WISSH QSO project: Giant Lyα Nebula around the hyper-luminous quasar SDSS-J1538+0855

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Collaborators OAR and more

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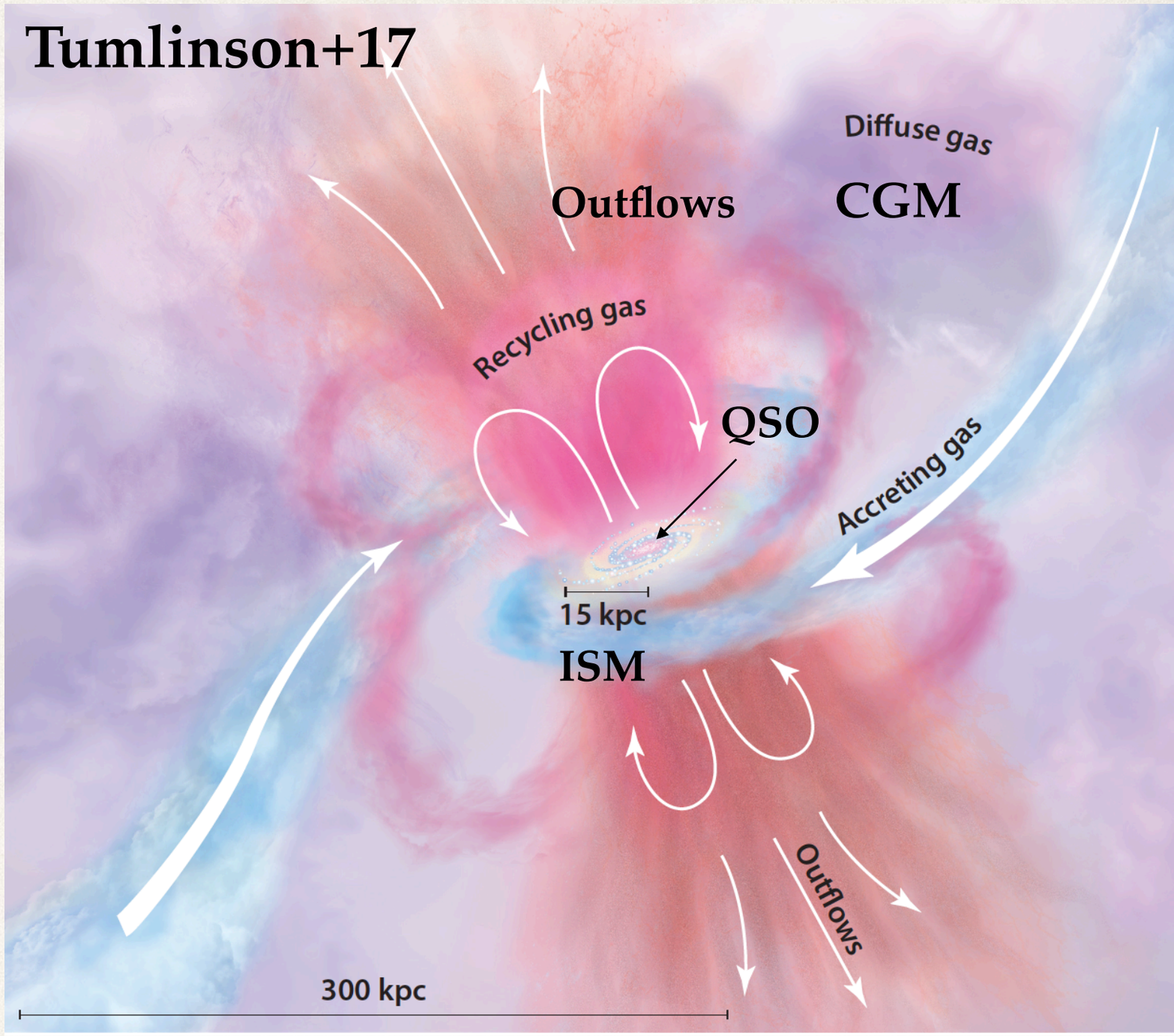
Circum-Galactic Medium (CGM)

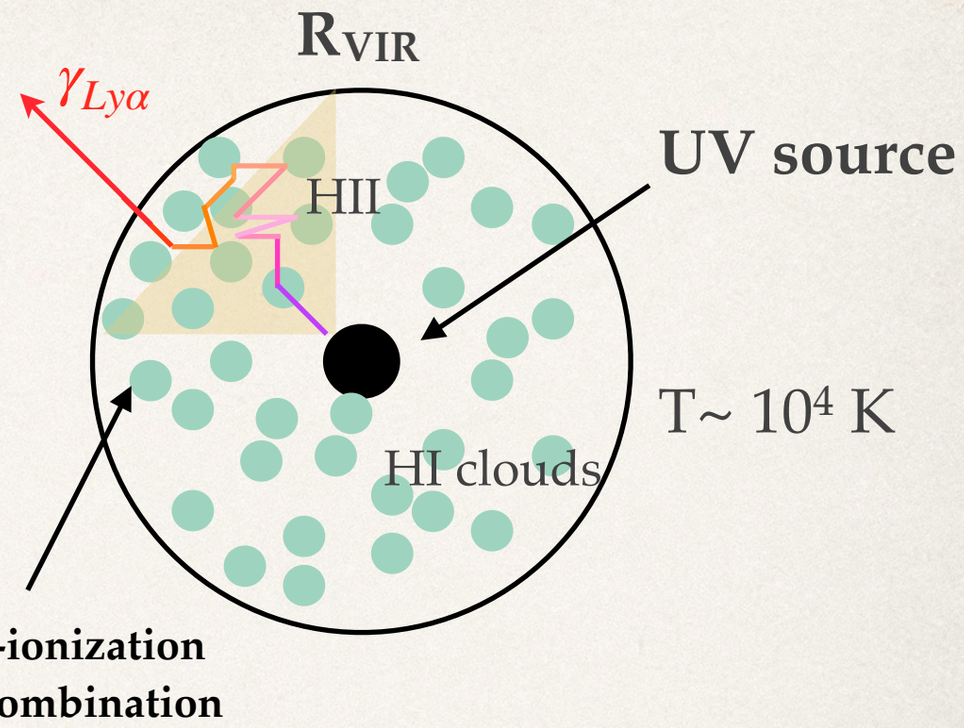
- Circum-Galactic Medium (CGM) is the gas surrounding galaxies outside their disks (>15 kpc) and inside their virial radii.
- Observations and simulations indicate that the CGM is
  - the venue for galactivc feedback and recycling
  - the reserve of galaxies star-forming fuel (Evidences of CGM in inflow?)
  - the key regulator of the galactic gas supply



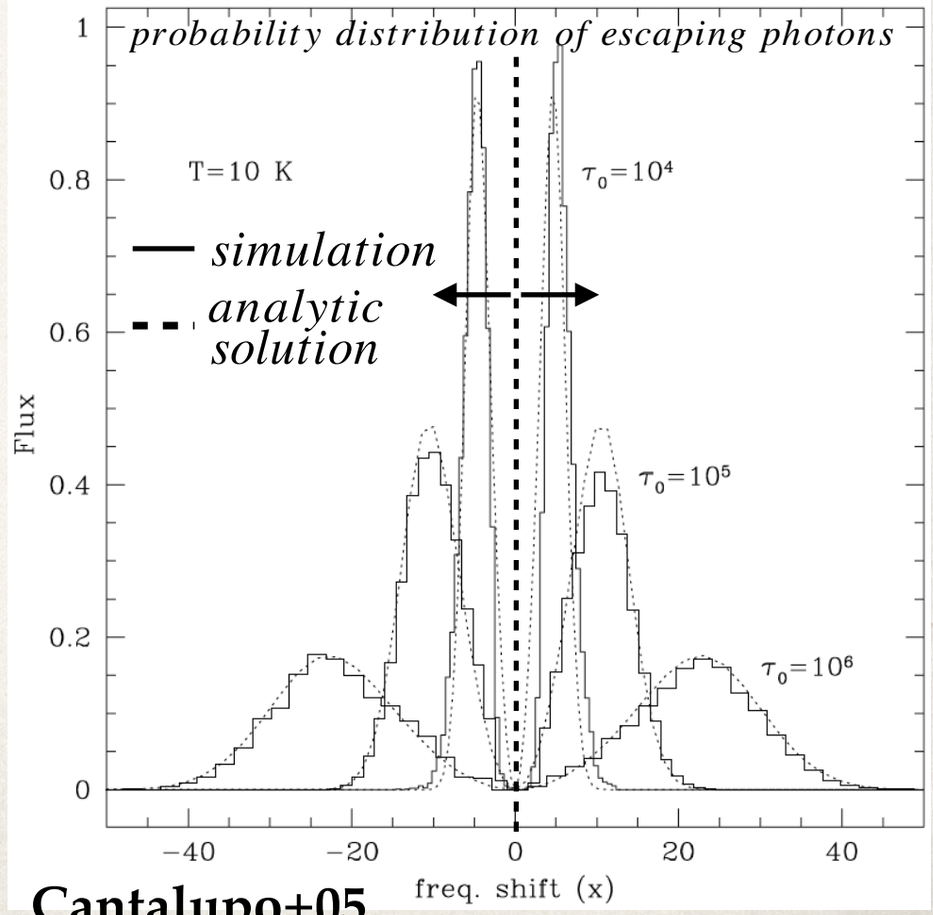
CGM has a key role in galaxy evolution and in the AGN feeding & feedback cycle

