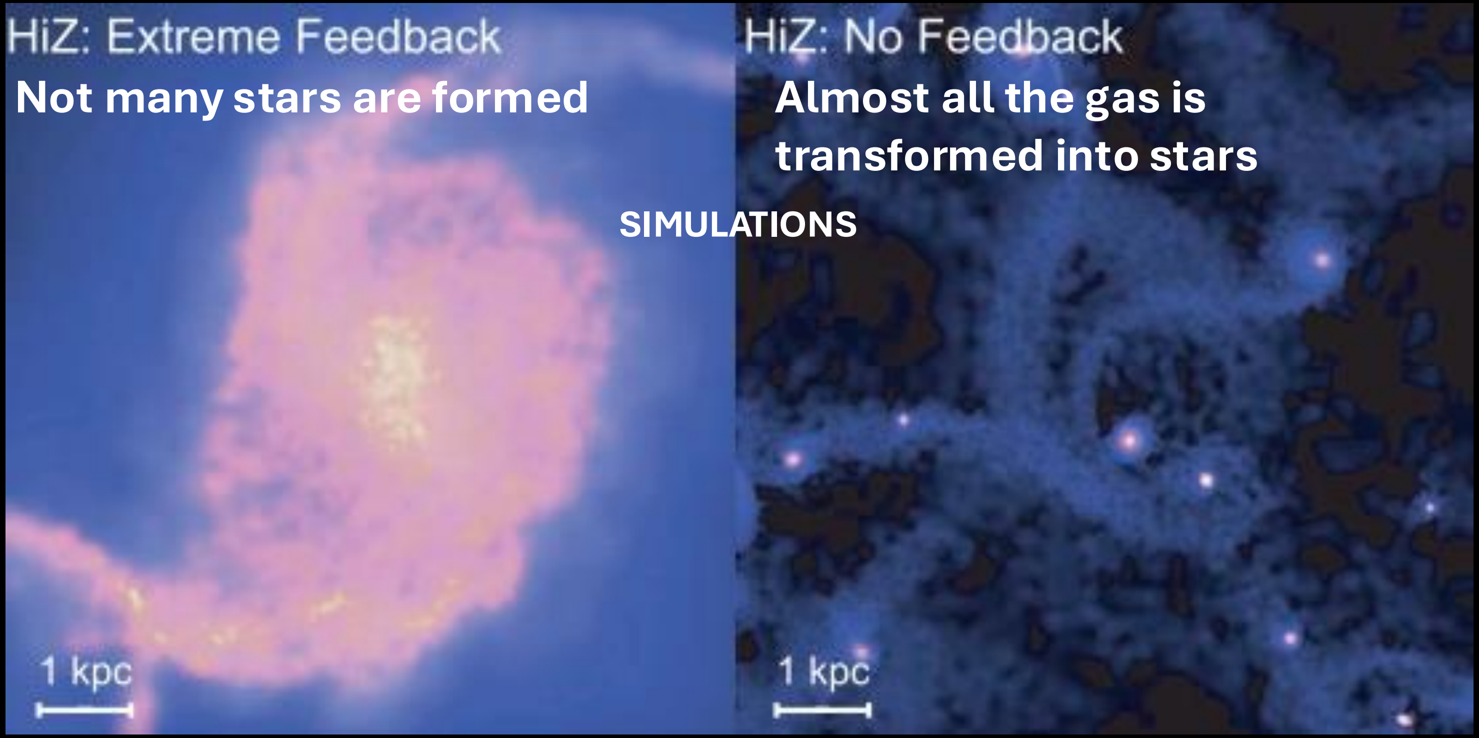








Without stellar feedback the simulated Universe would not look like the observed.



Hopkins+11

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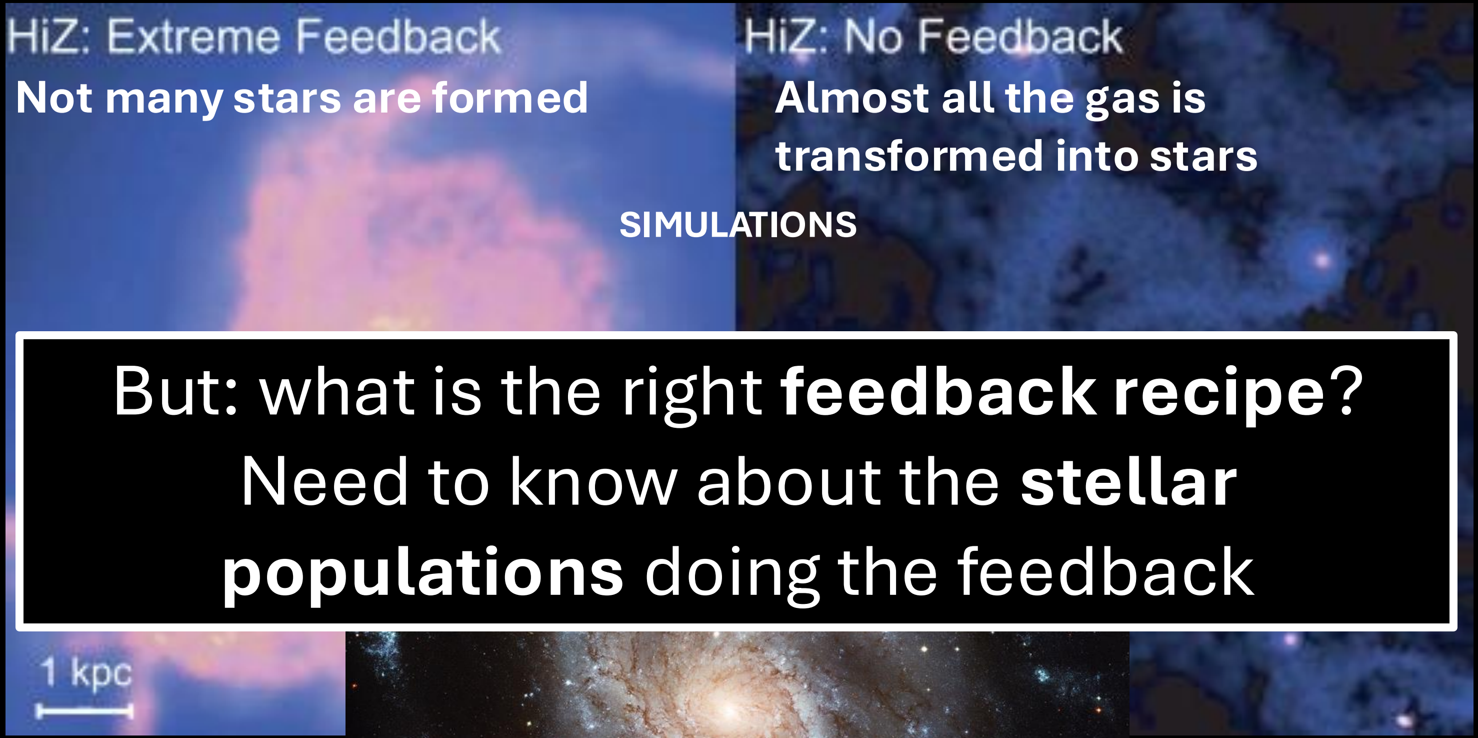

But: what is the right **feedback recipe**?
Need to know about the **stellar populations** doing the feedback

Hopkins+11

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We have quantified the photoevaporative effect of ionizing feedback

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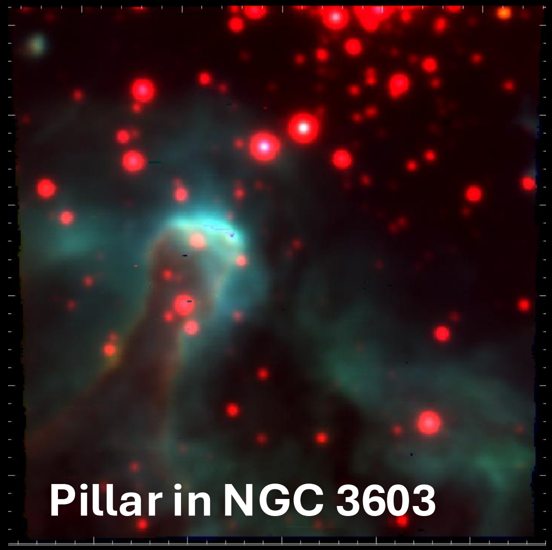
Pillars in Carina



McLeod+16; ESO press release eso1639b, credit ESO/A. McLeod

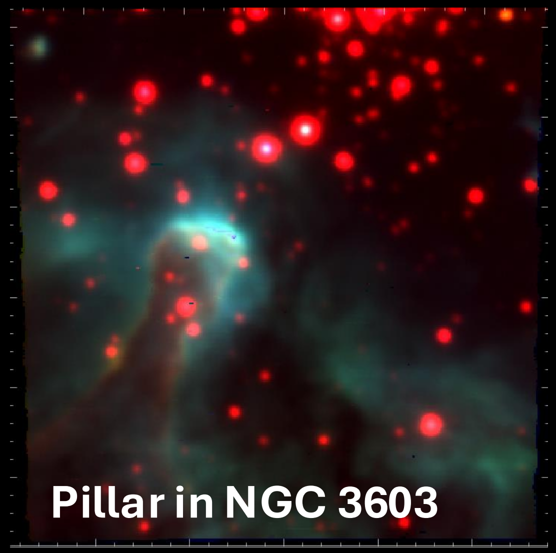
We have quantified the photoevaporative effect of ionizing feedback

Pillars in Carina

49.02

48.
02

49.49



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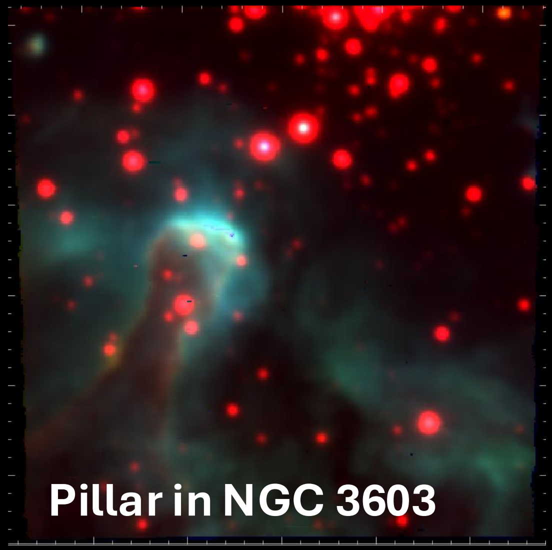

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50.98

49.87

49.02

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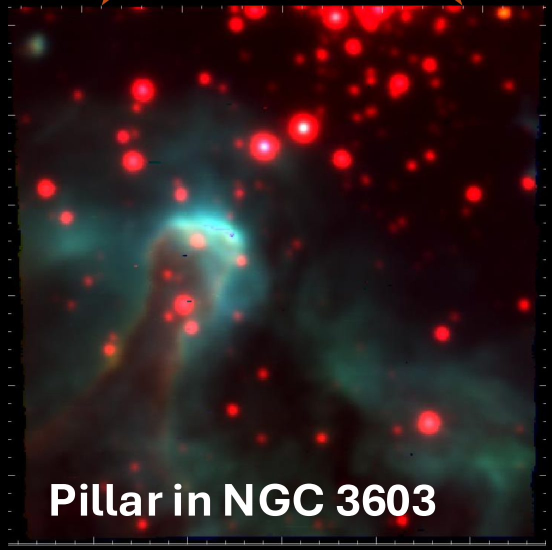
48.
02

49.49



McLeod+16; ESO press release eso1639b, credit ESO/A. McLeod

We have quantified the photoevaporative effect of ionizing feedback

How? By measure the photo-evaporation rate for pillars in different types of environments

50.98

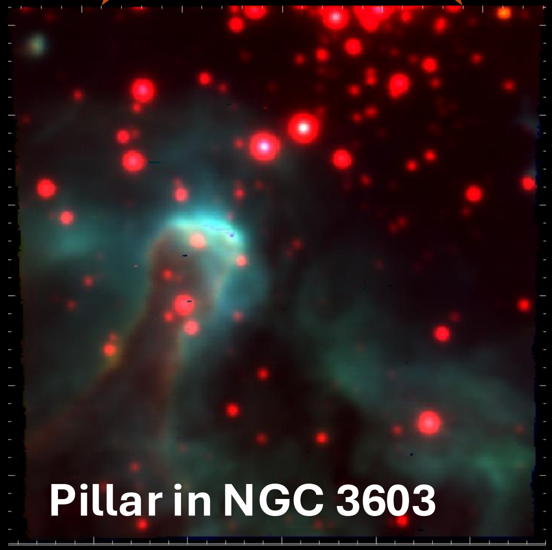
49.87

49.02

Pillars in Carina

48.02

49.49



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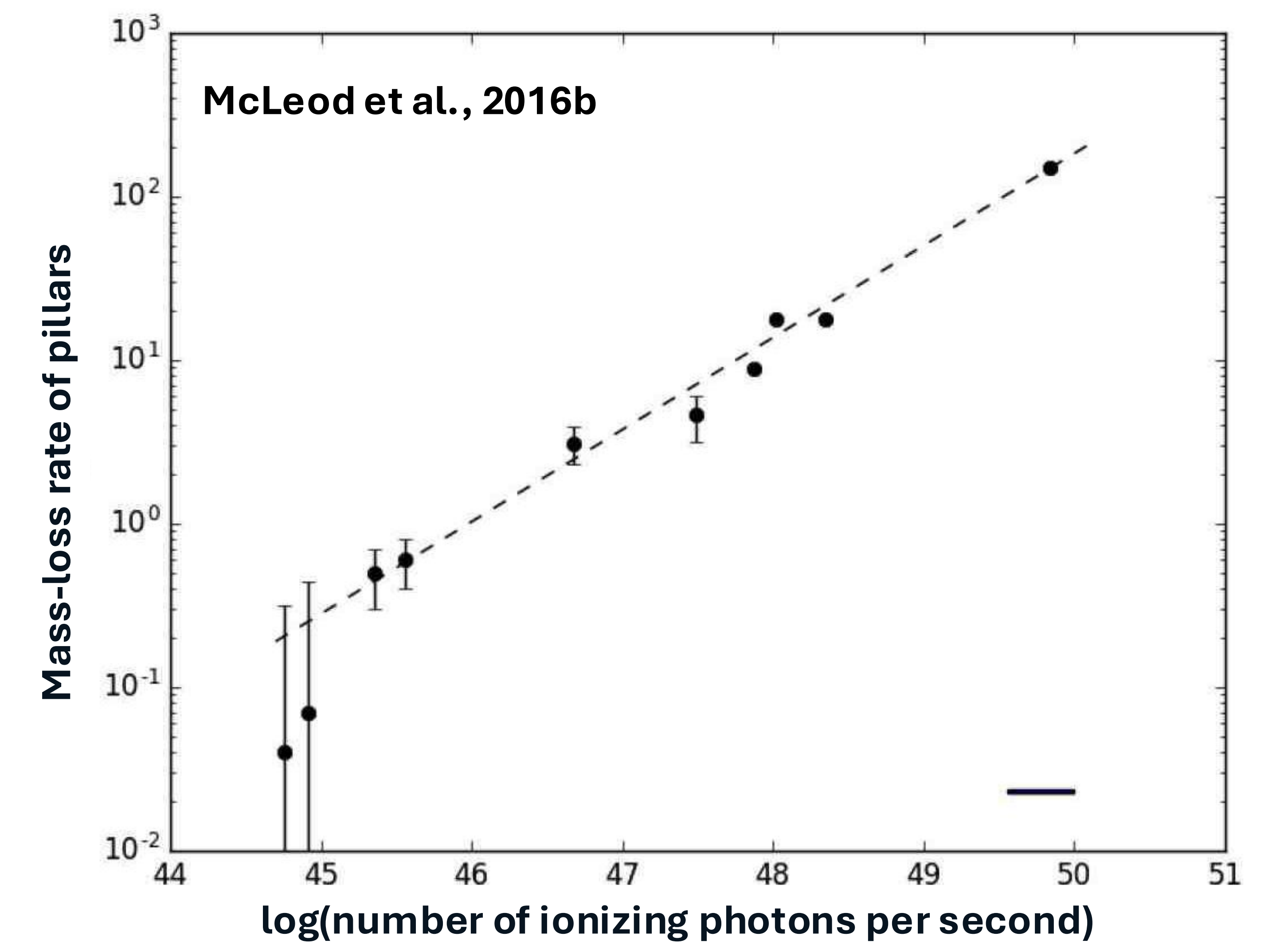
Pillars exposed to more stars (or more massive stars) evaporate faster



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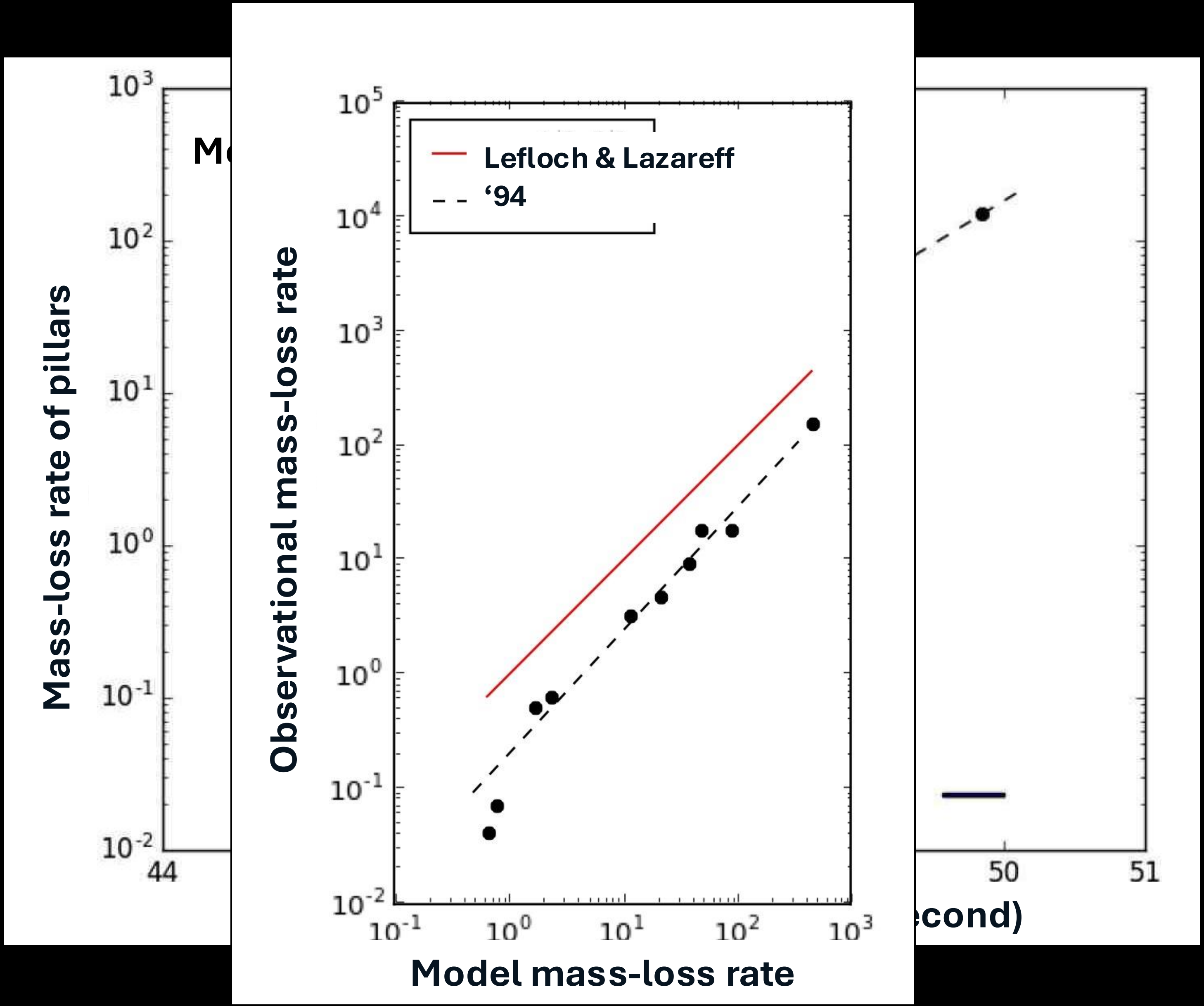

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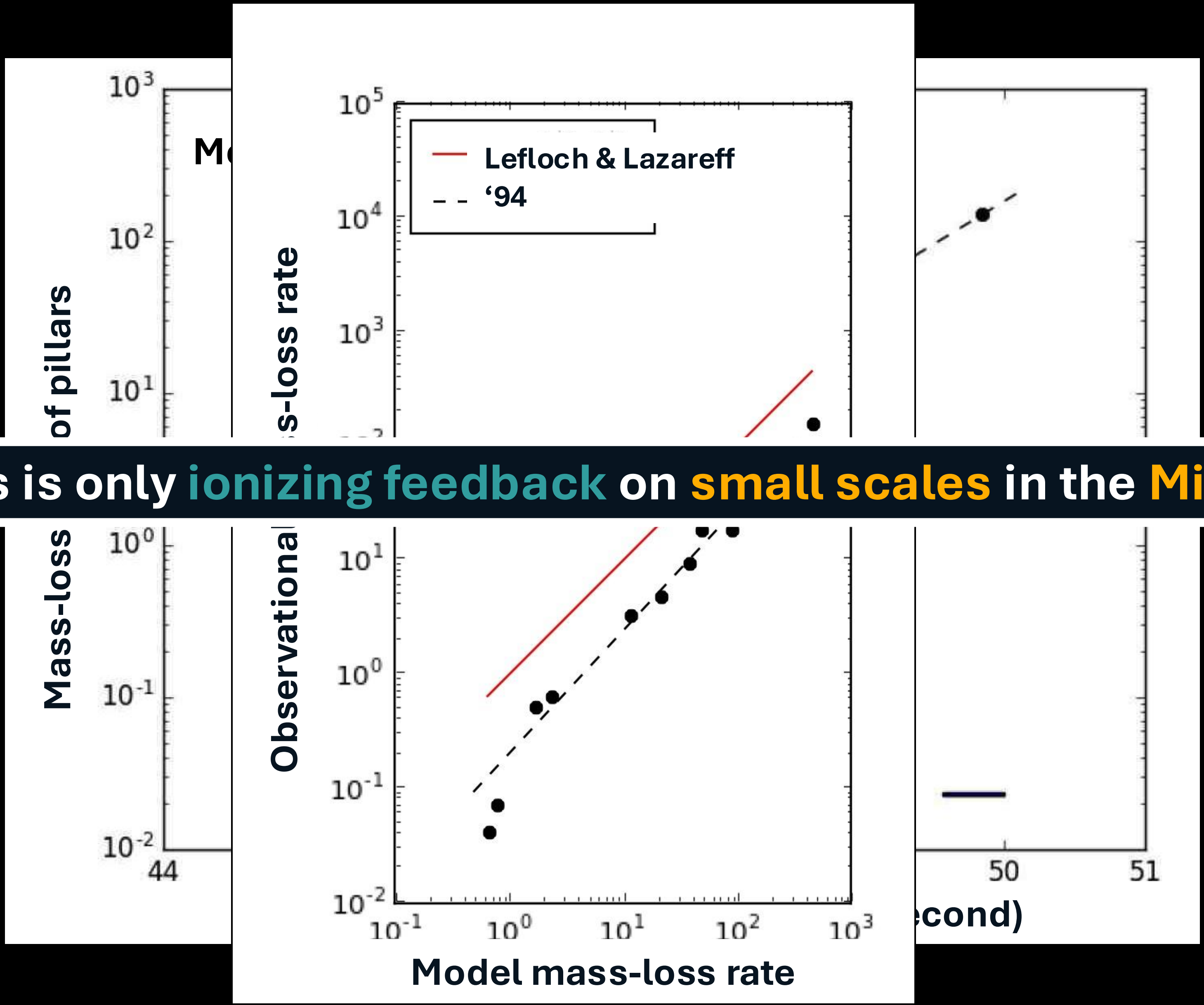

... but: this is only ionizing feedback on small scales in the Milky Way...

Need large number of observations in different environments to statistically characterize feedback

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Why the Milky Way is not the final frontier of feedback studies:

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Why the Milky Way is not the final frontier of feedback studies:

1. Imaging entire regions is prohibitively expensive

Credit: ESO

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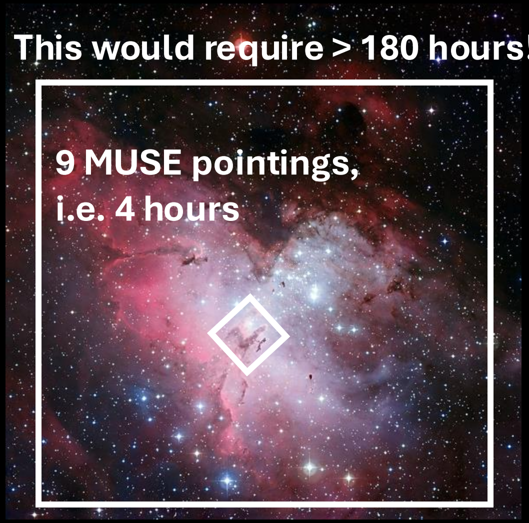

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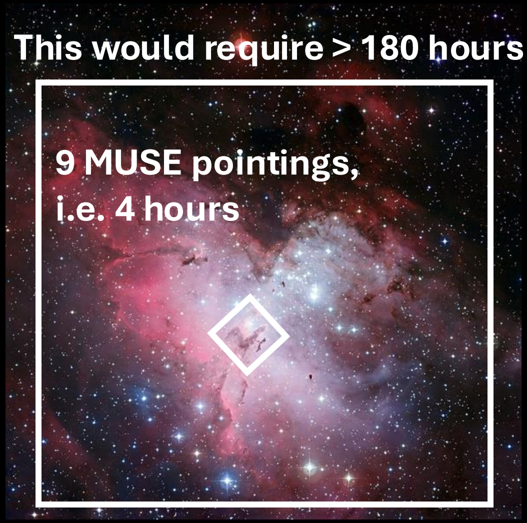

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2. Extinction caused by gas and dust limits our view

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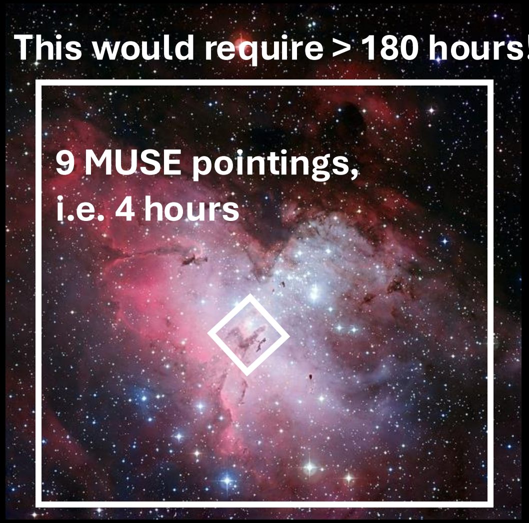

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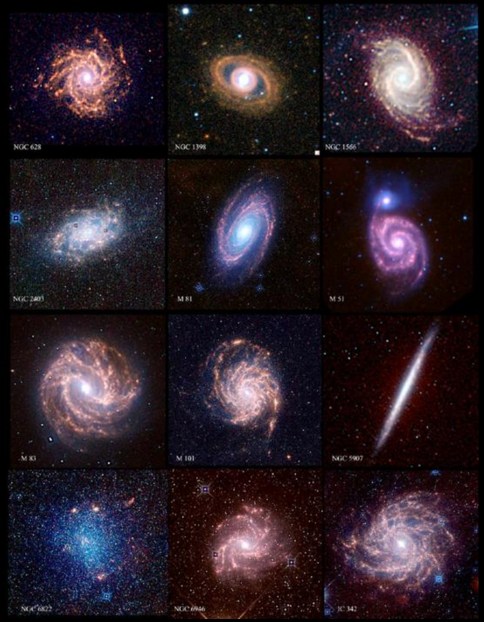
2. Extinction caused by gas and dust limits our view

3. The Milky Way is not representative of feedback across the Universe



Jarrett+12

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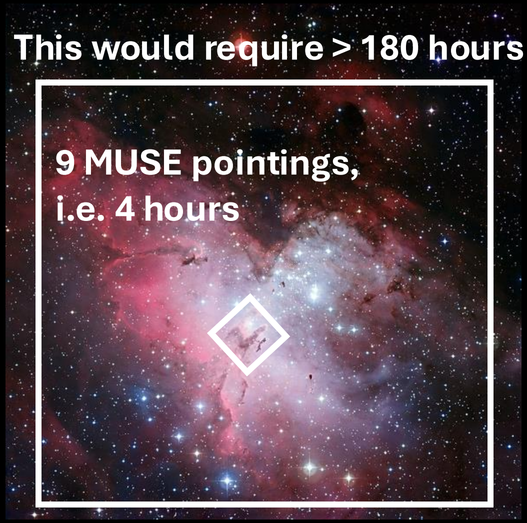

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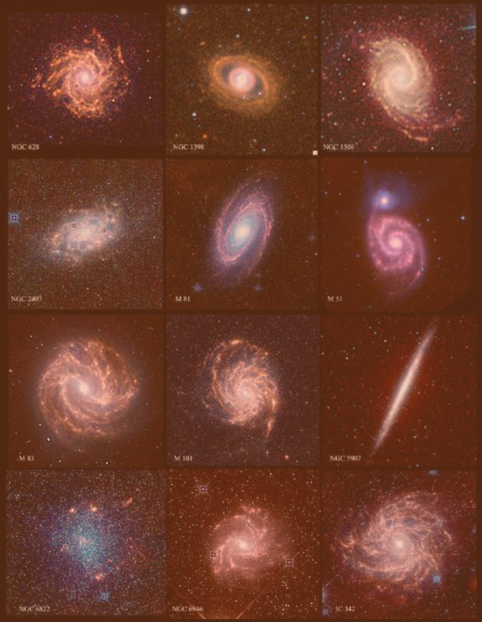

Jarrett+12

Conditions in the Universe differ, and vary with Cosmic Time, e.g., metallicity

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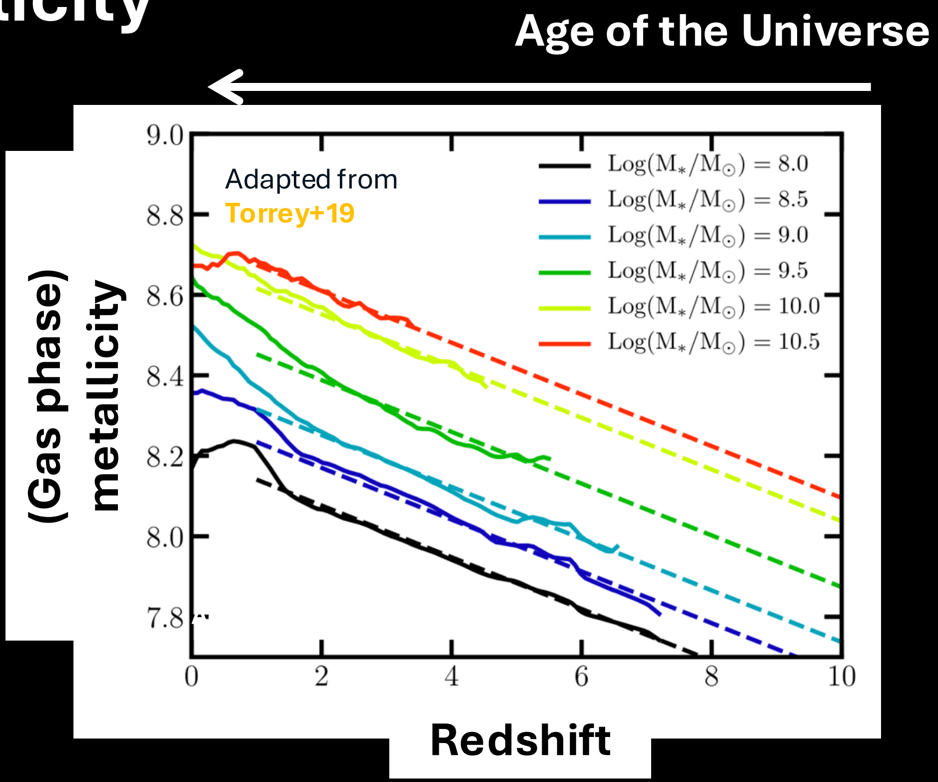
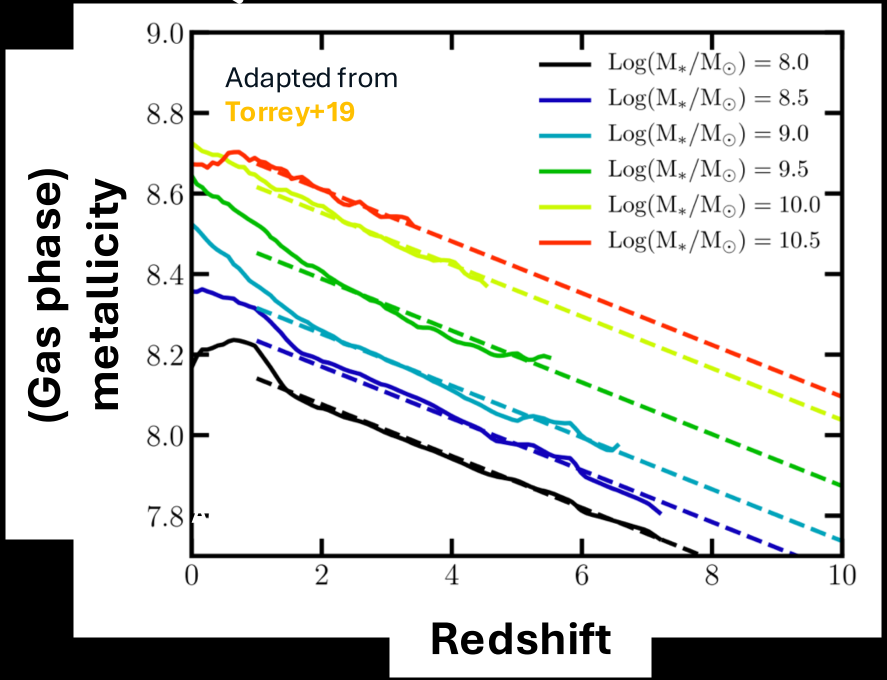


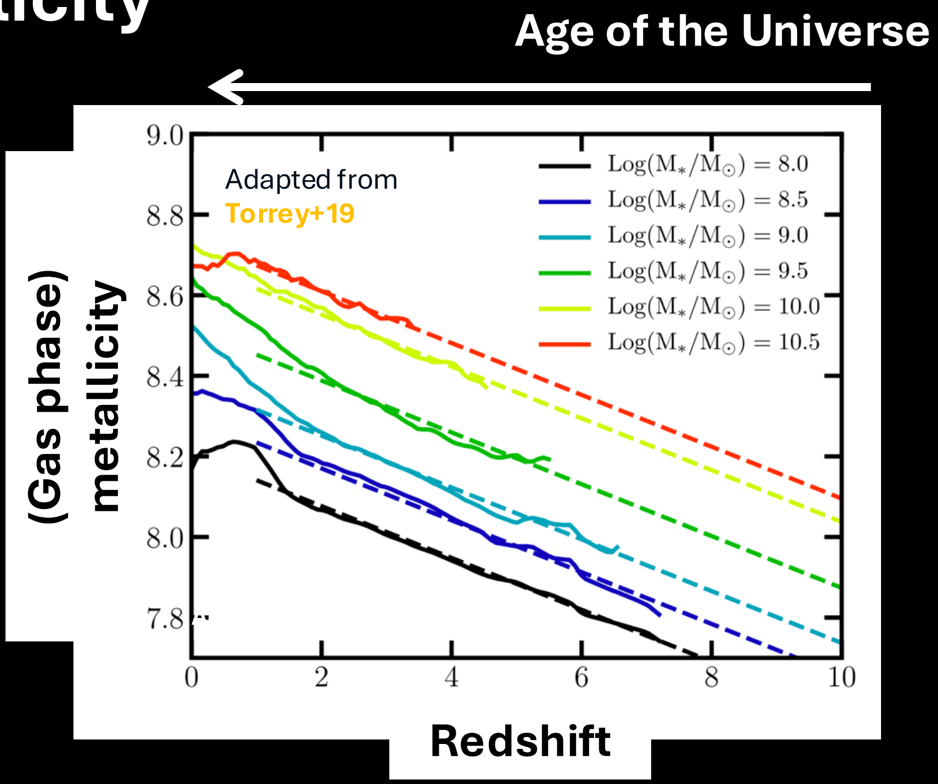
Conditions in the Universe differ, and vary with Cosmic Time, e.g., metallicity

Age of the Universe



Lower metallicity, what does it do?

Conditions in the Universe differ, and vary with Cosmic Time, e.g., metallicity



Lower metallicity, what does it do?

-> stellar winds are line-driven

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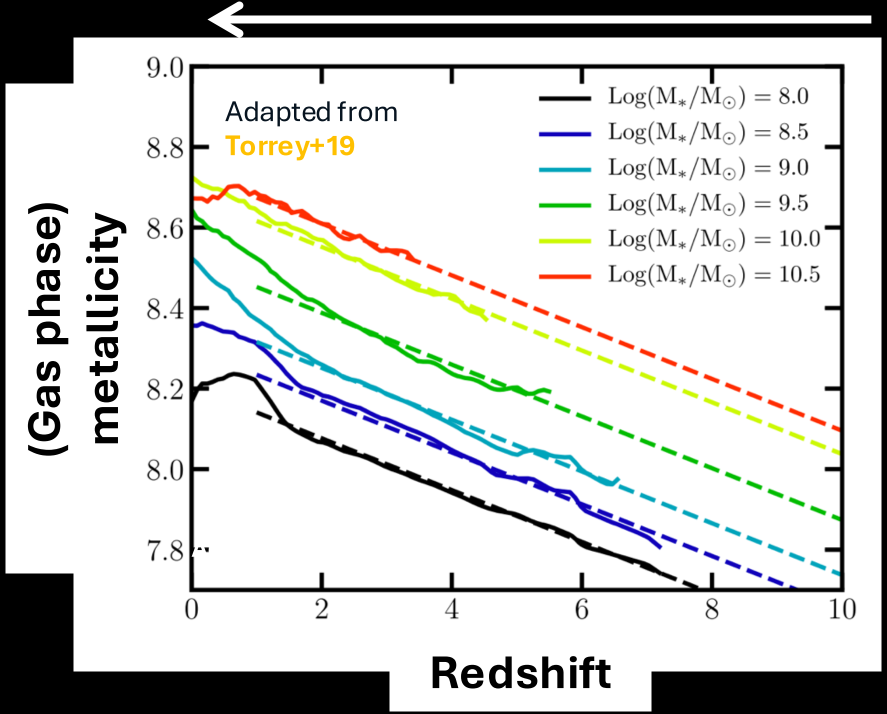

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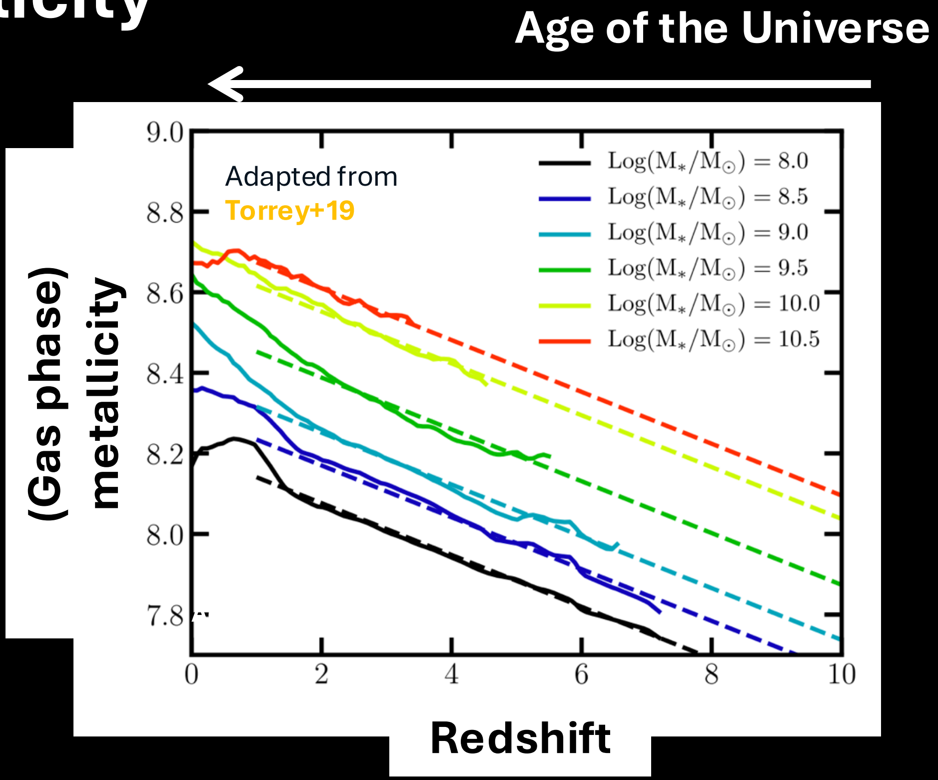
-> stellar winds are line-driven
-> less lines means less momentum transfer

Conditions in the Universe differ, and vary with Cosmic Time, e.g., metallicity



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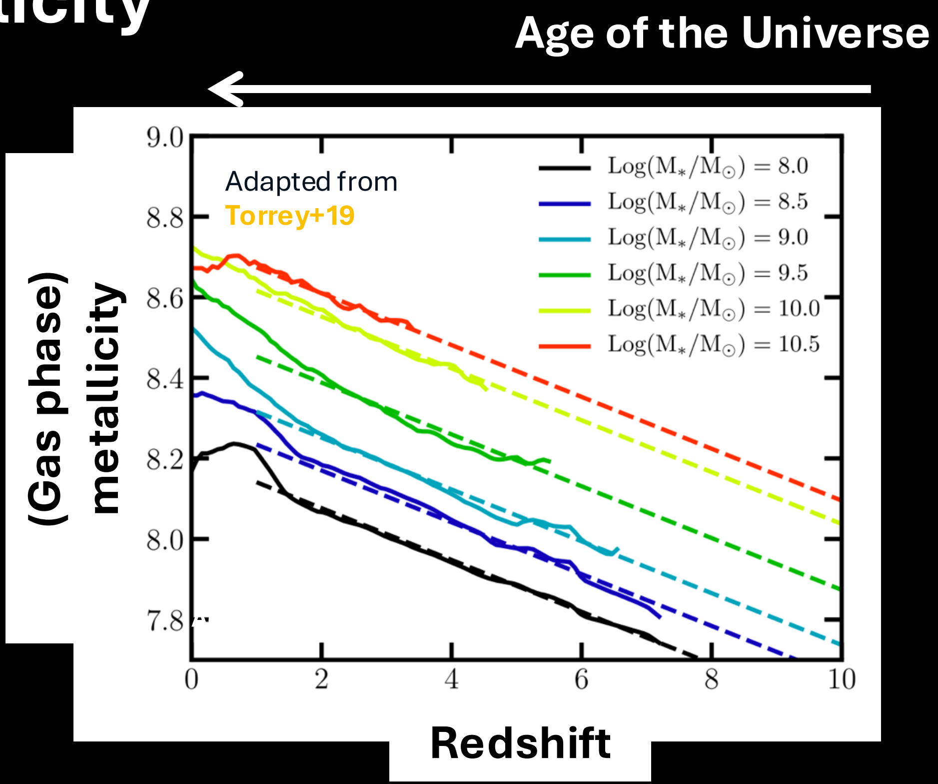
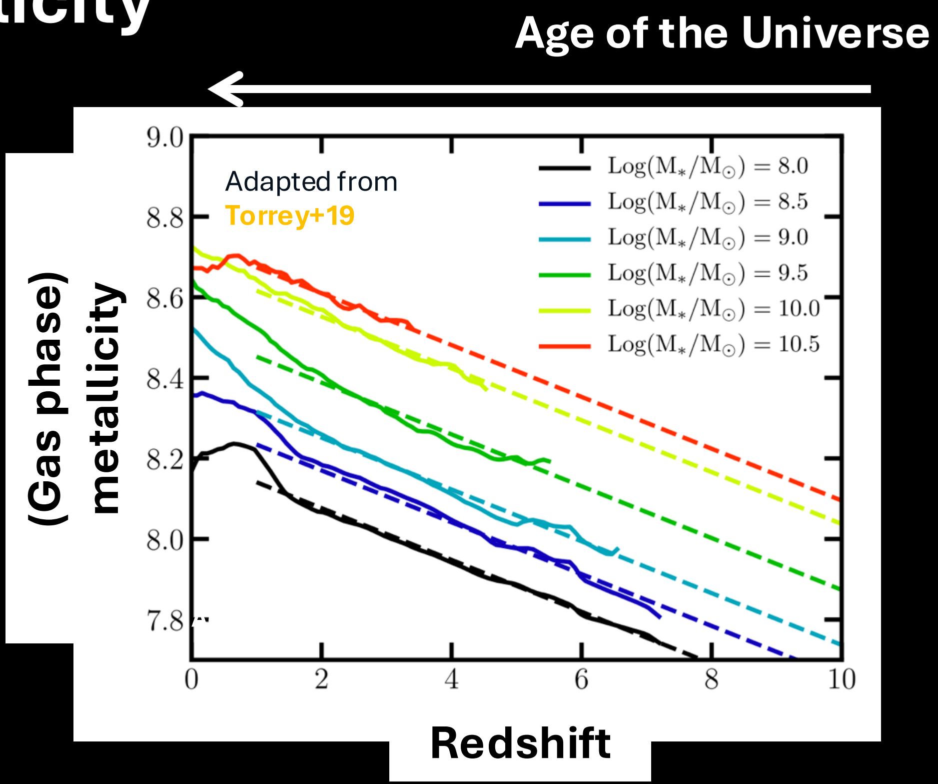


Lower metallicity, what does it do?

-> stellar winds are line-driven
-> less lines means less momentum transfer
-> weaker stellar winds at lower metallicities

-> stars are hotter

Conditions in the Universe differ, and vary with Cosmic Time, e.g., metallicity



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-> stellar winds are line-driven
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-> weaker stellar winds at lower metallicities

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-> higher photon flux

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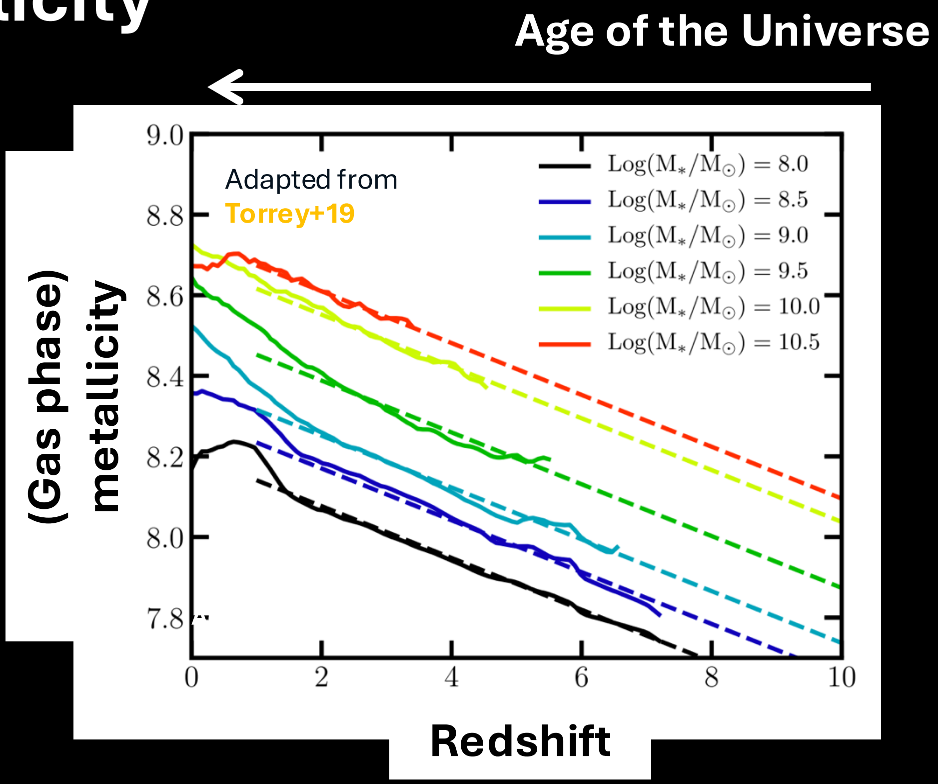

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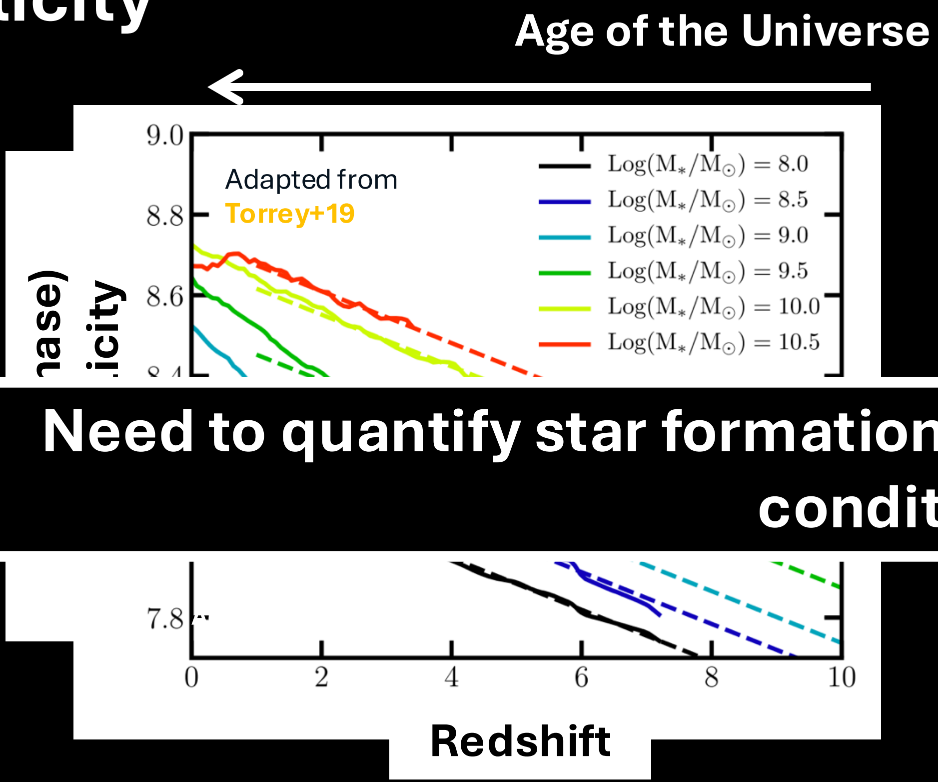

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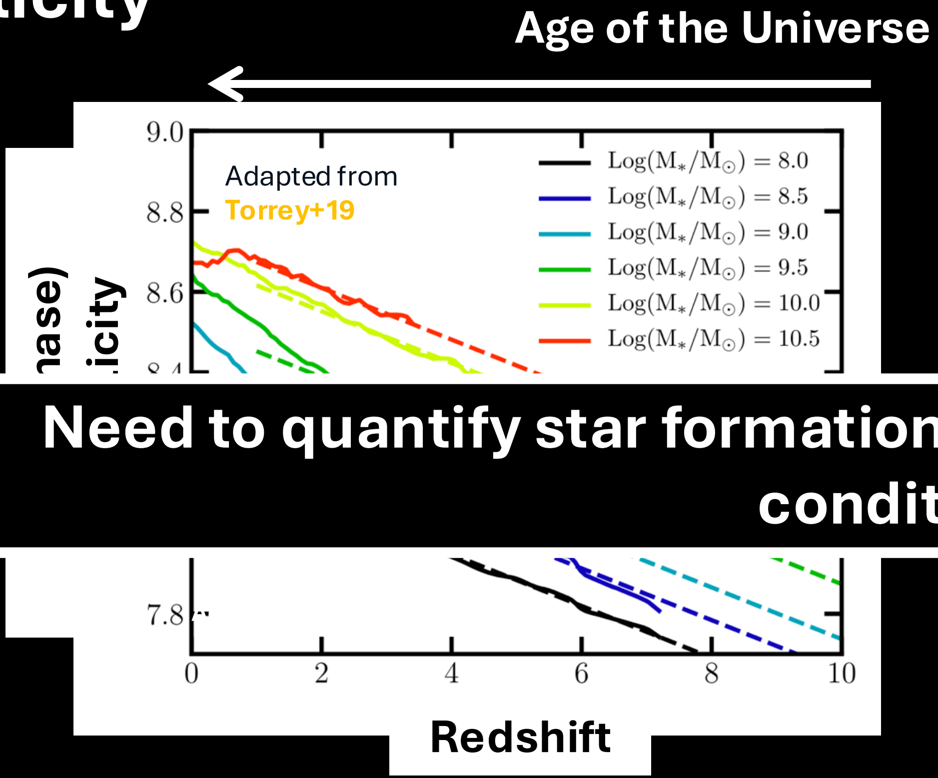

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➔ Exploit nearby (resolved), metal-poor galaxies to understand feedback at high redshifts (Lopez+14, McLeod+19, McLeod+22, McLeod+24, Rowland+24)

