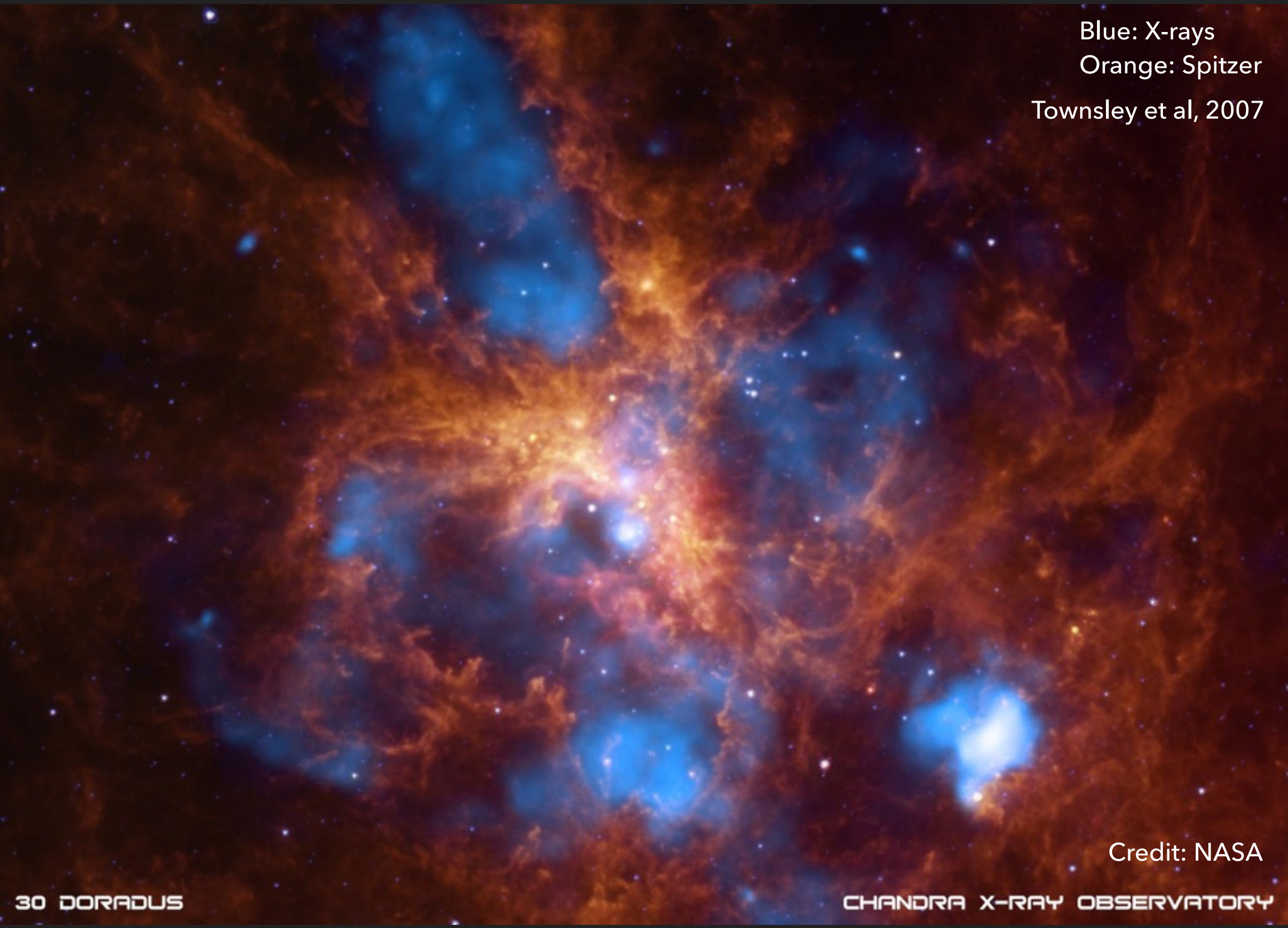
STELLAR FEEDBACK IN BCG ESO338-IG04

ARJAN BIK (STOCKHOLM UNIV, SWEDEN)

Göran Östlin (SU), Veronica Menacho (SU) , Angela Adamo (SU), Matthew Hayes (SU), Christian Herenz (SU), Jens Melinder (SU)

Bik et al, A&A, in press, arXiv:1809.03597

STELLAR FEEDBACK


Blue: X-rays
Orange: Spitzer
Townsley et al, 2007
Credit: NASA
30 DORADUS
CHANDRA X-RAY OBSERVATORY

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Townsley et al, 2007

- LyC radiation: radiation pressure + photo ionization (<3-4 Myr)
- Stellar winds: mechanical energy, shocks, enrichment (<3-4 Myrs)
- Supernovae explosions: mechanical energy, shocks, enrichment (3 - 40 Myrs)

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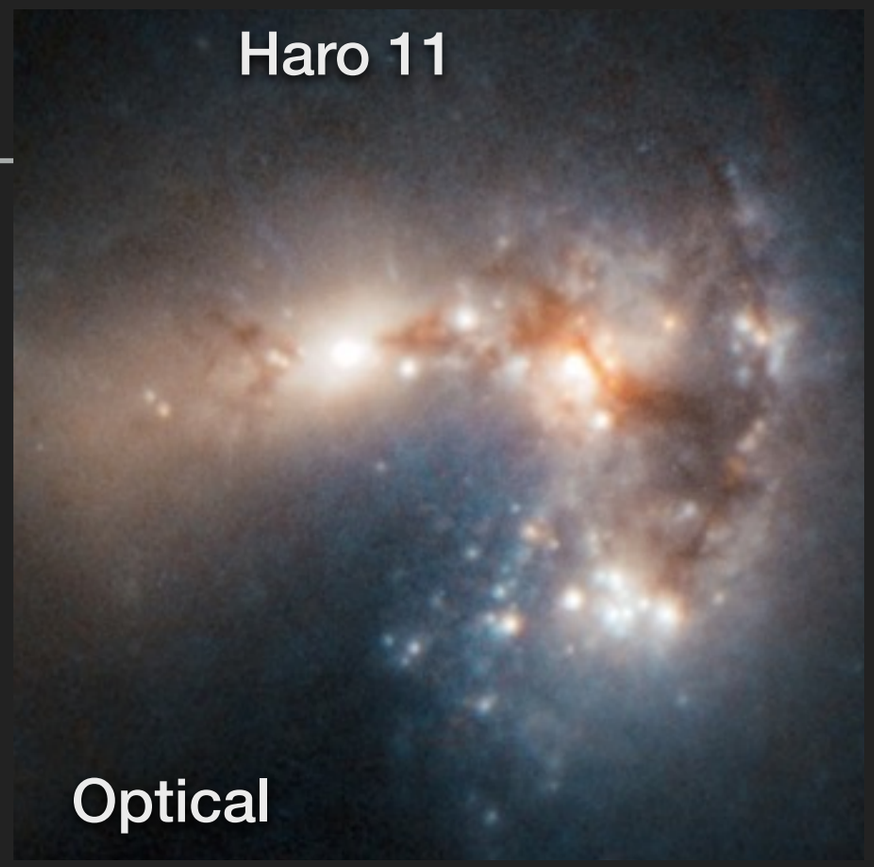
- Supernovae explosions: mechanical energy, shocks, enrichment (3 - 40 Myrs)
- super bubbles, outflows
- ISM phases
- Metal enrichment of the IGM
- Responsible for LyC and Lyα escape in galaxies.

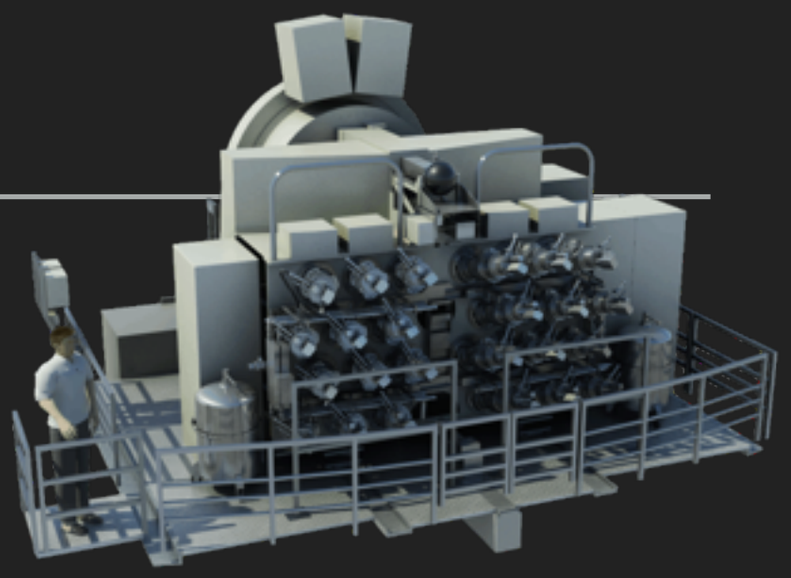
Credit: NASA

BLUE COMPACT GALAXIES

- Local analogues of high-redshift dwarf galaxies.
  - Strongly star forming within a few 100 Mpc in order to study them in detail.
  - contain dozens of super star clusters
  - Quantify feedback mechanisms
  - Few LyC leakers, more suspected



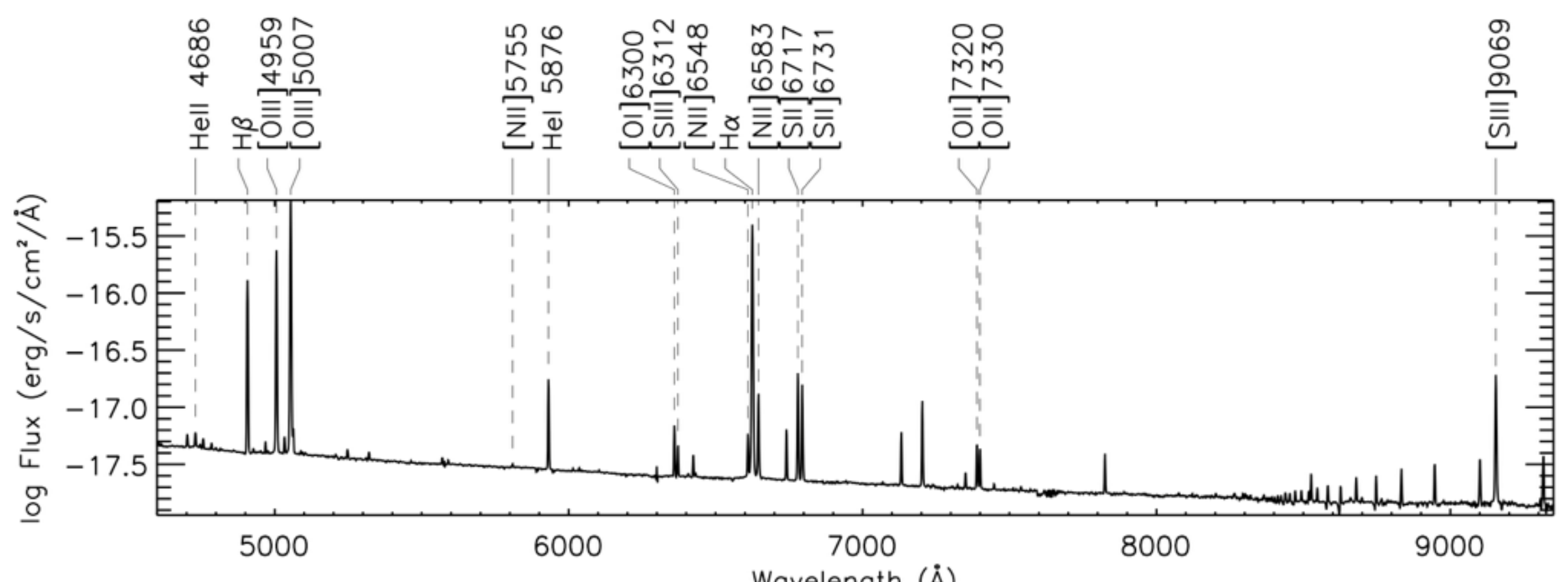
VLT/MUSE OBSERVING PROGRAM



- MUSE: optical Integral Field Spectrograph at the VLT (AO supported)
- 1x1 arc minute field of view with 0.2“ pixel scale, R=2000
- 4600 - 9300 Å: many optical emission lines tracing the physical conditions of the ISM
- Study the effect of cluster feedback on the ISM in detail.

Talks: Göran Östlin, Veronica Menacho

Poster: Christian Herenz



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ESO 338-IG04

DISTANCE (MPC)	MASS (M_{sun})	12+LOG(O/H)	SFR (M_{SUN}/YR)	MUSE RESULTS
37.5	$4x10^9$ stars $1.4x10^9$ HI	7.9	3.2	Bik et al, 2015, 2018

UV, optical, Hα

Östlin et al, 2009 credit: Jens Melinder

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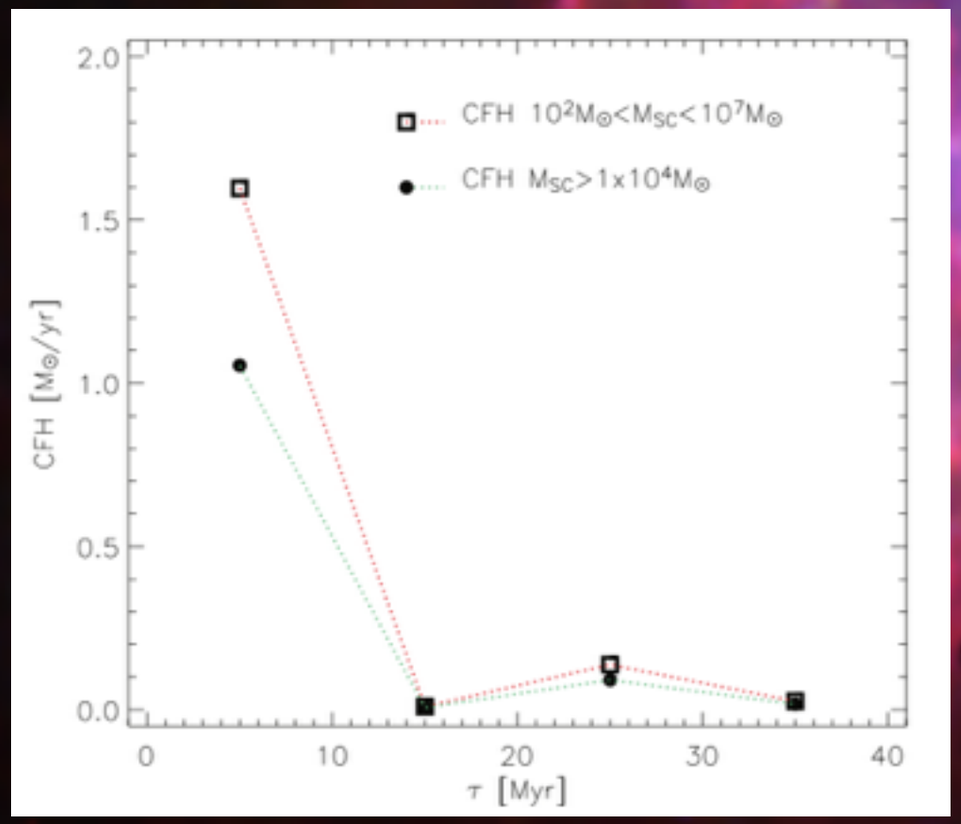
- ESO 338: host of large number of super star clusters.
- Indirect evidence for LyC leakage



Östlin et al, 1998, 2003
Adamo et al, 2011

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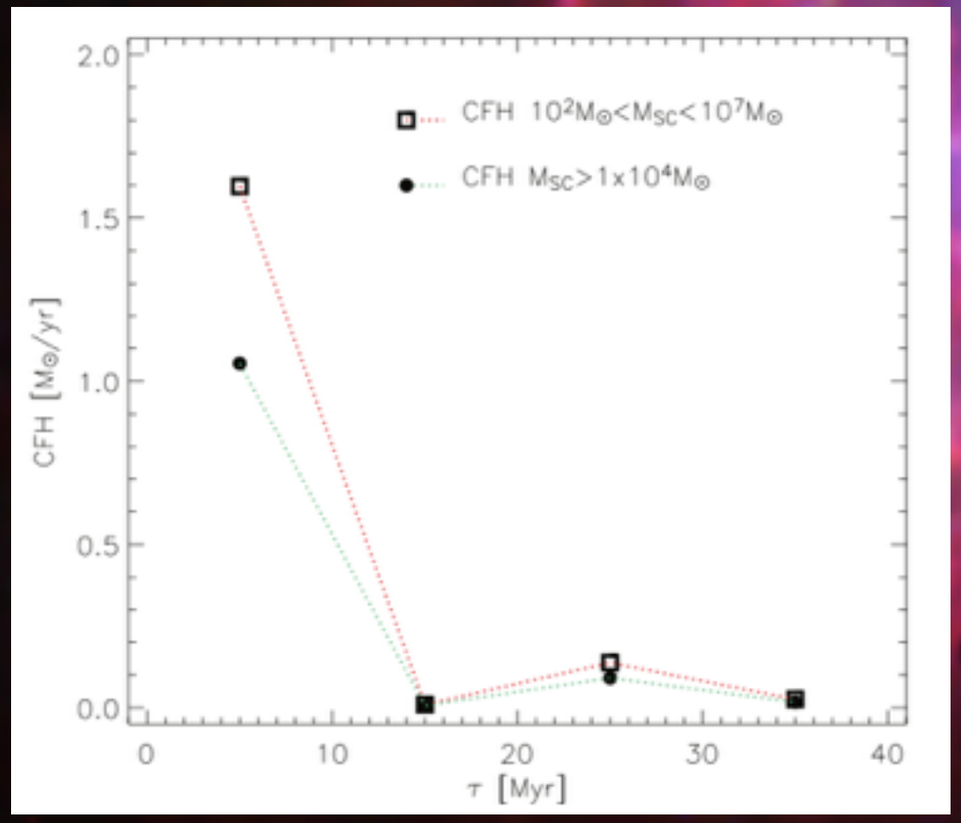

