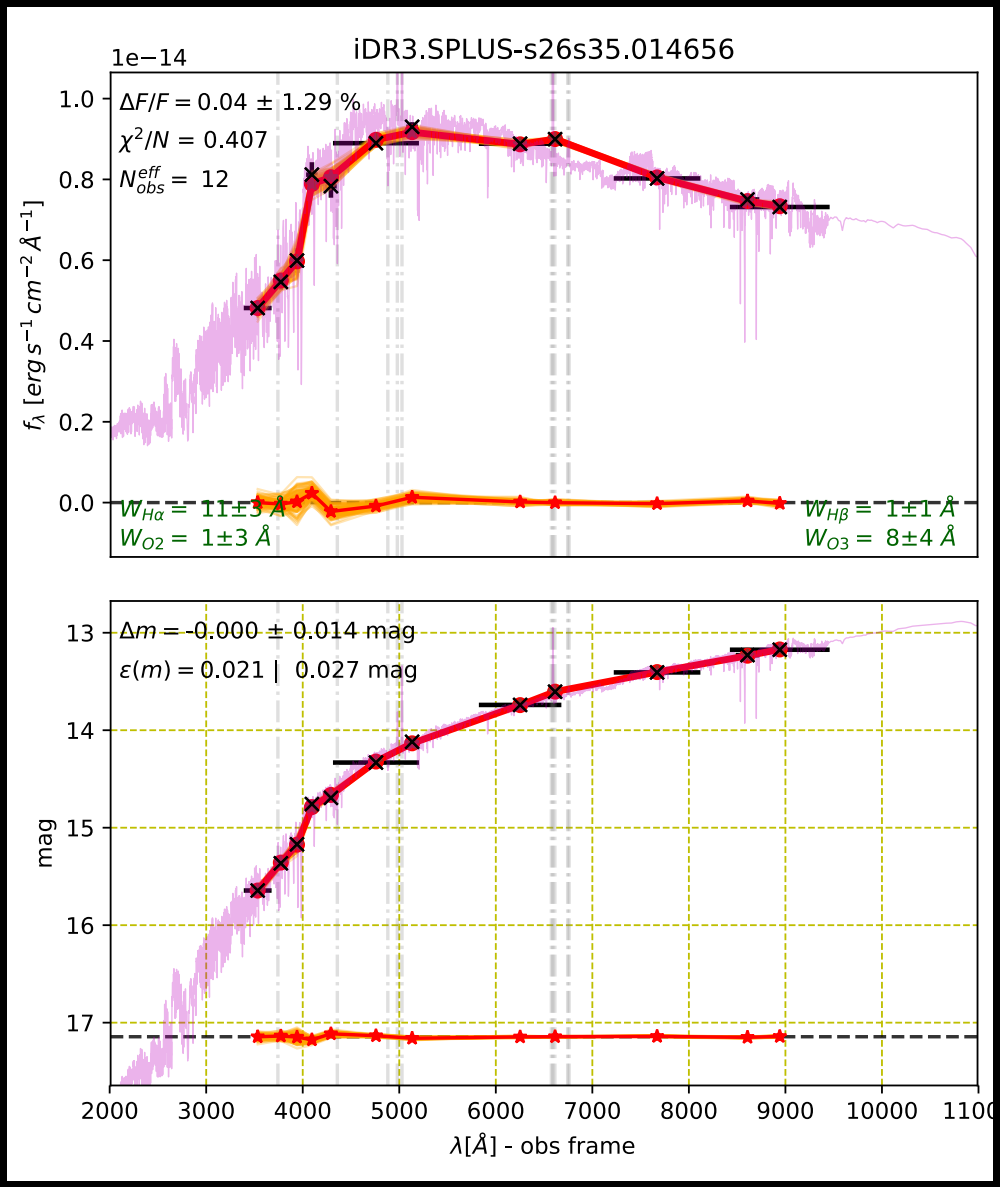
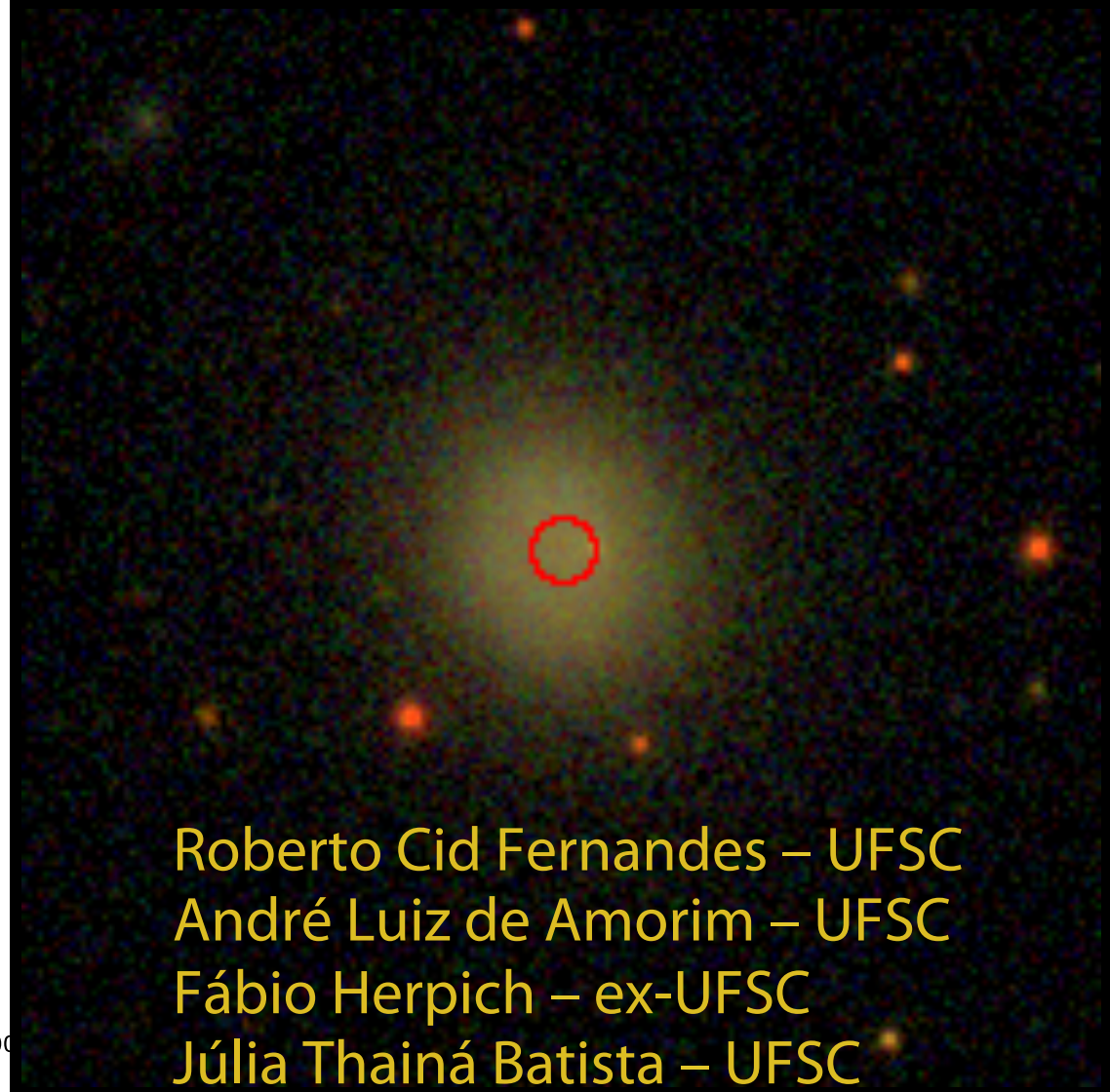
1st AlStar “results” for Fornax galaxies





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OUTLINE

+ WTF is AlStar – a spectral/SED fitting code ~ like STARLIGHT

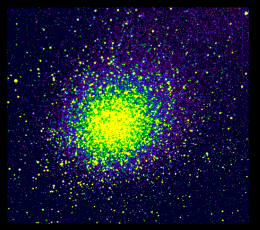
+ Ingredients – stellar & emission line bases

+ Examples

+ Preliminary results for Fornax iDR3 data

Spectral synthesis / SED fitting: The problem



$$= x_1 + x_2 + x_3 + \ldots$$

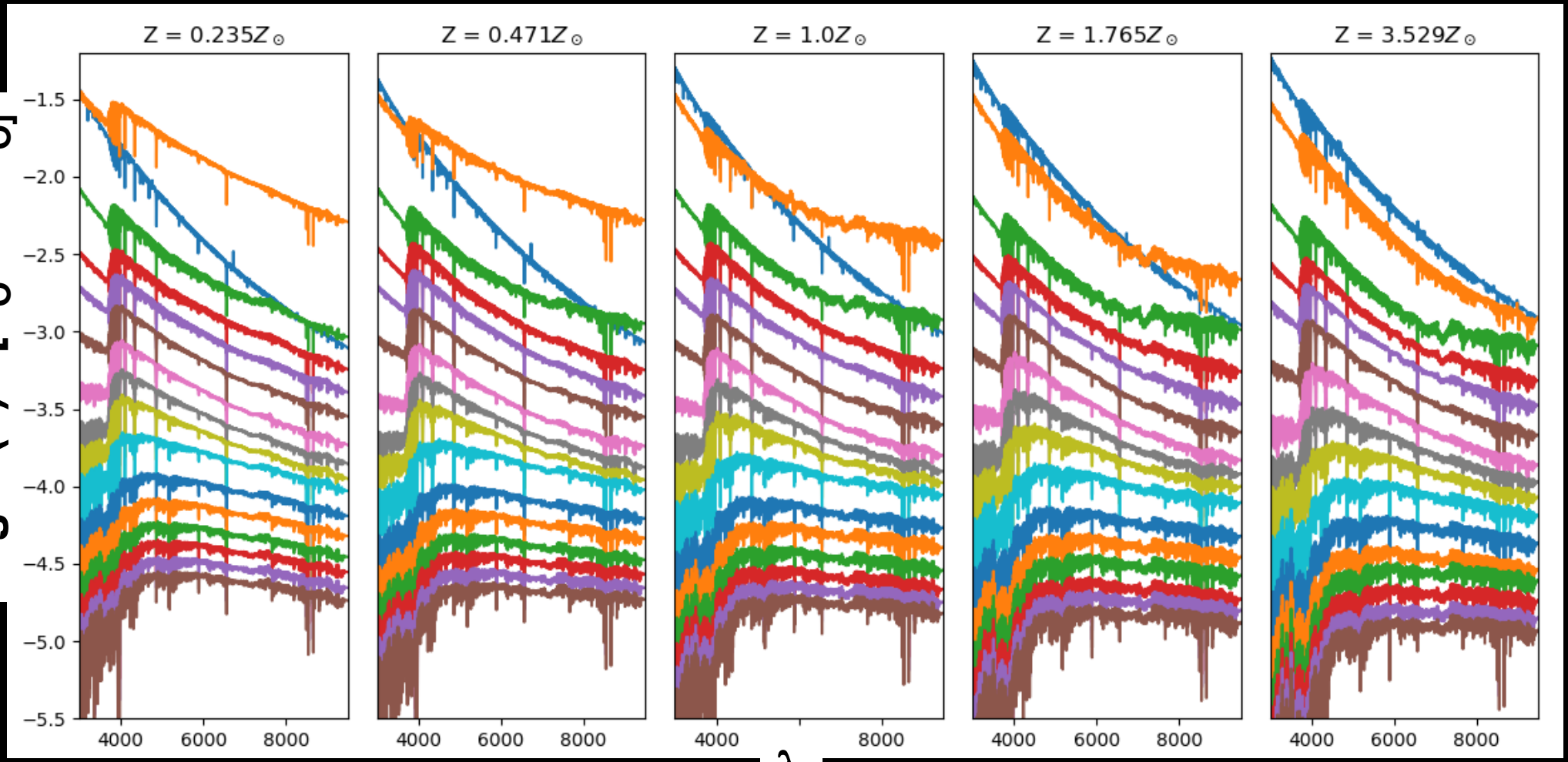
$$M(\lambda) = \sum_{t,Z} \mathbf{x}(t,Z) \times \text{Base}(\lambda;t,Z) \times e^{-\tau(t,Z)} \times q(\lambda)$$

Spectrum (photometry)	**light or mass fractions** **x = pop vector**	**Spectral Base** SSPs or CSPs from BC03, MILES, CB17 …	**Dust** τ_V

➔ Linear system solvable via NLLS (except for dust attenuation)
➔ Monte Carlo to estimate uncertainties