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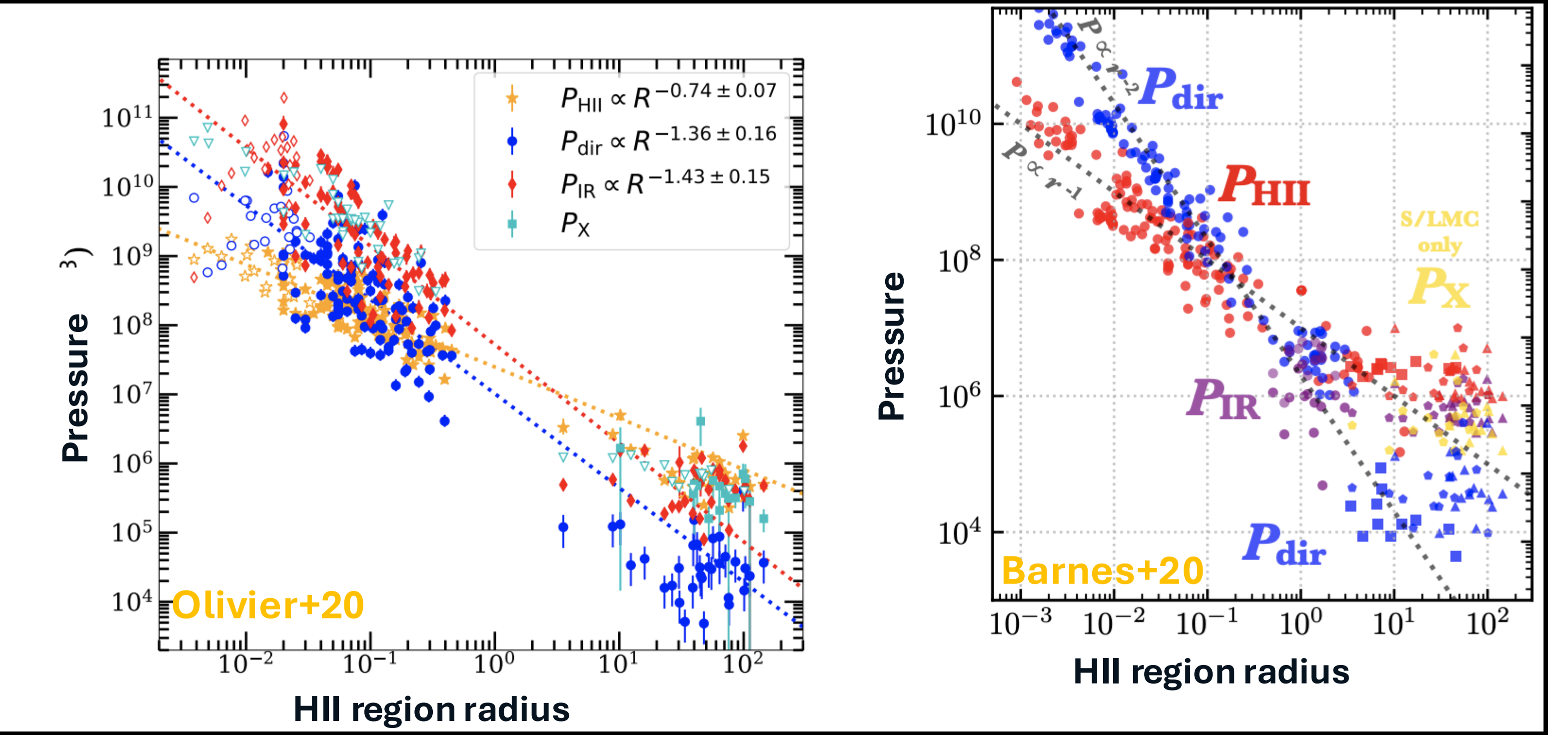

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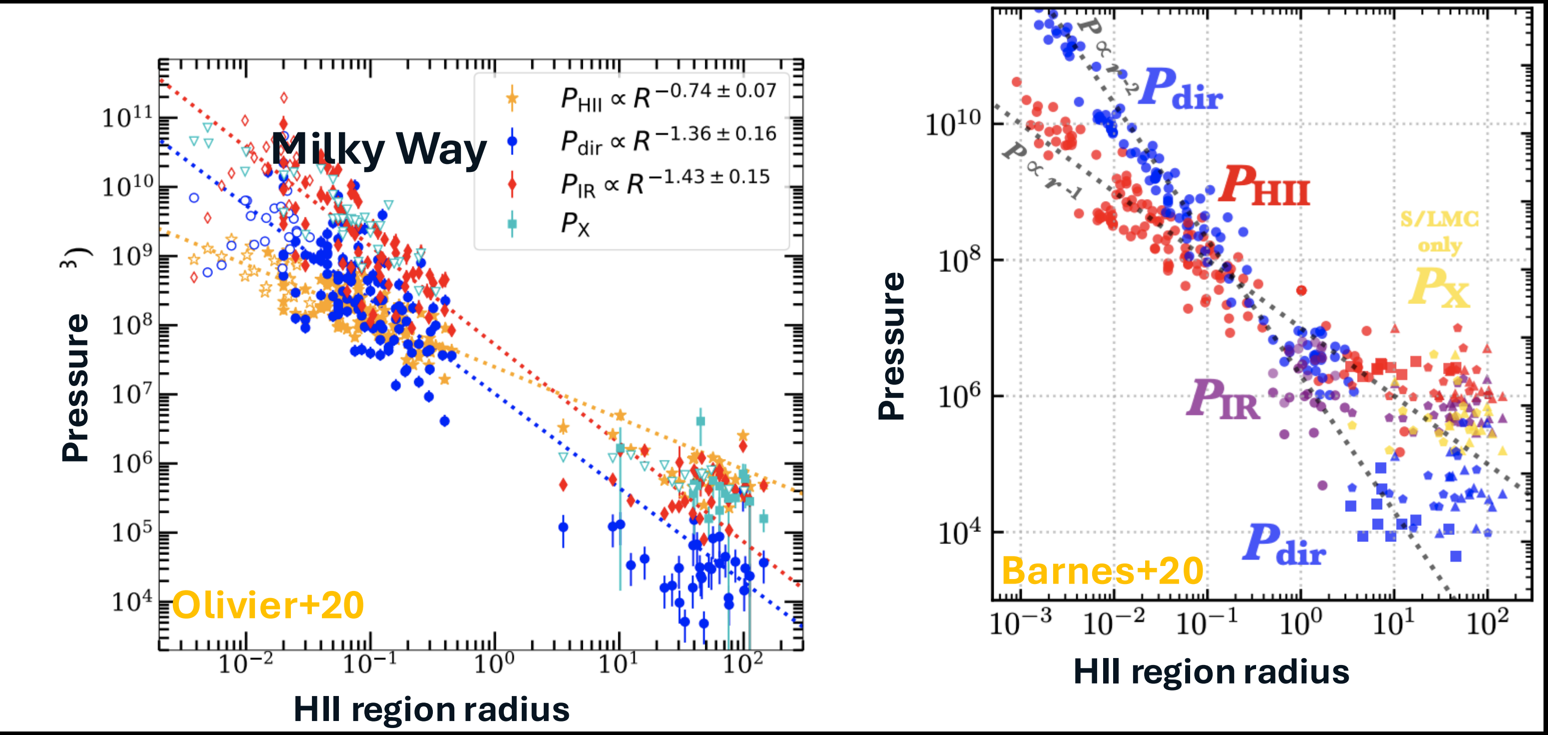

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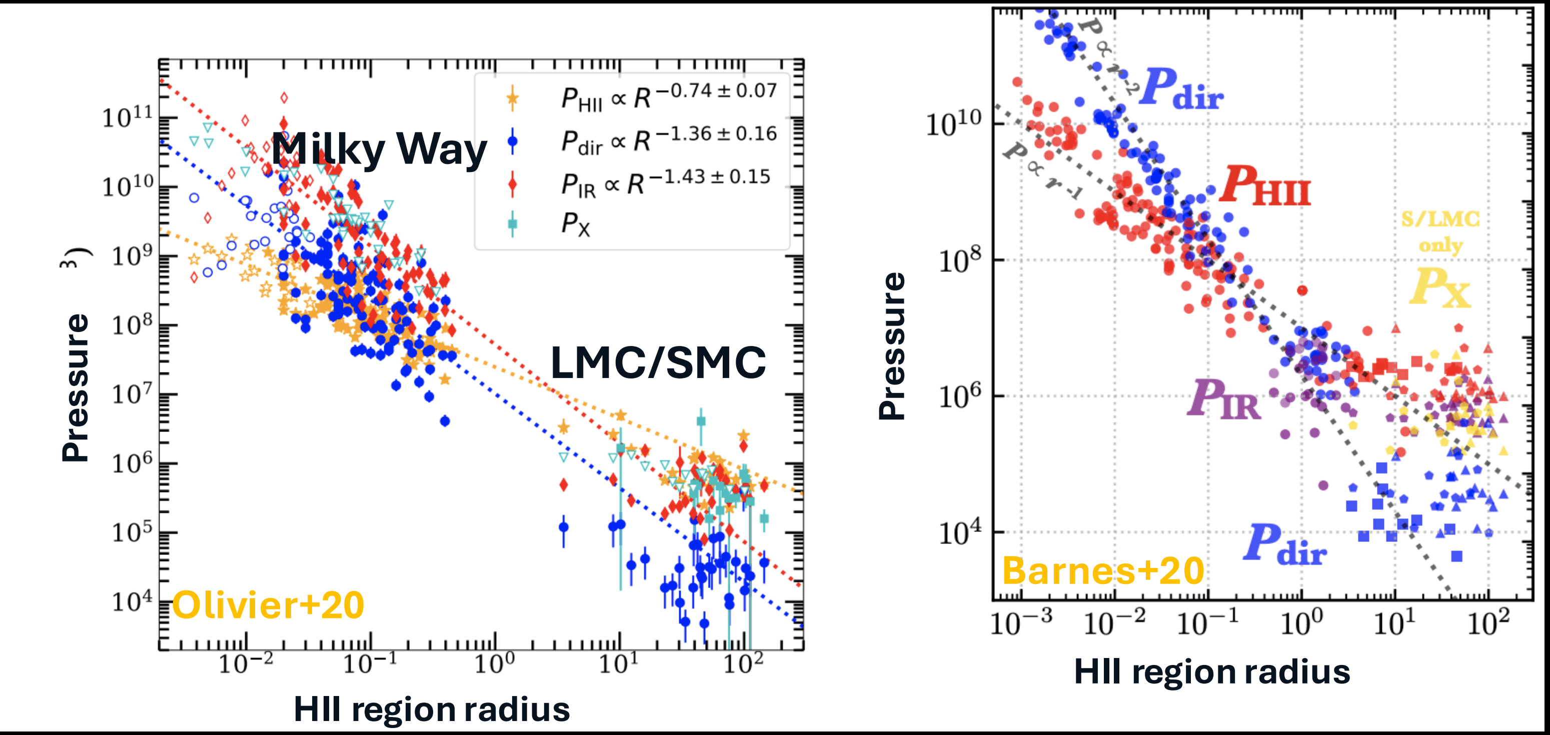

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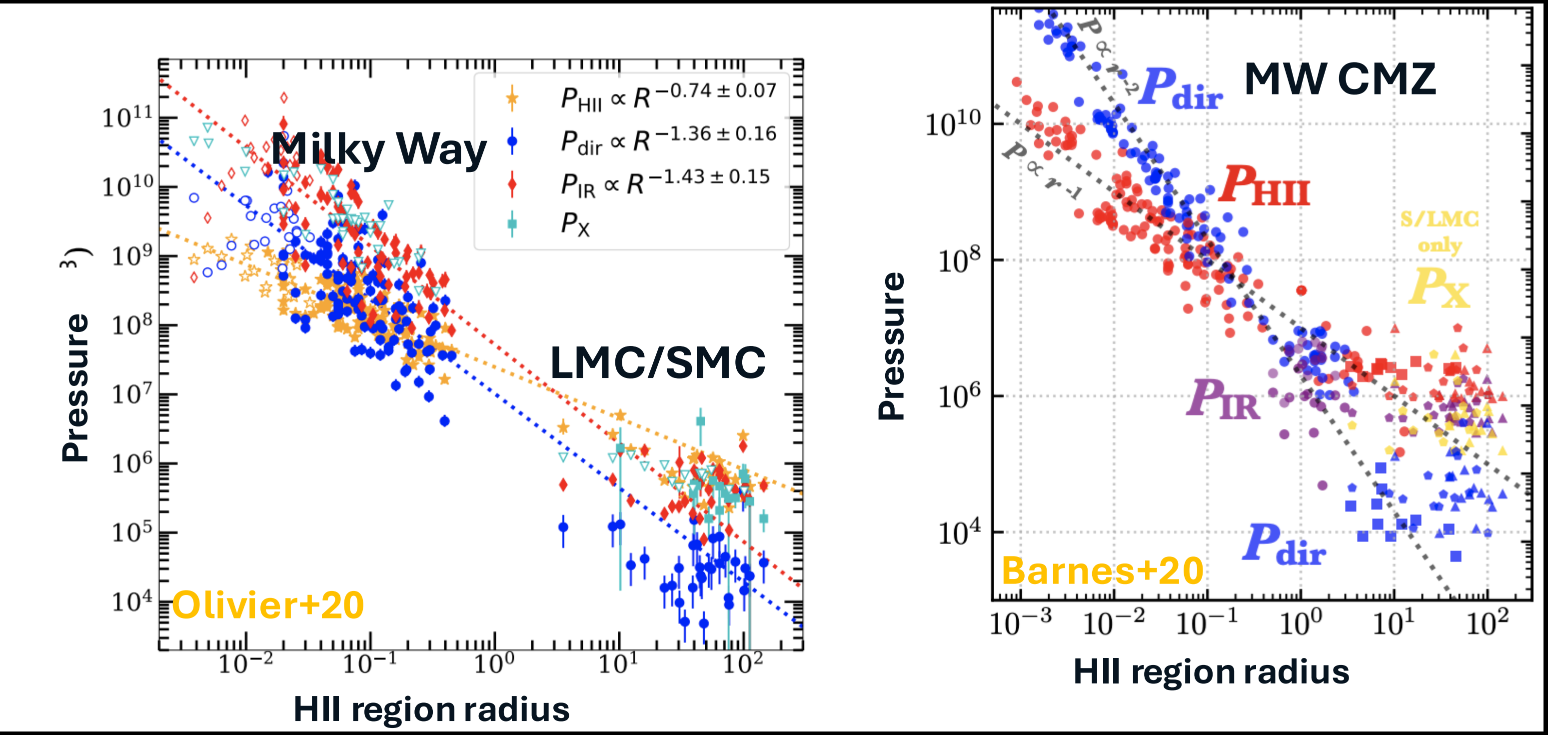

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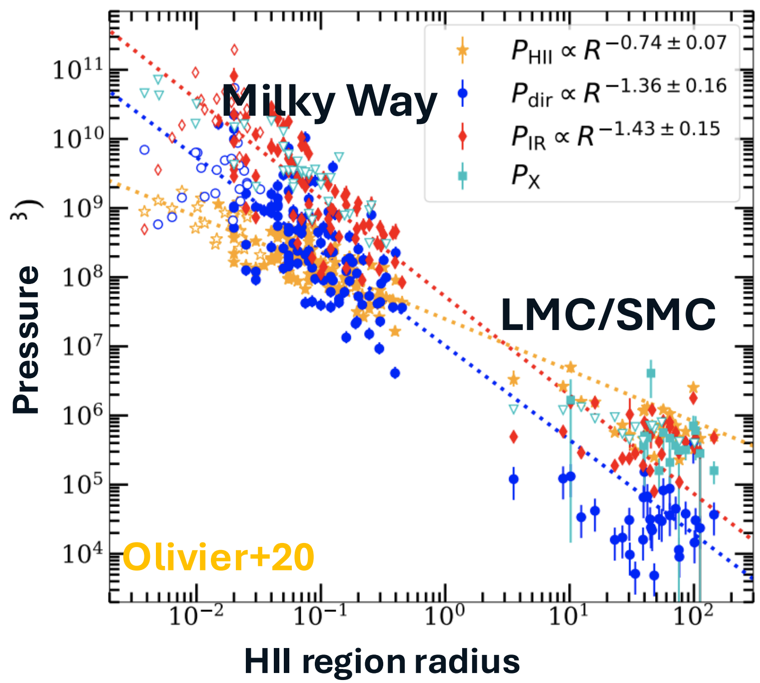

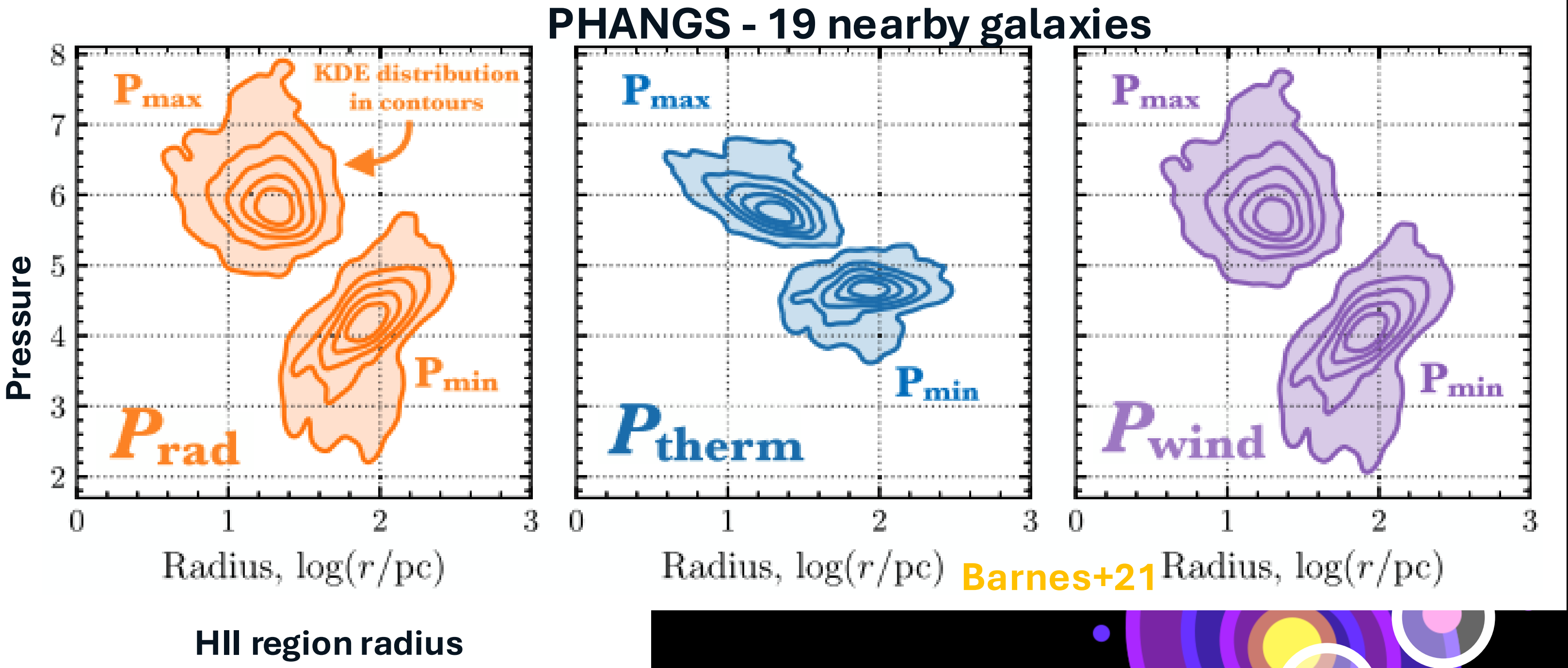

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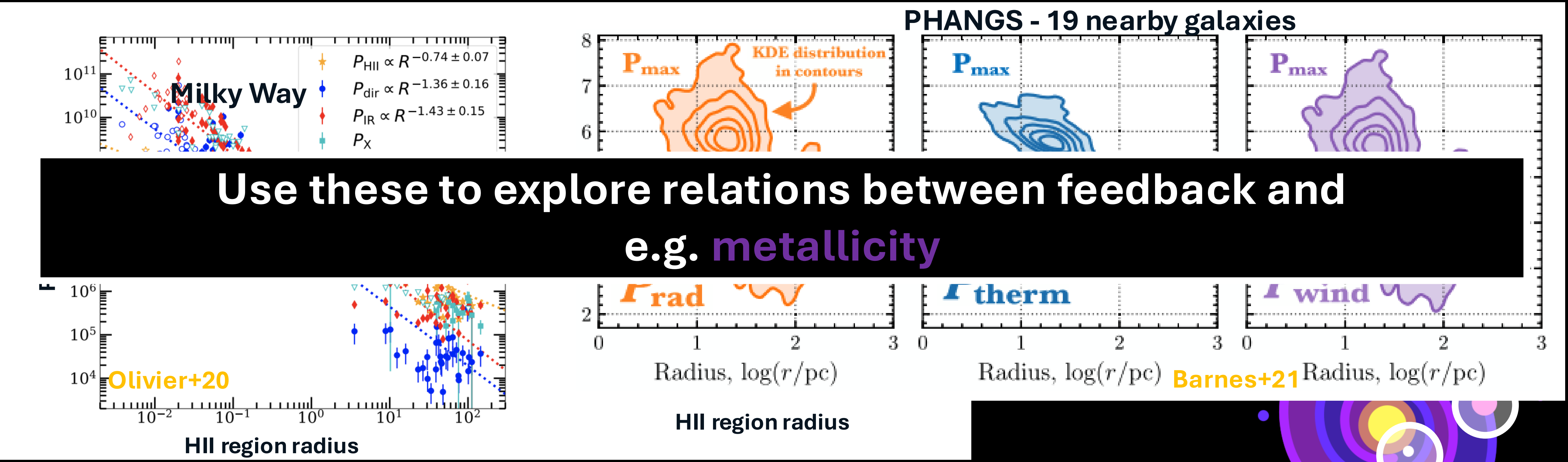

Use these to explore relations between feedback and e.g. metallicity

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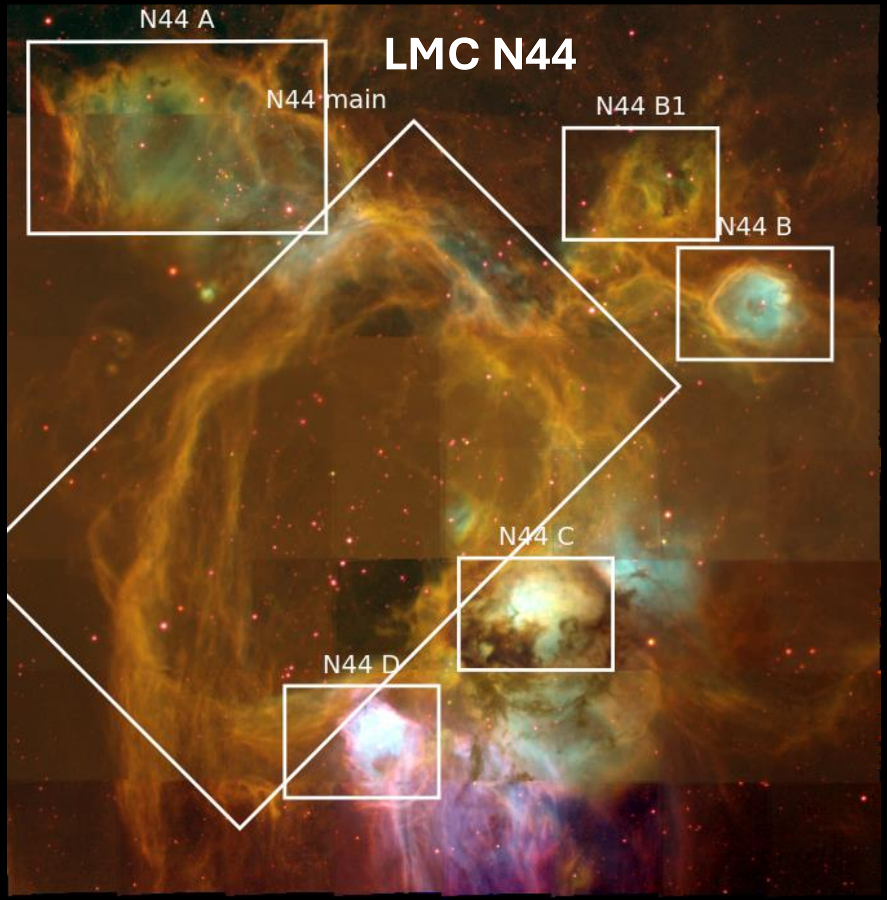
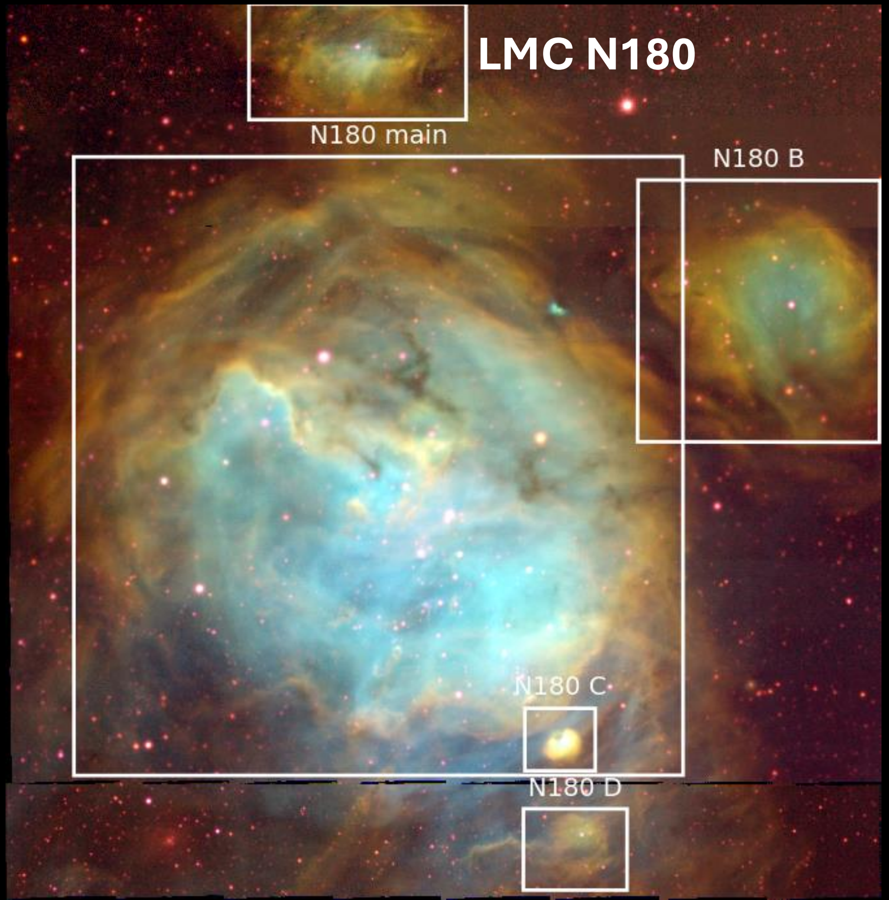
VLT/MUSE observations

Simultaneous characterization of **individual feedback-driving stars** and resolved **feedback-driven gas**

> 60 O & WR stars



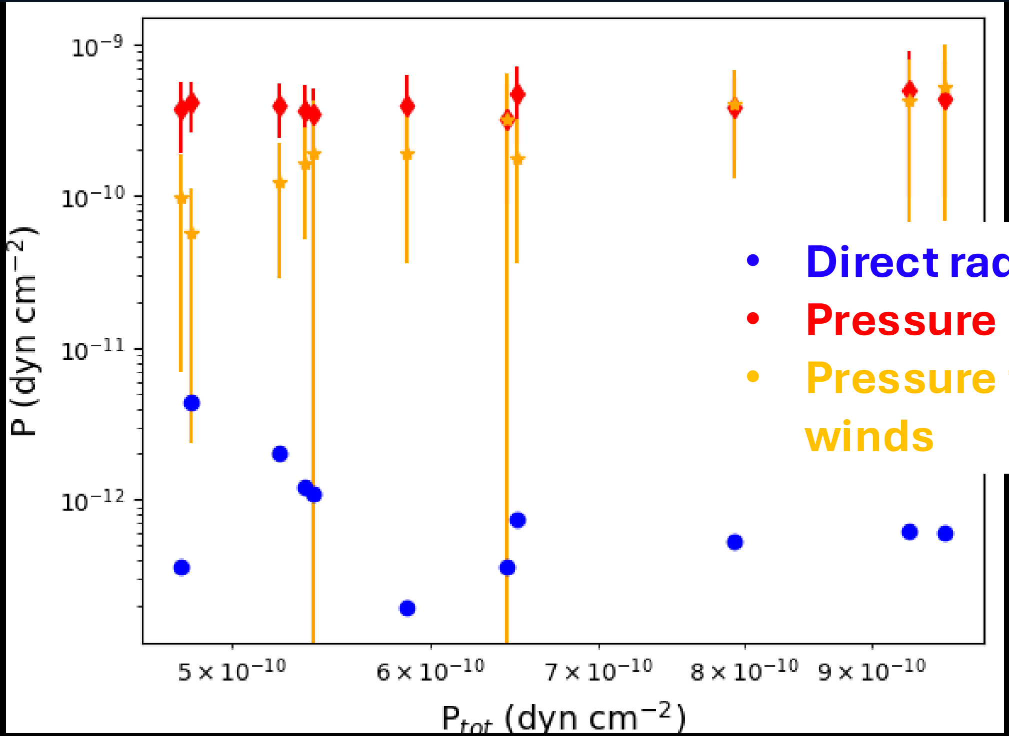


[SII]6717
Hα
[OIII]5007

McLeod+18b

Feedback in massive star-forming regions in the LMC: quantify different feedback mechanisms

Which feedback mechanisms are dominant?



- Direct radiation pressure
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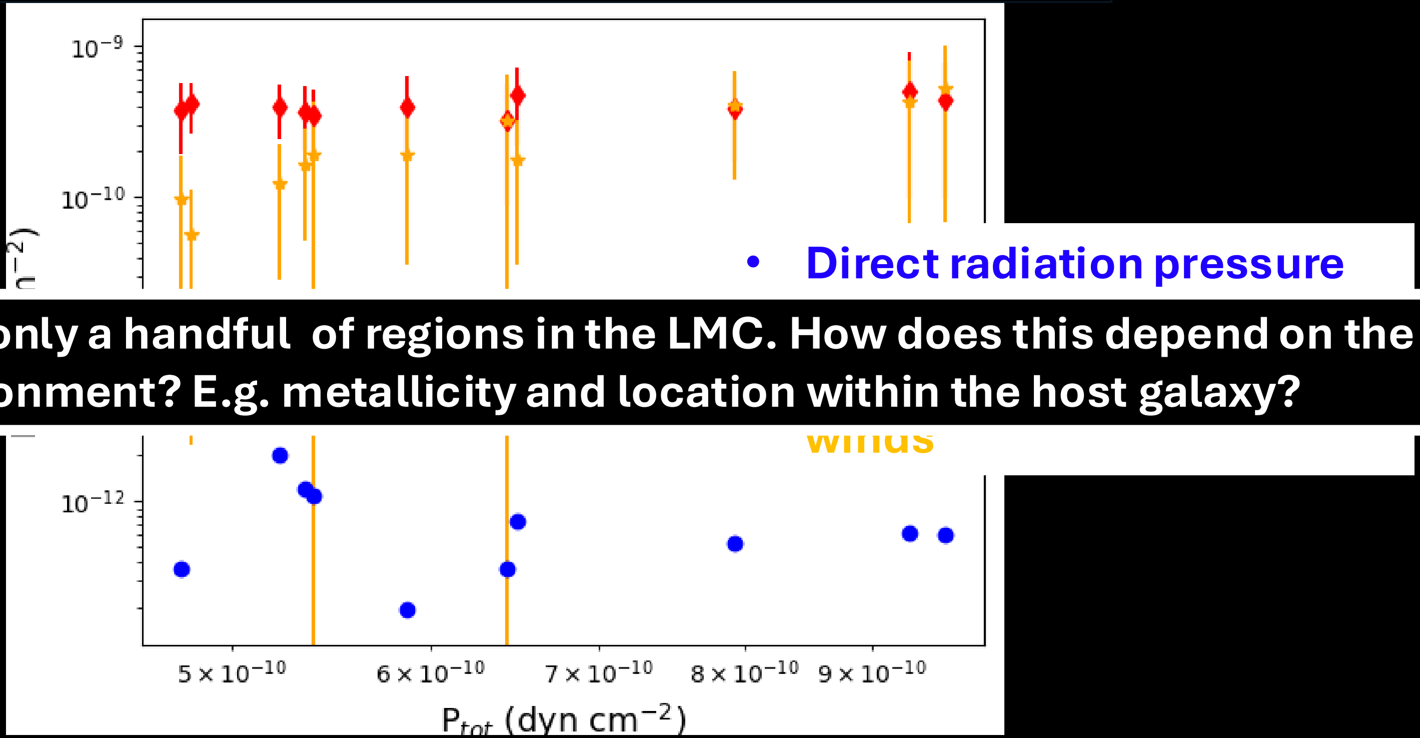

These are only a handful of regions in the LMC. How does this depend on the environment? E.g. metallicity and location within the host galaxy?

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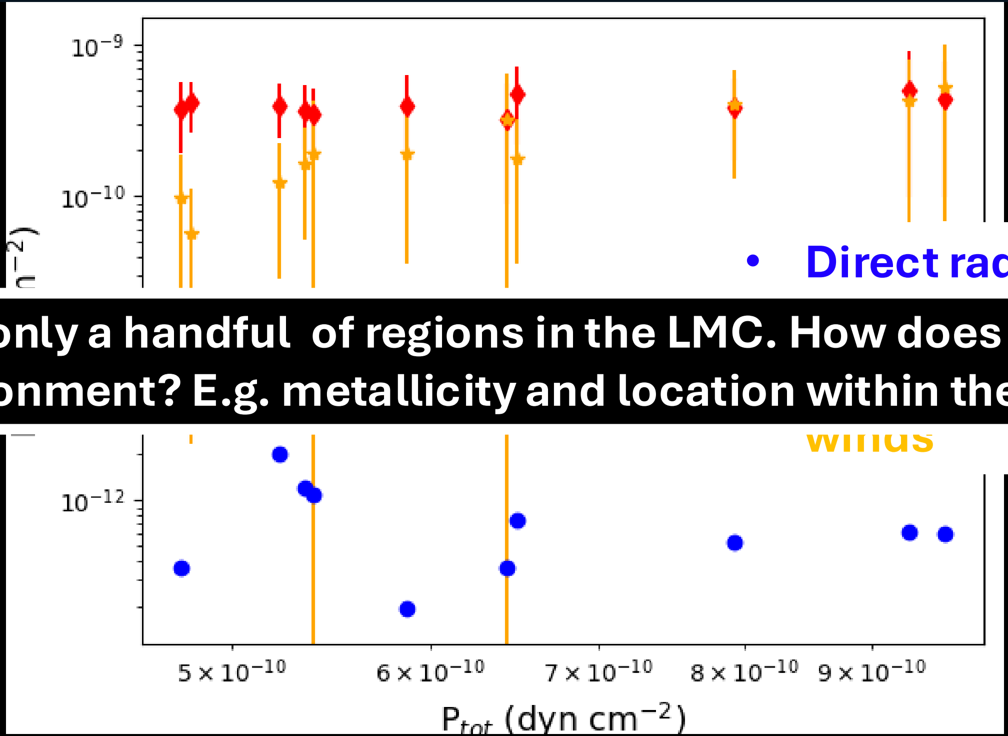

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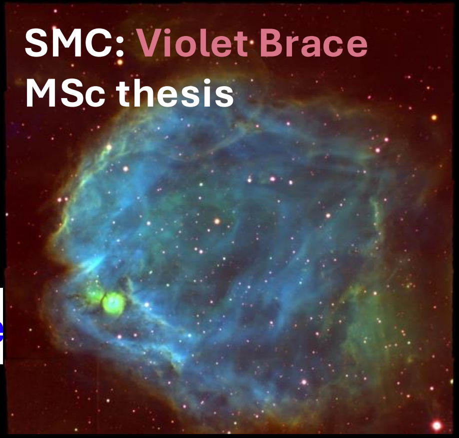

SMC: Violet Brace
MSc thesis

MW: Amber Sedgley
MSc thesis

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Why the LMC (SMC) is not the final frontier of feedback studies

Instead of tens of regions with this level of detail, need hundreds to thousands to statistically characterize feedback

Credit: C. Fairbairn

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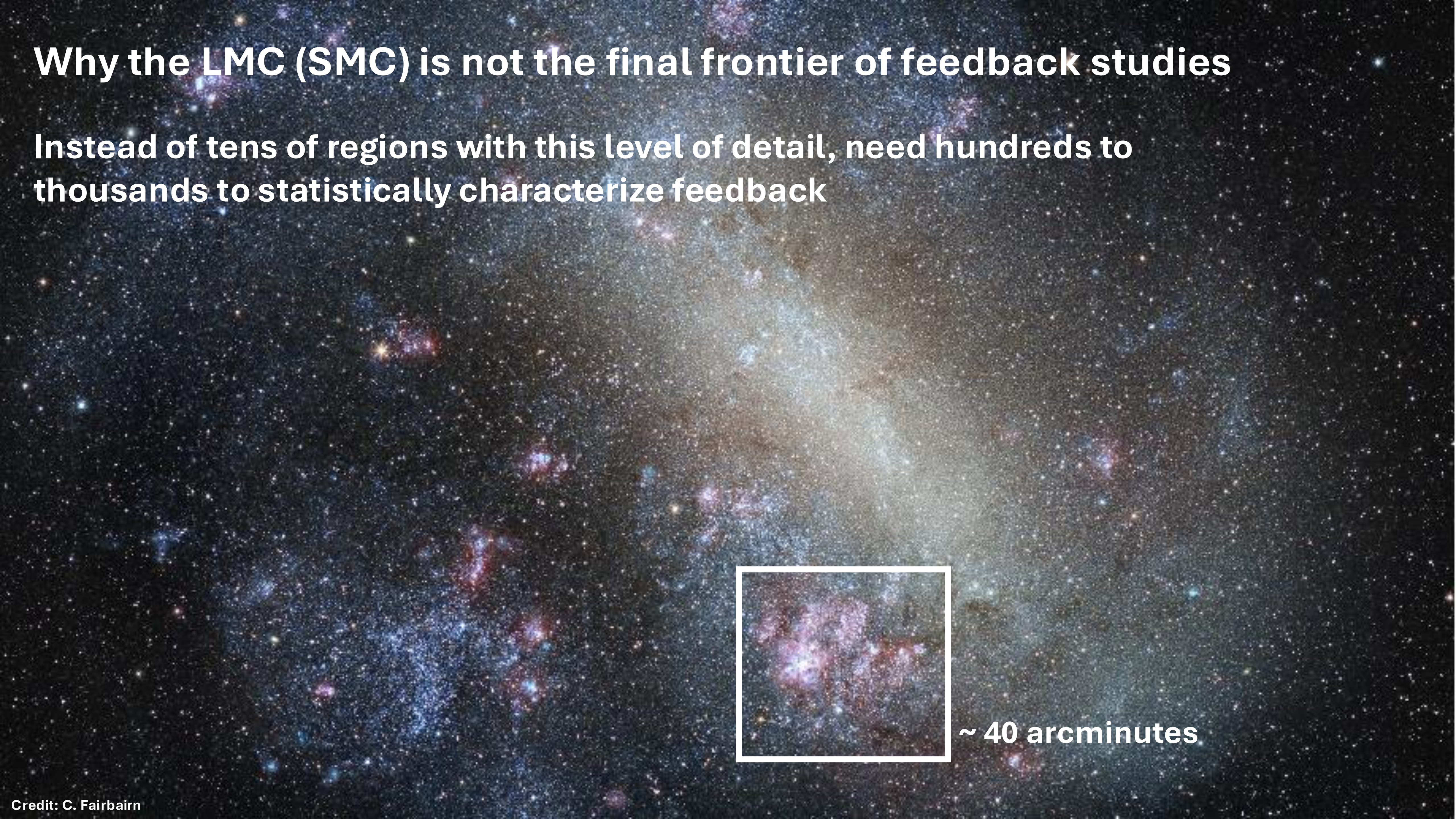

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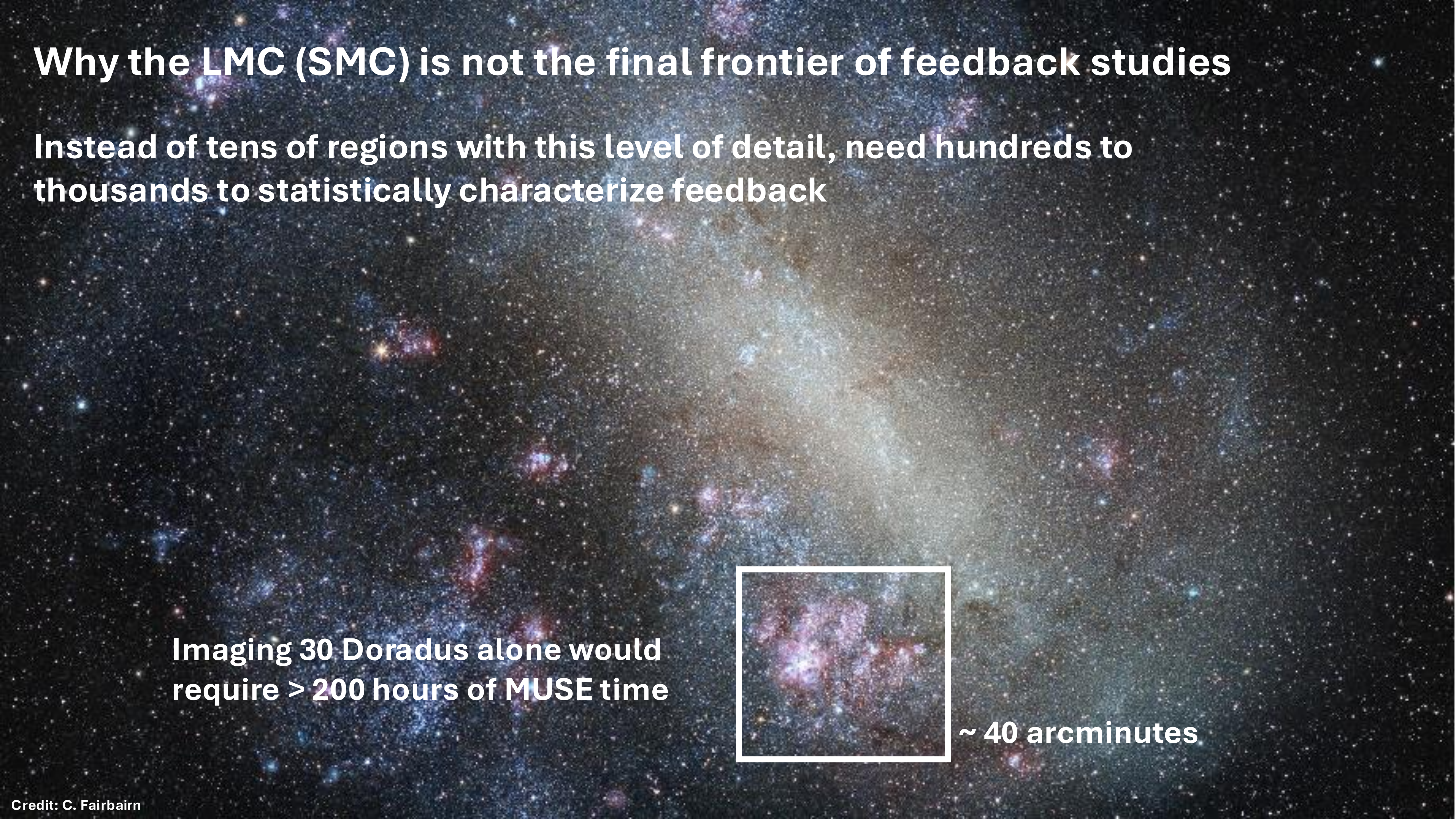

Why the LMC (SMC) is not the final frontier of feedback studies

Instead of tens of regions with this level of detail, need hundreds to thousands to statistically characterize feedback

Also, this does not sample the environment of different host galaxies

Solution: survey nearby galaxies (beyond the LMC)

Imaging 30 Doradus alone would require > 200 hours of MUSE time

~ 40 arcminutes

Credit: C. Fairbairn

Metallicity-dependent pre-SN feedback in NGC 300

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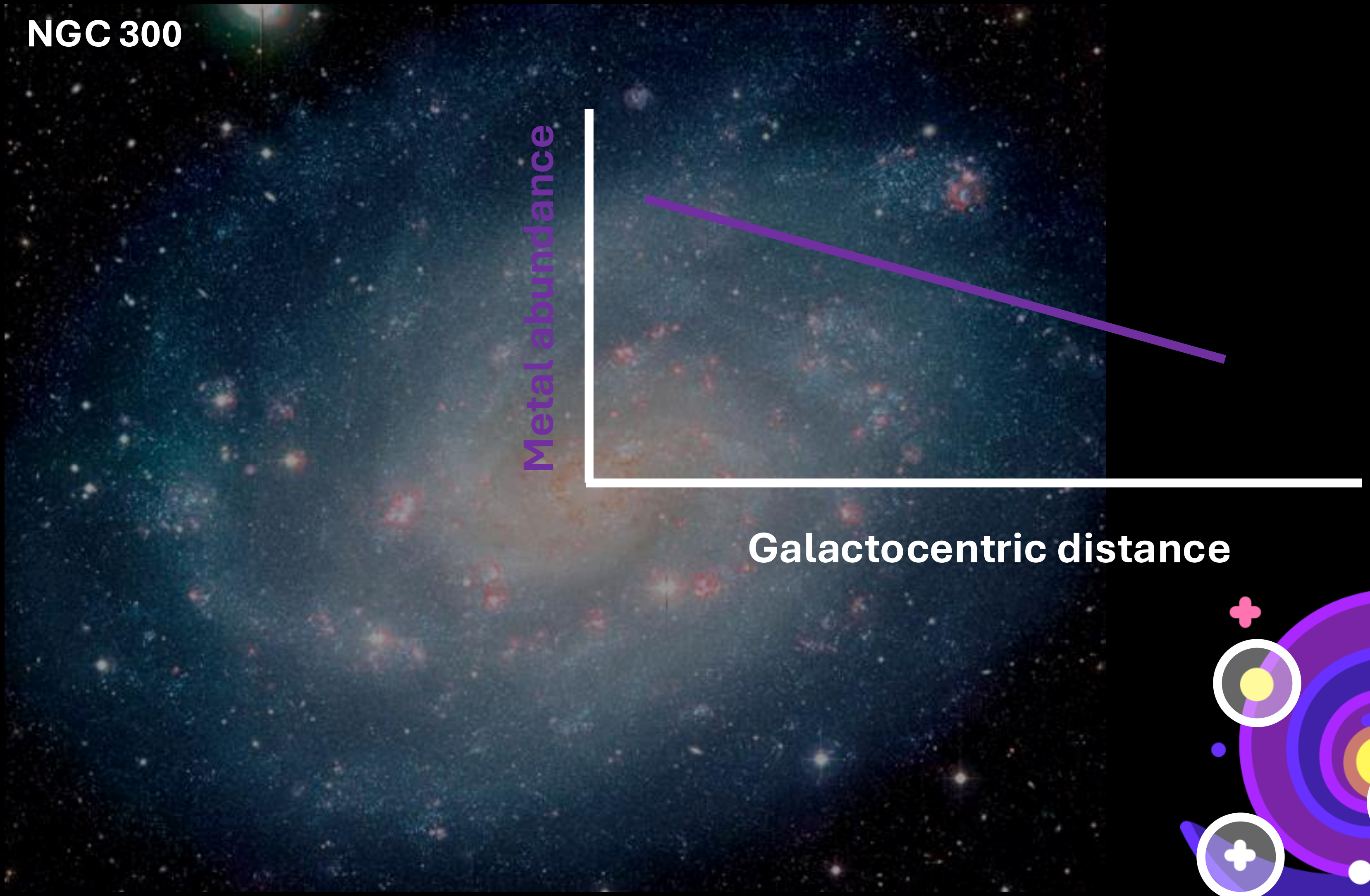

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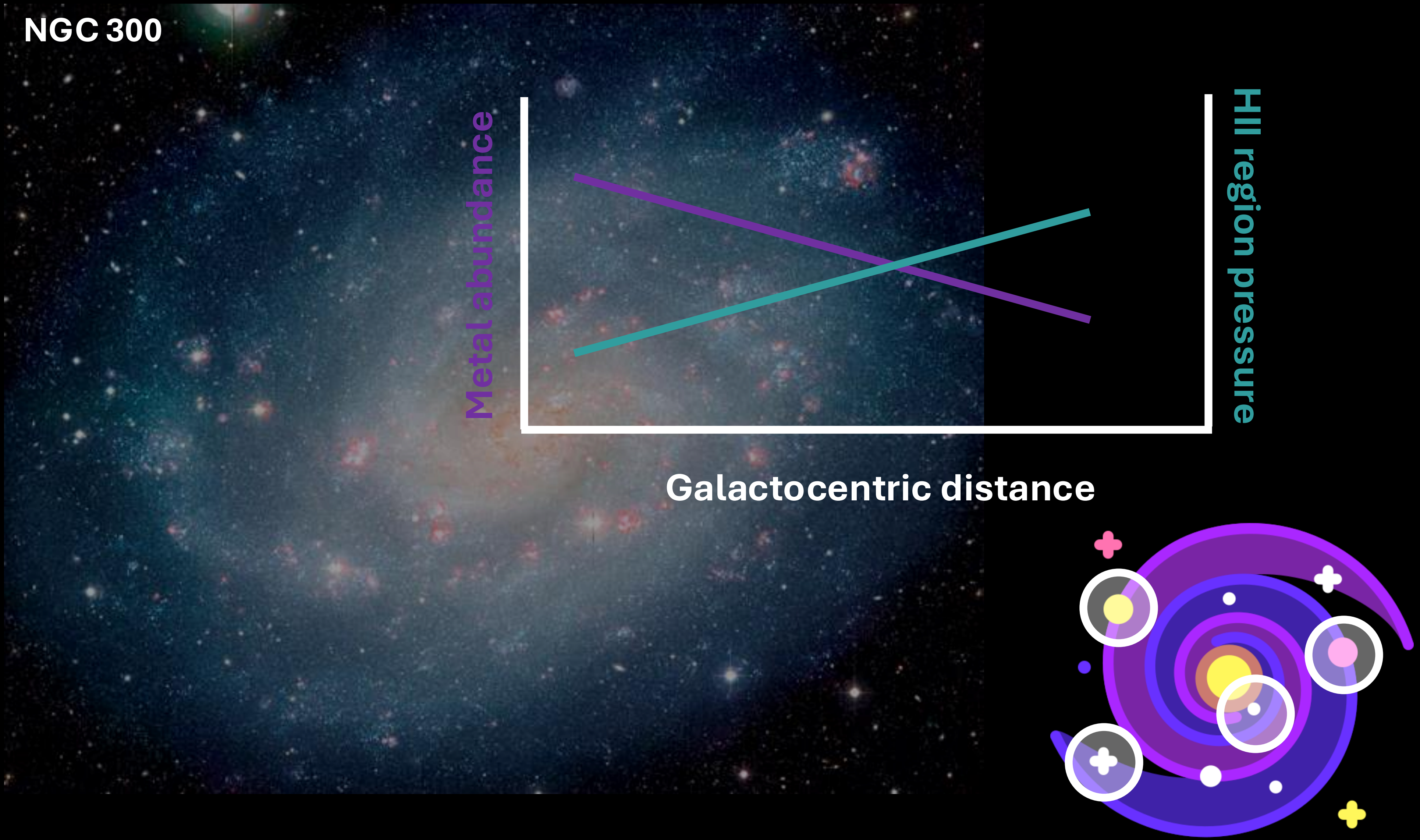