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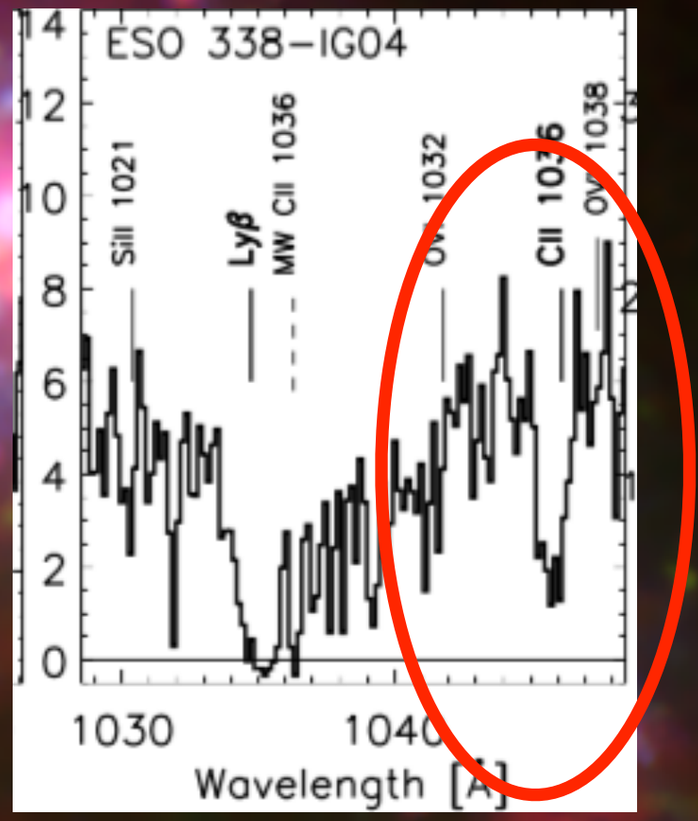

Leitet et al, 2013

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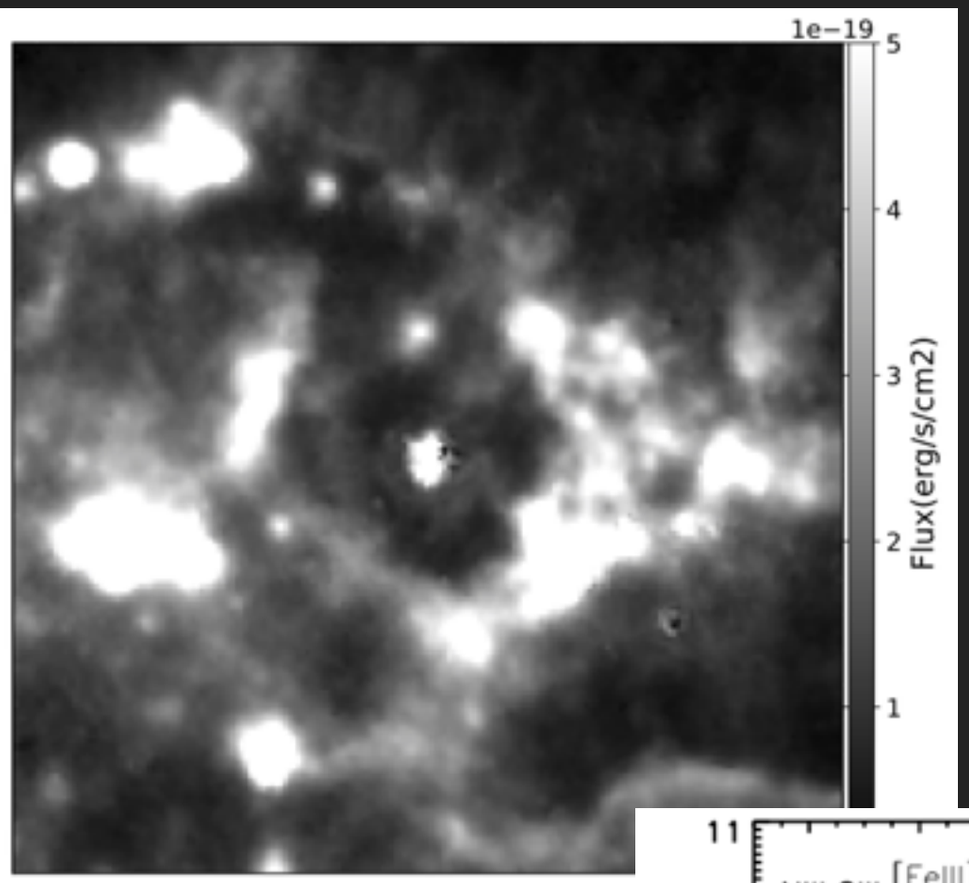
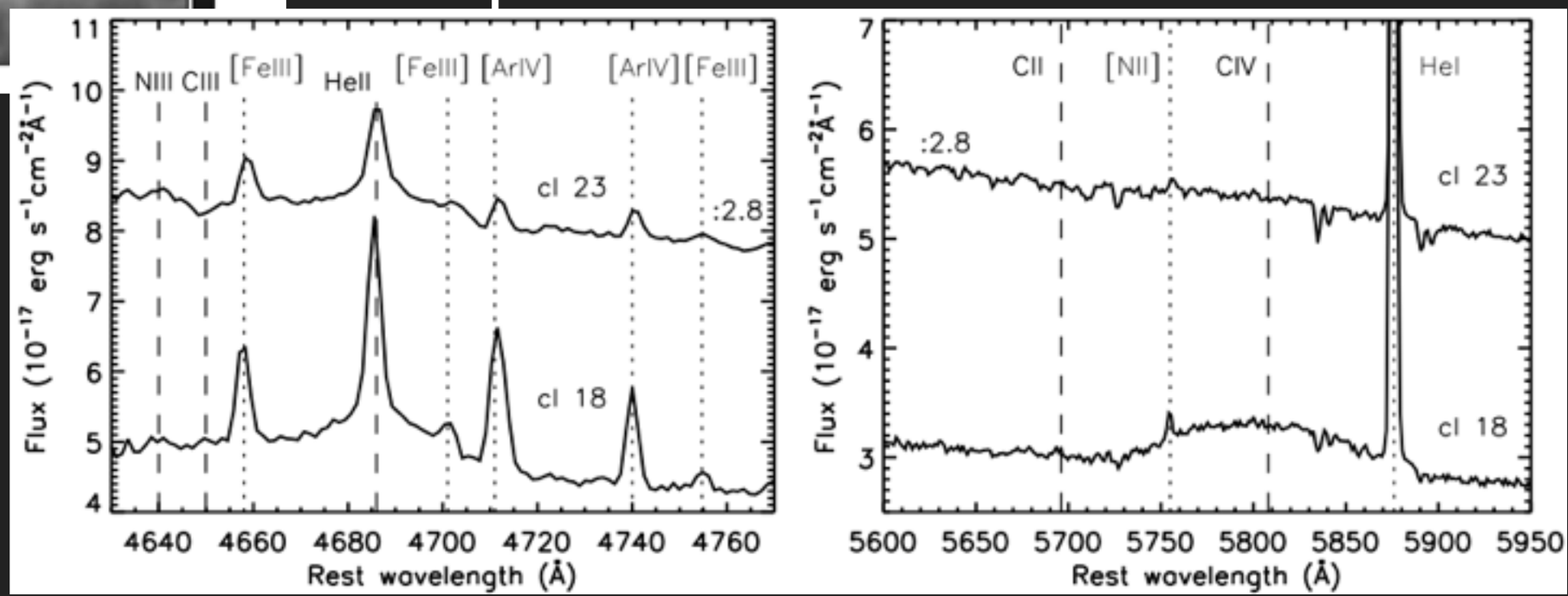
STAR CLUSTER POPULATION

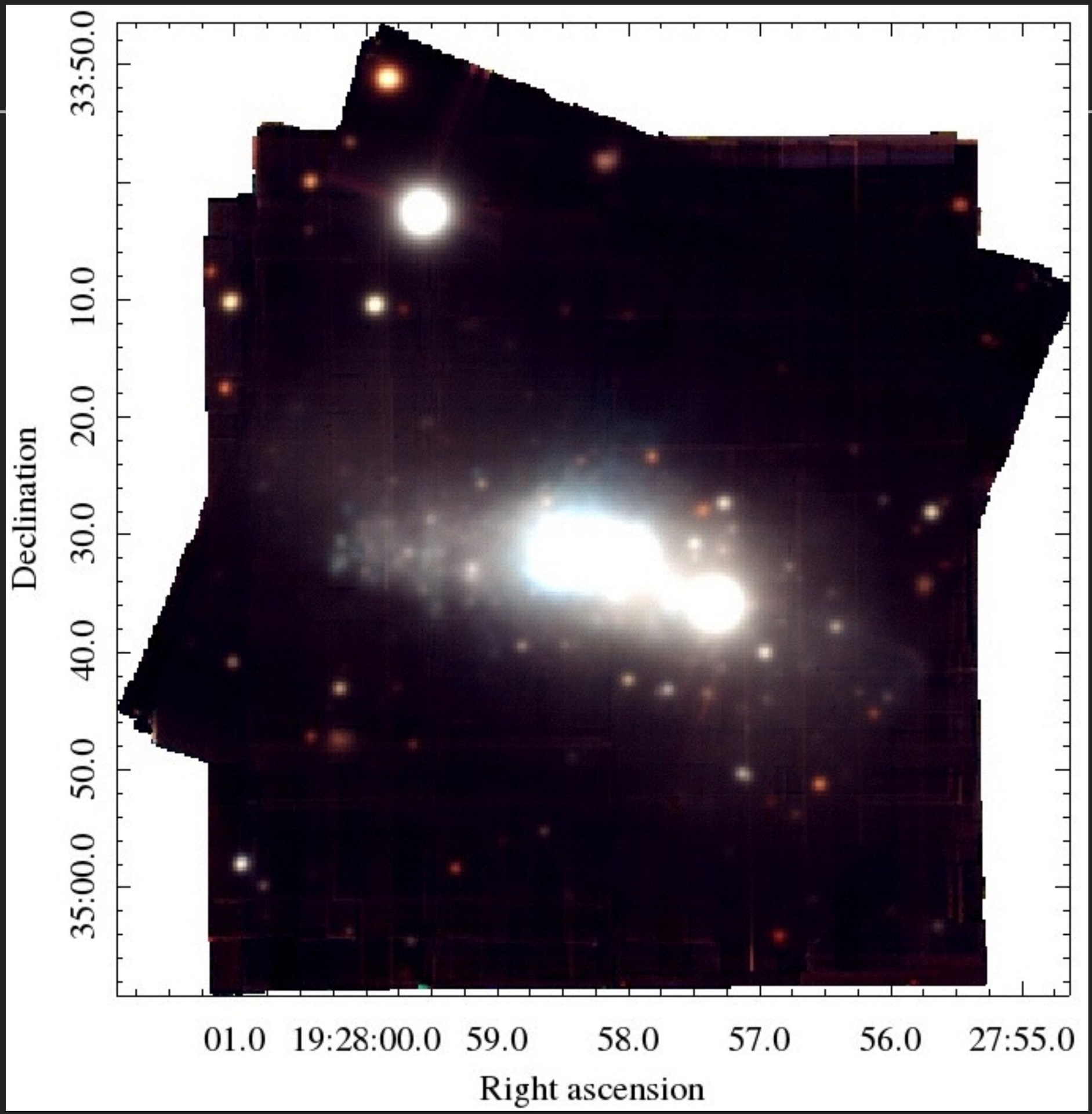


- Cluster 23: most massive cluster
- M_dyn = $10^7 M_{sun}$ (Östlin et al, 2007)
- age: ~ 6 Myr (Östlin et al, 2007)
- WR features in the optical spectrum



Bik et al, 2018

ESO338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10.0
20.0
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40.0
50.0
35:00.0
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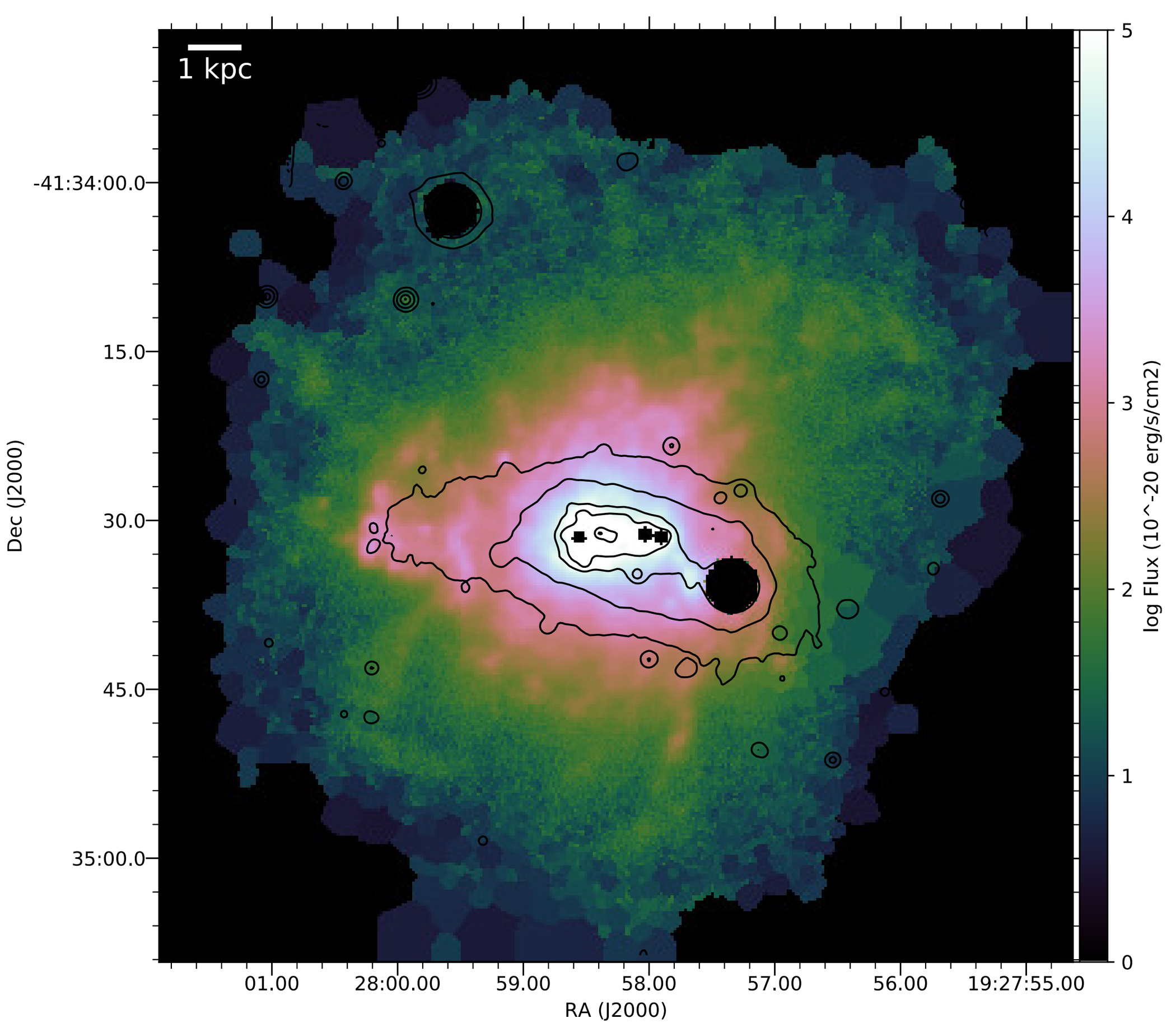
19:28:00.0
59.0
58.0
57.0
56.0
27:55.0
Right ascension

