Group 7: Multigris

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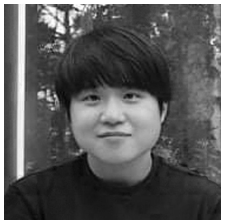


Observed line fluxes + input parameter distribution

- Select a model grid context
- Select a model configuration
- PyMC does its Bayesian inference

Predicted line fluxes + posterior probability of parameters

Installation:

- Can be found in GitLab:

```
git clone --depth 1
https://gitlab.com/MULTIGRIS/mgris.git
```

- Install model contexts via git lfs:

```
./install_contexts.sh
```

- Install PyMC and its dependencies

Best to use a virtual environment

- Pre-process model grid:

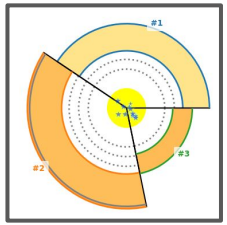
```
pre-processing.py
```

Input file structure:

```
output Results_directory/
.
context Contexts/mgris_bond
.
USE configuration 1C1S_shell
.
BEGIN observations linear
BLND_372700A 0.286 0.0067779
H__1_486133A 1 1e-06
NE_3_386876A 0.158 0.0047319
BLND_436300A 0.064 0.0031699
O__3_500684A 1.91 0.044538
HE_1_587564A 0.064 0.0031699
N__2_658345A 0.009 0.0020052
delta_add 0.1
scale_factor 1
END
.
obs_to_predict ['HE_1_447149A']
```

Configuration example:

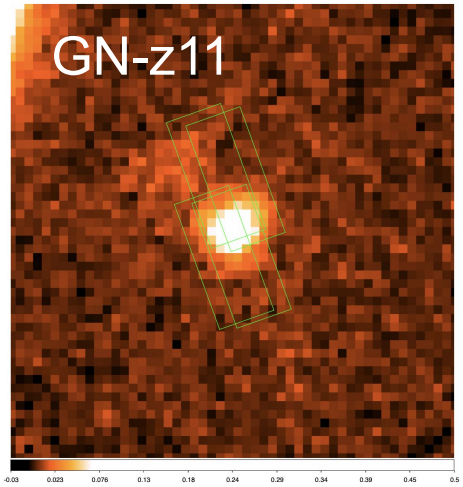
```
BEGIN configuration 1C1S_shell
# single representative
cluster, single sector
n_comps 1
# shell
select geom [3,3]
END
```



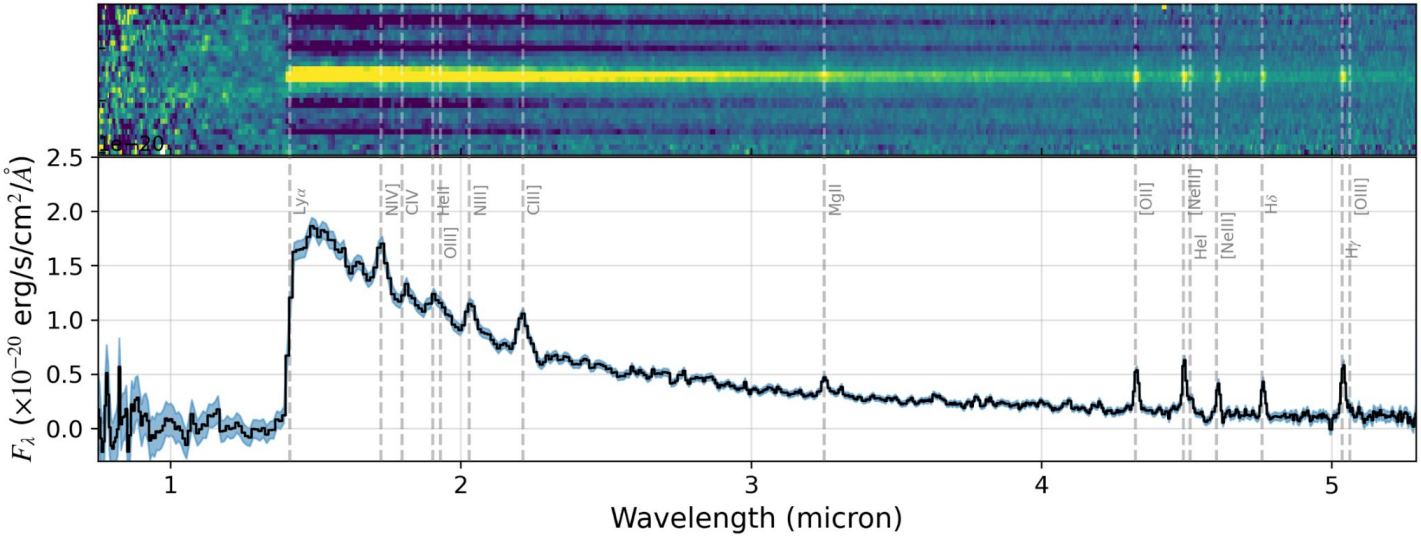
Running Multigris:

```
python mgris_search.py -v input_file.txt

python mgris_process.py -v input_file.txt

python mgris_post_process.py -v input_file.txt
```