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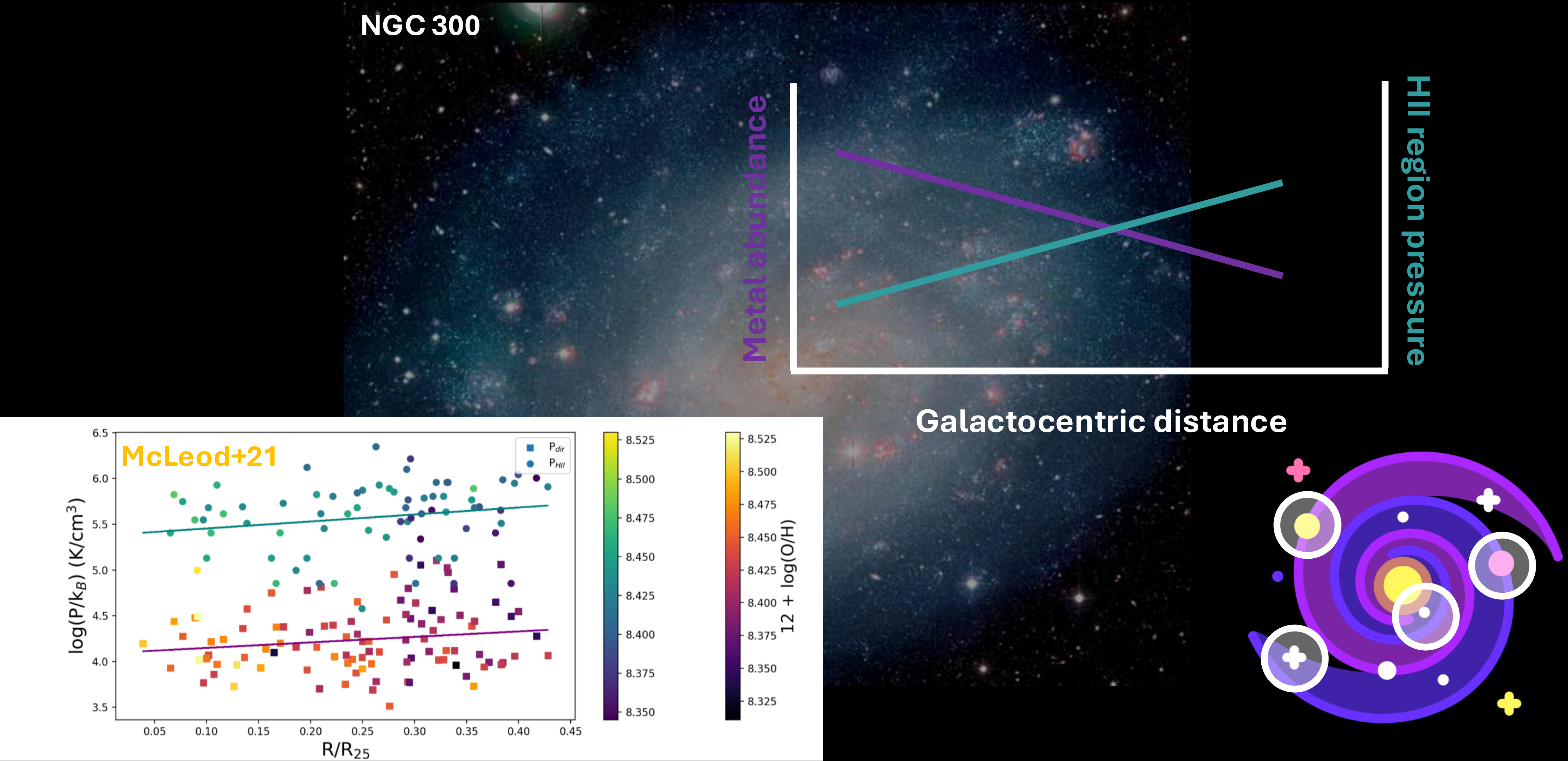
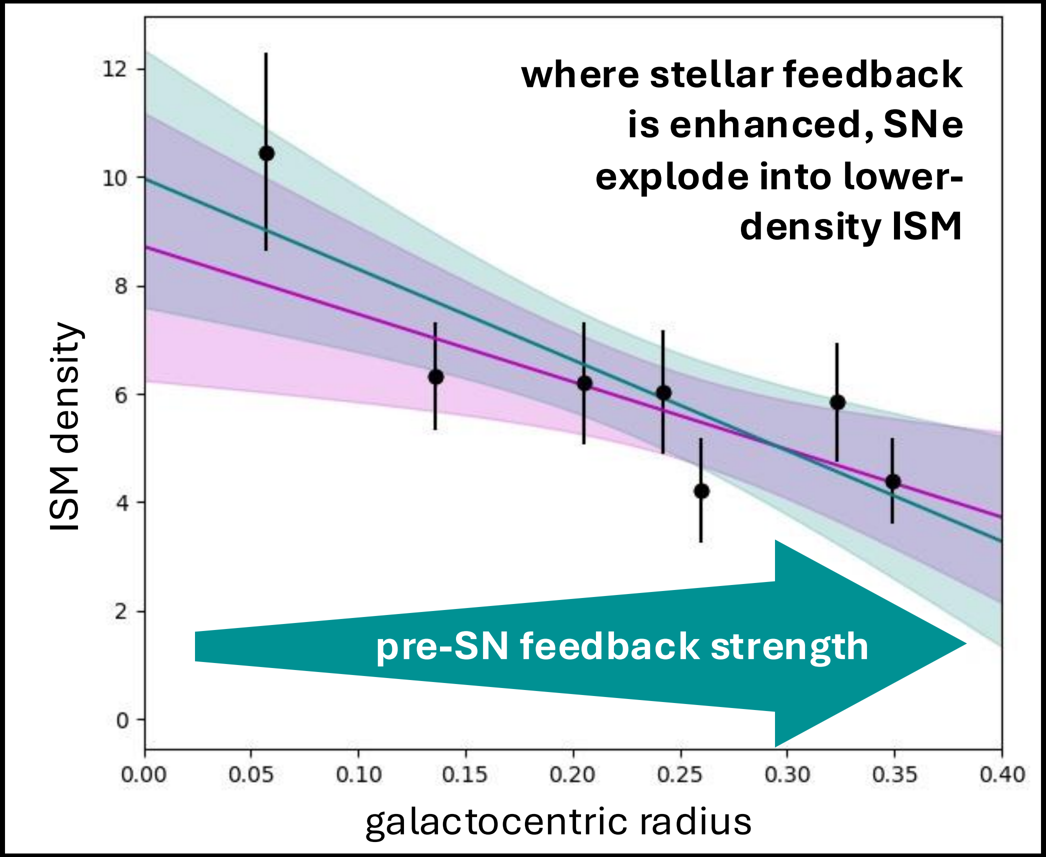
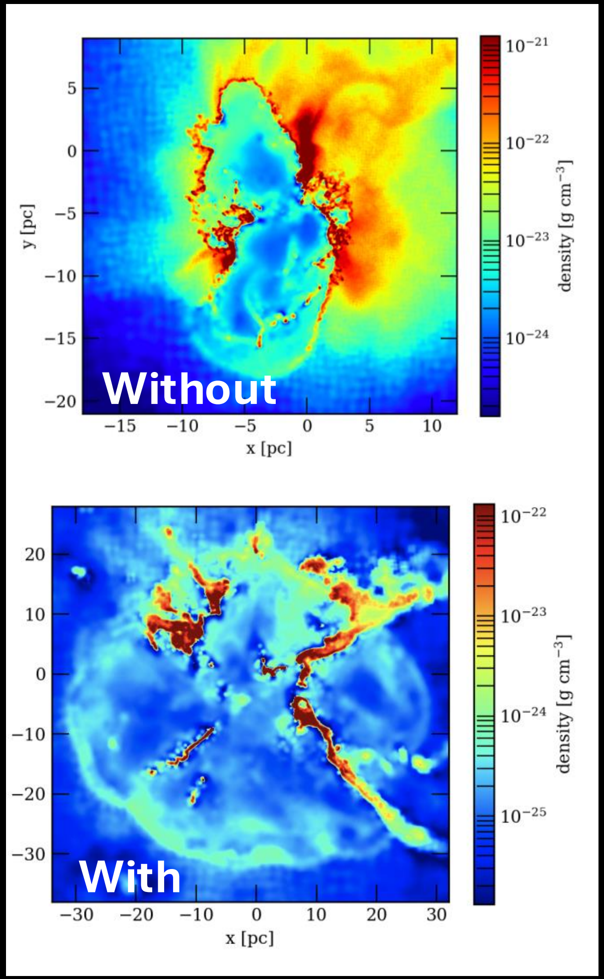


Pre-SN feedback affects the density and 3D ISM geometry a SN will explode into





Lucas+20
McLeod+21

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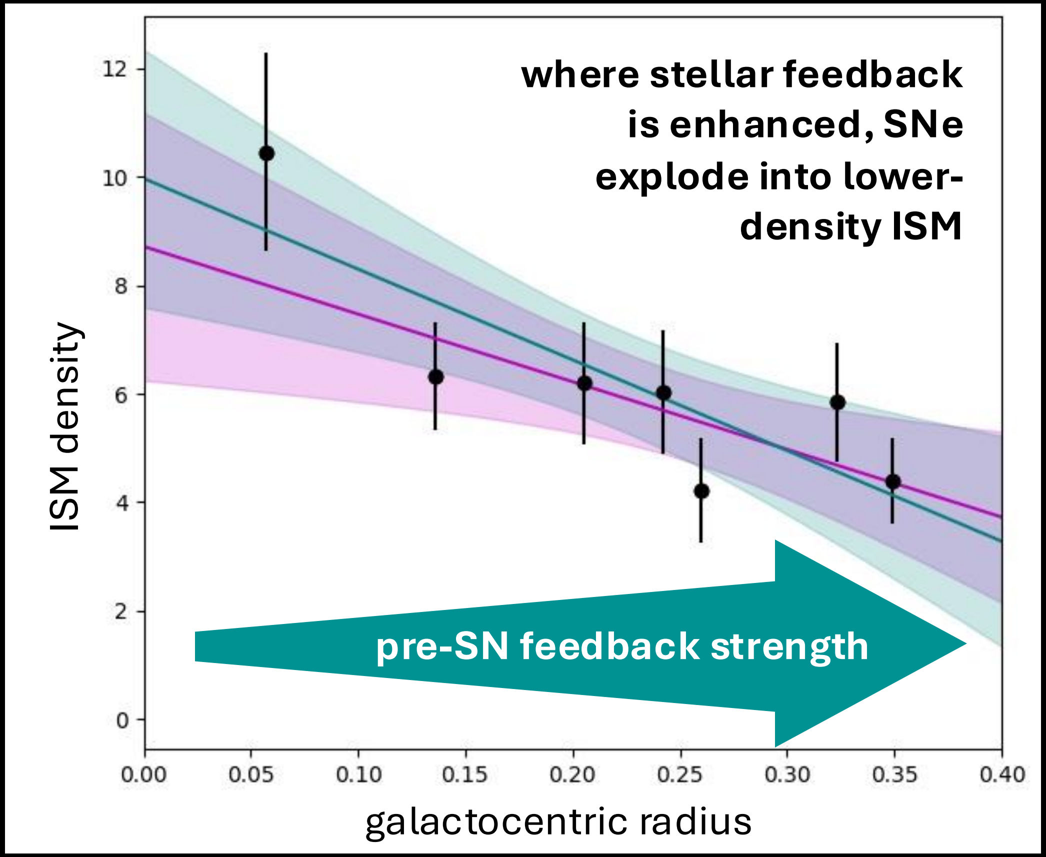
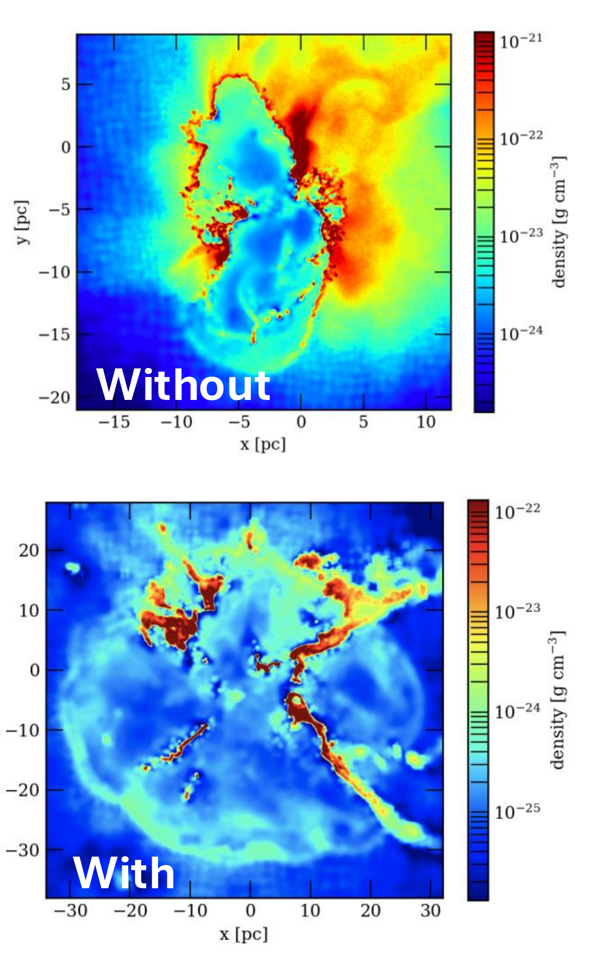




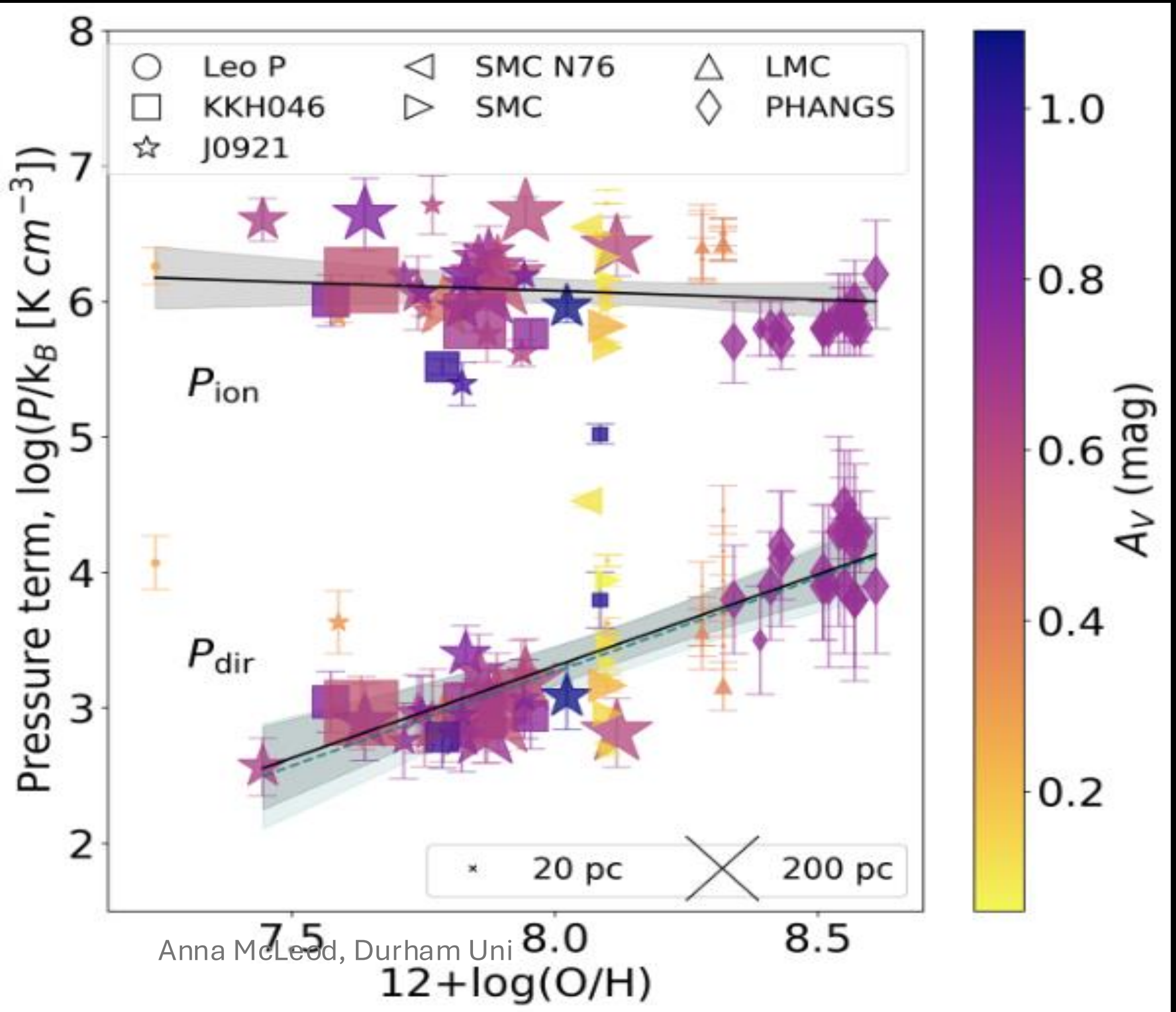
different impact of supernovae with/without early stellar feedback

Lucas+20
McLeod+21

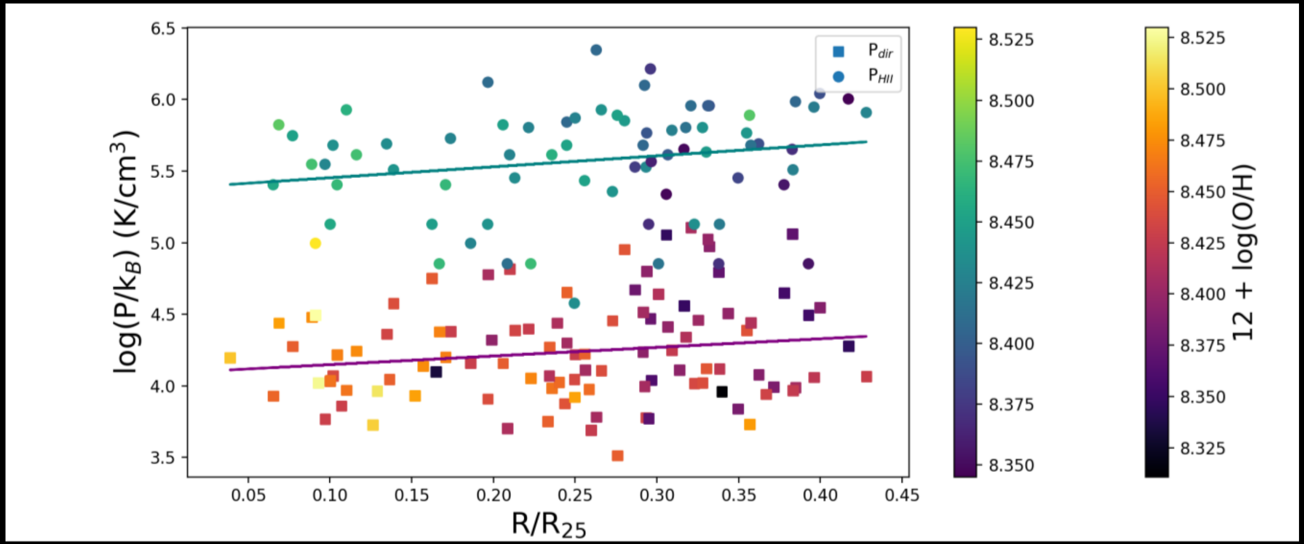
Exploring the very low metallicity regime

Dwarf starburst galaxies

Rowland, McLeod+24
(see also Marasco+23)



Feedback studies in nearby galaxies



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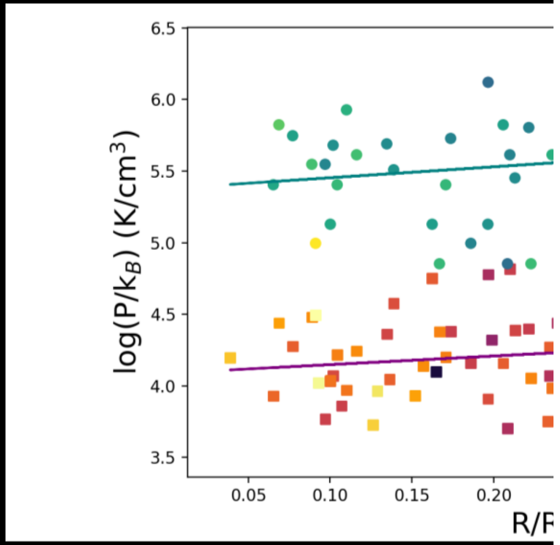
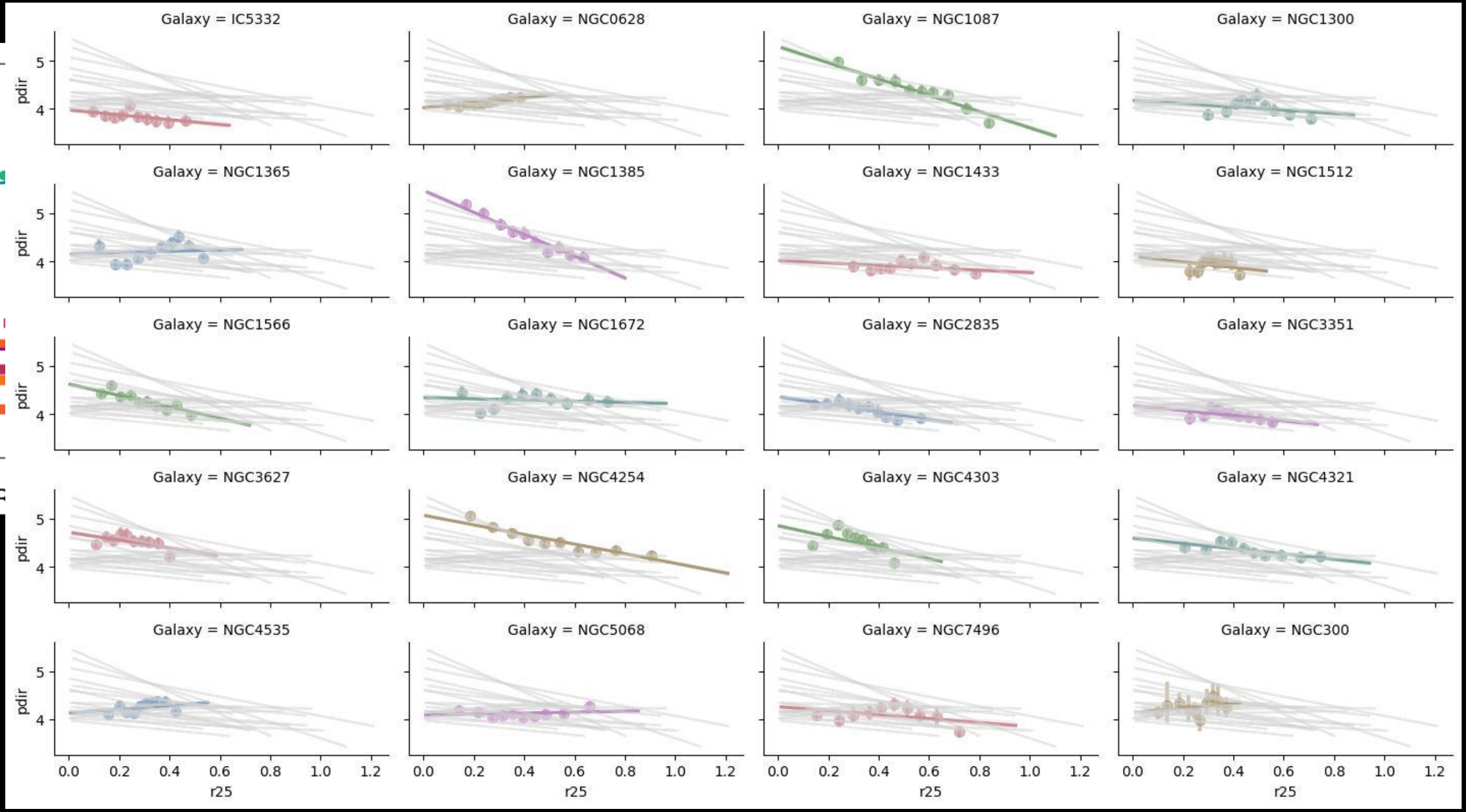
McLeod+in prep.





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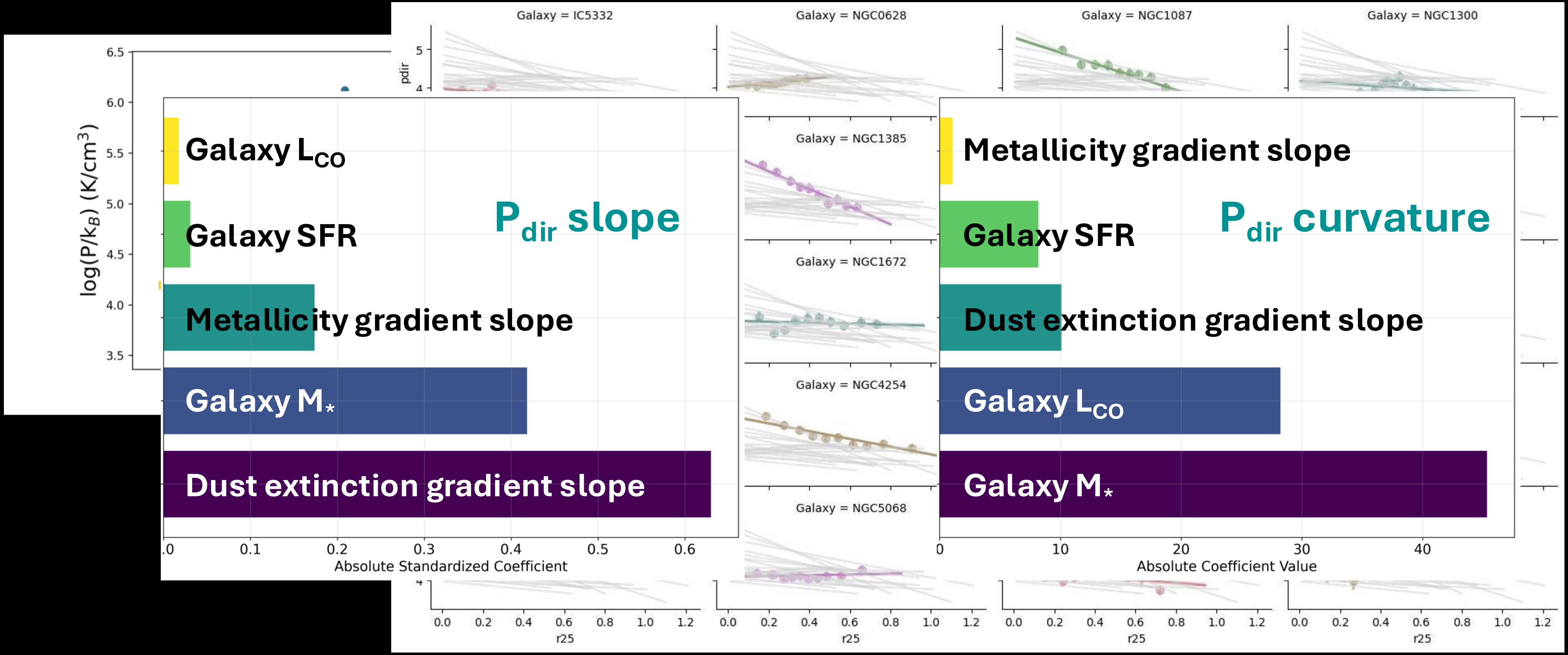

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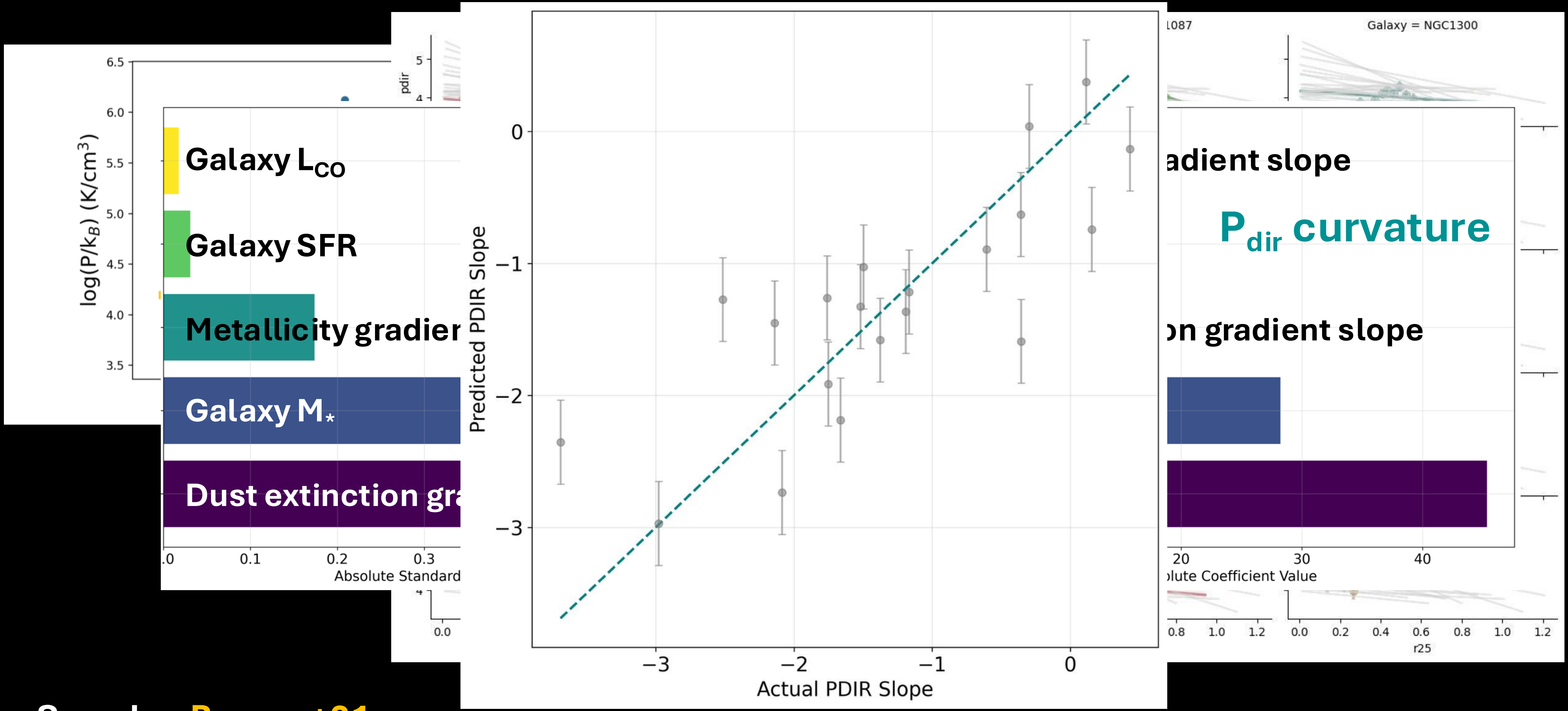

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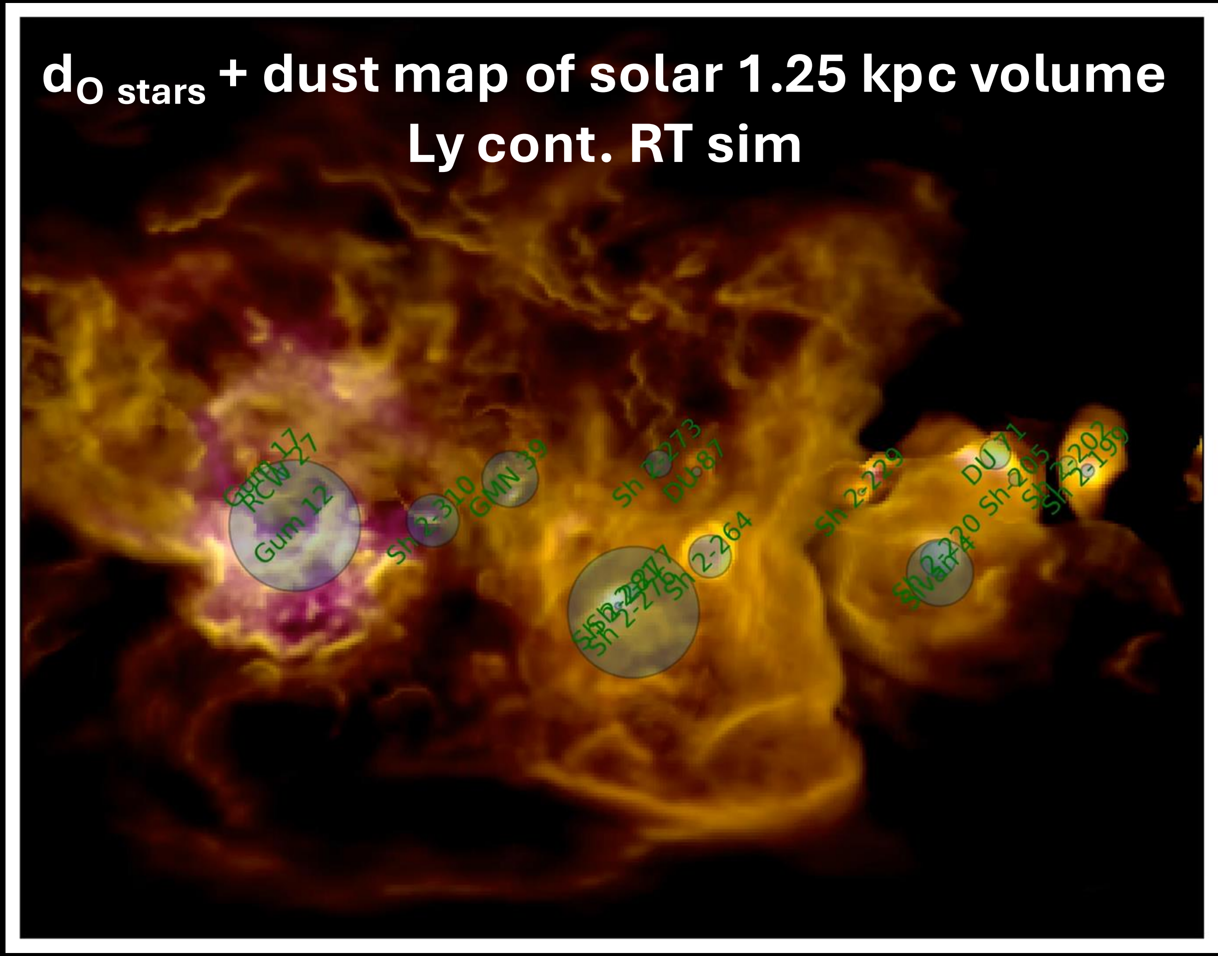
And where are we with simulations?



McCallum+25
(incl. McLeod)

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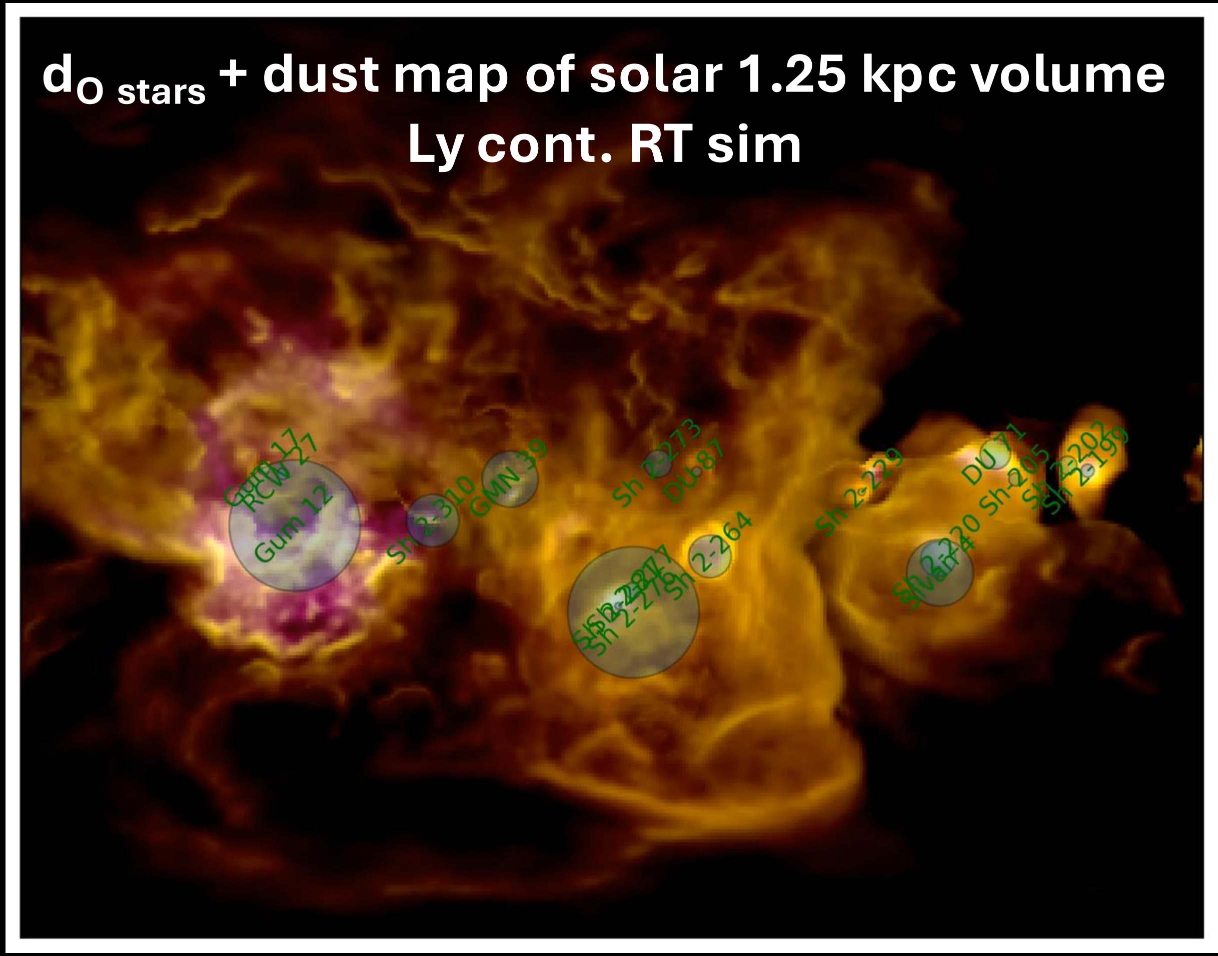

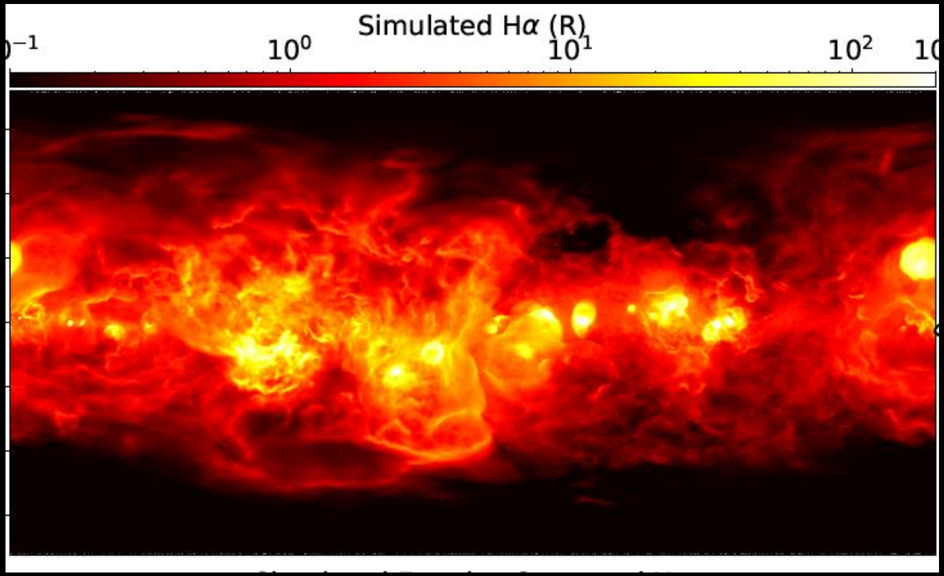

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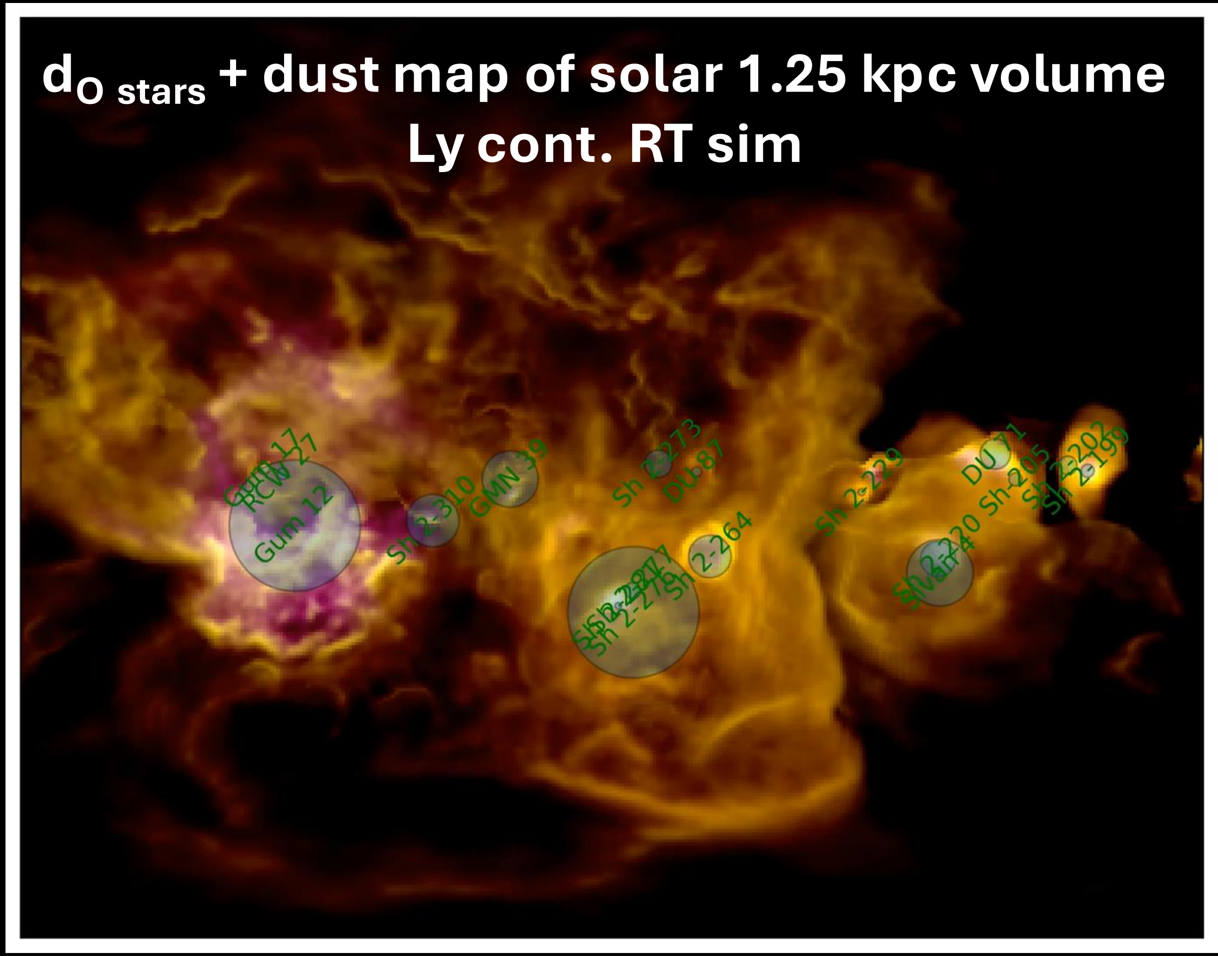

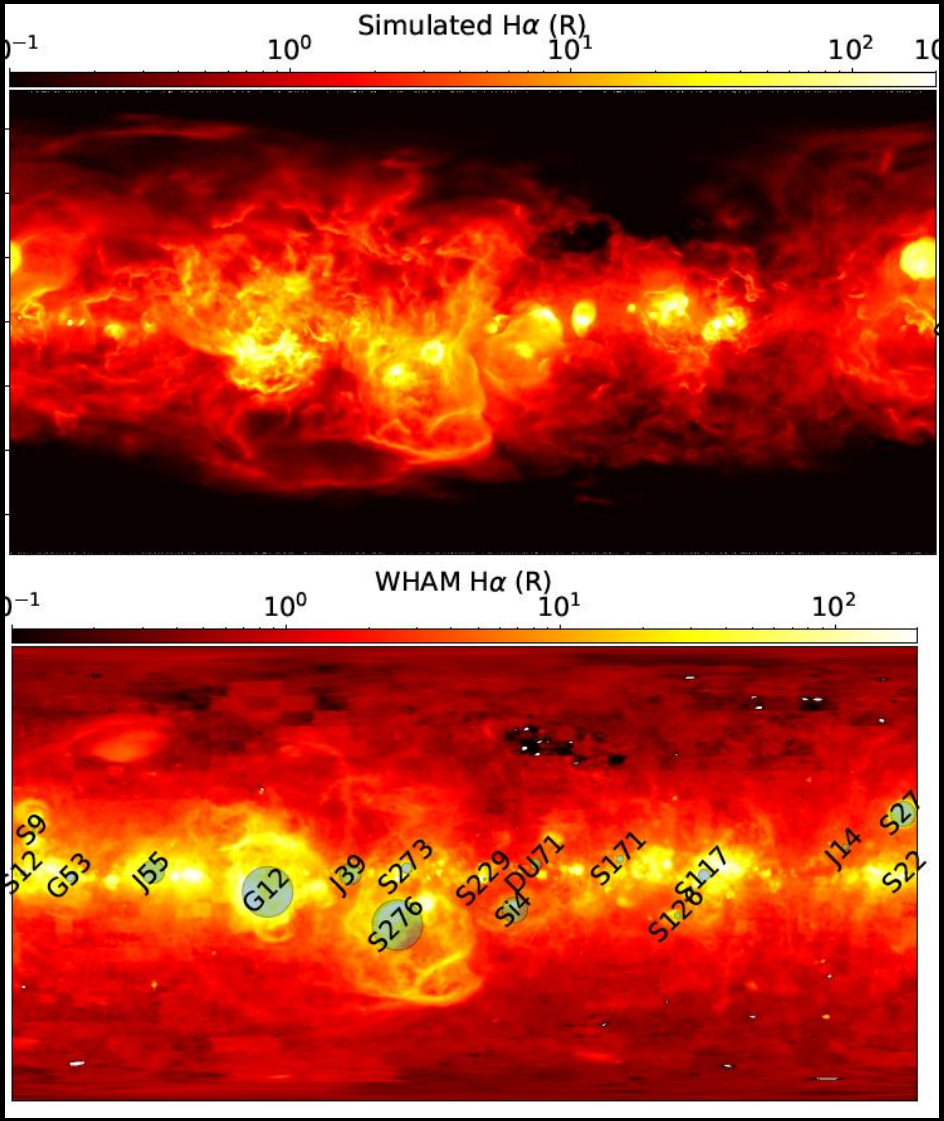

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Let’s take a moment to digest

- Stellar feedback is an essential component in regulating star formation and galaxy evolution
- This inherently becomes a cosmic time issue
- To understand the interdependence of the ISM conditions and feedback we must know about the **stars**
- Stars & star clusters in the early Universe are unresolved

Today's program

1. Stellar feedback: a bit of background
2. What have we learned from resolved feedback studies so far?
3. Can we learn something about the early Universe from local studies?
4. Stellar population synthesis & the IMF
5. Connecting the local to the distant Universe

Can we learn something (about the high-z Universe) from resolved massive stars (clusters) in the nearby Universe?

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→ use **local analogs** of high-z galaxies

Do local analogs of high-z galaxies exist?

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Properties change as a function of redshift, for example:

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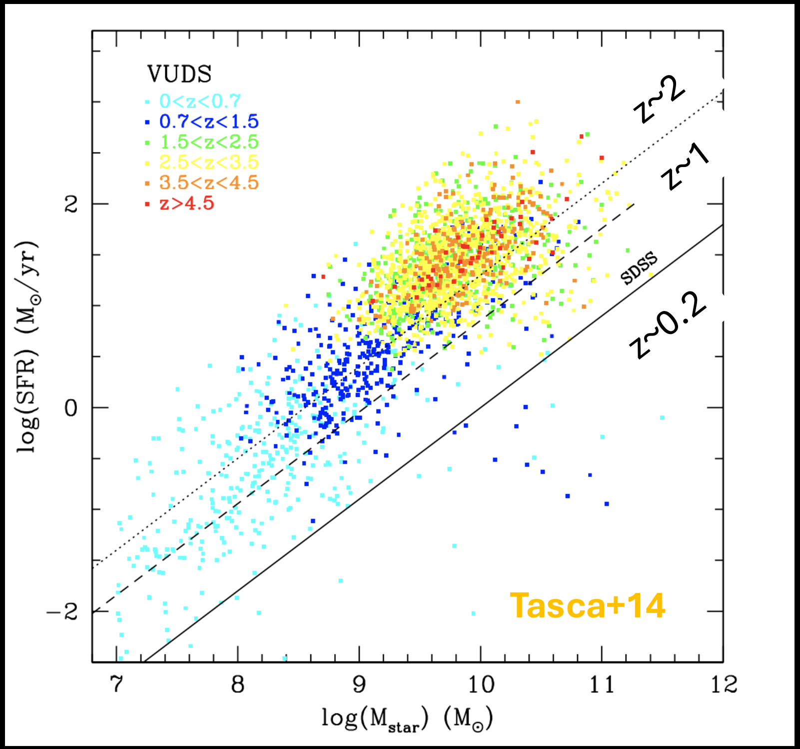
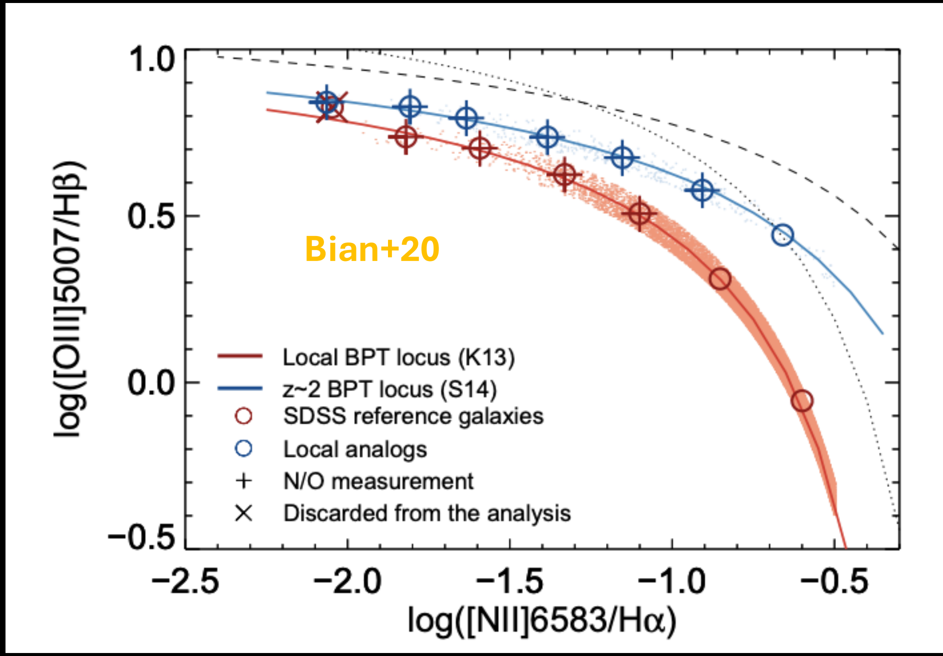


z-evolution of SFR – stellar mass relation



z-evolution of BPT loci

Do local analogs of high-z galaxies exist?

