“Kinematics” of the nearest Green Pea analog

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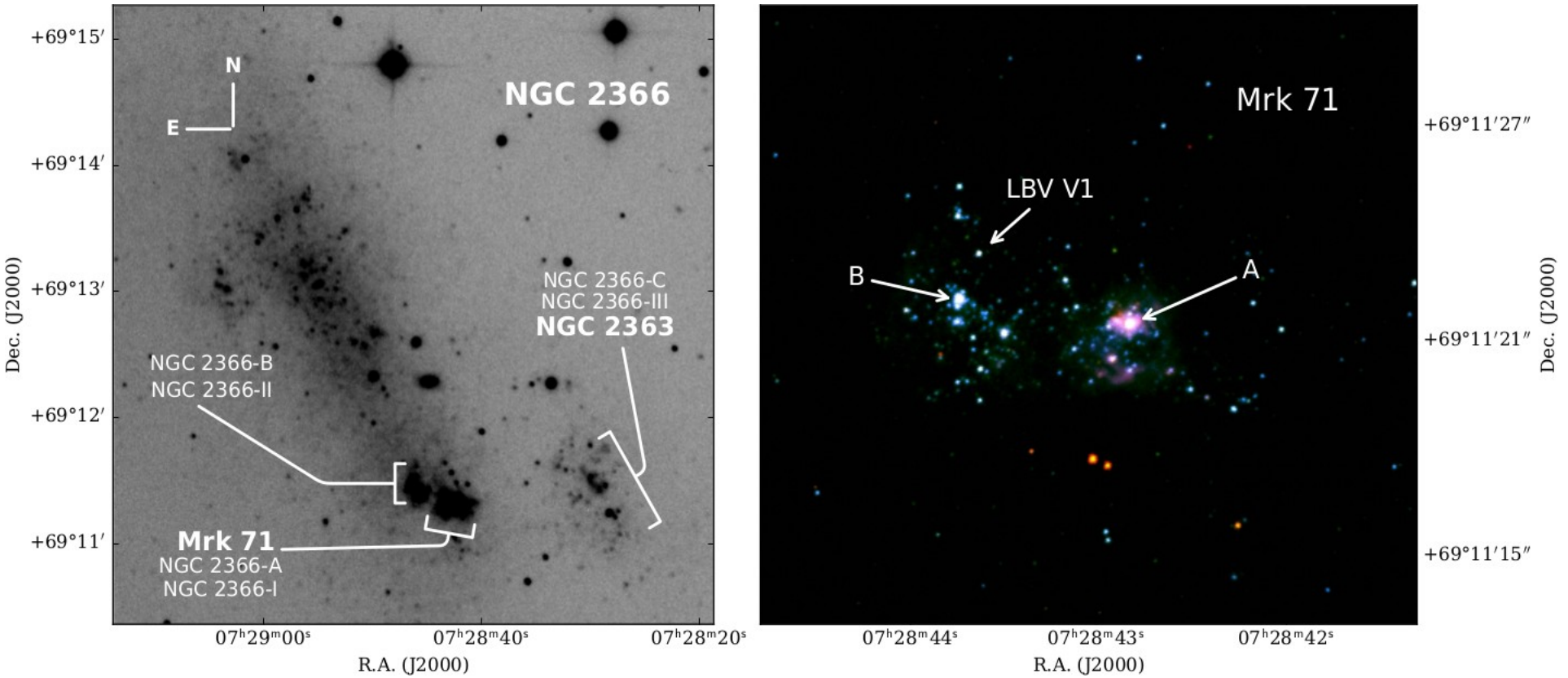
Martin Roth
sends his regards

NGC 2366/Mrk 71



Nearest Green Pea (GP) analog (3.4Mpc away):

Morphology
Excitation properties
Specific star-formation rate (sSFR)
Kinematics
Absorption of low-ionization species
Reddening
Chemical abundance

Micheva, Oey, Jaskot & James 2017

GP-analog → GP class very rich in LyC emitters (Izotov+2016a,b,2018; talks by Verhamme and Schaerer)

Numerous circumstantial evidence for Mrk 71 being a LyC leaker candidate (Micheva+2017)

Dawn Erb's talk - "Spatially resolved spectroscopy is the next step"

In Mrk 71 can study possible mechanisms of LyC escape in unprecedented detail

IFU Observations

1h with PMAS/Calar Alto 3.5m

R1200 backward-blazed grating with Lens Array (Larr)

FoV 16”×16” in double magnification mode

Reduction

P3D data reduction pipeline (Sandin+2010,2012)