Lyα emission

- Mechanisms of emission:
  - collisional excitation (Haiman+00)
  - resonant scattering from the quasar BLR (Cantalupo+05)
  - **fluorescent** (photoionization+recombination) (Hogan & Weymann 1987, Cantalupo+12)

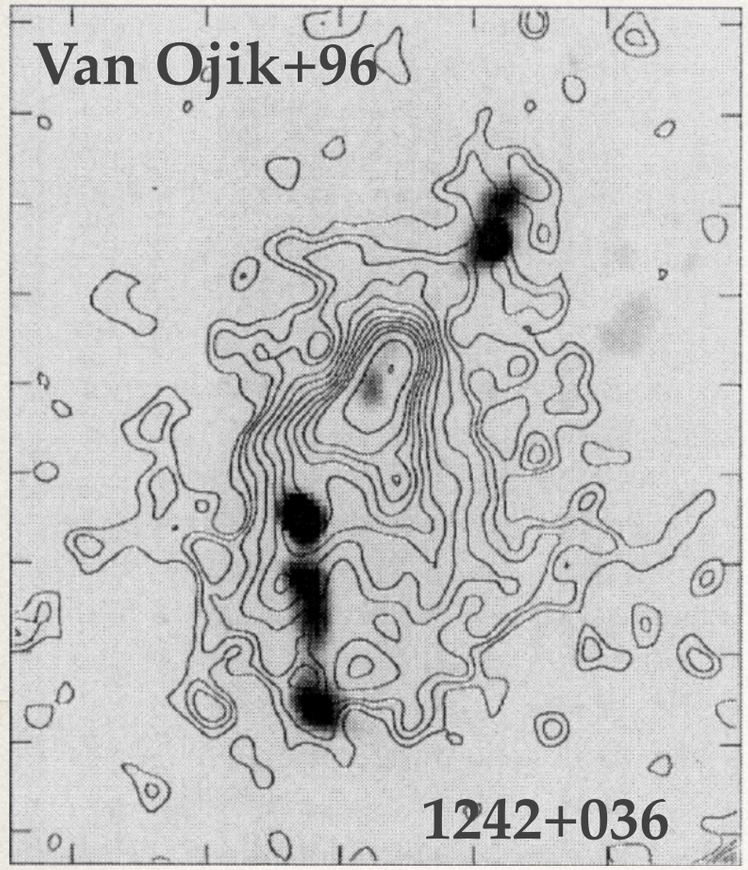


- Lyα line: λ=1215.67 A $\quad \tau(\lambda) = \left(\frac{N_{HI}}{10^{17.2} cm^{-2}}\right)\left(\frac{\lambda}{912\text{Å}}\right)^3$
- hν=10.2 eV, t=1.59 ns
- Resonant scattering
- Random walk in frequency and position: escaping from the system



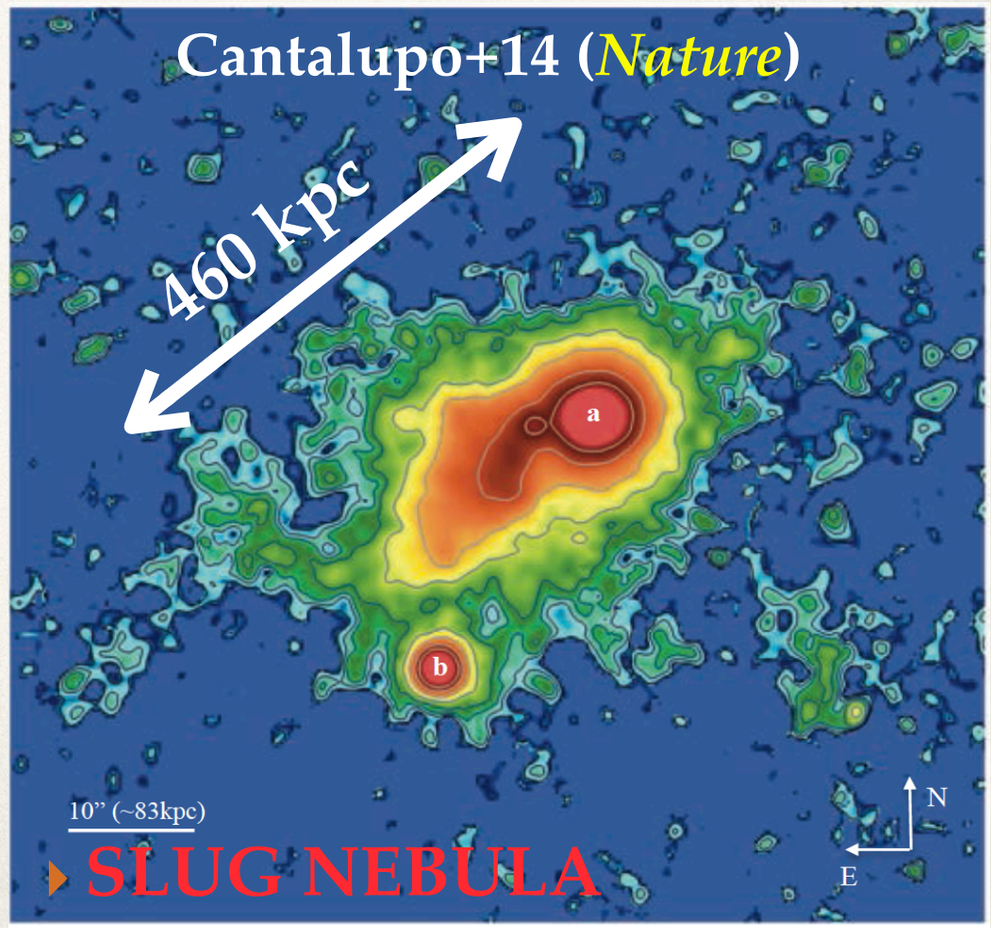
Cantalupo+05

Giant Lyα Nebulae in the past



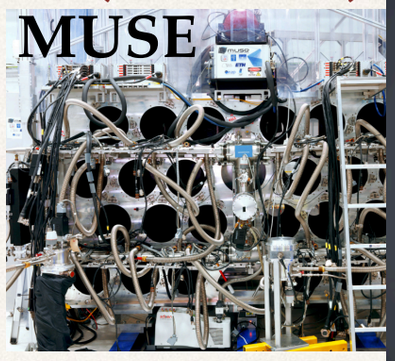
- Giant Lya nebulae around High z Radio Galaxies (HzRGs) (Lilly & Longair 84, Van Ojik+96, Adam+97)
- L~10^{45}erg/s, size up to ~200 kpc
- Optical/UV and radio emissions spatially correlated (McCarthy+87)
- photoionization + shock-ionization (Villar Martin+97)

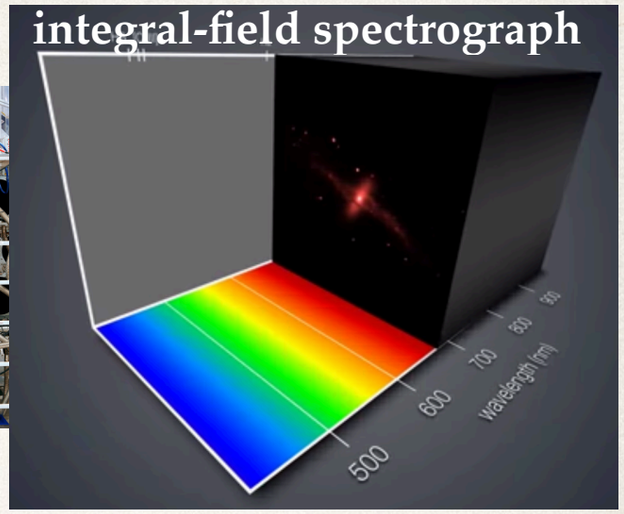
- Discovered in Narrow Band (NB) imaging a Enormous Lyman-Alpha Nebulae (ELAN) around multiple **radio quiet QSOs** (RQQs) z~2.3
- do not have radio-jets that may power Lya emission on large scales
- size **460 kpc** (beyond the virial radius) and L~2 x 10^{44} erg/s



Giant Lyα Nebulae with MUSE (GLAN)

★ Advent of Multi Unit Spectroscopic Explorer (MUSE)