Application 1: Deriving physical properties of ISM of a galaxy at z = 10.60 with MULTIGRIS



Bunker et al. (2023)



BEAGLE SED fitting:

Parameter	GN-z11
$\log(M/\mathrm{M}_\odot)$	$8.73^{+0.06}_{-0.06}$
$\psi/\mathrm{M}_\odot\ \mathrm{yr}^{-1}$	$18.78^{+0.81}_{-0.69}$
$\log(t/\mathrm{yr})$	$7.27^{+0.19}_{-0.15}$
$\log(t_\mathrm{M}/\mathrm{yr})$	$7.01^{+0.1}_{-0.07}$
$\log(Z_\mathrm{neb}/Z_\odot)$	$-0.92^{+0.06}_{-0.05}$
$\log U_\mathrm{S}$	$-2.25^{+0.97}_{-0.87}$
A_V	$0.17^{+0.03}_{-0.03}$
$\log(\xi_\mathrm{ion}/\mathrm{erg}^{-1}\mathrm{Hz})$	$25.67^{+0.02}_{-0.02}$
f_esc	$0.03^{+0.05}_{-0.02}$

Application 1: Deriving physical properties of ISM of a galaxy at z = 10.60 with MULTIGRIS

BOND (Cloudy; Vale Asari+ 2016) model grid fitting:

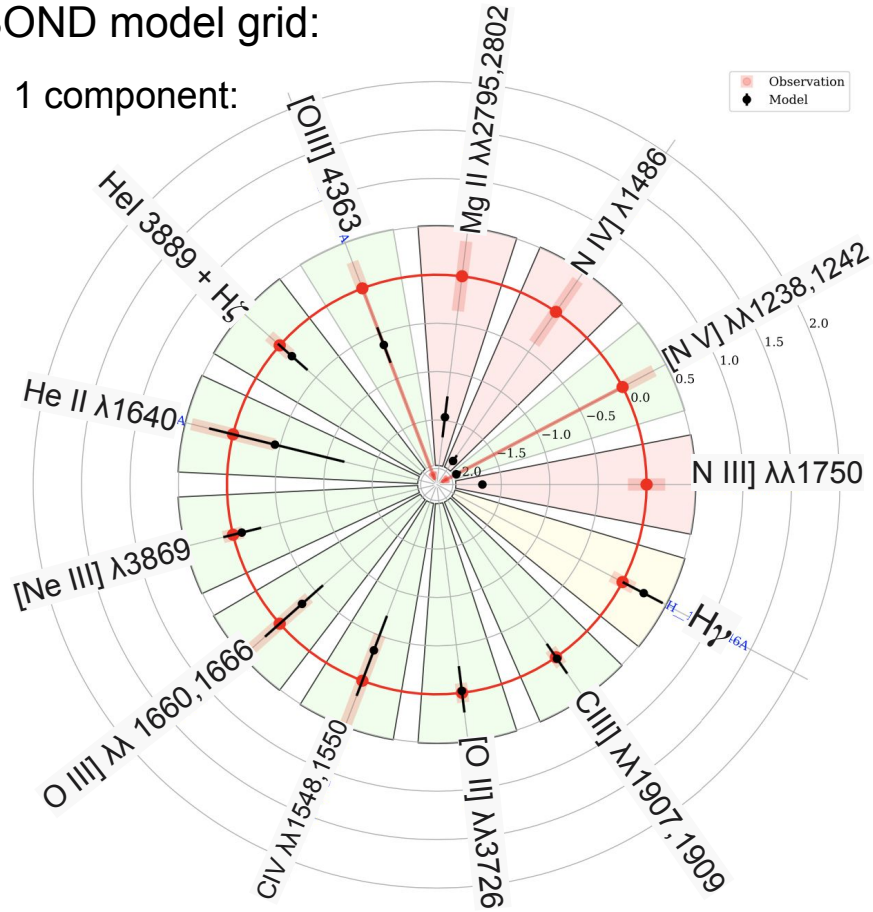
1 component			
	Median	Upper error	Lower error
logU	-2.19	+5.55e-1	-3.63e-1
log(age/yr)	5.91e-1	+5.9e-2	-4.56e-1
log(N/O)	-1.01	+1.36e-1	-2.58e-1
$\log(Z/Z_{\odot})$	-6.14e-1	+2.24e-1	-2.26e-1