AlStar: Stellar base

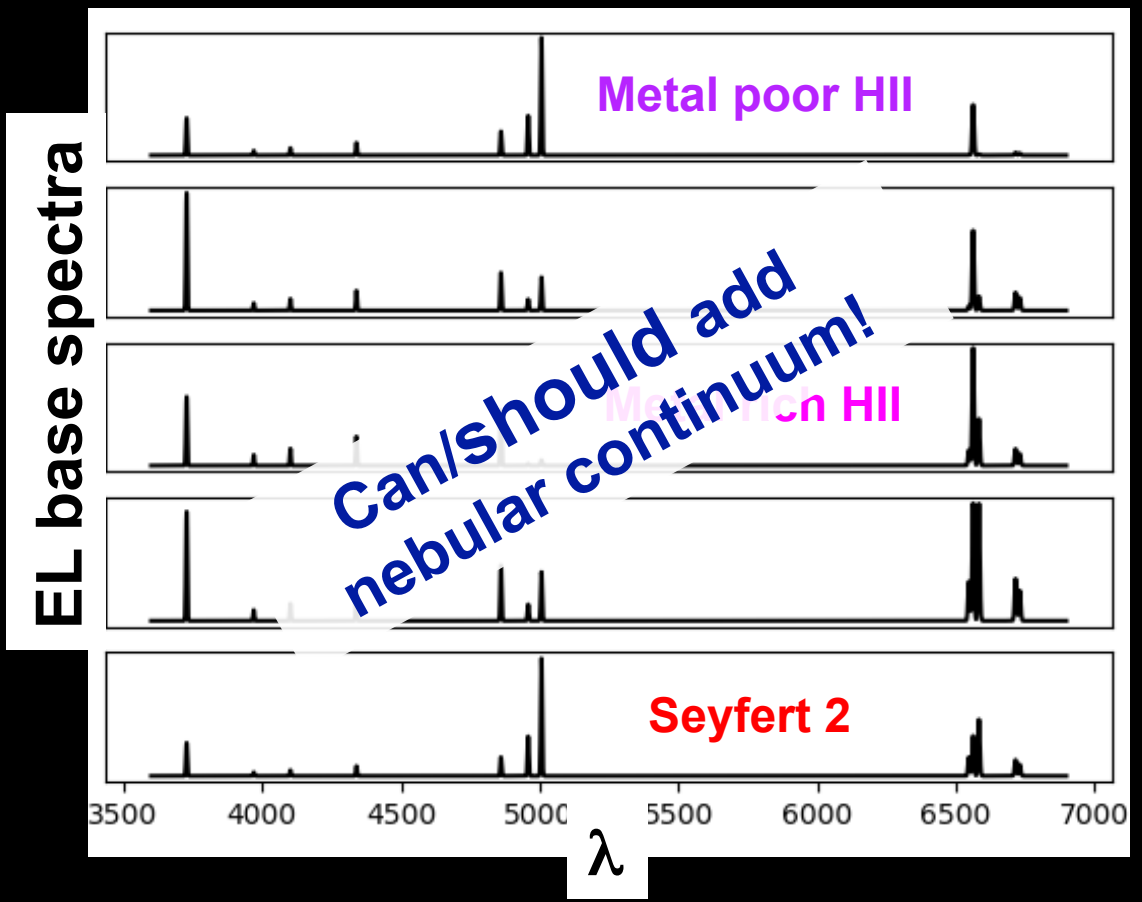
- 80 stellar populations = 16 ages x 5 metallicites
- Each component = “square burst”: SFR = const between $t_i < t < t_f$

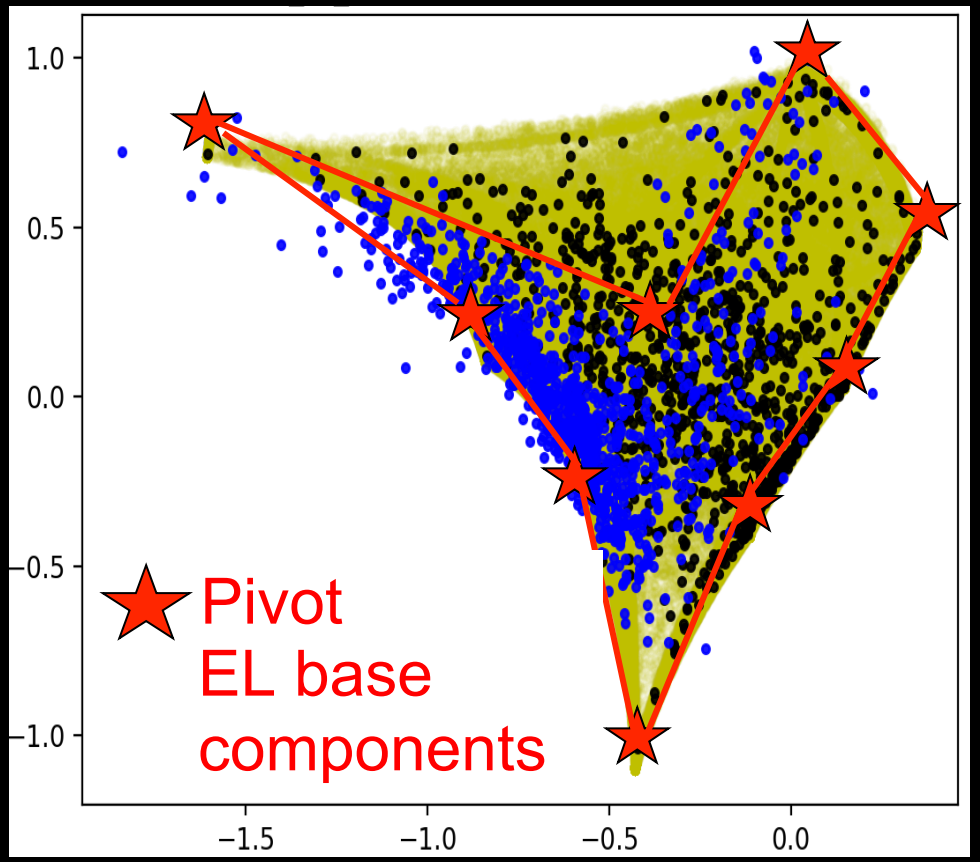


t = 0 → 3M → 10M → 30M → 60M → 100M → 250M → 450M → 700M → 1G → 2G → 3G → 4.5G → 6.25G → 8.5G → 11G → 14G

AlStar: Emission Line base

- individual lines – too much freedom ☹
- BPT-based line components – smarter / realistic ☺





5 line-groups : [OII]3727 , [OIII]4959+5007 , [NII]6548+6584 , [SII]6716+6731 , Hα+Hβ+Hγ+Hδ+...

In short, AIStar can:

- ☑ Fit spectra λ-by-λ (like STARLIGHT)
- ☑ Fit photometry: GALEX, JPAS, SPLUS, YouNameIt…
- ☑ Fit (recombination) emission lines: Hα, Hβ, Hα/Hβ, …
- ☑ Fit dust-reprocessed (FIR) luminosity

all **simultaneously**!

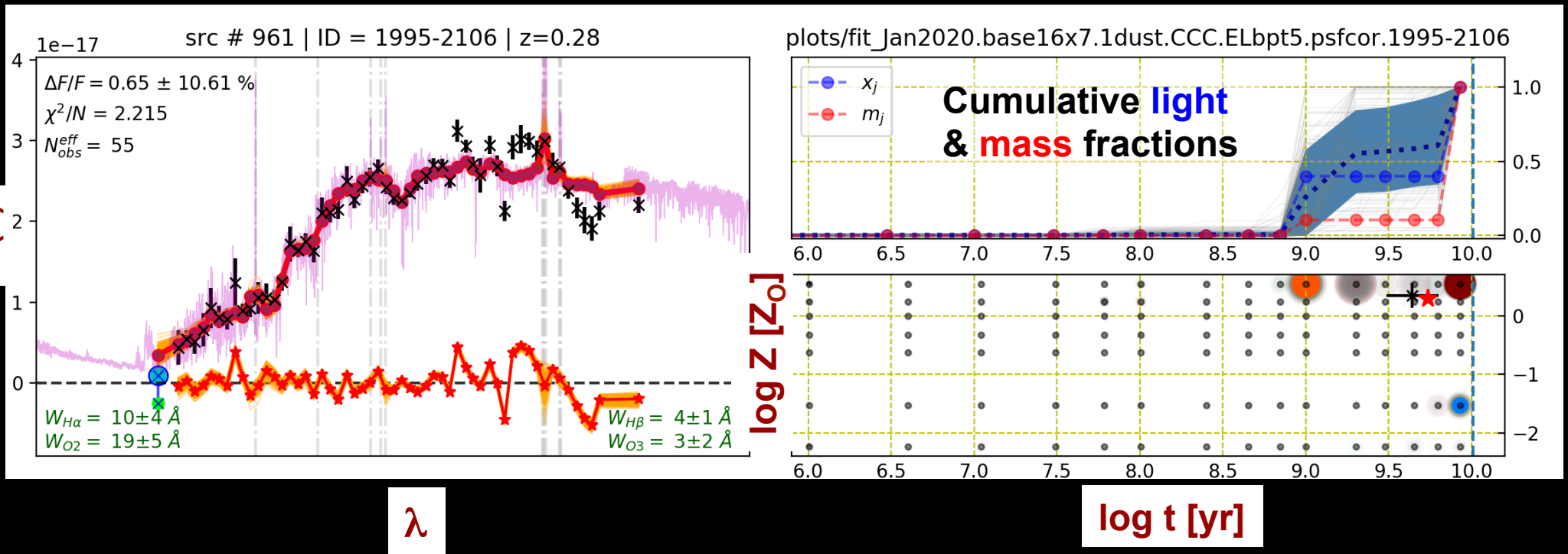
In short, AIStar can:

- ☑ ~~Fit spectra λ by λ (like STARLIGHT)~~
- ☑ Fit photometry: ~~GALEX, JPAS~~, SPLUS, ~~YouNameIt…~~
- ☑ ~~Fit (recombination) emission lines: Hα, Hβ, Hα/Hβ, …~~
- ☑ ~~Fit dust-reprocessed (FIR) luminosity~~

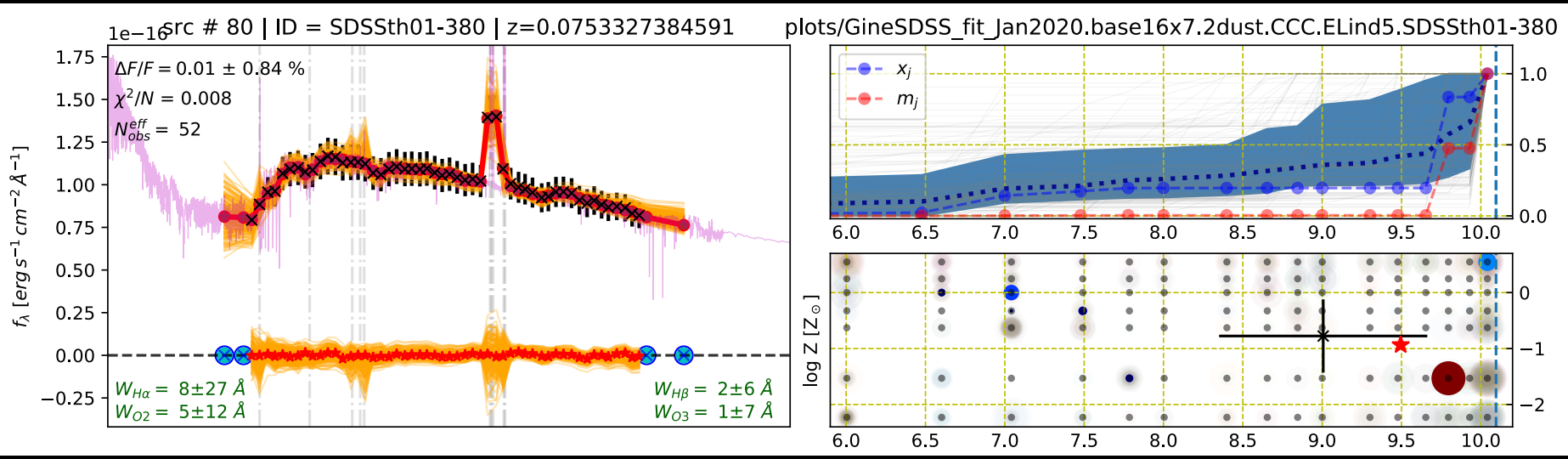
all **simultaneously**!