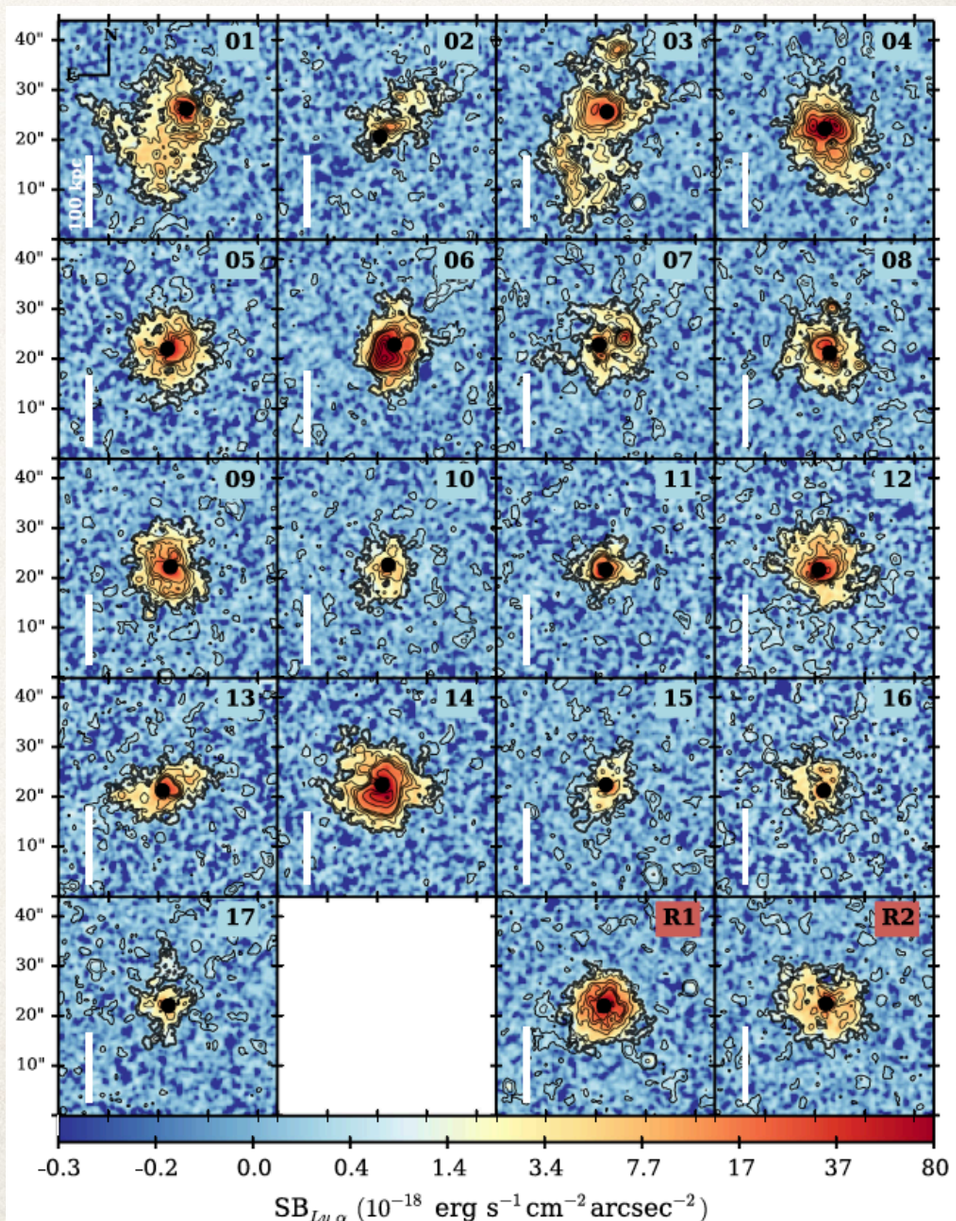
- MUSE Optical integral-field spectrograph
  - No filter and slit losses

- FoV **1'x1'**, pixel scale **0.2 "/pixel**
  - at redshift **z=3.5**: FoV (**450x450 kpc²**), pixel scale (**1.5 kpc/pixel**)
  - High sensitivity

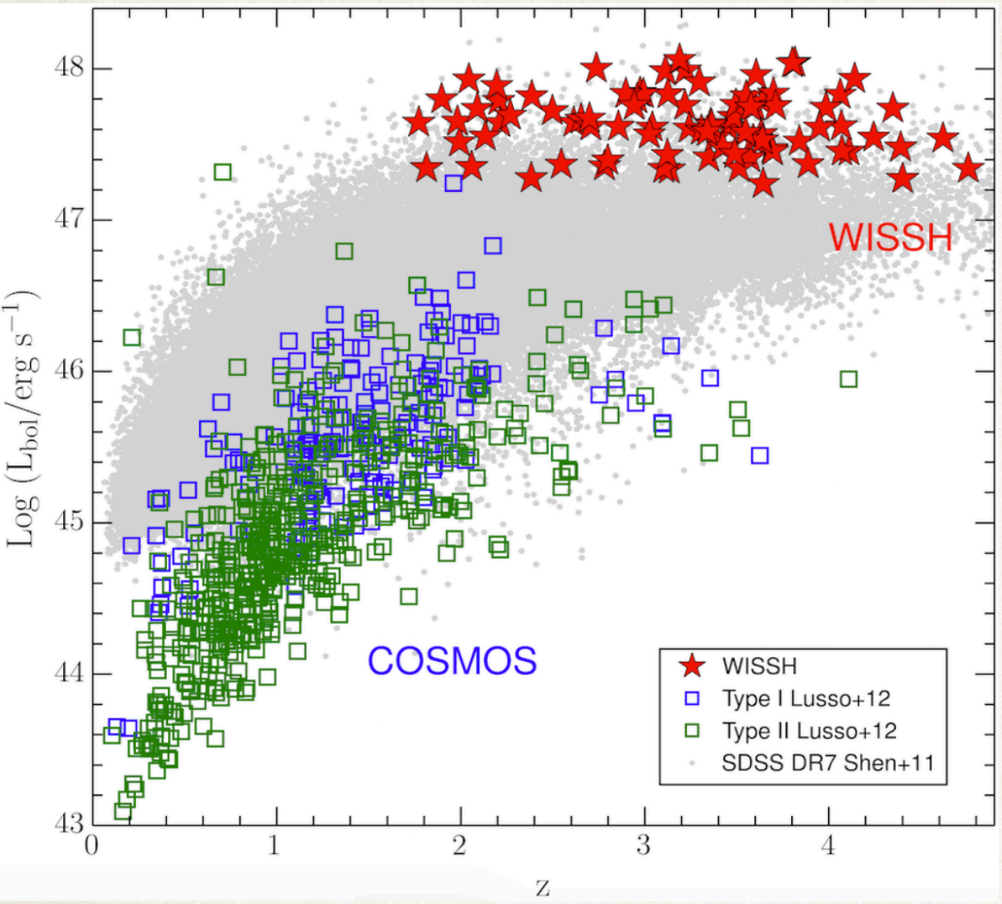
★ GLAN today

- GLAN are ubiquitous (**detection rate 100%**) around RQQs at z~3-4 within at least 50 kpc (Borisova+16)

- see also Ginolfi+18, Arrigoni-Battaia+18



the WISSH QSO project: MUSE



- Sample of ~86 broad-line **WISE/SDSS Selected Hyper-luminous** (**WISSH**) quasars
- Bolometric Luminosity log(Lbol) > 47.2, z>1.5 and WISE(22μm) > 3 mJy
- Aims: ***AGN feedback in the most luminous quasars of the Universe***

- see Vietri's, Duras's, Bischetti's talk

Bischetti+17,+18, Martocchia+17, Duras+17, Vietri+18, Bruni+ in prep

★WISSH MUSE PROJECT

- 7 WISSH QSOs targeted by MUSE
- 2 are proprietary data (PI Fiore) (**J1538+08**, J2238-08)