2 component			
	Median	Upper error	Lower error
logU	-1.77 -2.57	+6.52e-1 +1.08	-5.97e-1 -1.3
log(age/yr)	5.7e-1 5.43e-1	+8.02e-2 +2.25e-1	-4.95e-1 -4.34e-1
log(N/O)	-9.99e-1 -9.99e-1	+1.36e-1 +1.36e-1	-2.79e-1 -2.79e-1
$\log(Z/Z_{\odot})$	-6.5e-1 -6.5e-1	+2.59e-1 +2.59e-1	-1.91e-1 -1.91e-1

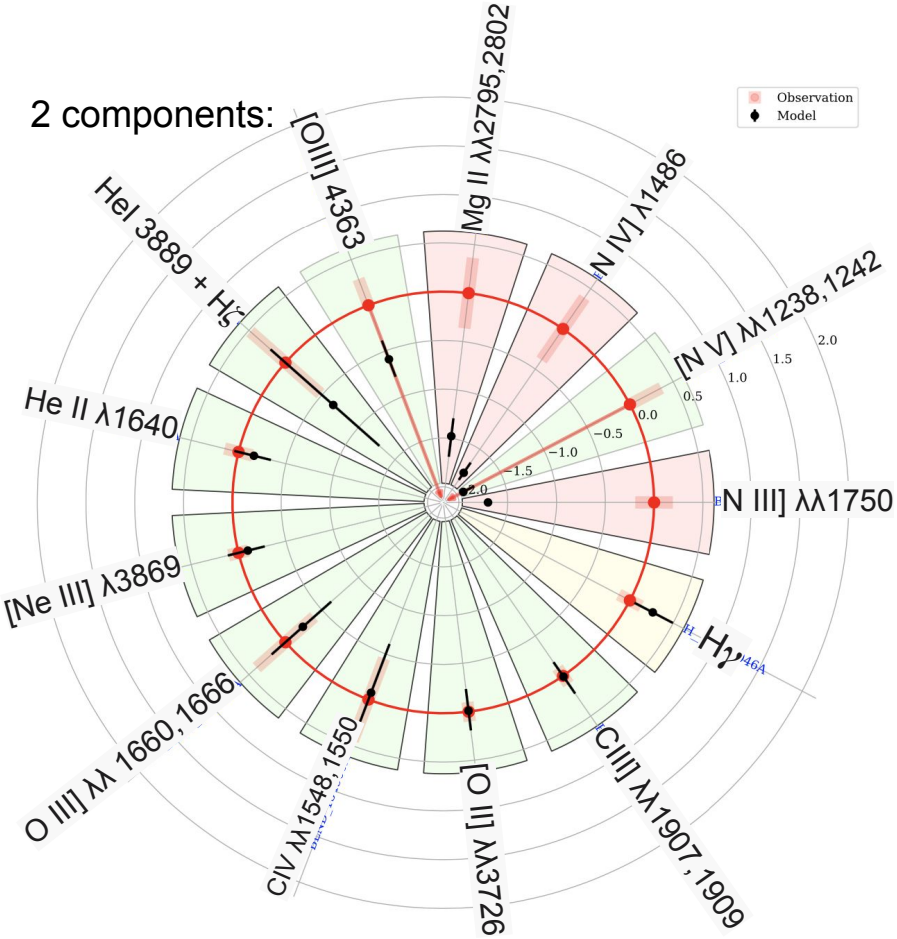
Application 1: Deriving physical properties of ISM of a galaxy at z = 10.60 with MULTIGRIS