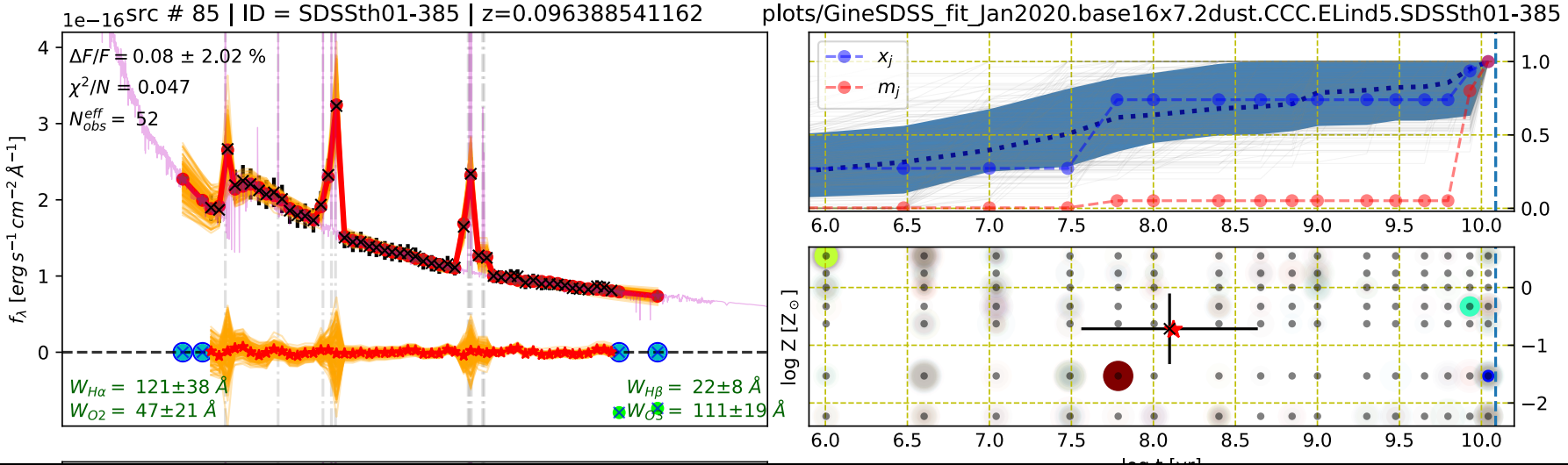
Examples

Photo-spectral fits & SFHs



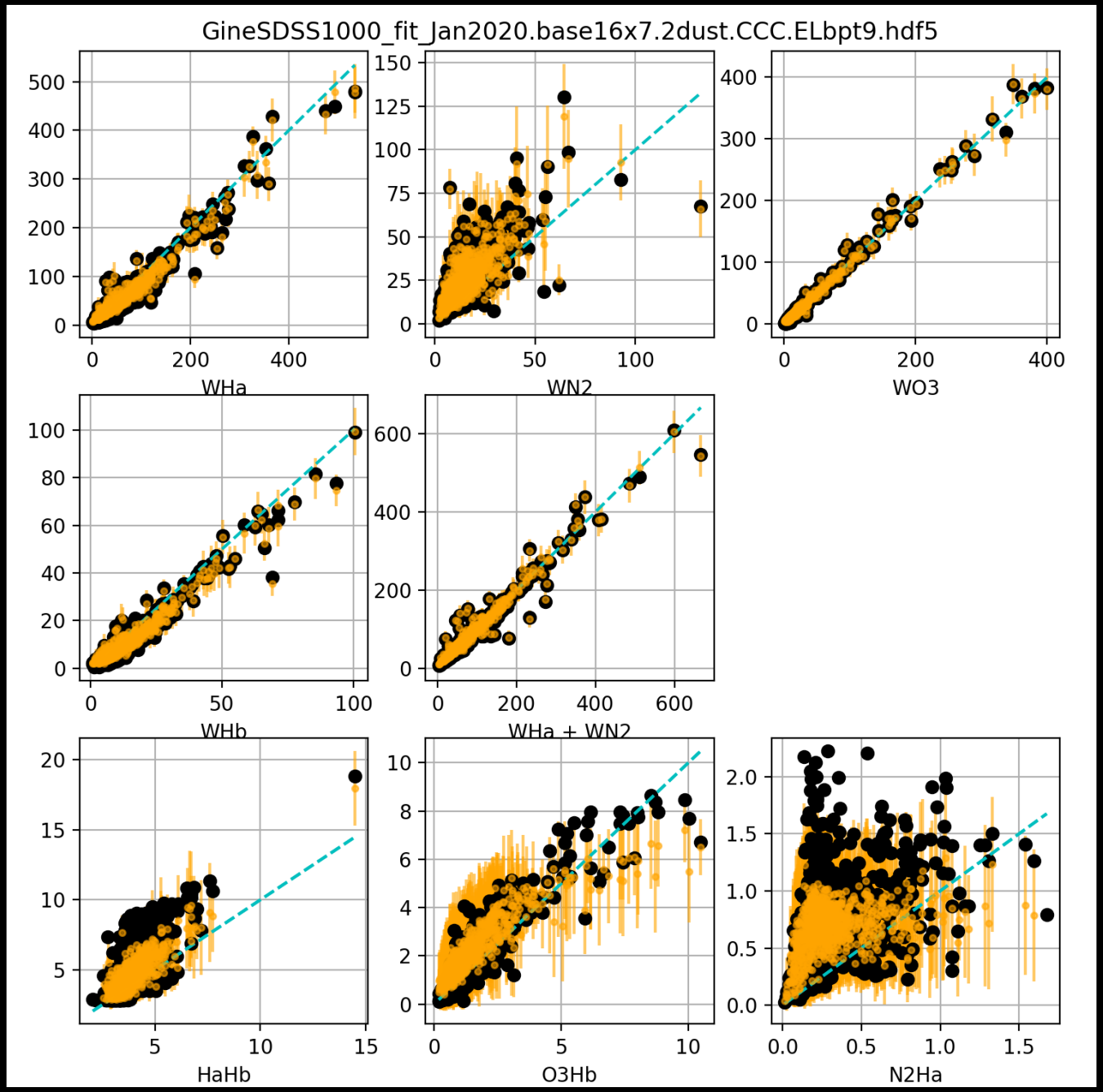
Experiments w/AlStar + SDSS/JPAS data





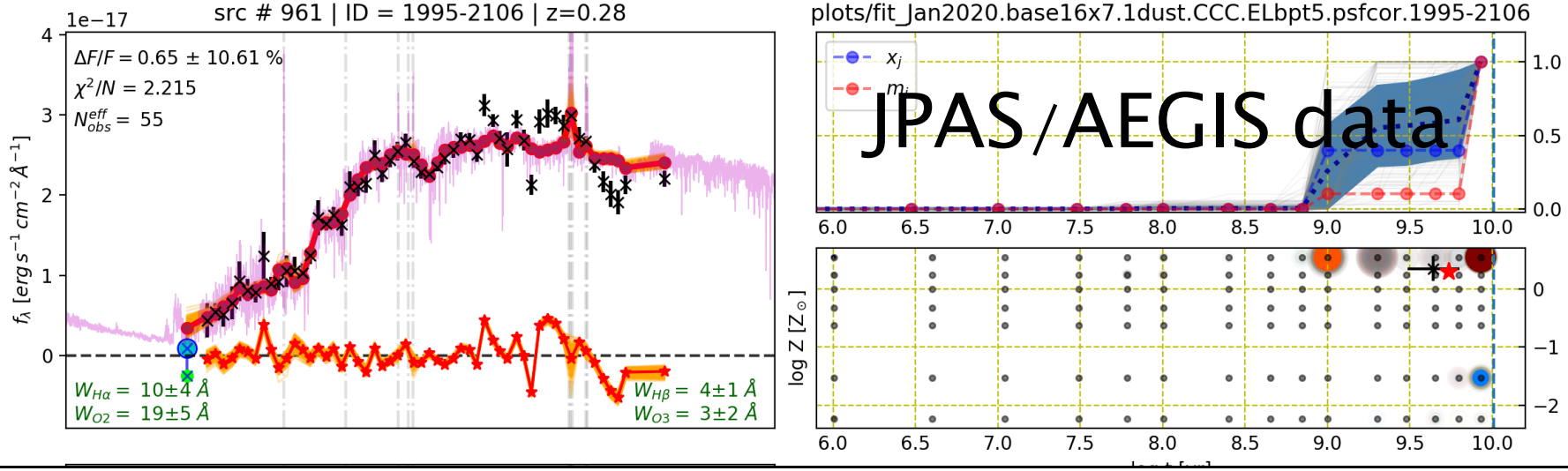
SDSS spectra seen through JPAS filters – testing code & emission line fitting … (Ginés)