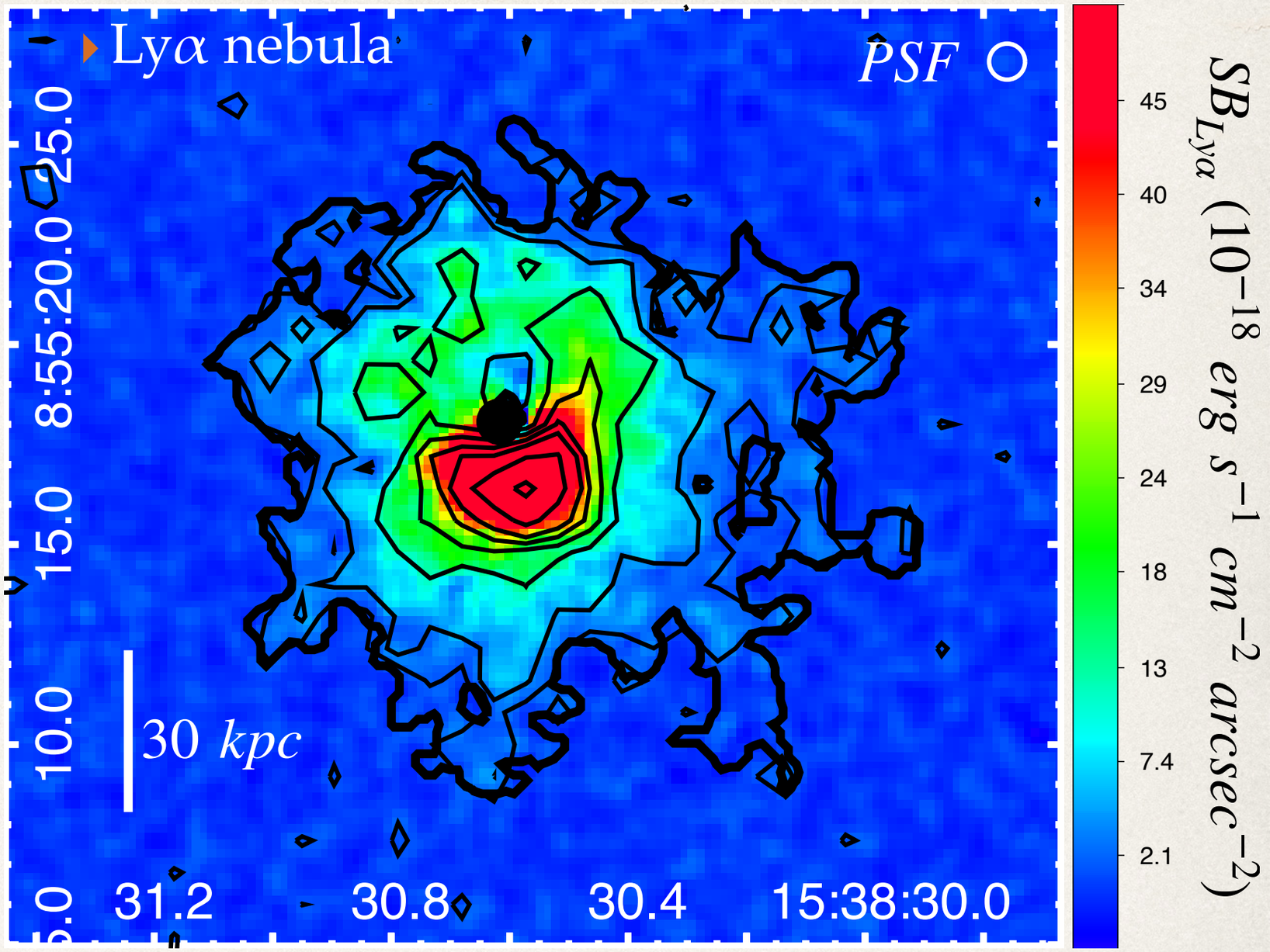
★Aims:

- ***Studying the CGM around the most luminous quasars of the Universe with powerful outflows***
- probe presence of possible AGN driven winds bejond host galaxy
- shedding light on AGN feeding and feedback

Giant Lyα nebula around J1538

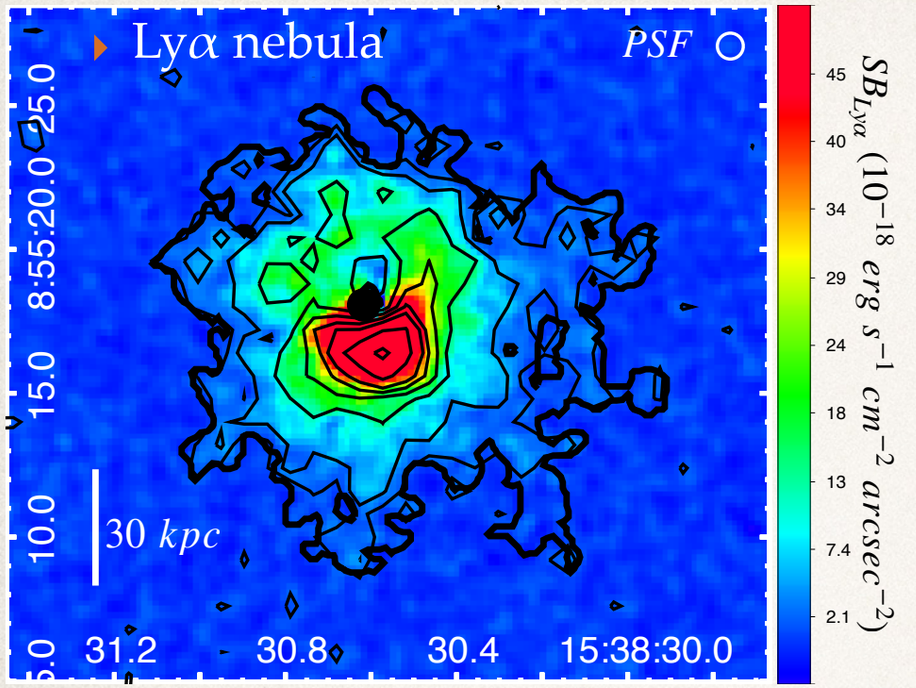
- SNR >2.5
- propagated SNR levels
- QSO (1 x 1 arcsec^2)

- Obtained with **CubExtractor,** a tool to perform PSF-subtraction and low surface brightness detection/analysis (Cantalupo+in prep)
- Maximum size **144 kpc**
- Integrated SNR(Lyα)~30
- z_{QSO}=3.567, $z_{Ly\alpha}$= 3.563
- $L_{Ly\alpha}$=**2.04 x 10^{44} erg/s**

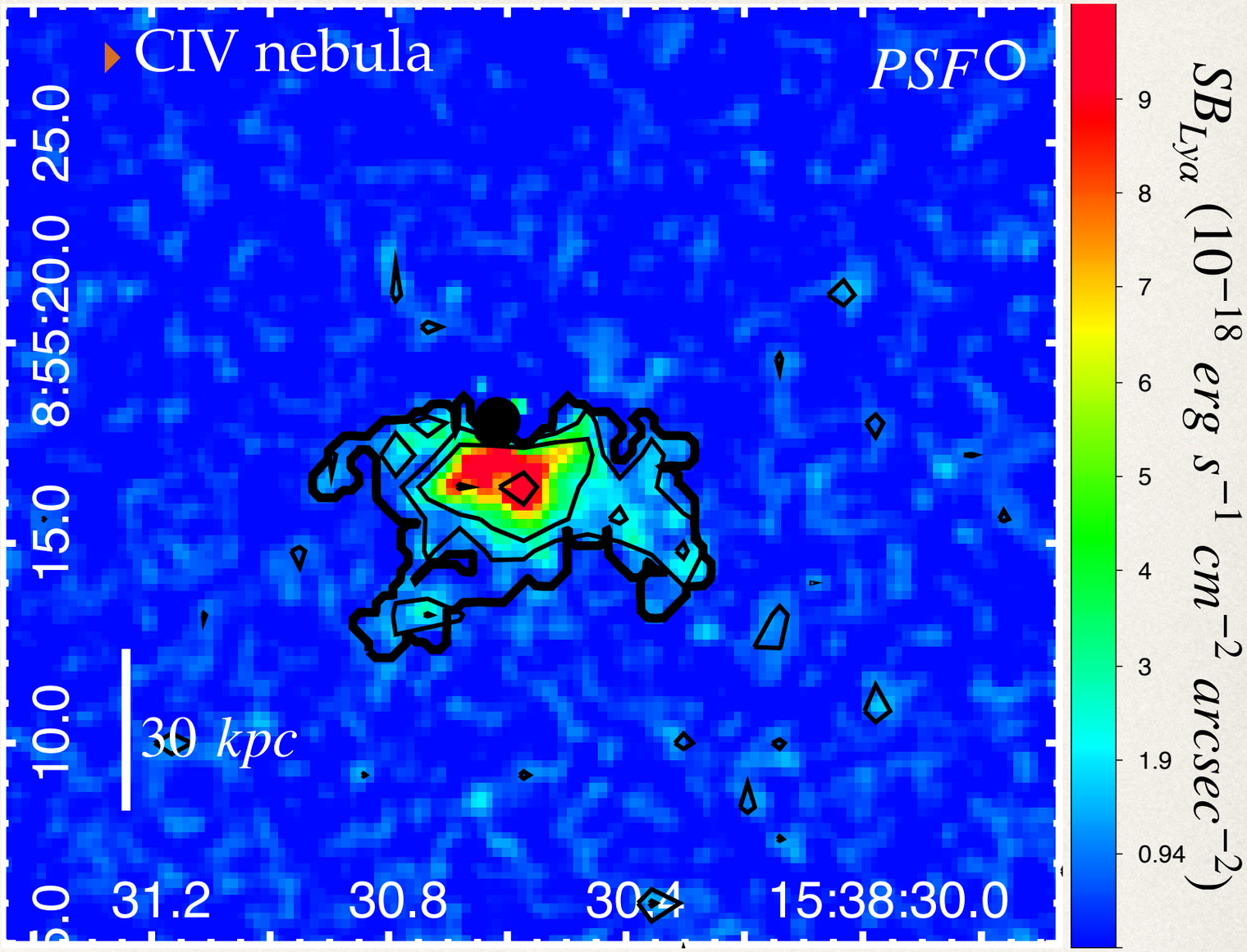


★SB peak in the south region of the nebula (UV radiation cone)

Surprise: discovery of giant CIV nebula



- Maximum size **60 kpc**
- Integrated SNR(Lyα)~5
- z_{QSO}=3.567, z_{CIV}= 3.562
- L_{CIV}=**9.63 x 10^{42} erg/s**