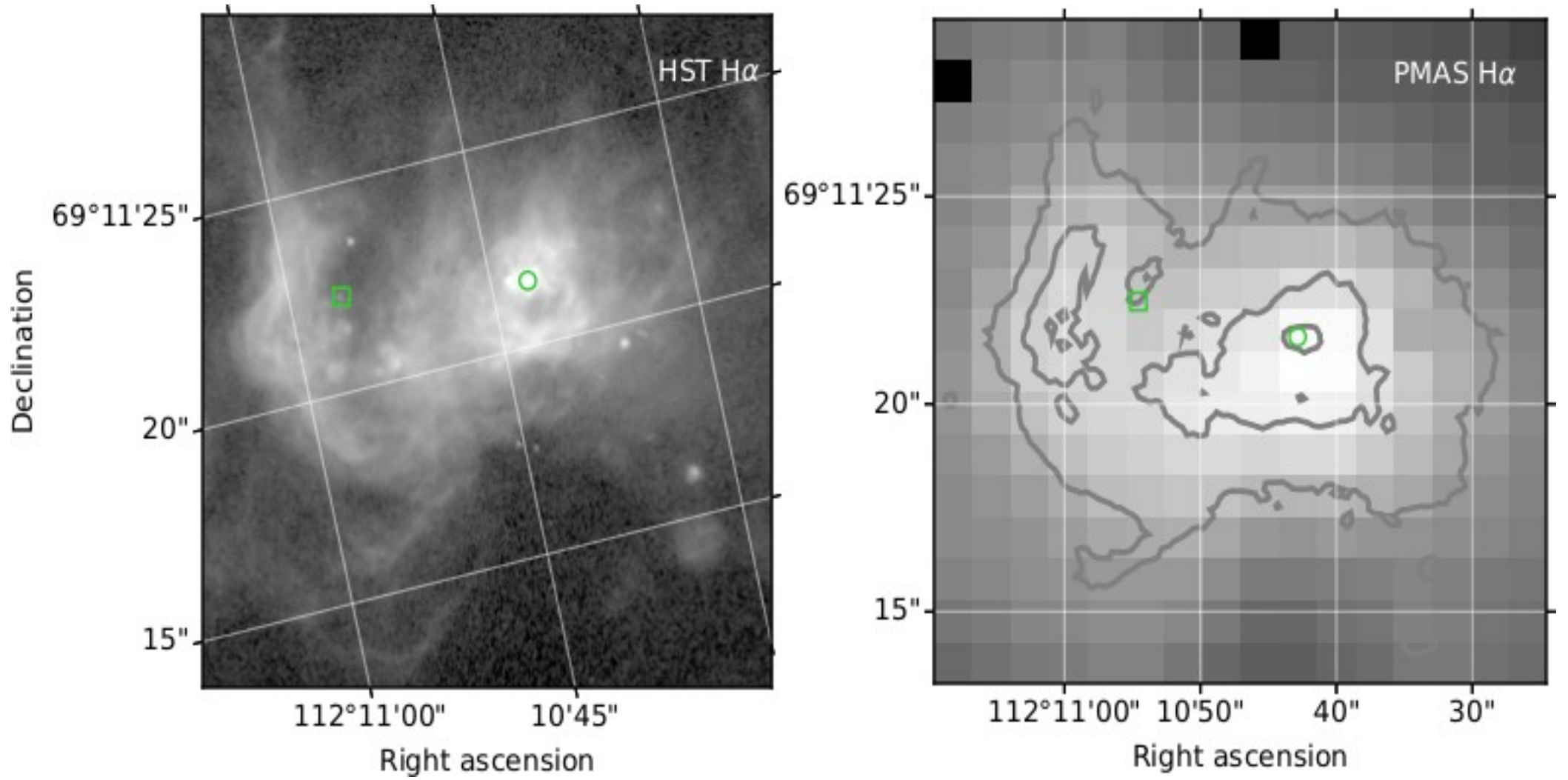
Final data product

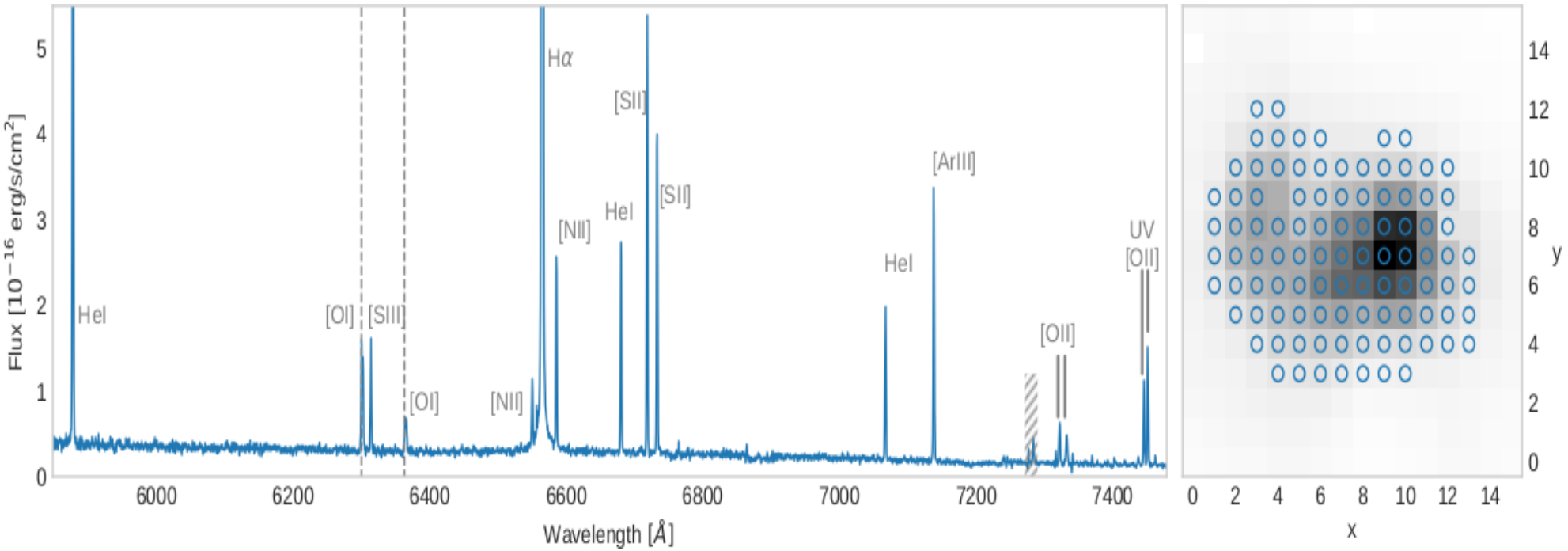
data cube of 16 × 16 × 3991 voxels

spatial sampling 1”×1” spaxels

spectral sampling 0.46 Å/pixel