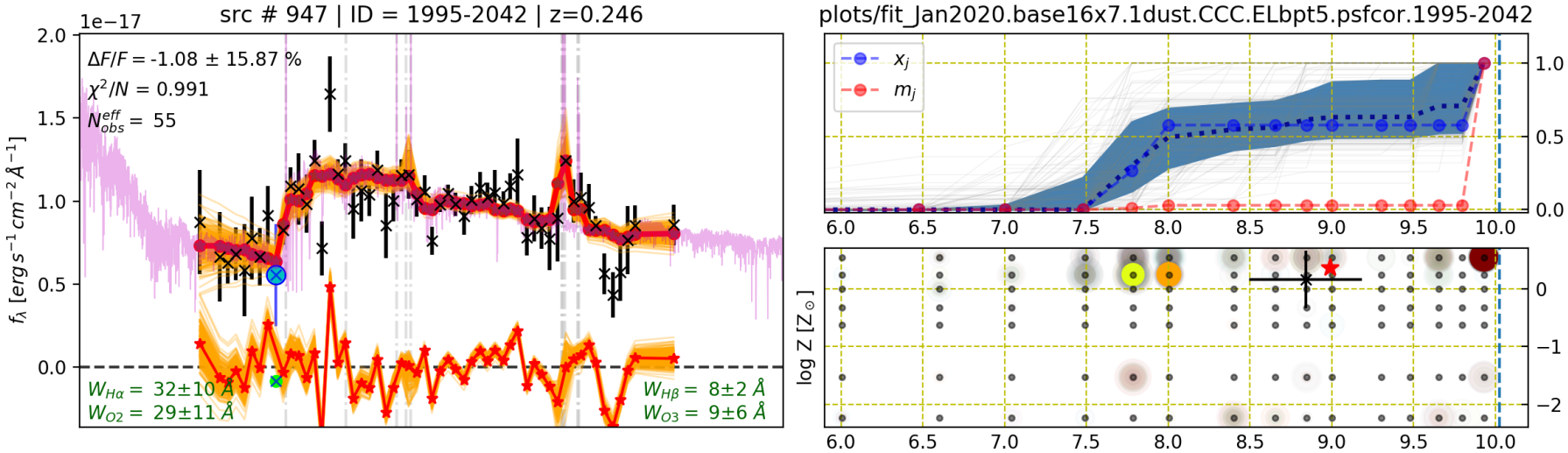
Experiments w/AlStar + JPAS/SDSS data

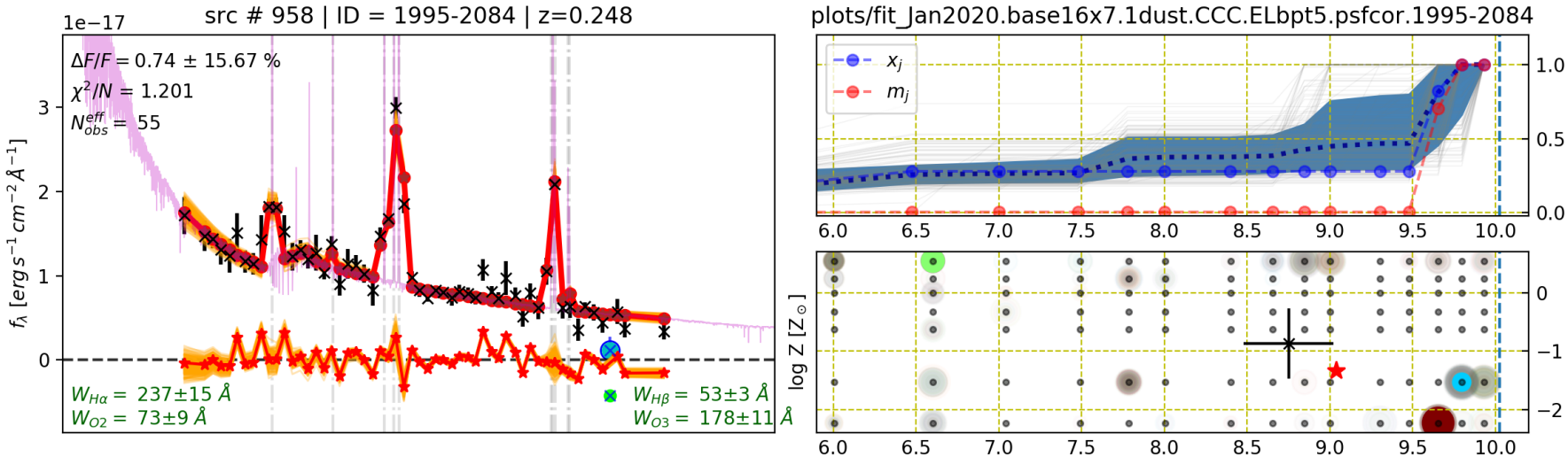


Output – JPAS+AlStar

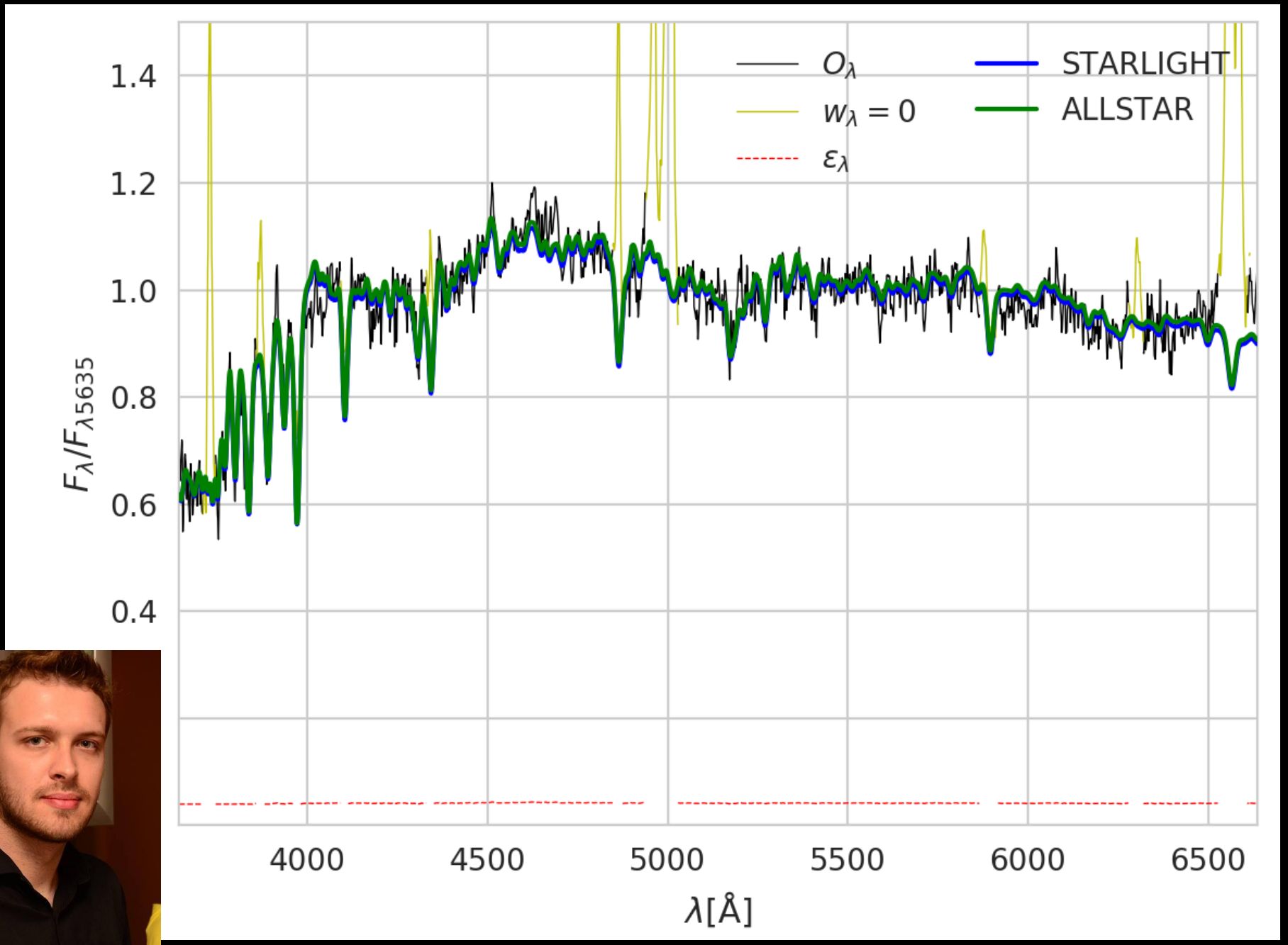
Input - SDSS

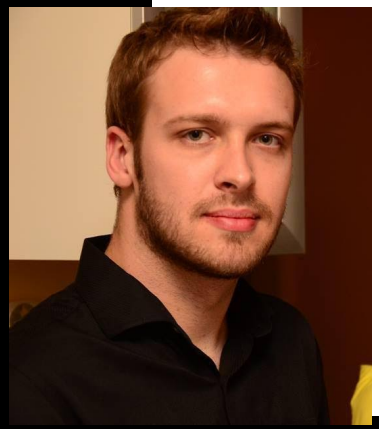

src # 961 | ID = 1995-2106 | z=0.28
1e−17
ΔF/F = 0.65 ± 10.61 %
χ²/N = 2.215
N_obs^eff = 55
W_Hα = 10±4 Å
W_O2 = 19±5 Å
W_Hβ = 4±1 Å
W_O3 = 3±2 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
plots/fit_Jan2020.base16x7.1dust.CCC.ELbpt5.psfcor.1995-2106
x_j
m_j
log Z [Z⊙]
JPAS/AEGIS data


src # 947 | ID = 1995-2042 | z=0.246
1e−17
ΔF/F = -1.08 ± 15.87 %
χ²/N = 0.991
N_obs^eff = 55
W_Hα = 32±10 Å
W_O2 = 29±11 Å
W_Hβ = 8±2 Å
W_O3 = 9±6 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
plots/fit_Jan2020.base16x7.1dust.CCC.ELbpt5.psfcor.1995-2042
x_j
m_j
log Z [Z⊙]


src # 958 | ID = 1995-2084 | z=0.248
1e−17
ΔF/F = 0.74 ± 15.67 %
χ²/N = 1.201
N_obs^eff = 55
W_Hα = 237±15 Å
W_O2 = 73±9 Å
W_Hβ = 53±3 Å
W_O3 = 178±11 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
plots/fit_Jan2020.base16x7.1dust.CCC.ELbpt5.psfcor.1995-2084
x_j
m_j
log Z [Z⊙]

alStar x STARLIGHT ... same results ☺

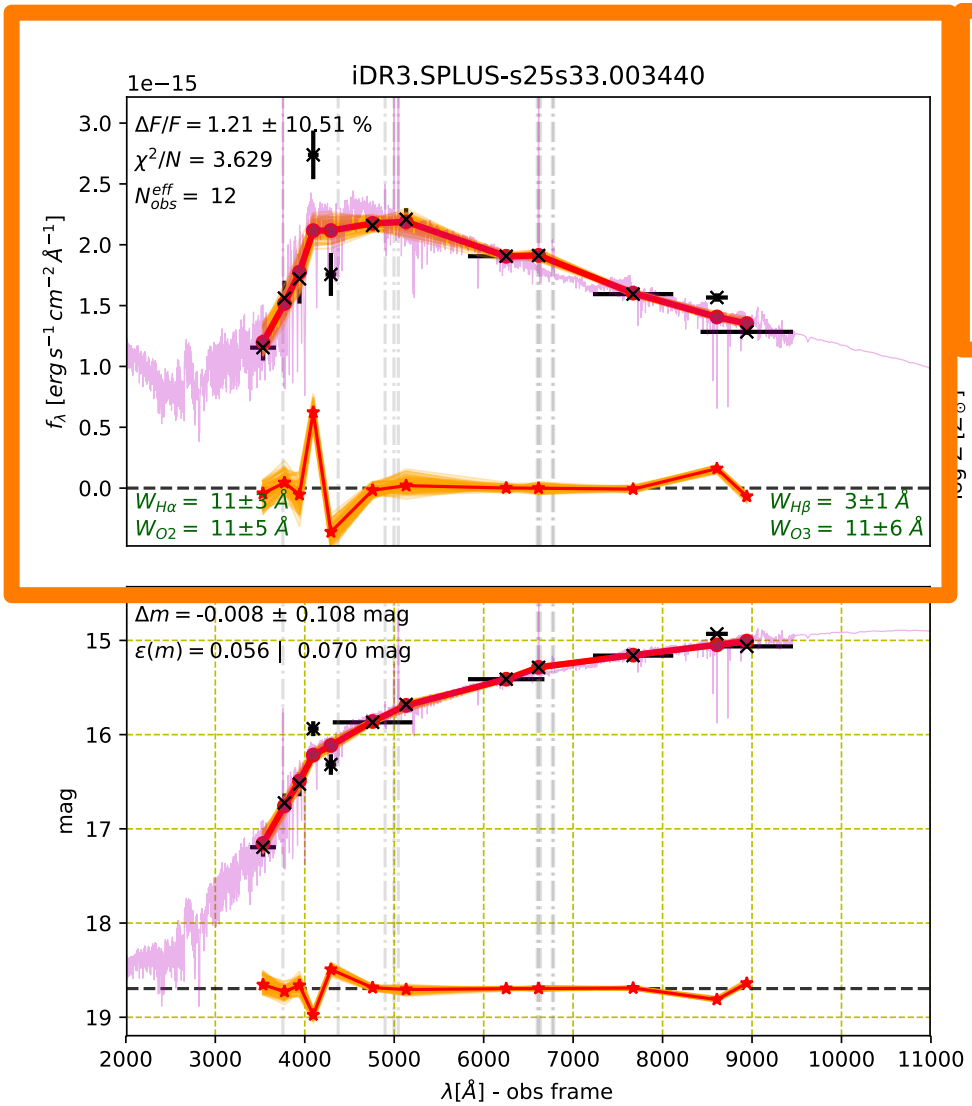


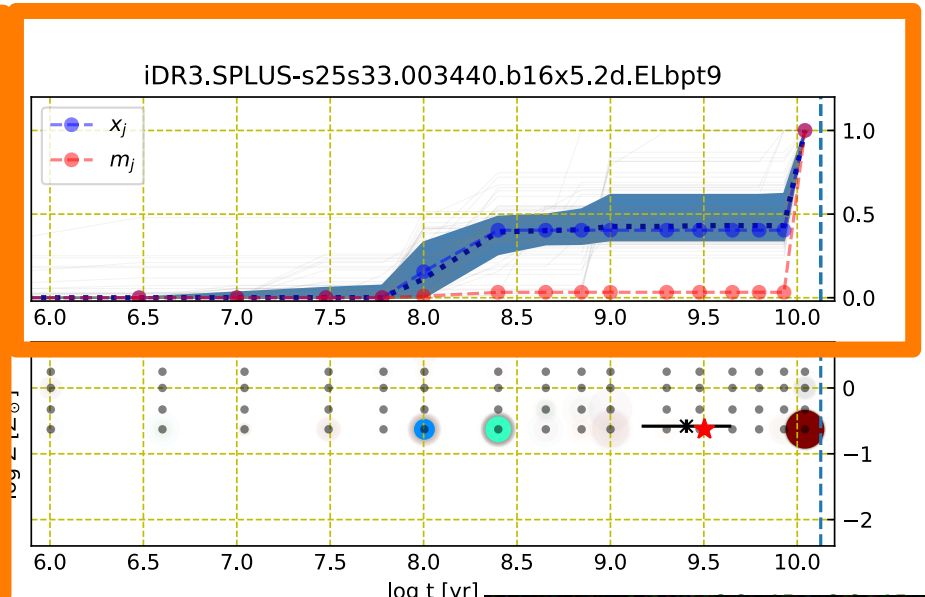


1st results for iDR3_23Fields_Fornax_galaxies.fits

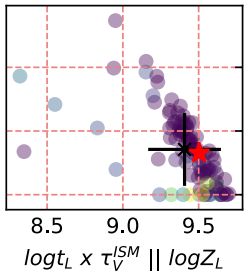
- St Pop : 16 ages x 5 Z's CB17
- Em Lines: 9 BPT-based elements
- τ_{ISM} & τ_{BC} (differential extinction)

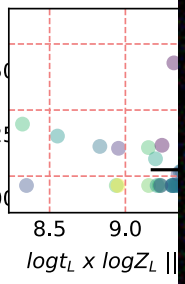
- n_{Bands} >= 10 → 662 galaxies
- cz = 1492 km/s when z not given ☹
- 99's are masked ☹
- Data prepared by Fabio (blame him!)

