ISM gas physical properties in local AGN with the MAGNUM survey

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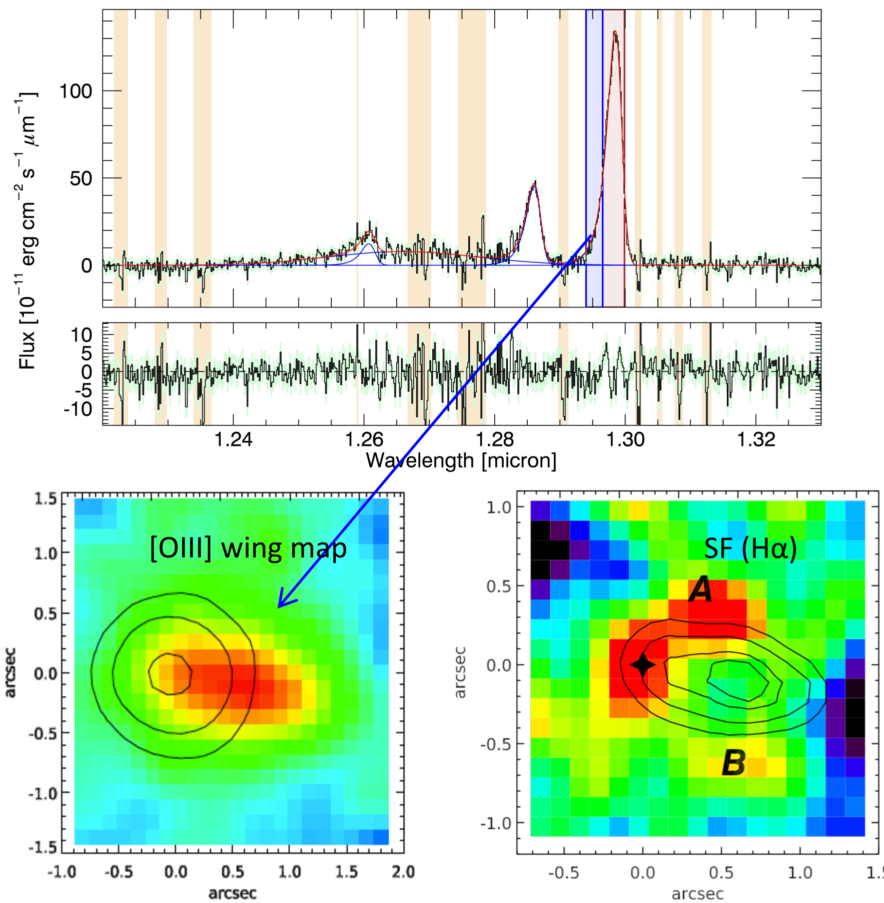
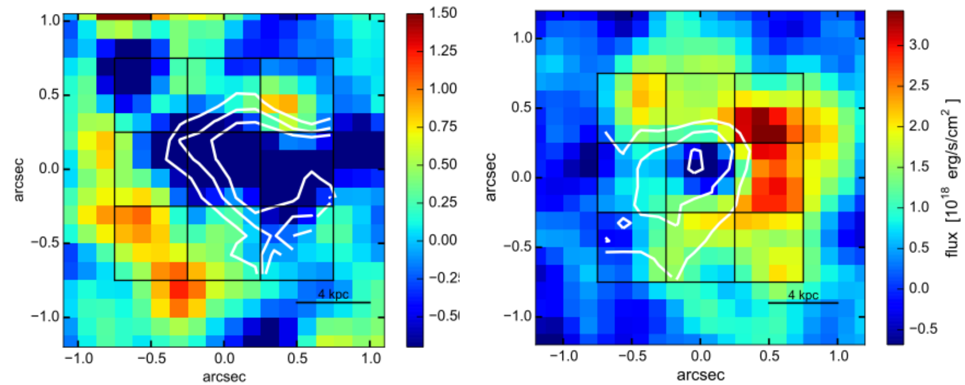
Negative and positive feedback at z ~ 1.5 - 2.5

QSO outflow feedback finally revealed at high-z…

Cresci+ 2015a



Narrow Hα flux + blueshifted [OIII] velocity



Carniani+ 16

… BUT at high-z very difficult to measure outflow physical quantities and provide interpretation even at high spatial resolution

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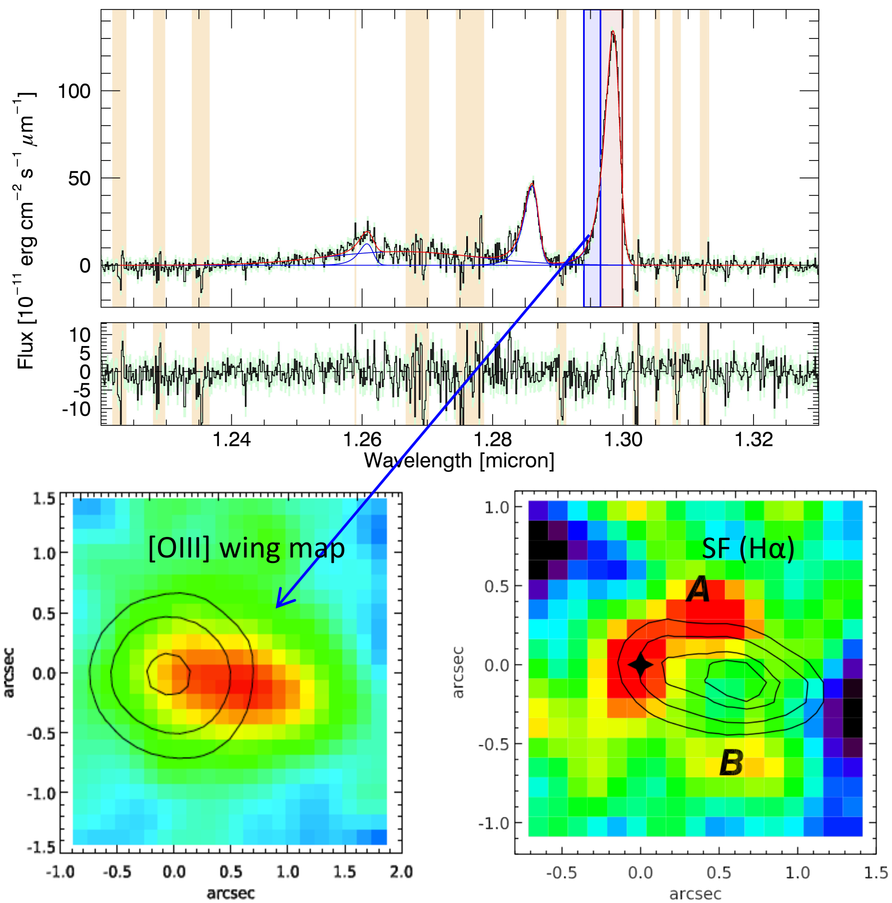

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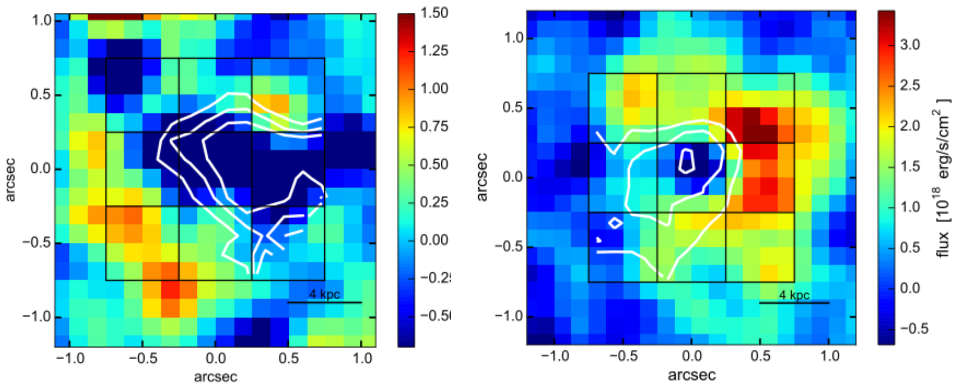