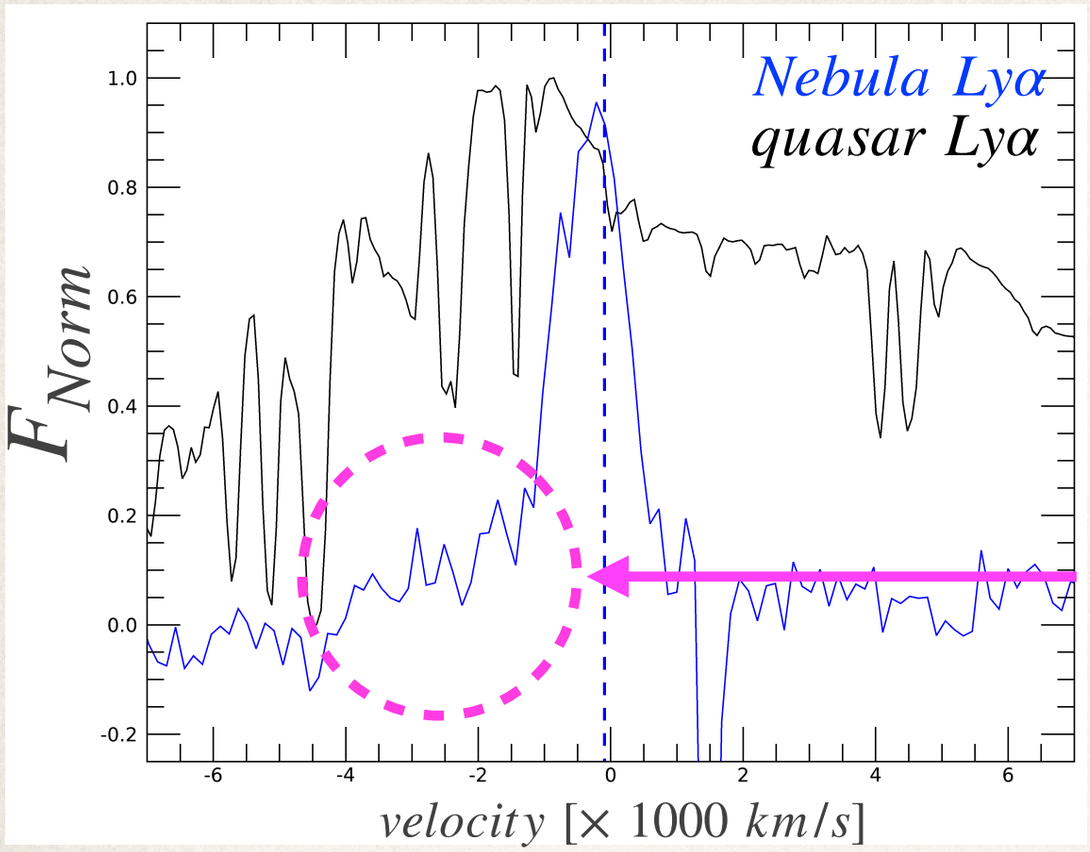
★ Discovery a CIV nebula in the same south region

★ CGM metal-rich

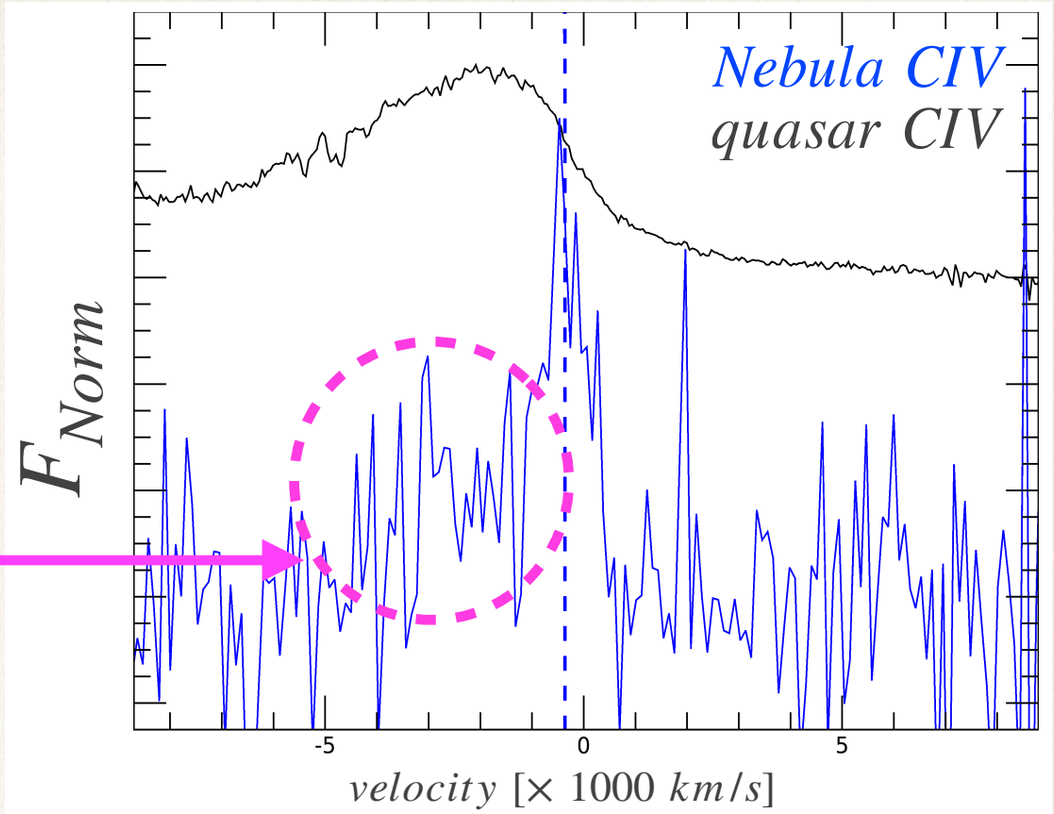
★ Which mechanism has transported the CIV up to here?

- Outflow? Stellar feedback?

Lyα line profile: blue tail = outflow?



blue tails

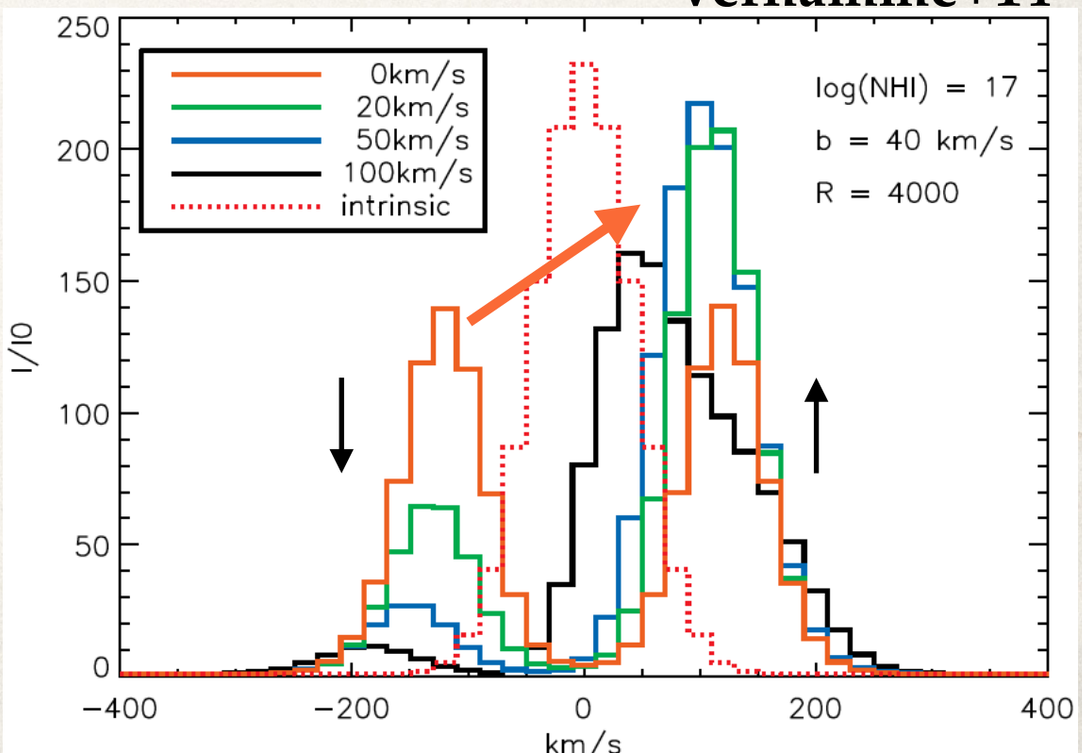


★ Blue tail of the Lyα emission line in the nebula spectrum: could it suggests the presence of an outflow? (Verhamme+14)

- Is it a simple Lyα blue component?
- Is it the second peak that we would observe typical for a resonant line?

★ What is the spatial distribution of this blue tail?