ESO338



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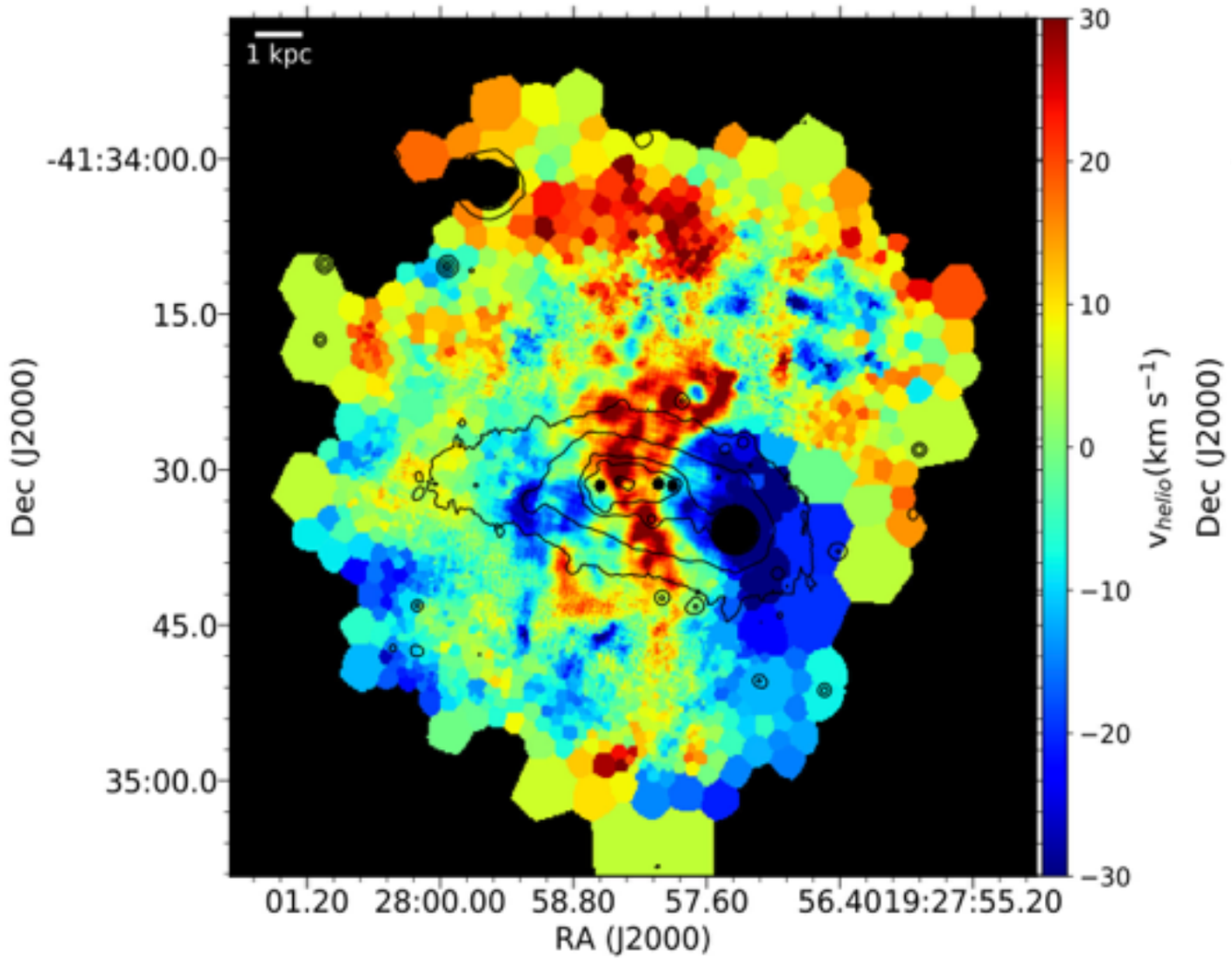
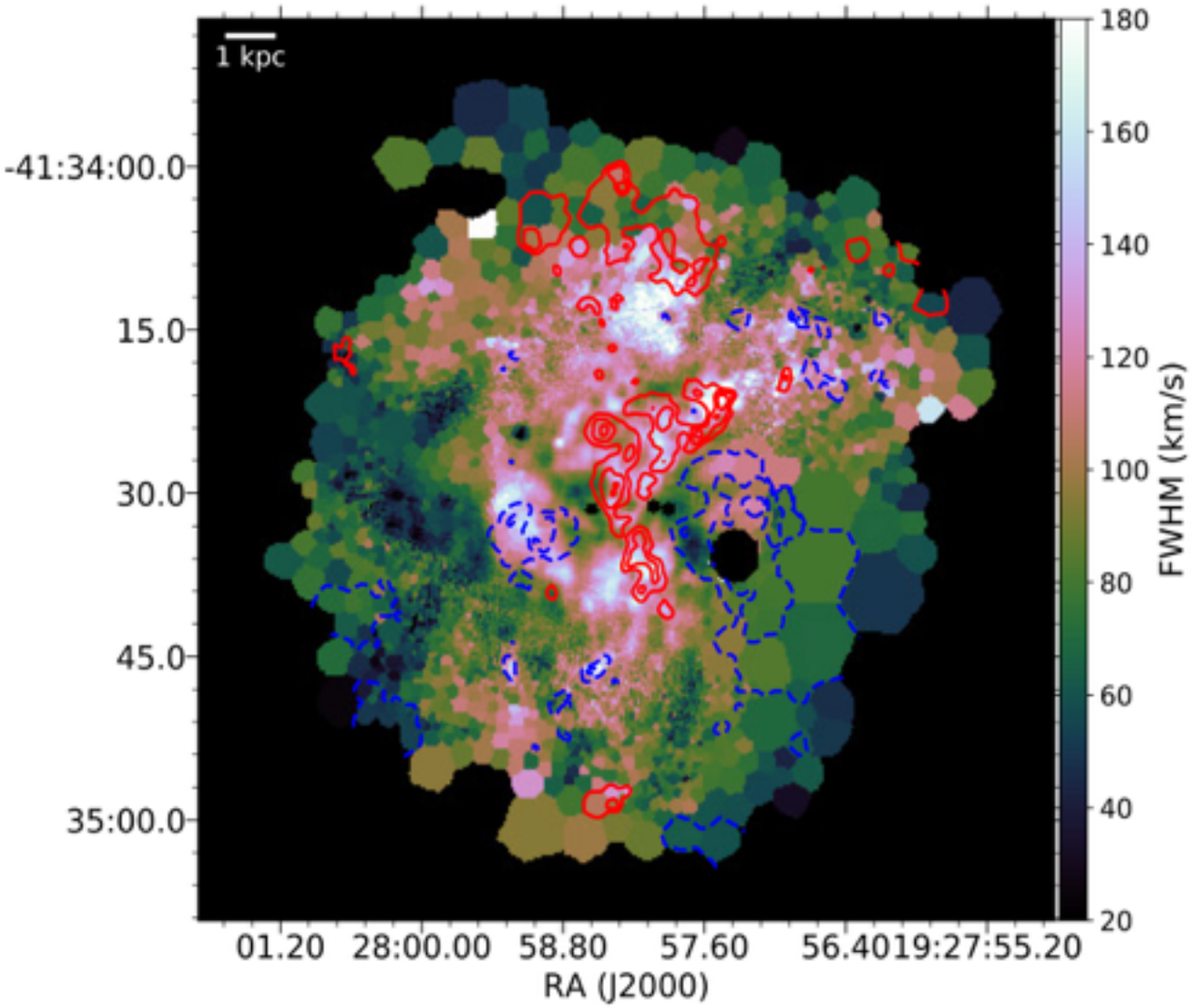
ESO338-IG04 – KINEMATICS



velocity



velocity dispersion

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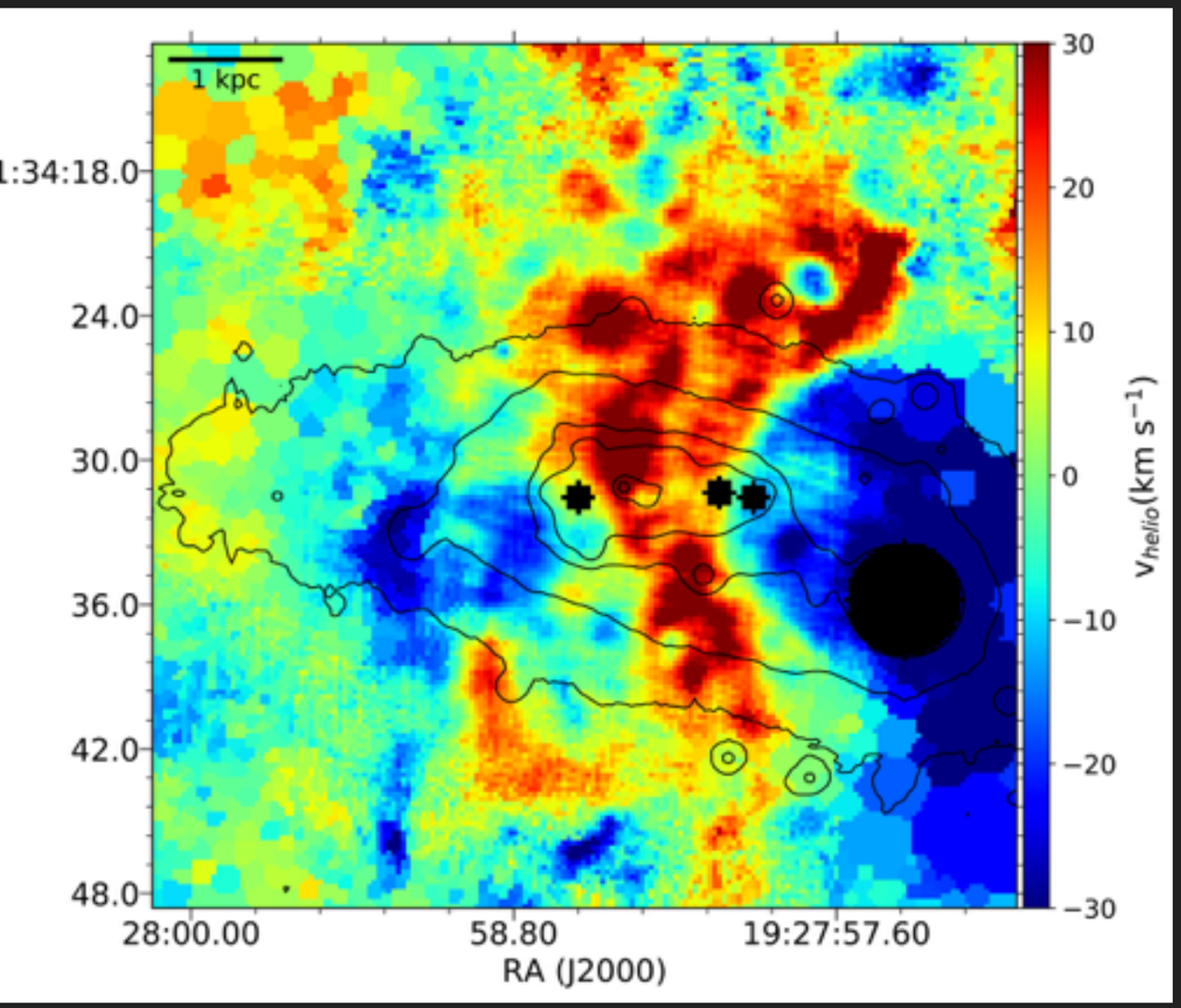
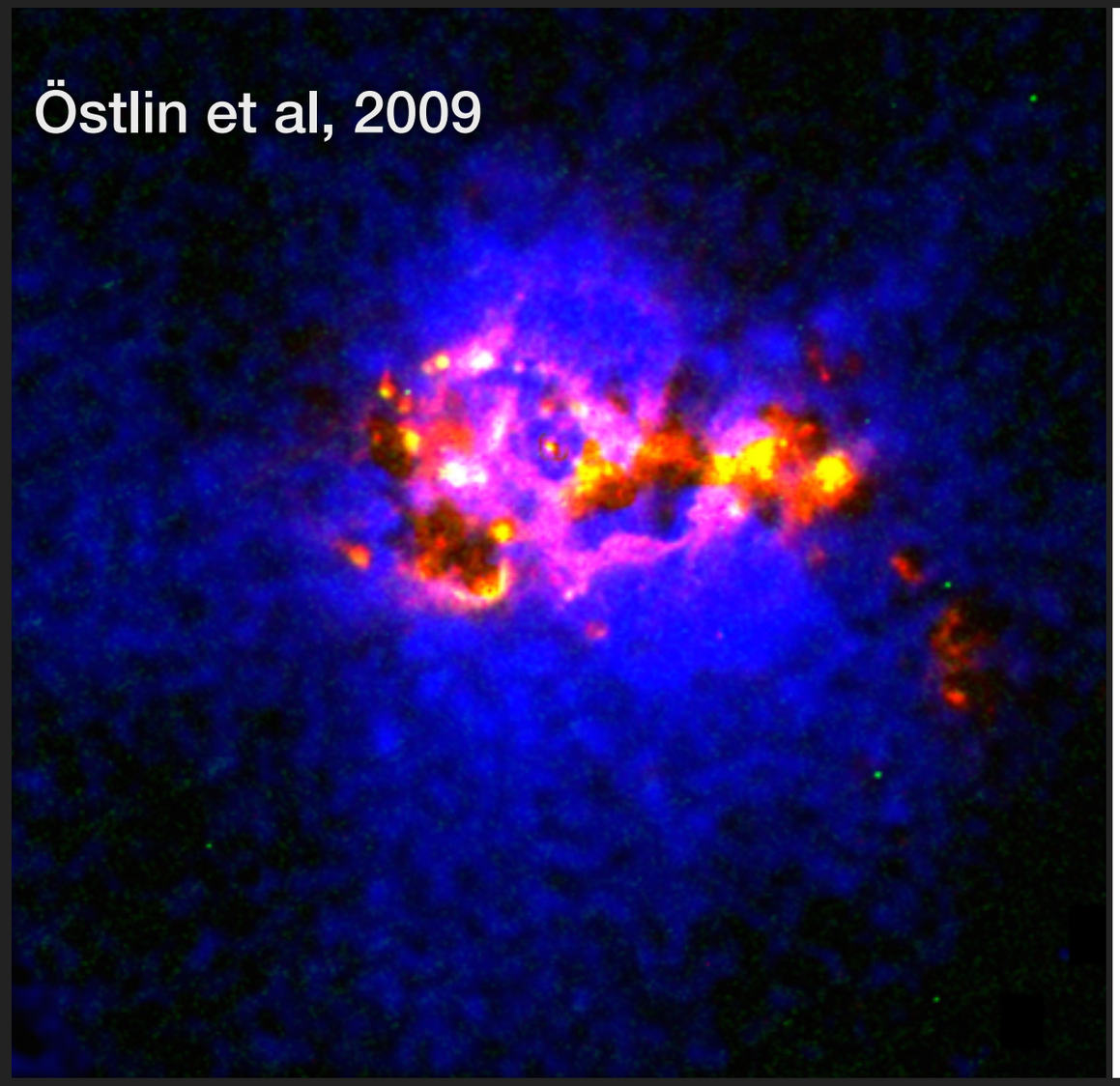
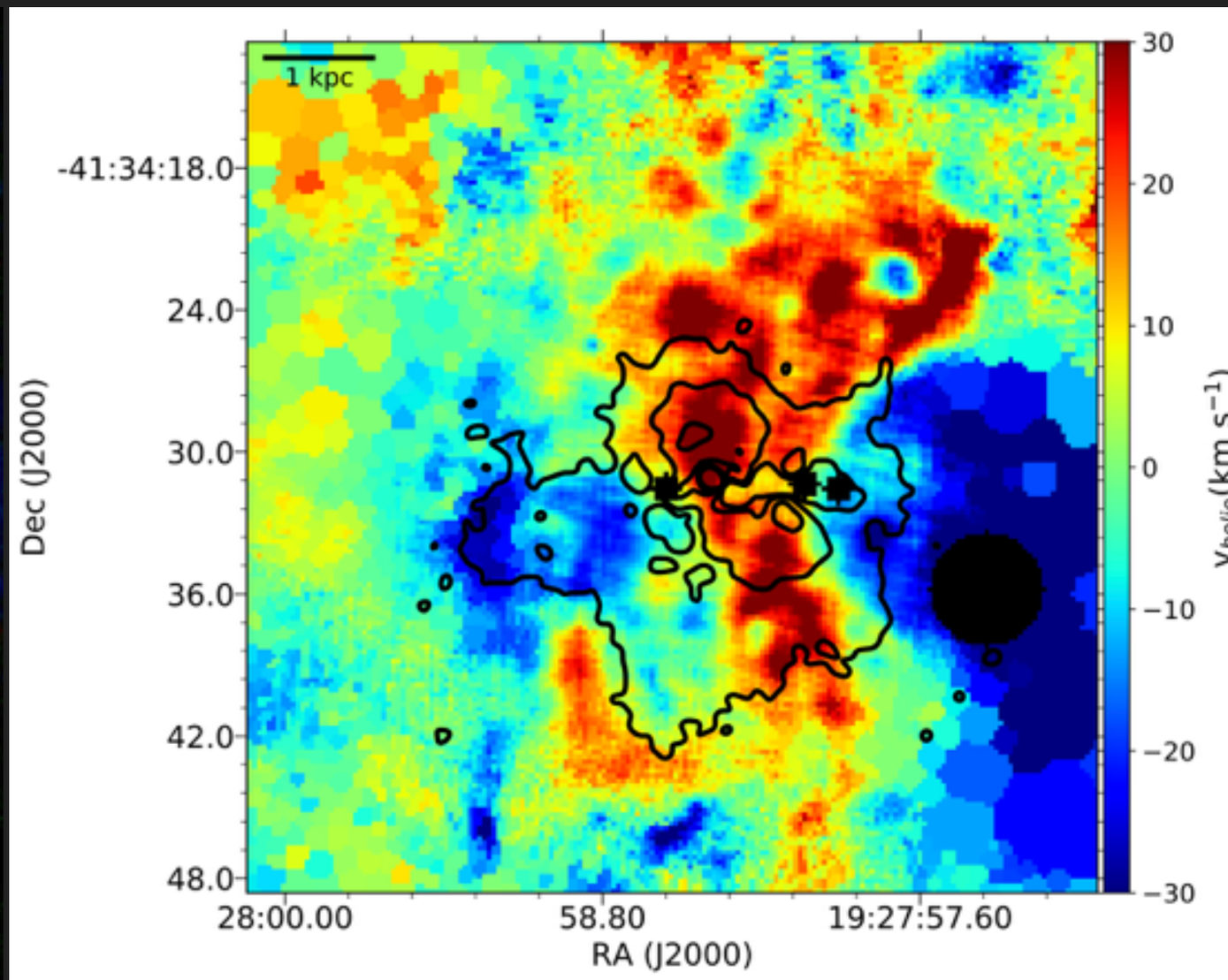


- Galactic scale redshifted outflows (Bik et al, 2015).
- Turbulent velocity field
- No ordered rotation (see also Östlin et al, 1999, 2001), low velocity amplitudes
- Kinematics are dispersion dominated (as also in high-z SF galaxies)

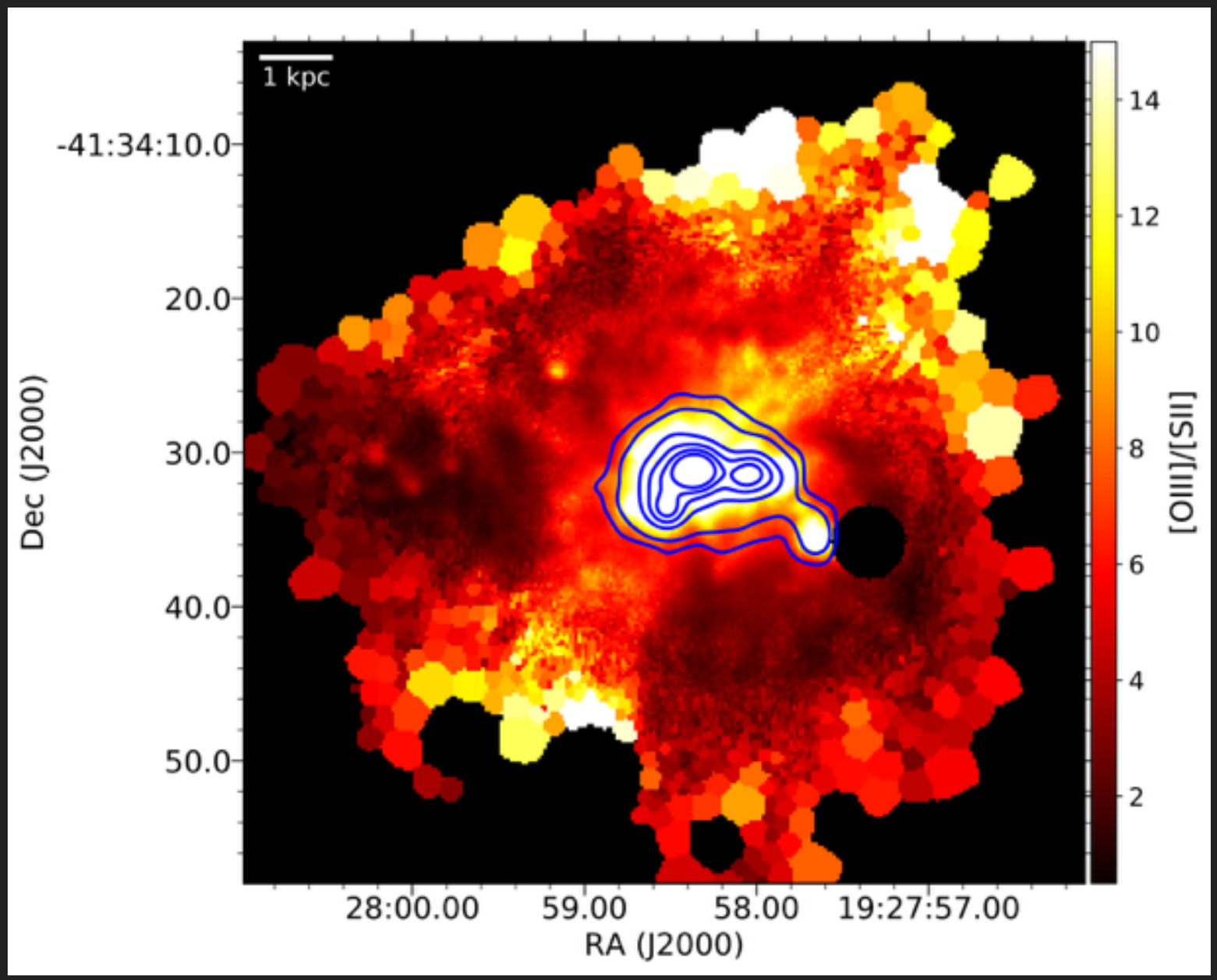
LYMAN ALPHA





- Diffuse halo of Lyα around ESO 338. Bik et al, 2015
- Lyα flux enhanced towards the two outflows.