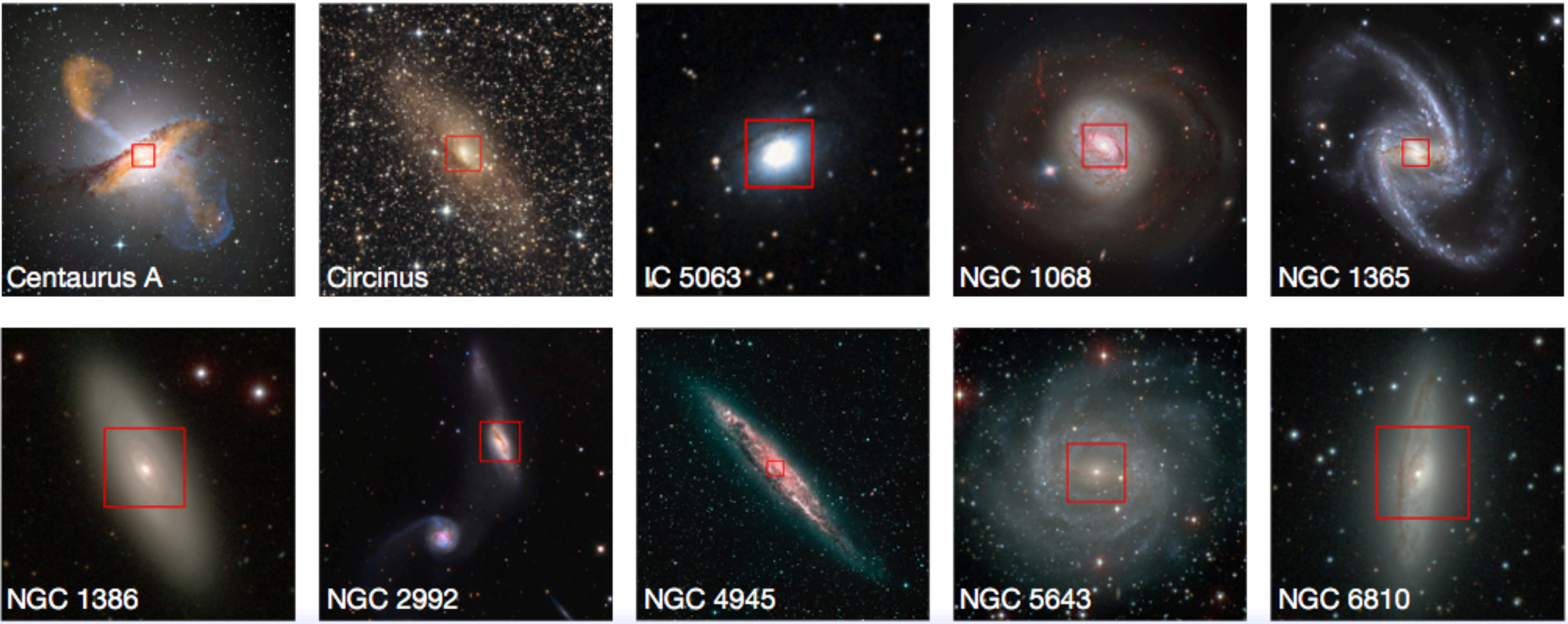
Carniani+ 16

A IFU view of the nearest AGN would provide much larger intrinsic spatial resolution to study SF and AGN activity, ionization conditions, inflows, outflows etc.

… BUT at high-z very difficult to measure outflow physical quantities and provide interpretation even at high spatial resolution

MAGNUM survey: Measuring AGN Under MUSE Microscope

- Nearby AGN (D < 50 Mpc – z < 0.002)
- MUSE (VLT) (1′×1′, 0.2″ sampling, 4750-9300 Å)
- So far ten object observed (90,000 spectra!)
- Seeing limited (~ 1” → 15 pc at 4 Mpc –115 pc at 30 Mpc)
- Multiwavelength data: *Chandra - XMM-Newton, Galex, HST, Spitzer, Herschel, ALMA*



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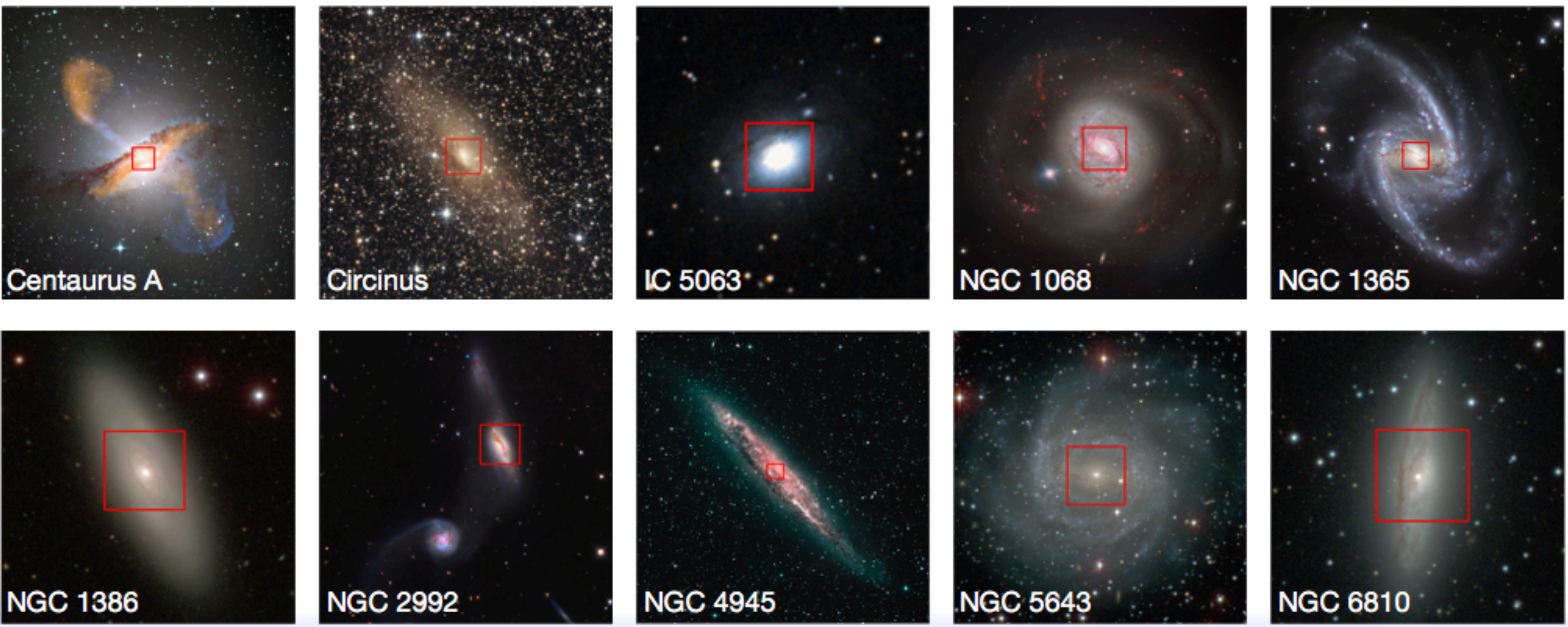
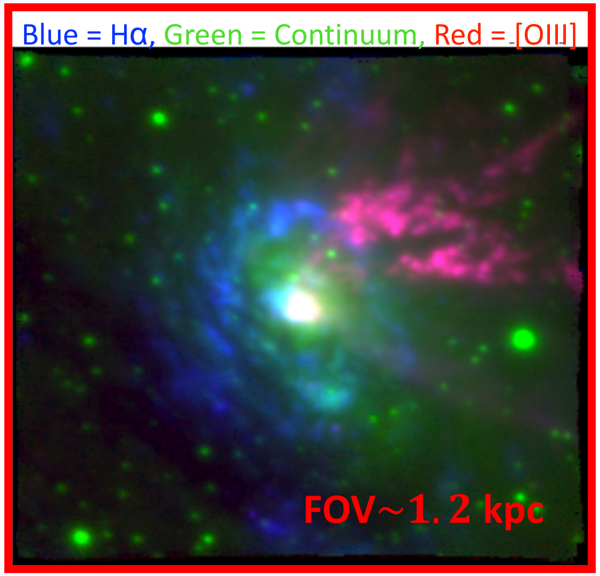
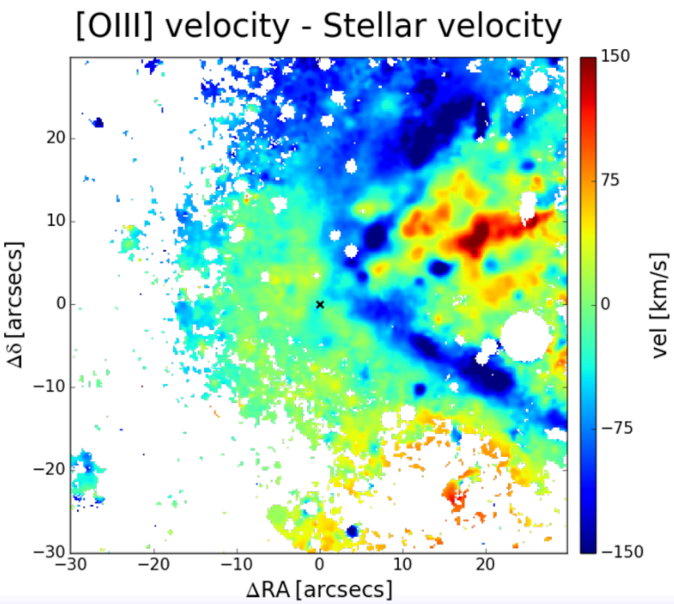
AIM