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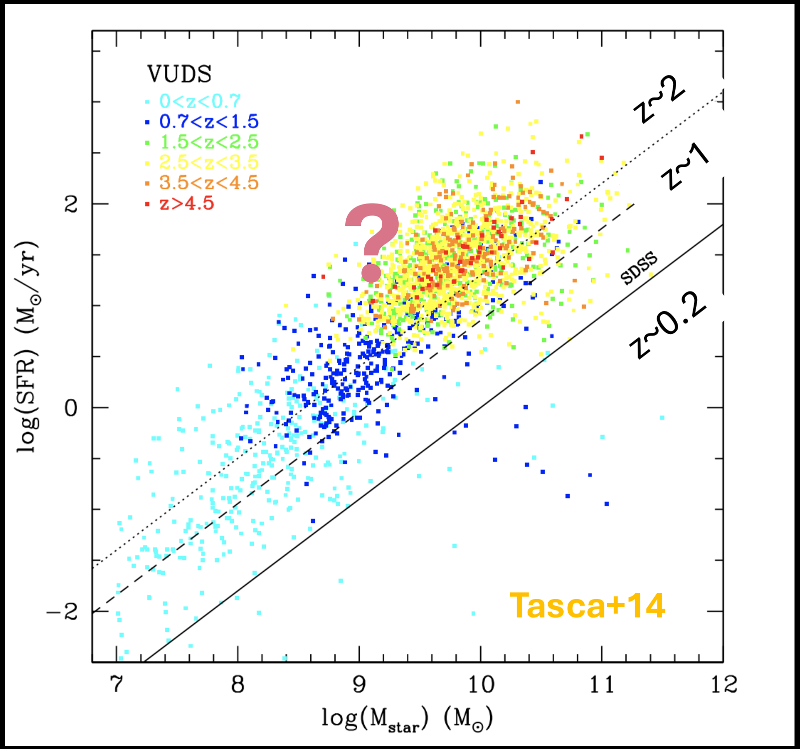

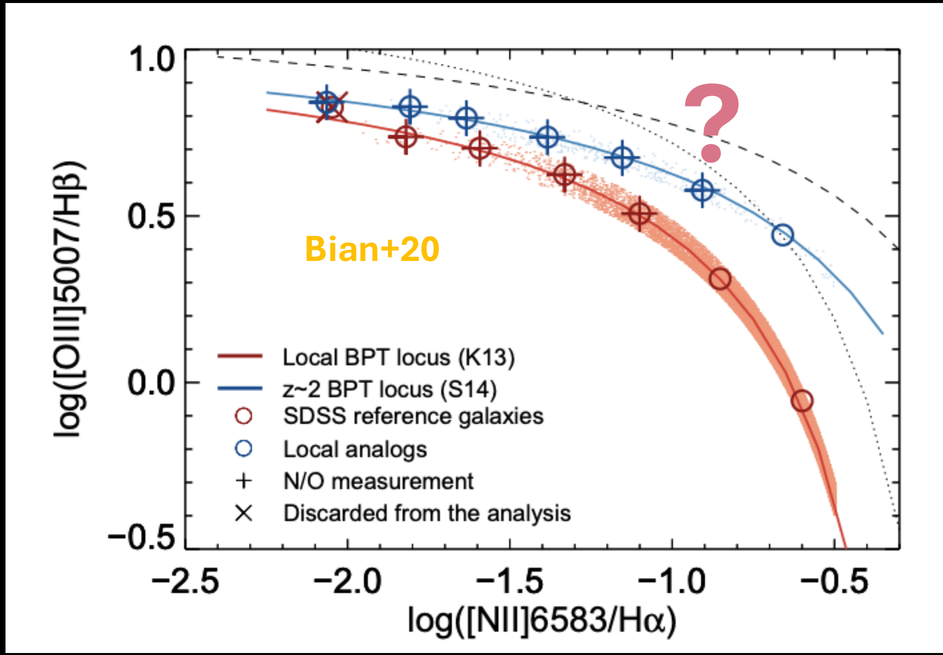

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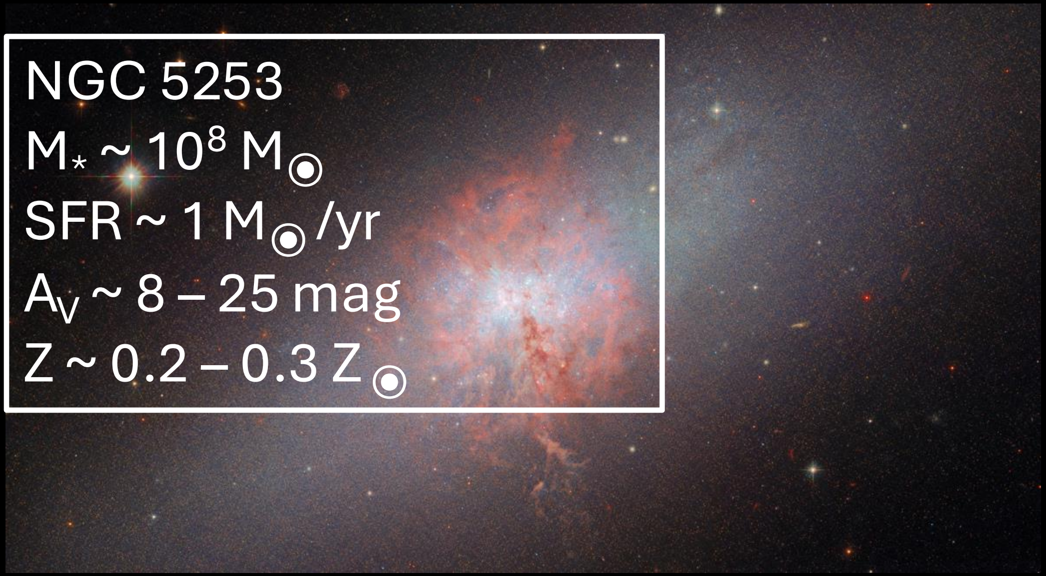

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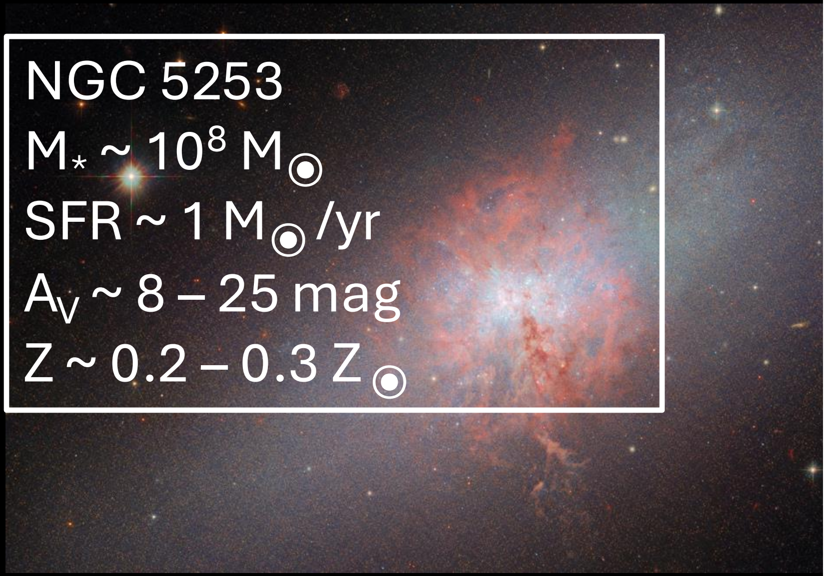

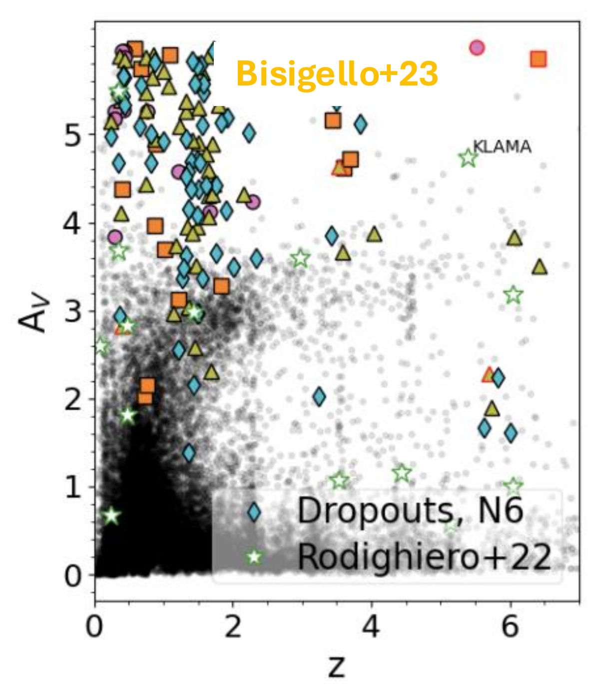

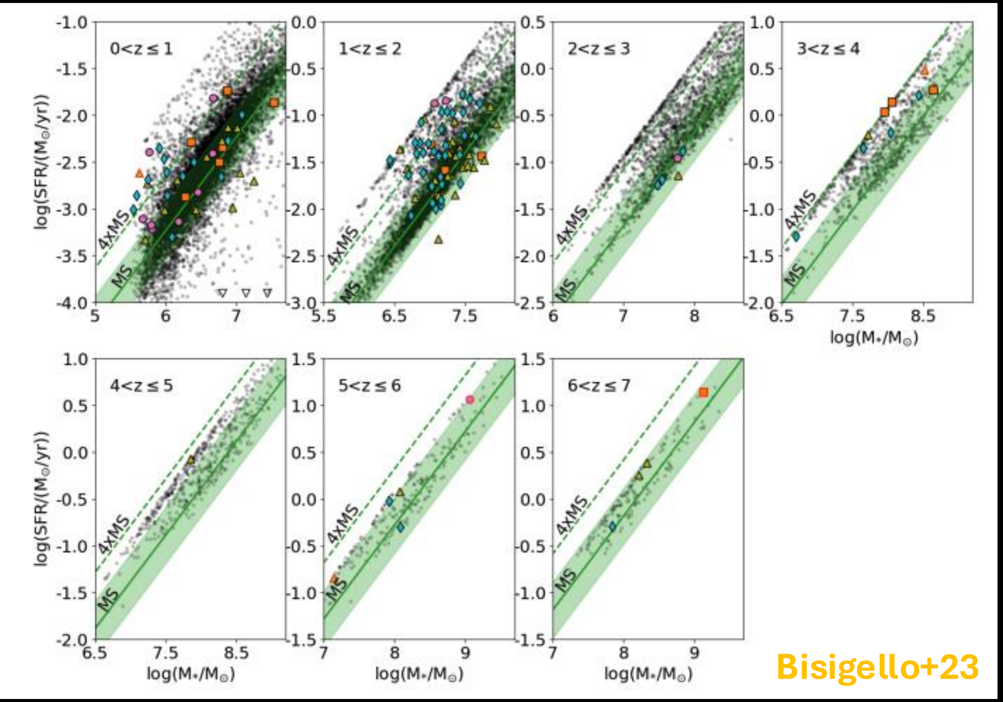

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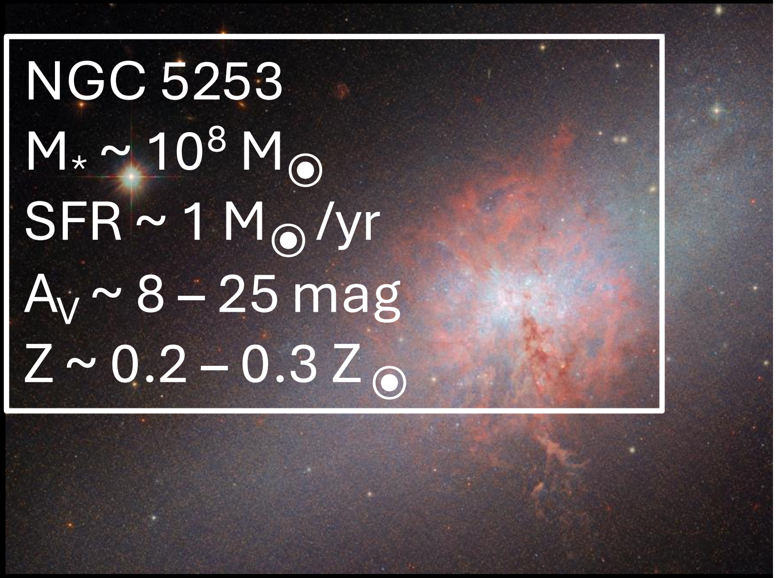
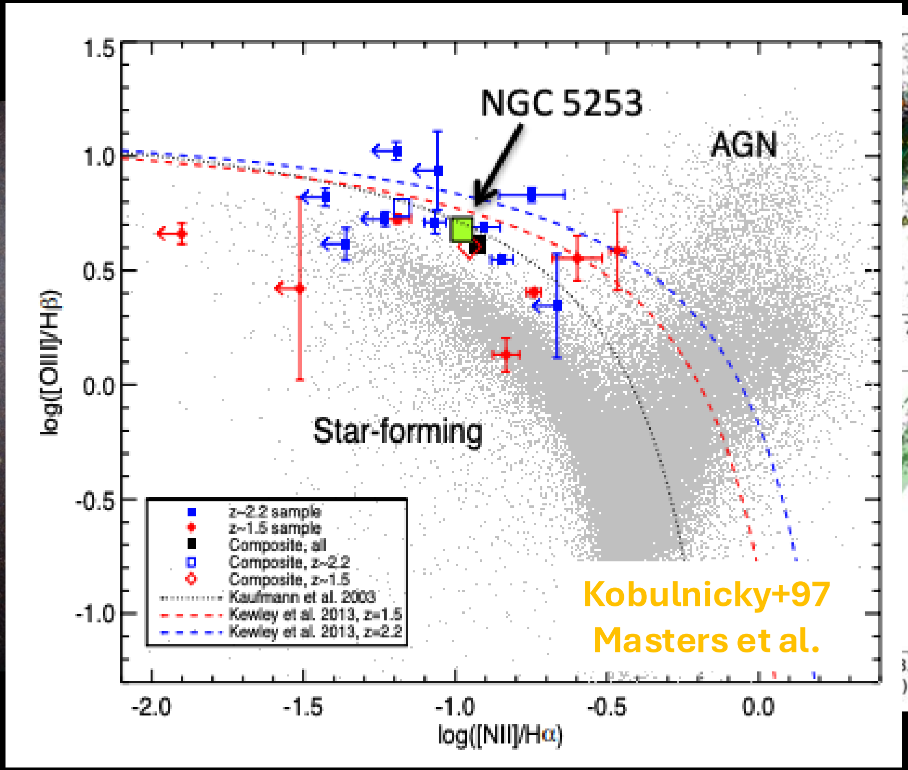
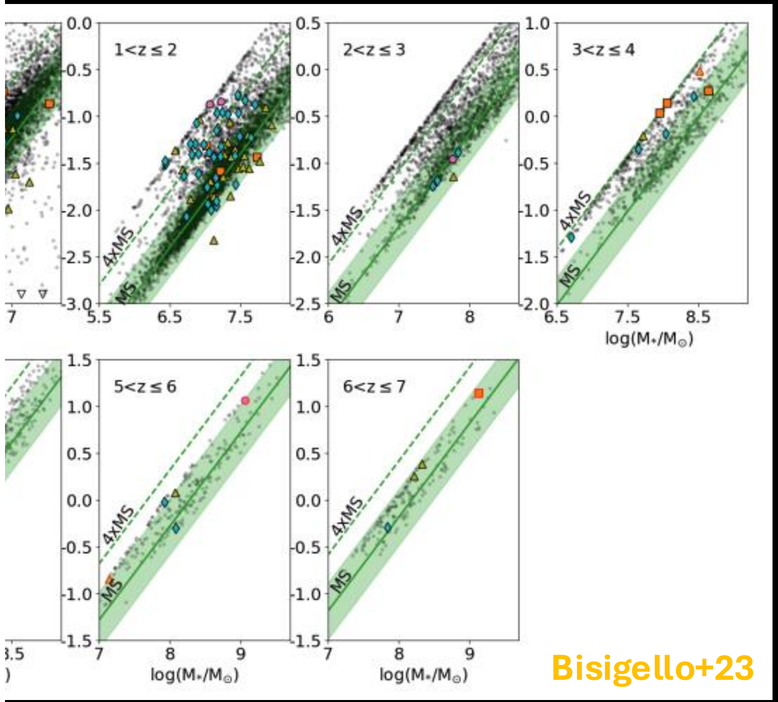


NGC 5253
$M_* \sim 10^8\ M_\odot$
$SFR \sim 1\ M_\odot/yr$
$A_V \sim 8 - 25$ mag
$Z \sim 0.2 - 0.3\ Z_\odot$





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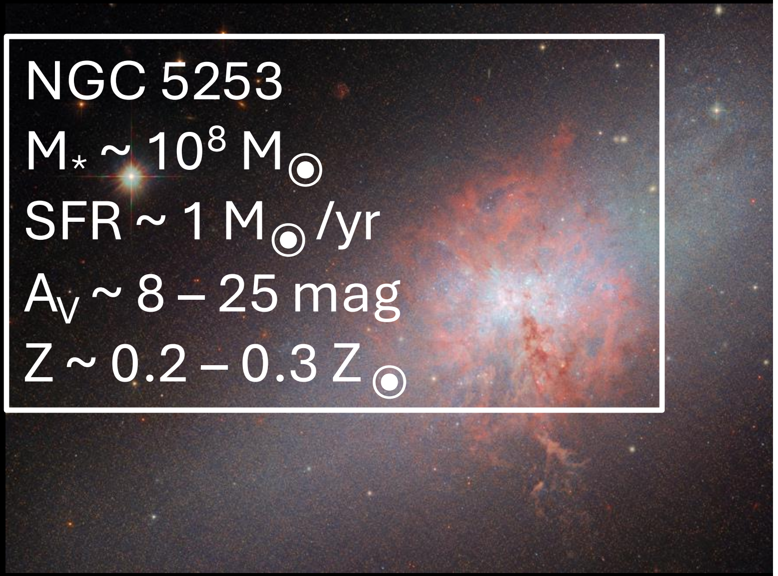

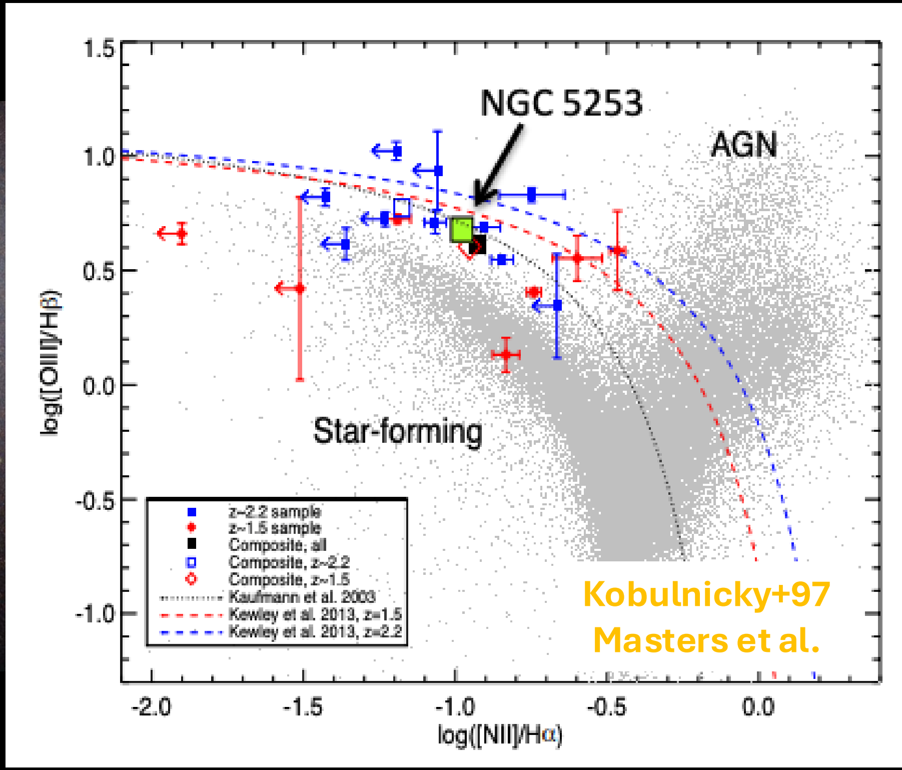

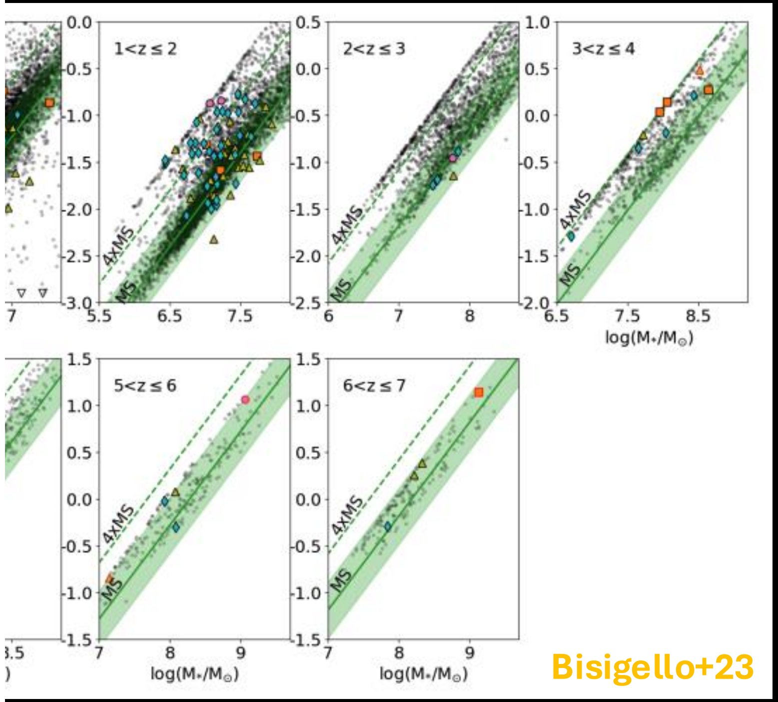

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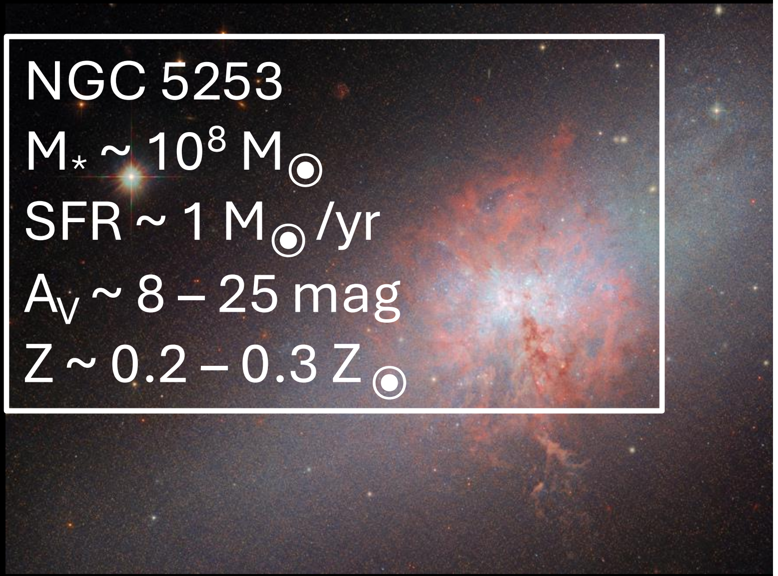

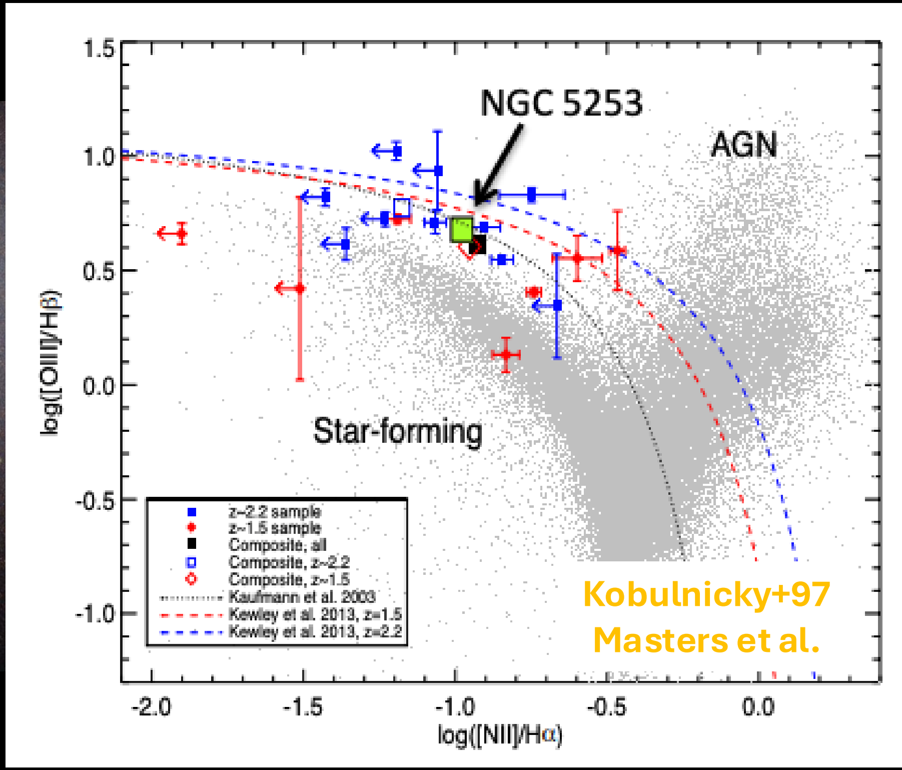

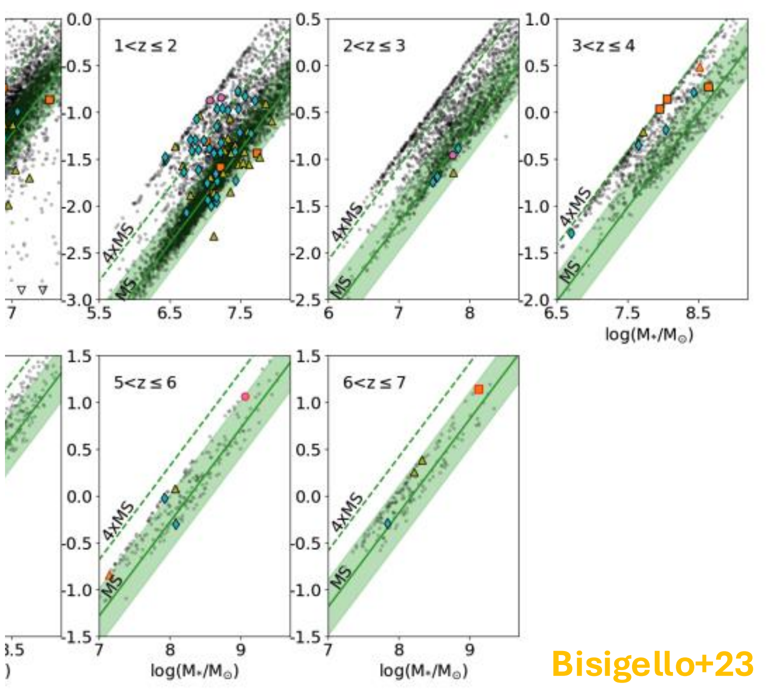

Maybe they do, but:

- Local analogs typically have higher metallicities

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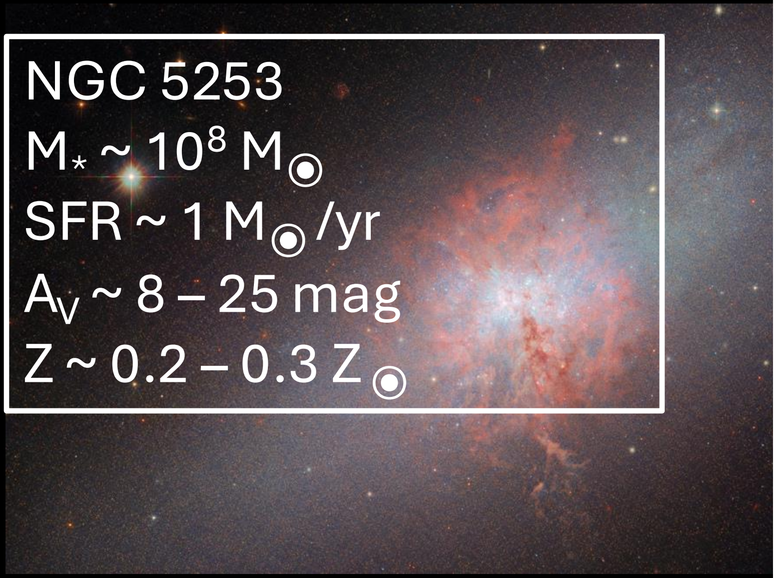

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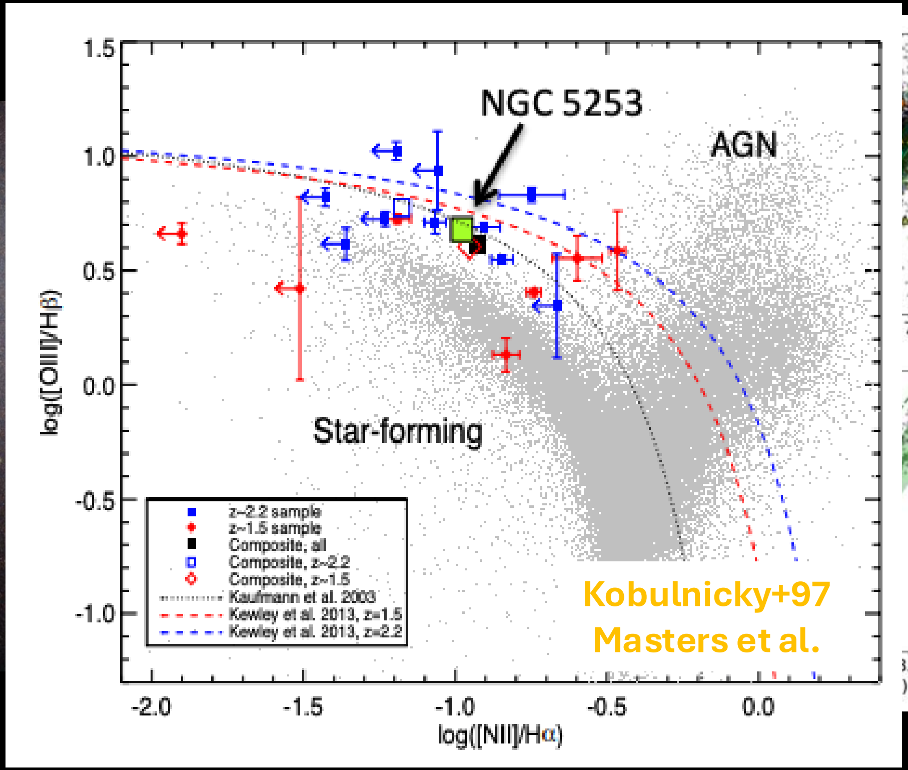
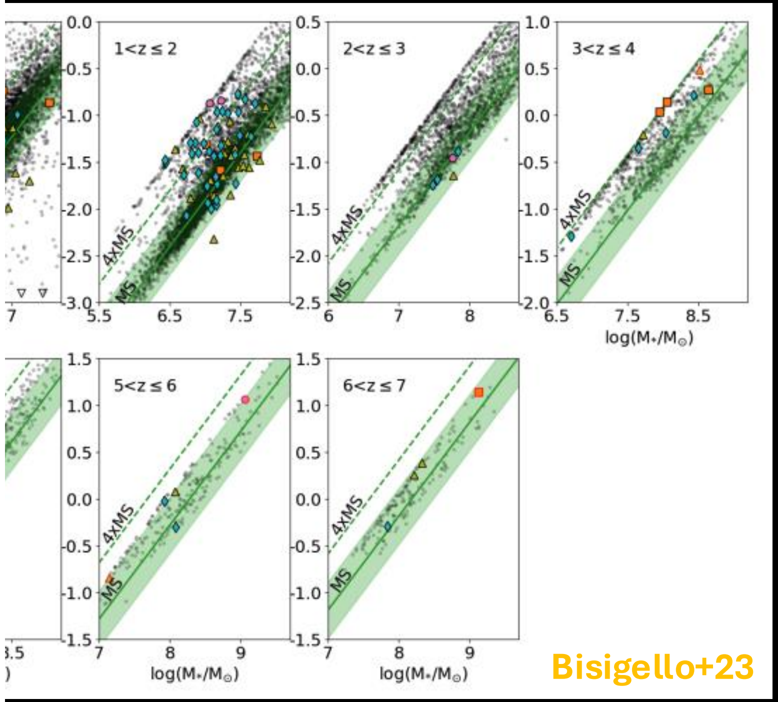




Maybe they do, but:

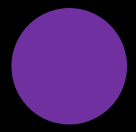
- Local analogs typically have higher metallicities
- Other factors to consider
  - E.g., uncertainty of escape fraction evolution with redshift
  - E.g., dynamical states might have been different at high z

Assuming local analogs exist

Assuming local analogs exist

Age
Metallicity
SFR
SFH
Escape fractions
IMF properties

Assuming local analogs exist



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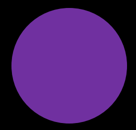

Age
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Stellar pop synthesis models →

Age
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Today's program

1. Stellar feedback: a bit of background
2. What have we learned from resolved feedback studies so far?
3. Can we learn something about the early Universe from local studies?
4. Stellar population synthesis & the IMF
5. Connecting the local to the distant Universe

Stellar population synthesis and the IMF

Curtesy of Elizabeth Stanway (U Warwick)

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Prediction of integrated light (color, spectrum, luminosity) of a stellar population (cluster, galaxy)

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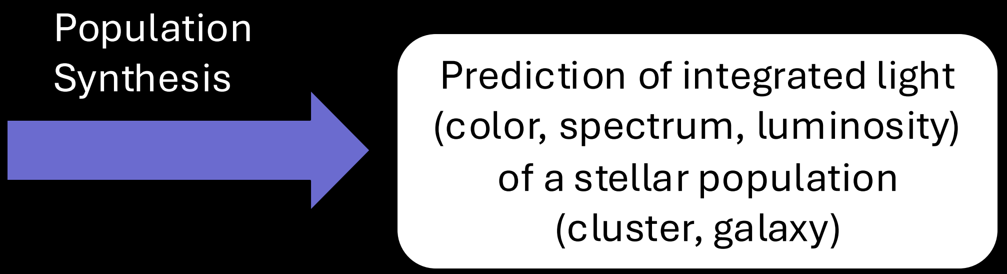

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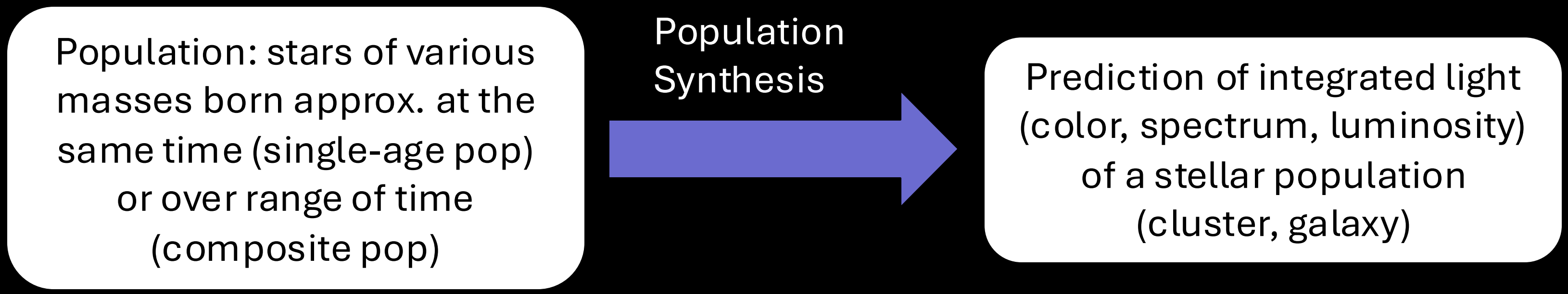

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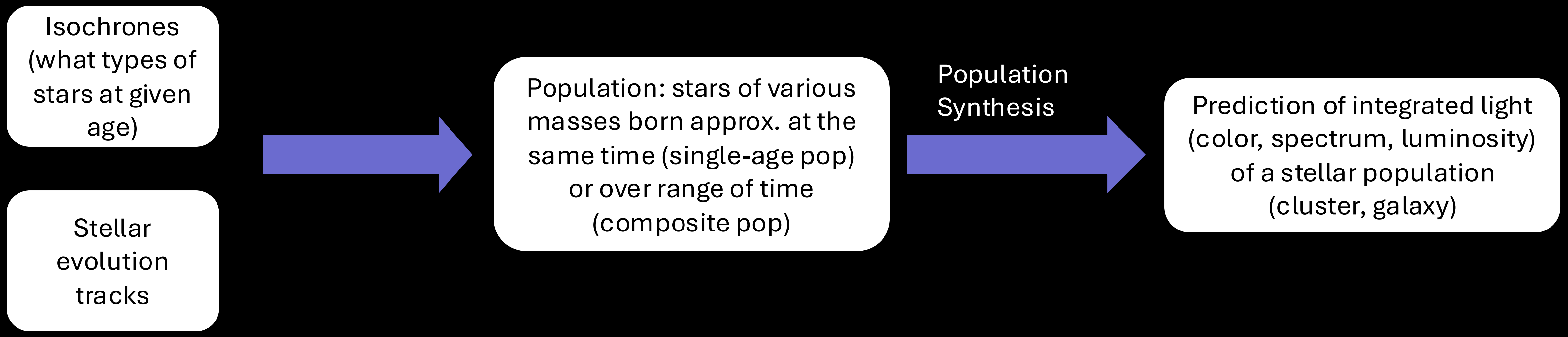


Stellar evolution tracks (isochrones)
Sun-like stars
Massive stars
Post-Main Sequence
Stellar remnants


Stellar evolution tracks (isochrones)
Initial Mass Function
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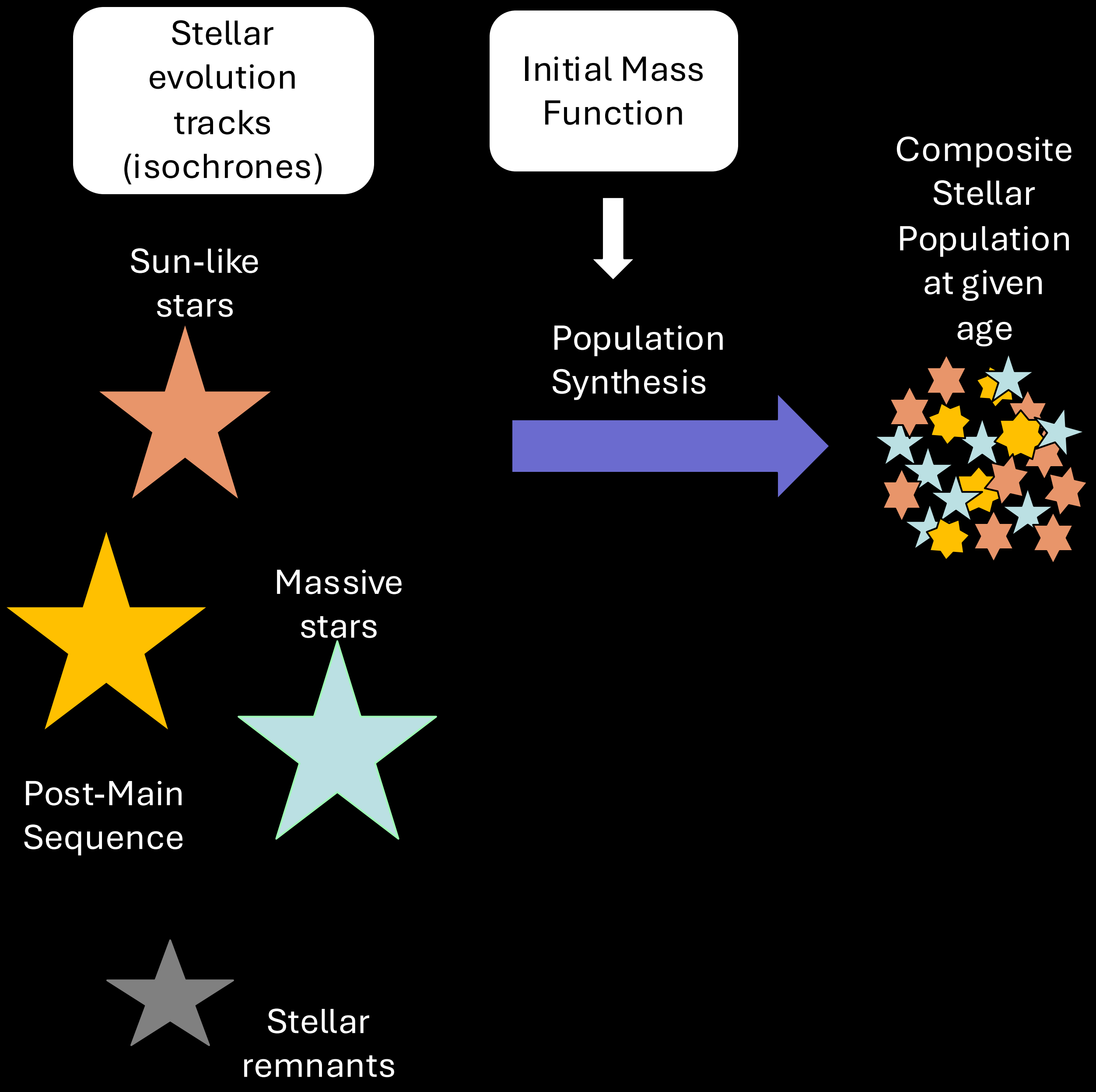

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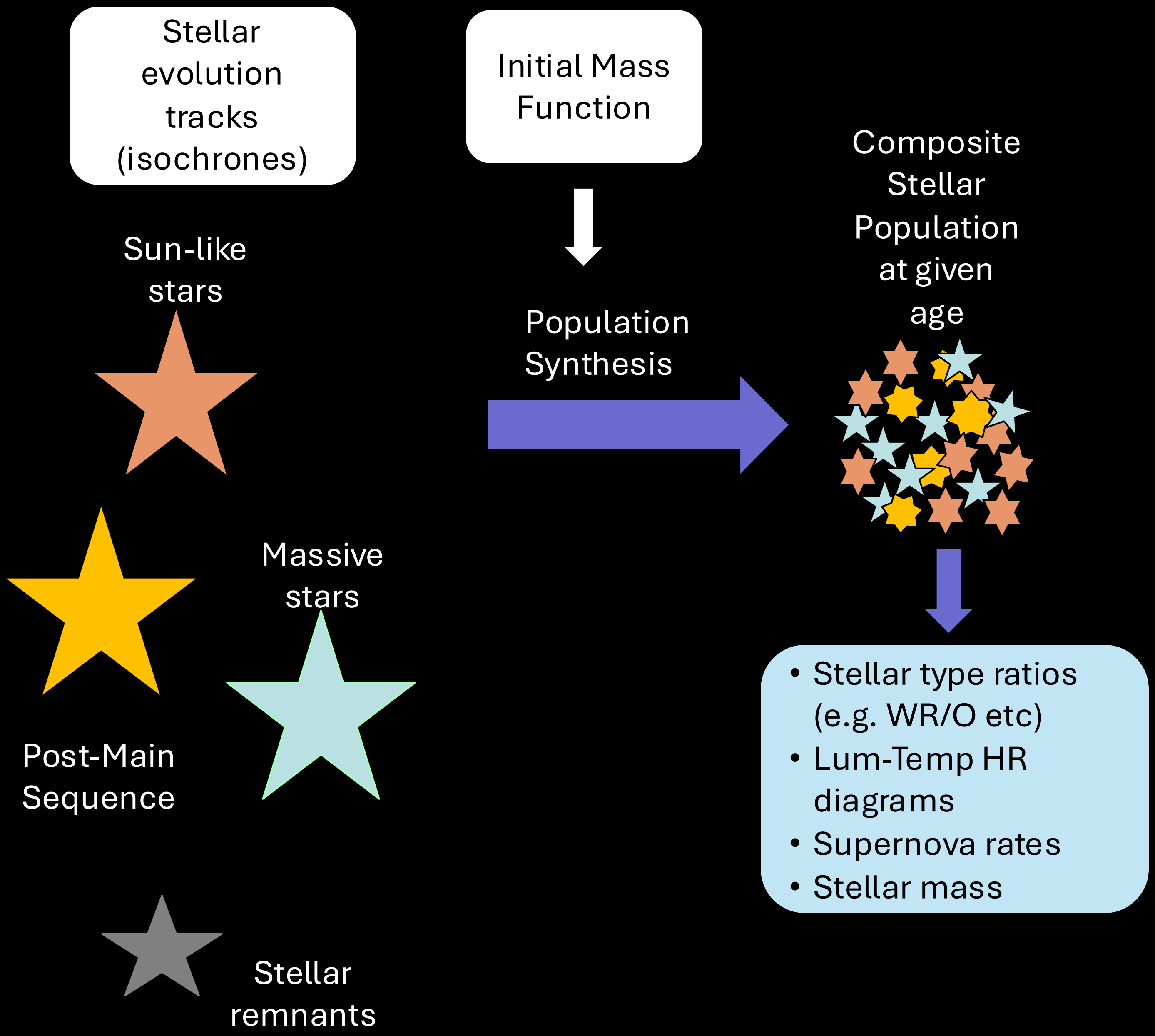
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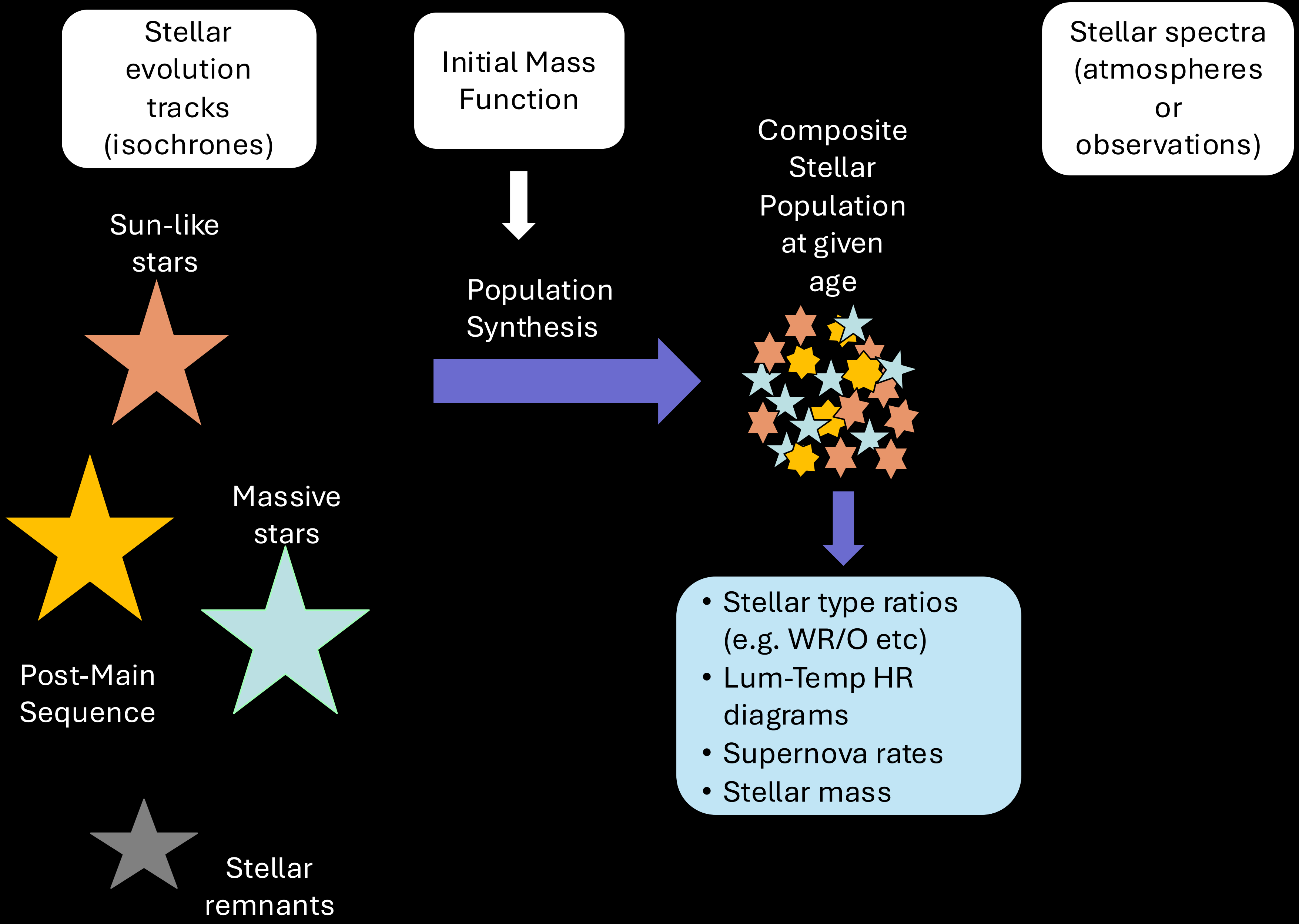
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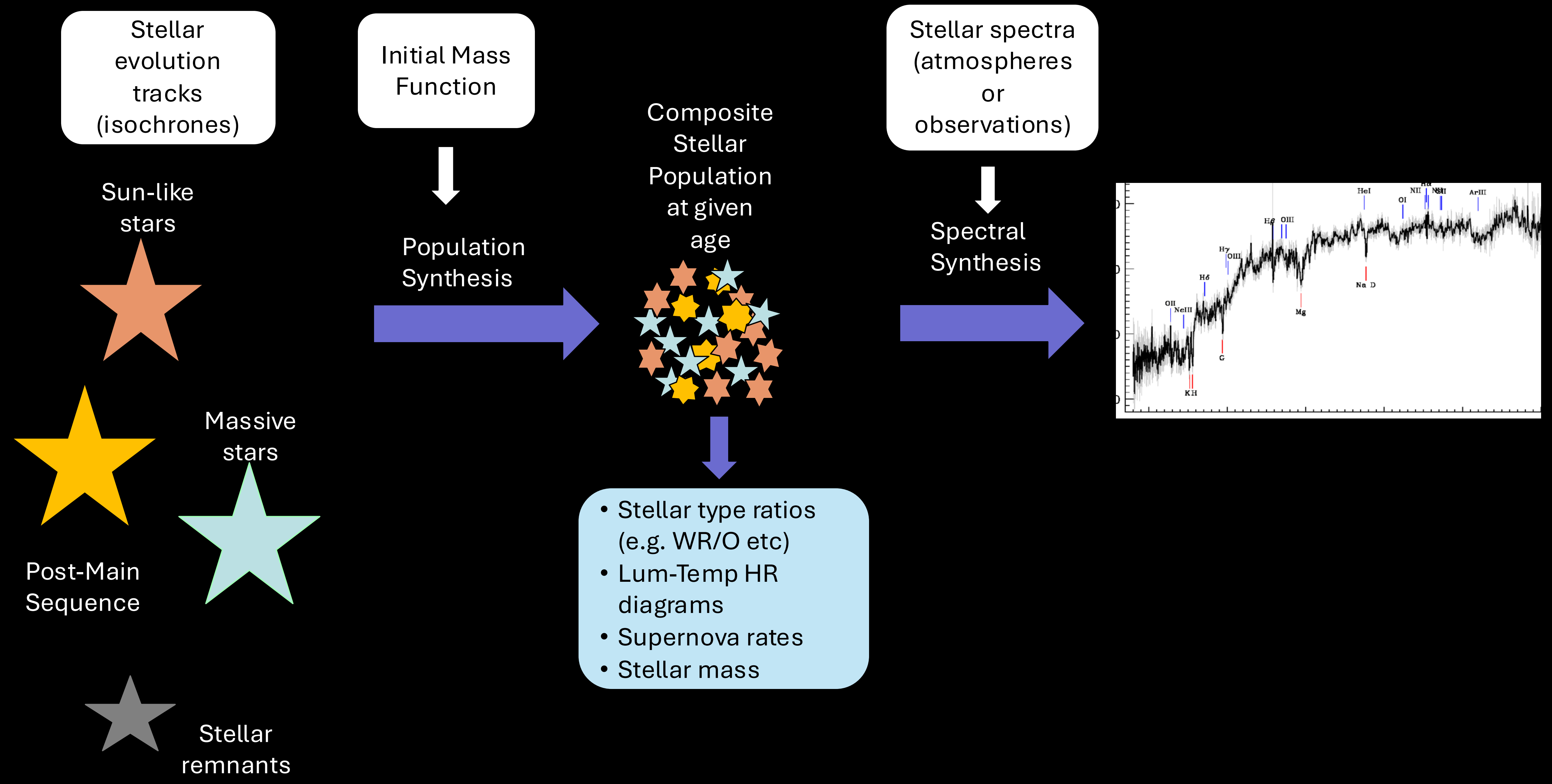

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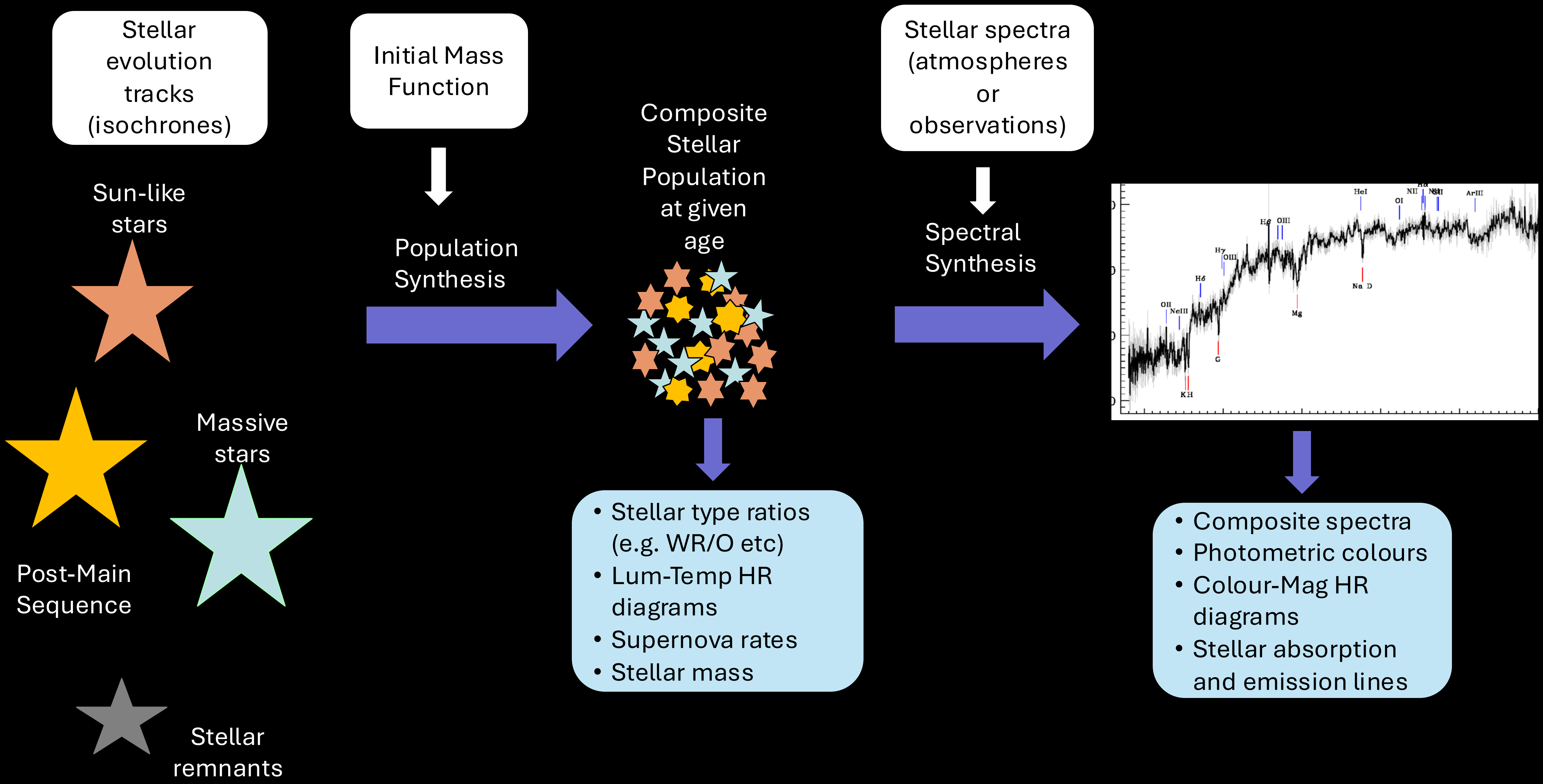
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Beatrice Tinsley

The concept of SPS codes can be traced back to New Zealand/American astrophysicist **Beatrice M Tinsley**.

1967 – PhD Thesis: Evolution of Galaxies and its Significance for Cosmology

EVOLUTION OF THE STARS AND GAS IN GALAXIES

BEATRICE M. TINSLEY
The University of Texas

Received March 2, 1967; revised June 12, 1967

ABSTRACT

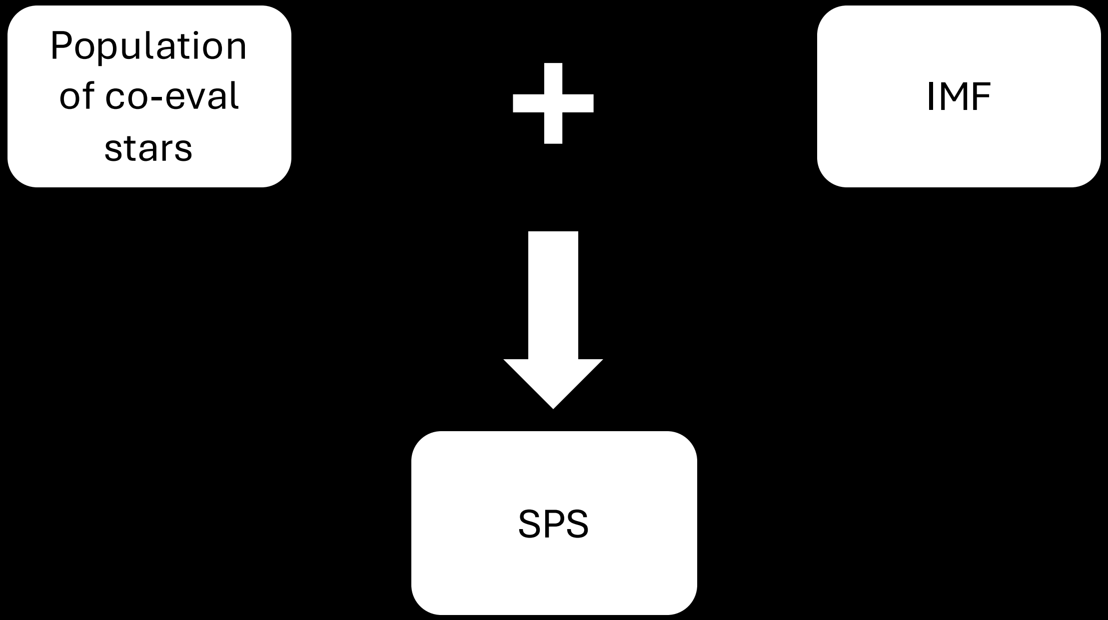
A numerical computation of evolution starts from gas with Population I composition; then stars are formed at all times, at rates which are functions of stellar mass and mass of gas in the galaxy. Discrete time steps of 10^9 years are used, and 13 stellar masses. The stars are placed on the H-R diagram according to their masses and ages; each star ends as a white dwarf, while its excess mass enriches the interstellar gas. Different evolutionary sequences are constructed by adjusting four parameters of a stellar birth-rate function. Then "galaxies" resulting from each sequence of $10–12 \times 10^9$ years are compared with observed local galaxies with respect to colors, mass-to-light ratio, relative mass of gas, and types of stars contributing to the light.