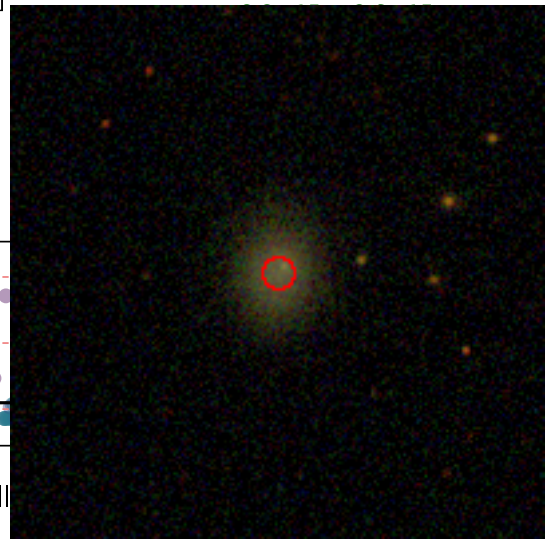


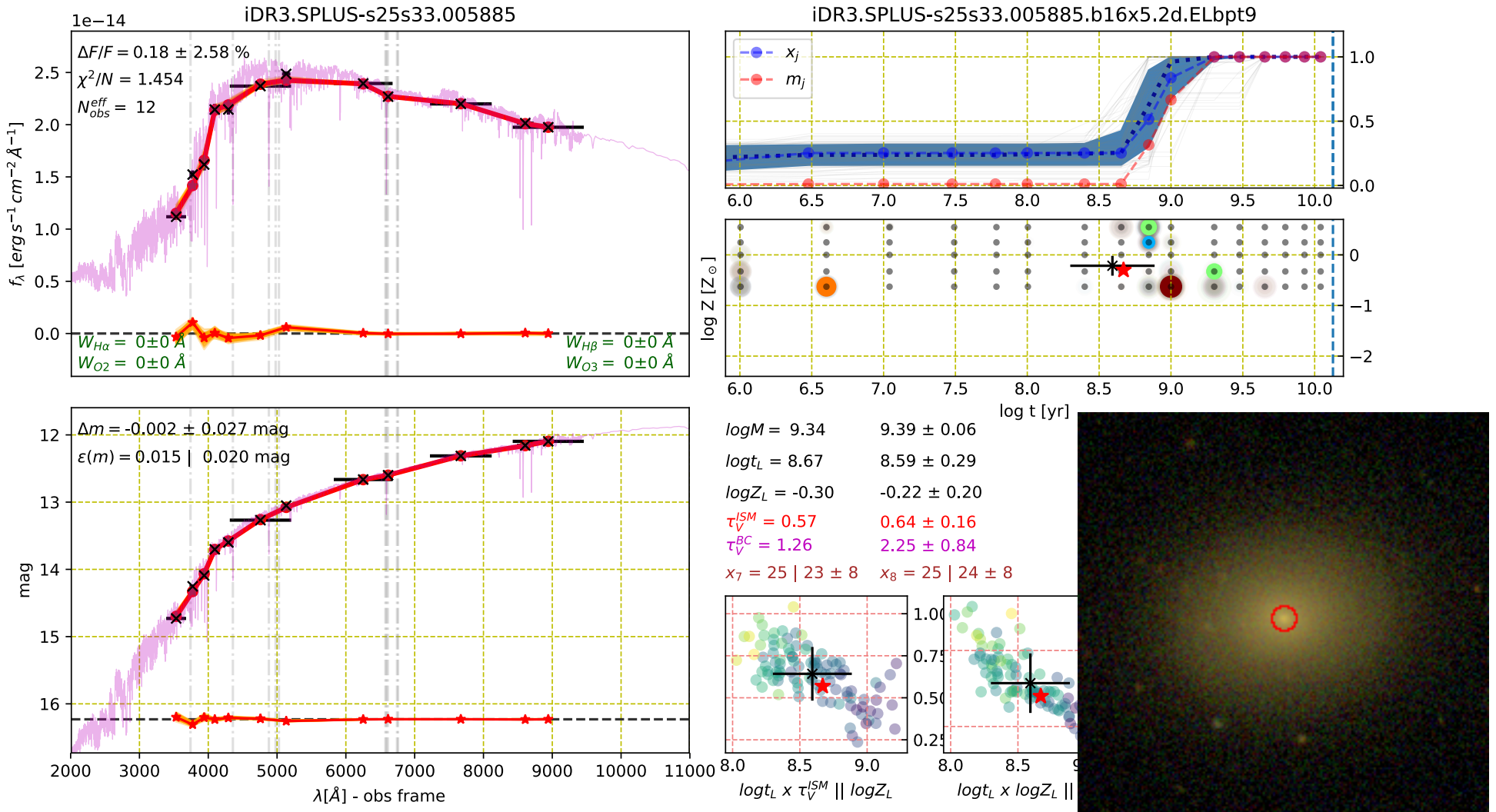


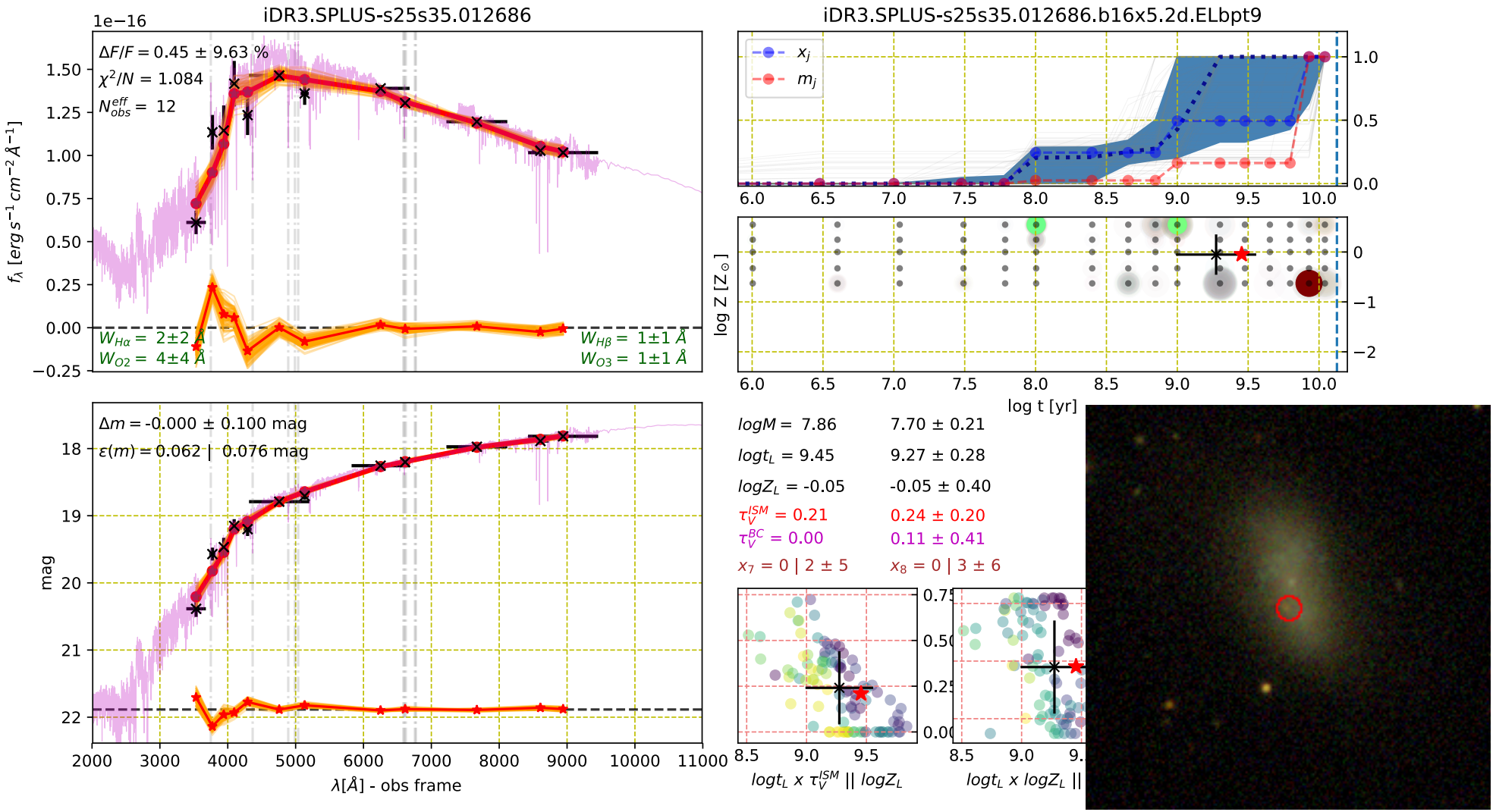
$logM$ = 9.29	9.24 ± 0.11
$logt_L$ = 9.50	9.41 ± 0.24
$logZ_L$ = -0.63	-0.58 ± 0.10
τ_V^{ISM} = 0.16	0.18 ± 0.14
τ_V^{BC} = 0.00	0.36 ± 0.87
x_7 = 0 | 2 ± 7	x_8 = 0 | 4 ± 8