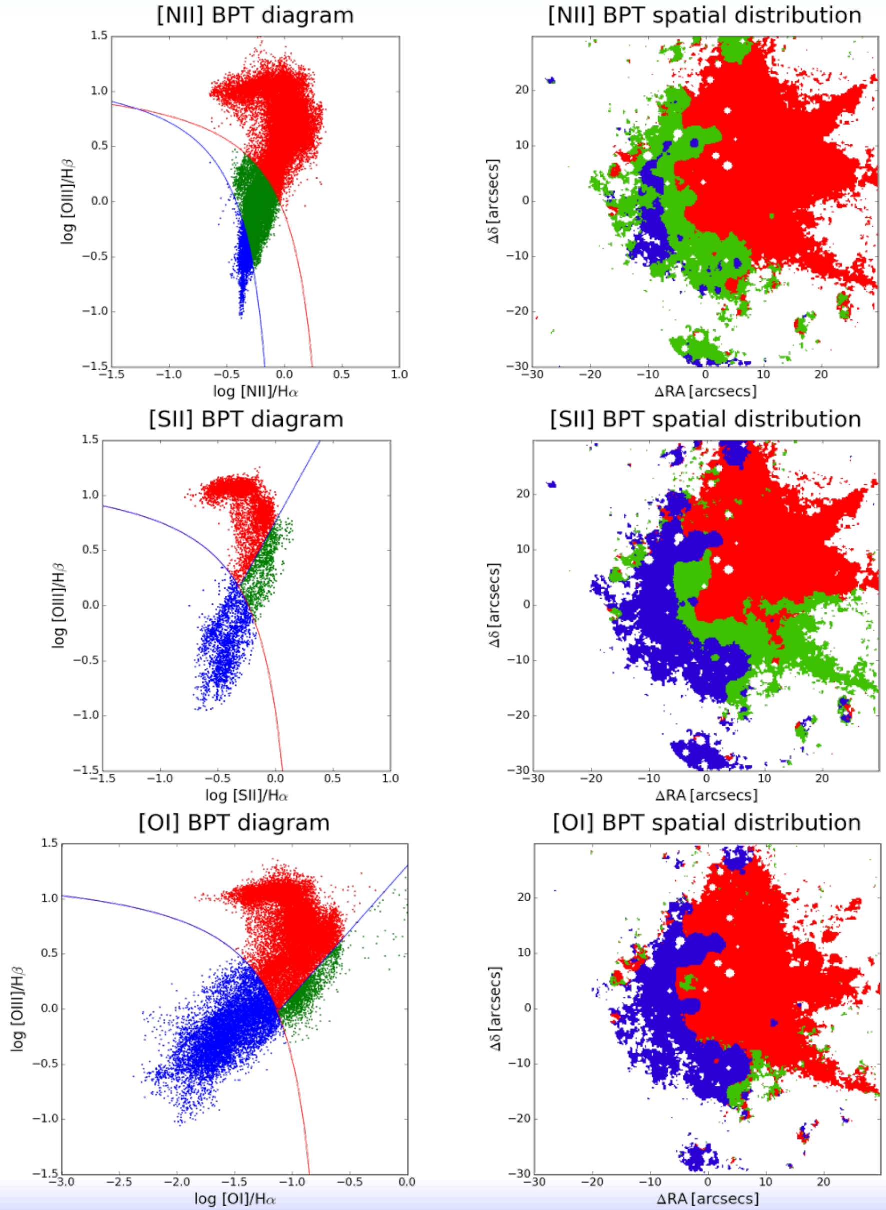
Study in details SF and AGN activities, ISM conditions and outflows, with kinematical and photoionization models



Circinus Galaxy

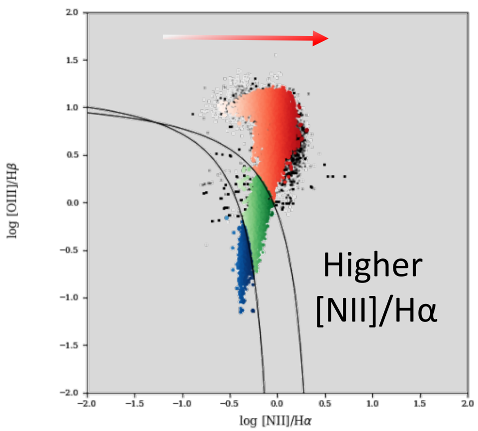




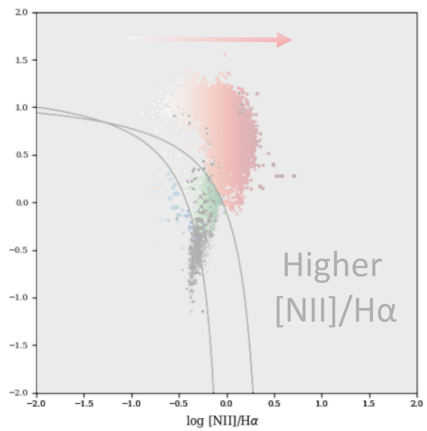


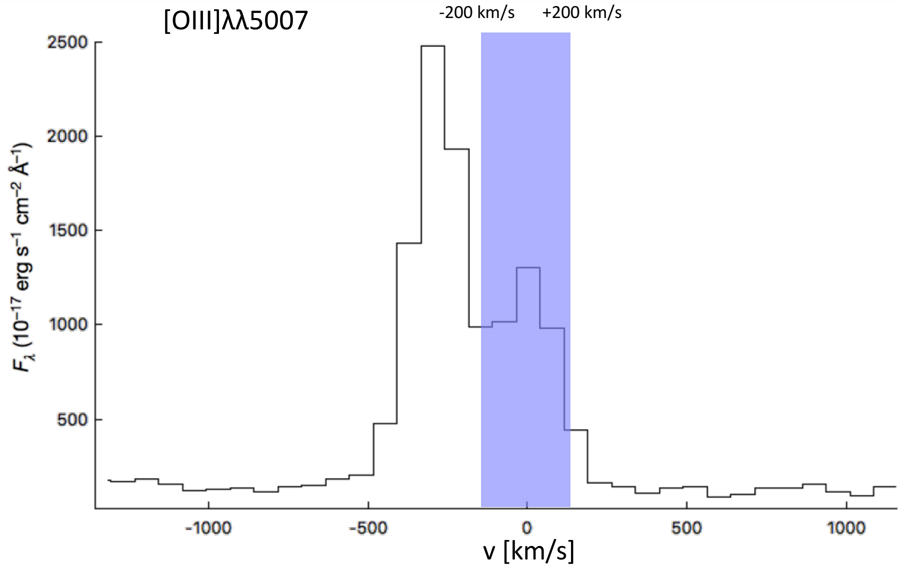
Circinus Galaxy: velocity resolved [NII] BPT diagram

Disk



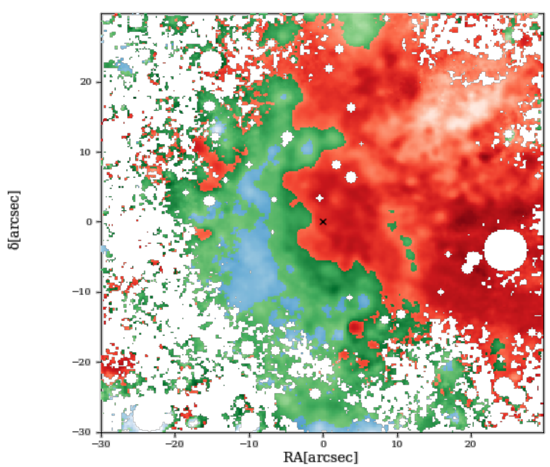
Outflow





0 corresponds to stellar velocity in that pixel

Disk



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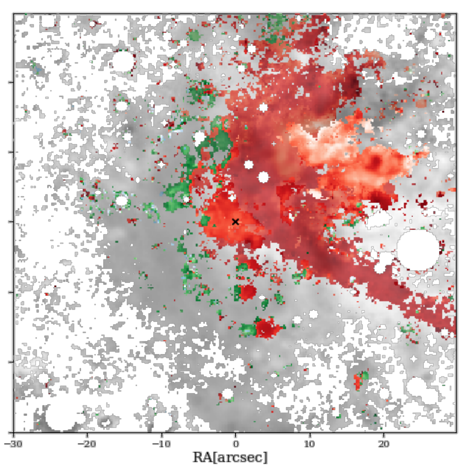