ESO 338– IONIZATION



See also Zastrow et al, 2011,2013, Herenz et al, 2017

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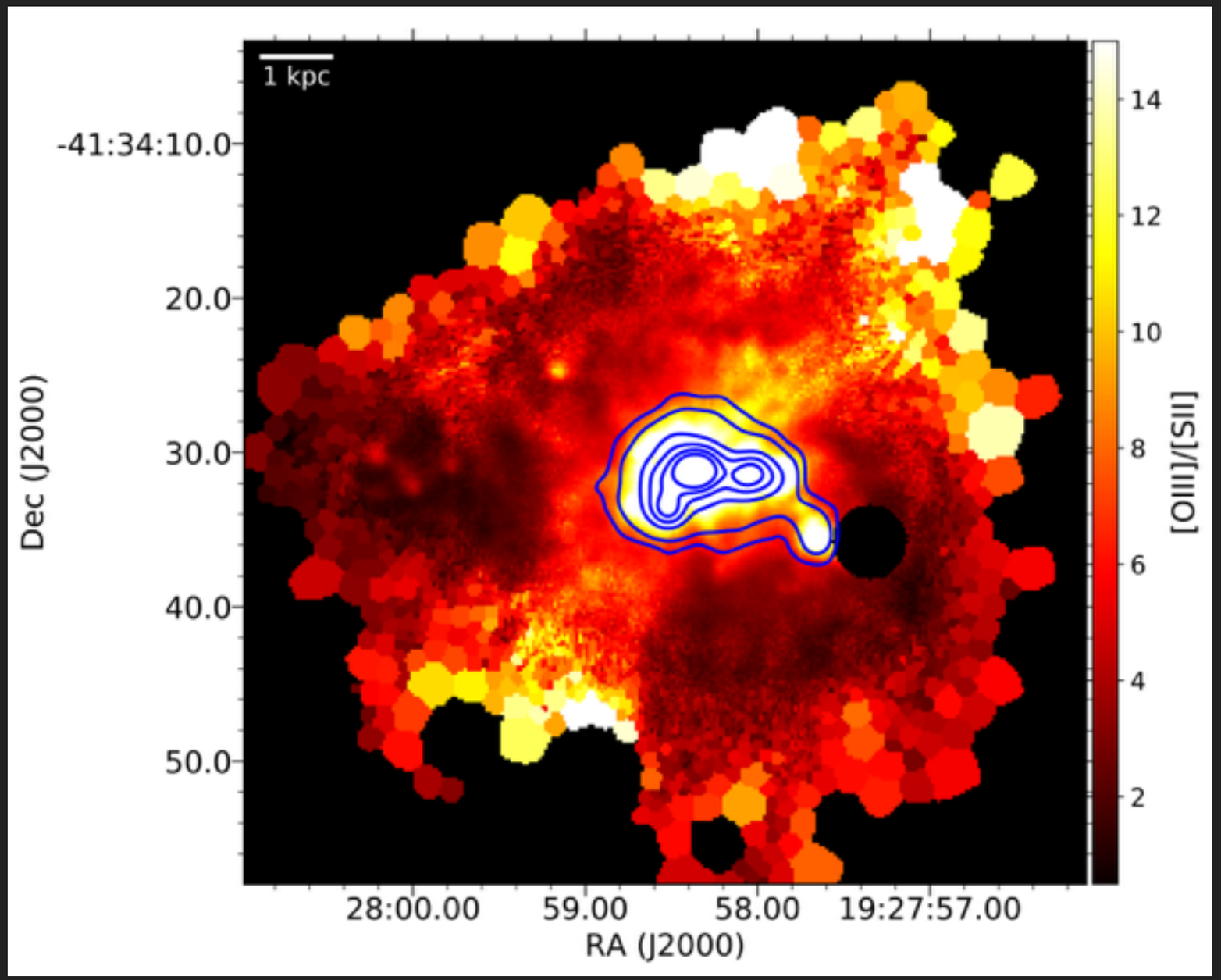

- [OIII]/[SII]: ionization and/or optical depth (Pellegrini et al, 2012)
- Ionization channels (Bik et al, 2015).
- Strong diffuse HeII in the centre.
- Ionization increases with distance: density bounded

See also Zastrow et al, 2011,2013, Herenz et al, 2017

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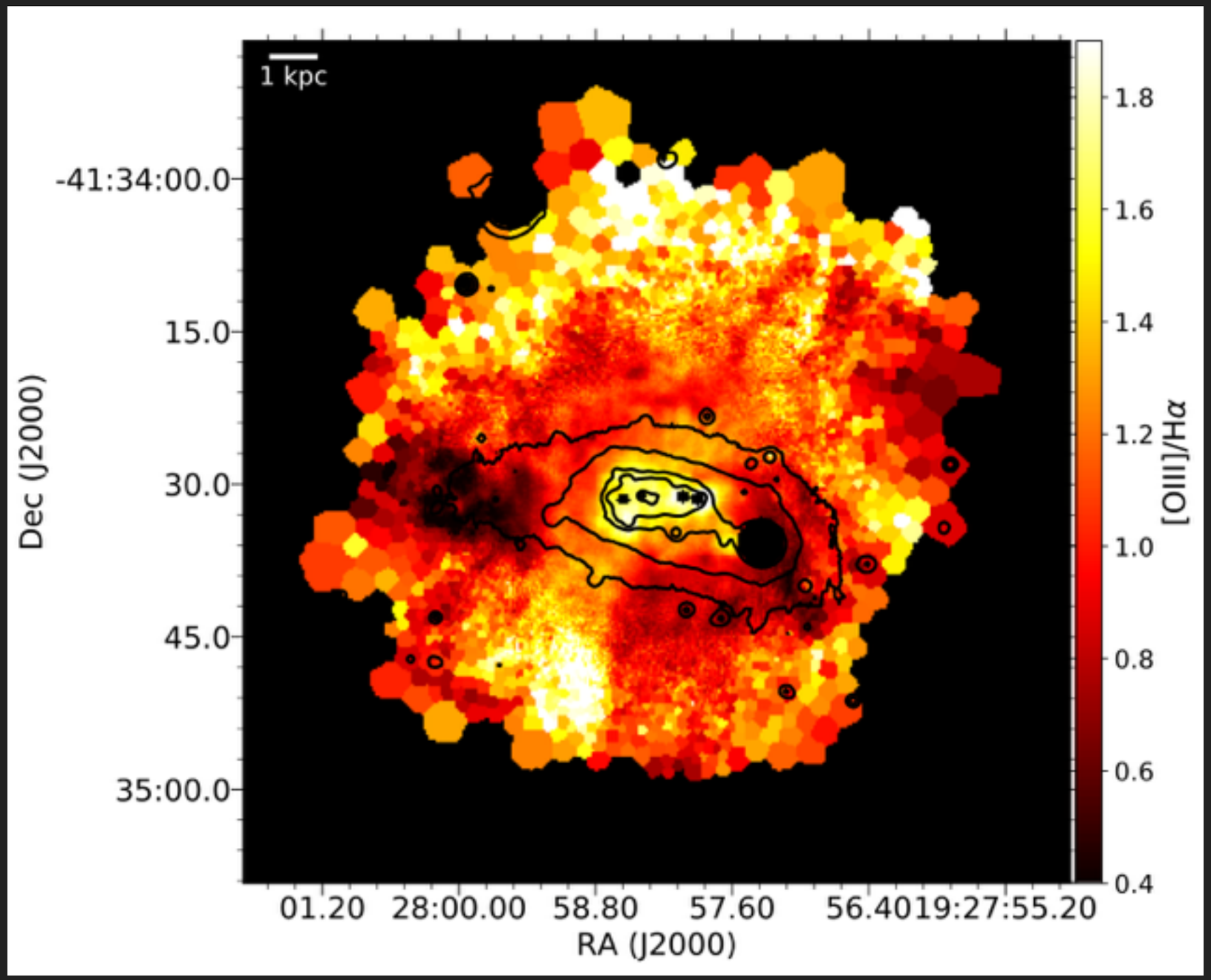

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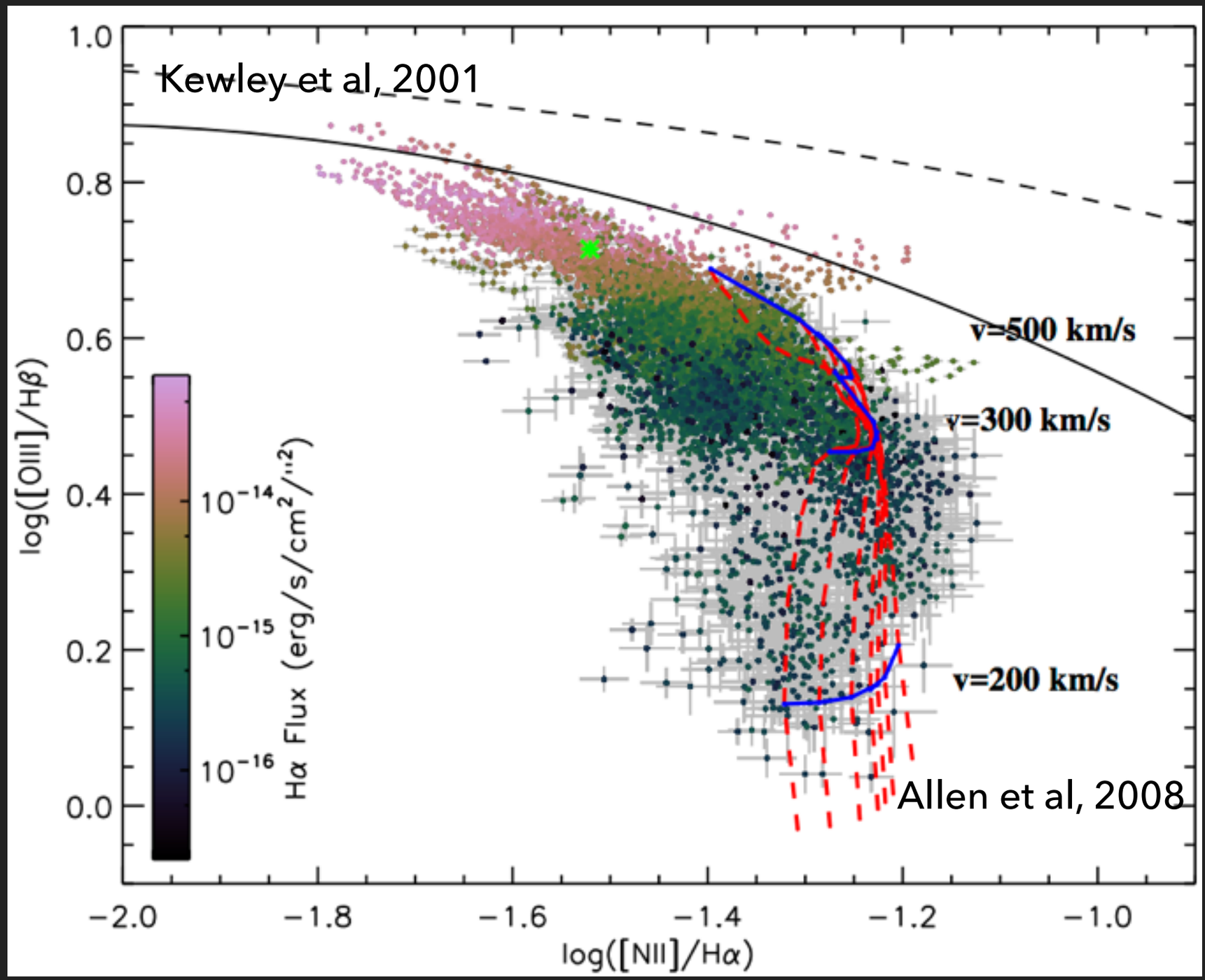
ESO 338– BPT ANALYSIS

- SF galaxies vs AGN
- 2D analysis: physical conditions ISM gas
- Photo ionization vs shocks.



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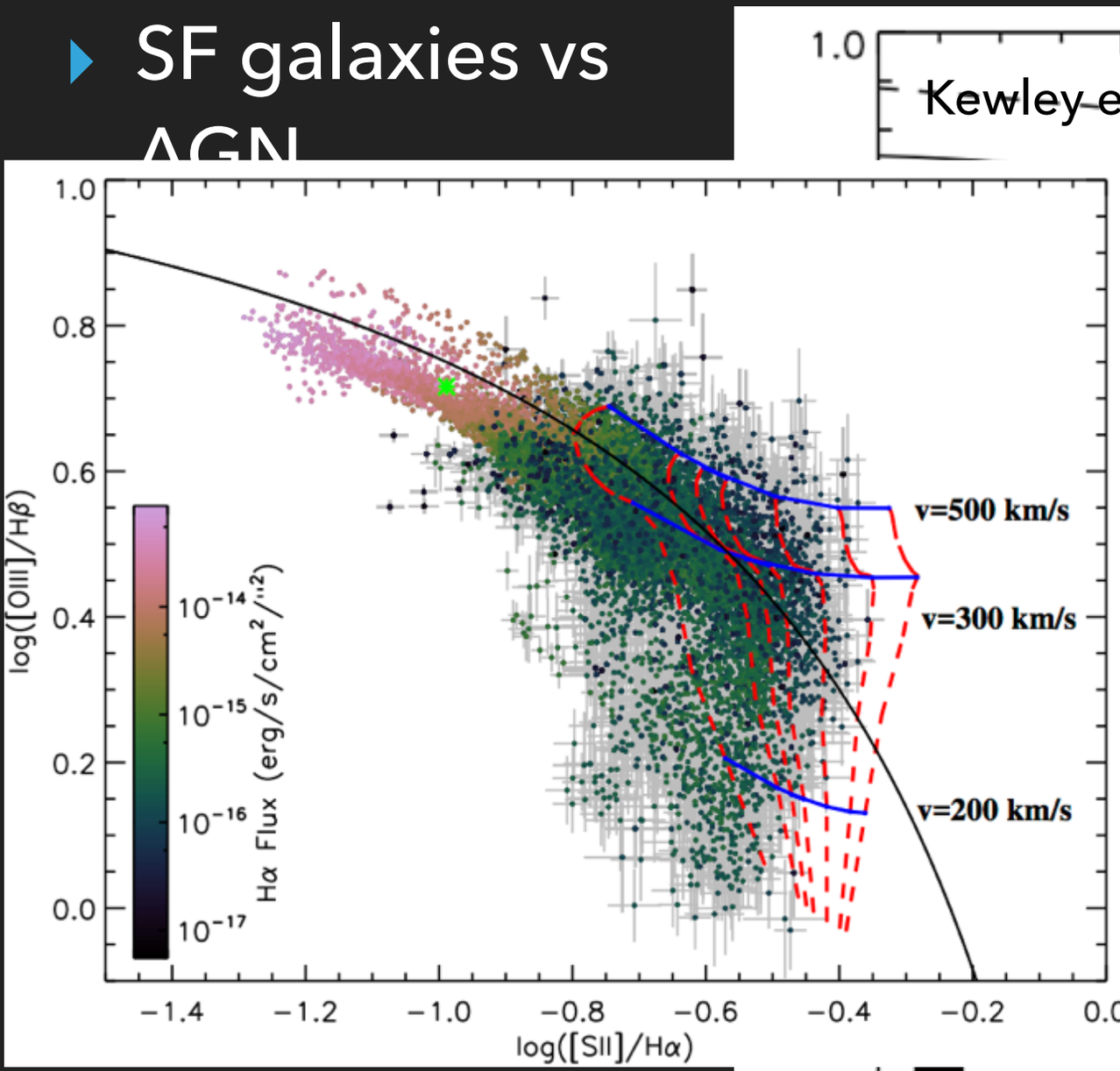