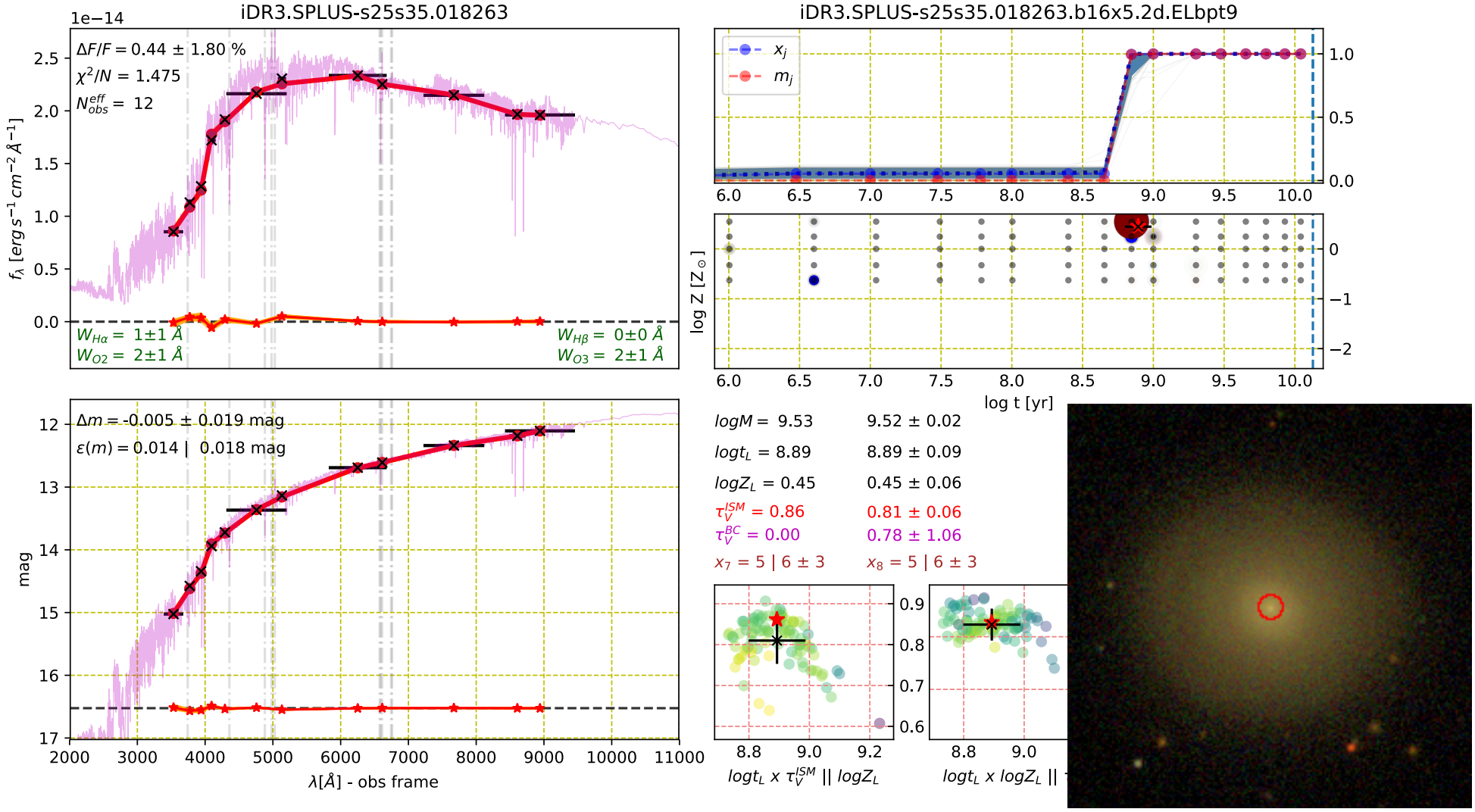


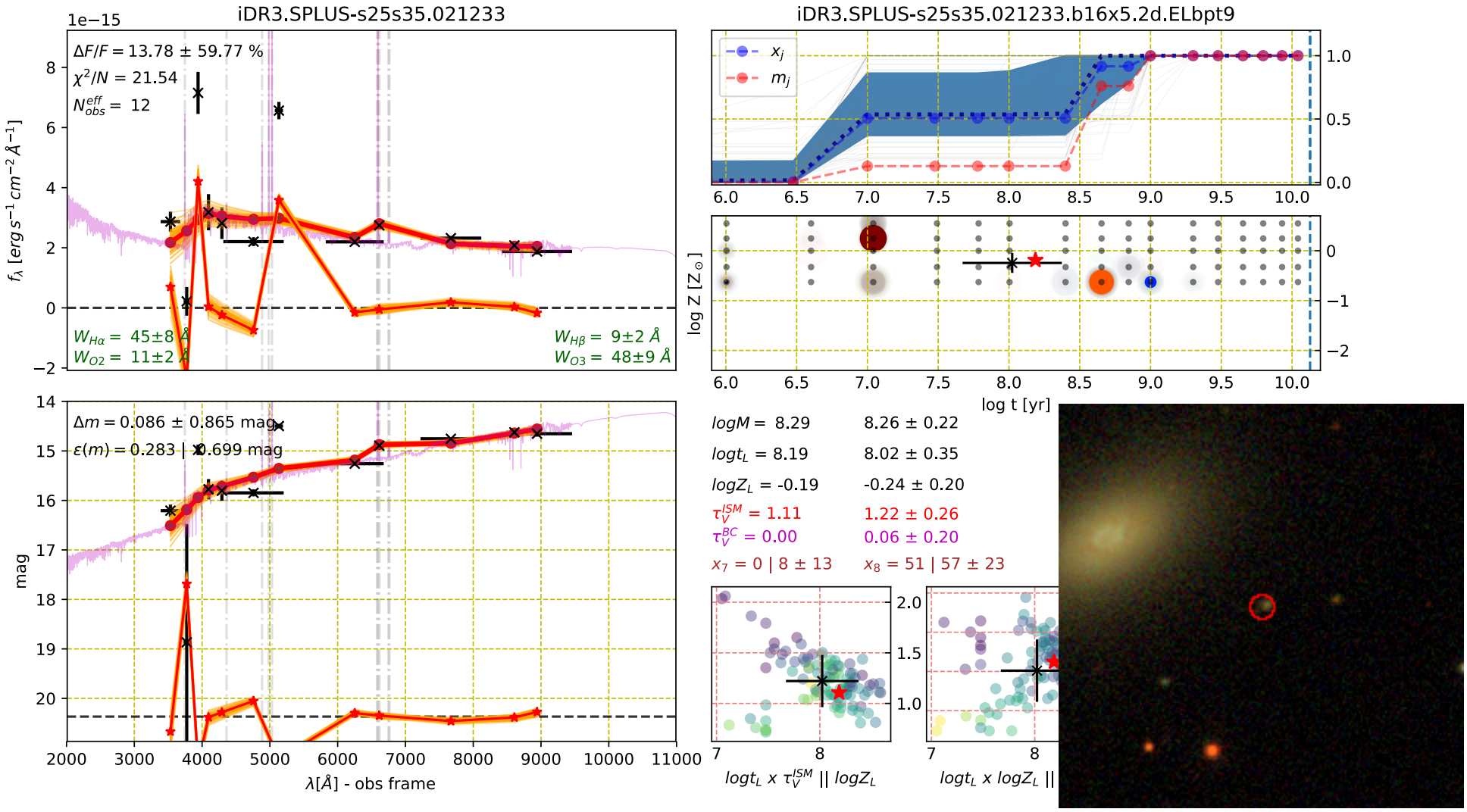


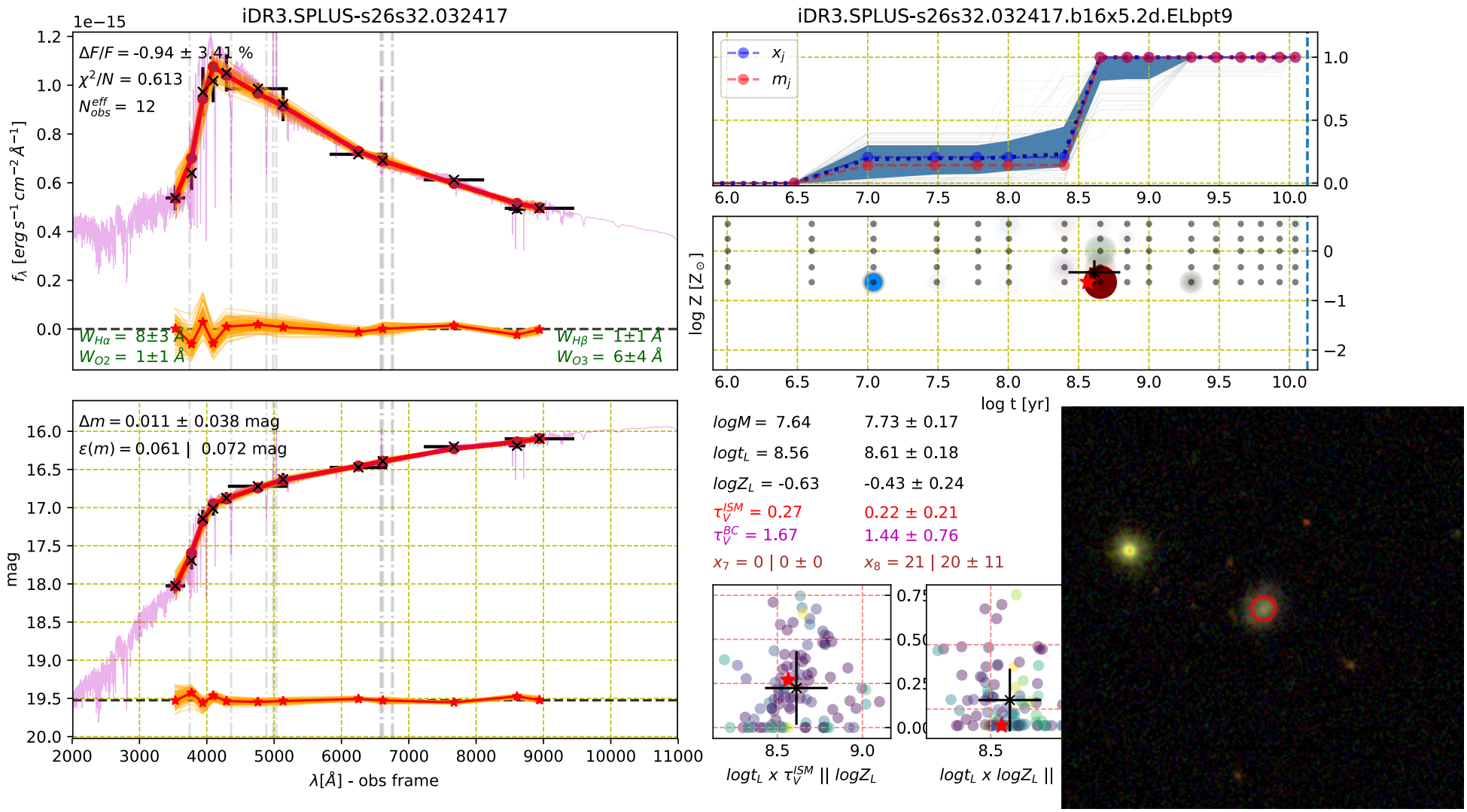


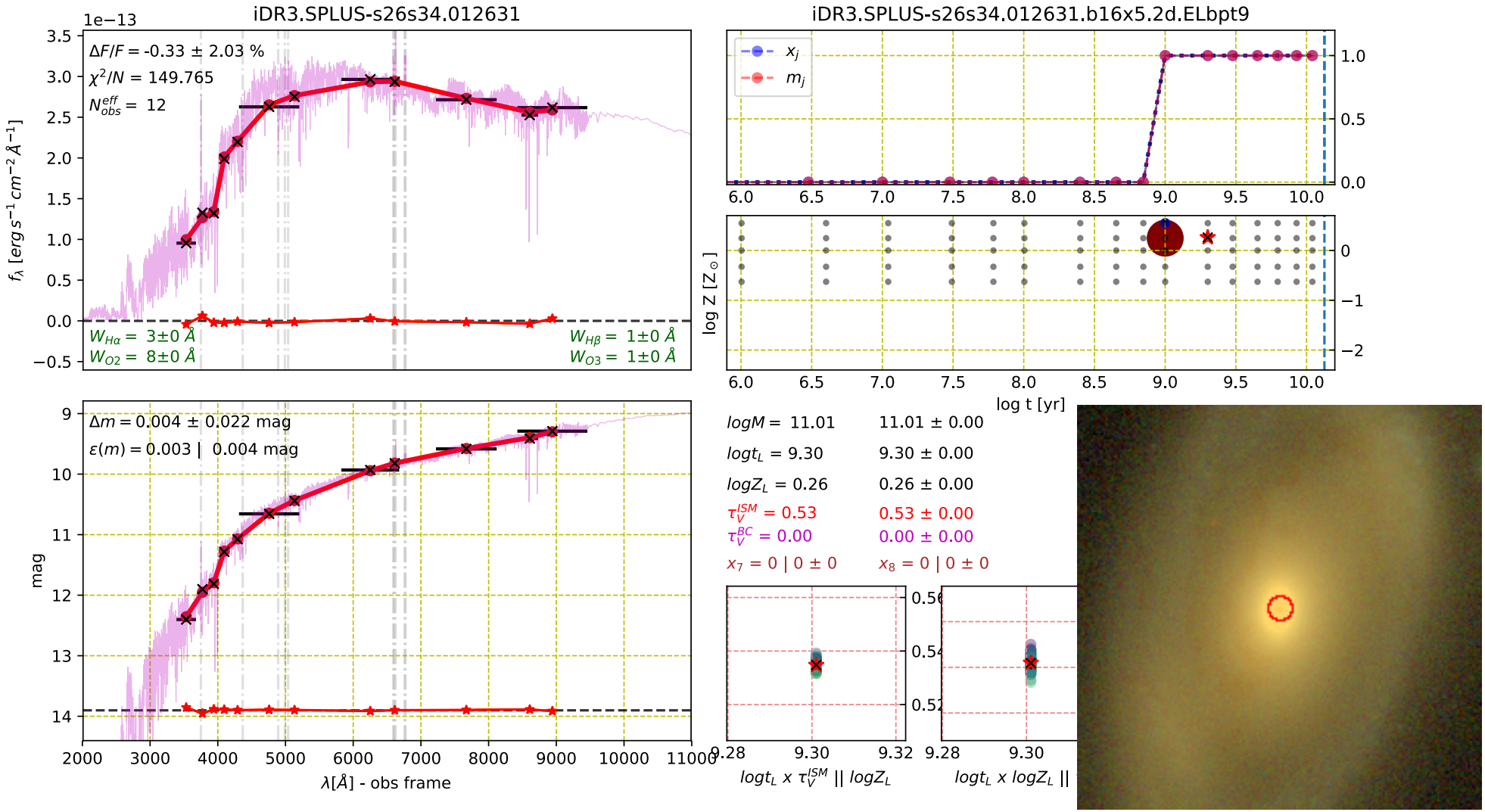

iDR3.SPLUS-s25s33.005885
1e−14
ΔF/F = 0.18 ± 2.58 %
χ²/N = 1.454
N_obs^eff = 12
W_Hα = 0±0 Å
W_O2 = 0±0 Å
W_Hβ = 0±0 Å
W_O3 = 0±0 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = -0.002 ± 0.027 mag
ε(m) = 0.015 | 0.020 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s25s33.005885.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 9.34 9.39 ± 0.06
logt_L = 8.67 8.59 ± 0.29
logZ_L = -0.30 -0.22 ± 0.20
τ_V^ISM = 0.57 0.64 ± 0.16
τ_V^BC = 1.26 2.25 ± 0.84
x_7 = 25 | 23 ± 8 x_8 = 25 | 24 ± 8
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

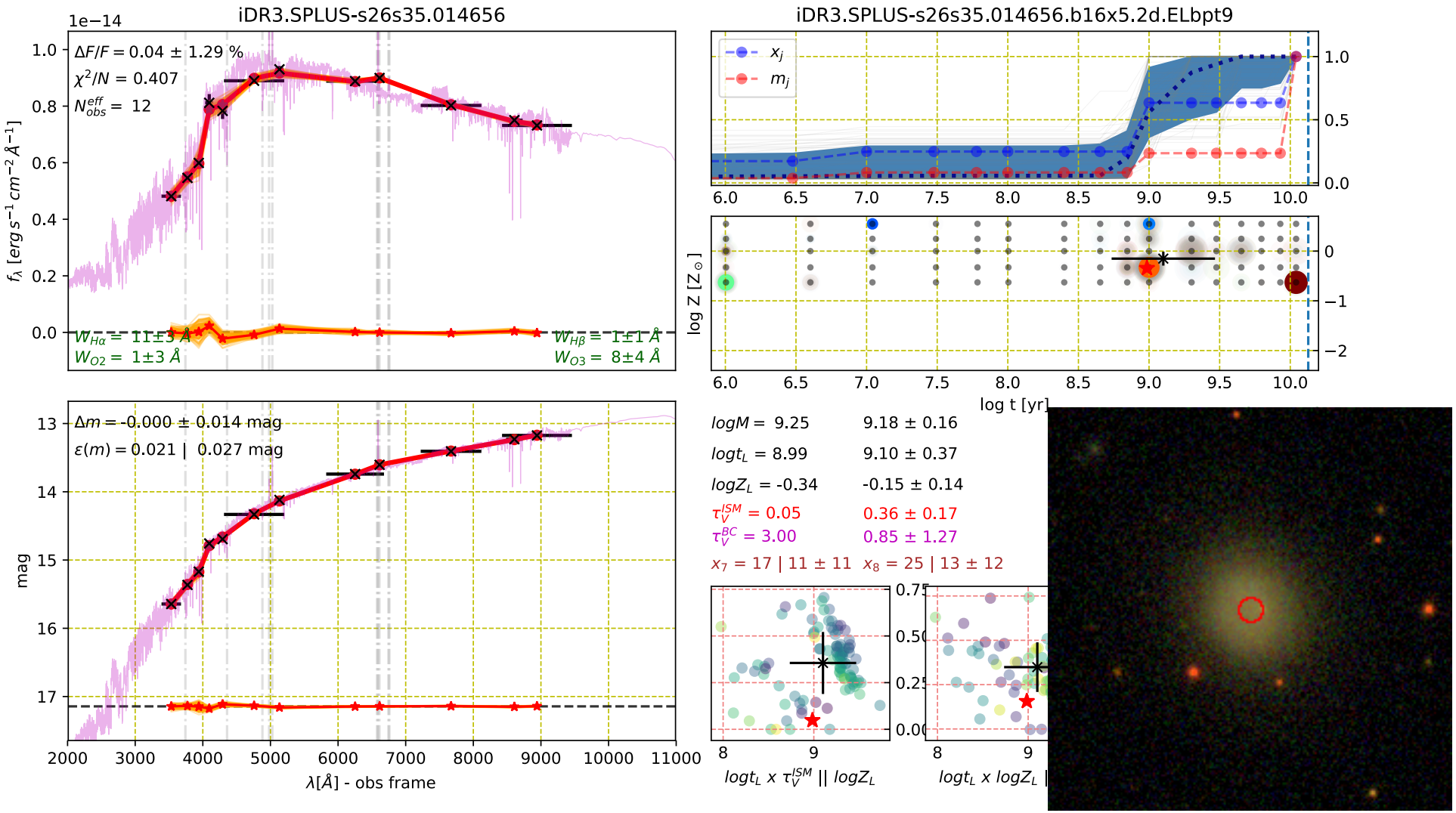

iDR3.SPLUS-s25s35.012686
iDR3.SPLUS-s25s35.012686.b16x5.2d.ELbpt9
1e−16
f_λ [erg s^{-1} cm^{-2} Å^{-1}]
ΔF/F = 0.45 ± 9.63 %
χ^2/N = 1.084
N_{obs}^{eff} = 12
$W_{H\alpha}$ = 2±2 Å
W_{O2} = 4±4 Å
$W_{H\beta}$ = 1±1 Å
W_{O3} = 1±1 Å
Δm = -0.000 ± 0.100 mag
ε(m) = 0.062 | 0.076 mag
mag
λ[Å] - obs frame
x_j
m_j
log Z [Z$_\odot$]
log t [yr]
logM = 7.86 7.70 ± 0.21
$logt_L$ = 9.45 9.27 ± 0.28
$logZ_L$ = -0.05 -0.05 ± 0.40
τ_V^{ISM} = 0.21 0.24 ± 0.20
τ_V^{BC} = 0.00 0.11 ± 0.41
x_7 = 0 | 2 ± 5
x_8 = 0 | 3 ± 6
$logt_L$ x τ_V^{ISM} || $logZ_L$
$logt_L$ x $logZ_L$ ||