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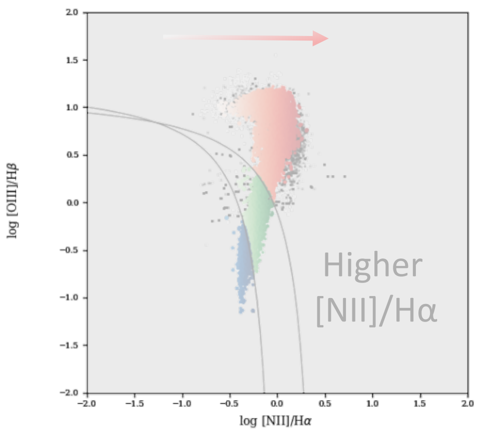

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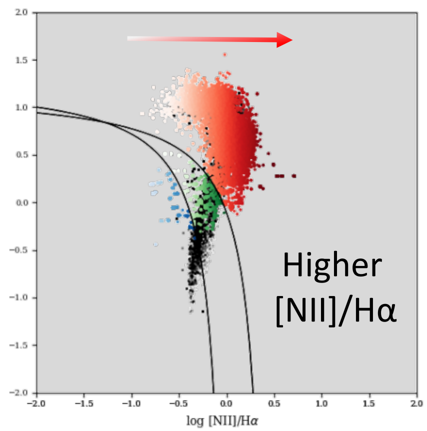

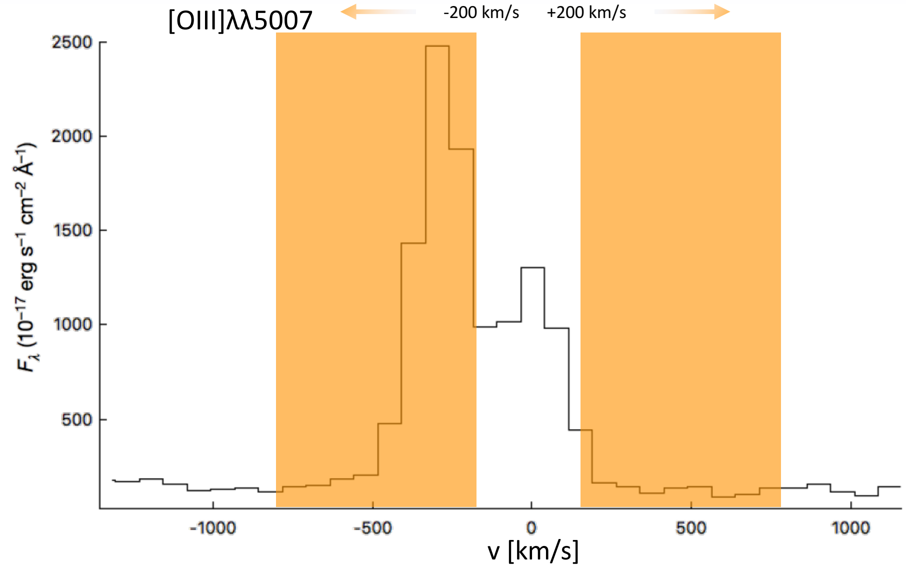

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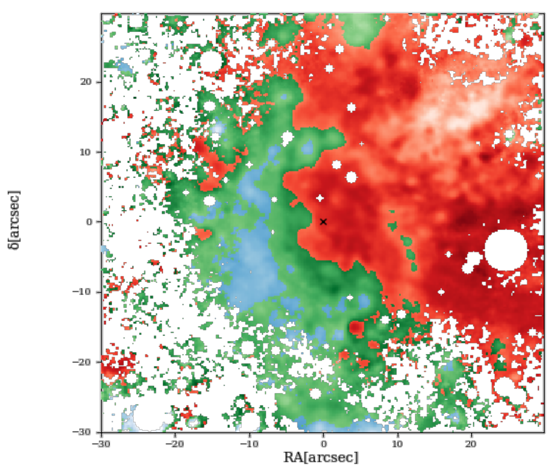

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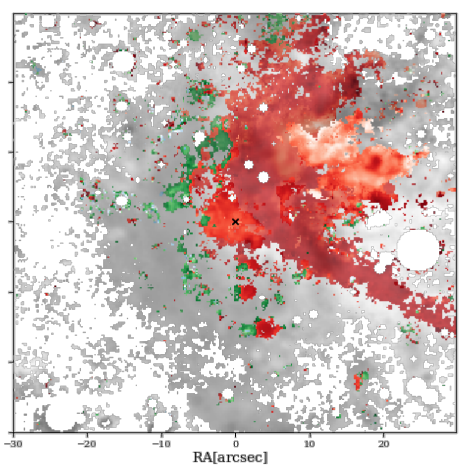

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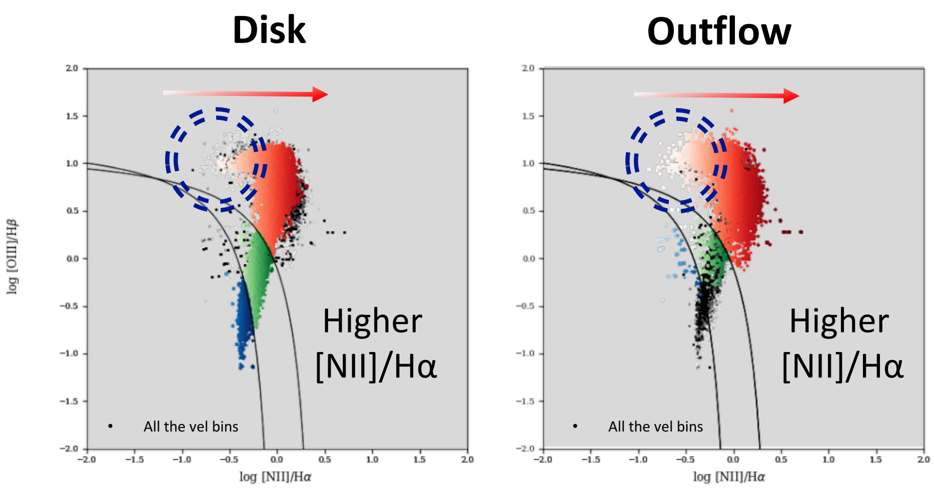

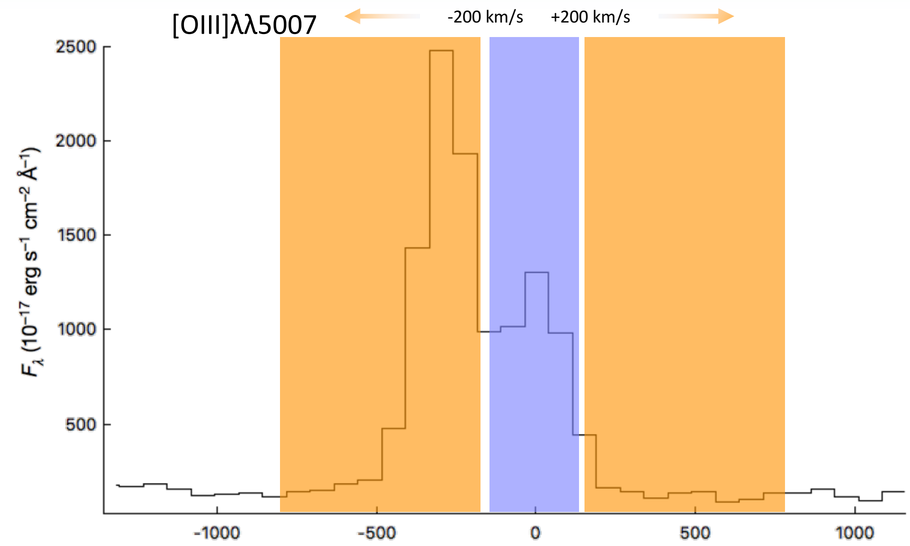

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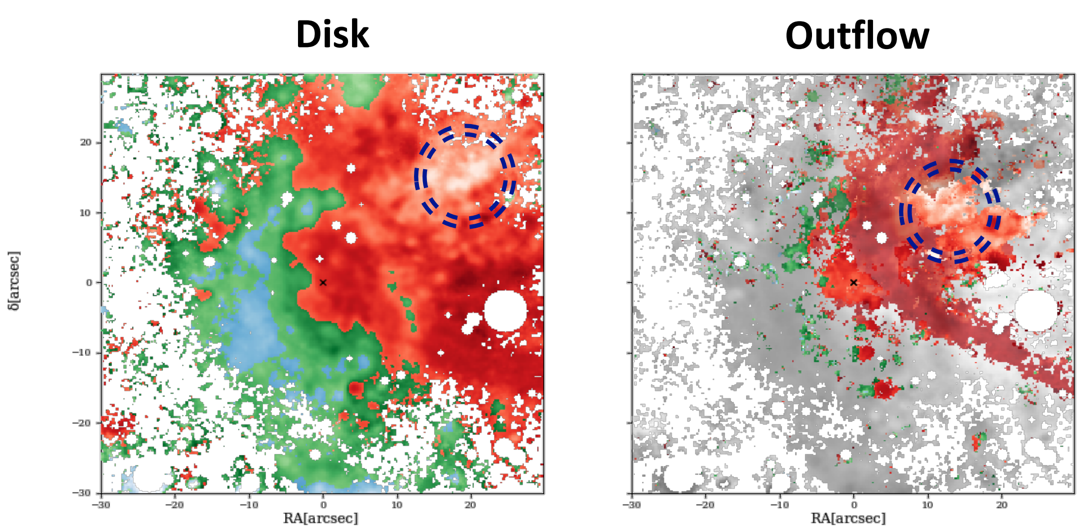