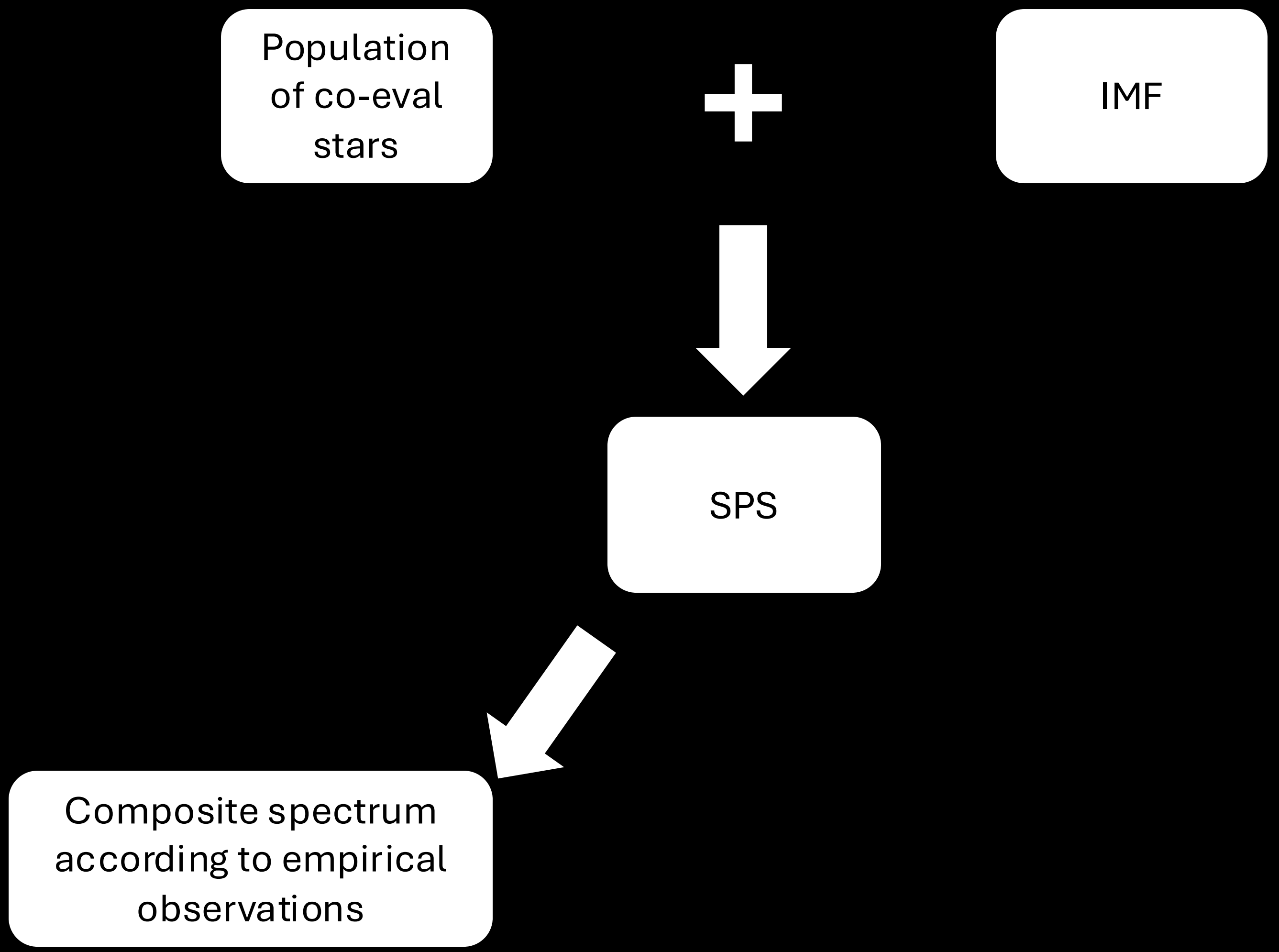
"Galaxies" closely resembling all normal types, Im to E, can be formed with a stellar birth rate proportional to the inverse square of stellar mass and to the mass of gas in the galaxy; the types differ in initial rate of gas consumption and in the birth rate of very low-mass stars. These types can all have the same age, and do not form an evolutionary sequence.

It is shown that giant elliptical galaxies may have been so much brighter at short wavelengths a few billion years ago that the observed magnitude-redshift relation can be interpreted in terms of cosmological models that do not suffer from the high density and small age of the conventionally preferred model.

ApJ, 151, 547 (1968)

Image source: wikimedia


Population of co-eval stars
IMF
SPS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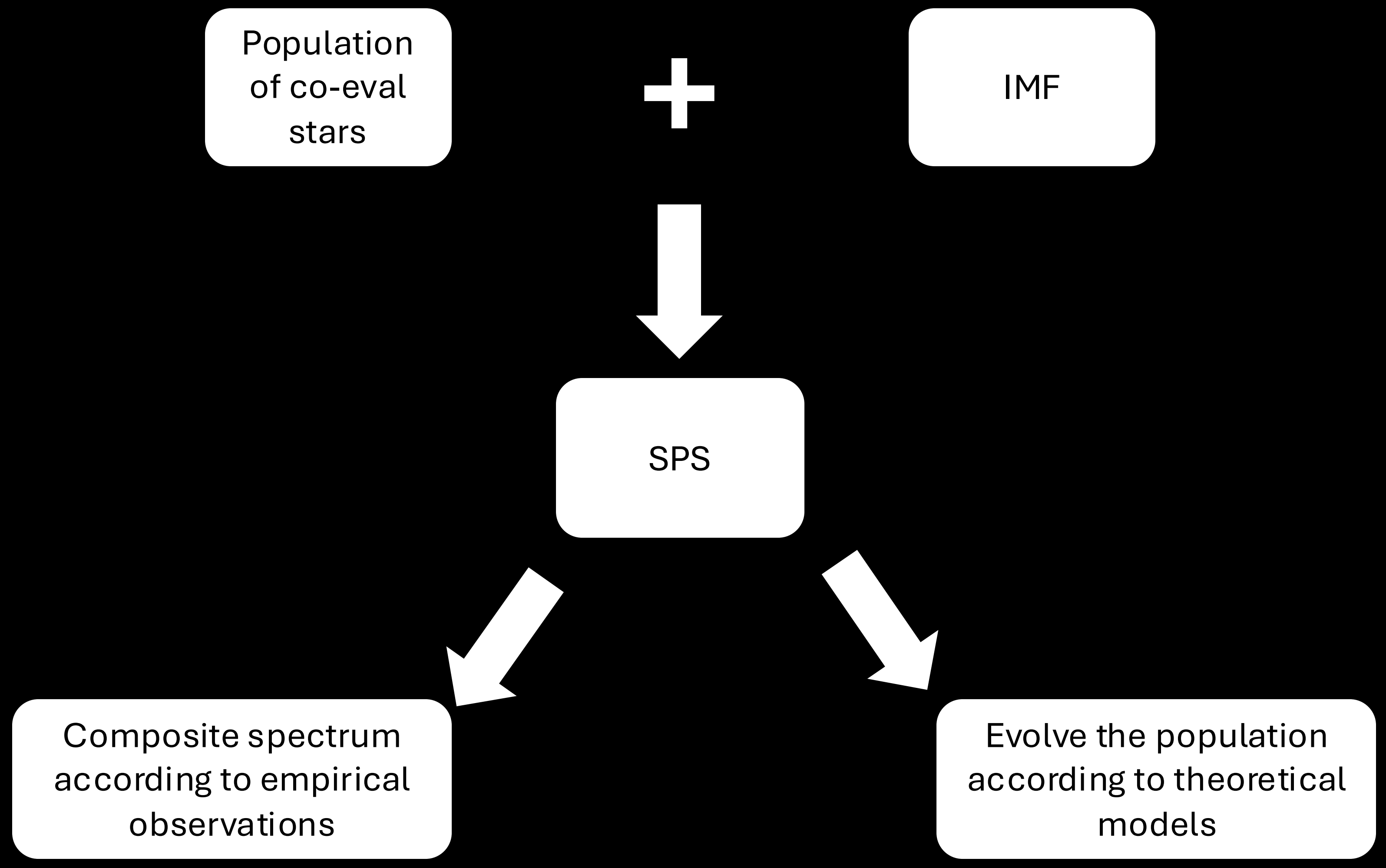
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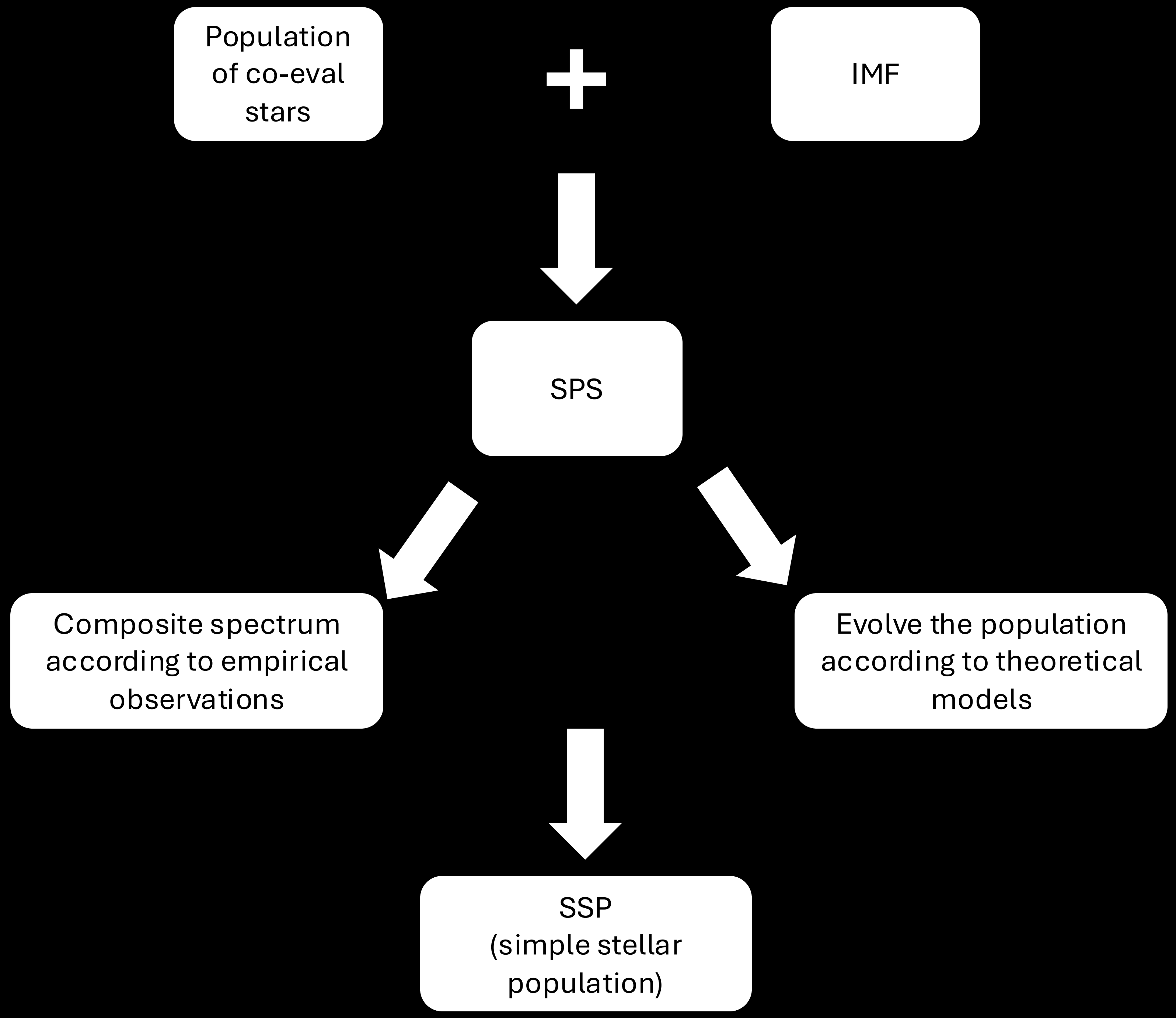
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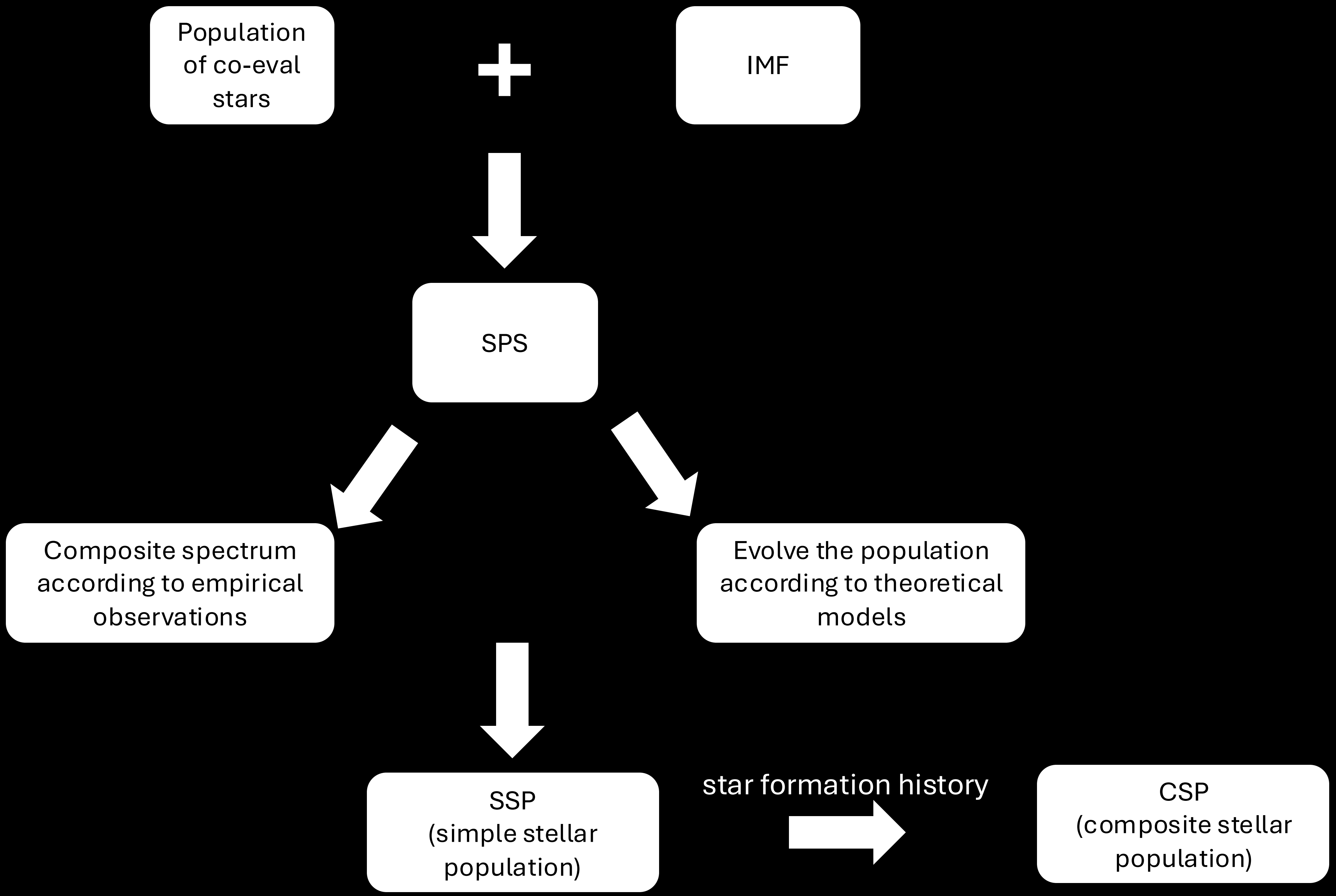
Population of co-eval stars
+
IMF
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Evolve the population according to theoretical models
SSP (simple stellar population)
star formation history
CSP (composite stellar population)

Full SED modeling

Combining SSPs with:

- star formation history
- metallicity history
- nebular gas
- dust absorption and emission

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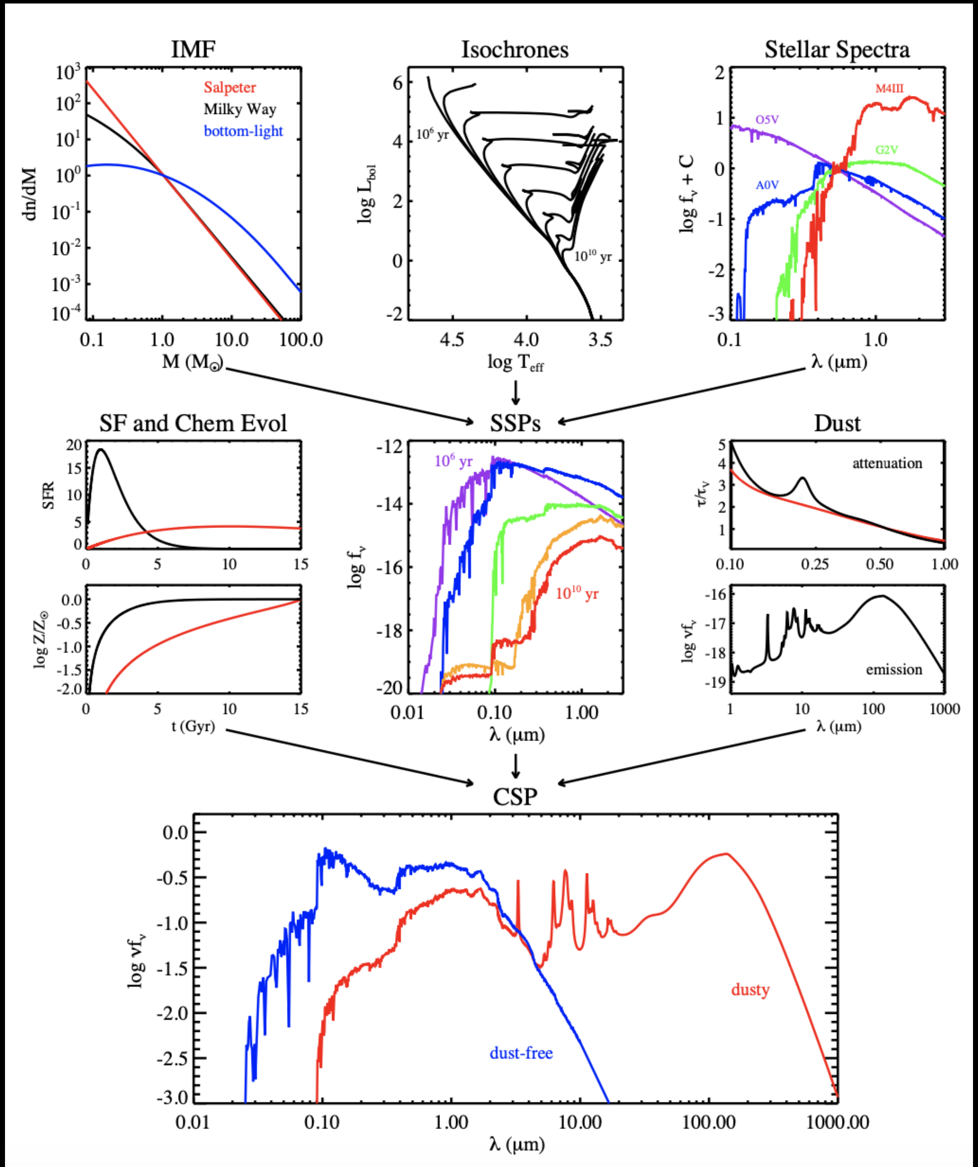

(image: Conroy 2014)

Full SED modeling

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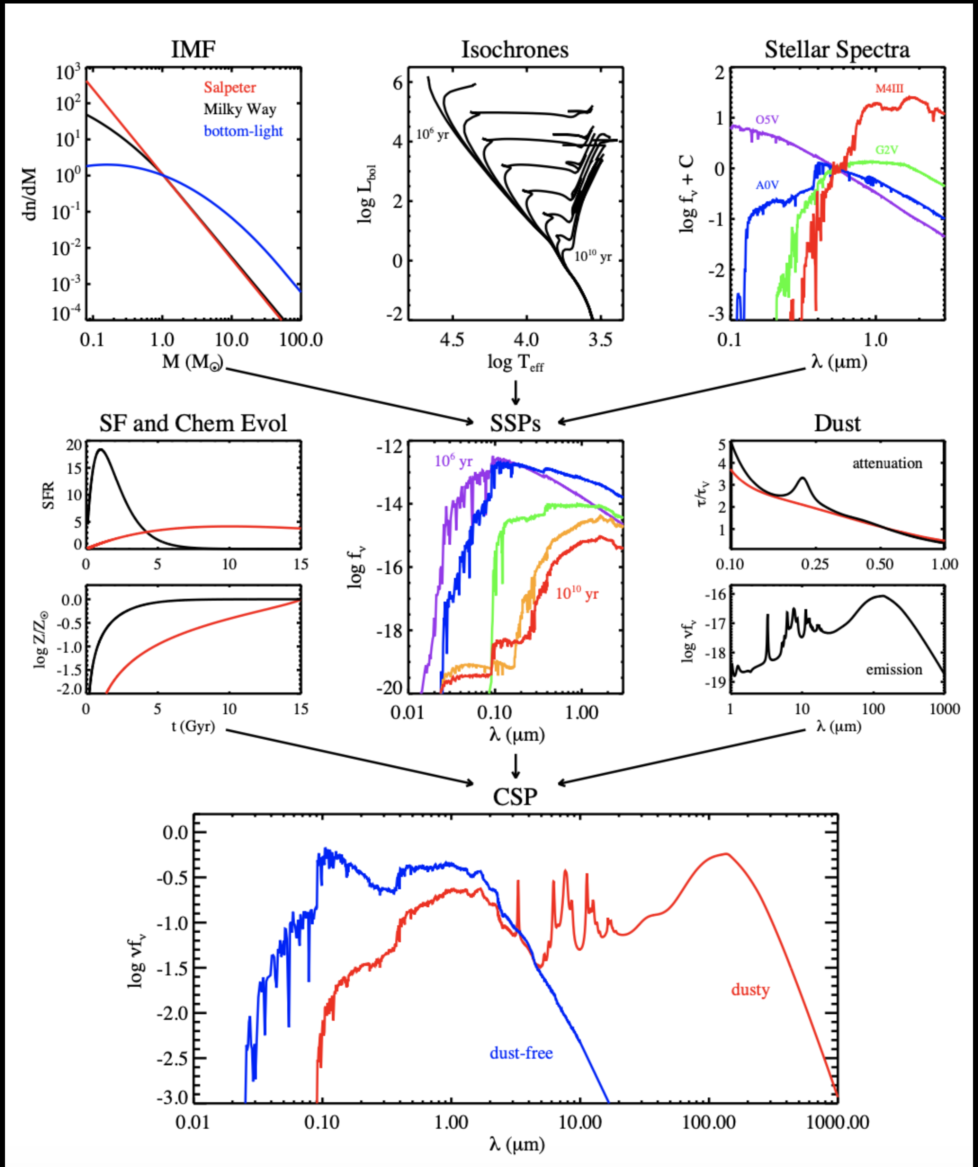
➔ **infer key physical properties () age, star formation rate, metallicity, dust content, and stellar mass of unresolved stellar populations**



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Into the 2000s

Leading evolutionary SPS codes (with spectroscopy) include

- GalaxEv (Bruzual and Charlot 2003, CB16)
- Starburst99 (Leitherer+)
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- the Maraston 2005, 2011 models

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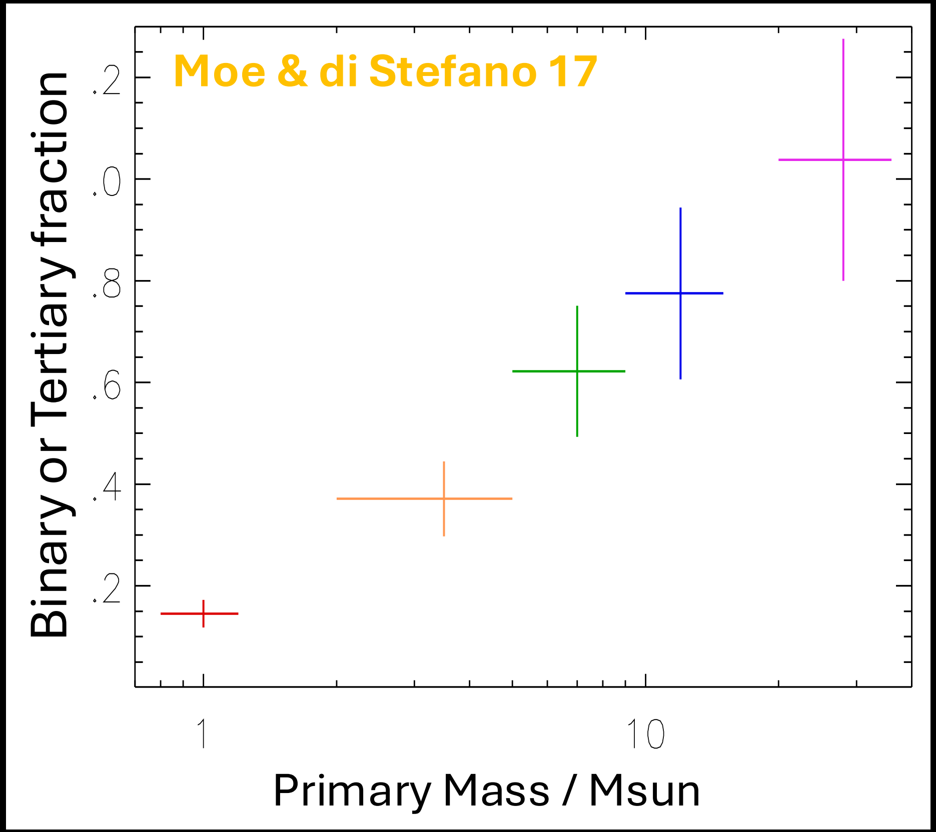
All of these use primarily isolated, **single star evolution**.

Next: 3 key ingredients to SPS models

1. Binaries
2. Nebular gas & dust
3. IMF

Binaries in the Universe



- the fraction of stars in binary systems increases with stellar mass
- binary interactions (mass transfer, mergers, etc.) affect stellar evolution

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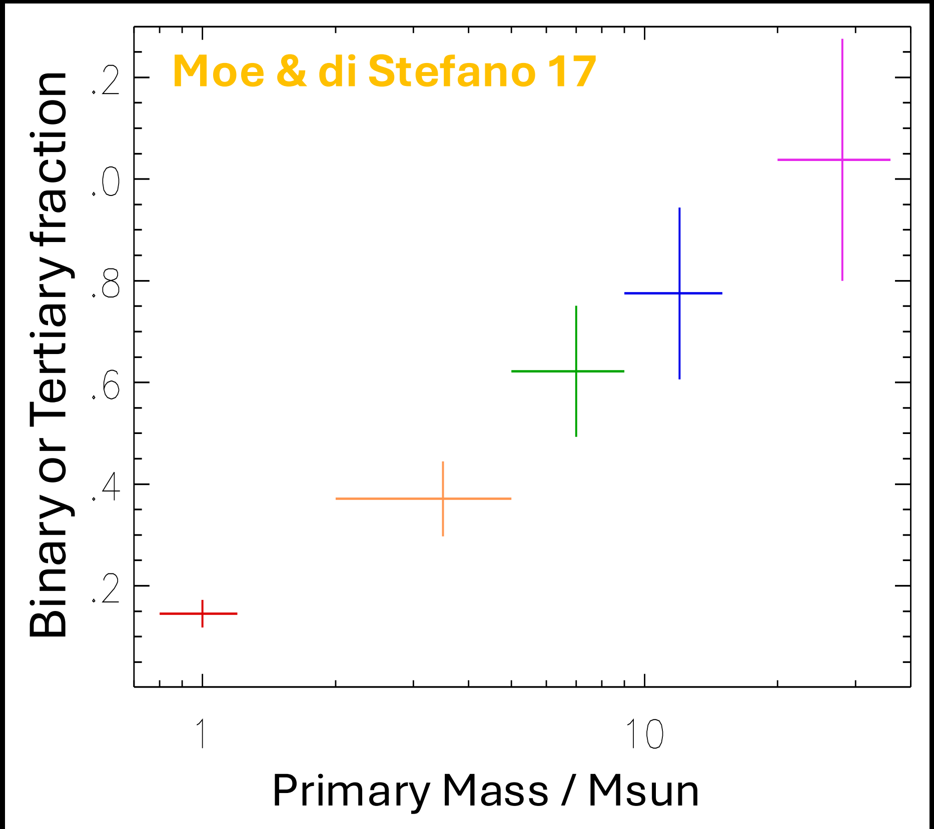

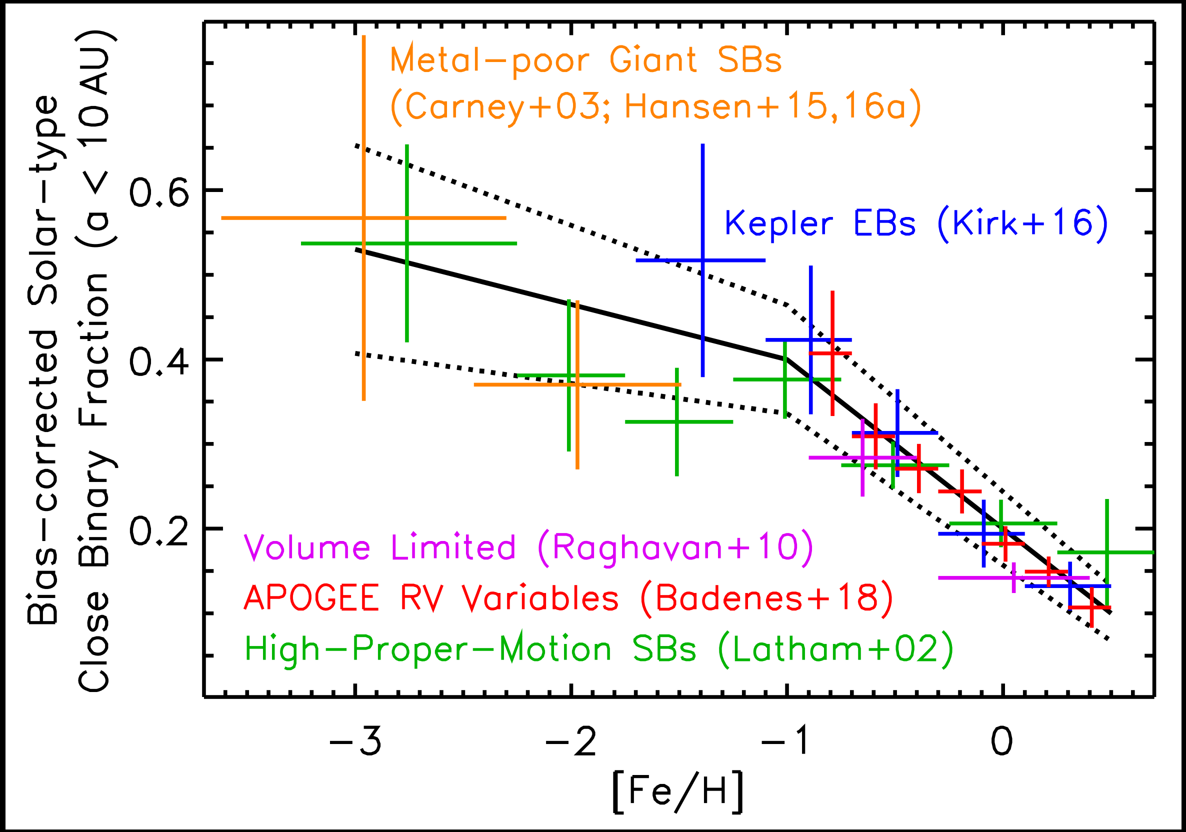

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"The Close Binary Fraction of Solar-type Stars Is Strongly Anticorrelated with Metallicity"

Moe+19

The need for binary models

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➜ We cannot ignore binaries in emission line galaxies

The need for binary models

What this means in practice:

Binary interactions
(mass transfer, common
envelope phases, mergers)

Hotter, more luminous,
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Ages: overestimated
SFR: underestimated
Stellar masses &
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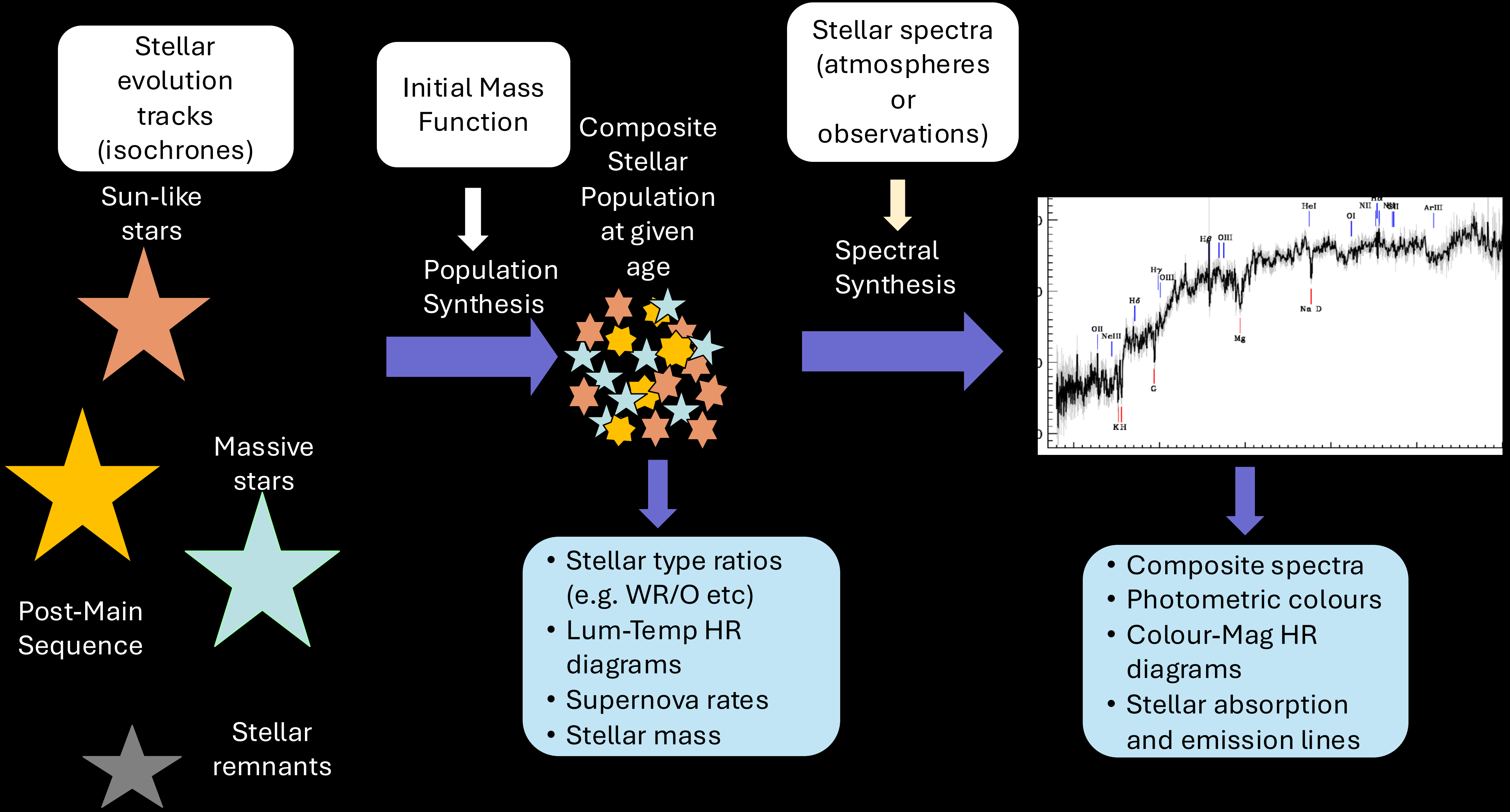
Young, massive stars

Blue part of SED

?

Luminous, older binaries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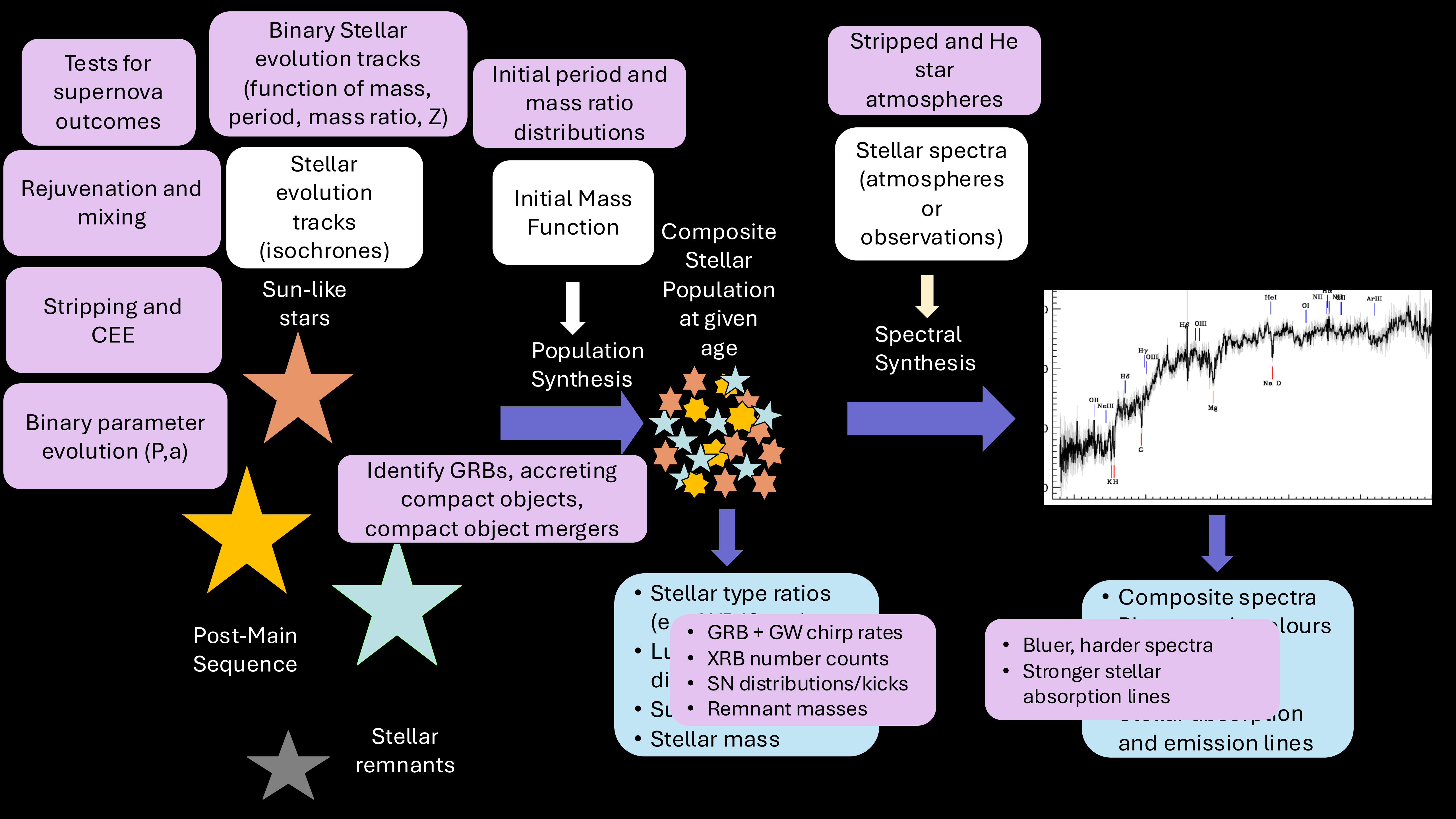
Tests for supernova outcomes
Binary Stellar evolution tracks (function of mass, period, mass ratio, Z)
Initial period and mass ratio distributions
Stripped and He star atmospheres
Rejuvenation and mixing
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Binary parameter evolution (P,a)
Identify GRBs, accreting compact objects, compact object mergers
Post-Main Sequence
Stellar remnants
• Stellar type ratios
• Stellar mass
• GRB + GW chirp rates
• XRB number counts
• SN distributions/kicks
• Remnant masses
• Composite spectra
and emission lines
• Bluer, harder spectra
• Stronger stellar absorption lines

Binary population synthesis

- Binary PopSynth Codes:
  - BSE (Hurley+)
  - StarTrack (Belcyznski+)
  - SEVN (Mapelli+)
  - POSYDON (Fragos+)

- Binary Spectral PopSynth Codes:

Eldridge, Stanway+

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Specialist radiative transfer codes (e.g. Cloudy) must be used

Mass functions

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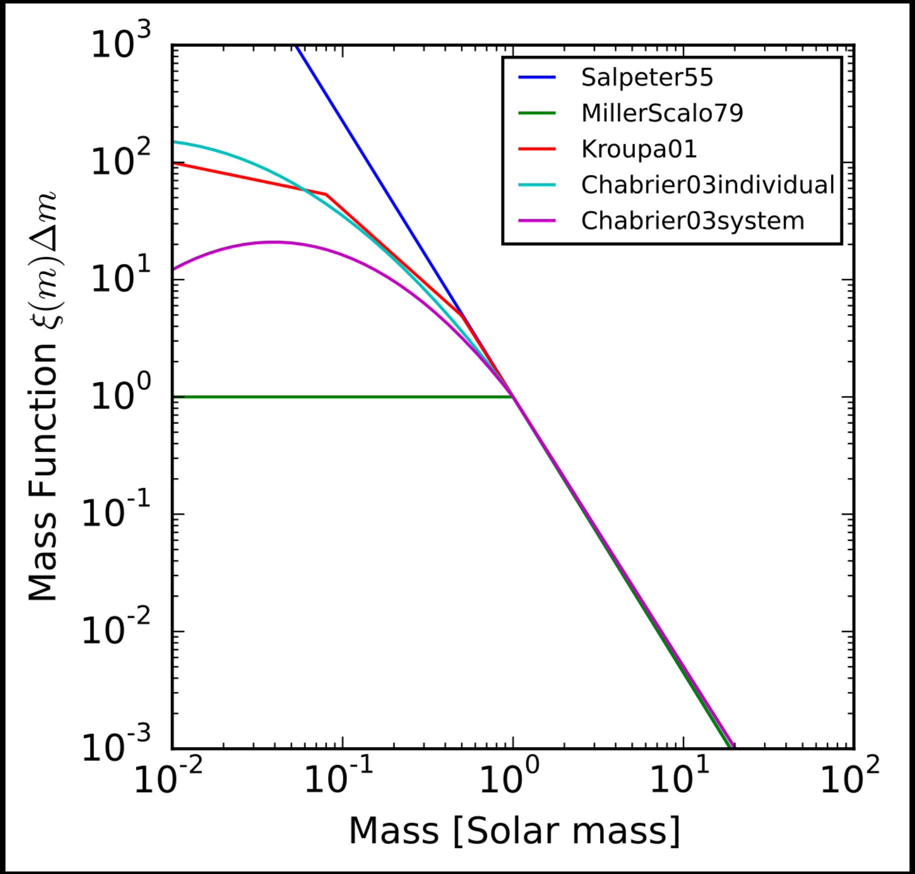
- **Composite IMFs**, e.g. galaxy-wide IMF, Salpeter IMF
  - stellar cluster mass functions + cluster stellar IMFs
  - e.g. IGIMF theory (Kroupa & Weidner 2003)

Initial mass functions

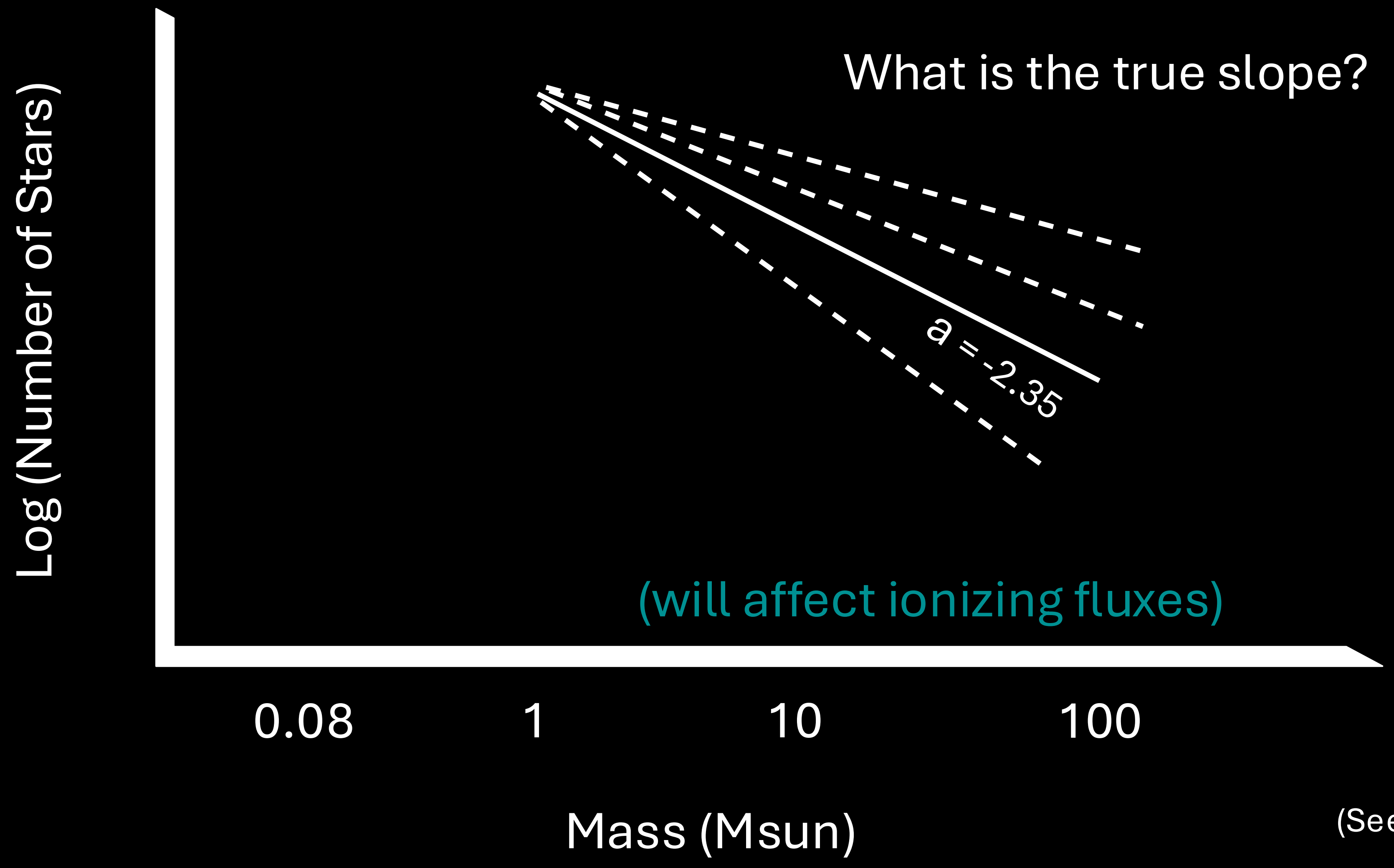
When a starburst occurs, stars of a wide range of masses are formed.



We now know that the Salpeter law (single powerlaw) overpredicts the number of low mass stars and needs a cut-off (e.g. Chabrier 2003, Kroupa 2001)

(See e.g. Hopkins, Dawes Review, 2018)

Initial mass functions



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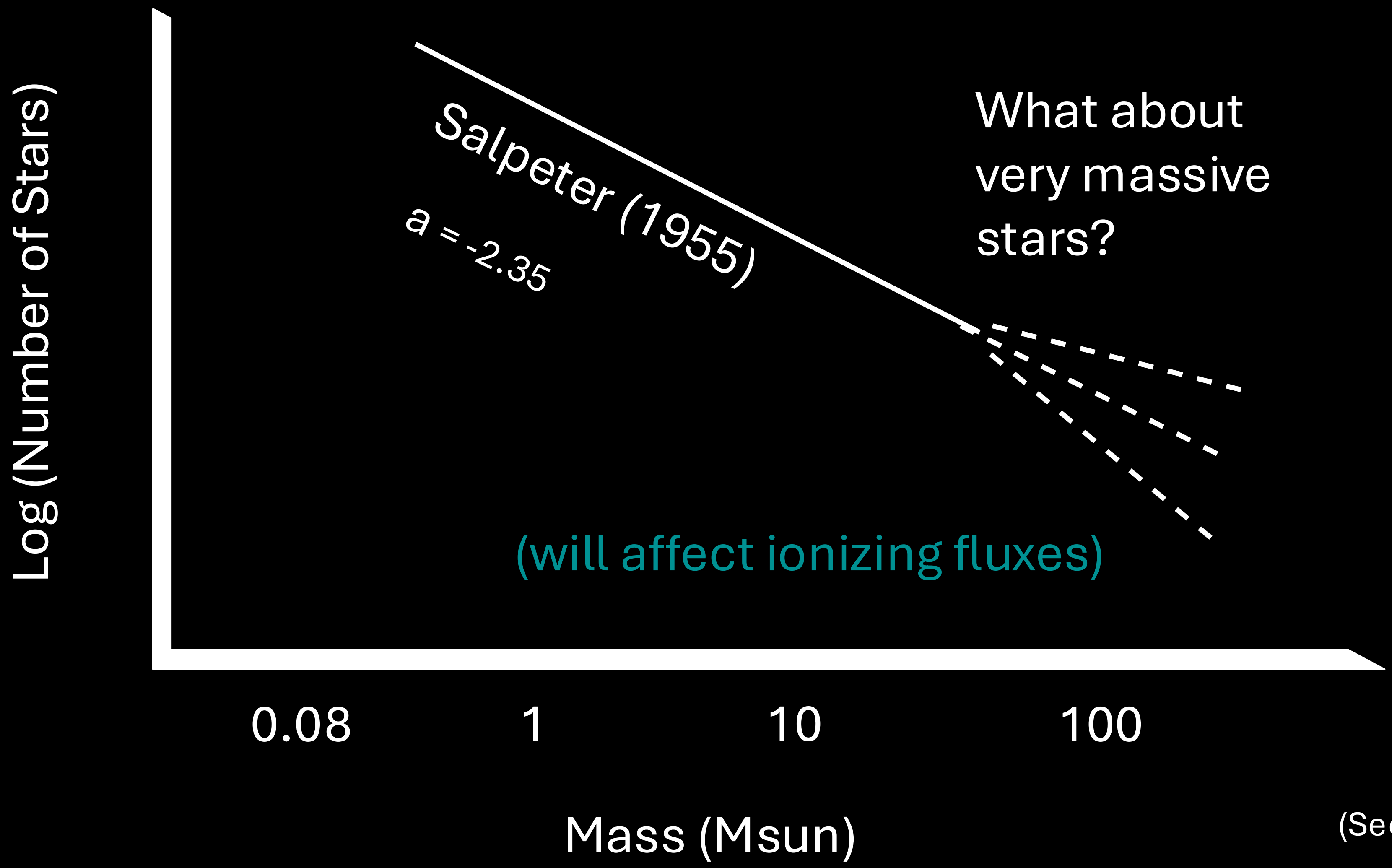

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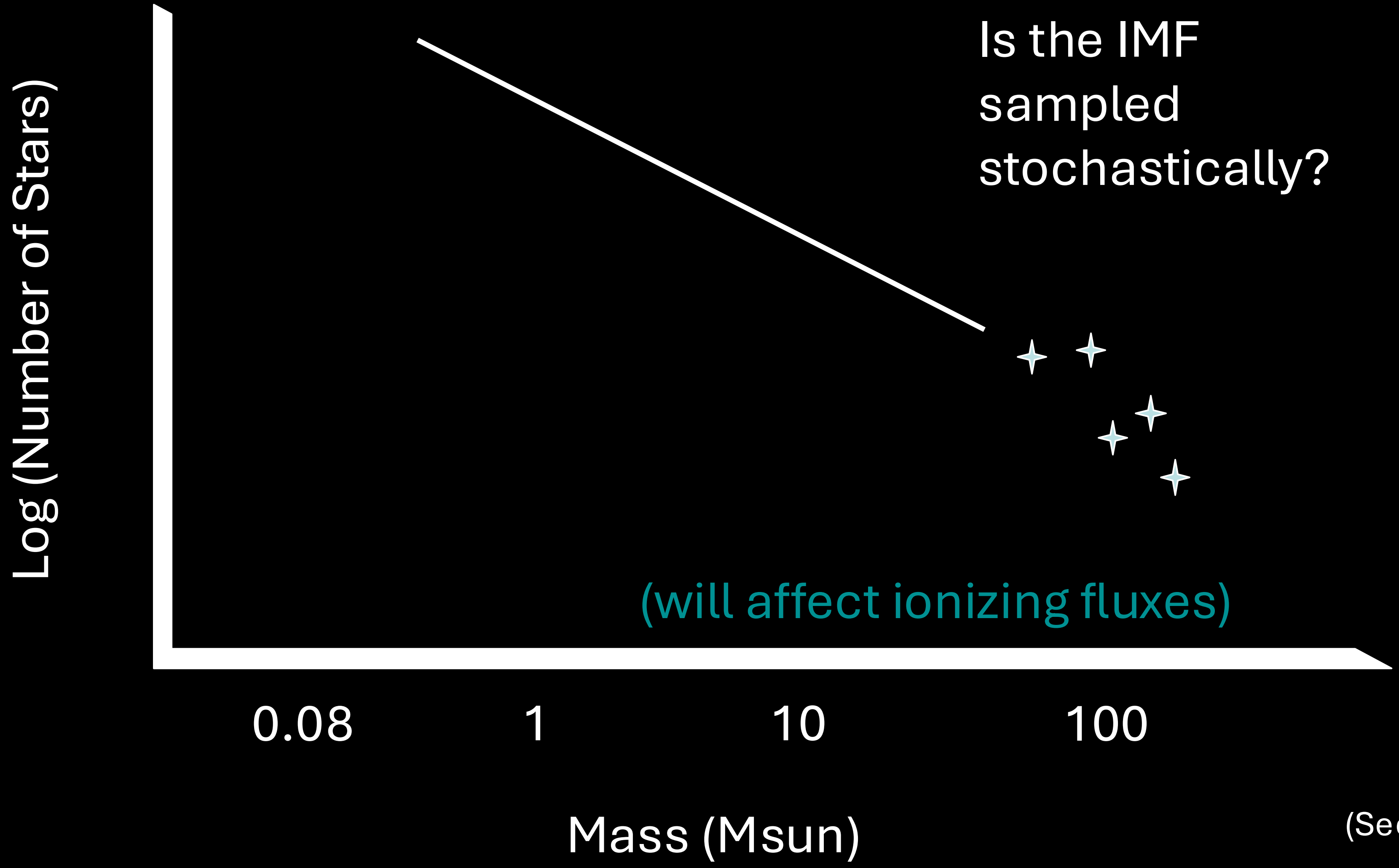

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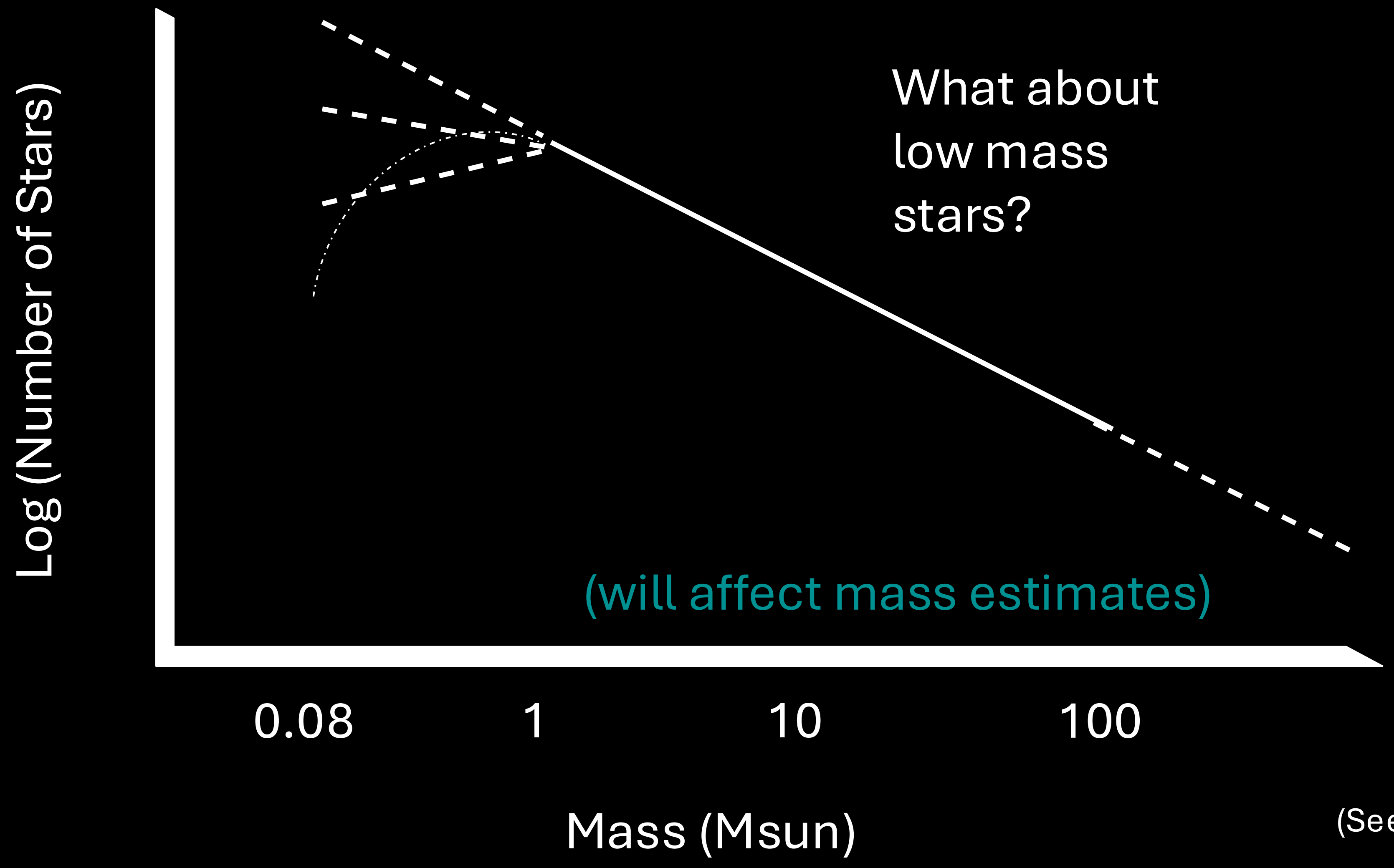

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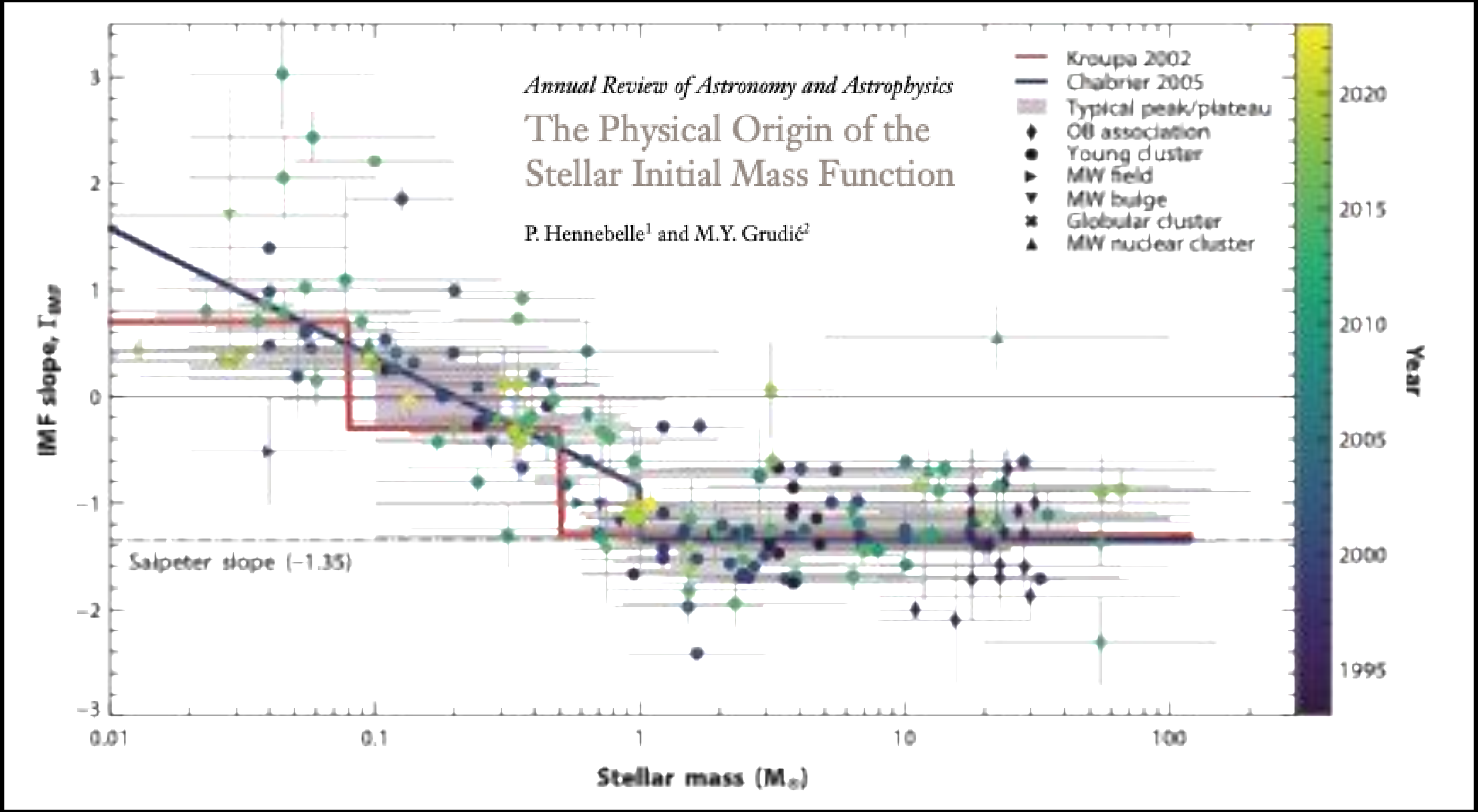
Initial mass functions: universality?