BOND model grid:

1 component:



2 components:



Application 1: Deriving physical properties of ISM of a galaxy at z = 10.60 with MULTIGRIS

LOC (locally optimally emitting clouds; Richardson+ 2019) model grid:

AGN fraction: 0%			
	Median	Upper error	Lower error
logU	-2.01	+2.95e-1	-3.07e-1
log(age/yr)	7.10	+3.93e-1	-7.63e-1
$\log(Z/Z_{\odot})$	-9.42e-1	+2.45e-1	-1.76e-1
$\log(n/cm^{-3})$	1.85	+1.43	-1.01

AGN fraction: 16%			
	Median	Upper error	Lower error
logU	-2.05	+3.57e-1	-3.09e-1
log(age/yr)	7.24	+2.41e-1	-8.18e-1
$\log(Z/Z_{\odot})$	-7.22e-1	+4.17e-1	-1.98e-1
$\log(n/cm^{-3})$	2.89	+6.51e-1	-1.99

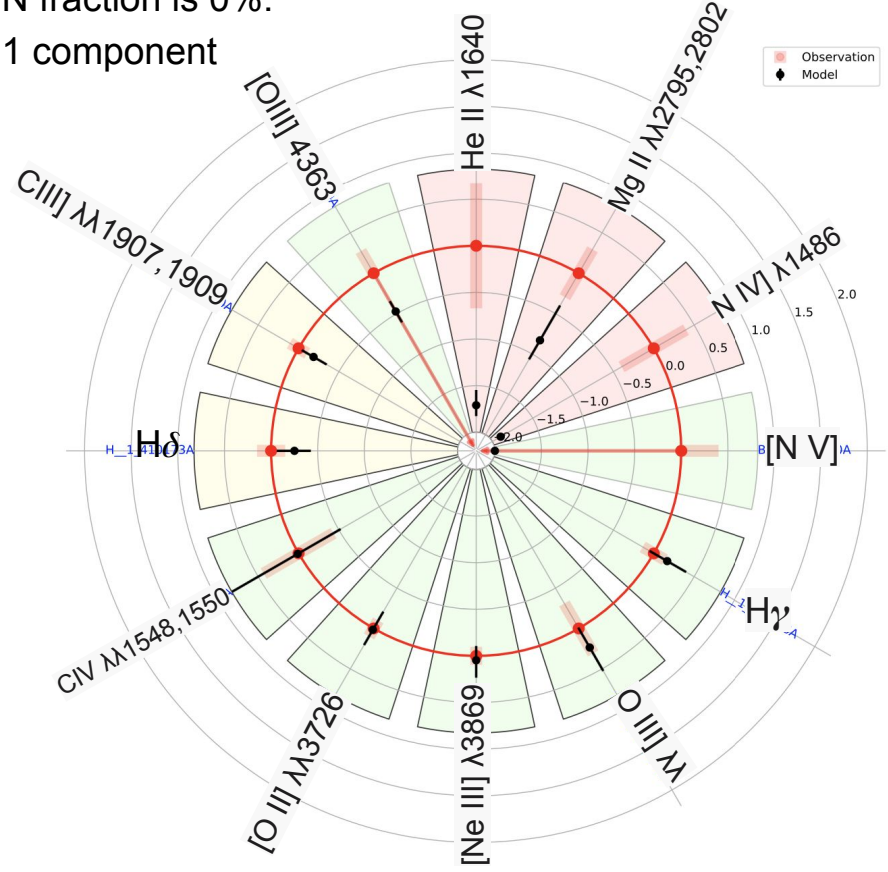
→The AGN fraction may be close to 0 in GN-z11