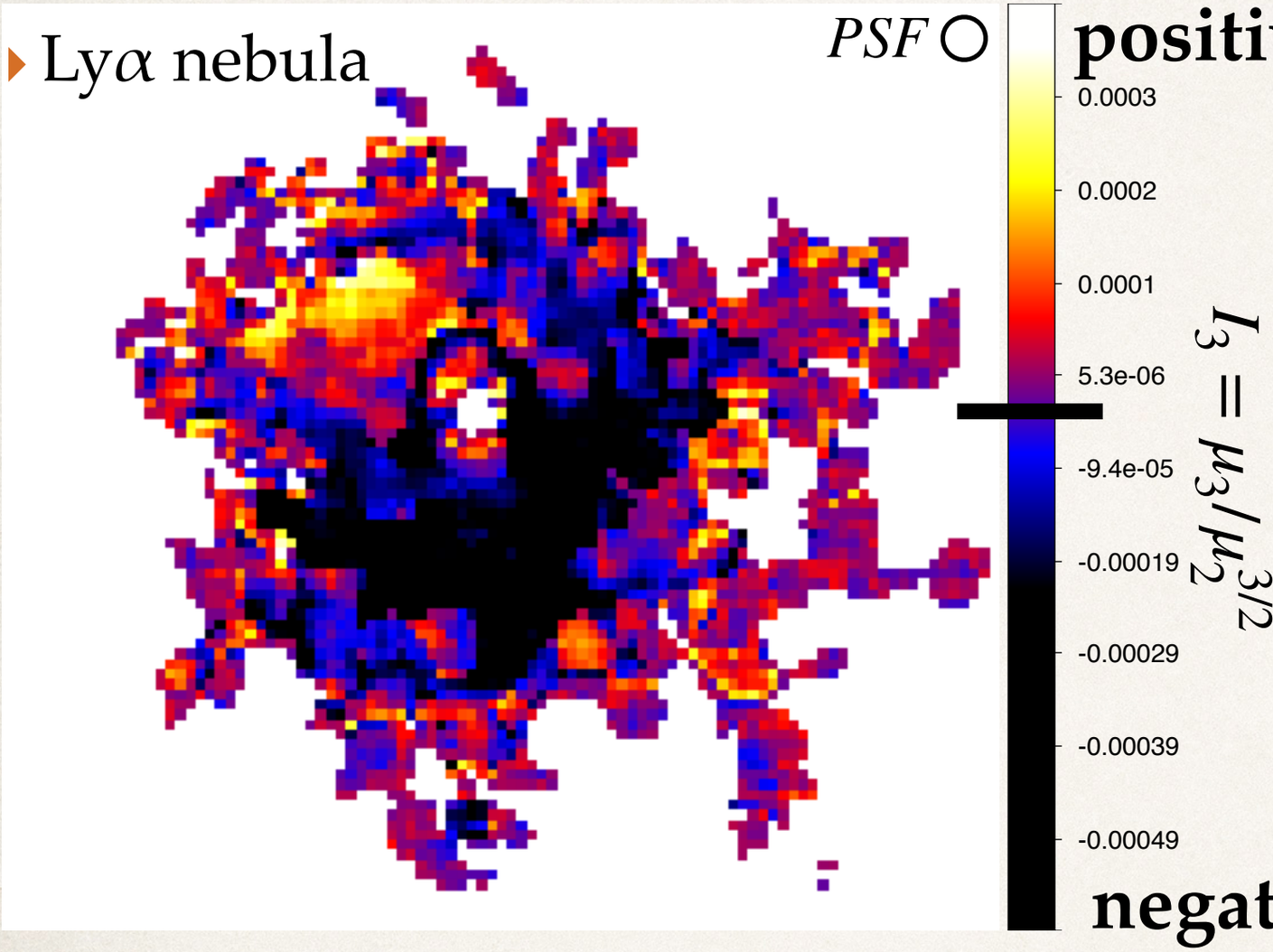
Verhamme+14



blue tail spatially resolved

- Skewness map

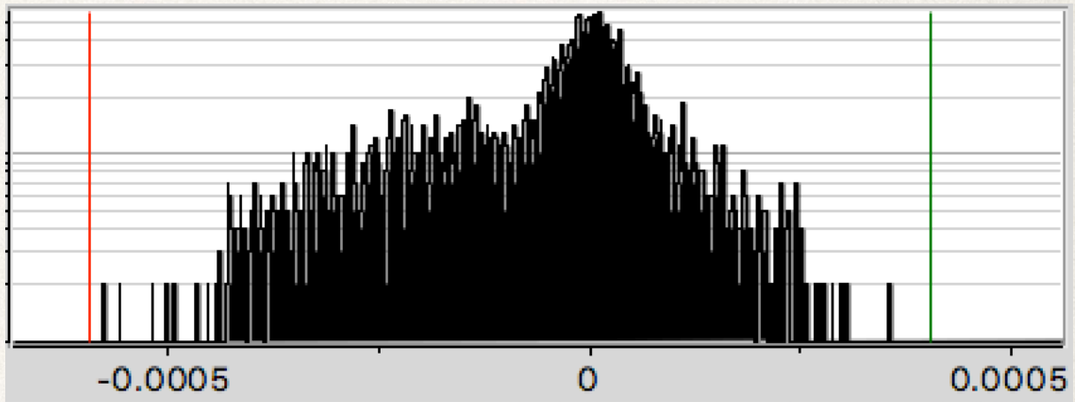
- Lyα nebula



positive values

negative values

- pixel value distribution



- It gives an indication of the Lyα emission line asymmetry and its spatial distribution

★ The Ly a profile is more skewed towards negative values in the SB peak of the nebula. Why?

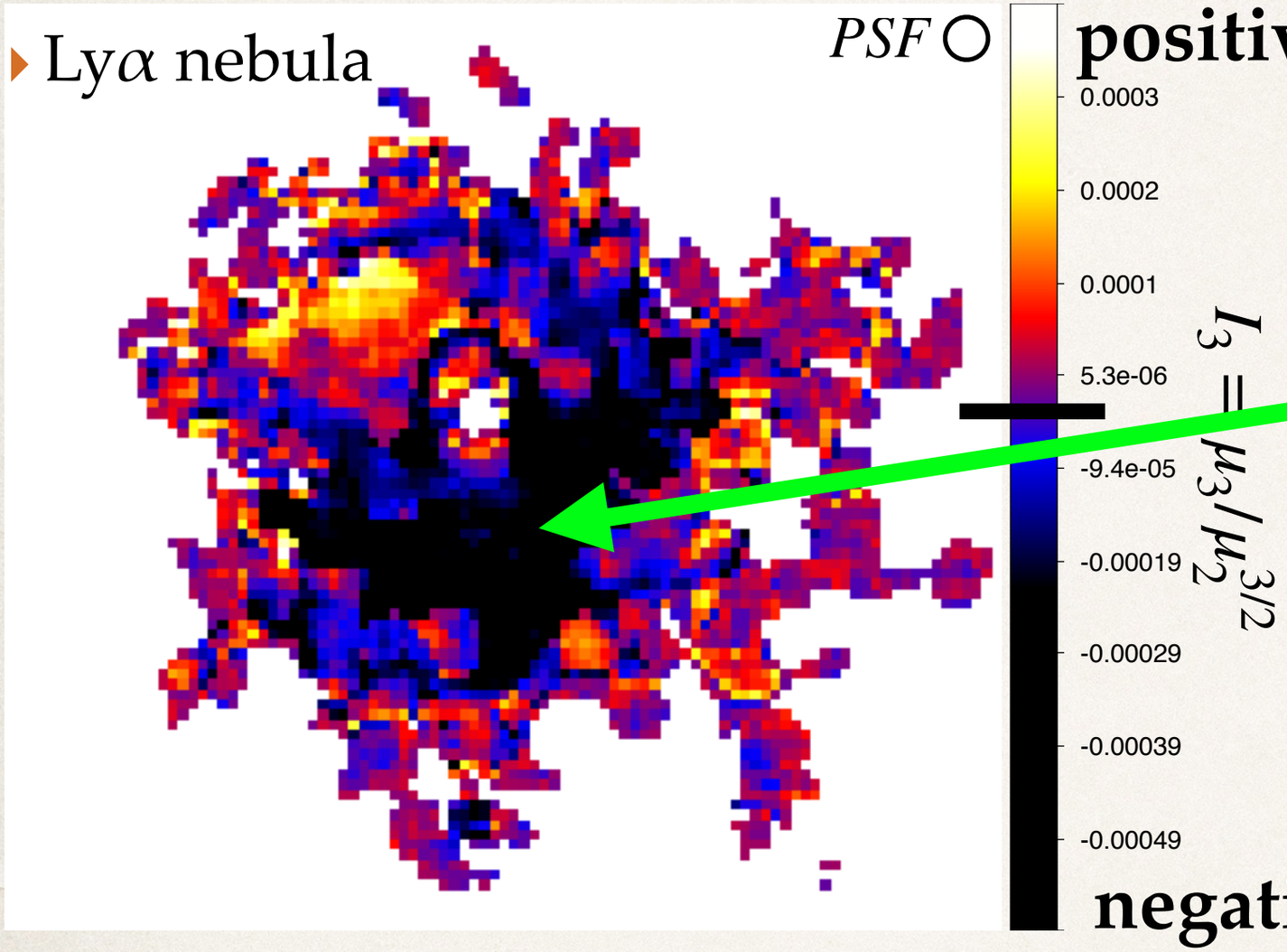
- Can we just resolve the blue tail with an higher SNR?