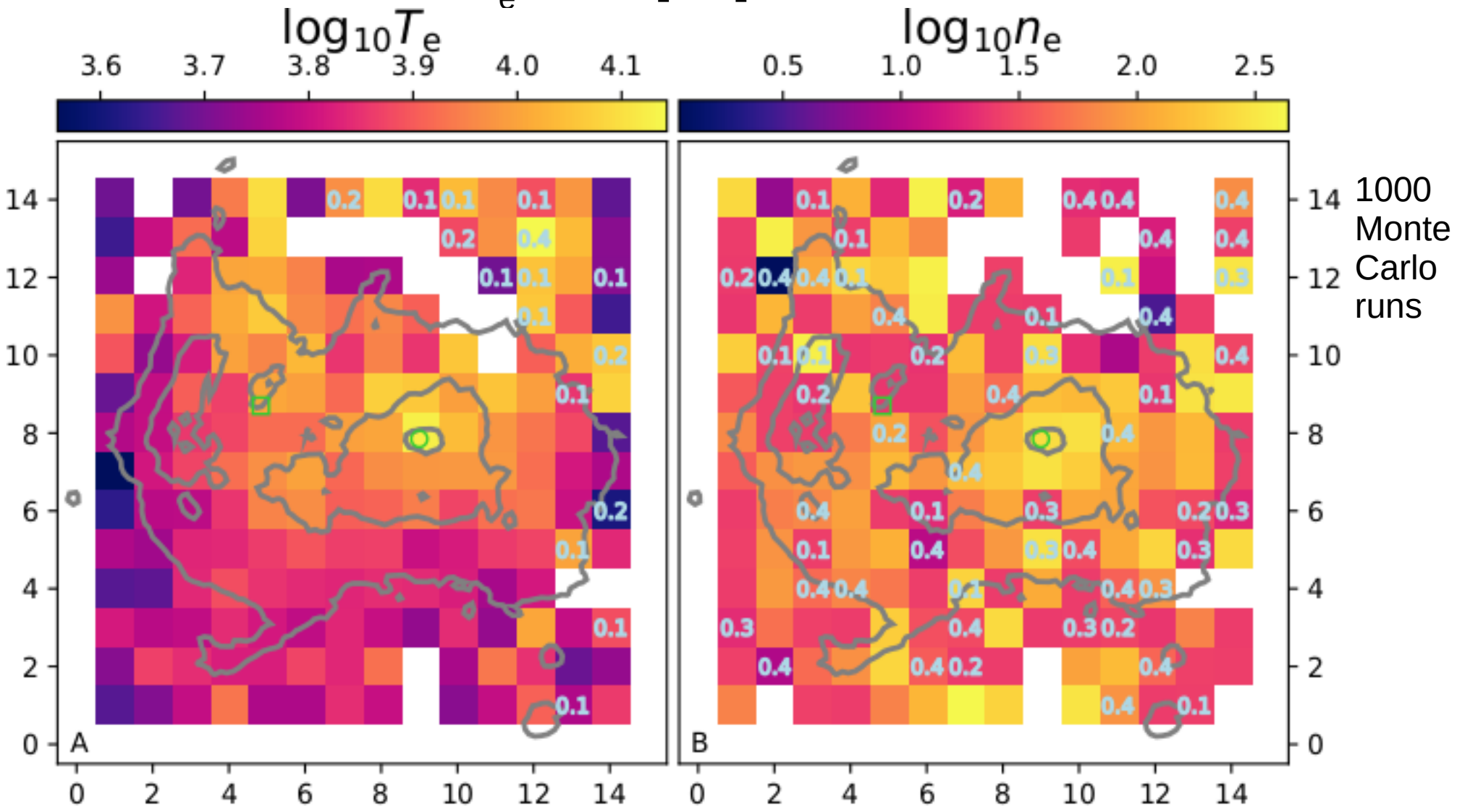
Spectral range 5825-7650 Å (same setup as for eLARS)


HST Hα
PMAS Hα
69°11'25"
20"
15"
Declination
112°11'00"
10'45"
10'50"
40"
30"
Right ascension