Application 1: Deriving physical properties of ISM of a galaxy at z = 10.60 with MULTIGRIS

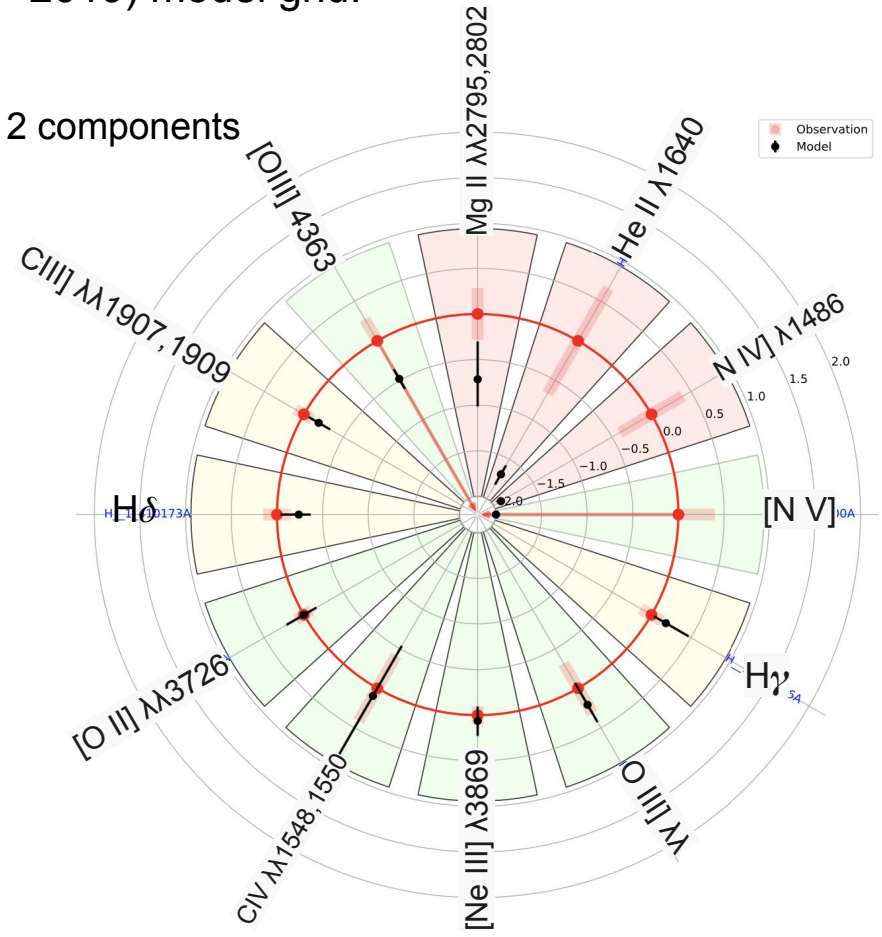
LOC (locally optimally emitting clouds; Richardson+ 2019) model grid:

AGN fraction is 0%:

1 component

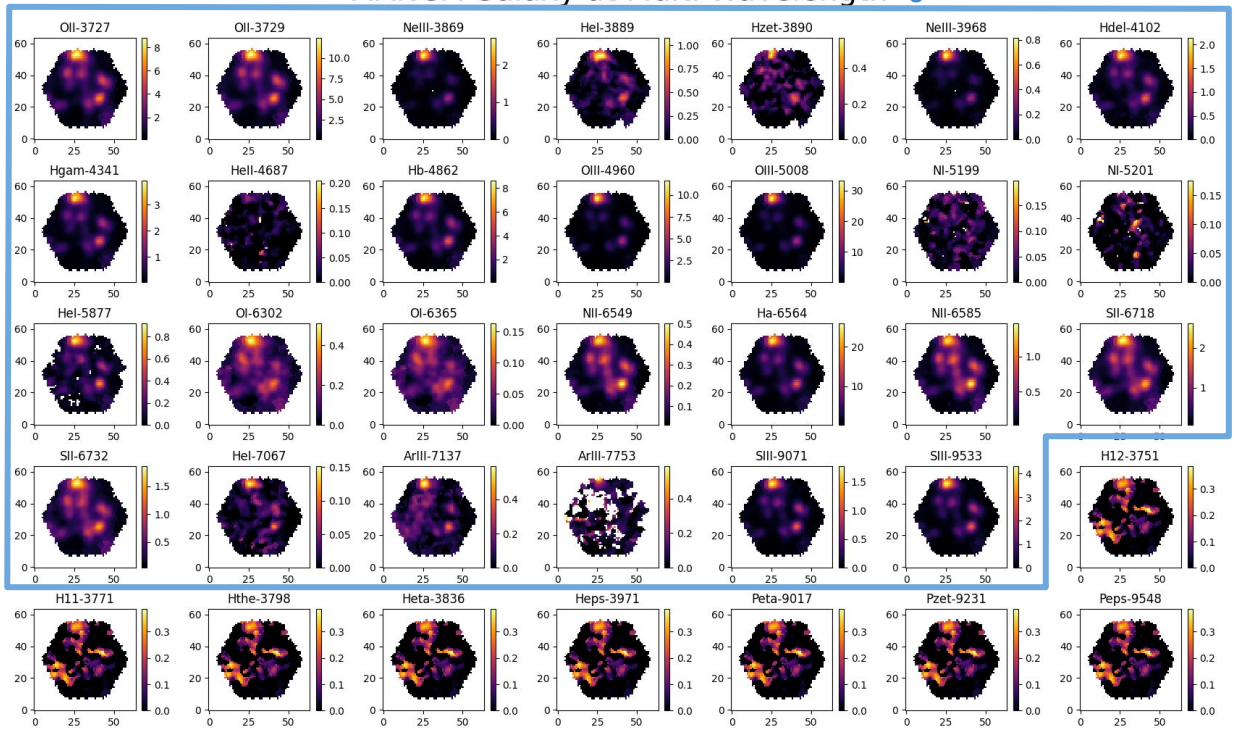


2 components



Application #2 : Compare Z with MANGA

Available in Cloudy model grids BOND and SFGX

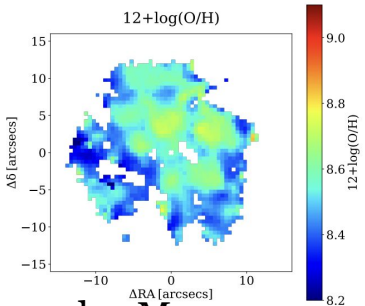


Expensive! Reduce to $\sum_{IFU} I_i(x,y)$

Predict?