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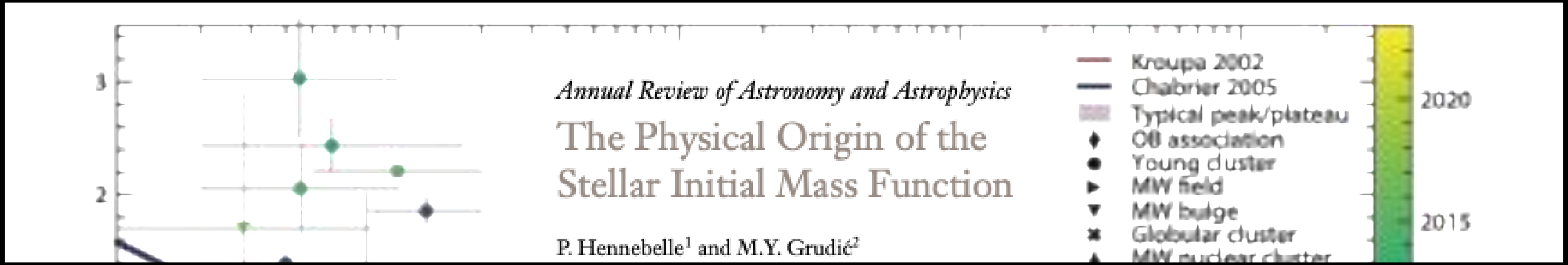
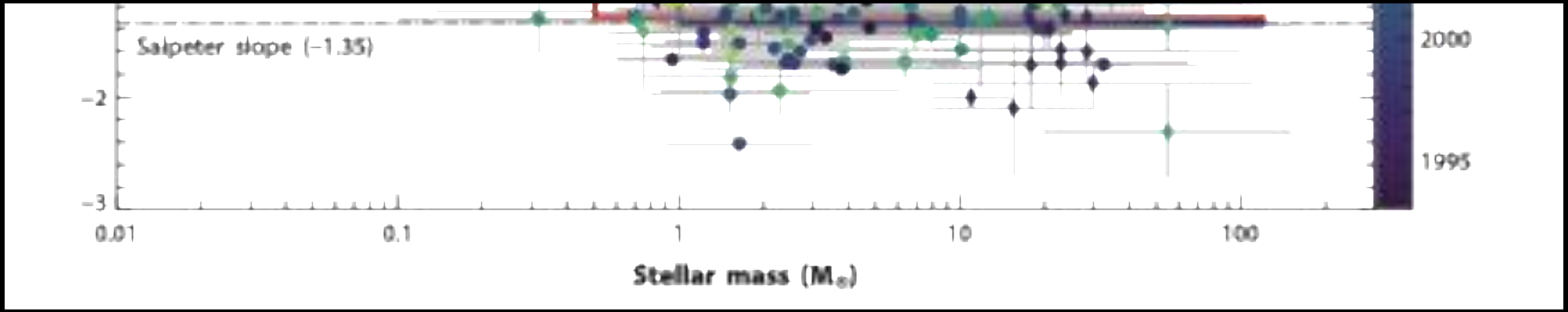


"Studies comparing these [Kroupa, Chabrier] models have generally found them to be similarly compatible with observations, as well as other parameterizations [...]. However, **it is not possible to draw a single curve through all data points** [...] that avoids tension with all measurements; [...]
The strong hypothesis of a true IMF universality is unlikely.



Let’s take a moment to digest

So, you’re using an SSP? You should ask what it’s using for:

- Stellar evolution models
- Stellar atmosphere models
- Initial mass function and model mass range
- Initial composition/metallicity
- Binary parameters
- Nebular gas or dust assumptions

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SPS models need validation

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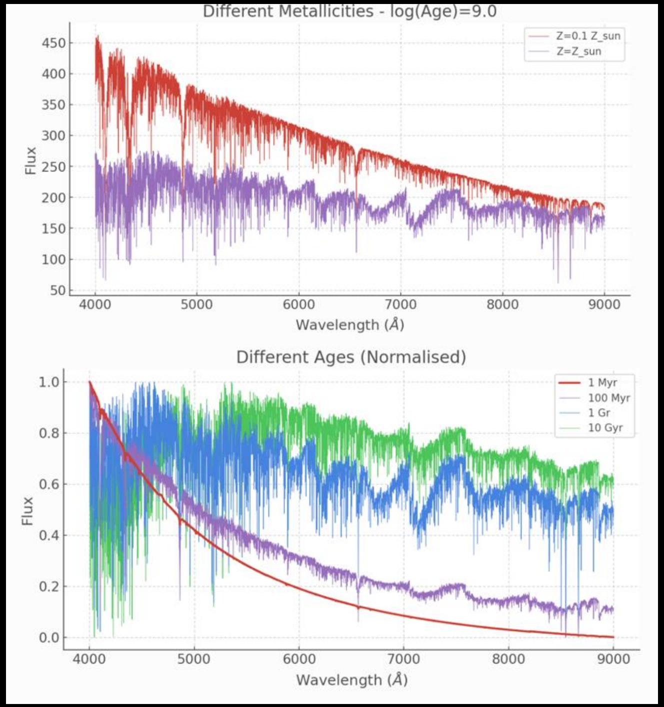
BPASS+hoki
(Stevance, Eldridge, Stanway)



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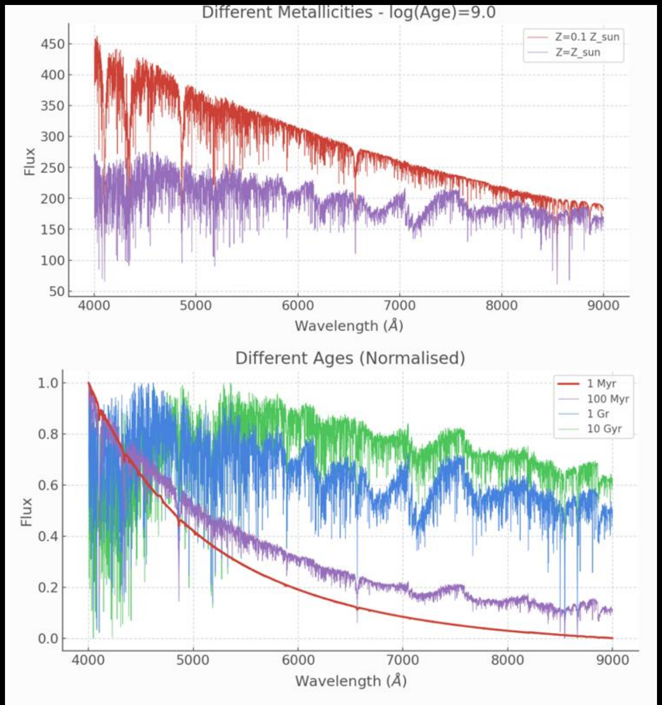

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BPASS+hoki
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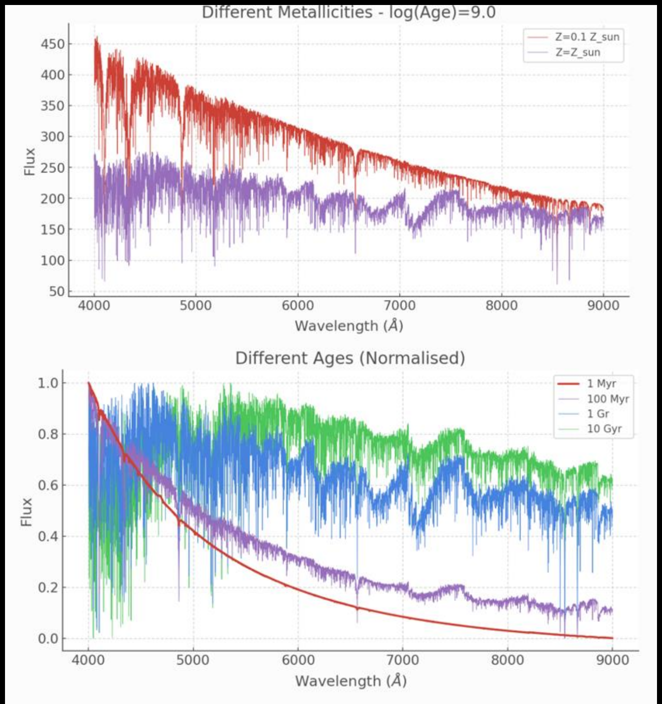
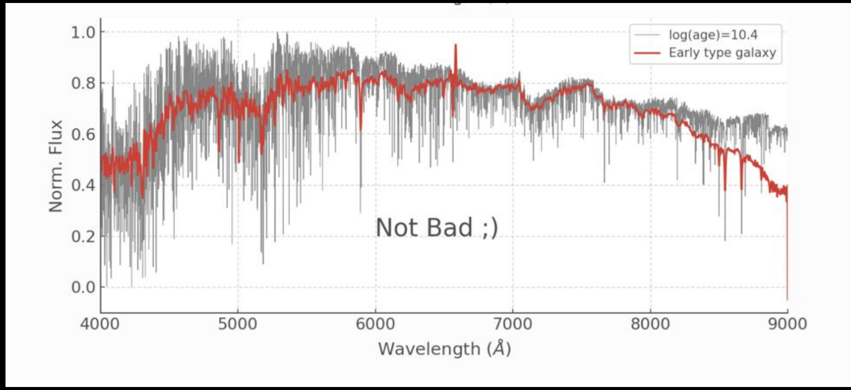


Age
Metallicity
SFR
SFH



Age
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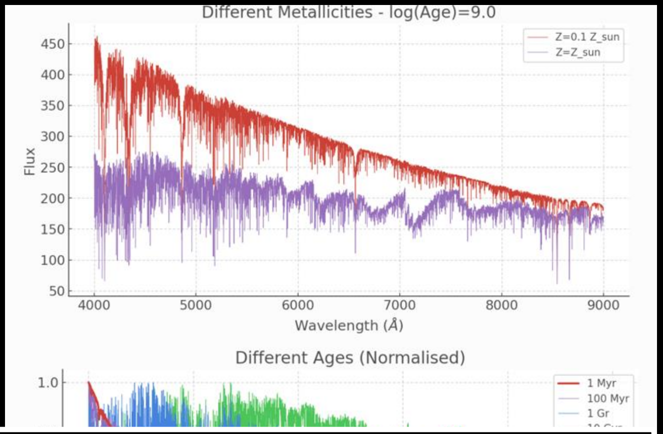
Degeneracies!
(Pforr+12, Maraston+10)

BPASS+hoki
(Stevance, Eldridge, Stanway)

SPS models need validation

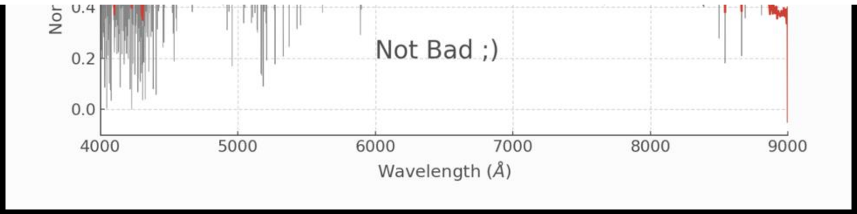


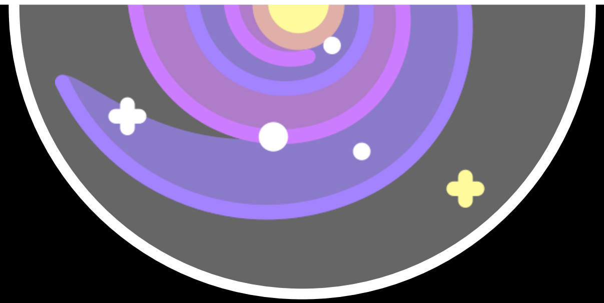
Age
Metallicity

➔Validate via apples-to-apples comparison
resolved + integrated observations
vs
resolved + integrated models
at known O/H and spatial variations

“Knowing what goes in to trust what comes out”

Age
Met
SFR
SFH





Degeneracies!
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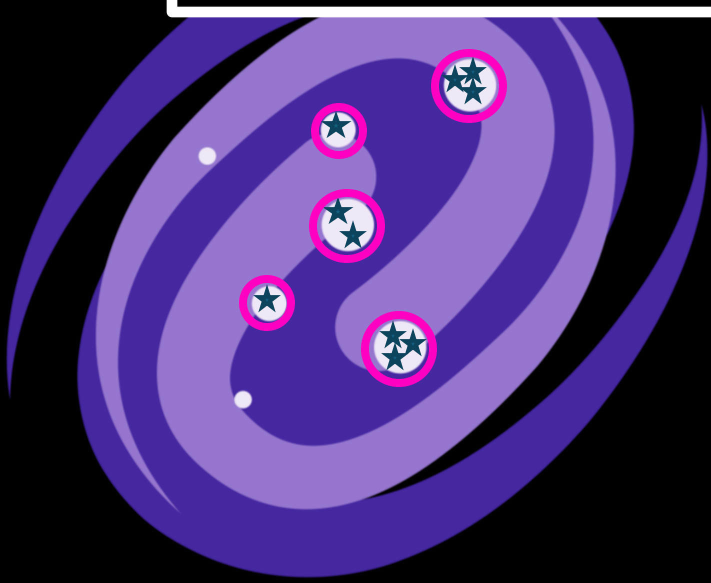
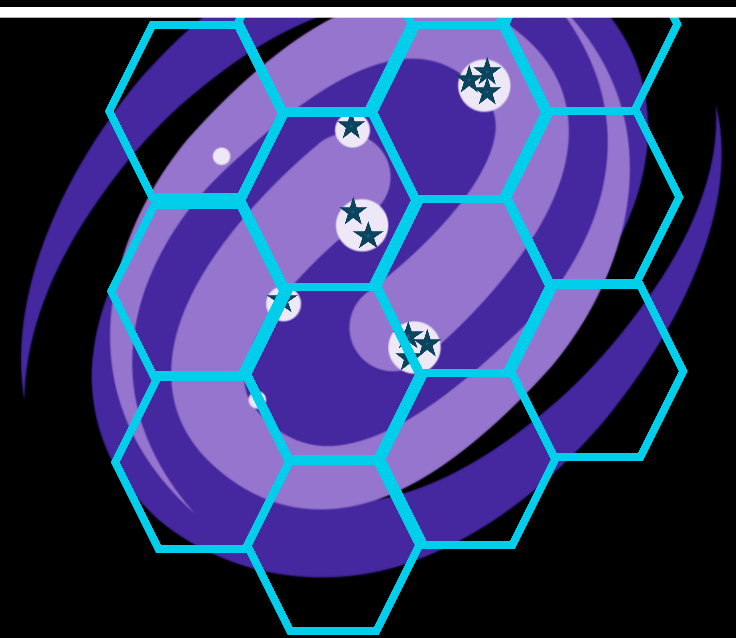
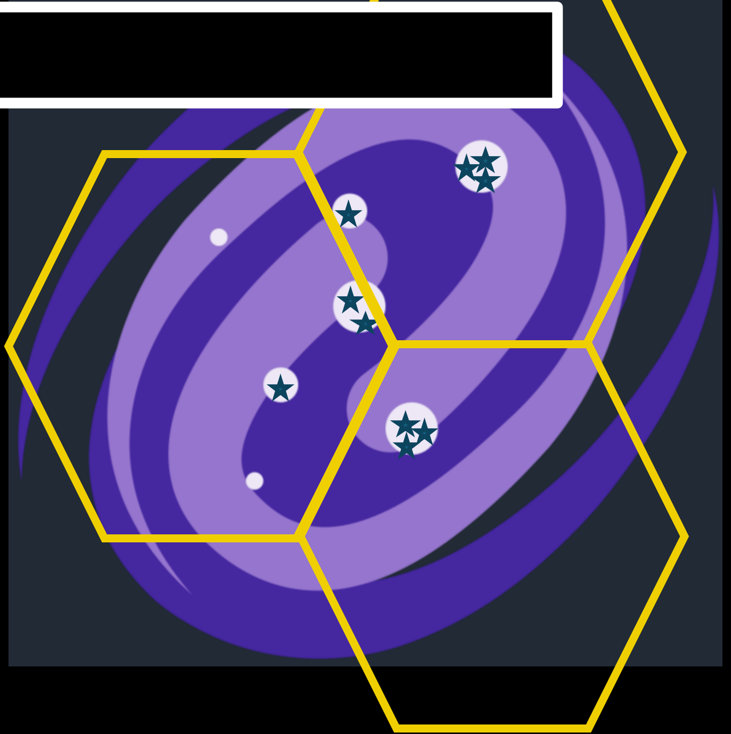
The Spatial Resolution Project







Individual stars and HII regions

Aim:

- Characterise the feedback-driving stars and the feedback-driven gas
- Quantify the star/gas interplay

Method:

- IFU+HST method (as proven in McLeod+20, 21)

GMC scales

Aim:

- Measure spatially resolved SFHs, SFRs, chemical enrichment
- Ground-truth SPS models

Method:

- Fit HST CMDs with MATCH
- Fit IFU integrated spectra with PROSPECTOR

Kiloparsec scales

Aims:

- Quantify effect of spatial resolution on galaxy properties
- Connect the local to the high-z Universe

Method:

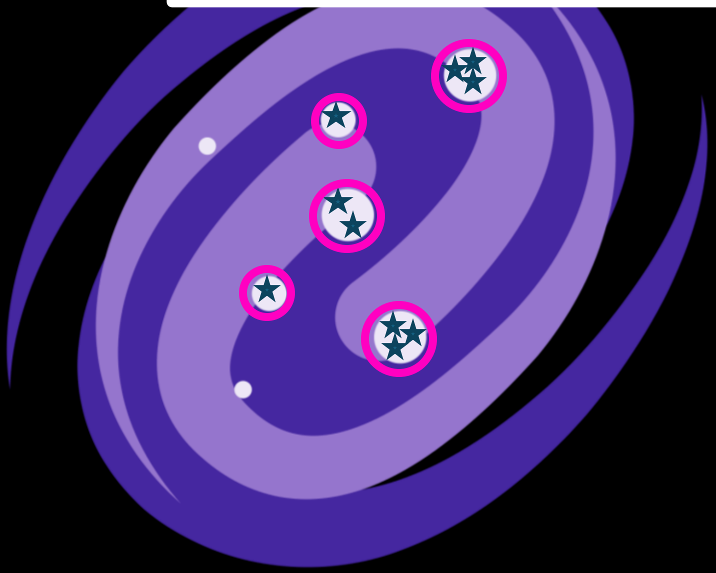
- Convolve observations to lower and lower spatial resolution

1-10s pc scales

100 pc scales

kpc scales

The Spatial Resolution Project



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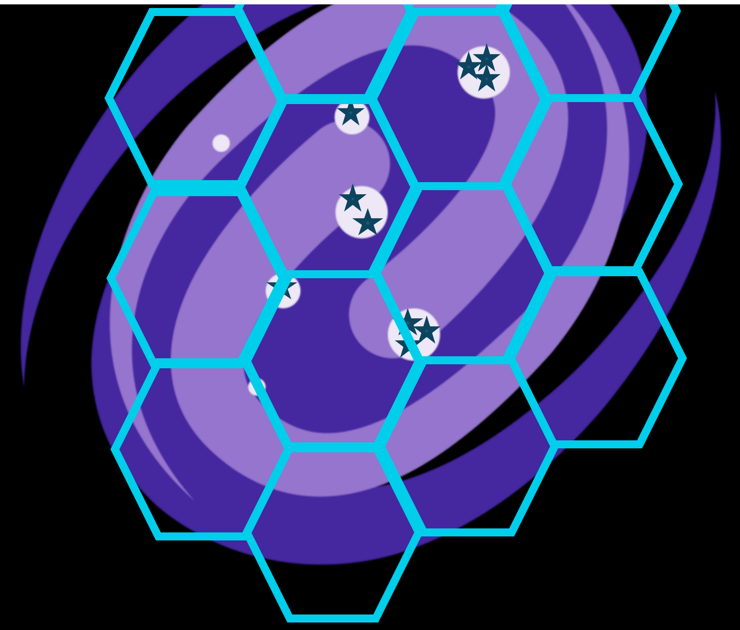

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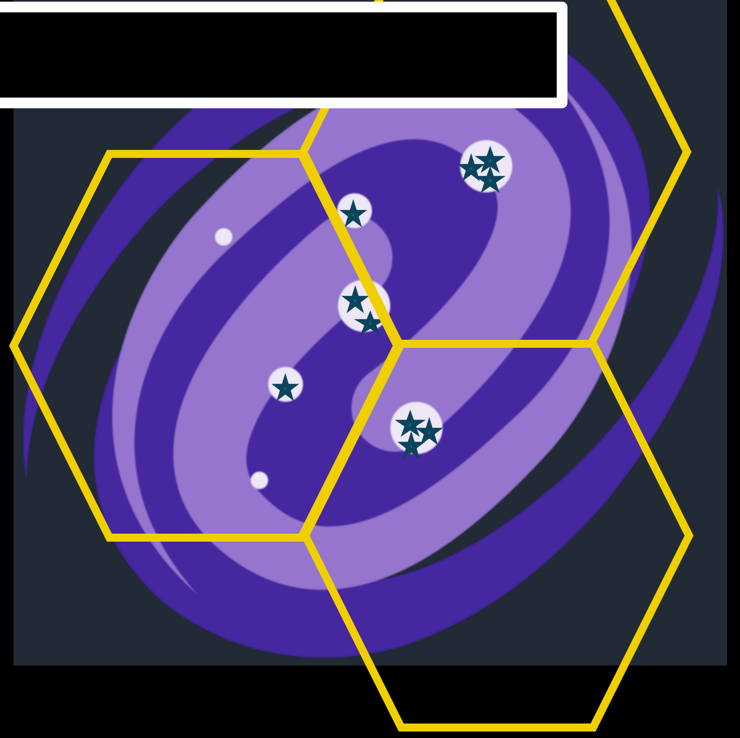

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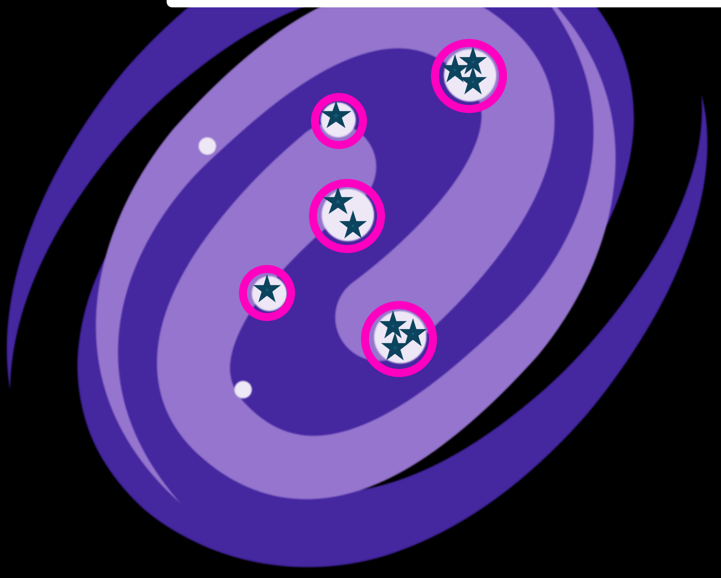

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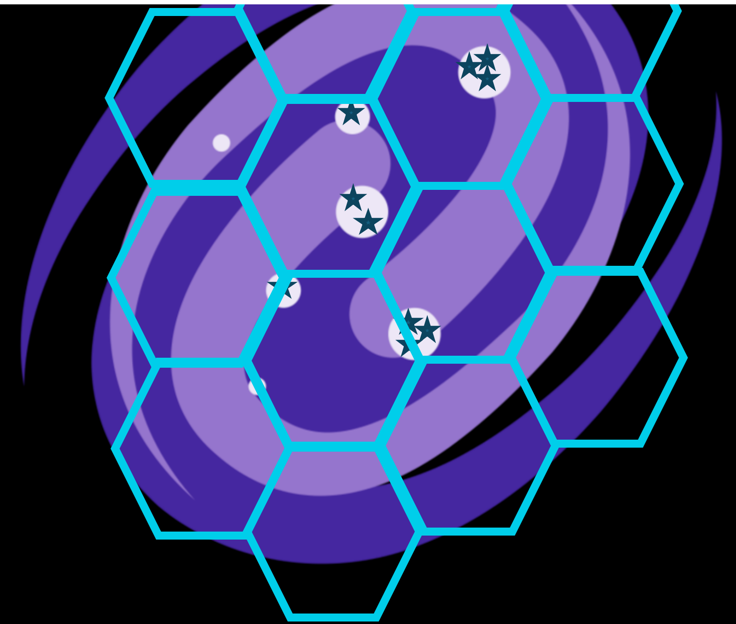

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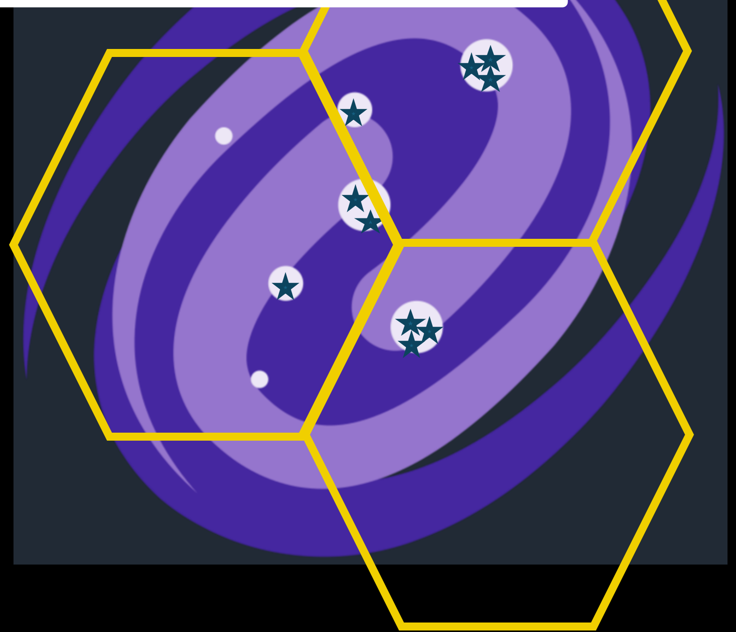

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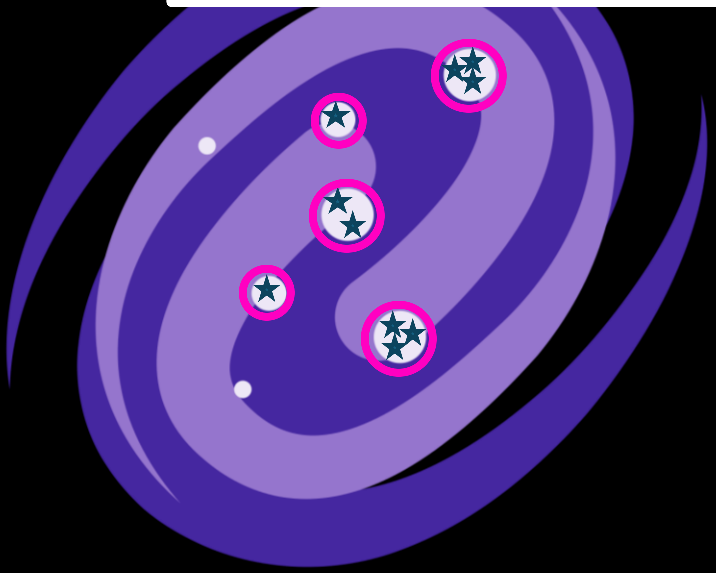

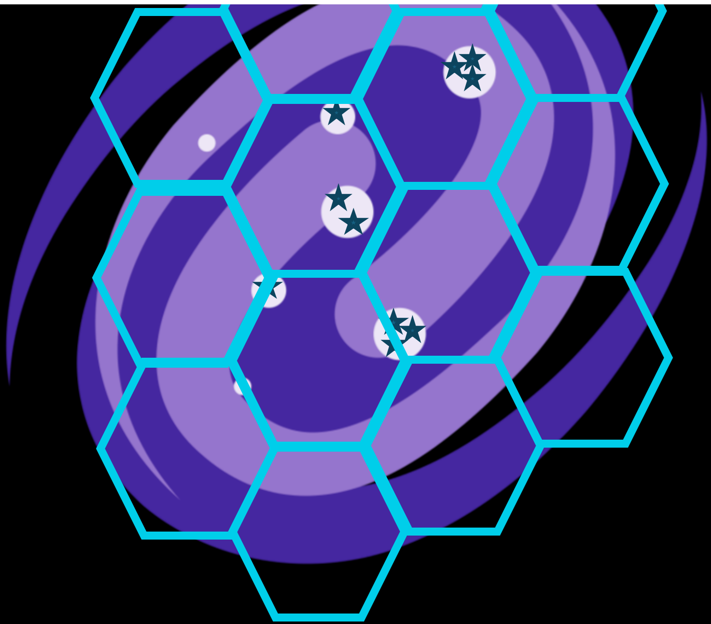

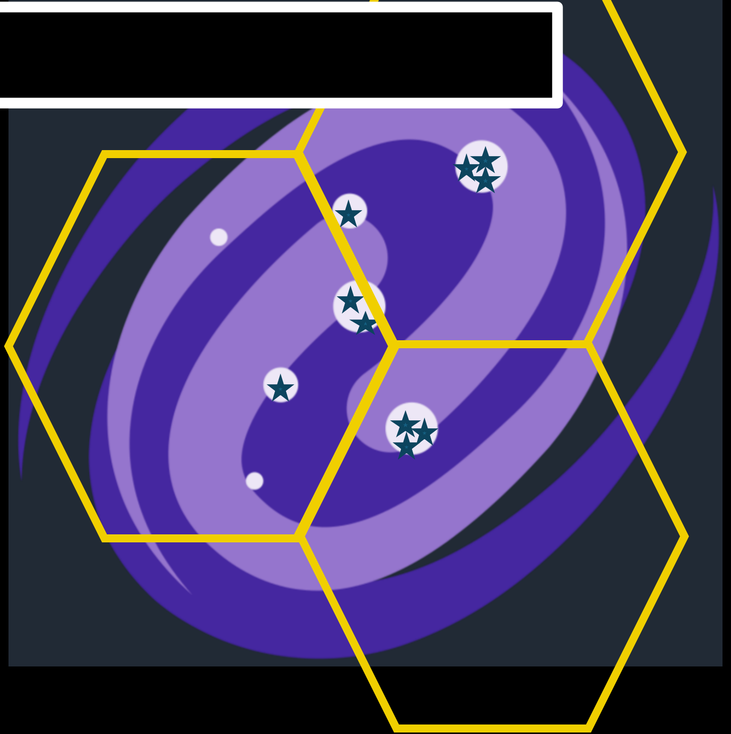

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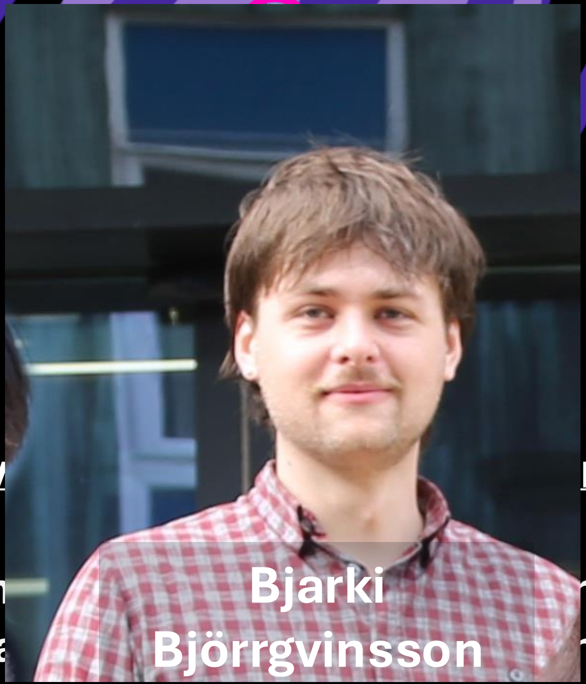

Indiv ns

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Kilop

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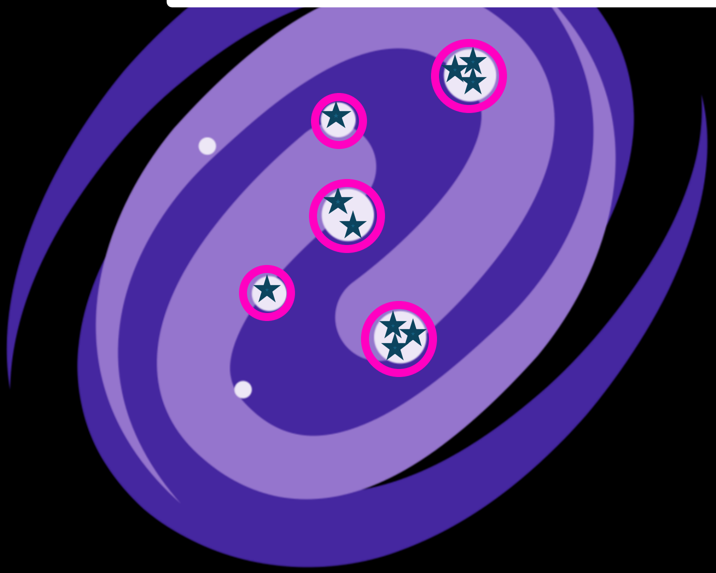
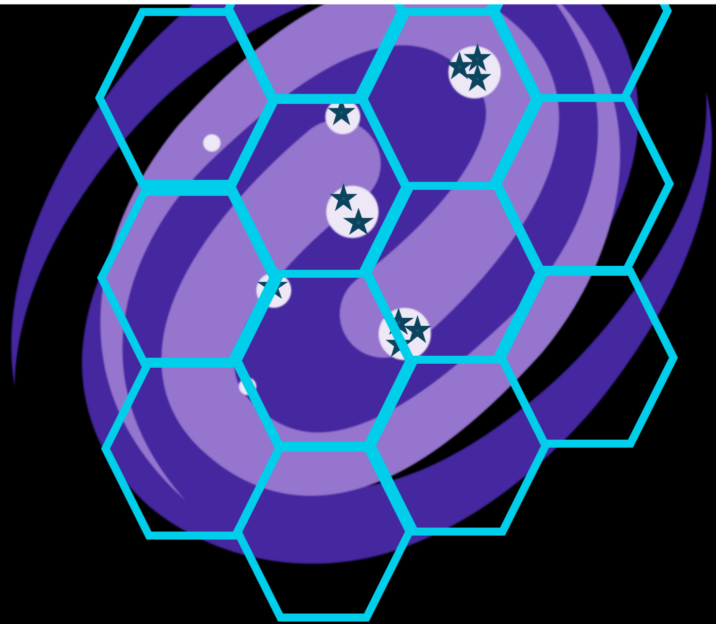
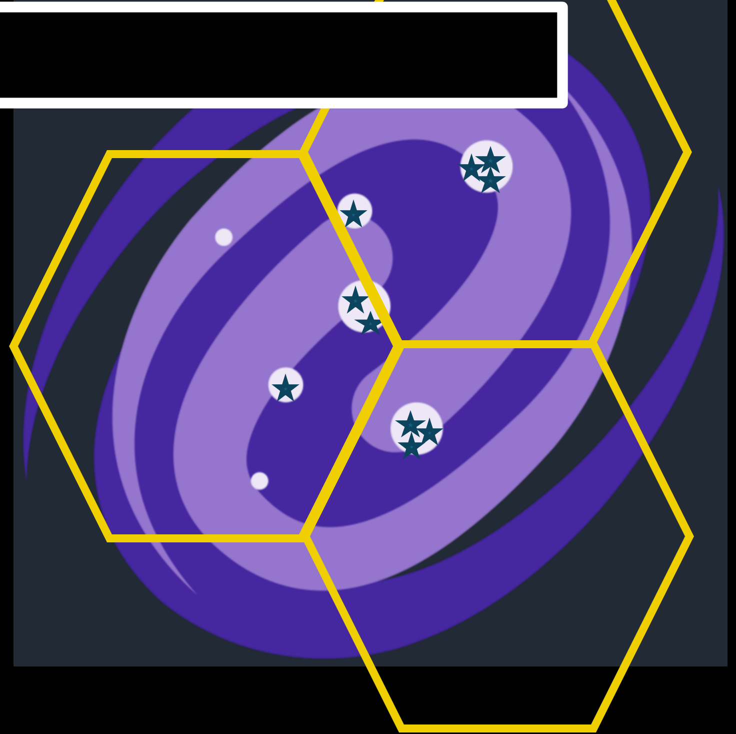
The Spatial Resolution Project







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SPS model validation workflow

Resolved

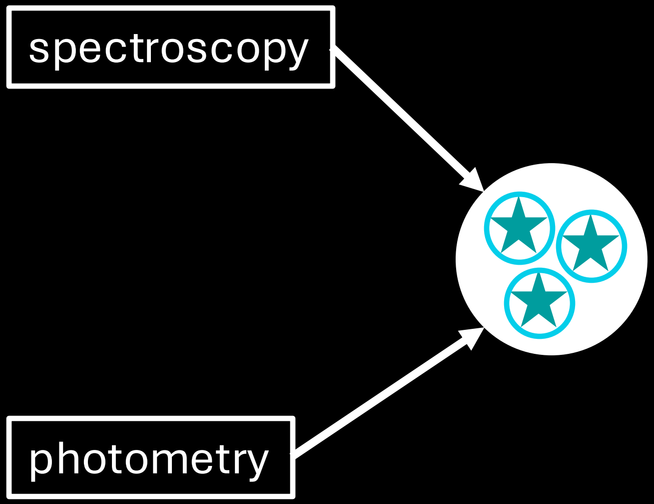
Unresolved

Resolved

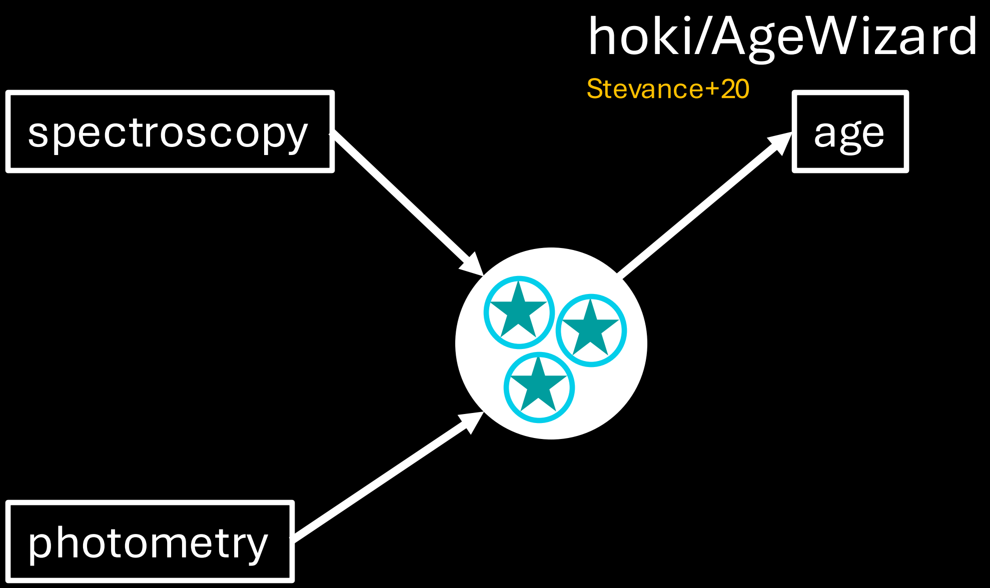
Unresolved

Resolved

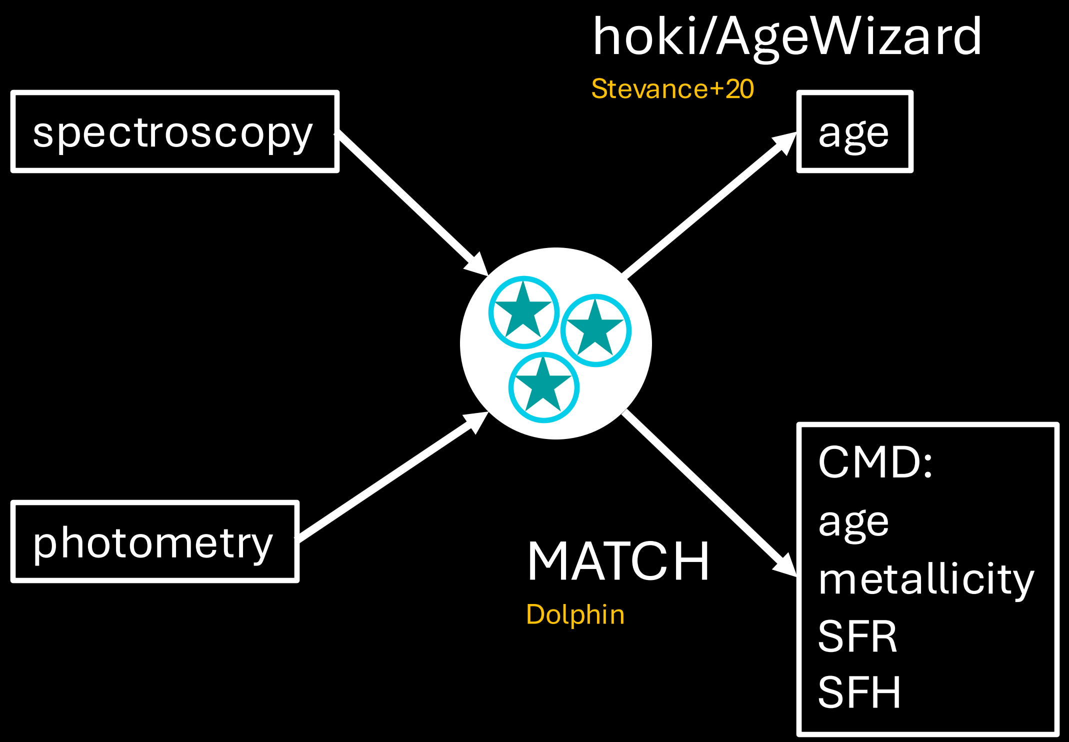
Unresolved



Resolved | **Unresolved**

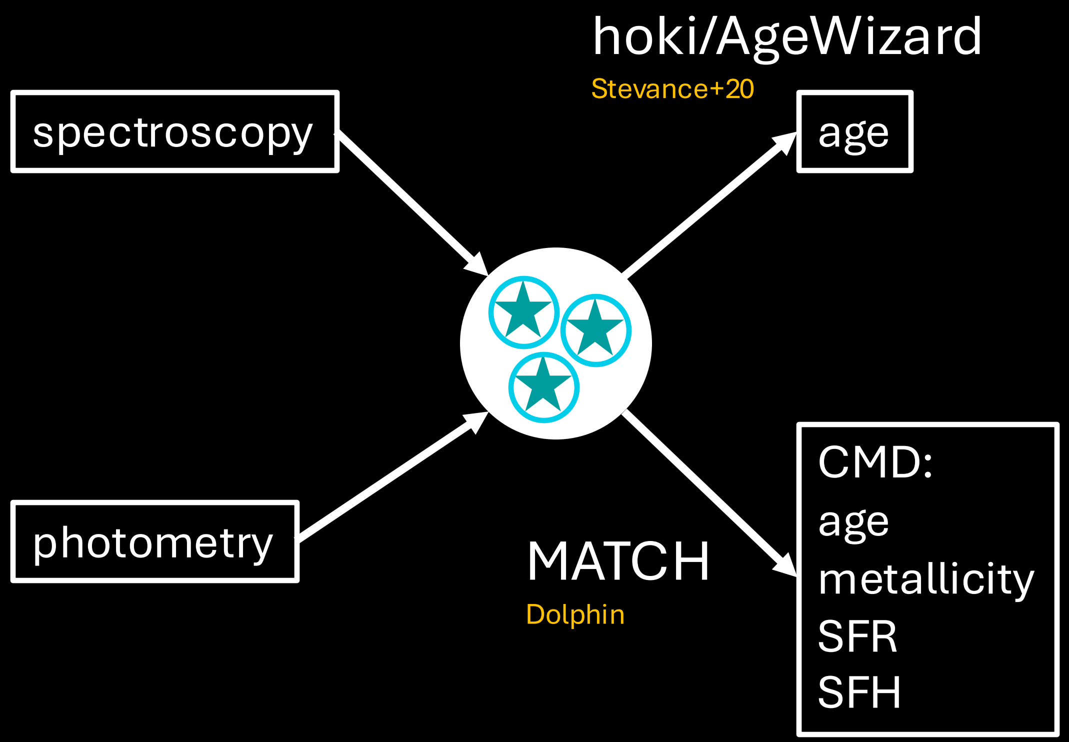


Resolved



Unresolved

Resolved



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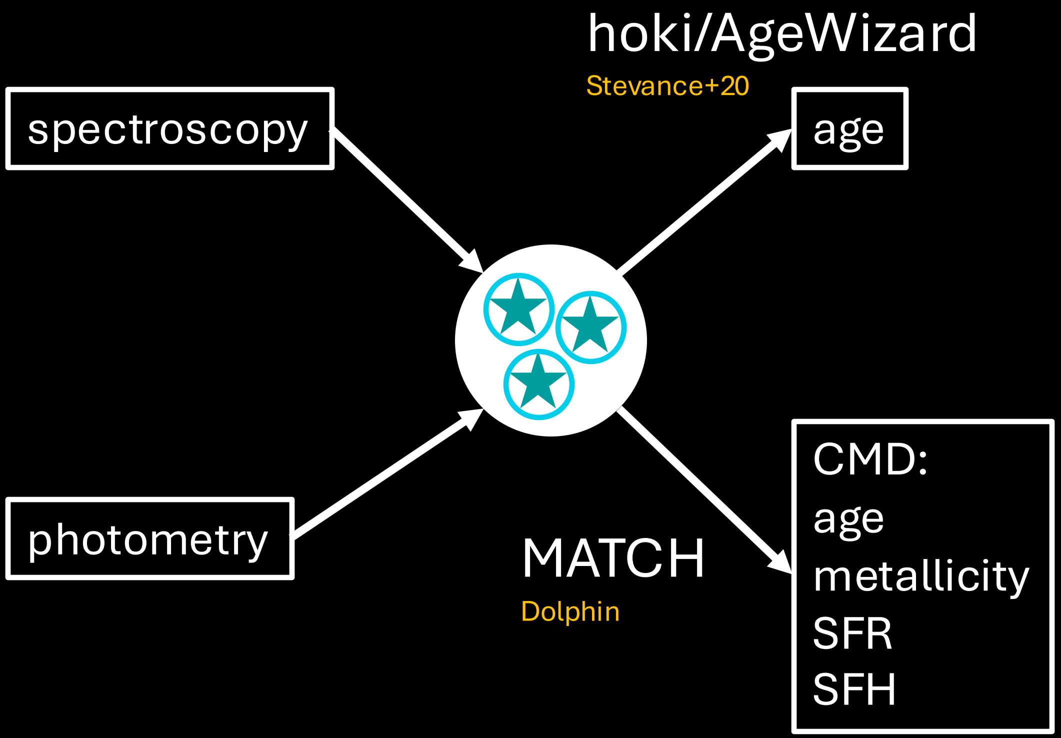
Resolved