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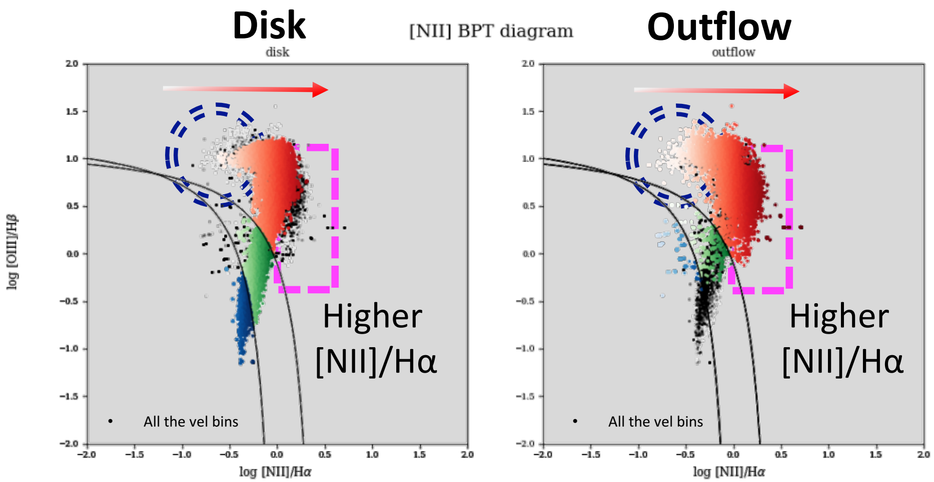

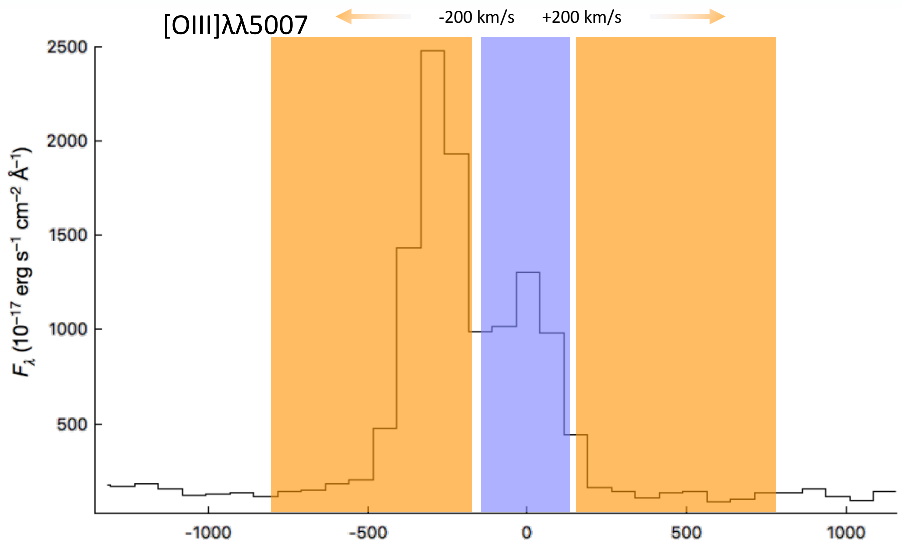

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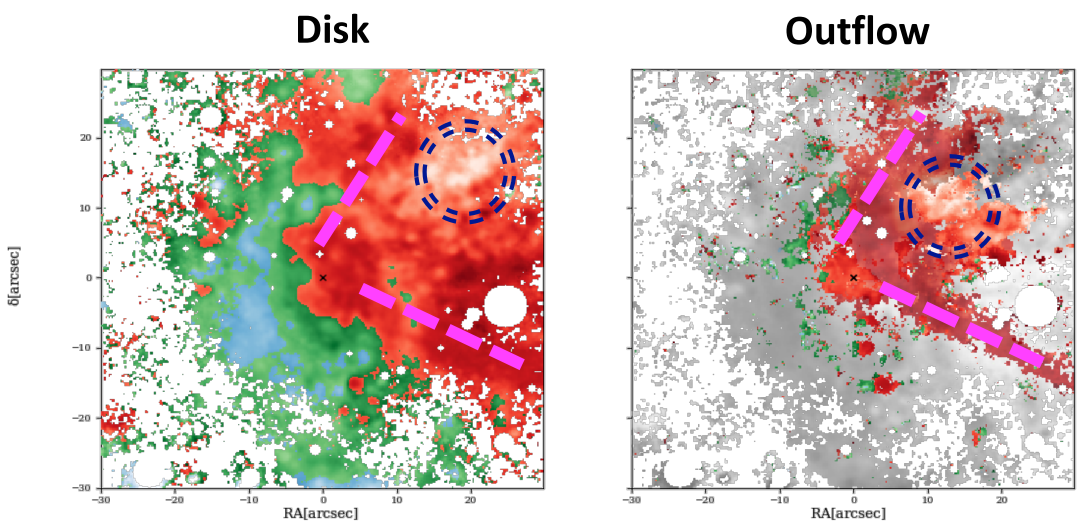

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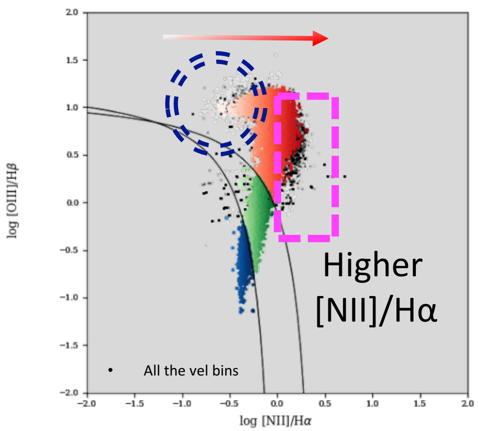

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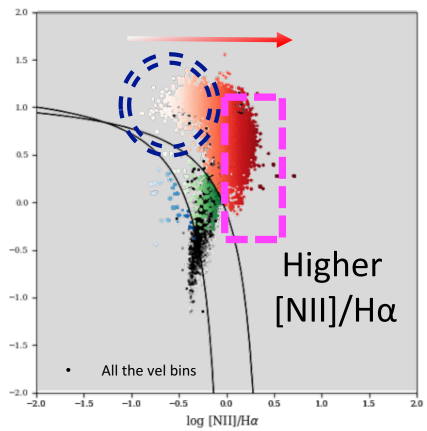

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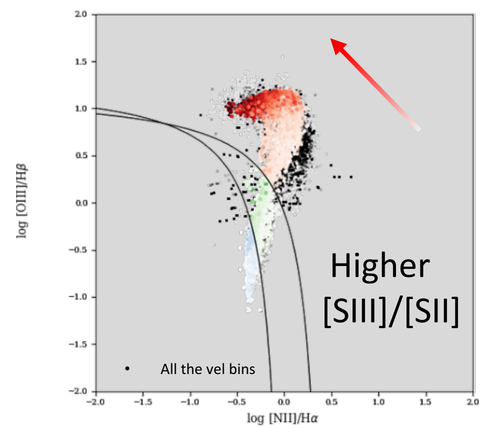

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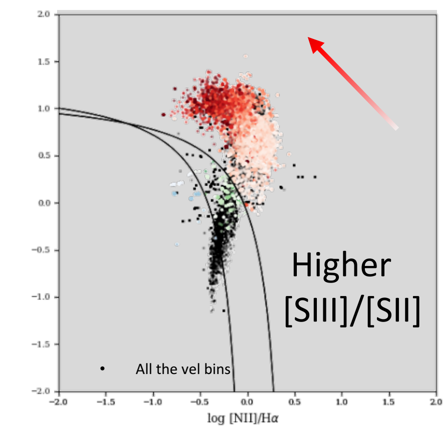