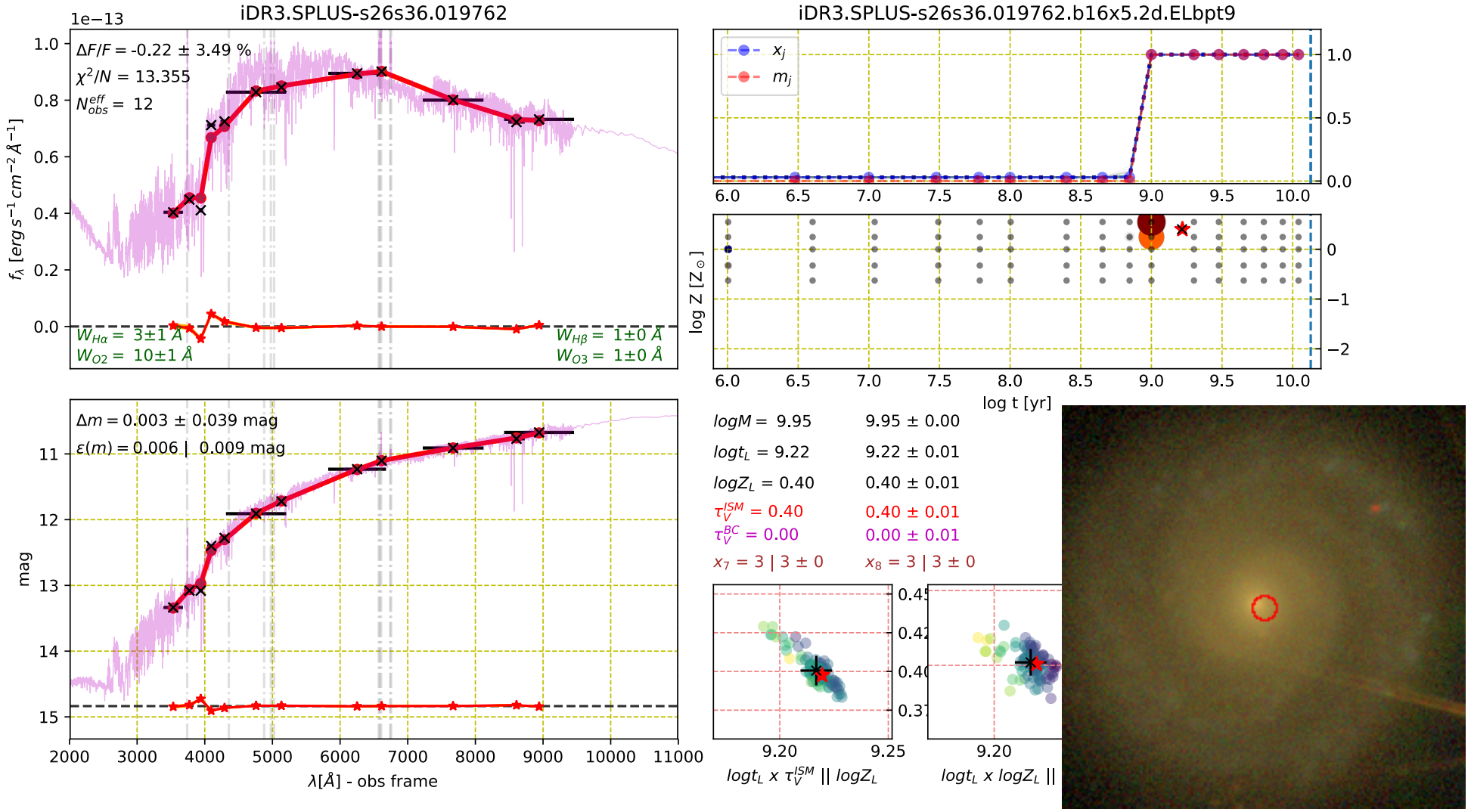

iDR3.SPLUS-s25s35.018263
1e−14
ΔF/F = 0.44 ± 1.80 %
χ²/N = 1.475
N_obs^eff = 12
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
W_Hα = 1±1 Å
W_O2 = 2±1 Å
W_Hβ = 0±0 Å
W_O3 = 2±1 Å
Δm = -0.005 ± 0.019 mag
ε(m) = 0.014 | 0.018 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s25s35.018263.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 9.53 9.52 ± 0.02
logt_L = 8.89 8.89 ± 0.09
logZ_L = 0.45 0.45 ± 0.06
τ_V^ISM = 0.86 0.81 ± 0.06
τ_V^BC = 0.00 0.78 ± 1.06
x_7 = 5 | 6 ± 3 x_8 = 5 | 6 ± 3
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

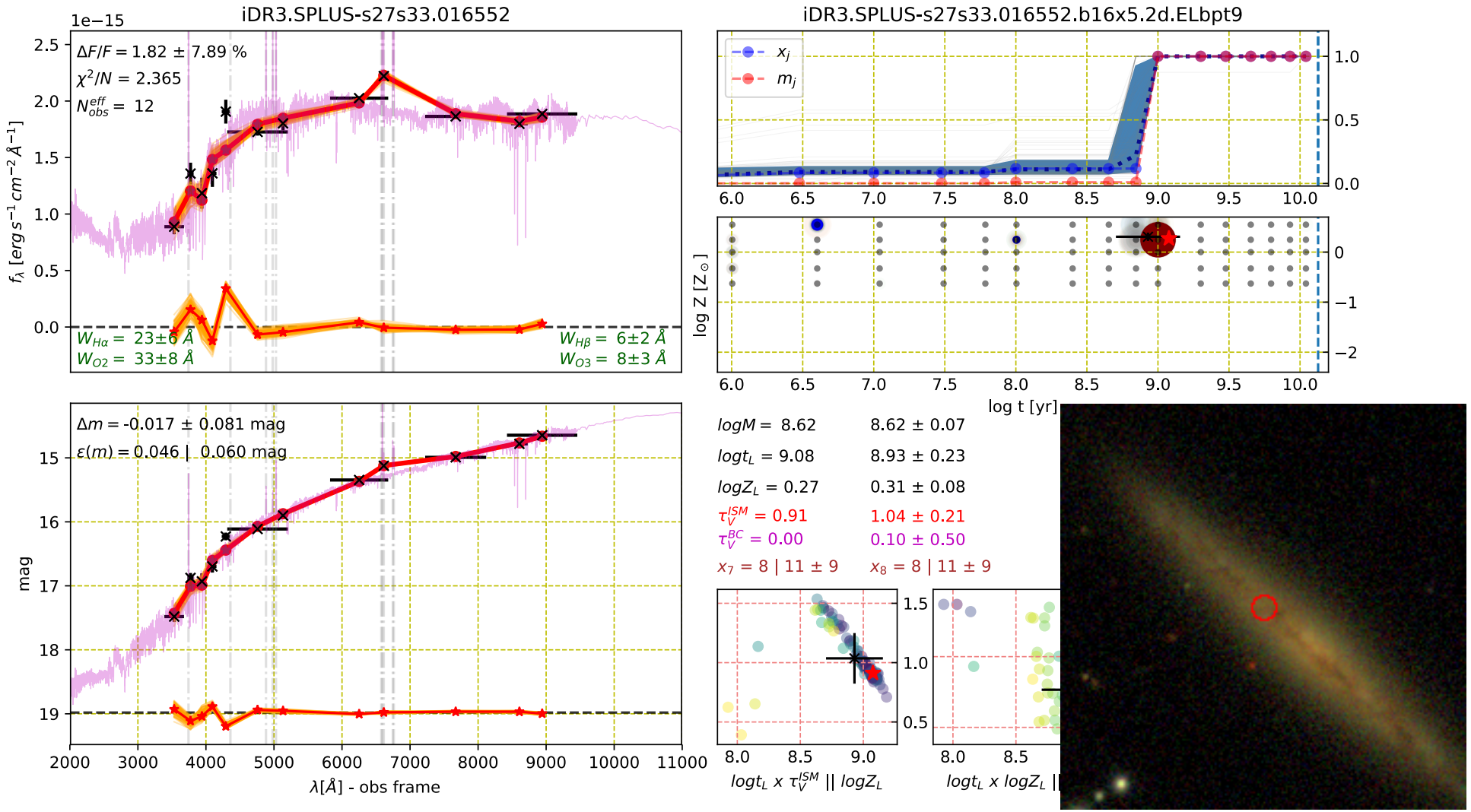

iDR3.SPLUS-s25s35.021233
1e−15
ΔF/F = 13.78 ± 59.77 %
χ²/N = 21.54
N_obs^eff = 12
W_Hα = 45±8 Å
W_O2 = 11±2 Å
W_Hβ = 9±2 Å
W_O3 = 48±9 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = 0.086 ± 0.865 mag
ε(m) = 0.283 | 0.699 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s25s35.021233.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 8.29 8.26 ± 0.22
logt_L = 8.19 8.02 ± 0.35
logZ_L = -0.19 -0.24 ± 0.20
τ_V^ISM = 1.11 1.22 ± 0.26
τ_V^BC = 0.00 0.06 ± 0.20
x_7 = 0 | 8 ± 13
x_8 = 51 | 57 ± 23
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

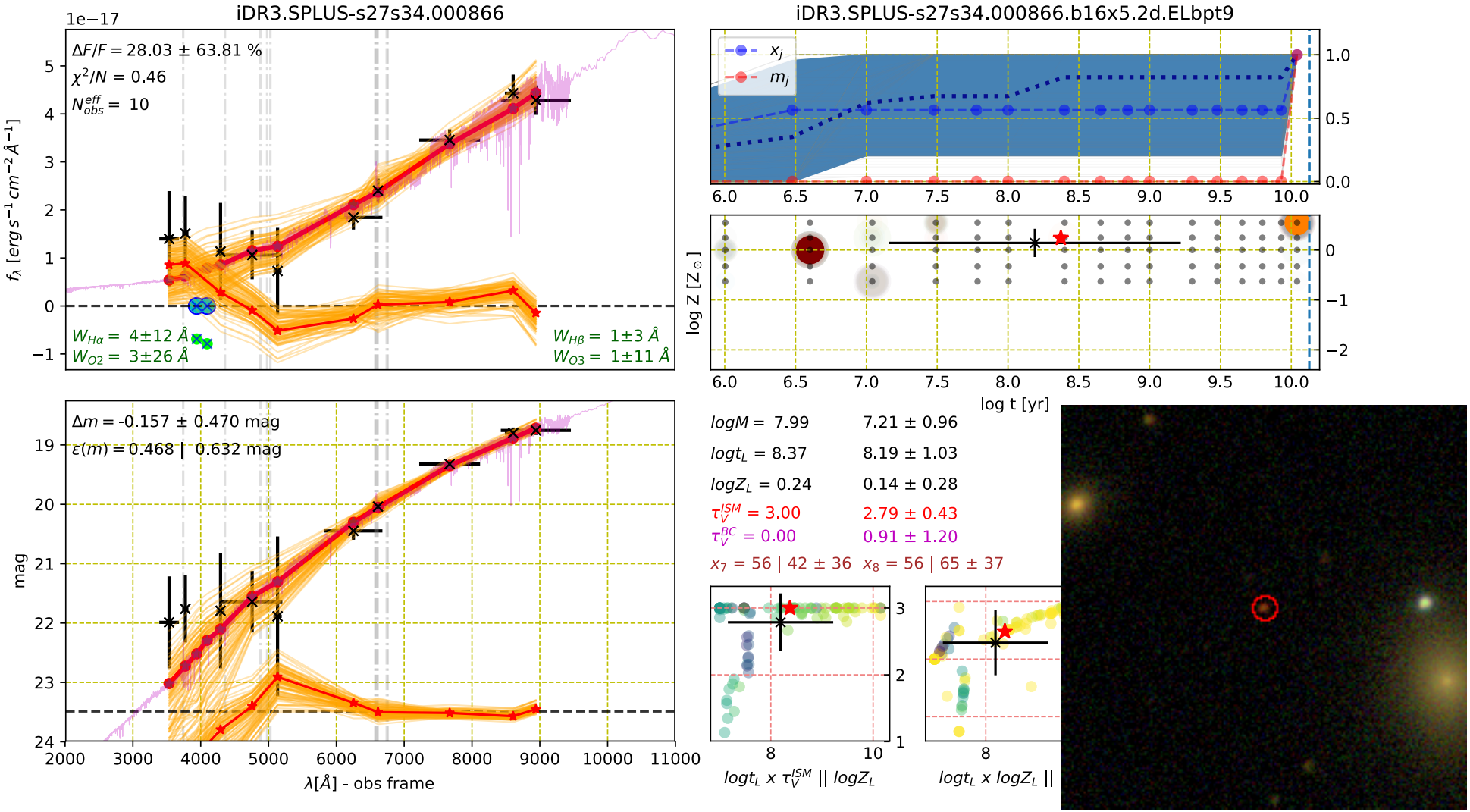

iDR3.SPLUS-s26s32.032417
1e−15
ΔF/F = -0.94 ± 3.41 %
χ²/N = 0.613
N_obs^eff = 12
W_Hα = 8±3 Å
W_O2 = 1±1 Å
W_Hβ = 1±1 Å
W_O3 = 6±4 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = 0.011 ± 0.038 mag
ε(m) = 0.061 | 0.072 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s26s32.032417.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 7.64 7.73 ± 0.17
logt_L = 8.56 8.61 ± 0.18
logZ_L = -0.63 -0.43 ± 0.24
τ_V^ISM = 0.27 0.22 ± 0.21
τ_V^BC = 1.67 1.44 ± 0.76
x_7 = 0 | 0 ± 0
x_8 = 21 | 20 ± 11
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