$$P(\theta_z | Obs, M_{cloudy})$$

& Compare Z from MANGA



log M ~ 9.1

Mingozzi+20

mgris Model

Input

$$\sum_{IFU} I_i(x, y)$$

27 available lines

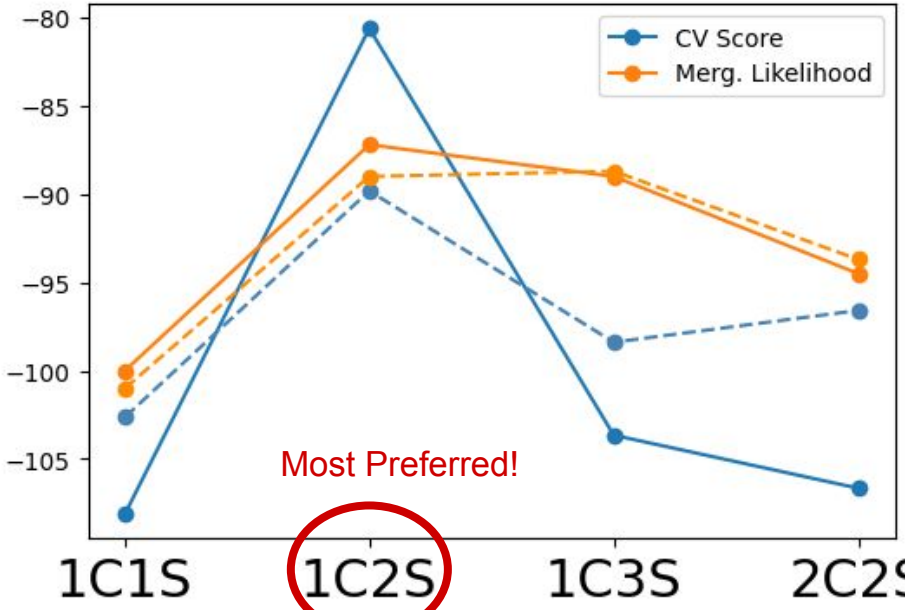
MULTIGRIS

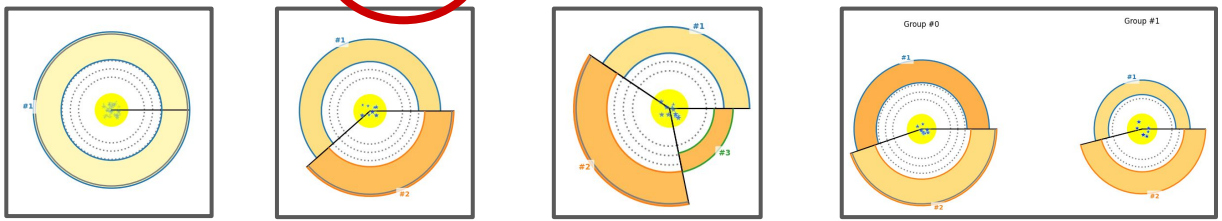
Many models

Output

$$P(\theta_z | Obs, M_{cloudy})$$

- Dust extinction E(B-V)
- He/H correction
- Prior

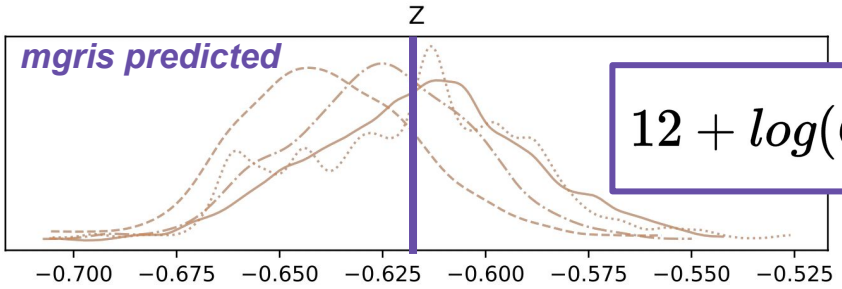




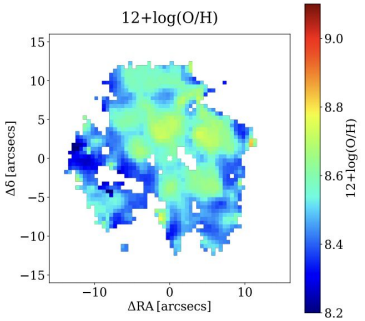
More Complex >

Predicted Metallicity vs MaNGA Metallicity

Mingozzi+20



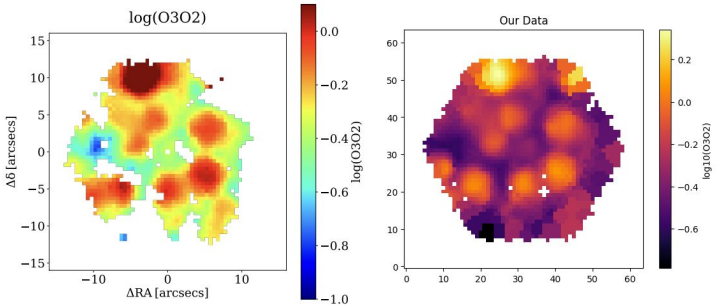
$$12 + log(O/H) = 8.066^{+0.097}_{-0.046}$$



$12+\log(O/H) \sim 8.5$

Mgris under-predicted the metallicity, Why?