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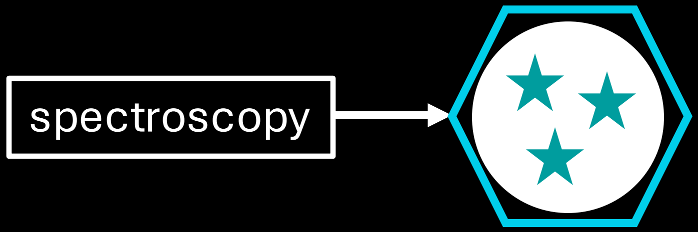

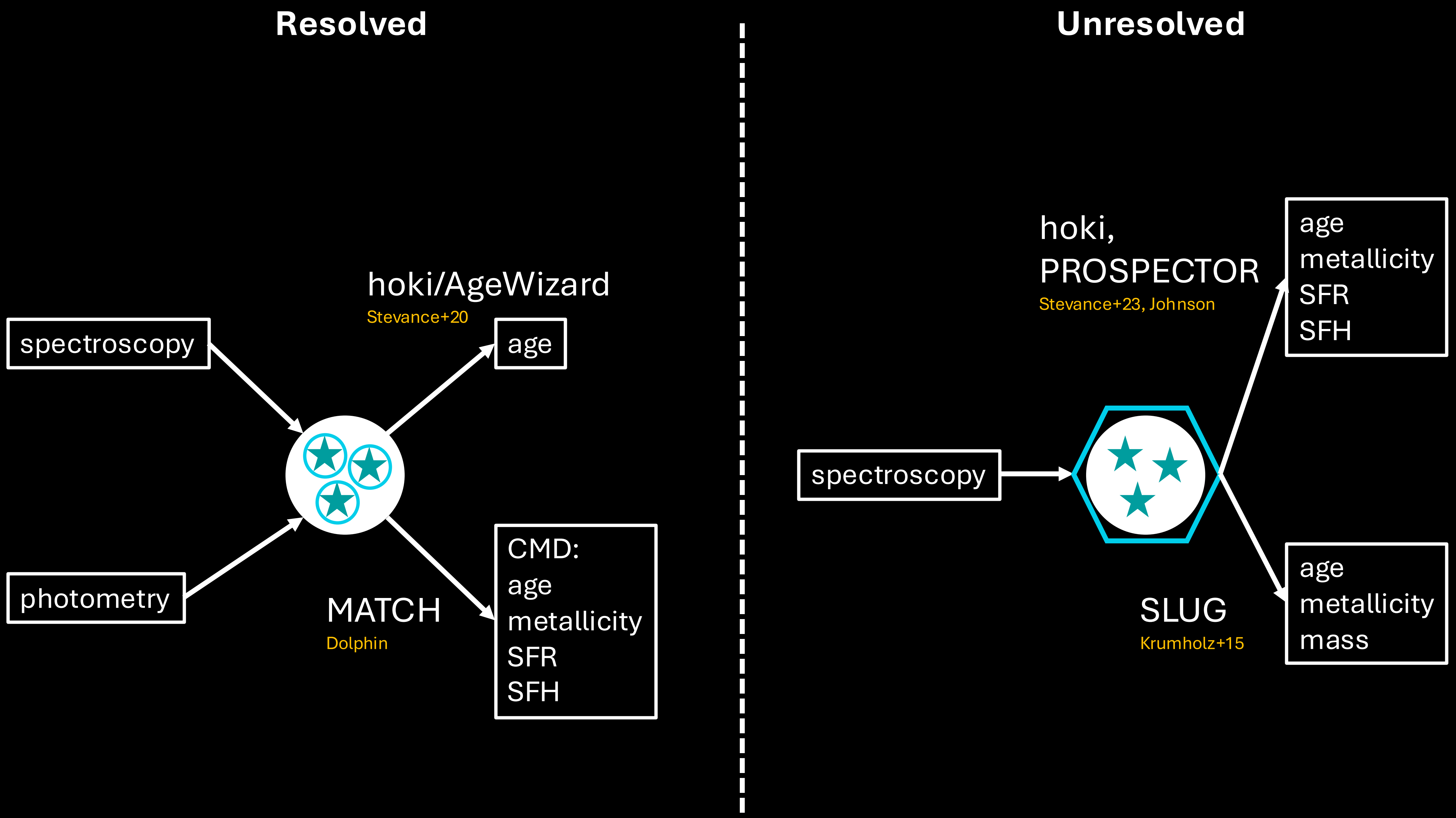

Resolved
Unresolved
spectroscopy
photometry
hoki/AgeWizard
Stevance+20
age
MATCH
Dolphin
CMD:
age
metallicity
SFR
SFH
hoki,
PROSPECTOR
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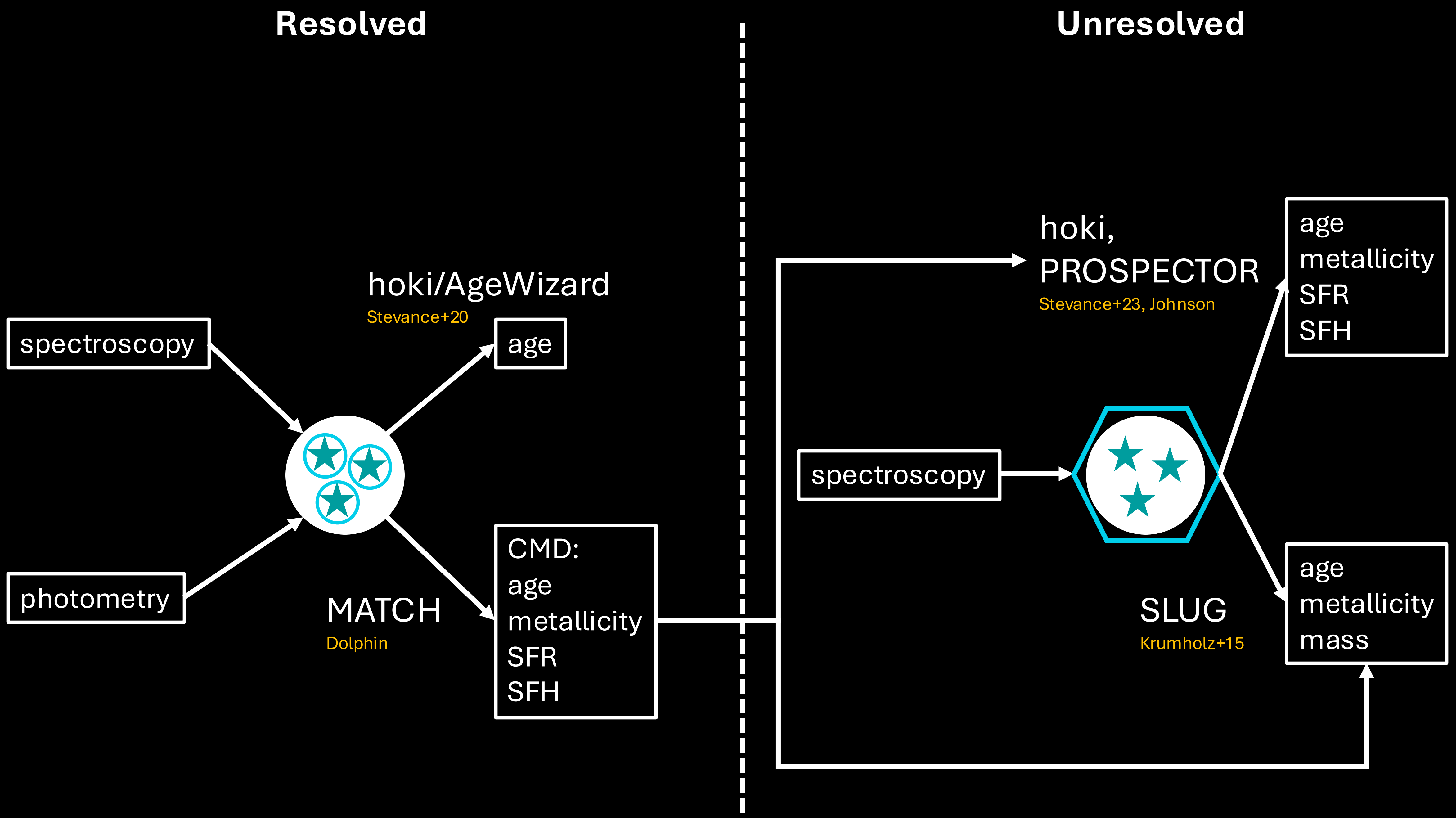
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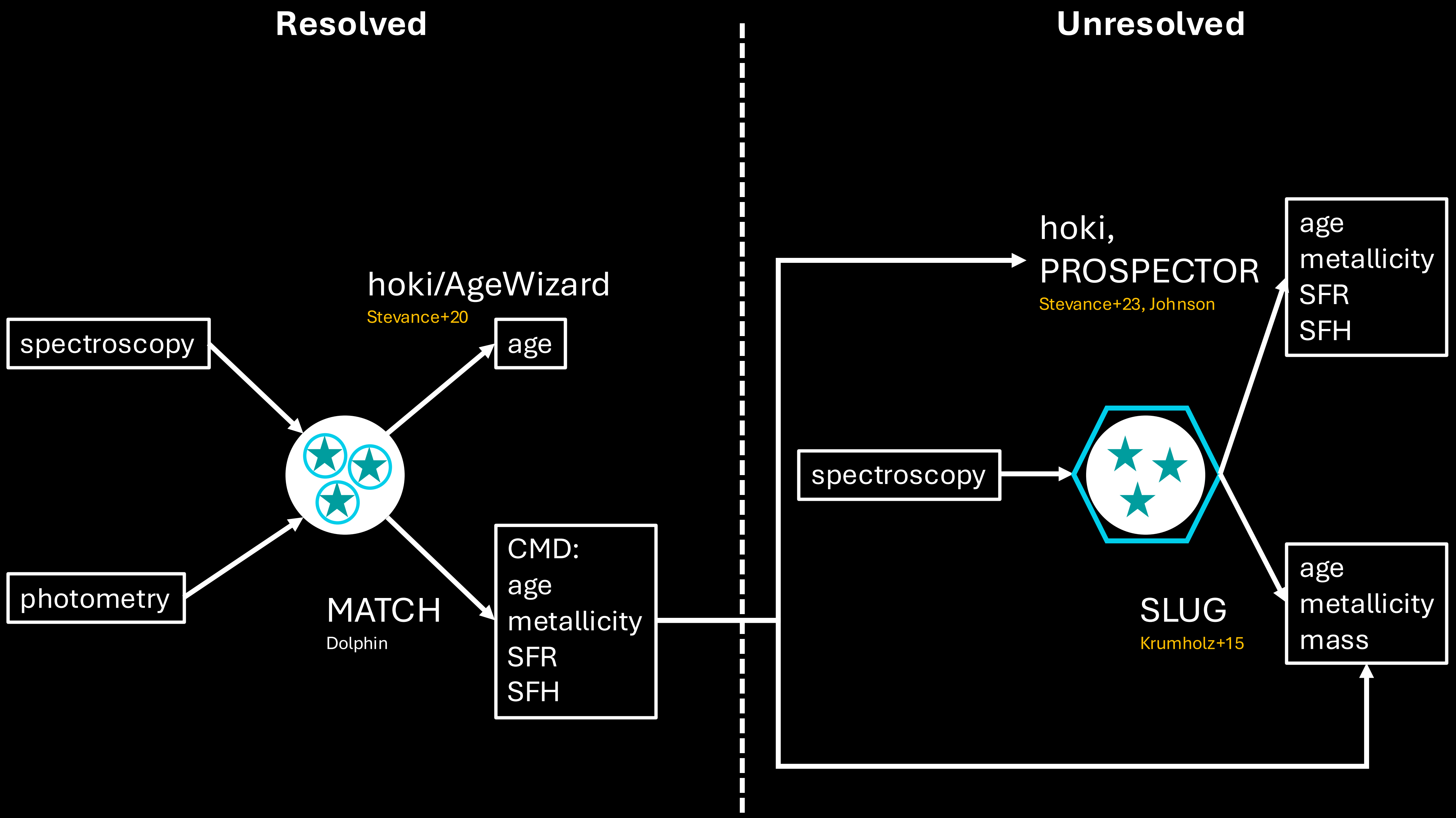
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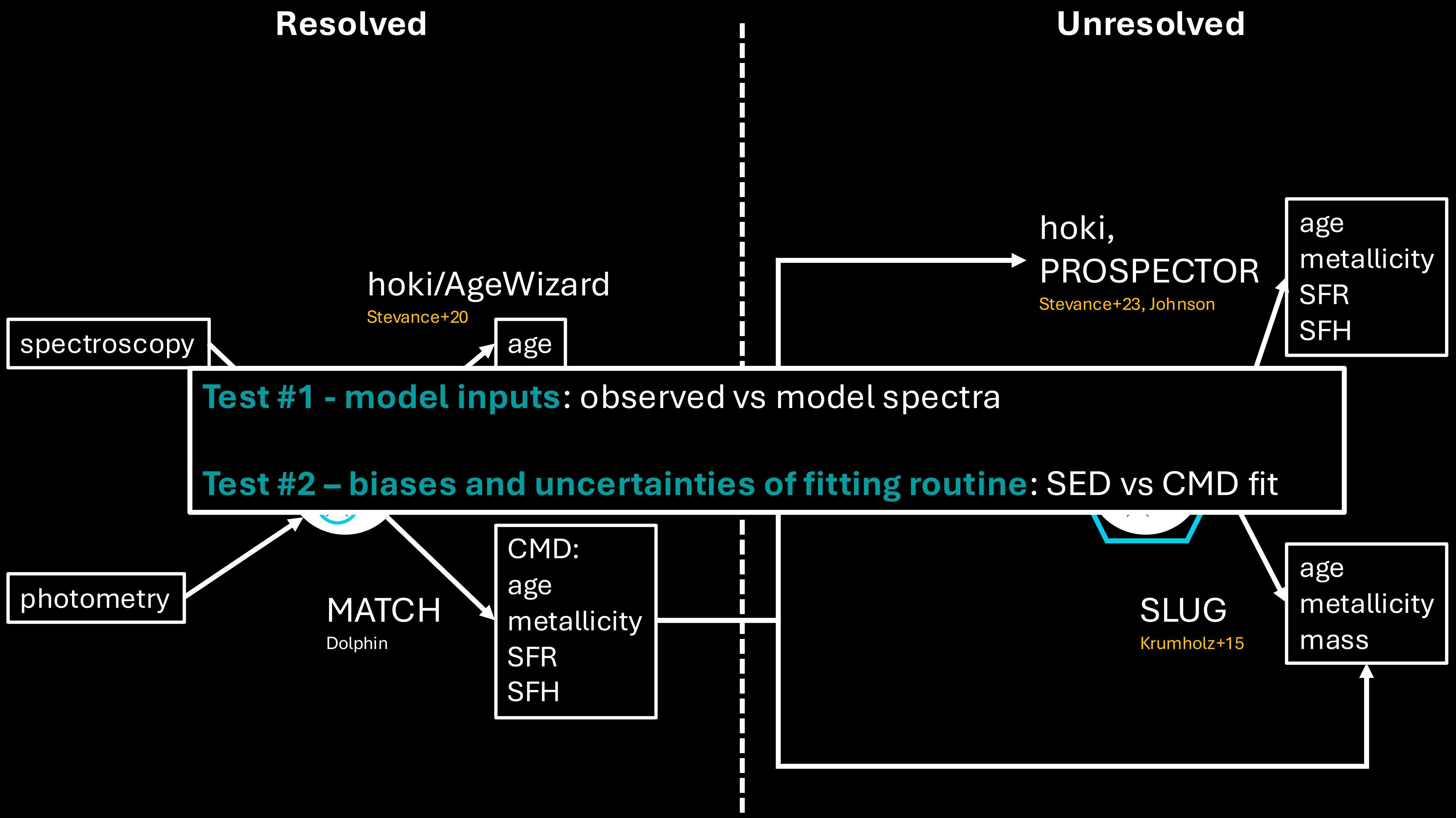

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Test #1 - model inputs: observed vs model spectra
Test #2 – biases and uncertainties of fitting routine: SED vs CMD fit
photometry
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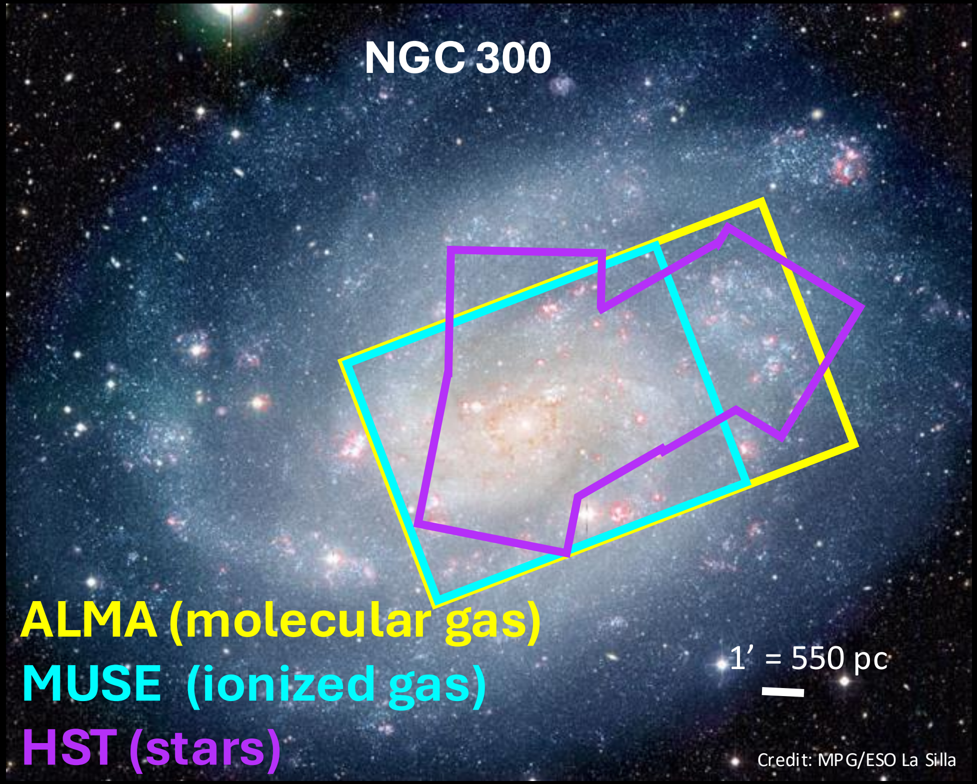
The nearby galaxy NGC 300 (2 Mpc) gives us access to > 100 star-forming regions & their stars simultaneously



See also Kruijssen+19 (incl. McLeod)

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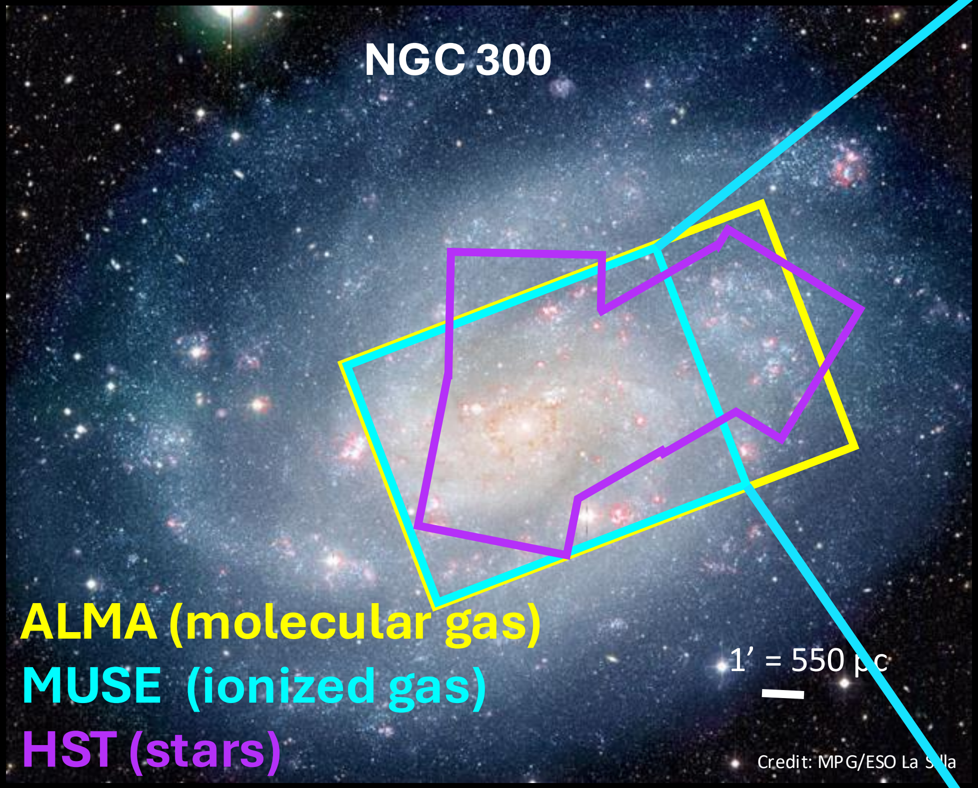

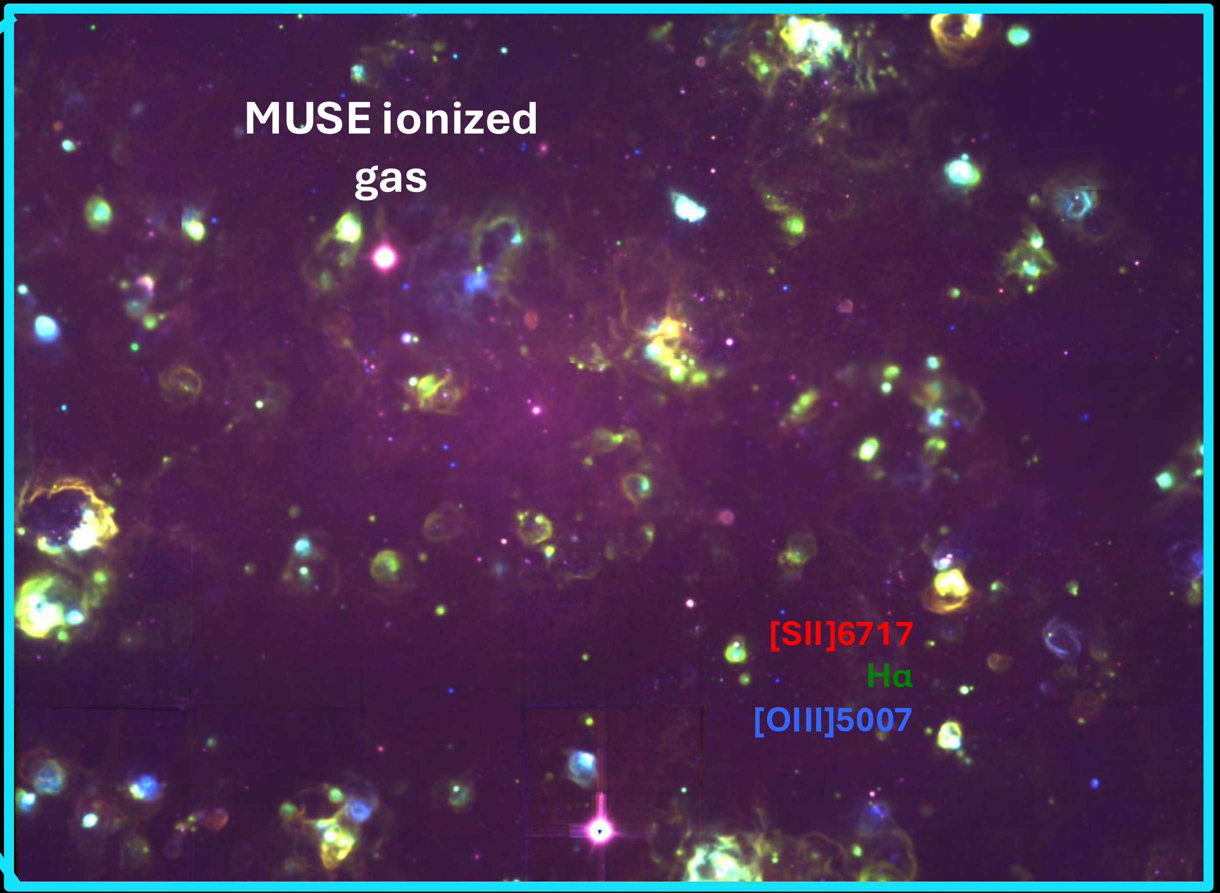

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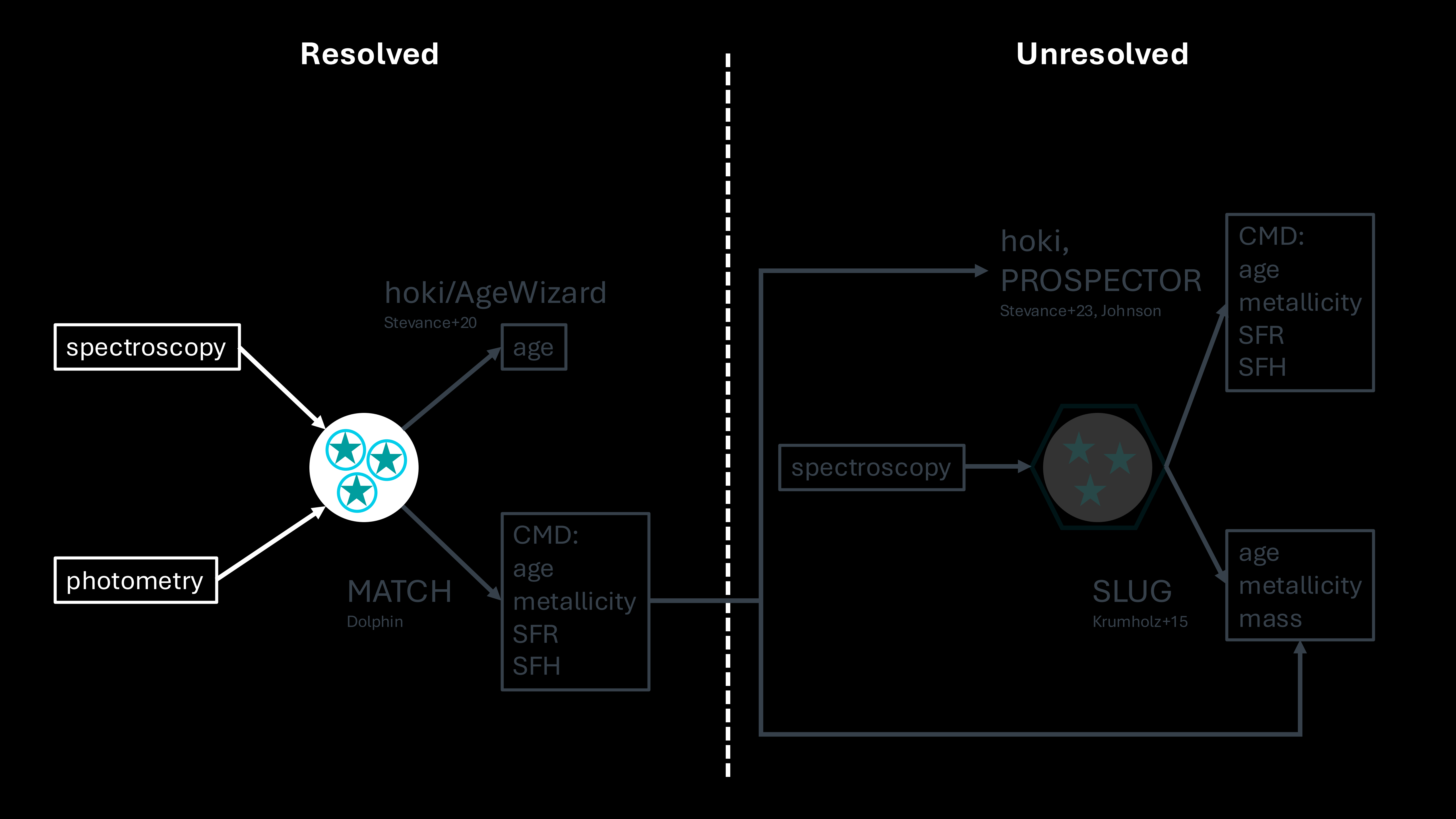

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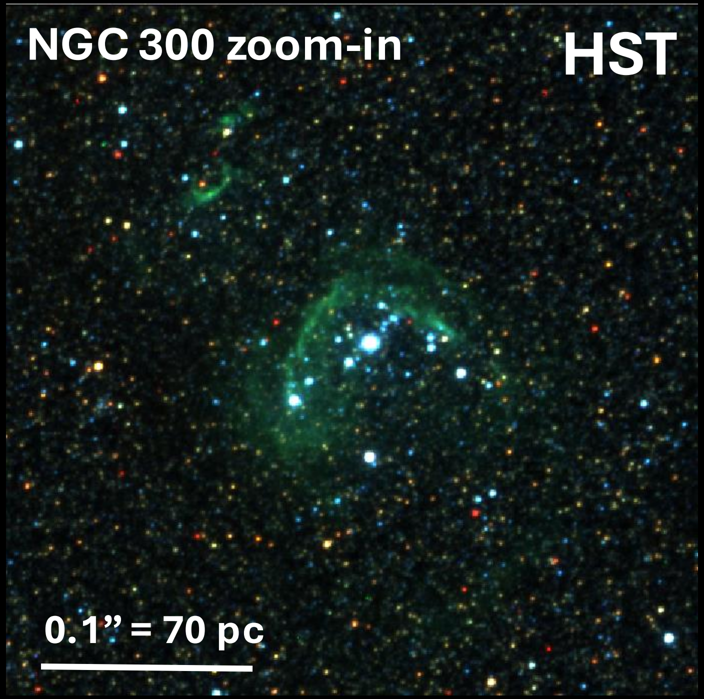
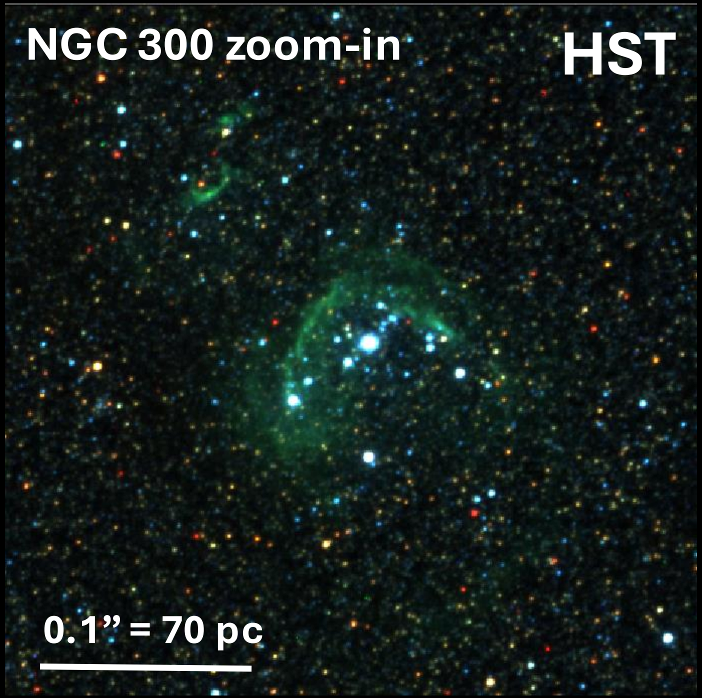
Resolving single stars at Mpc distances with IFUs



Resolving single stars at Mpc distances with IFUs

exploiting high spatial resolution photometry from the Hubble Space Telescope



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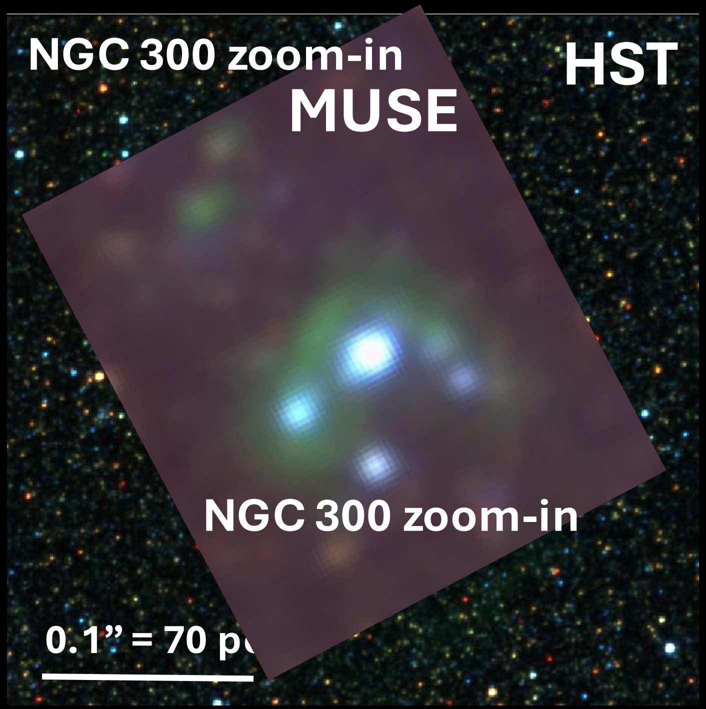

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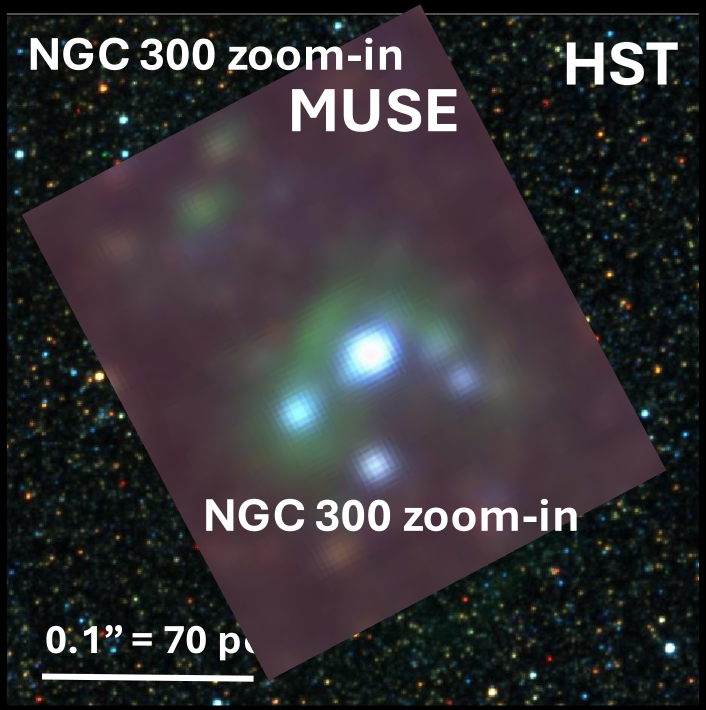

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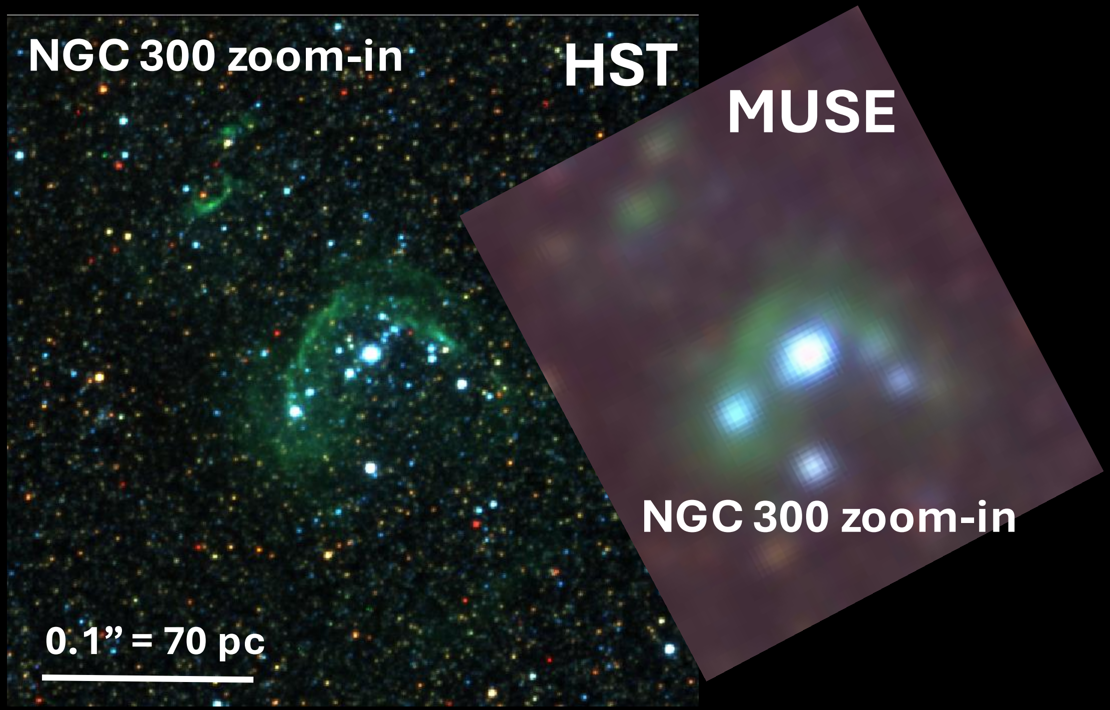

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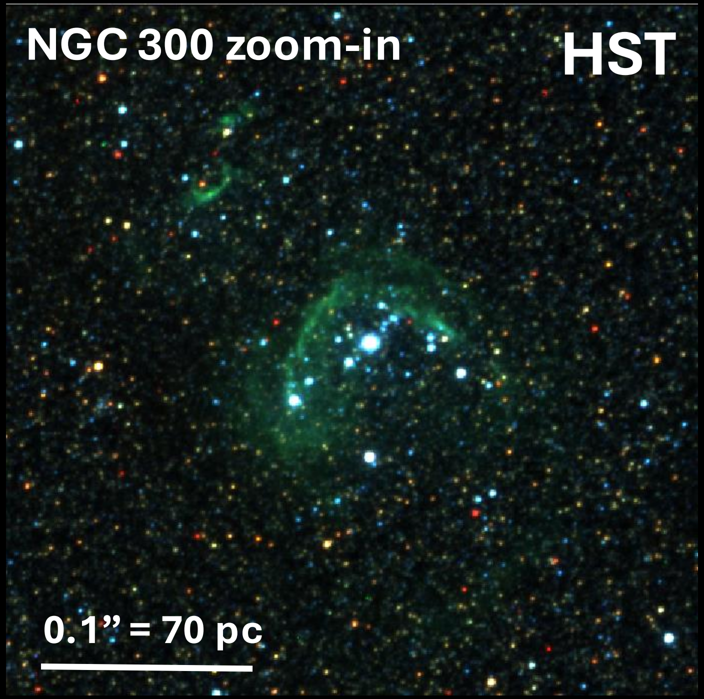

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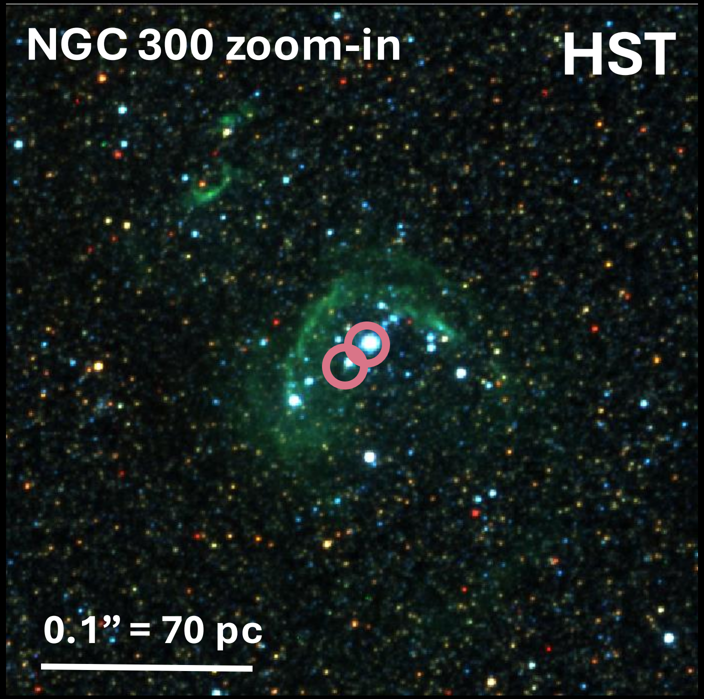

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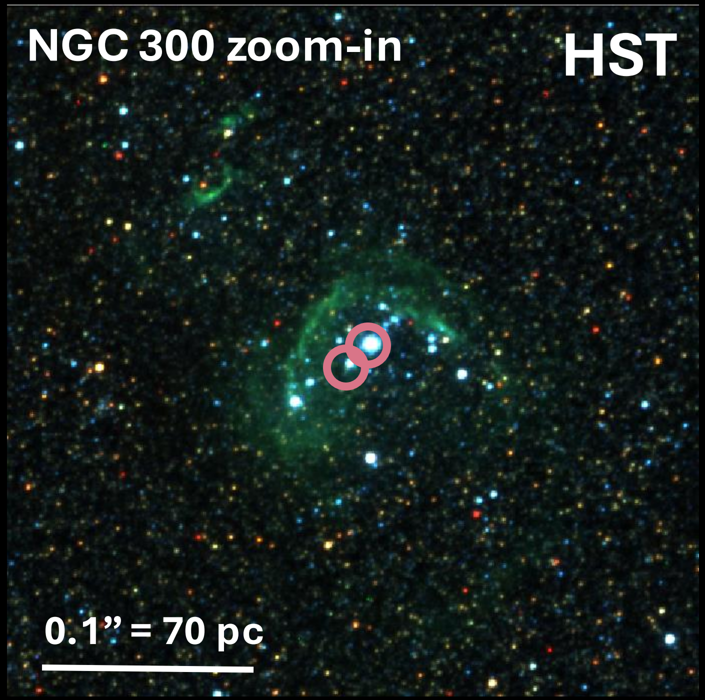

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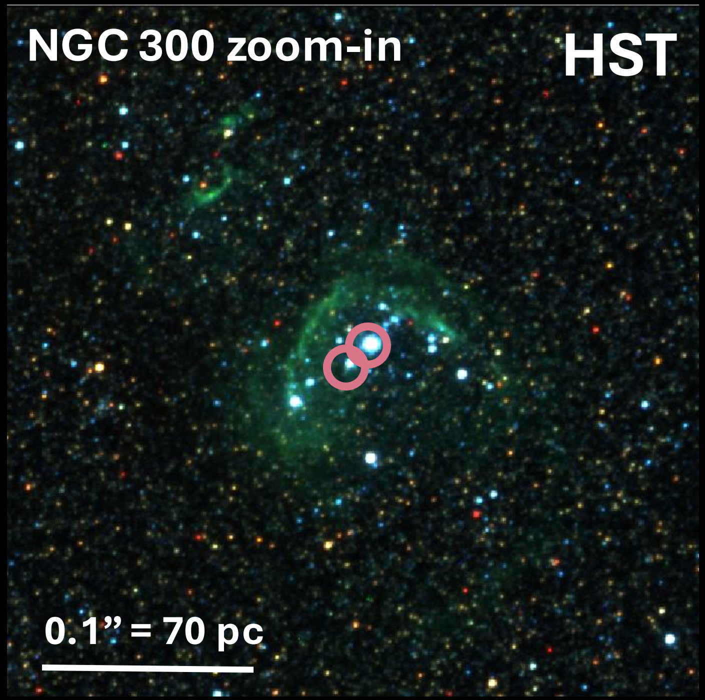
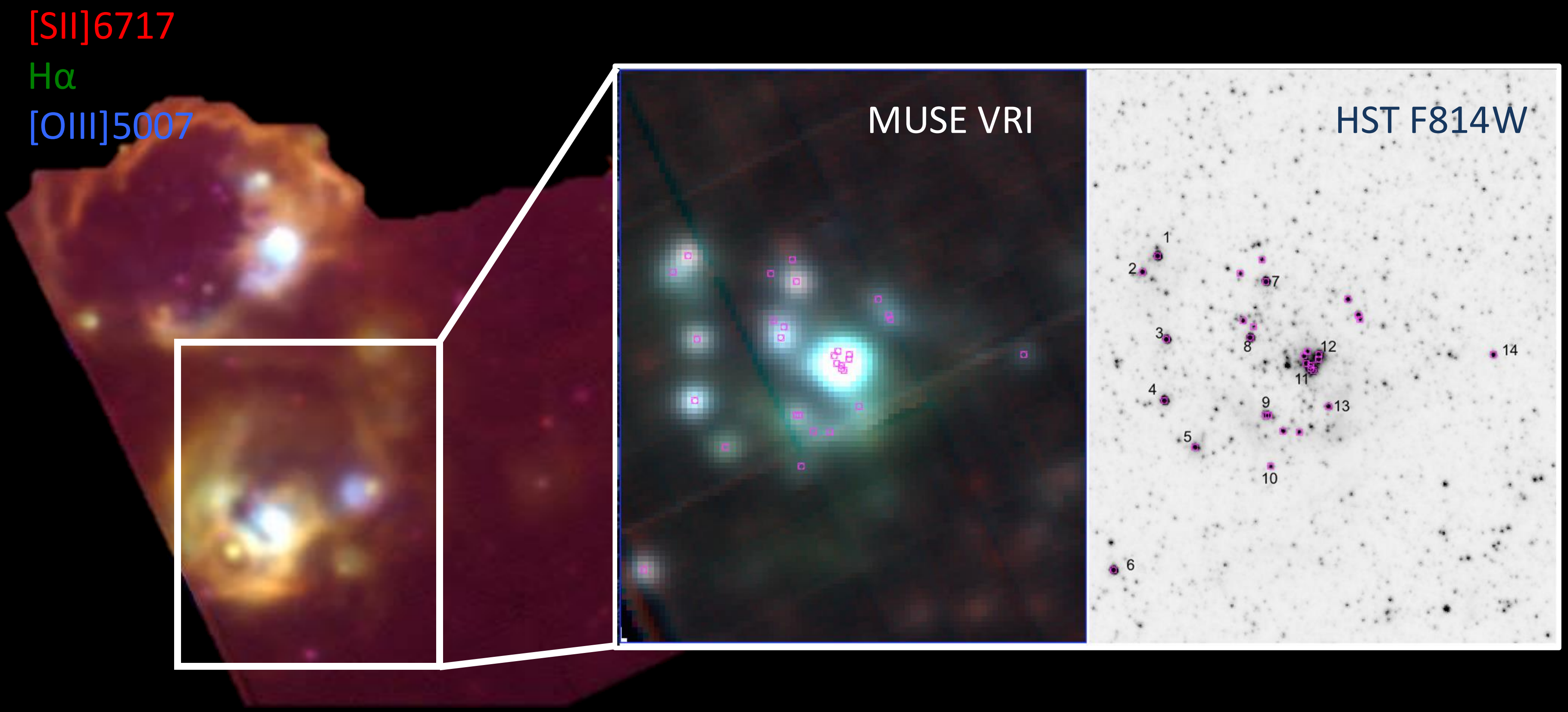


➔ Accurate PSF fitting allows <u>enhanced spectral extraction</u> at large distances / in crowded fields (as demonstrated in Kamann+16)

MUSE IFU data + enhanced spectral extraction: identification of 13 O-type and 4 WR stars in an initial study of 5 star-forming regions in NGC 300



McLeod et al. 2020

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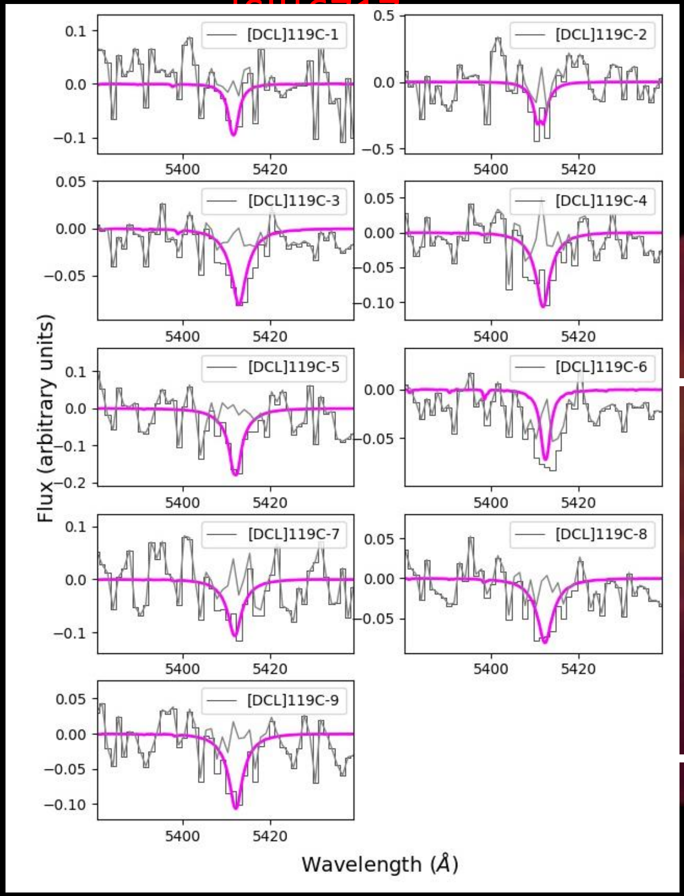

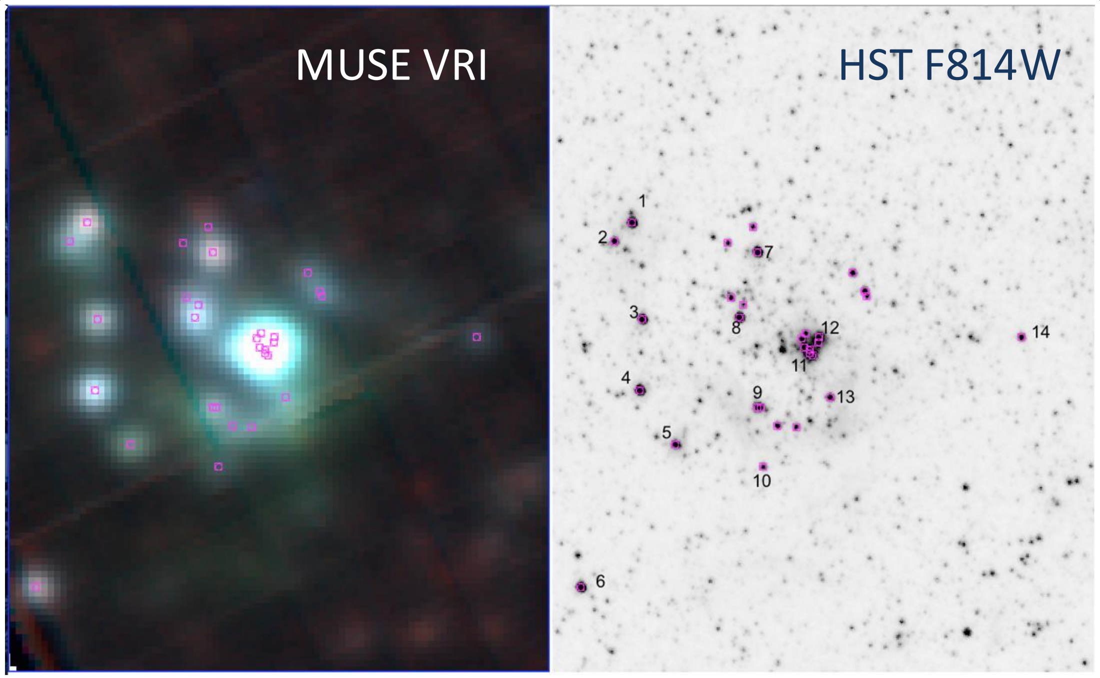

McLeod et al. 2020

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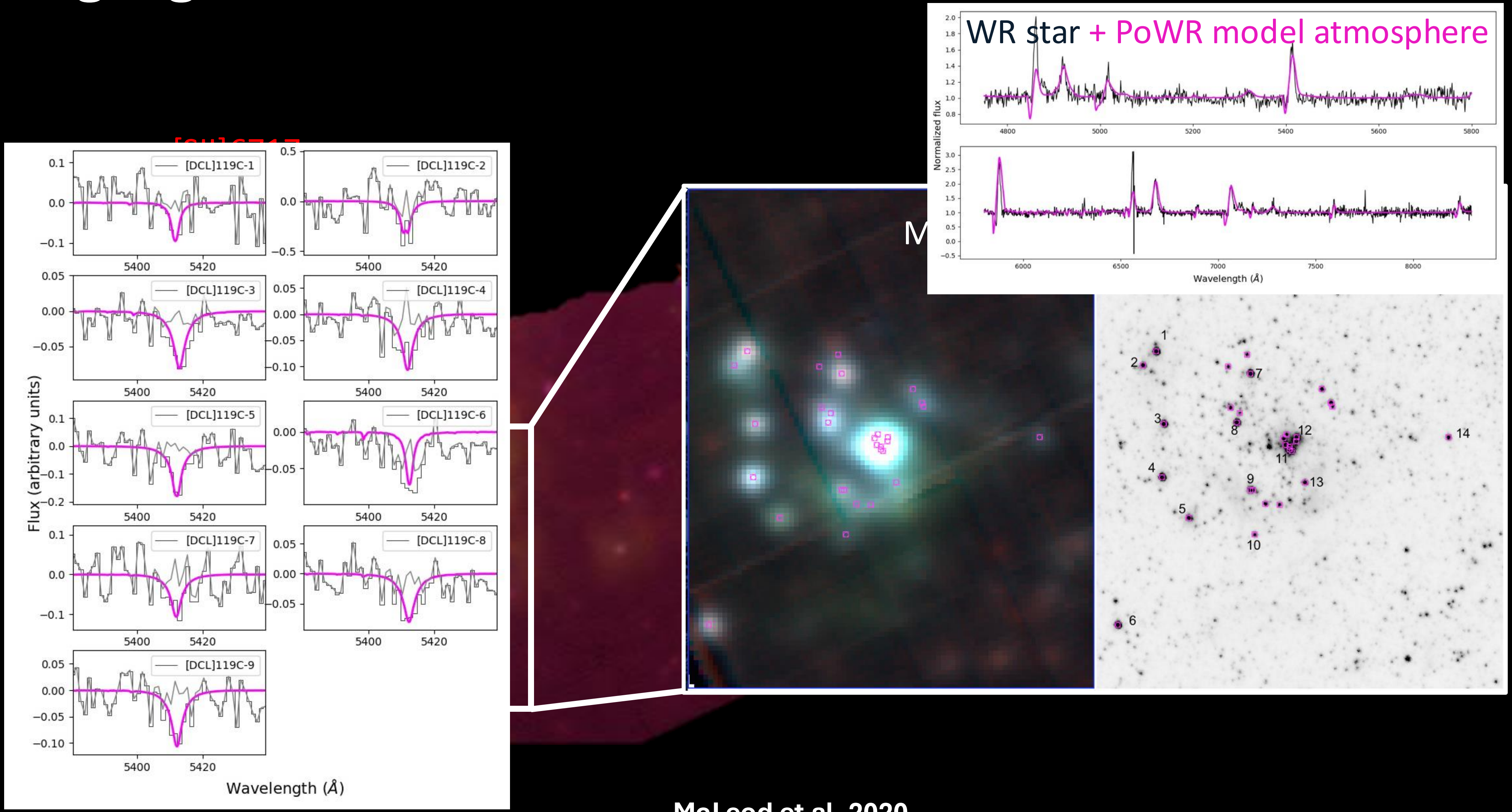

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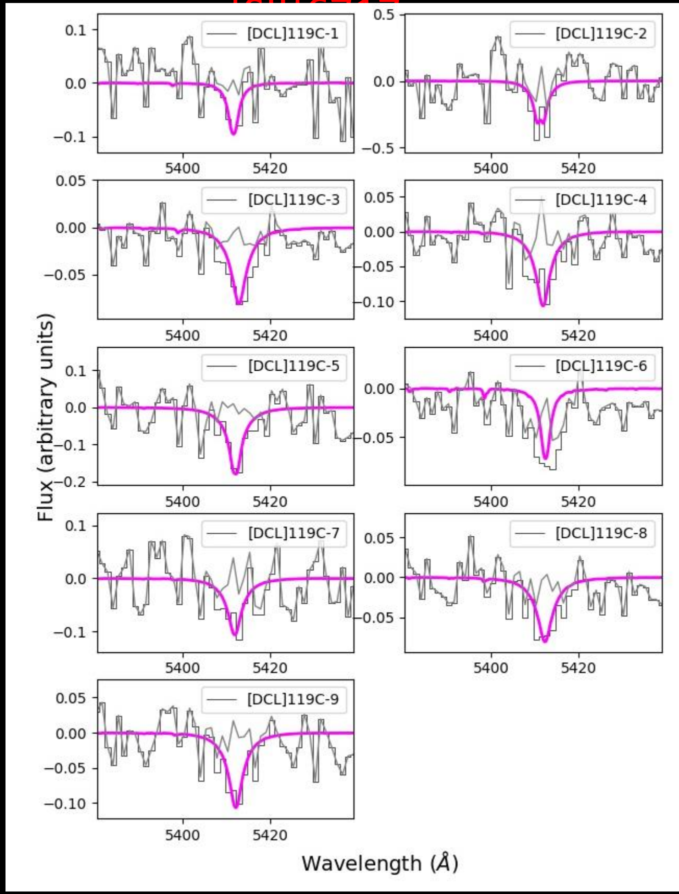

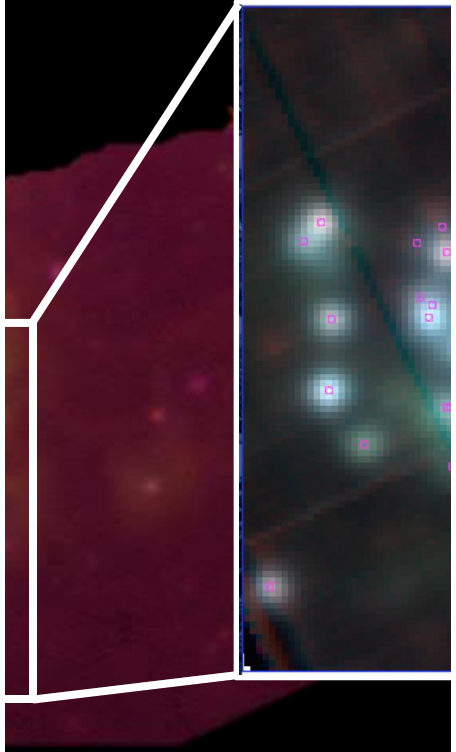

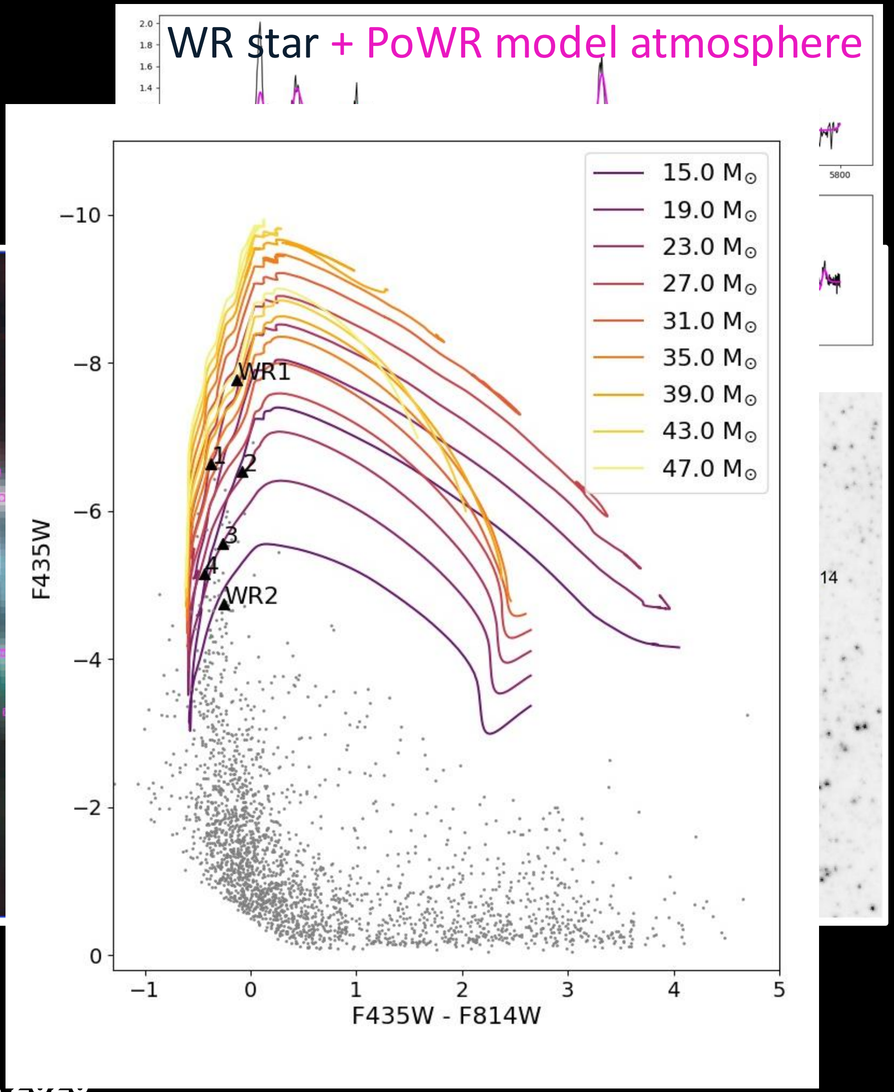

McLeod et al.