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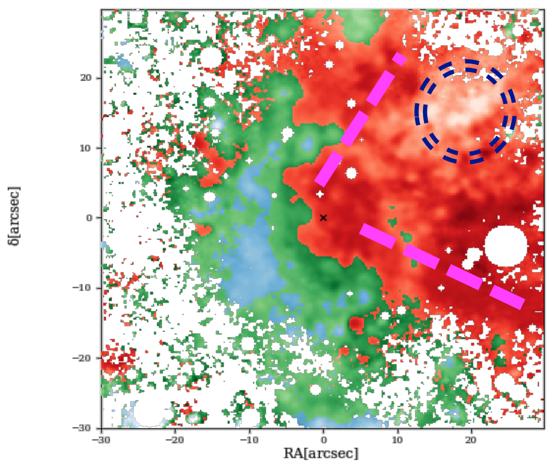

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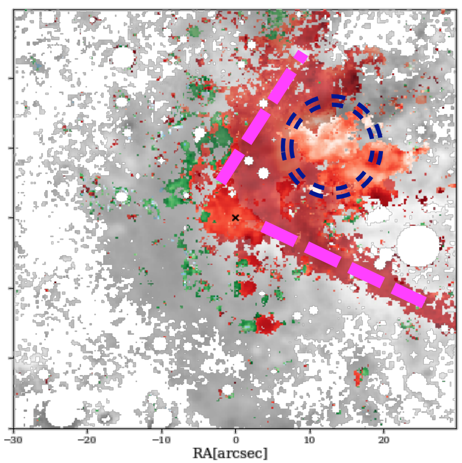
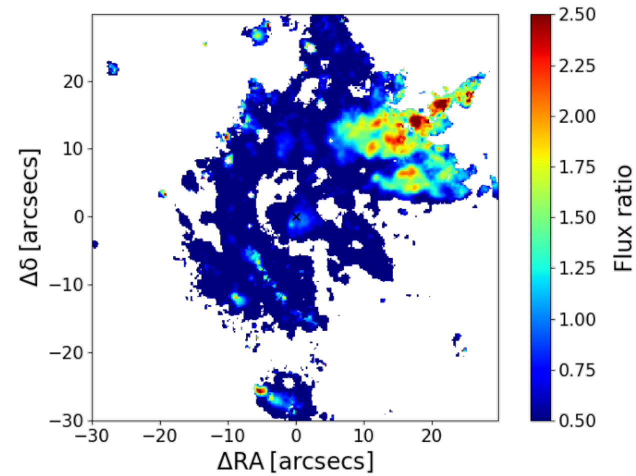


[SIII]λλ9531/[SII] λλ6724



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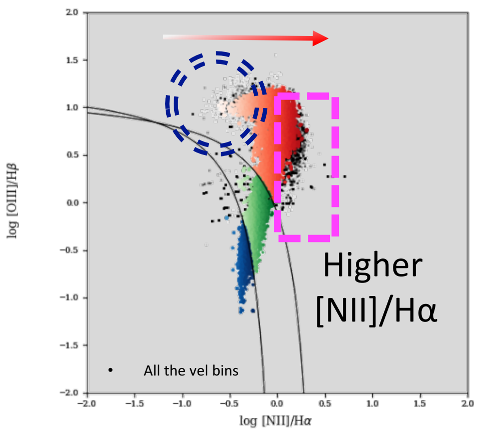

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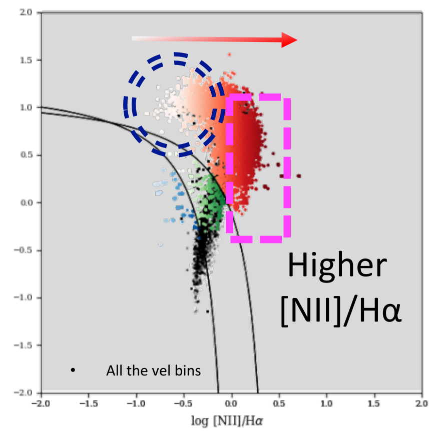

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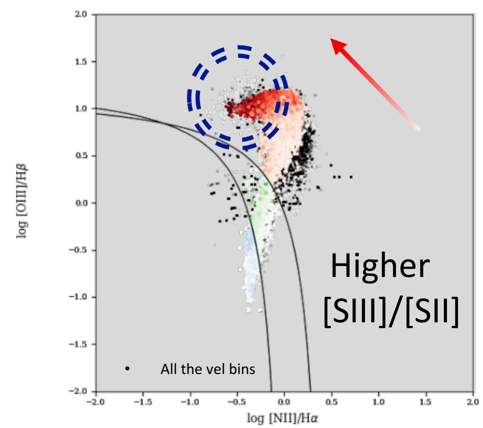

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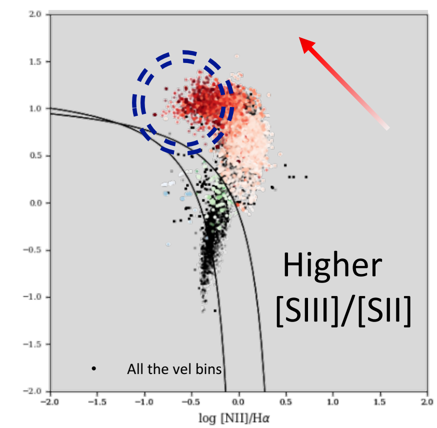

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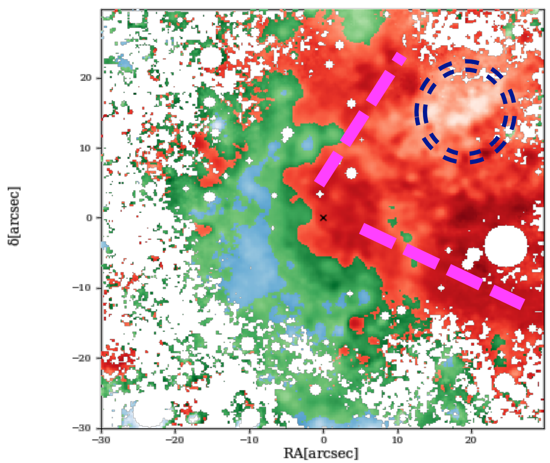

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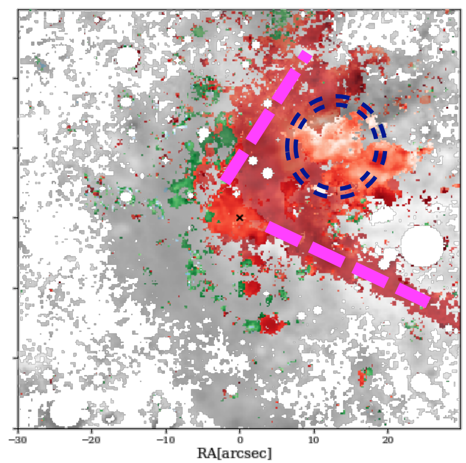

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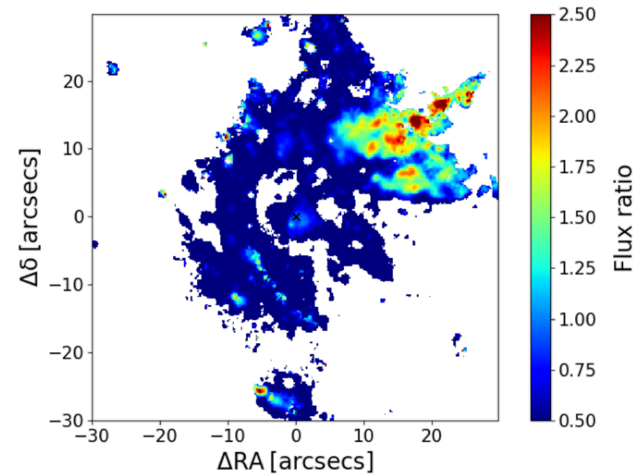

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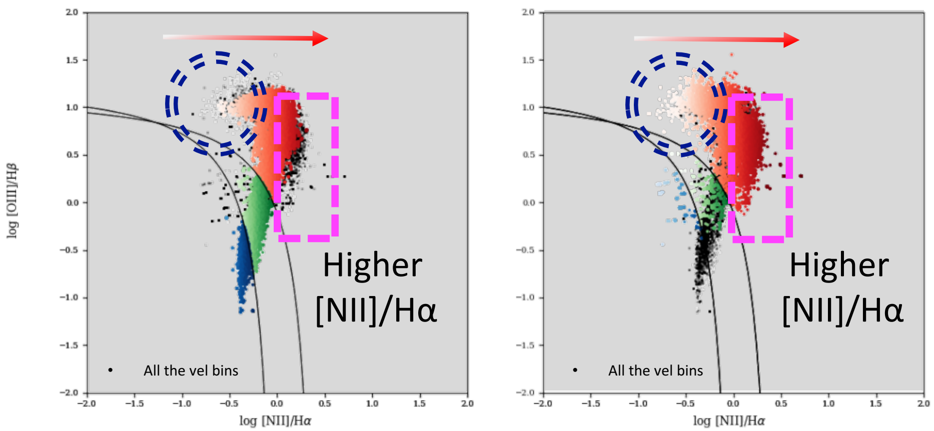
Disk **Outflow**