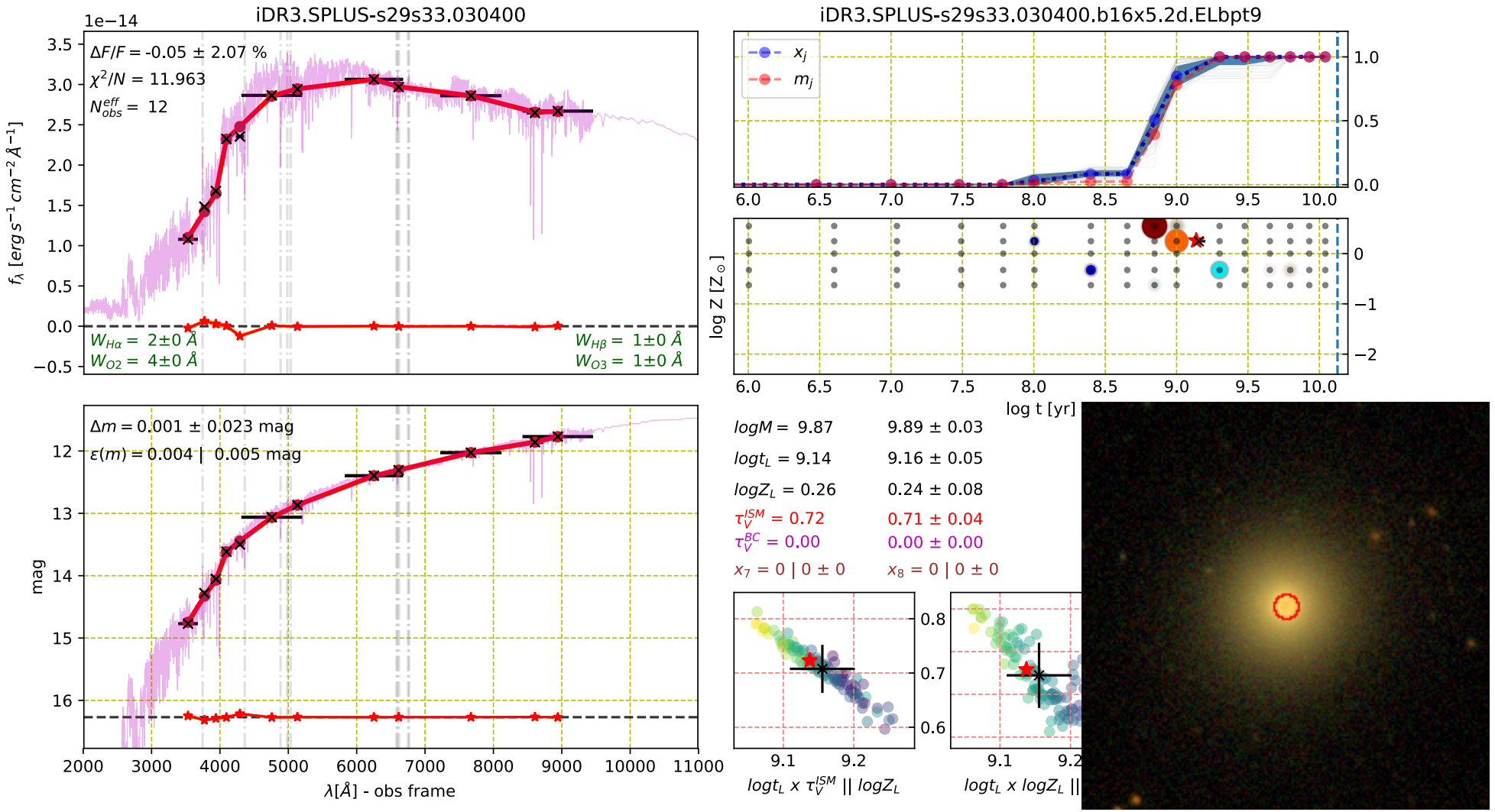

iDR3.SPLUS-s26s34.012631
1e−13
ΔF/F = -0.33 ± 2.03 %
χ²/N = 149.765
N_obs^eff = 12
W_Hα = 3±0 Å
W_O2 = 8±0 Å
W_Hβ = 1±0 Å
W_O3 = 1±0 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = 0.004 ± 0.022 mag
ε(m) = 0.003 | 0.004 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s26s34.012631.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 11.01 11.01 ± 0.00
logt_L = 9.30 9.30 ± 0.00
logZ_L = 0.26 0.26 ± 0.00
τ_V^ISM = 0.53 0.53 ± 0.00
τ_V^BC = 0.00 0.00 ± 0.00
x_7 = 0 | 0 ± 0
x_8 = 0 | 0 ± 0
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||


iDR3.SPLUS-s26s35.014656
1e−14
ΔF/F = 0.04 ± 1.29 %
χ²/N = 0.407
N_obs^eff = 12
W_Hα = 11±3 Å
W_O2 = 1±3 Å
W_Hβ = 1±1 Å
W_O3 = 8±4 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = -0.000 ± 0.014 mag
ε(m) = 0.021 | 0.027 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s26s35.014656.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 9.25 9.18 ± 0.16
logt_L = 8.99 9.10 ± 0.37
logZ_L = -0.34 -0.15 ± 0.14
τ_V^ISM = 0.05 0.36 ± 0.17
τ_V^BC = 3.00 0.85 ± 1.27
x_7 = 17 | 11 ± 11 x_8 = 25 | 13 ± 12
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L


iDR3.SPLUS-s26s36.019762
1e−13
ΔF/F = -0.22 ± 3.49 %
χ²/N = 13.355
N_obs^eff = 12
W_Hα = 3±1 Å
W_O2 = 10±1 Å
W_Hβ = 1±0 Å
W_O3 = 1±0 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = 0.003 ± 0.039 mag
ε(m) = 0.006 | 0.009 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s26s36.019762.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 9.95 9.95 ± 0.00
logt_L = 9.22 9.22 ± 0.01
logZ_L = 0.40 0.40 ± 0.01
τ_V^ISM = 0.40 0.40 ± 0.01
τ_V^BC = 0.00 0.00 ± 0.01
x_7 = 3 | 3 ± 0
x_8 = 3 | 3 ± 0
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

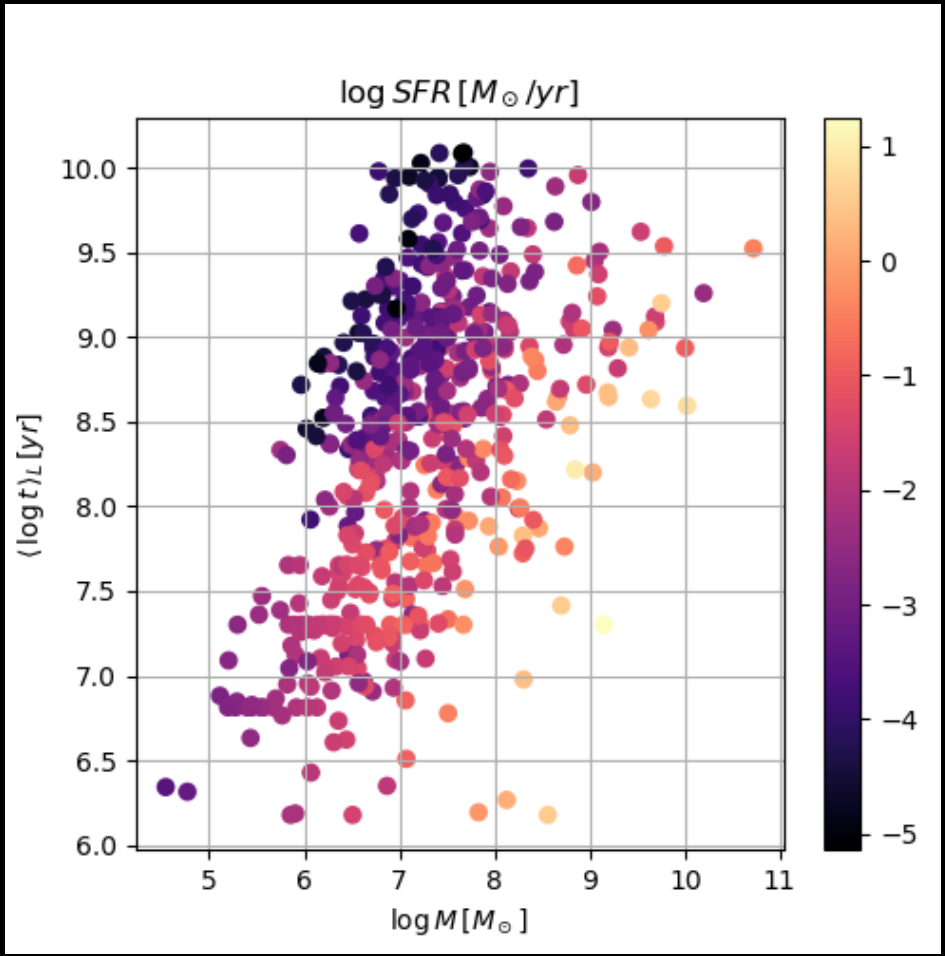

iDR3.SPLUS-s27s33.016552
1e−15
ΔF/F = 1.82 ± 7.89 %
χ²/N = 2.365
N_obs^eff = 12
W_Hα = 23±6 Å
W_O2 = 33±8 Å
W_Hβ = 6±2 Å
W_O3 = 8±3 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = -0.017 ± 0.081 mag
ε(m) = 0.046 | 0.060 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s27s33.016552.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 8.62 8.62 ± 0.07
logt_L = 9.08 8.93 ± 0.23
logZ_L = 0.27 0.31 ± 0.08
τ_V^ISM = 0.91 1.04 ± 0.21
τ_V^BC = 0.00 0.10 ± 0.50
x_7 = 8 | 11 ± 9
x_8 = 8 | 11 ± 9
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||


iDR3.SPLUS-s27s34.000866
1e−17
ΔF/F = 28.03 ± 63.81 %
χ²/N = 0.46
N_obs^eff = 10
W_Hα = 4±12 Å
W_O2 = 3±26 Å
W_Hβ = 1±3 Å
W_O3 = 1±11 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = -0.157 ± 0.470 mag
ε(m) = 0.468 | 0.632 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s27s34.000866.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 7.99 7.21 ± 0.96
logt_L = 8.37 8.19 ± 1.03
logZ_L = 0.24 0.14 ± 0.28
τ_V^ISM = 3.00 2.79 ± 0.43
τ_V^BC = 0.00 0.91 ± 1.20
x_7 = 56 | 42 ± 36 x_8 = 56 | 65 ± 37
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

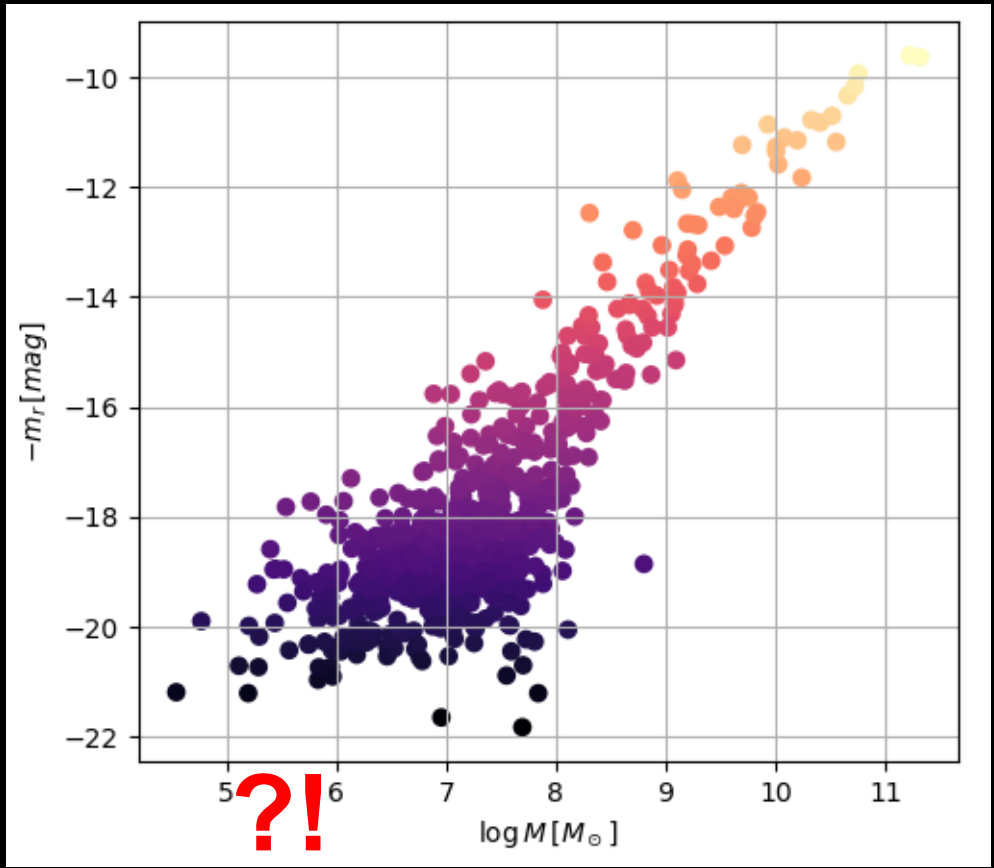

iDR3.SPLUS-s29s33.030400
1e−14
ΔF/F = -0.05 ± 2.07 %
χ²/N = 11.963
N_obs^eff = 12
W_Hα = 2±0 Å
W_O2 = 4±0 Å
W_Hβ = 1±0 Å
W_O3 = 1±0 Å
f_λ [erg s⁻¹ cm⁻² Å⁻¹]
Δm = 0.001 ± 0.023 mag
ε(m) = 0.004 | 0.005 mag
mag
λ[Å] - obs frame
iDR3.SPLUS-s29s33.030400.b16x5.2d.ELbpt9
x_j
m_j
log Z [Z⊙]
log t [yr]
logM = 9.87 9.89 ± 0.03
logt_L = 9.14 9.16 ± 0.05
logZ_L = 0.26 0.24 ± 0.08
τ_V^ISM = 0.72 0.71 ± 0.04
τ_V^BC = 0.00 0.00 ± 0.00
x_7 = 0 | 0 ± 0
x_8 = 0 | 0 ± 0
logt_L x τ_V^ISM || logZ_L
logt_L x logZ_L ||

? Conclusions ?

Mass x mean age



Mass x m_r



A lot to fix … and even more to understand!

Experiments w/AlStar + JPAS/SDSS data