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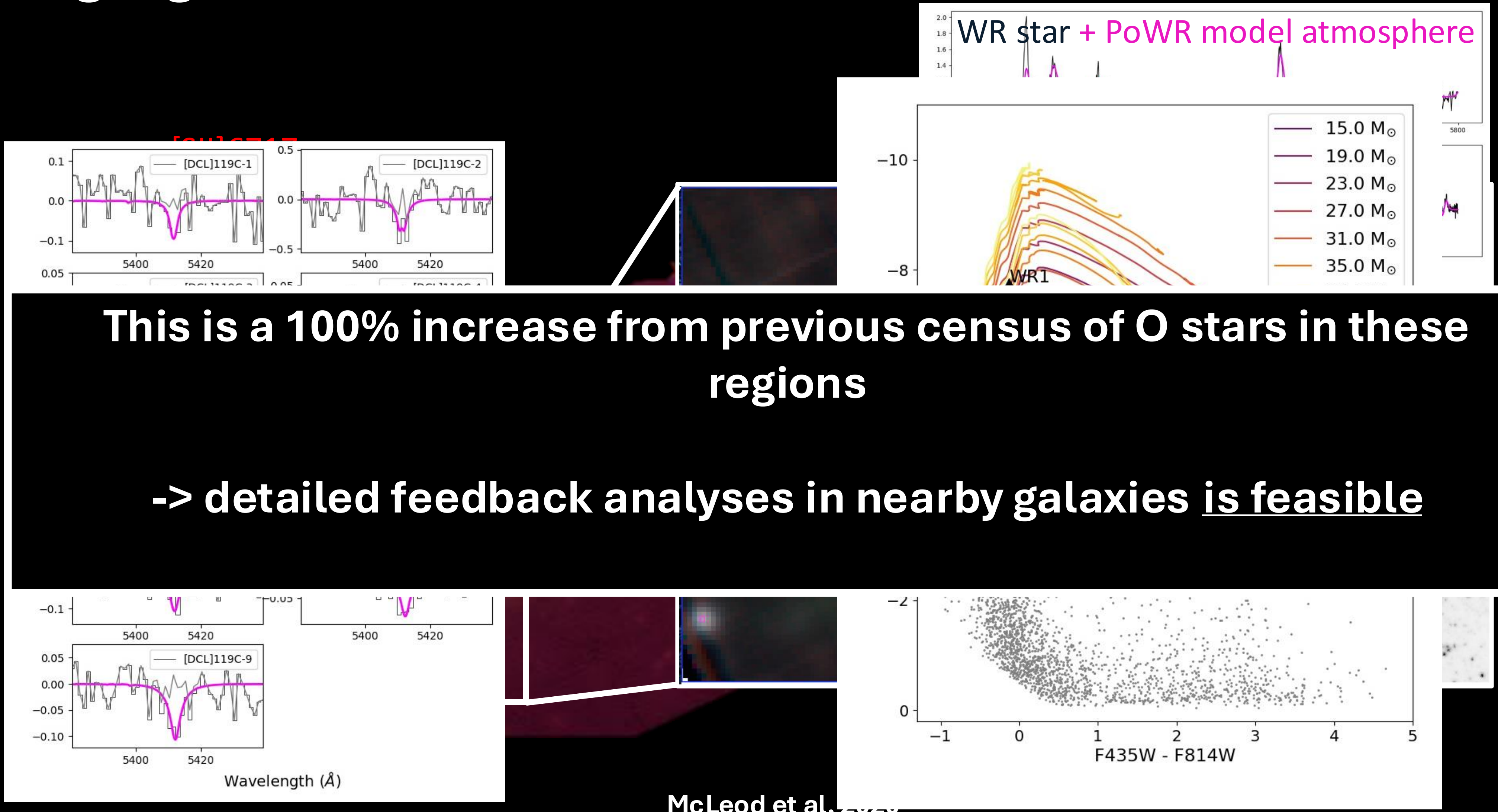
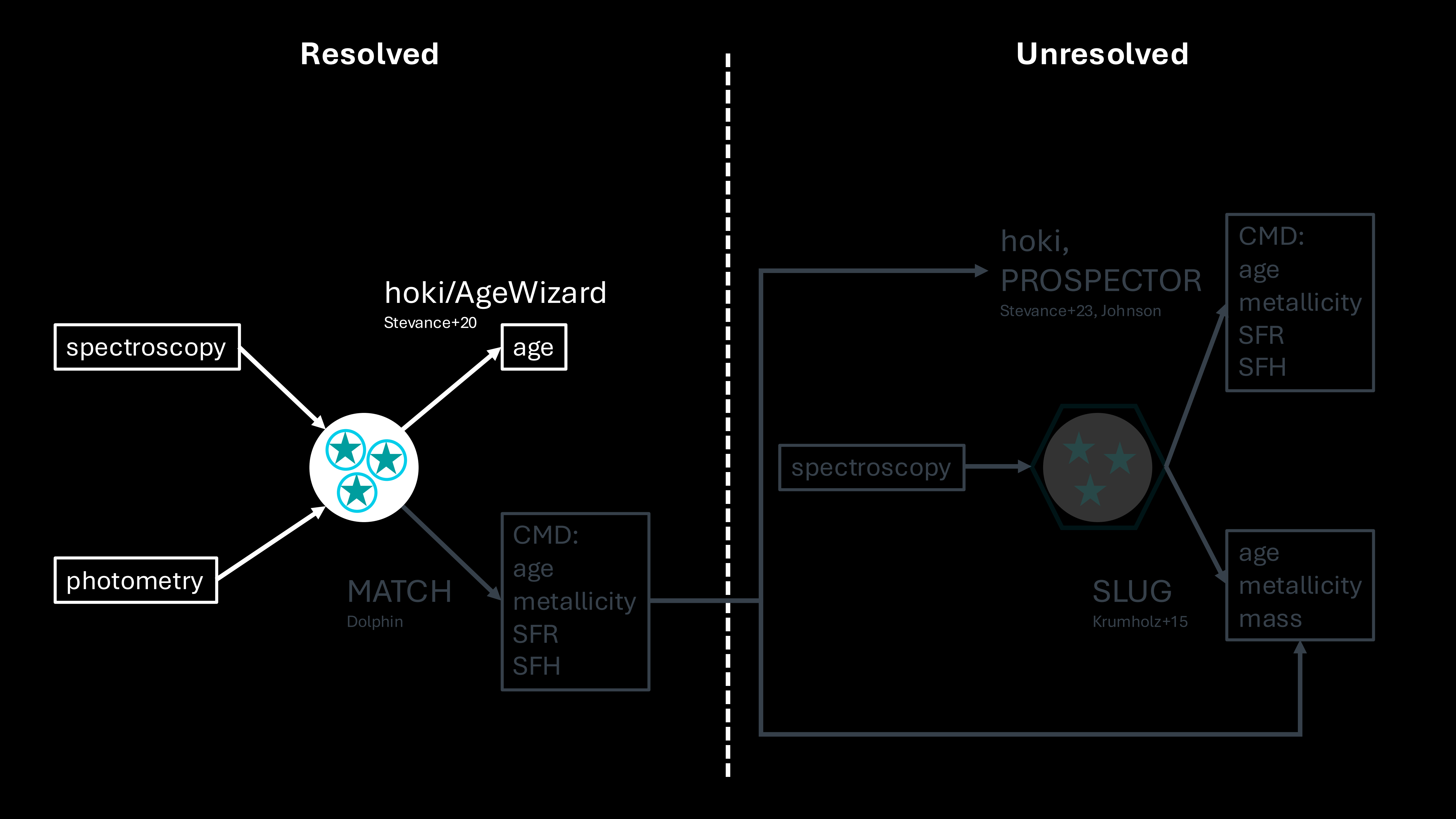


This is a 100% increase from previous census of O stars in these regions

-> detailed feedback analyses in nearby galaxies <u>is feasible</u>

McLeod et al.


Resolved
Unresolved
spectroscopy
photometry
hoki/AgeWizard
Stevance+20
age
MATCH
Dolphin
CMD:
age
metallicity
SFR
SFH
hoki,
PROSPECTOR
Stevance+23, Johnson
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age
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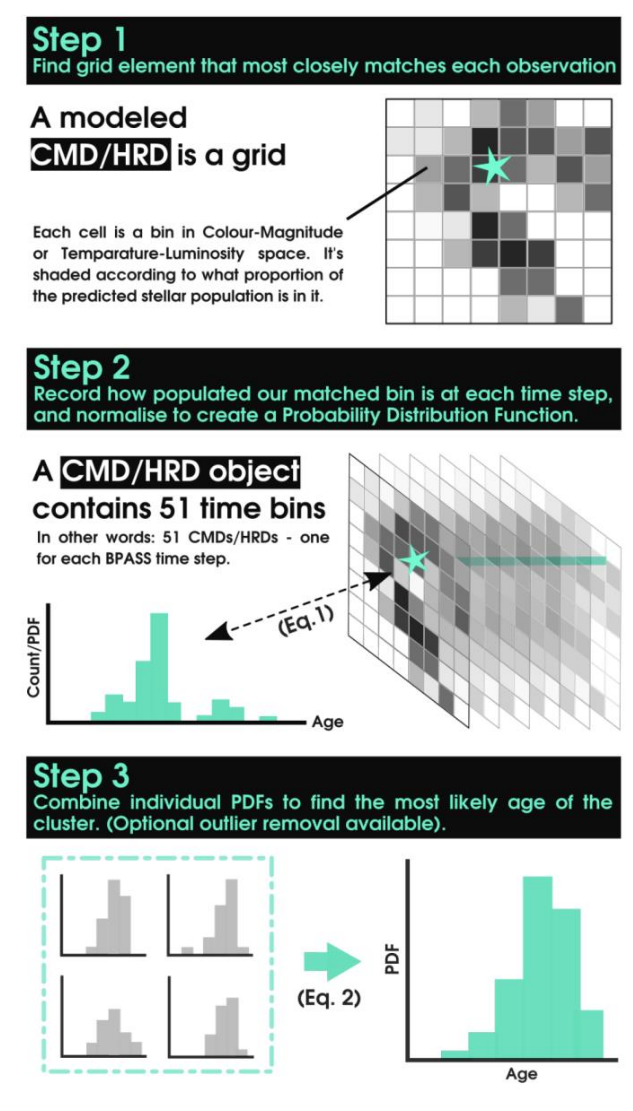
SLUG
Krumholz+15
age
metallicity
mass

From massive stars on a CMD to cluster ages (not using isochrones)

Stevance, Eldridge, McLeod, Stanway, Chrimes, 2020



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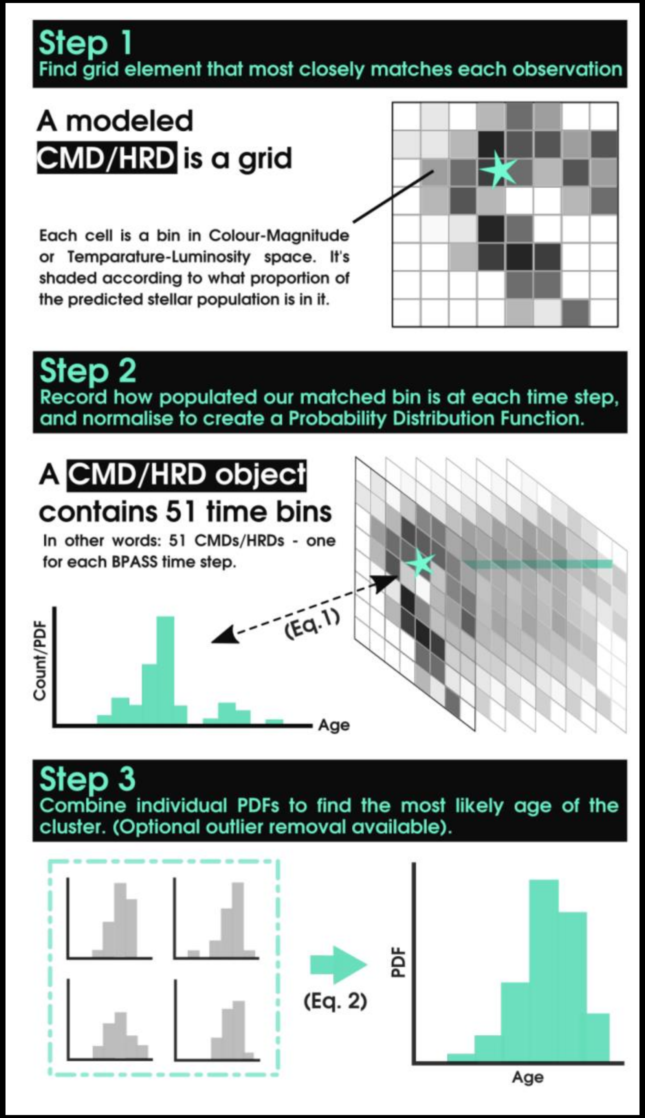

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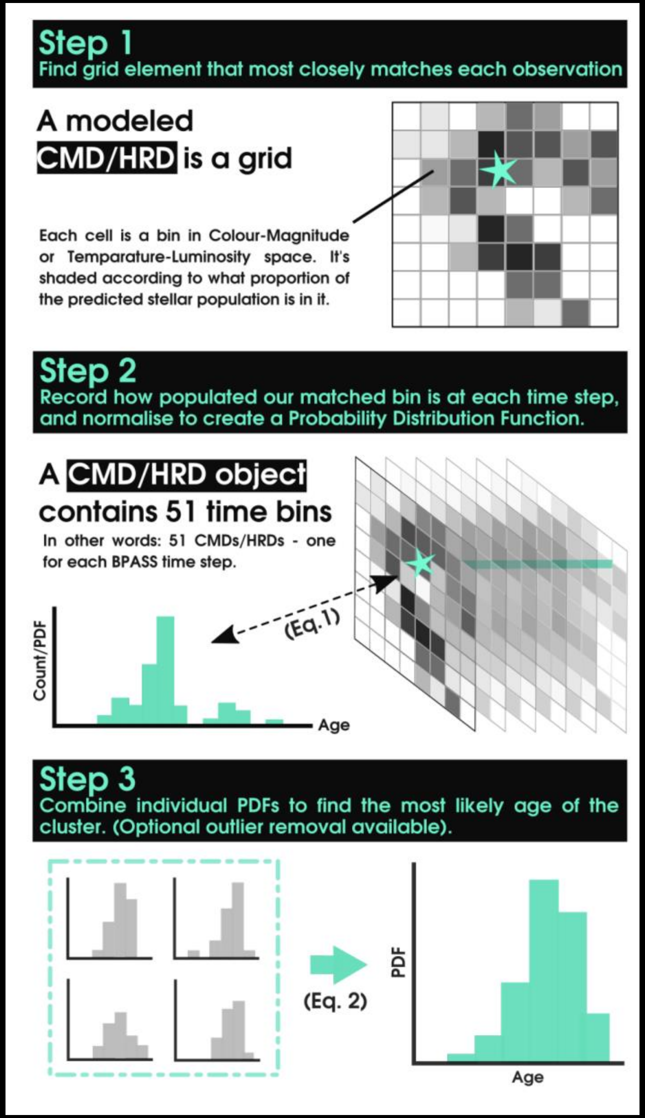

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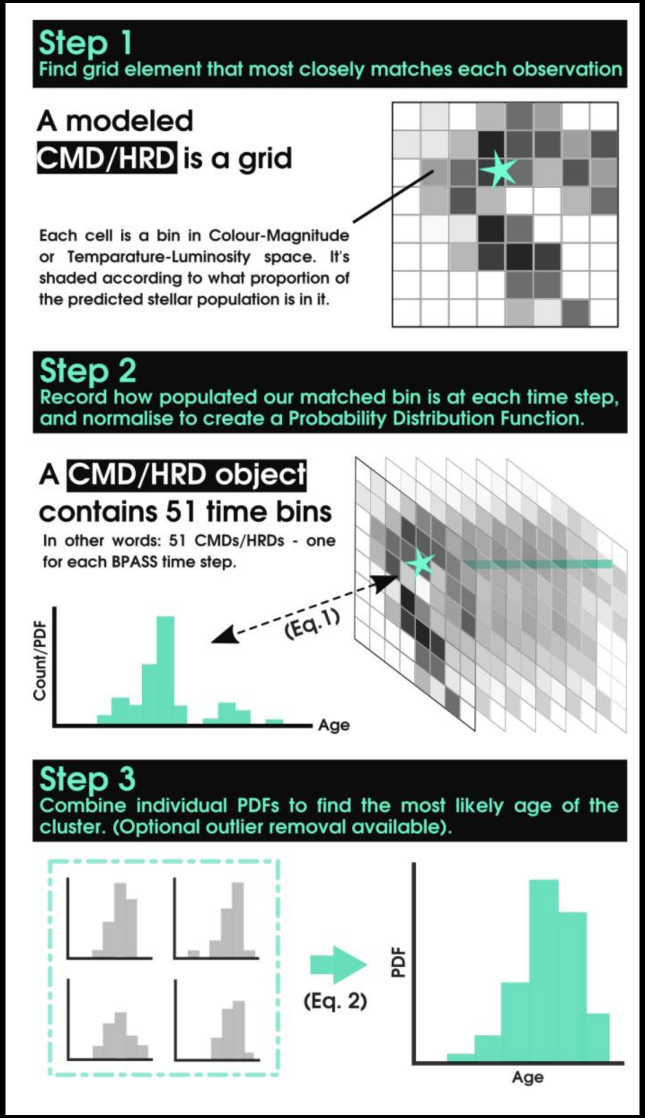

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- Applicable even with small sample sizes

The Spatial Resolution Project

Galaxy	D	Z	IFU	HST
NGC6822	0.5	8.06	SITELLE	archival
IC1613	0.7	7.86	SITELLE	archival
M31	0.8	8.72	SITELLE	PHAT[1]
M33	0.9	8.48	SITELLE	PHAT[2]
Leo P	1.6	7.25	MUSE	archival
NGC 300	2	8.40	MUSE	ANGST[3]
NGC247	3.3	-	SITELLE	ANGST
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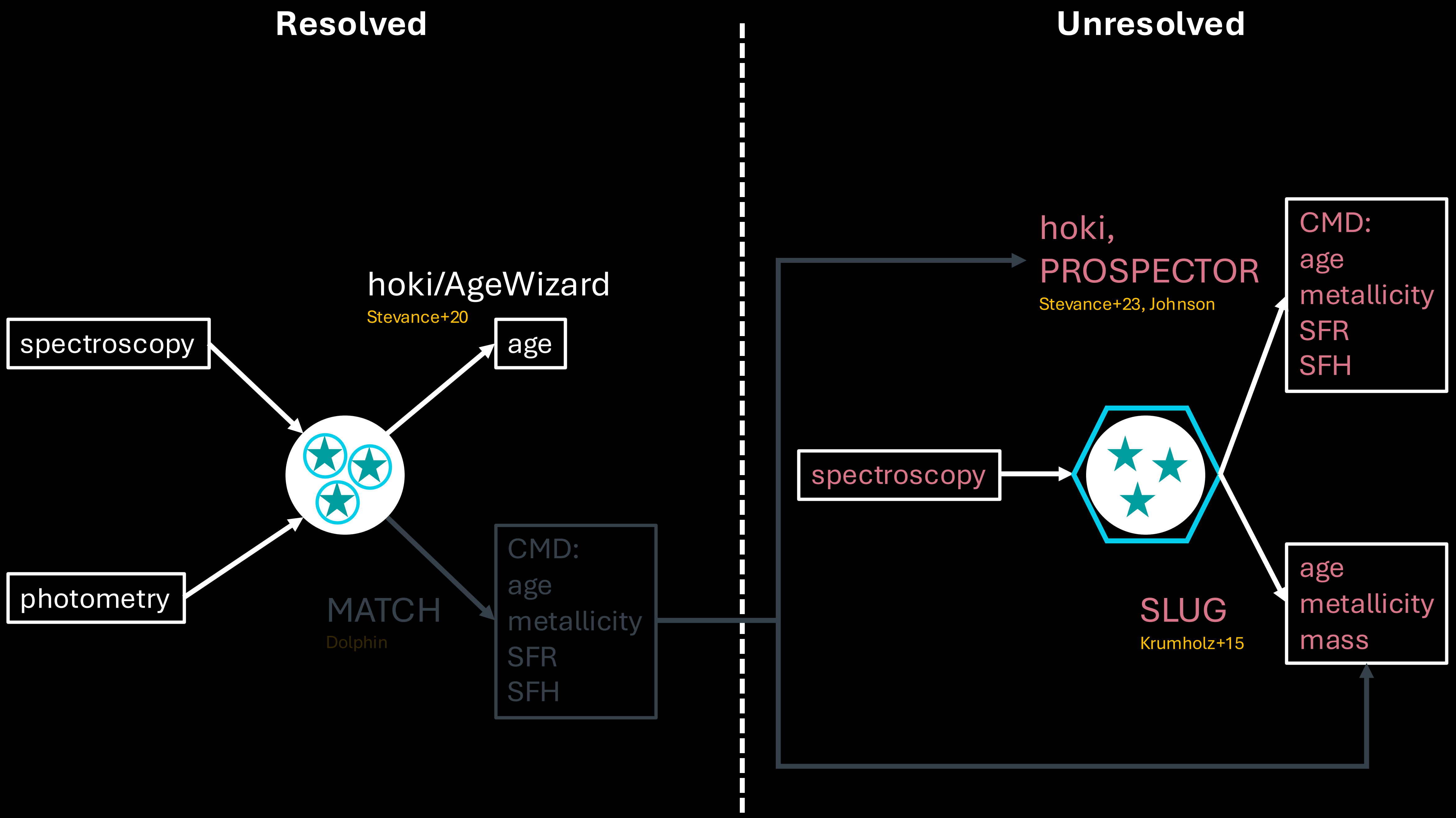
+ future data (LVM, JWST, ...)
+ simulations (e.g., EDGE)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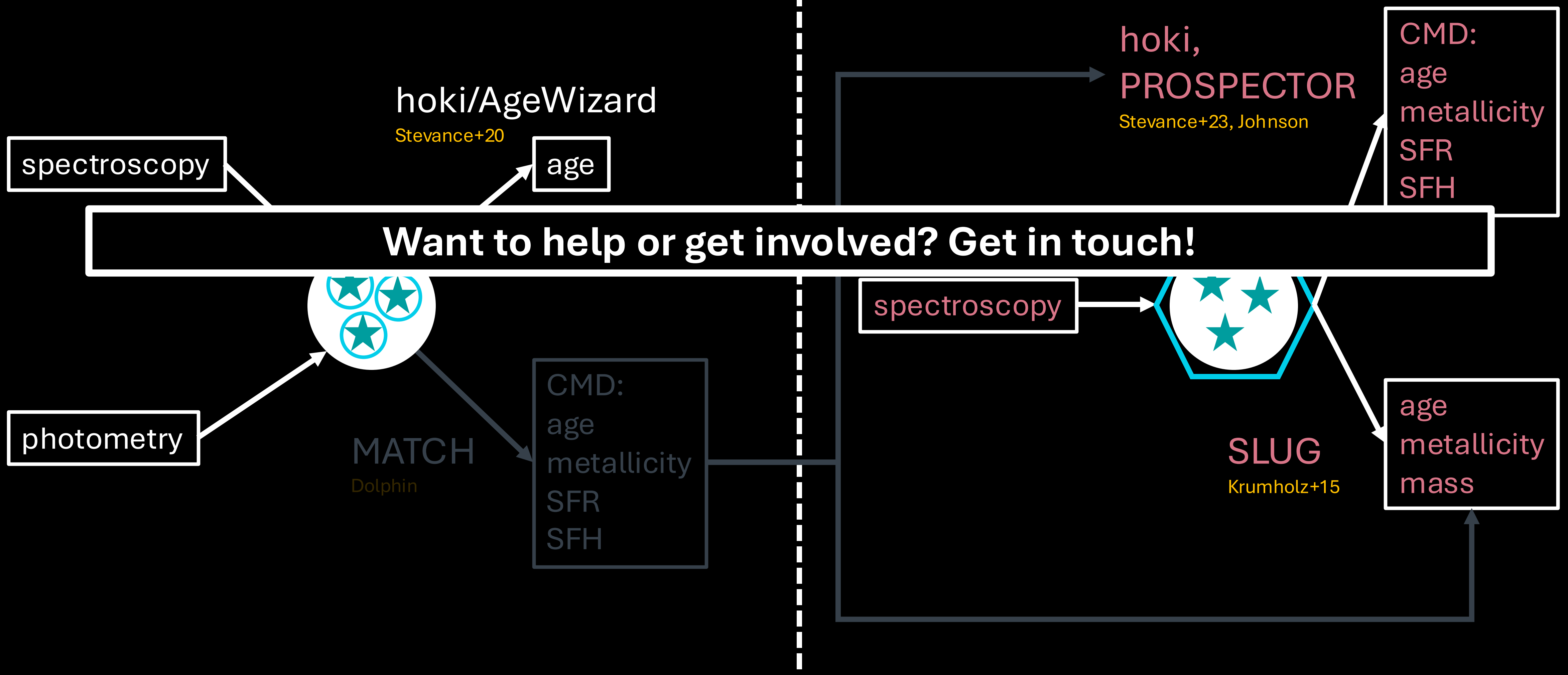

Want to help or get involved? Get in touch!

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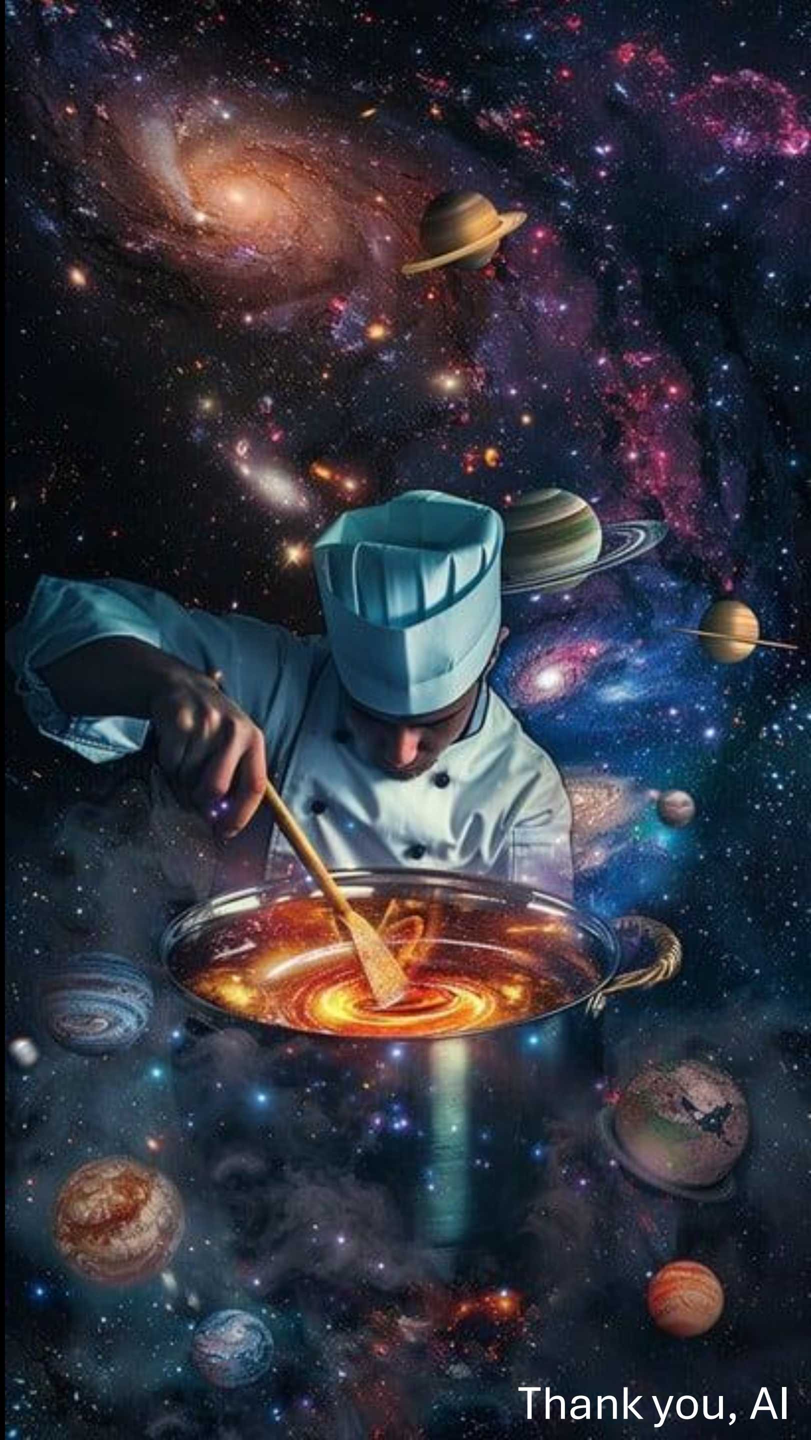
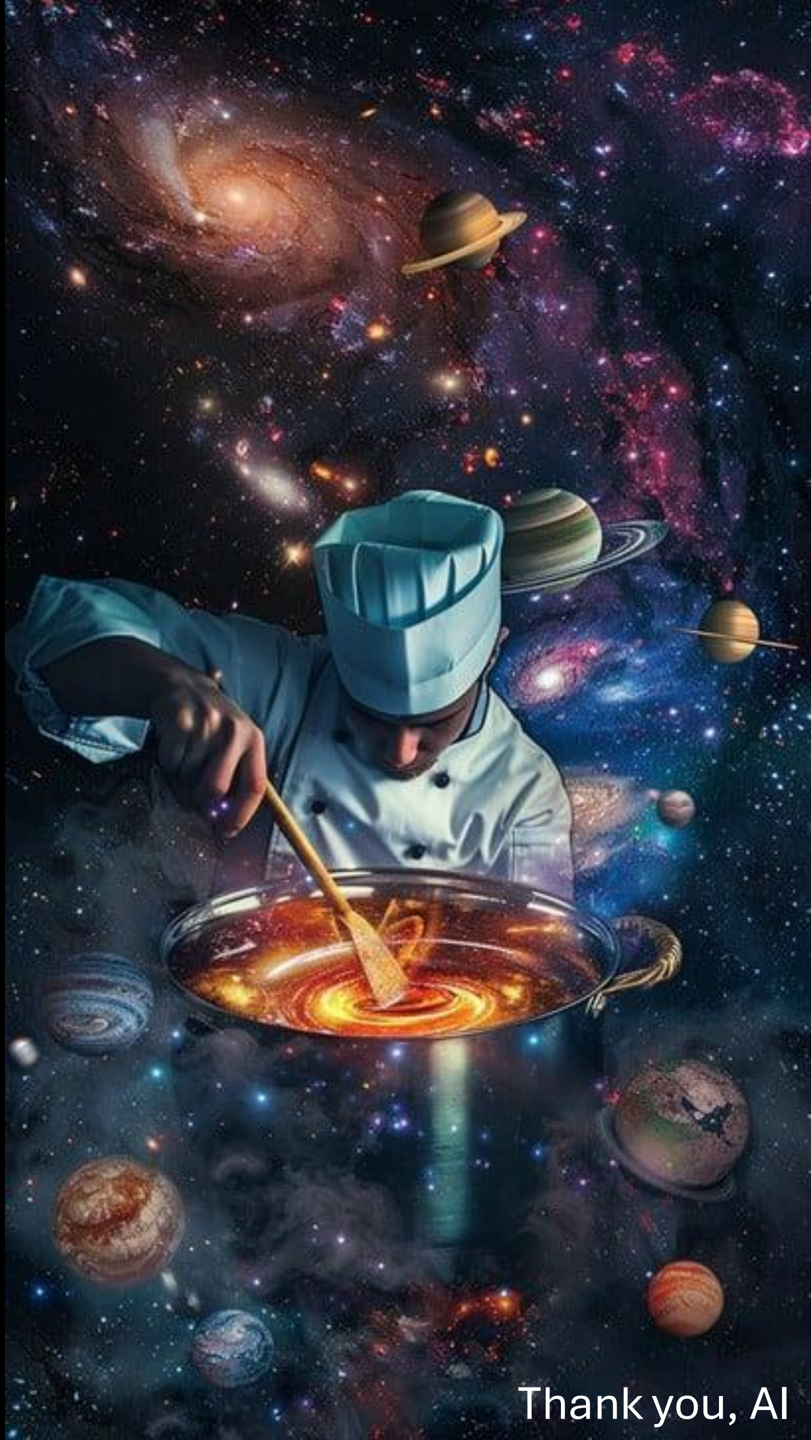
The massive stars in them are sources of feedback and of escaping photons

Putting it all together



Putting it all together

Stellar feedback is the (not so) secret ingredient



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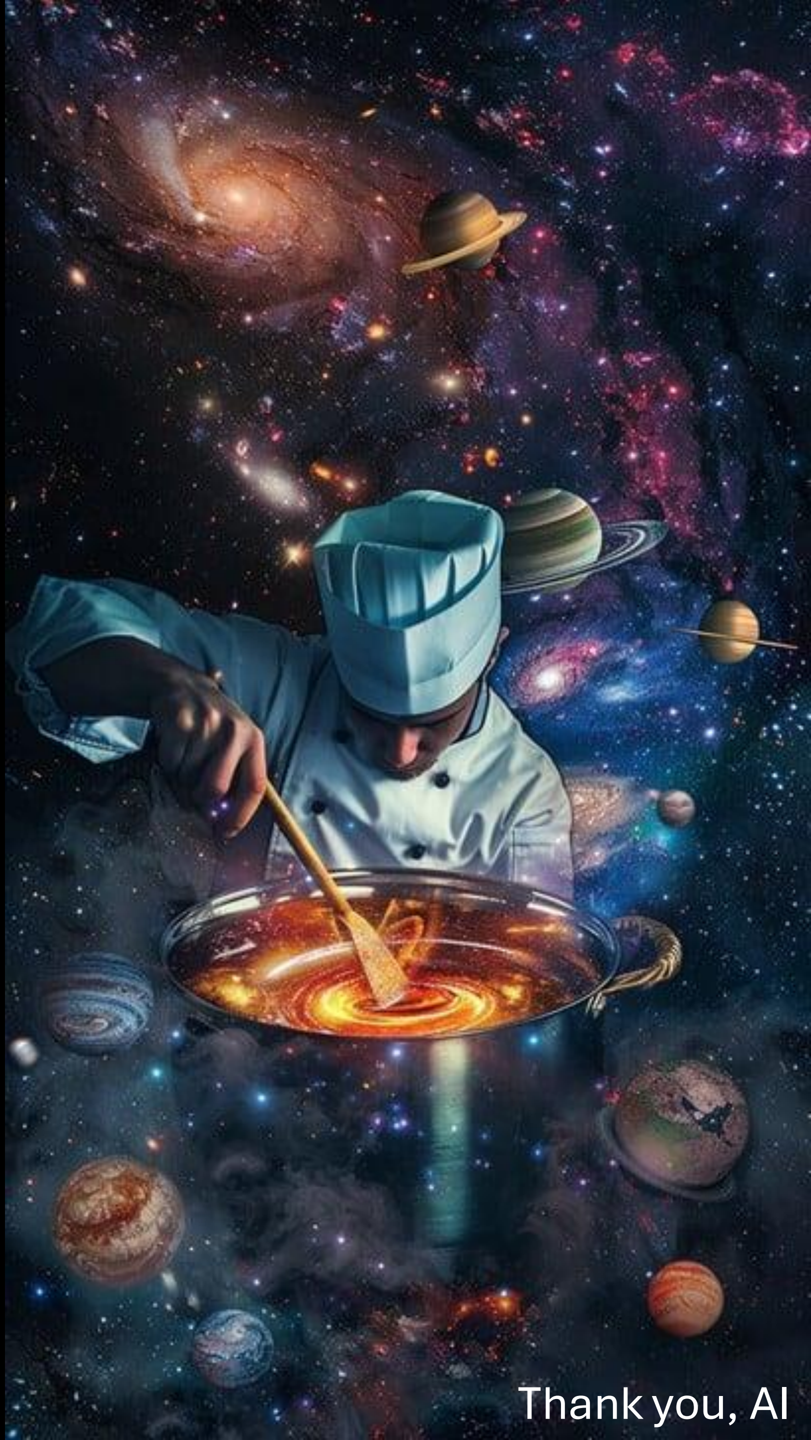

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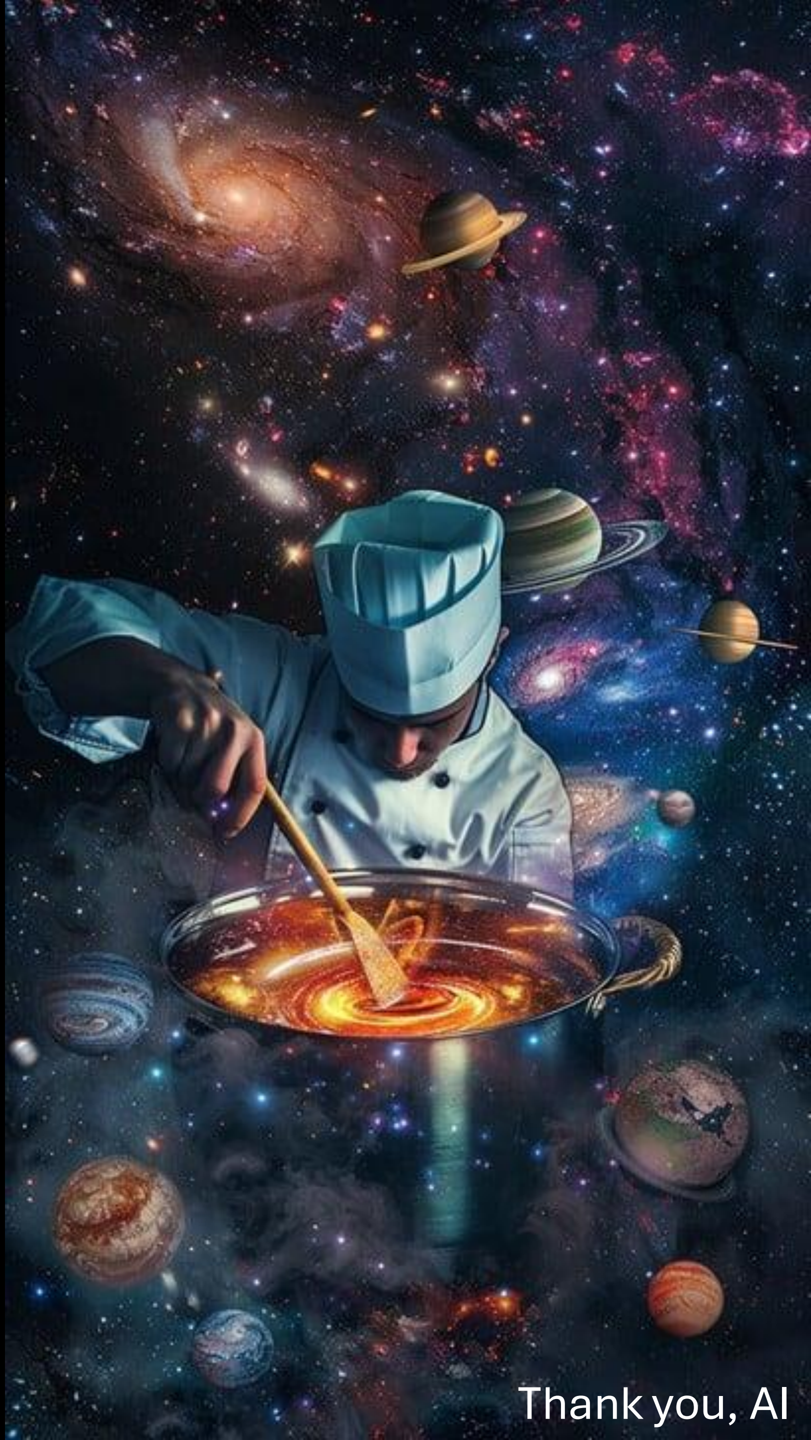

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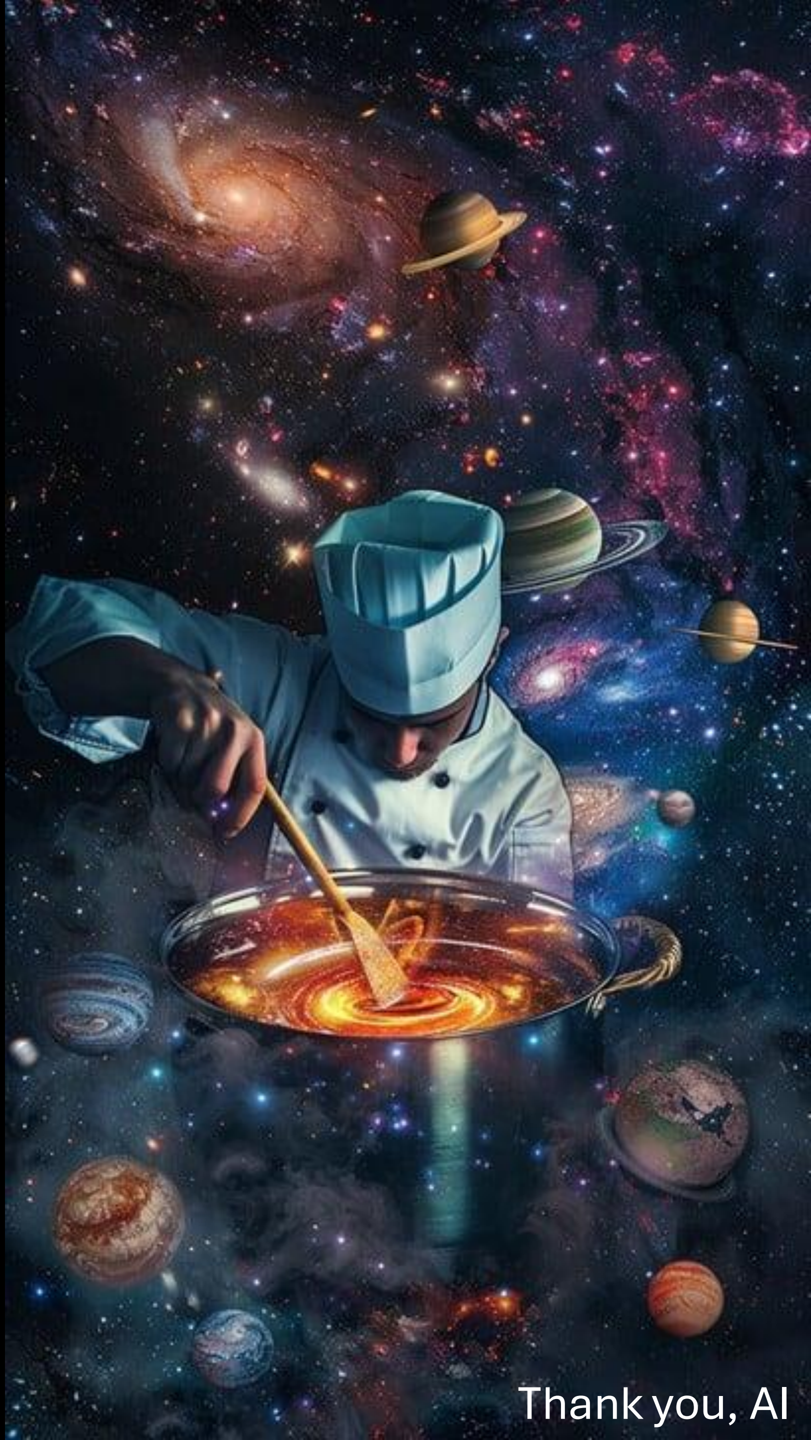

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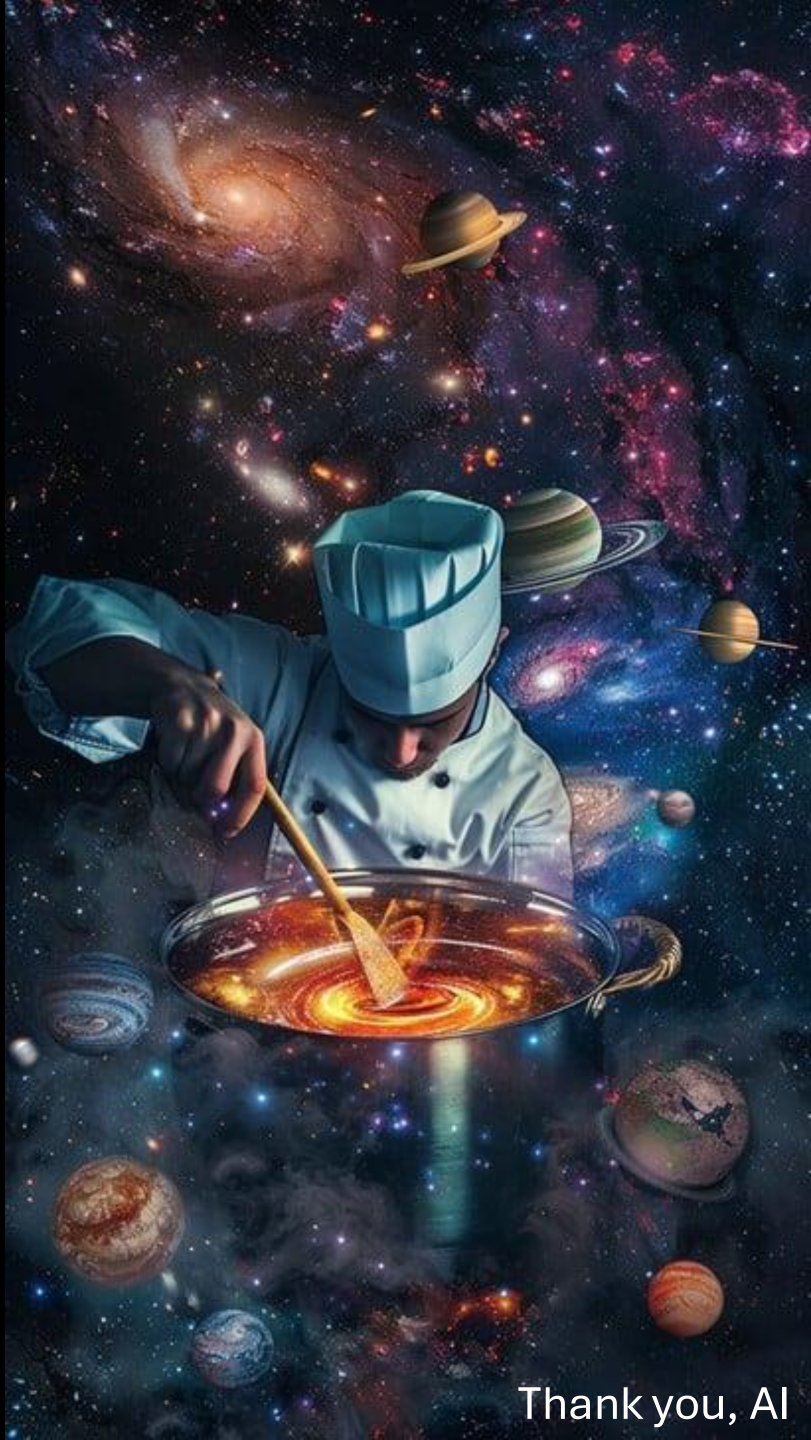
Next step: taste-test the recipe



THE MANY SCALES OF GALAXY ENVIRONMENTS

July 13-17, 2026
Ascona (Switzerland)

The Local Galactic Ecosystem - Star Formation, AGN, and Feedback in Context
Galaxies in the Cosmic Web - Environmental Drivers of Evolution
Cosmic Time and Environmental Transformation
The Environmental Cascade - Linking Mpc to pc Scales

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Benedetta Vulcani (co-chair)	Allison Noble
Sandro Tacchella	Stephanie Tonnesen
Giovanni Cresci	Hannah Übler
Angela Adamo