2nd order UV [OII] “contamination” because no UV-blocking filter

T_e from [OII]3727+/[OII]7325+
n_e from [SII]6716/6731

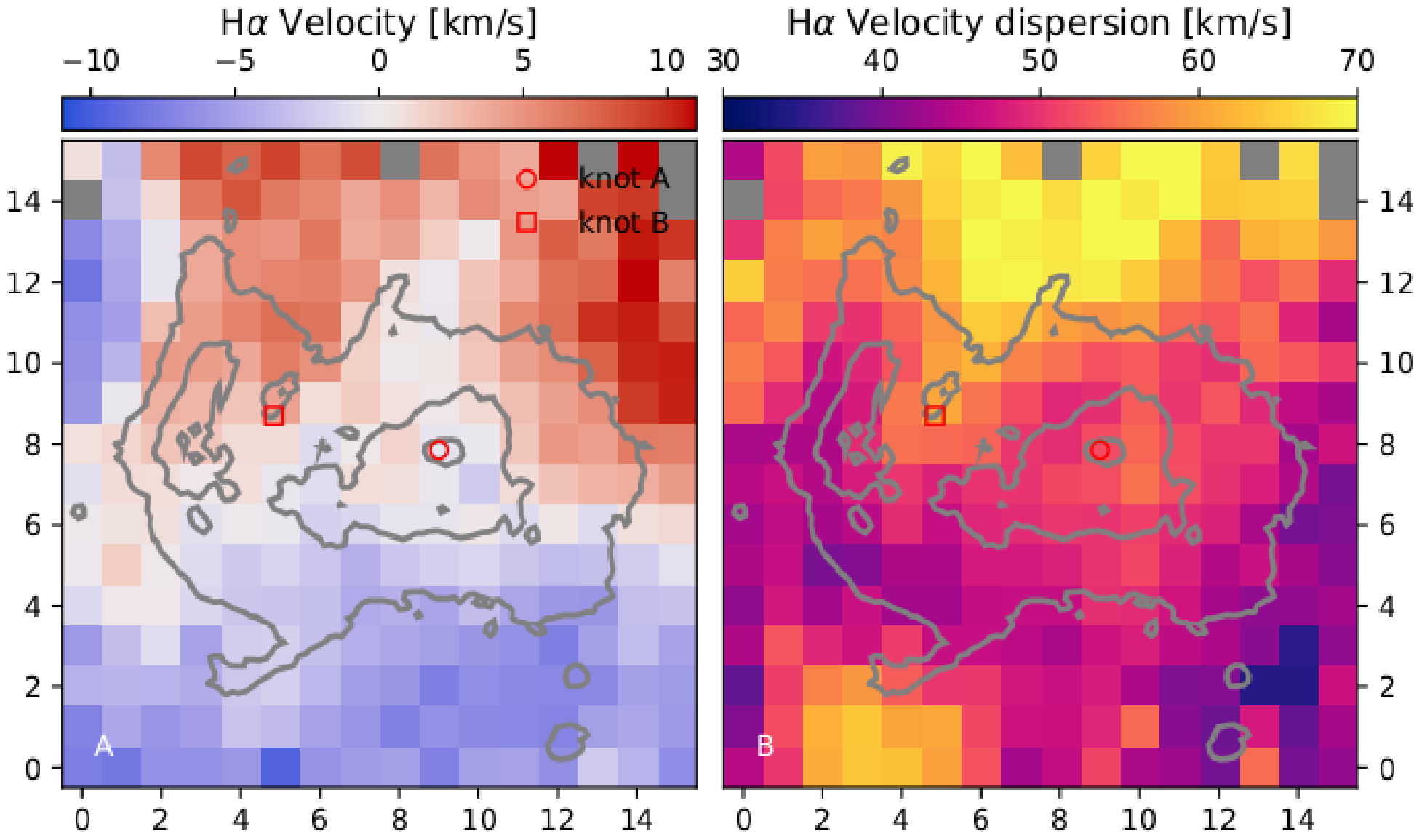


1000 Monte Carlo runs

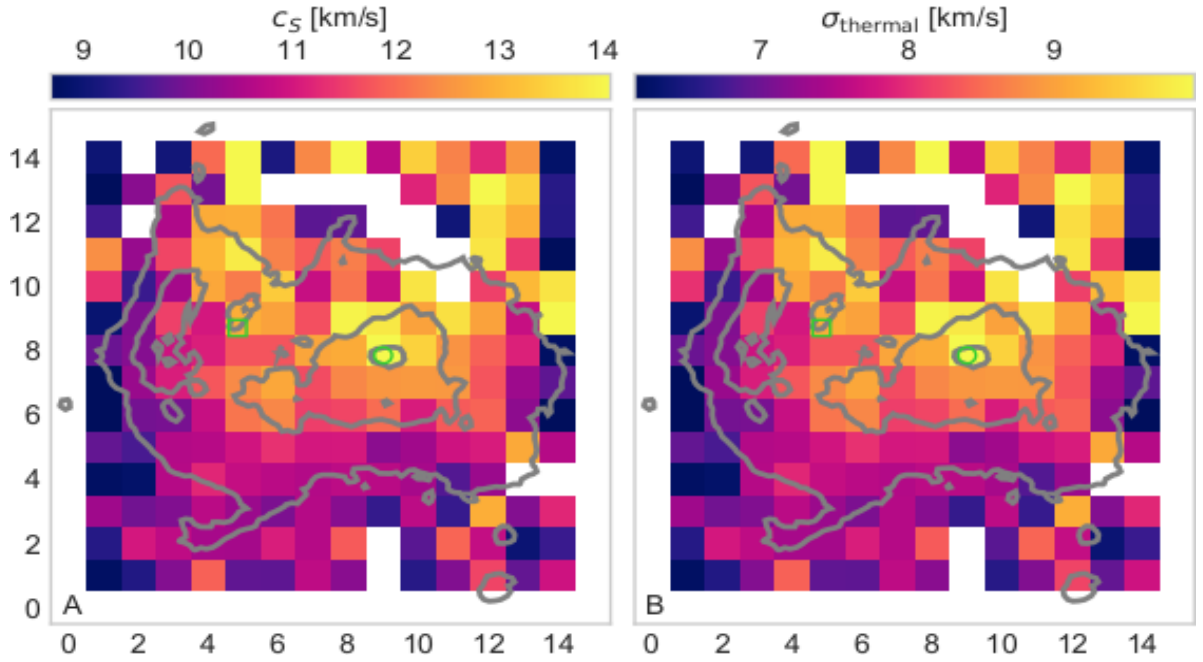
Knot A: T_e ([O II])=13375 K; n_e = 272 cm $^{-3}$;

Sokal+2016 T_e([O II])= 1.3 ± 0.3 × 10^4 K; n_e = 512 ± 264 cm $^{-3}$

Gonzalez-Delgado+1994 T_e ([O II])= 1.45 ± 0.13 × 10^4 K; n_e= 235 ± 41 cm^{-3}

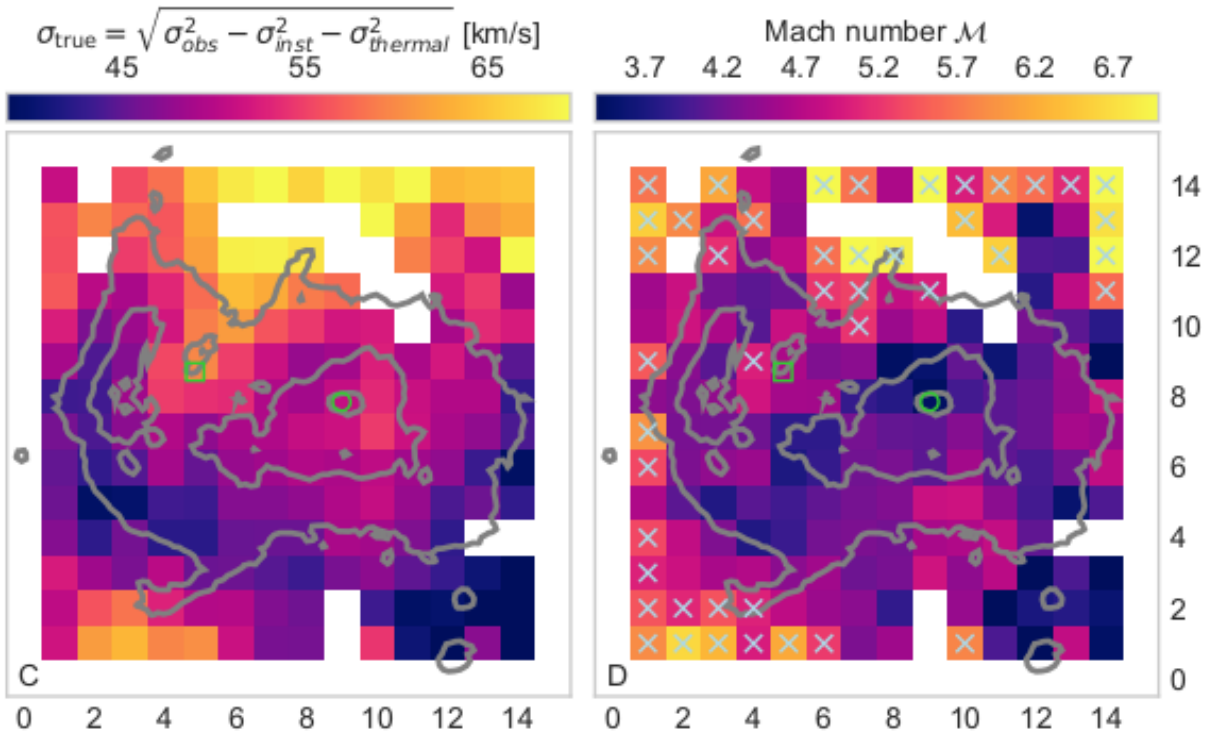

Hα Velocity [km/s]
−10
−5
0
5
10
Hα Velocity dispersion [km/s]
30
40
50
60
70
knot A
knot B
A
B
0
2
4
6
8
10
12
14