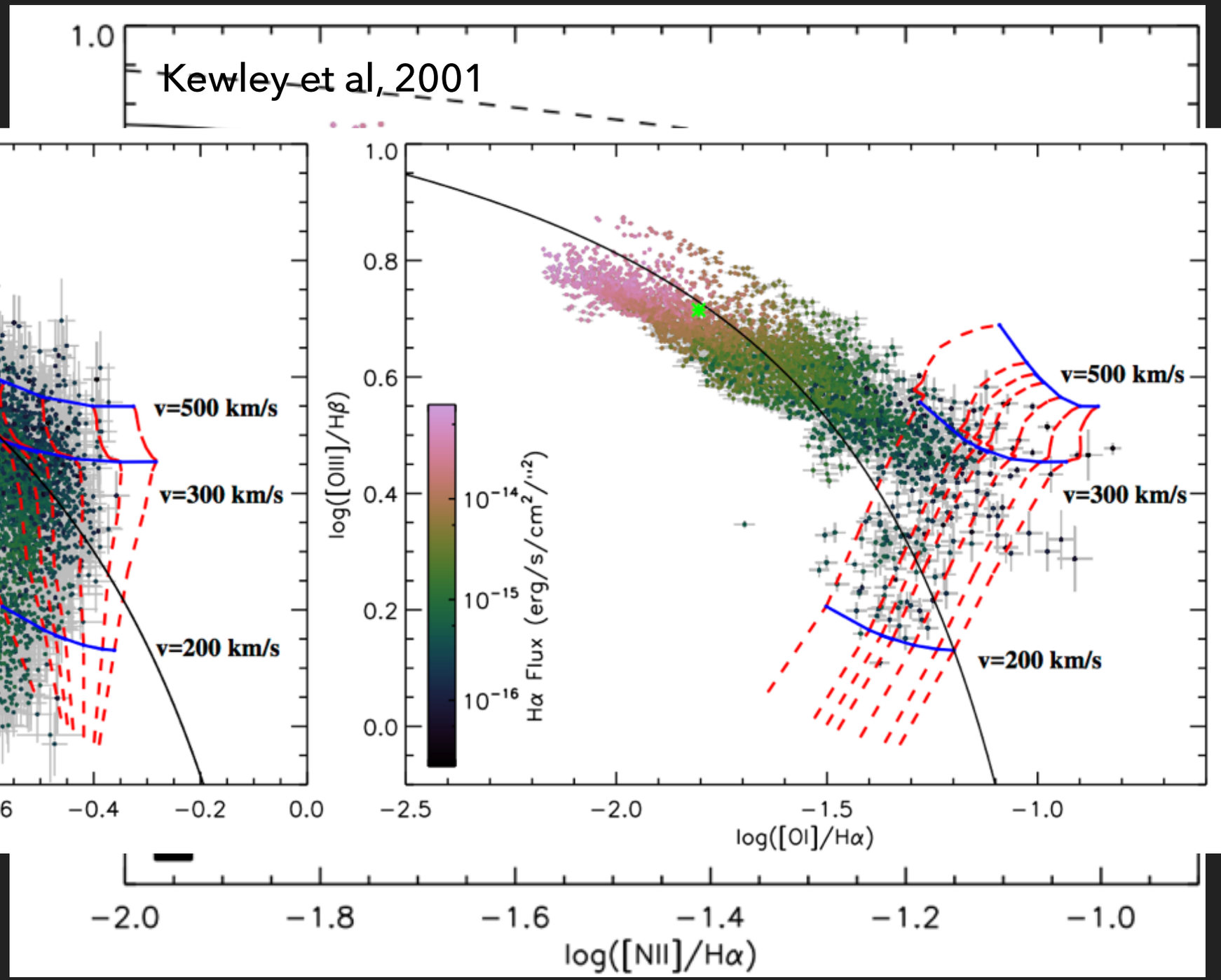

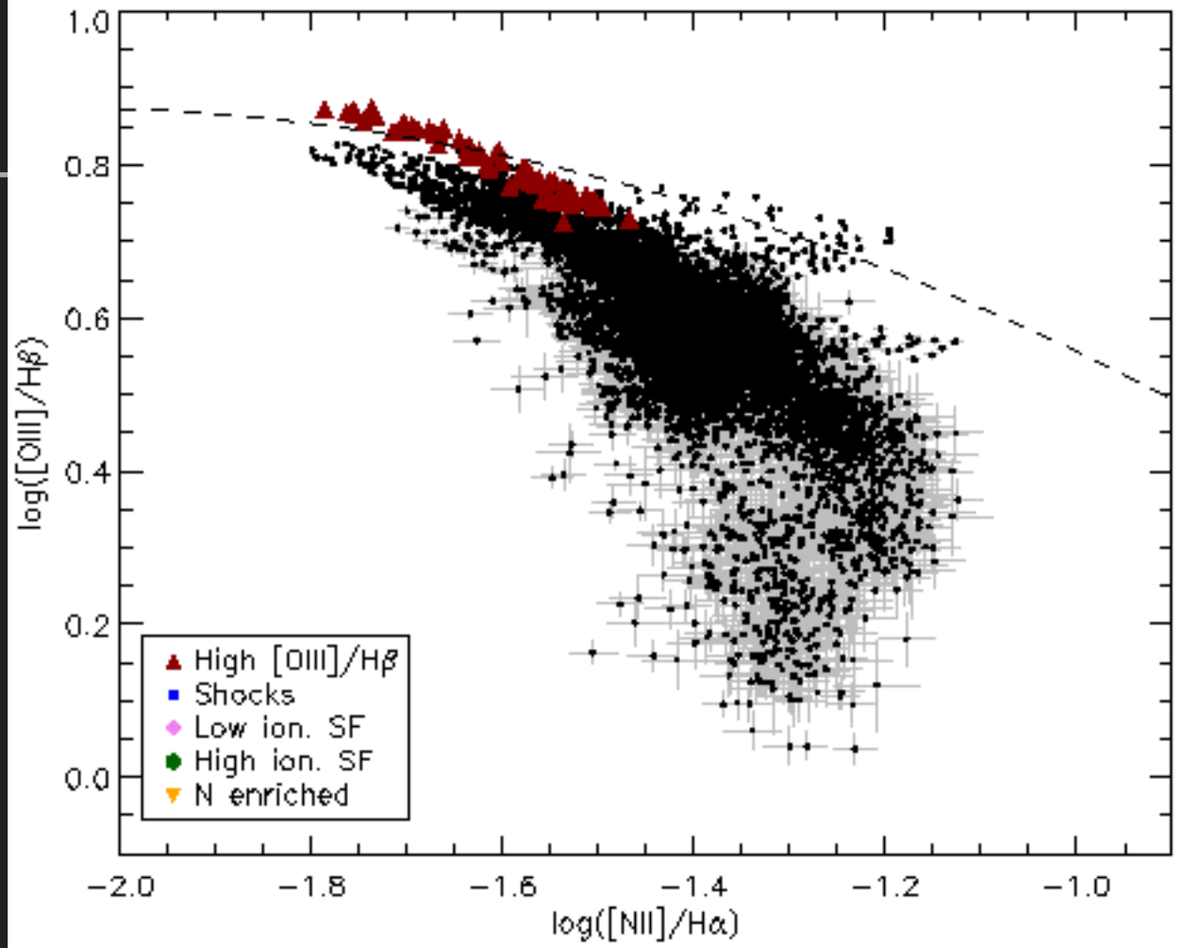
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High [OIII]/Hβ
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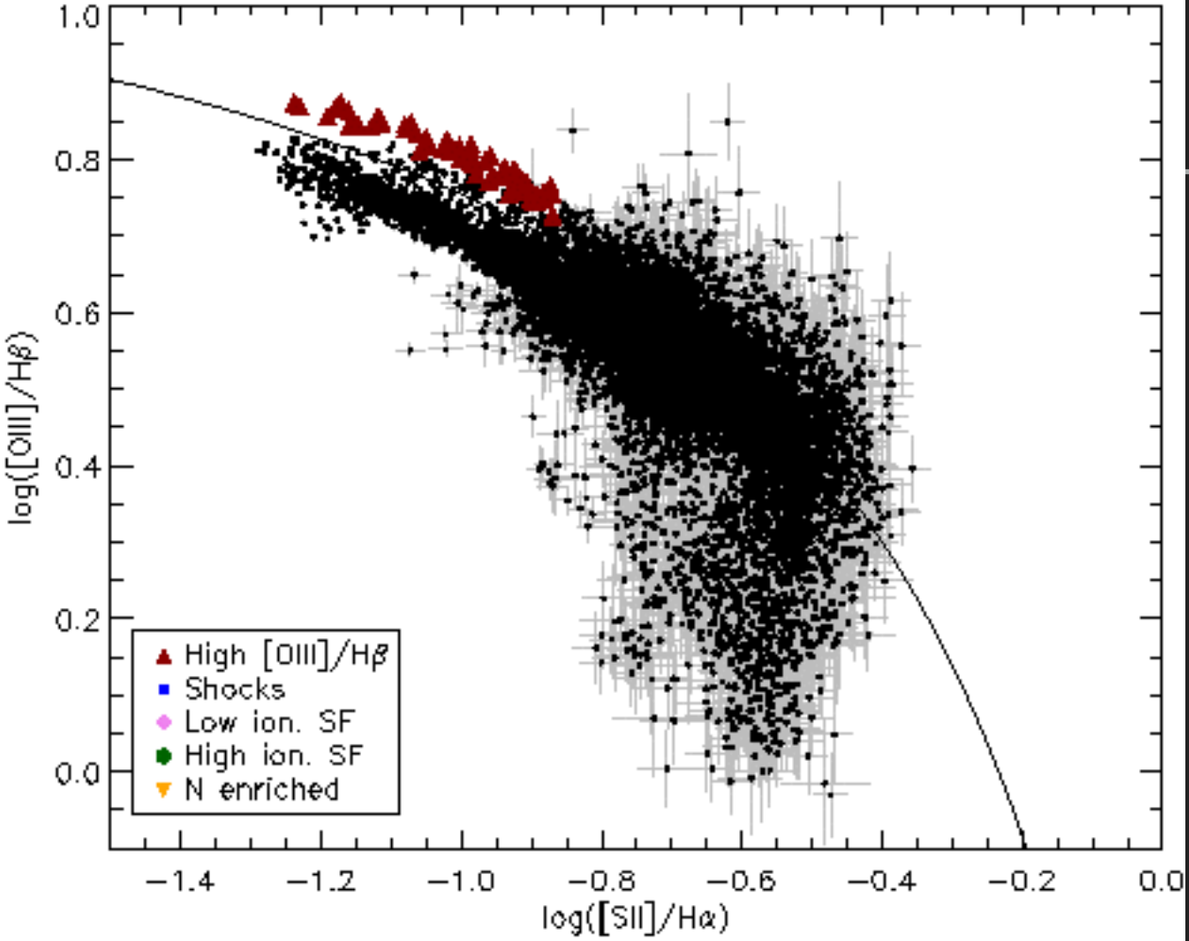
High ion. SF
N enriched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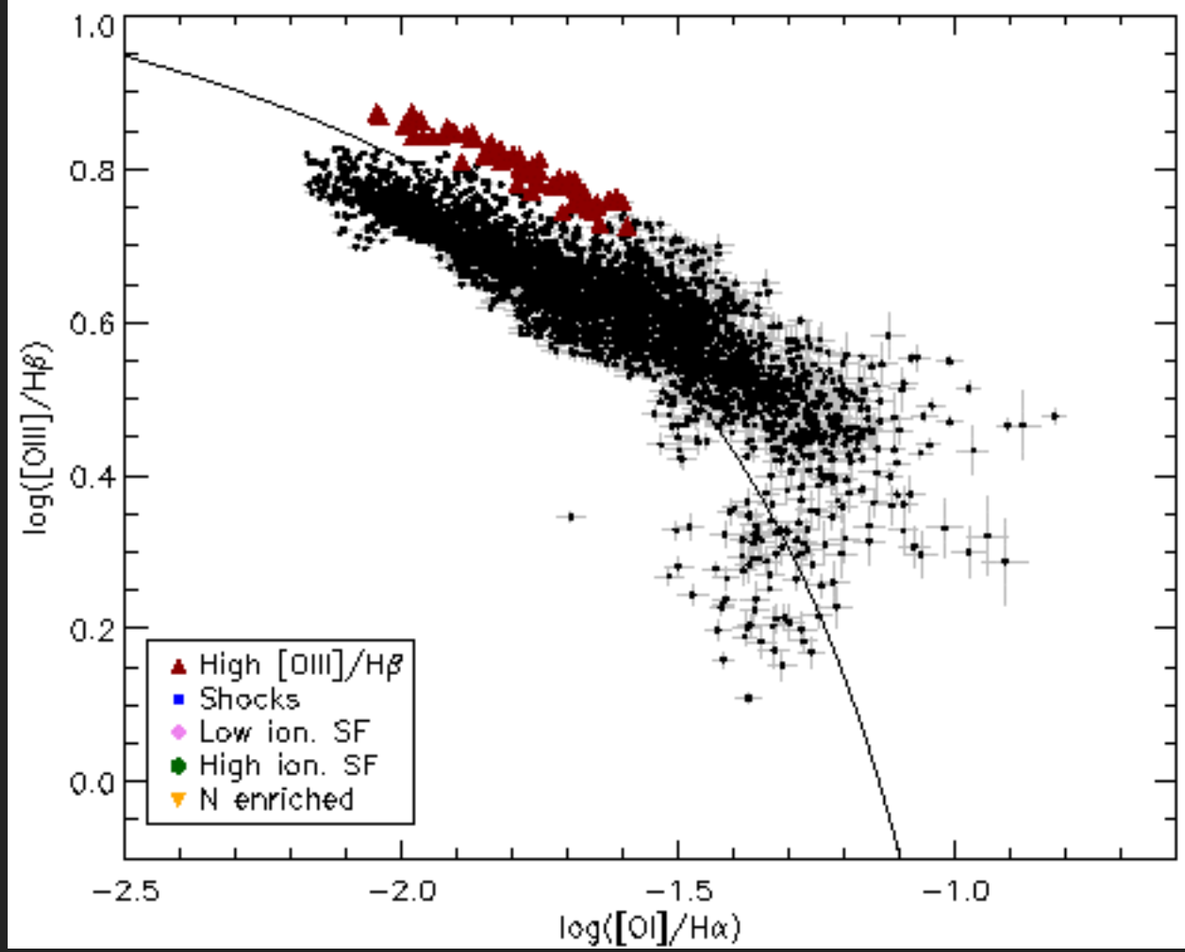
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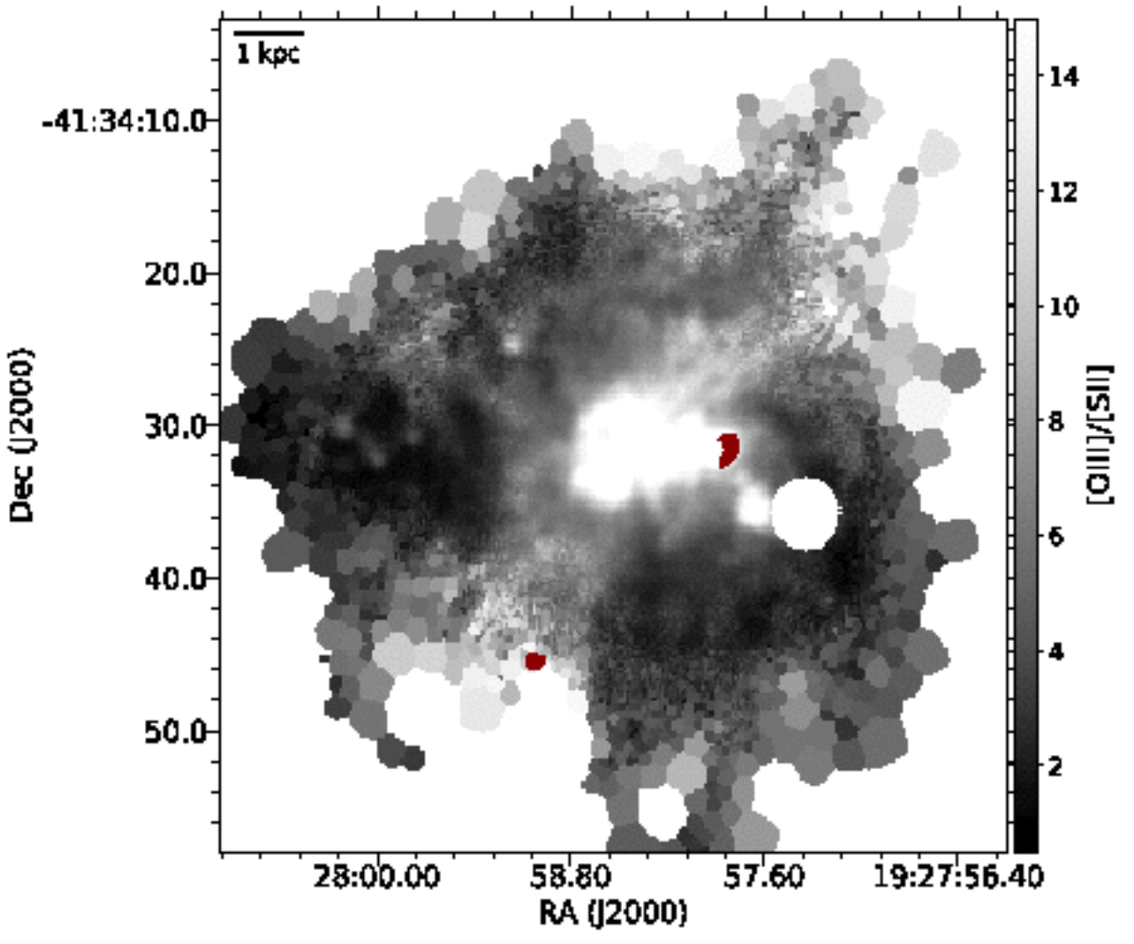
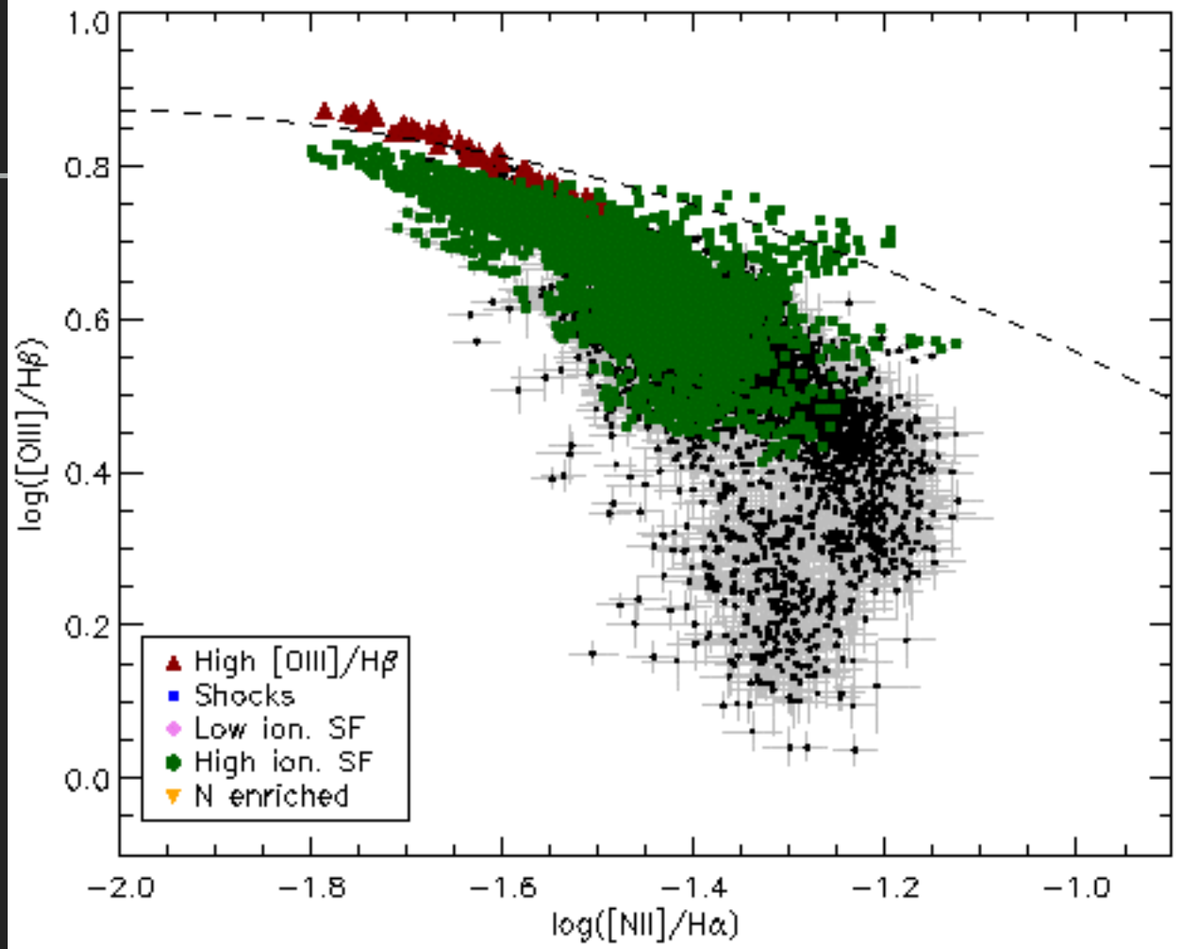