- Is it indicating the presence of an outflow?

● **Work in progress! Any comments or suggestions please? :)**

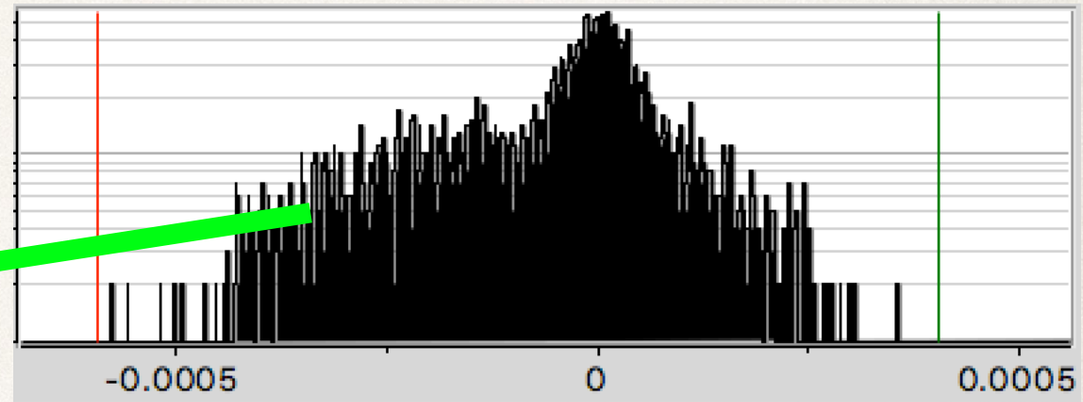
blue tail spatially resolved

- Skewness map



- Lyα nebula

- pixel value distribution



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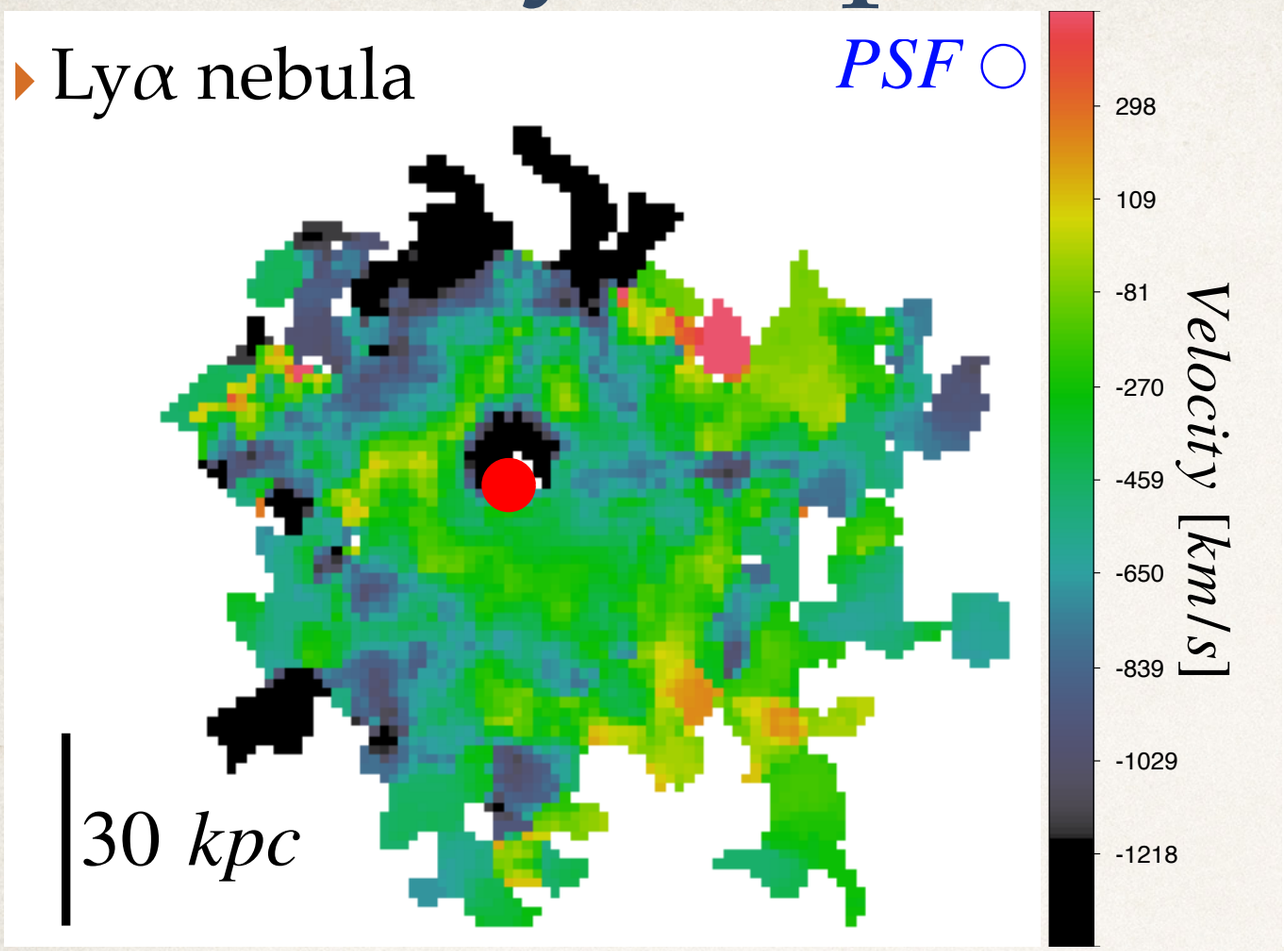
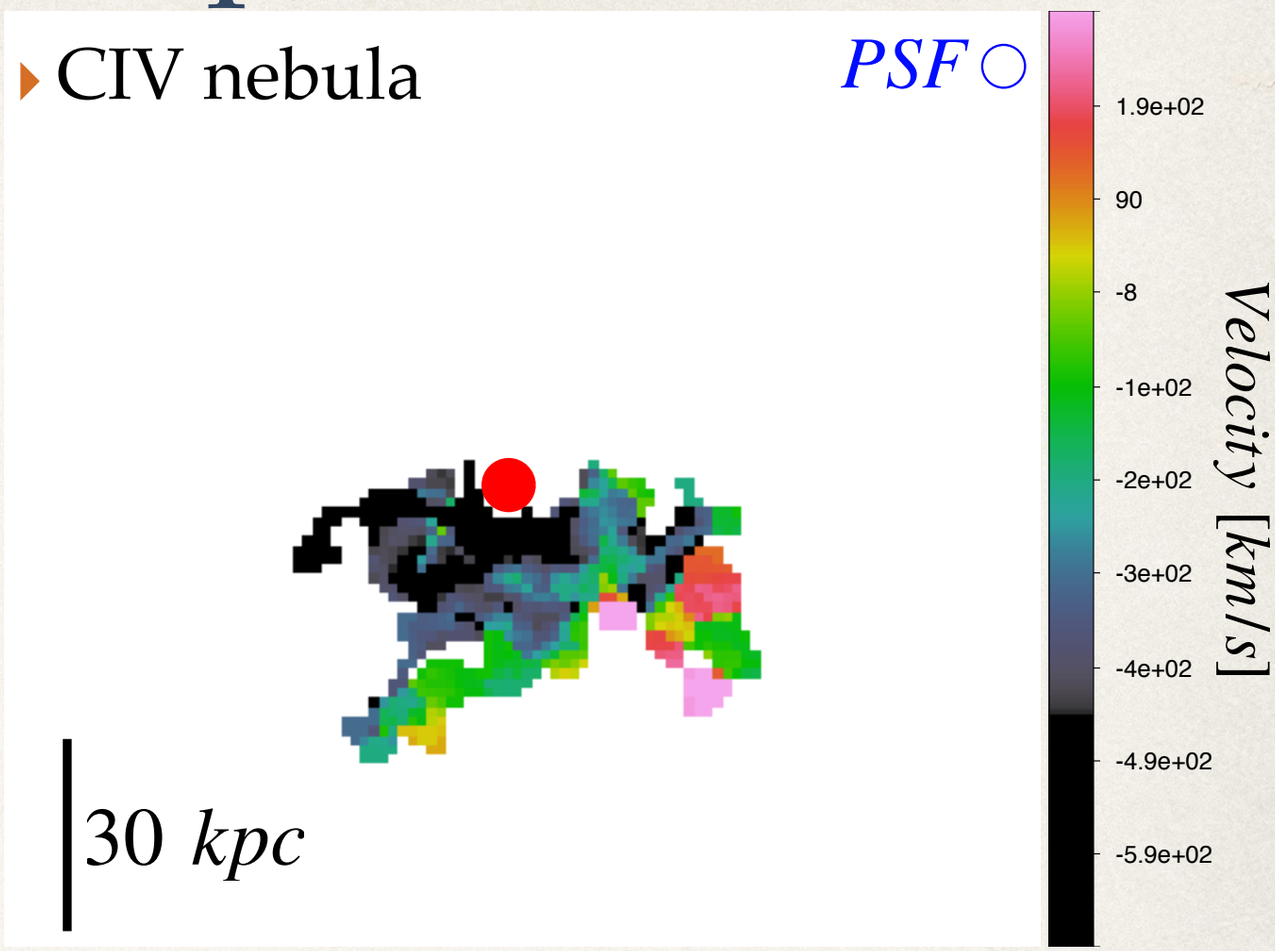
Velocity map with respect to the z_{QSO}