Speed of sound



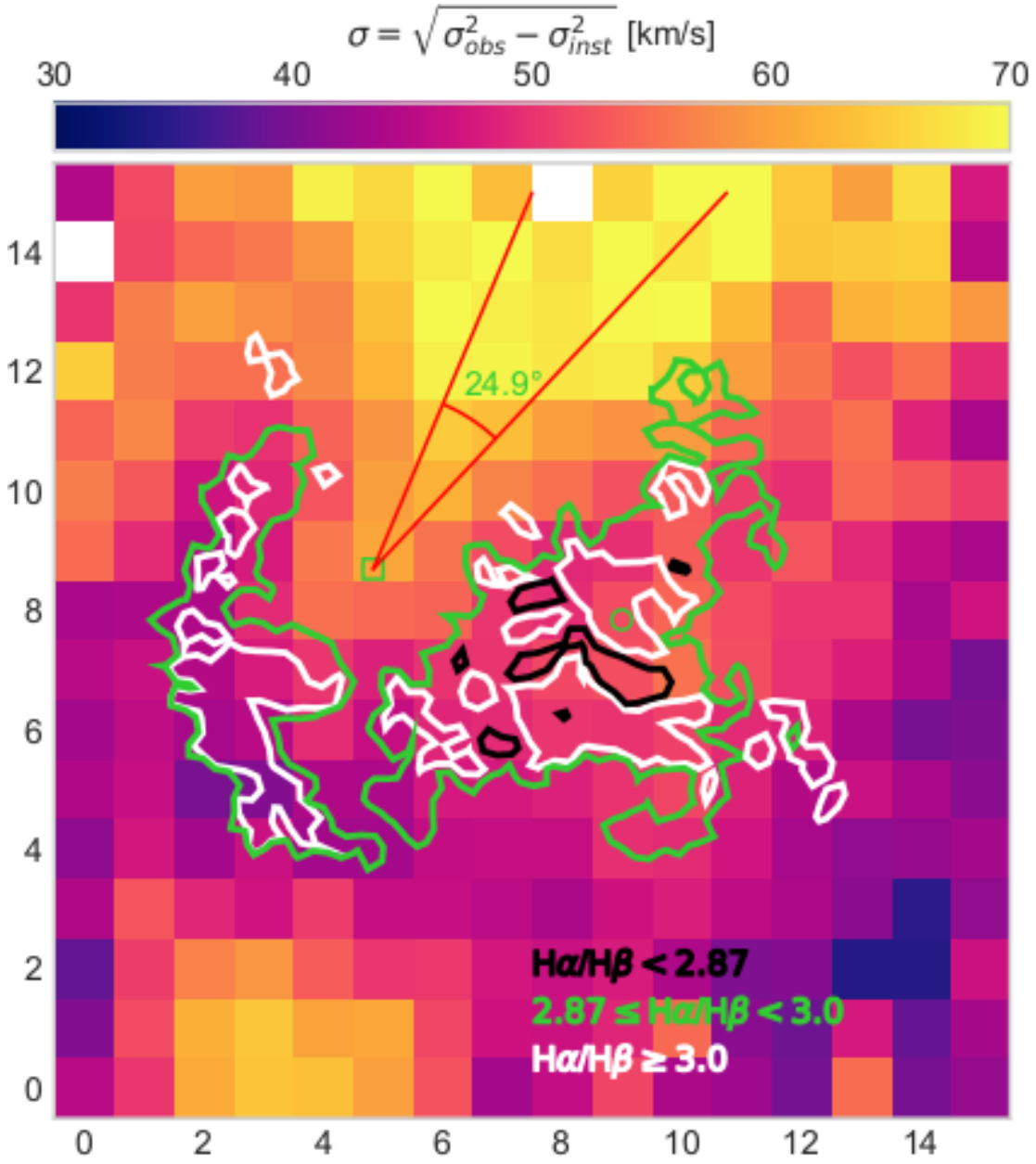
Thermal broadening

“true” Velocity dispersion

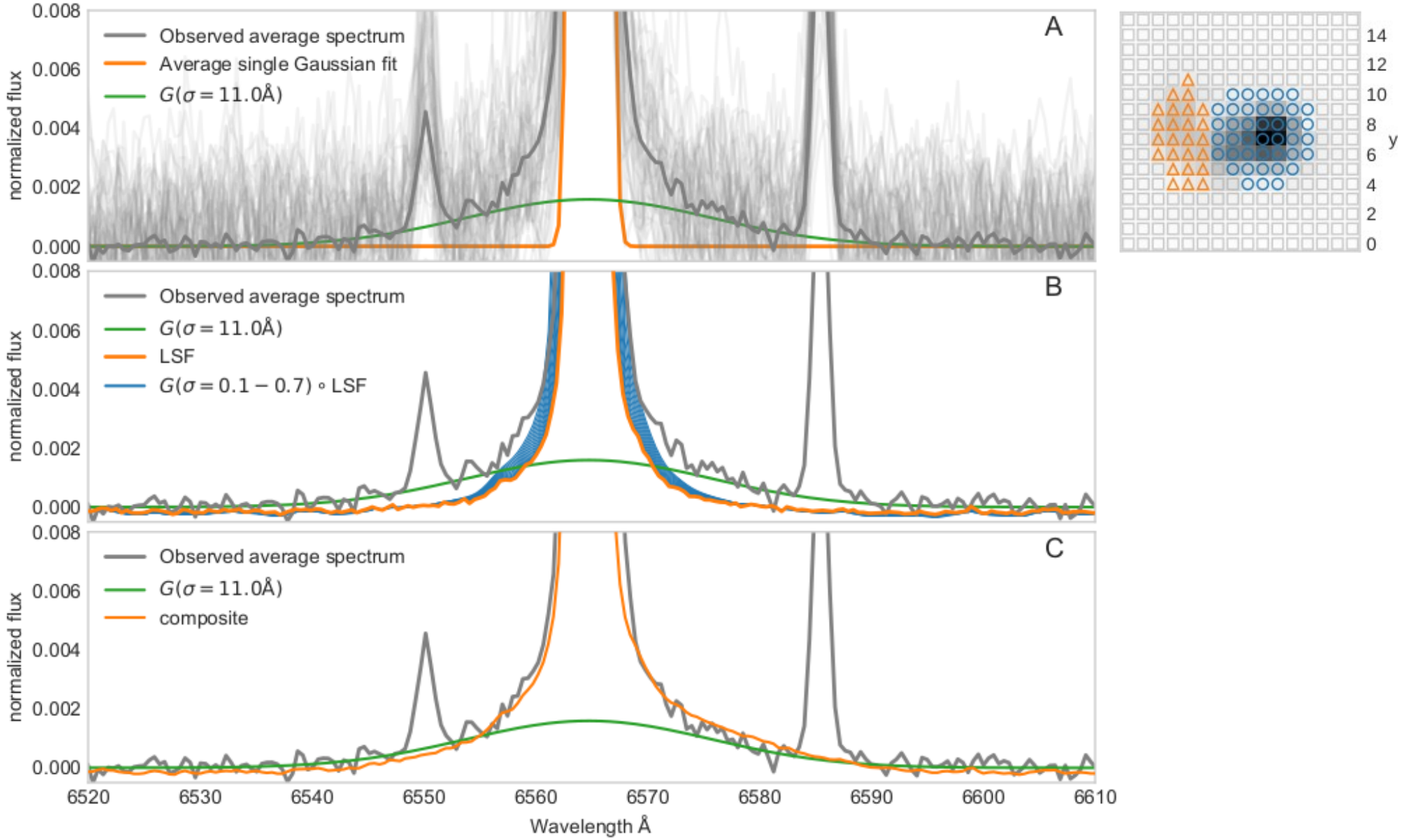


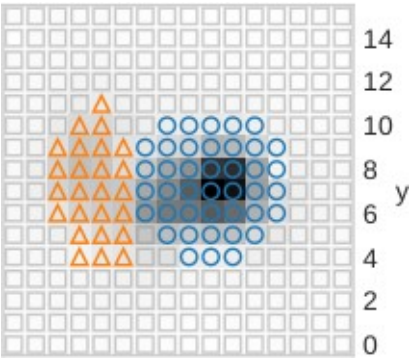
Mach number

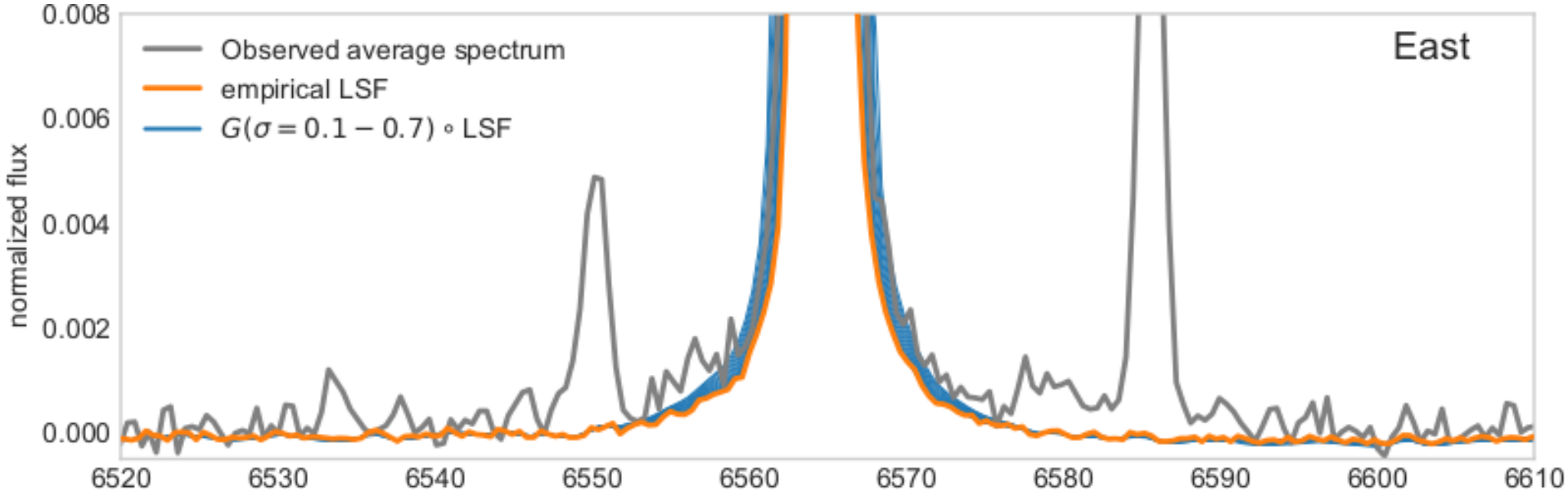