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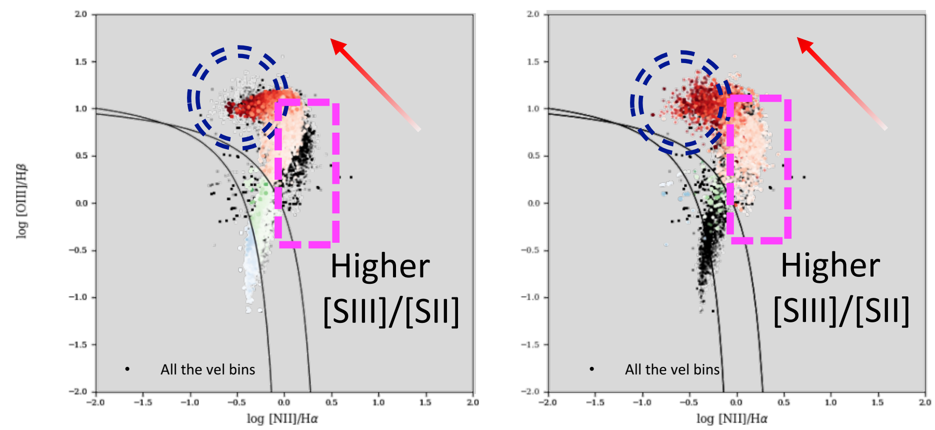

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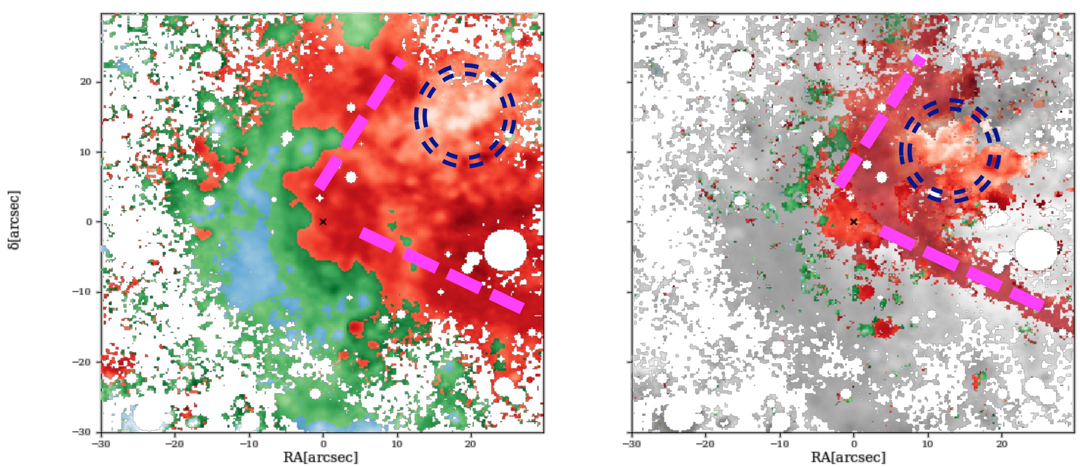

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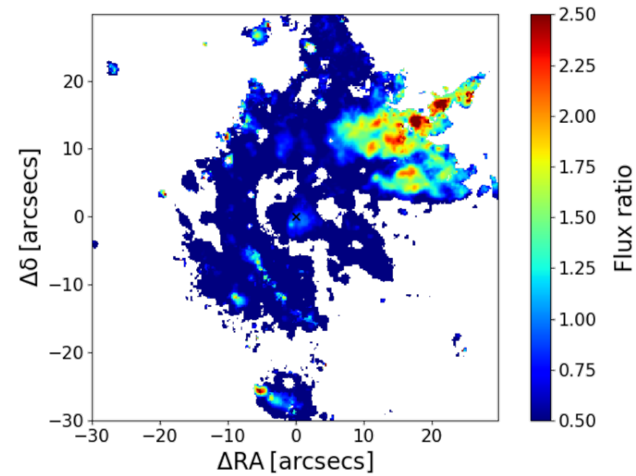
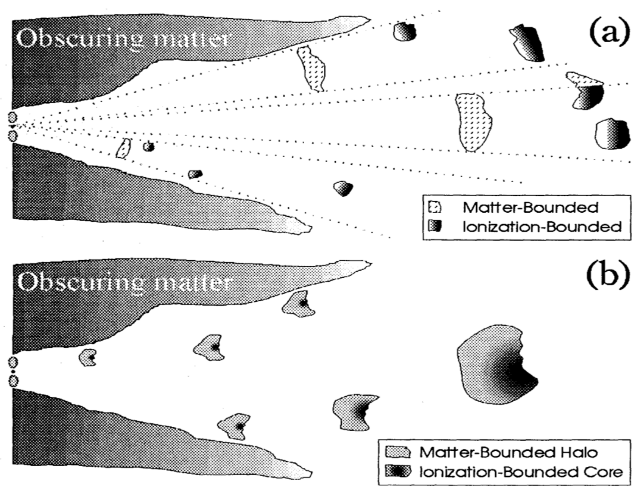


Matter and ionization bounded clouds

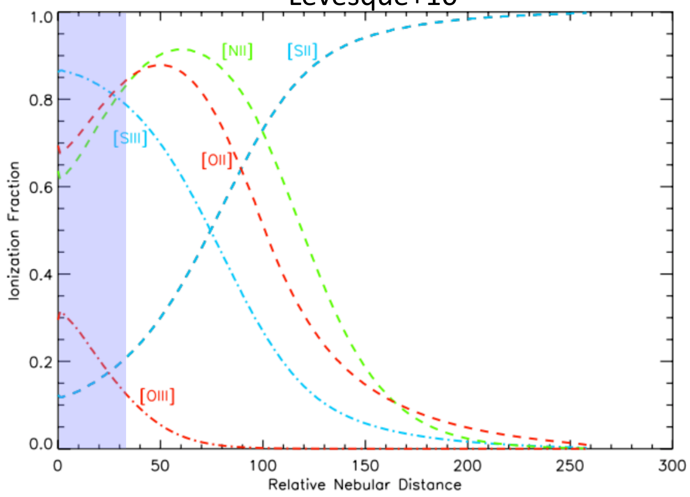
Matter bounded clouds (MB)

geometrically smaller than the depth needed to absorb all ionizing photons

Binette+96



Levesque+10



e.g. Thin (hot) halo surrounding a dense cloud core, the **ionization bounded cloud (IB)**

- Ionizing spectrum impinges to the **MB** clouds : high-ionization lines
- Radiation field incident to **IB** is filtered : low-ionization lines

Sequence parameterized by $\boldsymbol{A_{M/I}}$

the solid angle ratio of the MB clouds to the IB clouds

higher $\boldsymbol{A_{M/I}}$ *means higher contribution of MB clouds*

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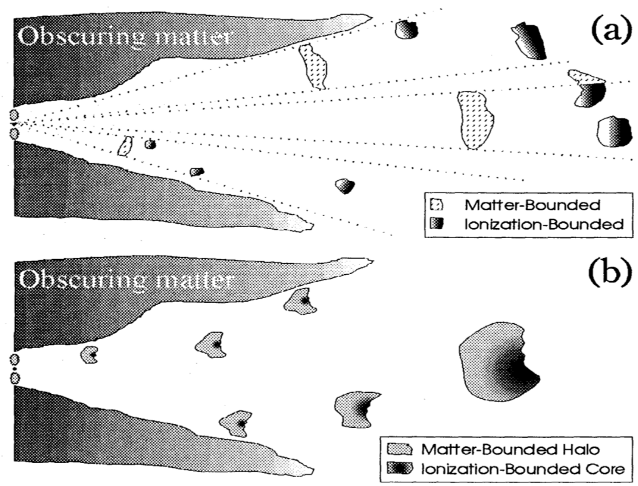