Lyα nebula



CIV nebula



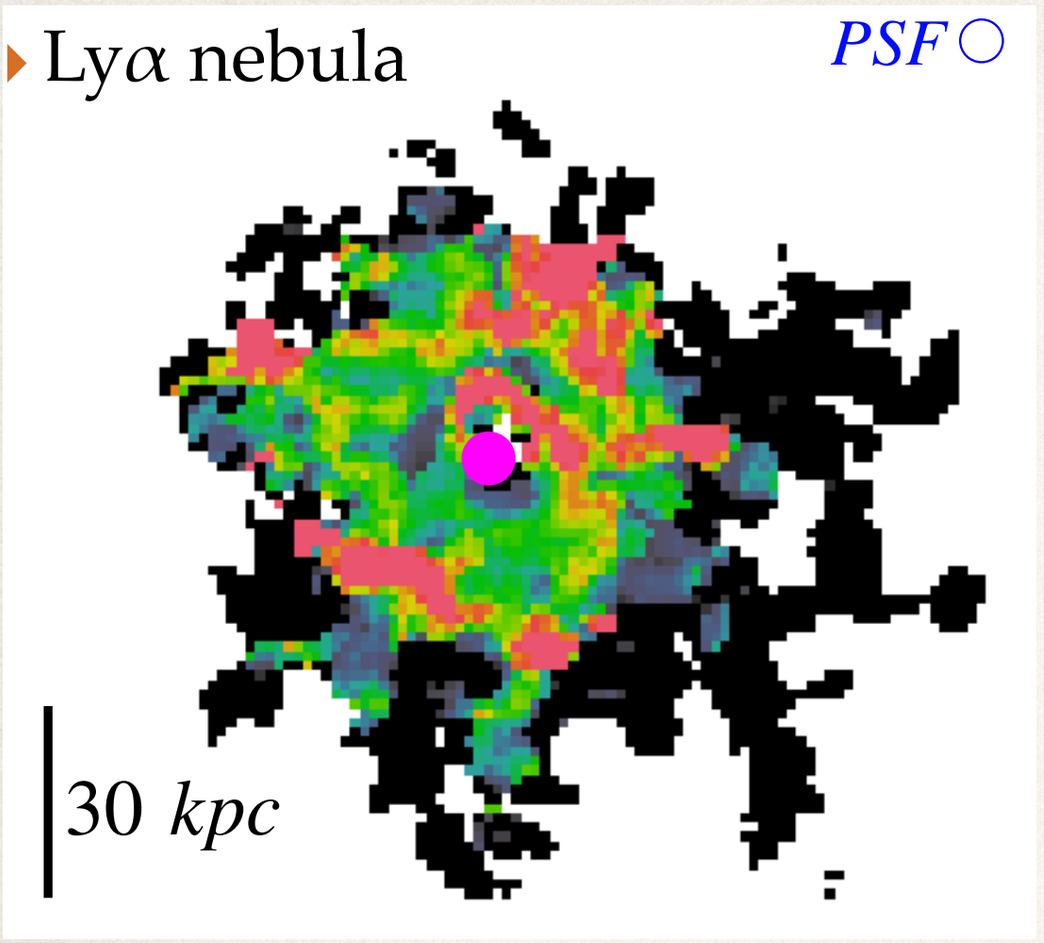
- problem to find the systemic redshift of the QSO
- complex radiative transfer effects = complex kinematic interpretation

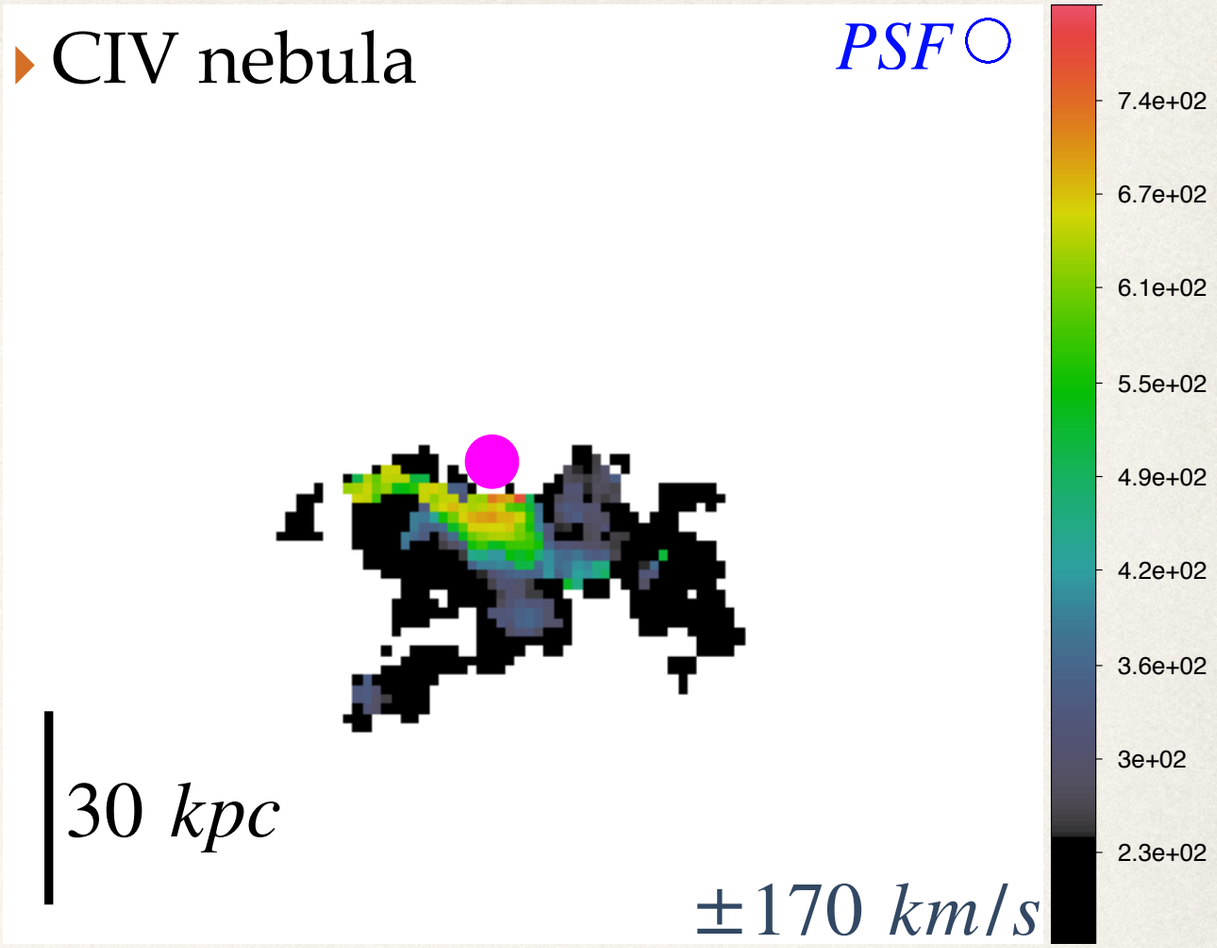
★ blue-shifted bulk motion of the Lya Nebula relative to the systemic z as determined from the Hβ —> hint of an outflow?

✓ We need to have molecular lines from the host galaxy in order to a reliable systemic redshift of the QSO and constrain the nebula kinematic

✓ We need to have non-resonant line (Hα, HeII etc…)

Velocity dispersion map





- Velocity dispersion marks the turbolence of the gas in the CGM
- GLAN around HzRGs: FWHM>1000 km/s (jet), FWHM<500 km/s (no jet)

★ high turbolence in the central region of the nebula

$$FWHM^{max}_{Ly\alpha} \sim 1300\ km/s \qquad FWHM^{max}_{CIV} \sim 700\ km/s$$

$$< FWHM_{Ly\alpha} > \sim 700\ km/s \qquad < FWHM_{CIV} > \sim 400\ km/s$$

SUMMARY

✓ We detected Lyα and CIV giant nebulae around a WISSH QSO which shows outflows in the BLR and NLR (Vietri+18)

- Lyα nebula has size ~ 144 kpc with $L_{Ly\alpha} \sim 10^{44}$ erg/s
- CIV nebula shows size ~60 kpc with $L_{CIV} \sim 10^{43}$ erg/s

✓ The line profiles and the velocity maps suggest that we are witnessing outflowing CGM. In order to confirm this theory we need to:

- estimate the systemic redshift of the quasar through a line that surely belongs to the host galaxy
- look for a non resonant emission line (e.g. Hα, HeII..)

✓ Powerful outflows are a plausible mechanism capable of bringing metals into the CGM, by explaning the presence of a giant CIV nebula

- AGN feedback on the CGM?

Thanks