X → M ≥ 5

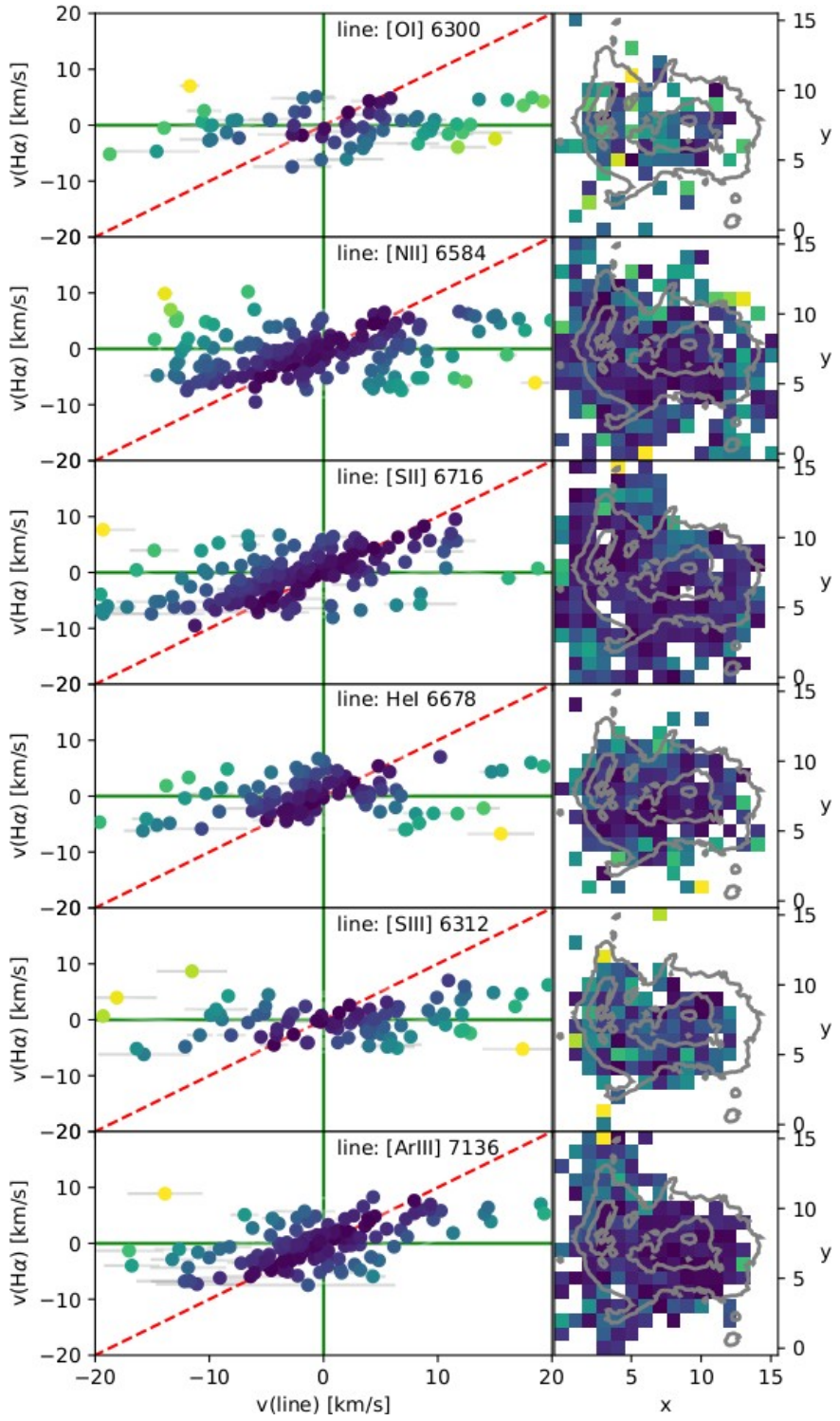

$\sigma = \sqrt{\sigma^2_{obs} - \sigma^2_{inst}}$ [km/s]
30
40
50
60
70
24.9°
Hα/Hβ < 2.87
2.87 ≤ Hα/Hβ < 3.0
Hα/Hβ ≥ 3.0
0
2
4
6
8
10
12
14

Is there a broad component?