1 kpc
Dec (J2000)
RA (J2000)
[SII]/[OIII]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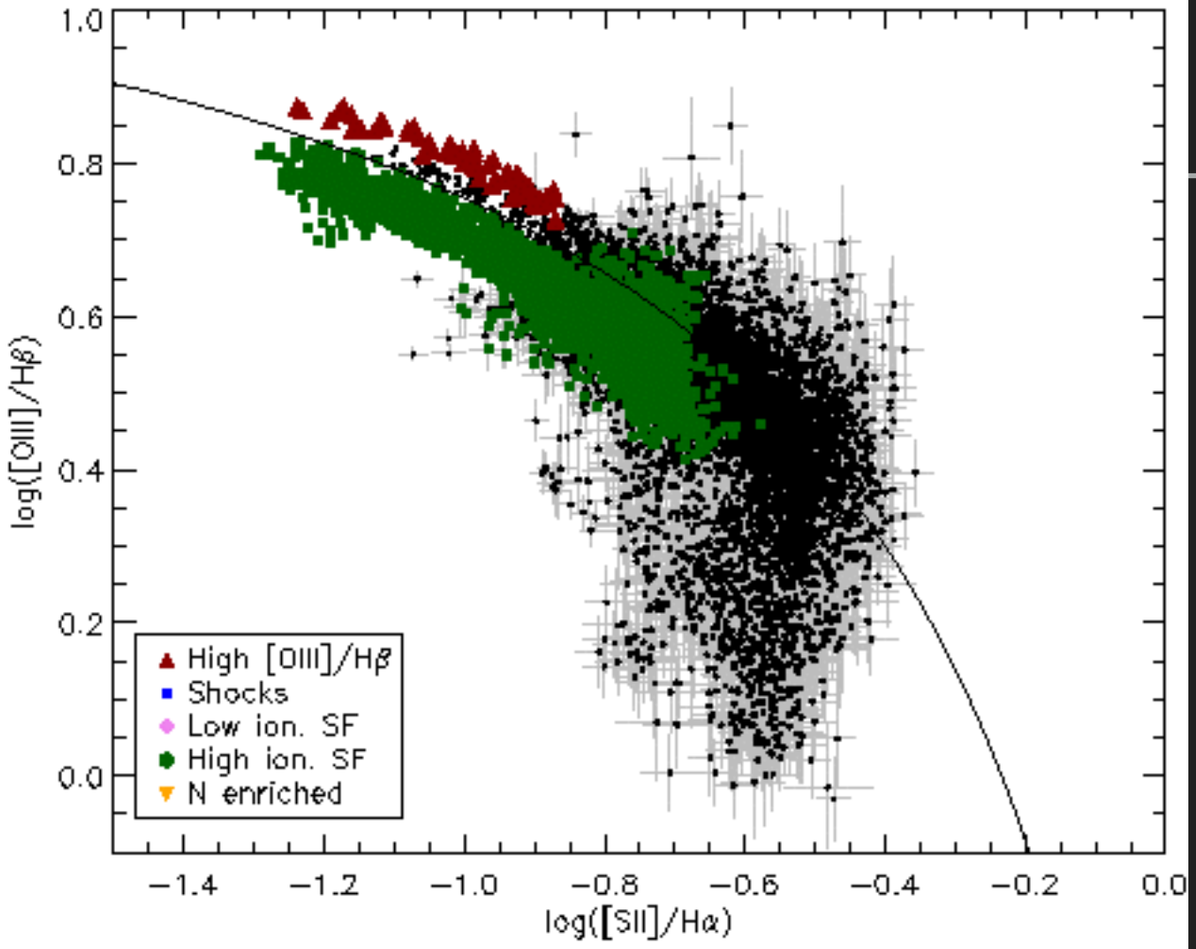
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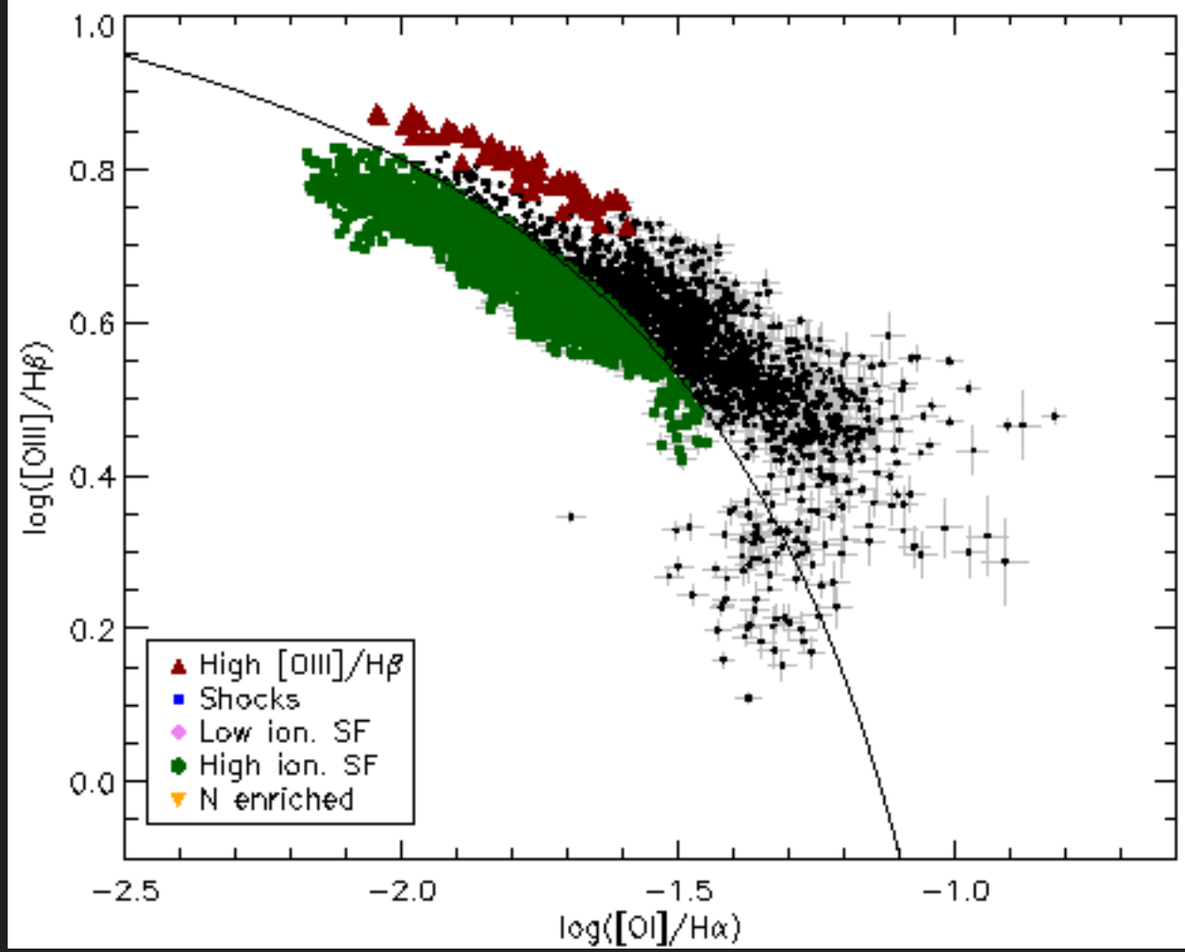
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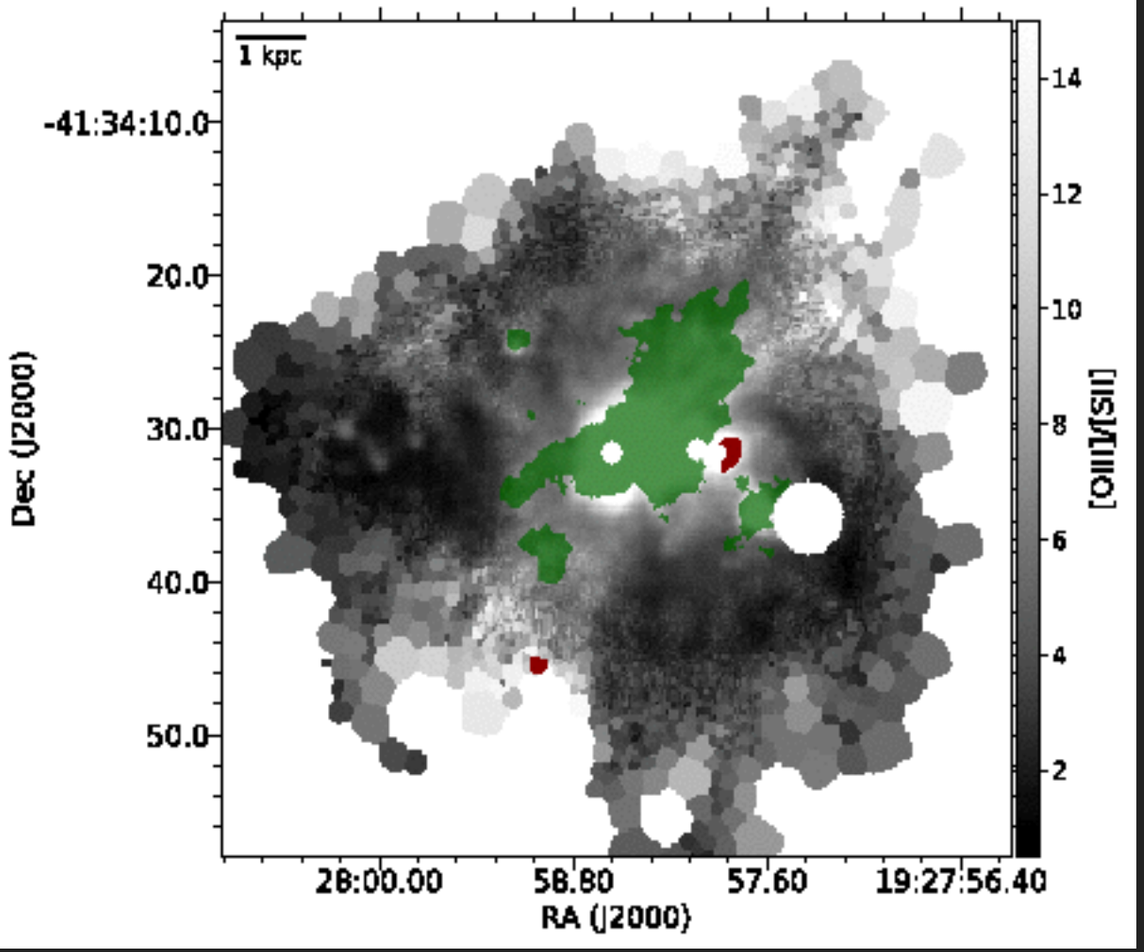
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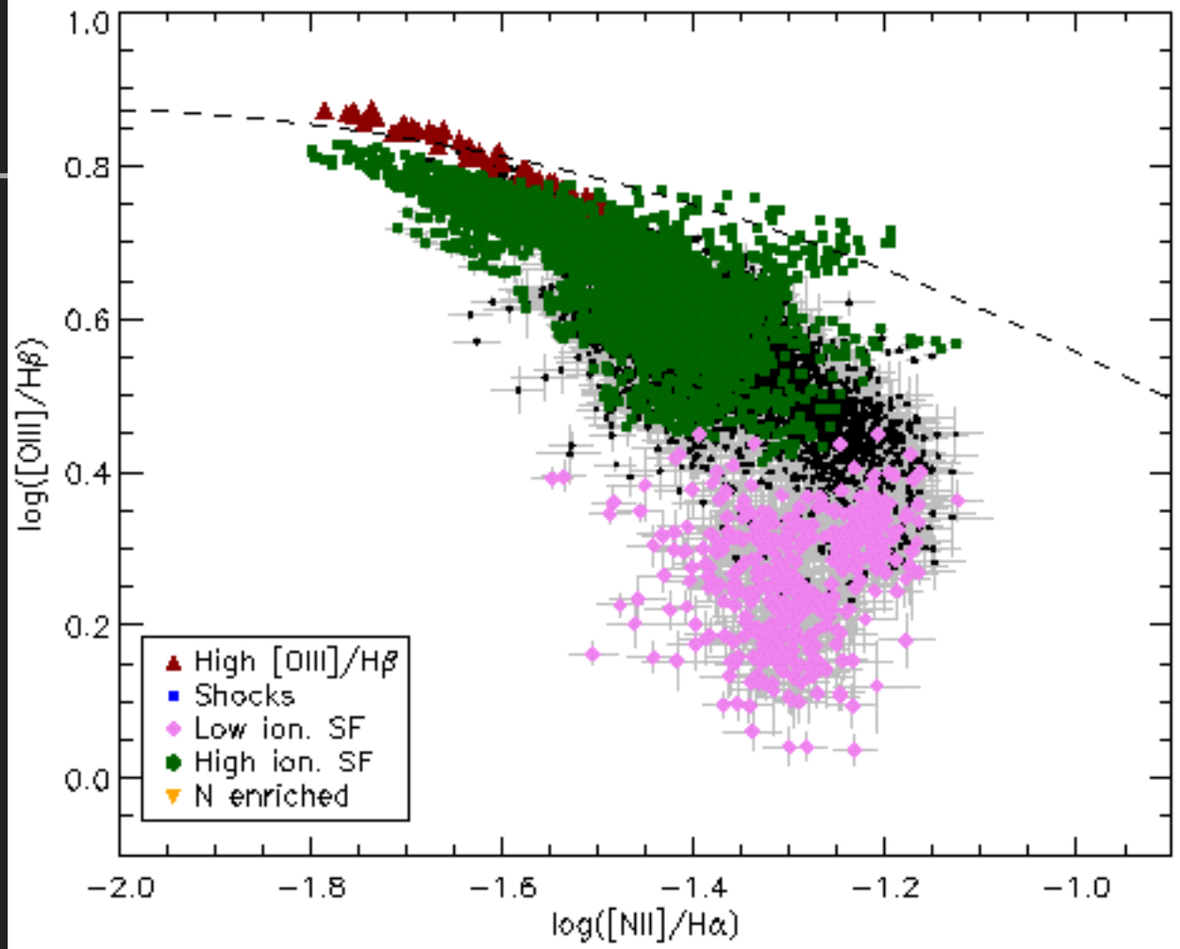
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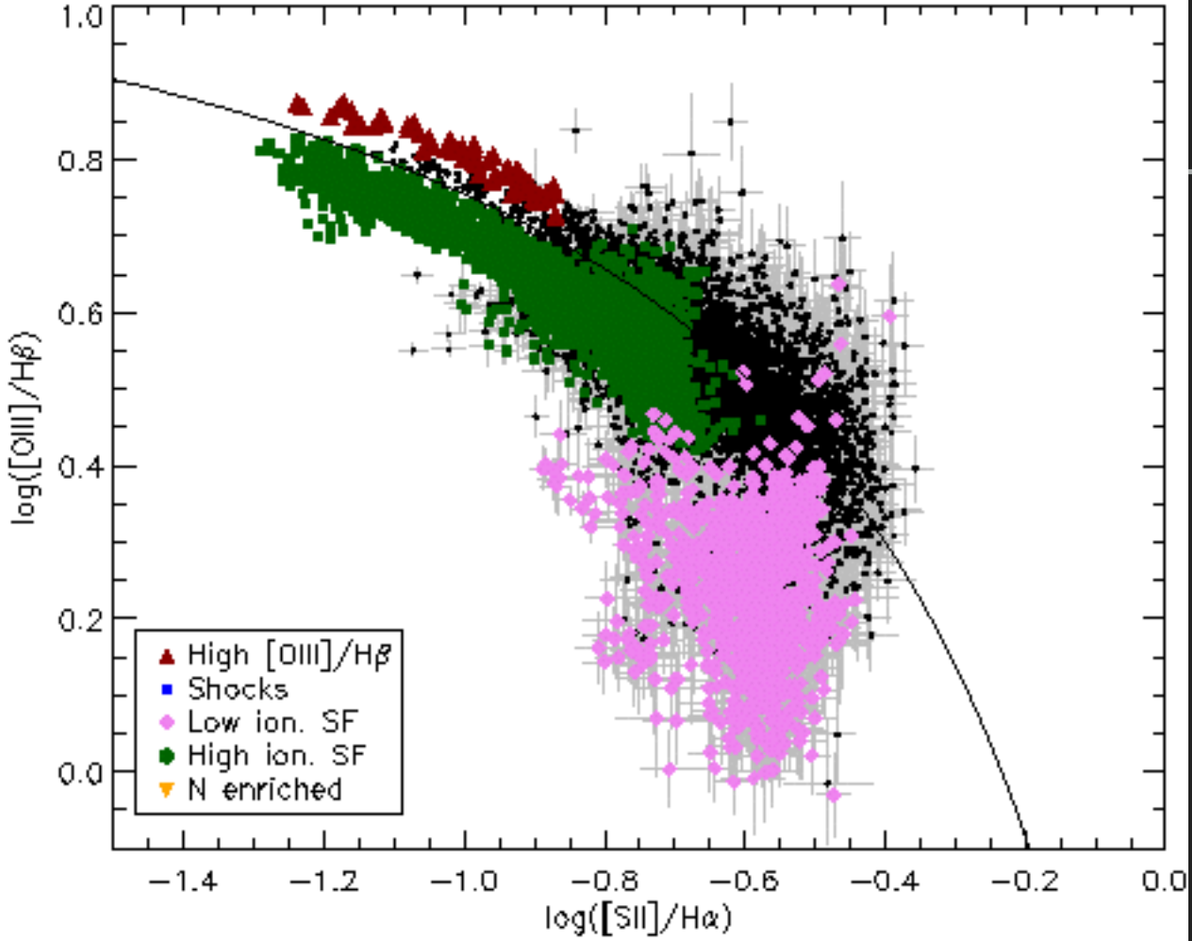
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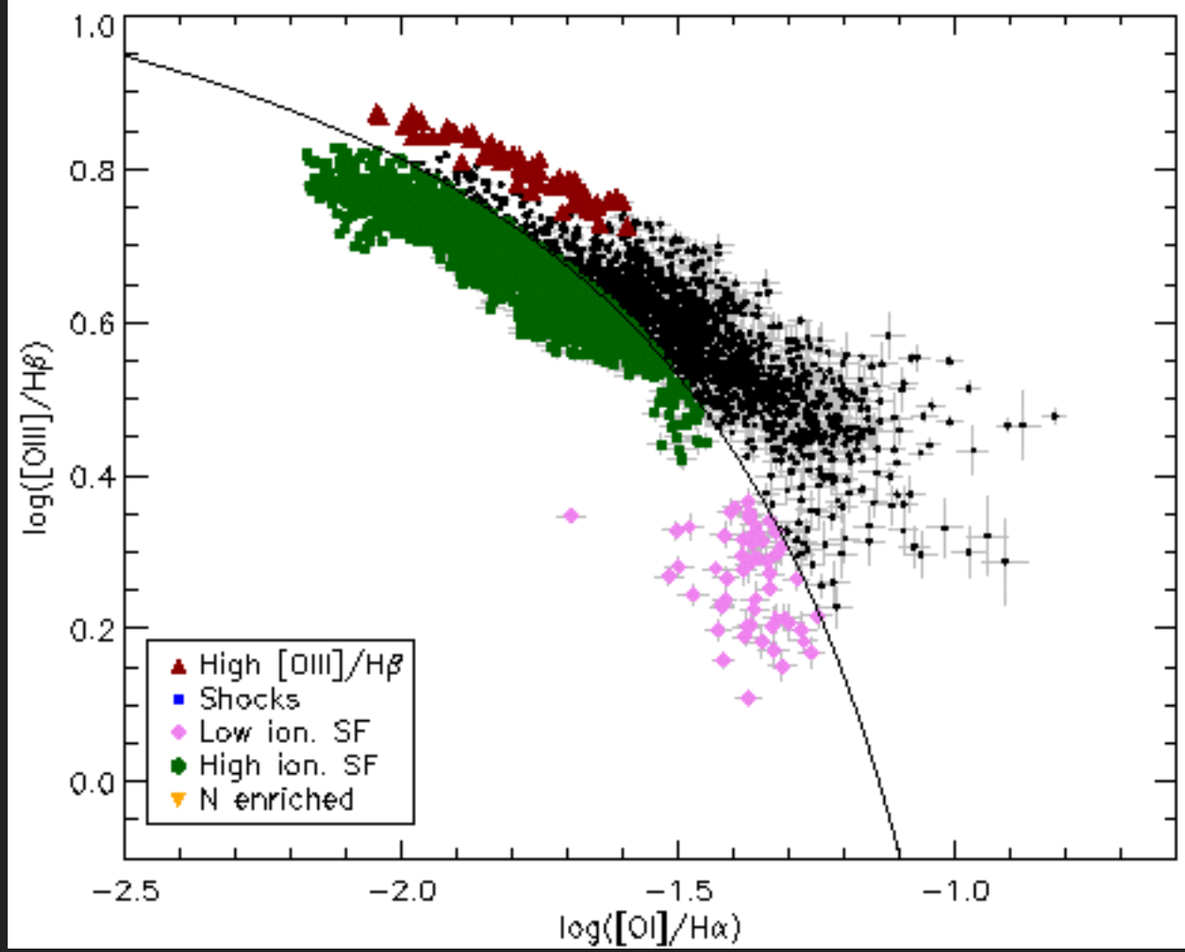
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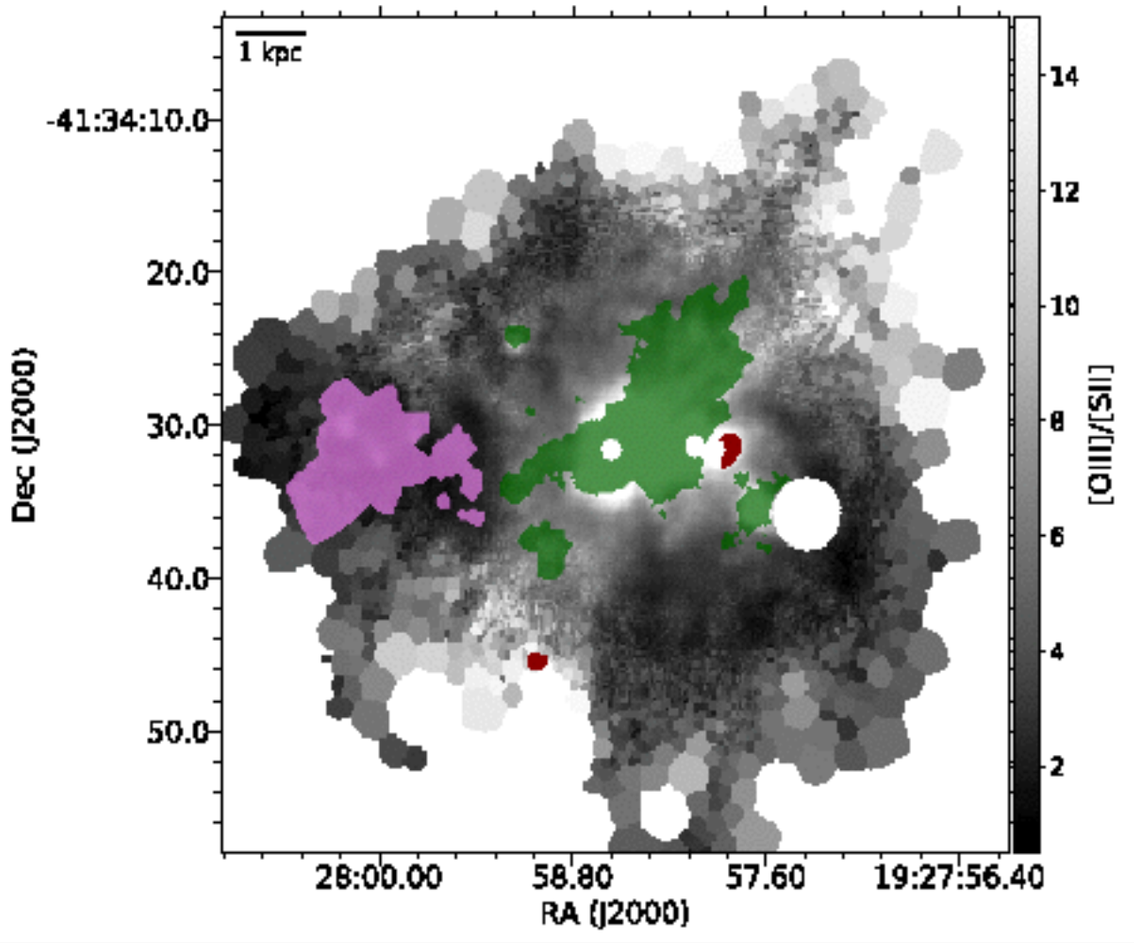
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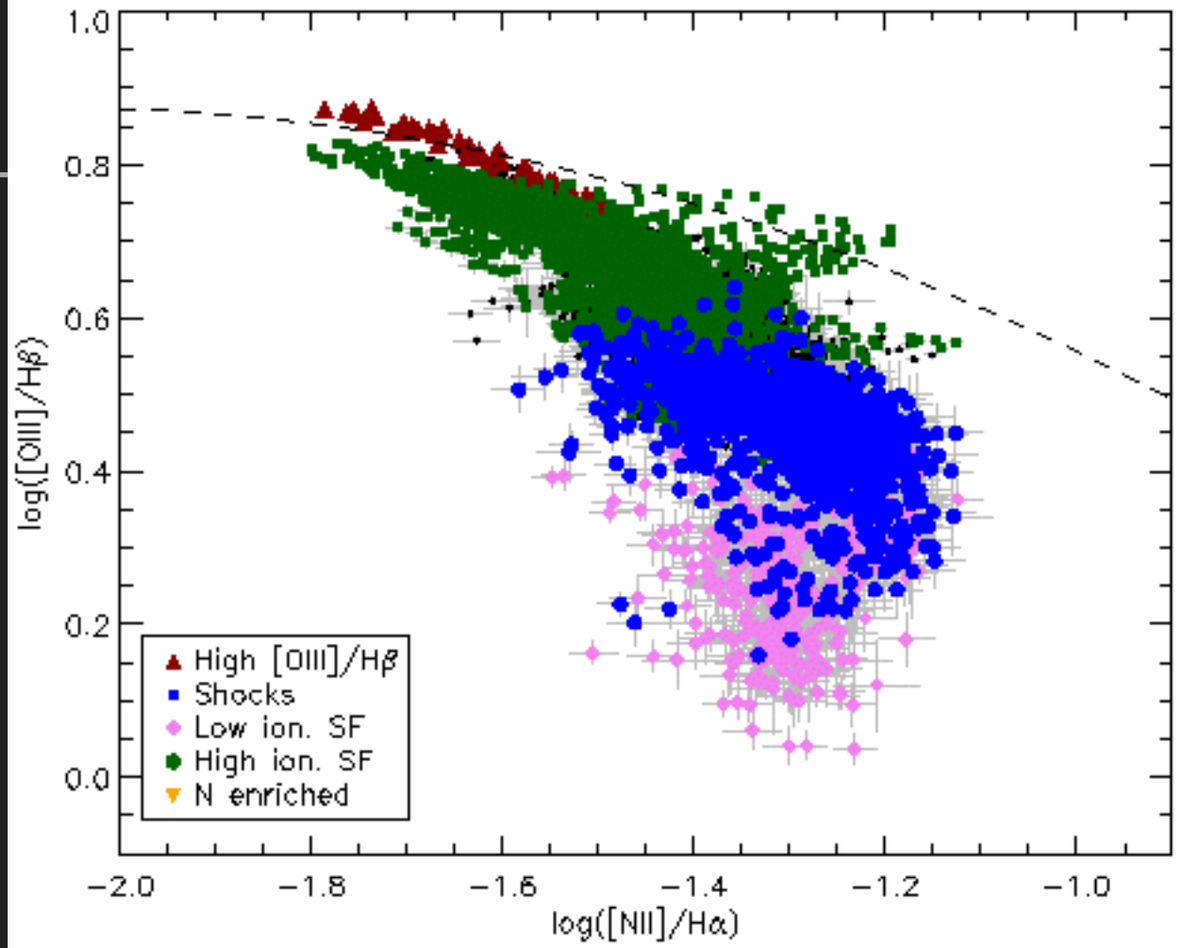