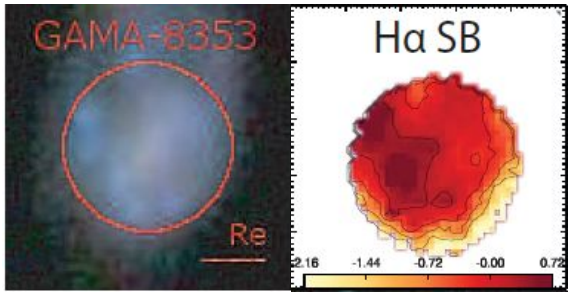
- Perhaps too many lines to simple model?
- Ratios of ones of strongest emission lines, (OII-3727, OII-3729, OIII-4960, OIII-5008) don't seem to agree with Mingozzi+20's O3O2 (emission lines that they used to process Z are weighted differently?).



Application 3

Deriving physical properties of galaxy ISM from SAMI galaxy survey

About the object: Poetrodjojo et.al. 2018



SDSS composite image obtained from DR10 and corresponding H_alpha map

GAMA	RA	Dec	z	log(Mass)	SFR	R_e	Elip	PA
	deg	deg		$M_*/M_\odot$	$M_\odot$/yr	arcsec	1-(b/a)	
008353	182.0164	0.6976	0.020	9.35	0.51	5.37	0.373	58.9

Spectral lines used in the model: Mgris

Line_Id	Int_lineflux	error
H__1_486133A	4.9097996	0.001857
H__1_656281A	12.232899	0.001857
O__1_630030A	2.268631	0.000762
O__2_372881A	35.496704	0.018156
O__3_500684A	4.823922	0.002079
N__2_658345A	2.6924129	0.001212
S__2_671644A	2.7384005	0.001216
S__2_673082A	3.3369405	0.001181

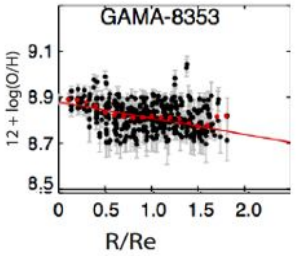
Units in: 10**(-16) erg/s/cm**2/angstrom/pixel / units

Parameters → MULTIGRIS

Estimation from Mgris

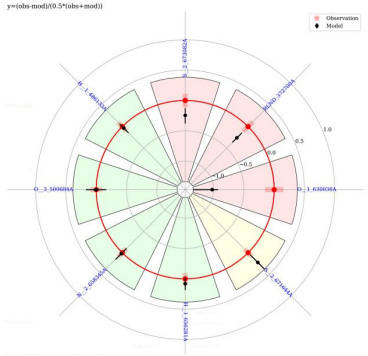
Mgris prediction	Metallicity from 1C1S	Metallicity from 1C2S	Metallicity from Z distribution
Z	-2.88e-01	-2.83e-01	-3.90e-01
+ve err bound	+9.52e-02	+2.54e-01	+2.15e-01
-ve err bound	-9.94e-02	-2.50e-01	-1.77e-01

Metallicity from Poetrodjojo et.al. 2018



GAMA ID	Central Metallicity 12+log(O/H)	Gradient dex/Re	RMS	PCC
008353	8.831±0.007	-0.061±0.007	0.081	-0.33

Z=0.131 (Assuming a specific calibrations, see fig 2, in the paper)



Reasons of discrepancy:

- Matter bounded models
- OI 6300A line is hard to recover