14
12
10
8
6
4
2
0
y

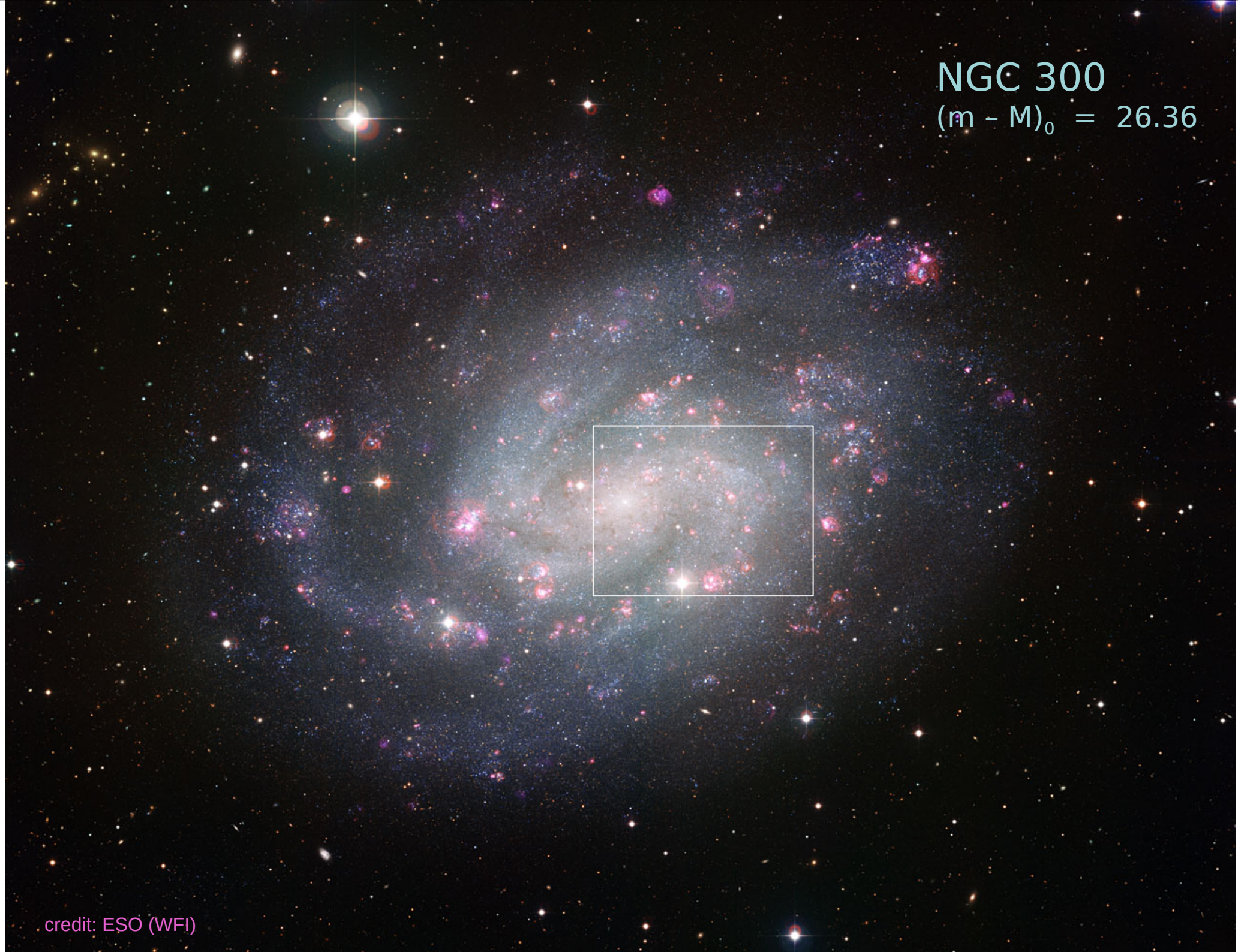

0.008
0.006
0.004
0.002
0.000
normalized flux
Observed average spectrum
empirical LSF
$G(\sigma = 0.1 - 0.7) \circ$ LSF
East
6520
6530
6540
6550
6560
6570
6580
6590
6600
6610