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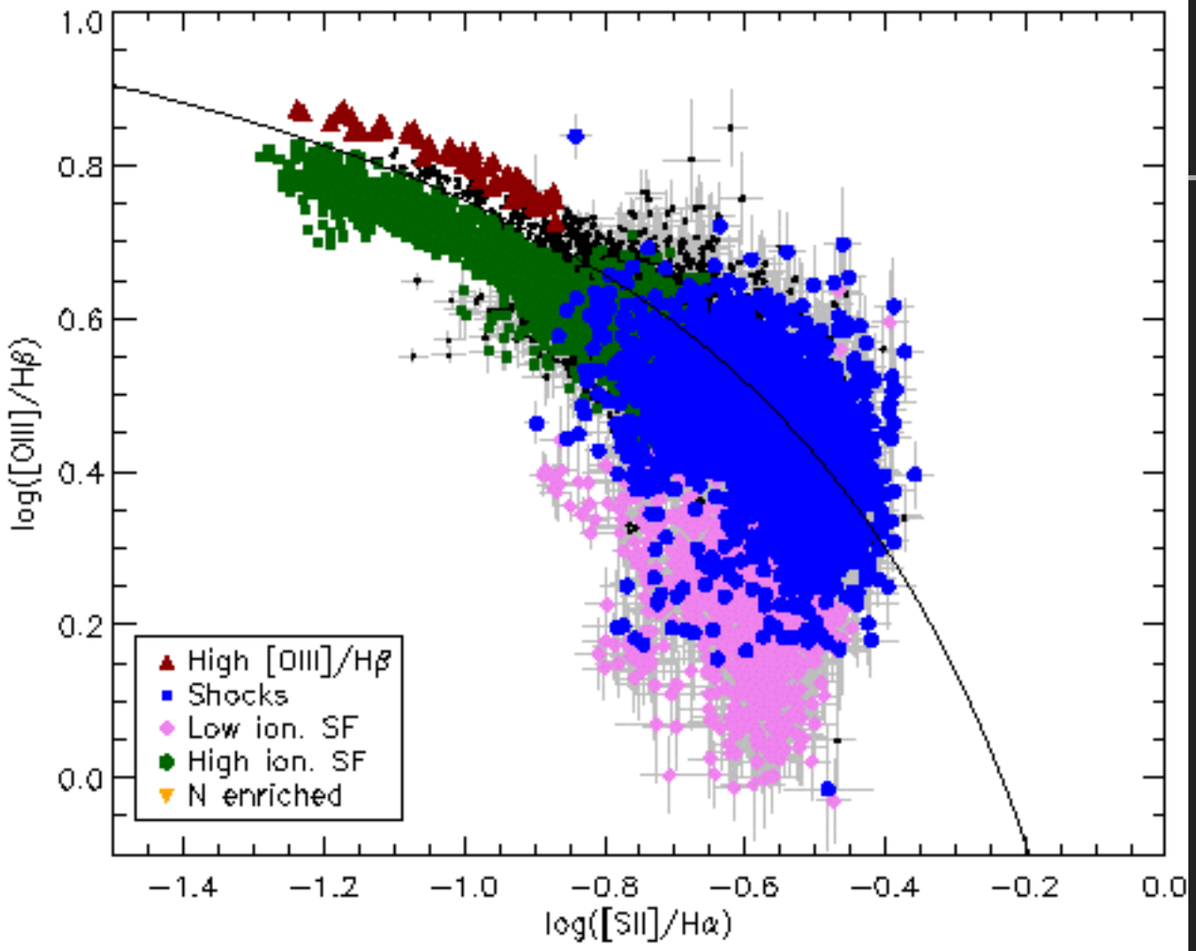
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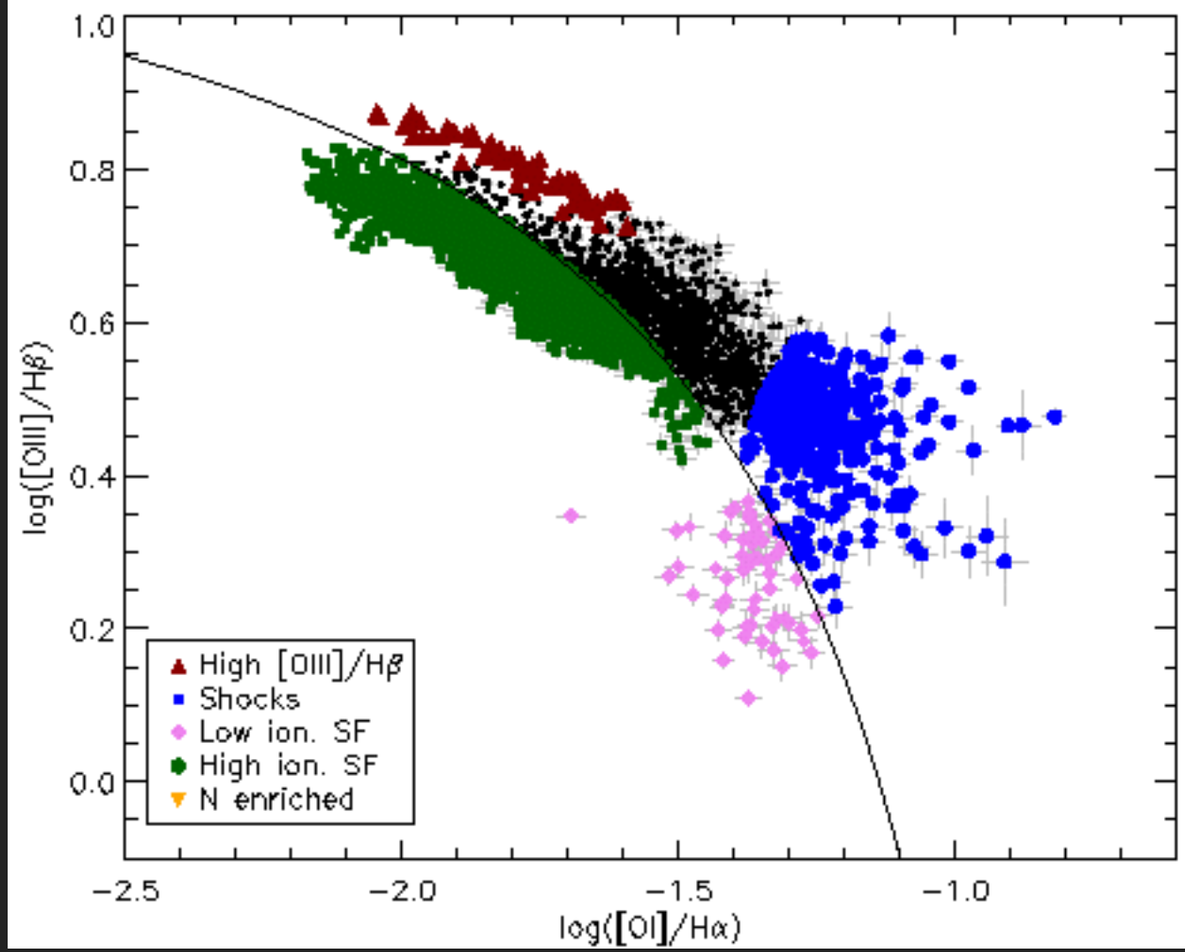
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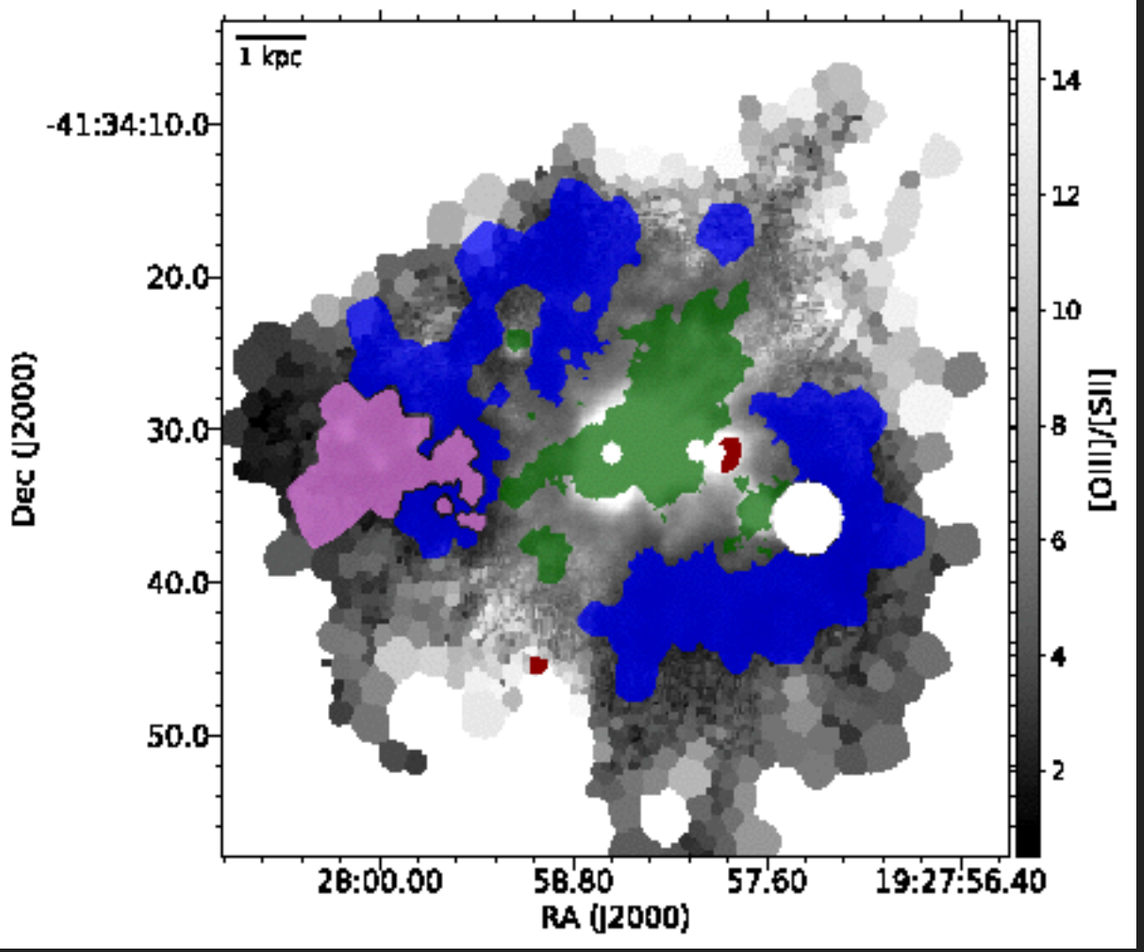
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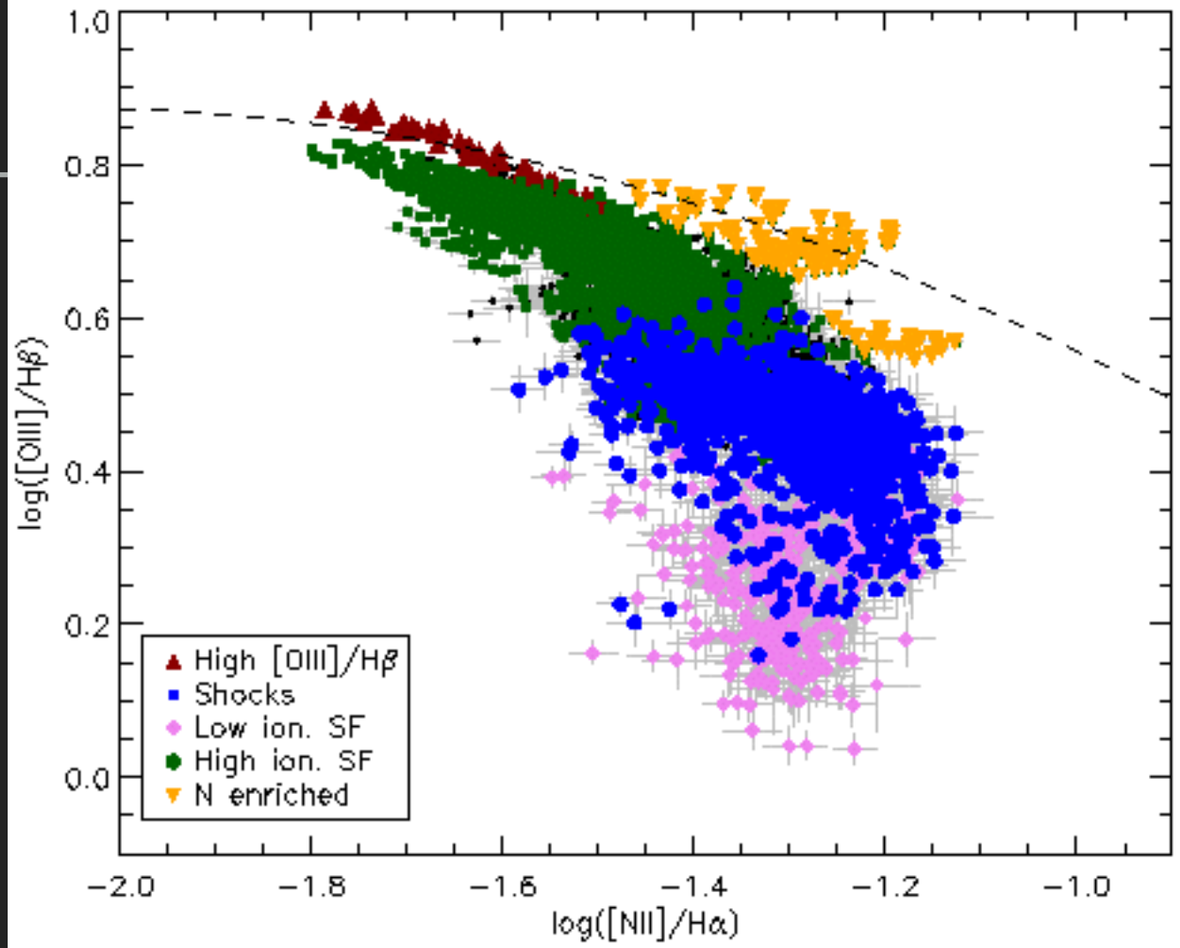
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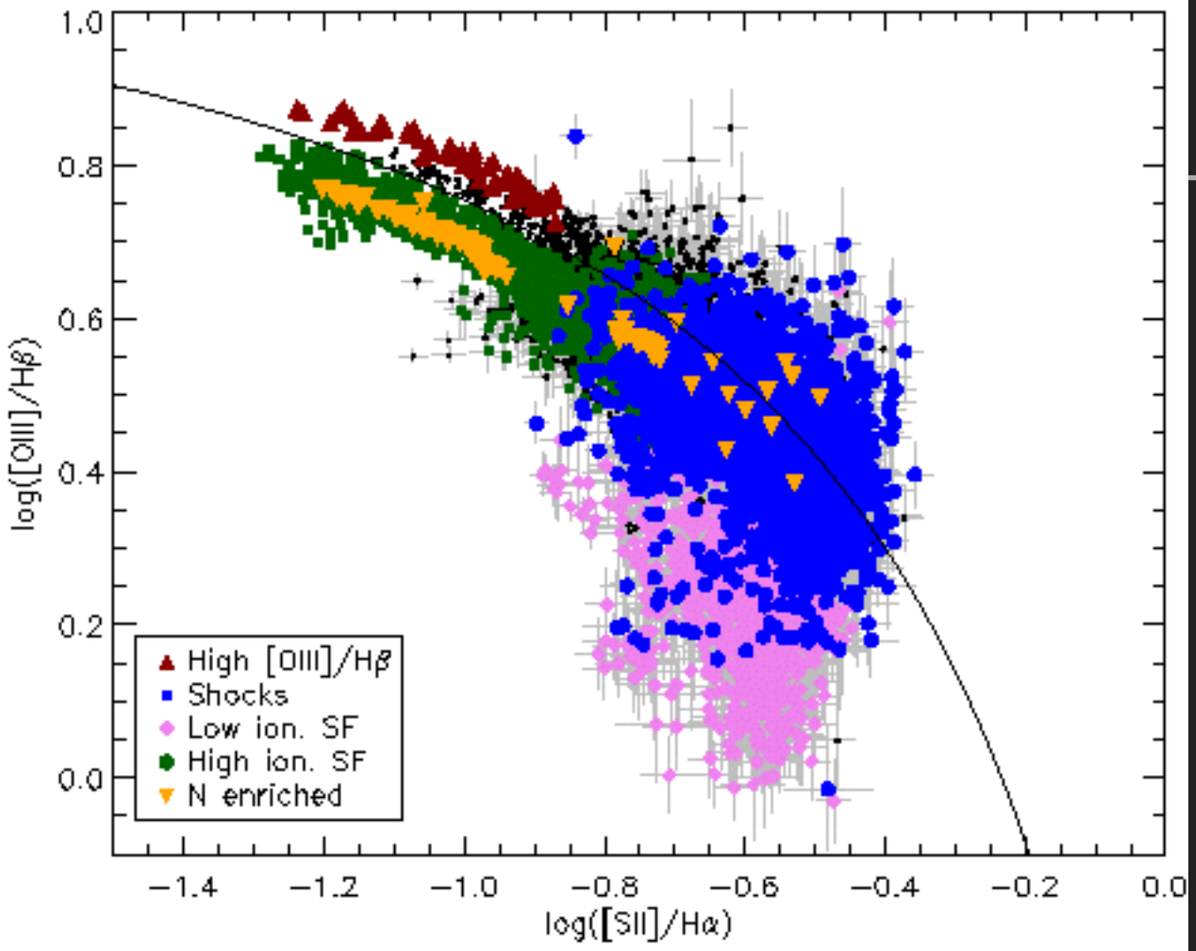
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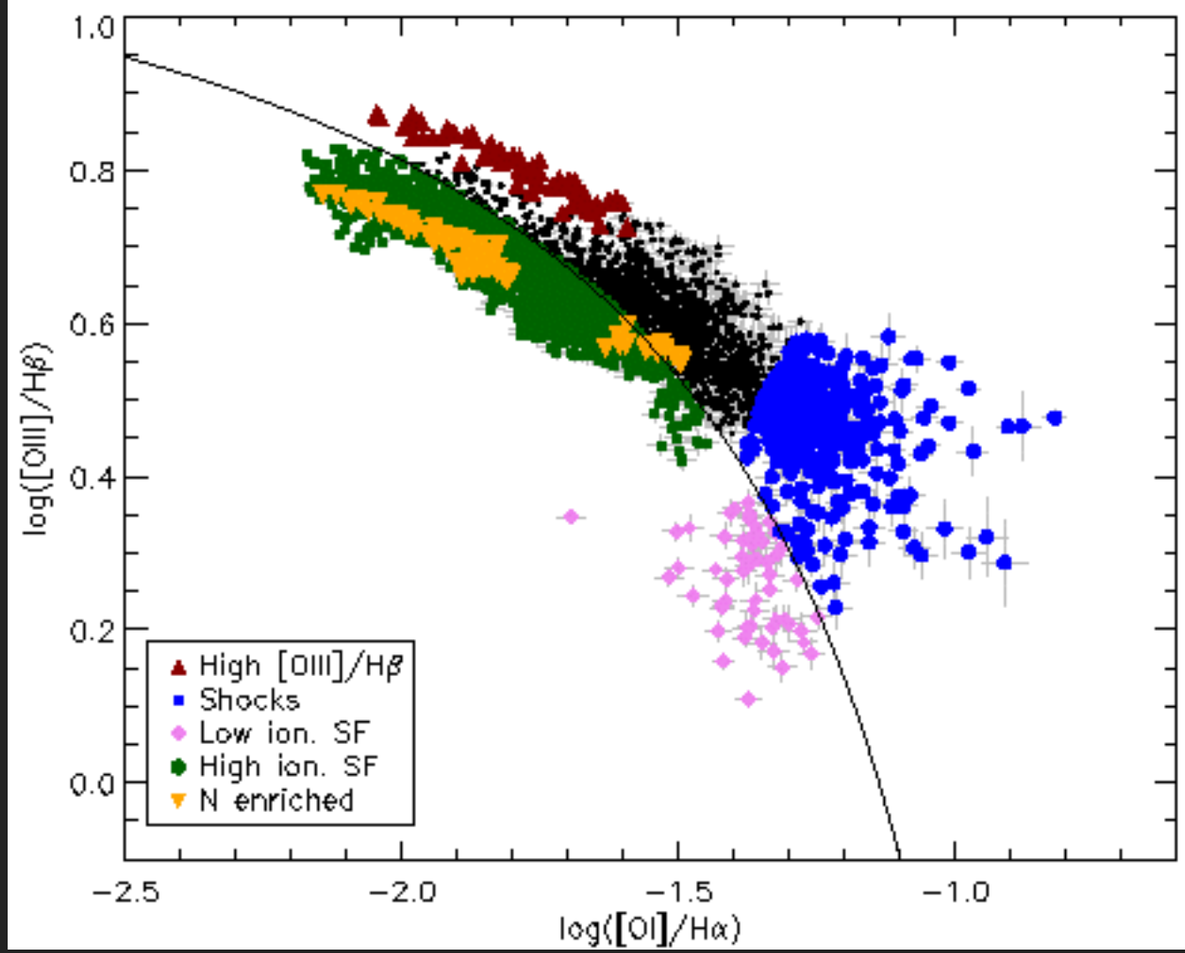
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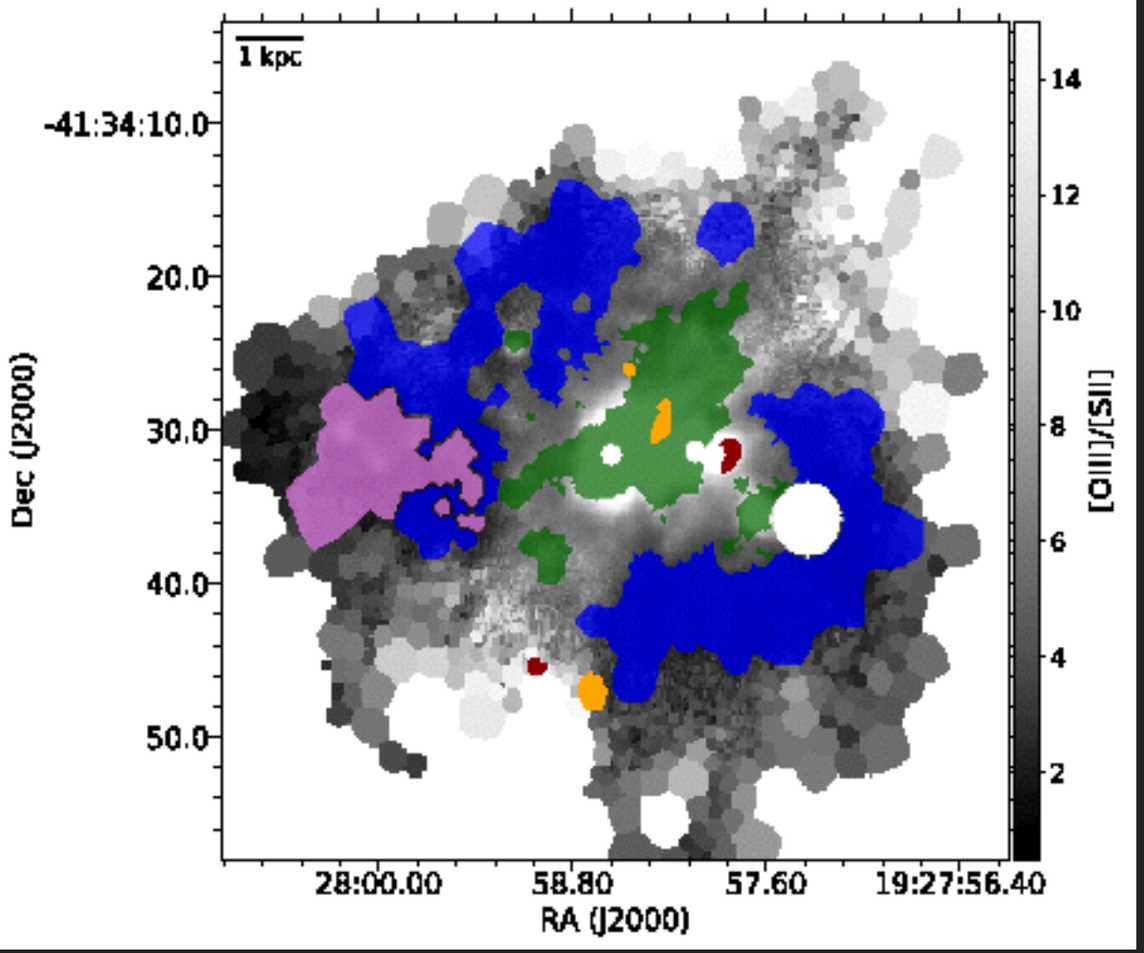
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ESO 338– BPT ANALYSIS

- The central starburst and the outflow is dominated by photo ionisation
  - Evidence for very high photo-ionisation around WR cluster.
- Outside, the gas becomes more shock dominated (enhanced [OI] emission).
  - expanding super bubble created by the central starburst
- More neutral gas towards the old stellar population

SUMMARY

Bik et al, A&A, in press, arXiv:1809.03597

- The ISM of ESO 338 is highly modified by stellar feedback:
  - Highly ionized (photo-ionization)
  - shocks due to expanding super bubbles
  - galactic scale outflows (SNe + winds)
  - nitrogen enrichment (WR stars)
- LyC photons can escape via ionization channels created by outflows and photo ionization.
  - Escape is not isotropic