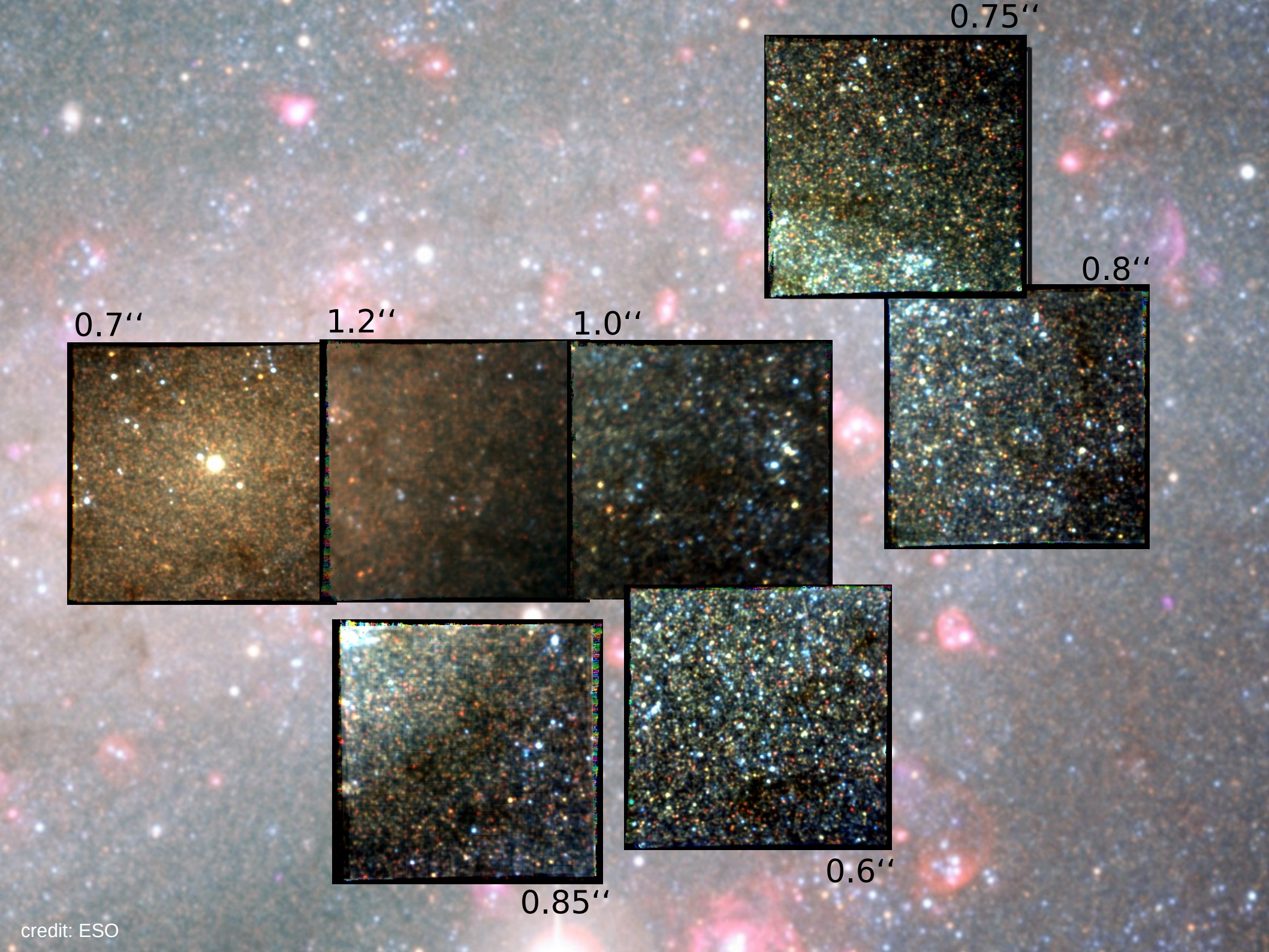


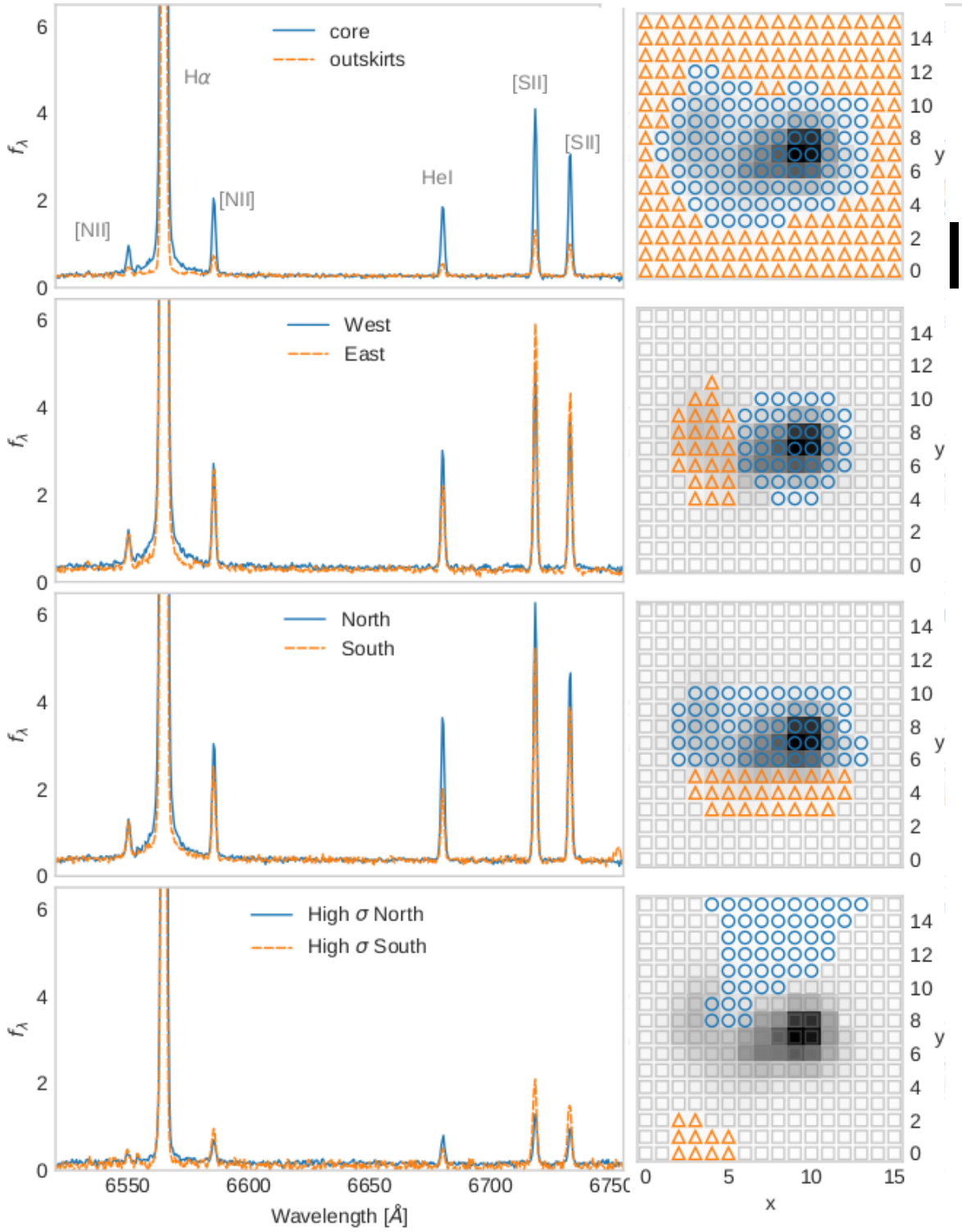
Neutral, low- and high-ionization gas move together (or not?)

Summary (no conclusions yet)

- Broad component – yes, but localized and extremely faint
  - 2 Gaussians enough, no need for more as in Amorin+2012 for GPs
- Electron Temperature (fluctuations t^2 ?)
- Bi-conal outflow associated with high velocity dispersion regions
- All gas is supersonic. Outskirts are hypersonic. → drop in gas density
- Bi-conal outflow seemingly originates from knot B (~5Myr old)
- Neutral, low-ionization and high-ionization gas move together?


NGC 300
$(m - M)_0 = 26.36$
credit: ESO (WFI)


0.75‘‘
0.8‘‘
0.7‘‘
1.2‘‘
1.0‘‘
0.6‘‘
0.85‘‘
credit: ESO



Is there a broad component?