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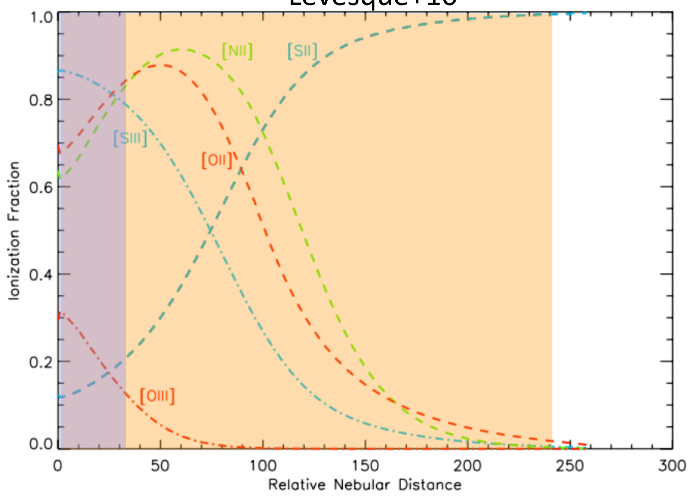

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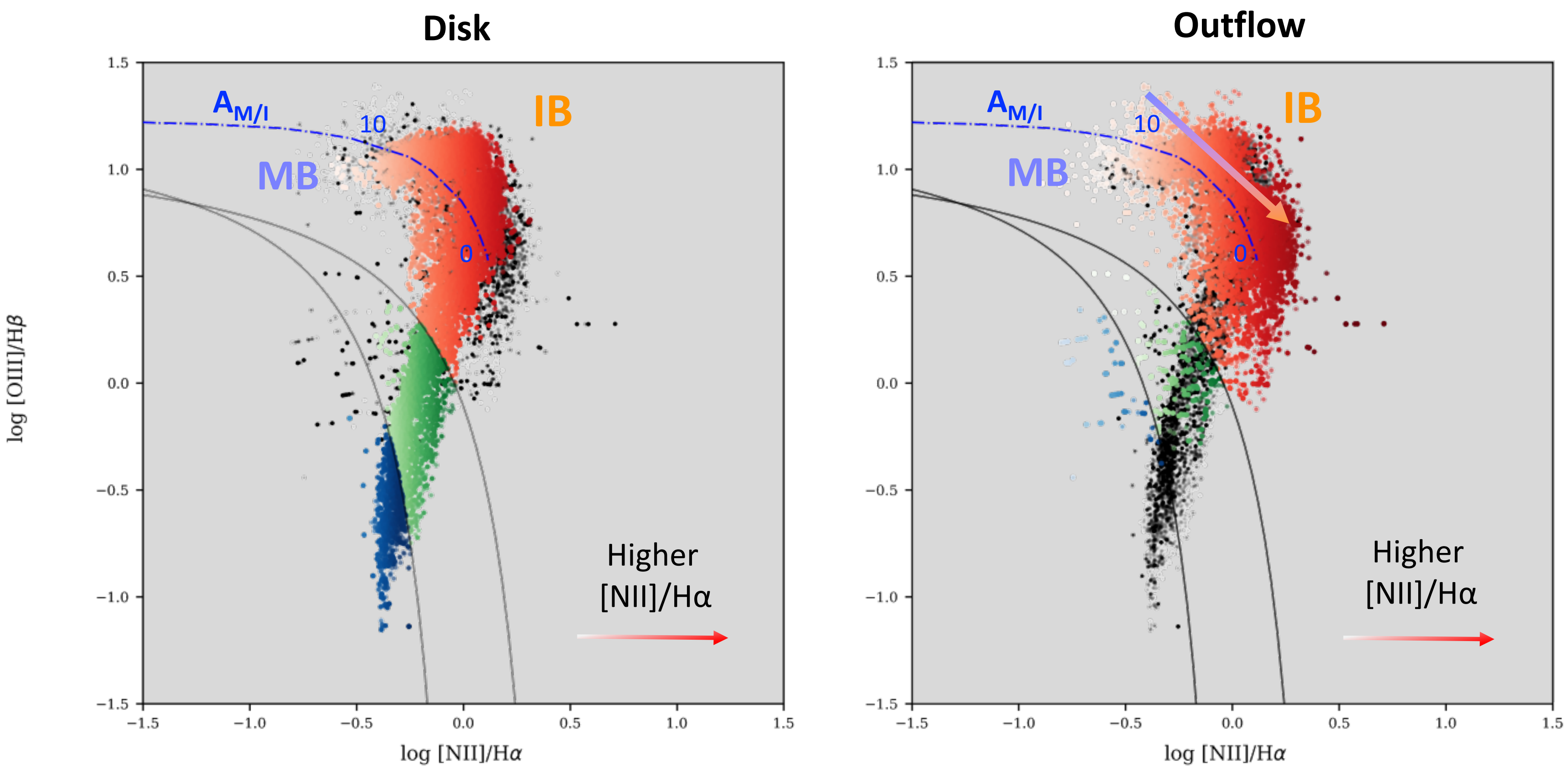
MB component : responsible for most of the [OIII] and [SIII] emission, coming from the outflowing material inside the cone



IB component : responsible for higher and higher [NII]/Hα (and also [SII]/Hα and [OI]/Hα)

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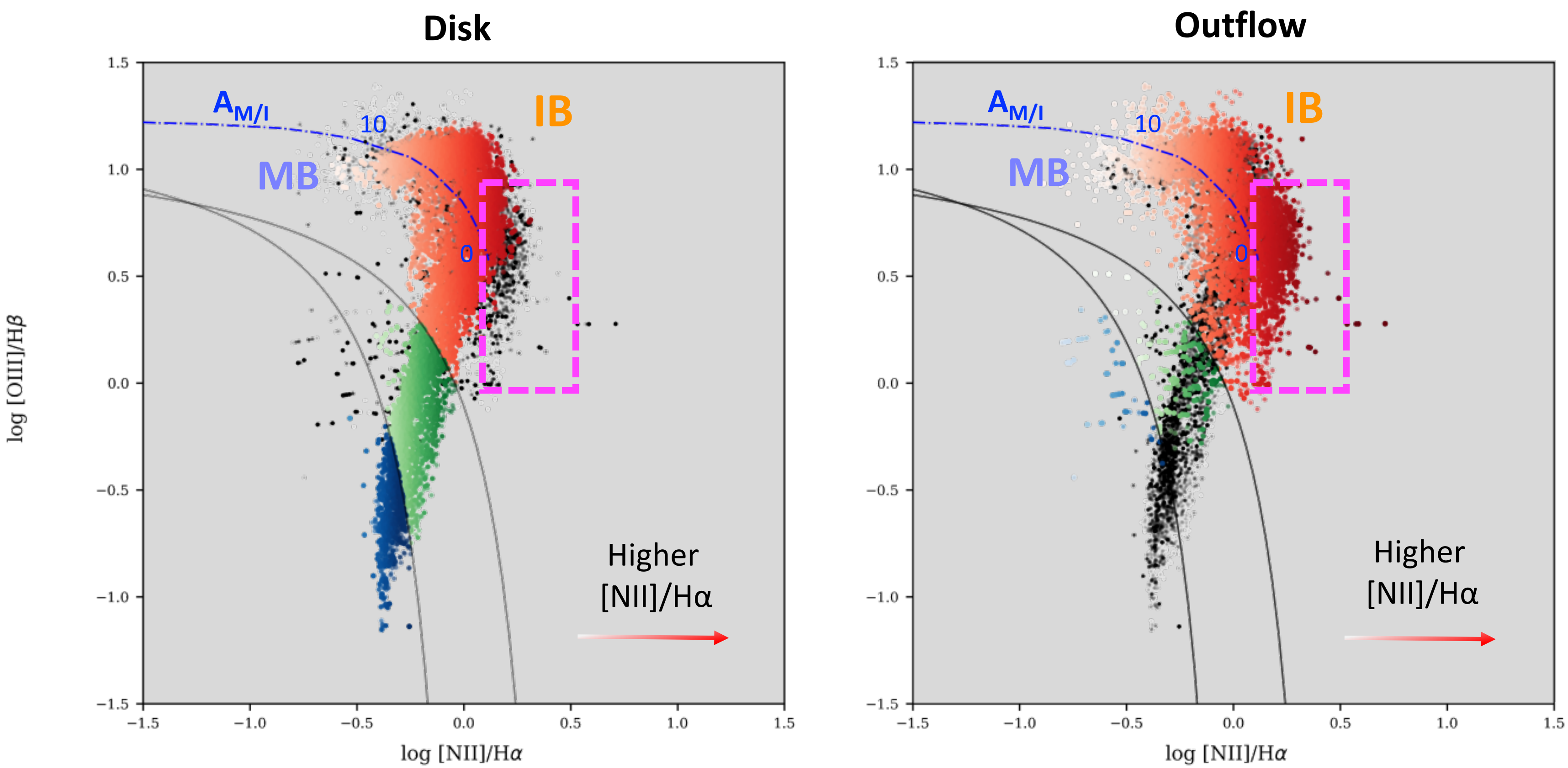

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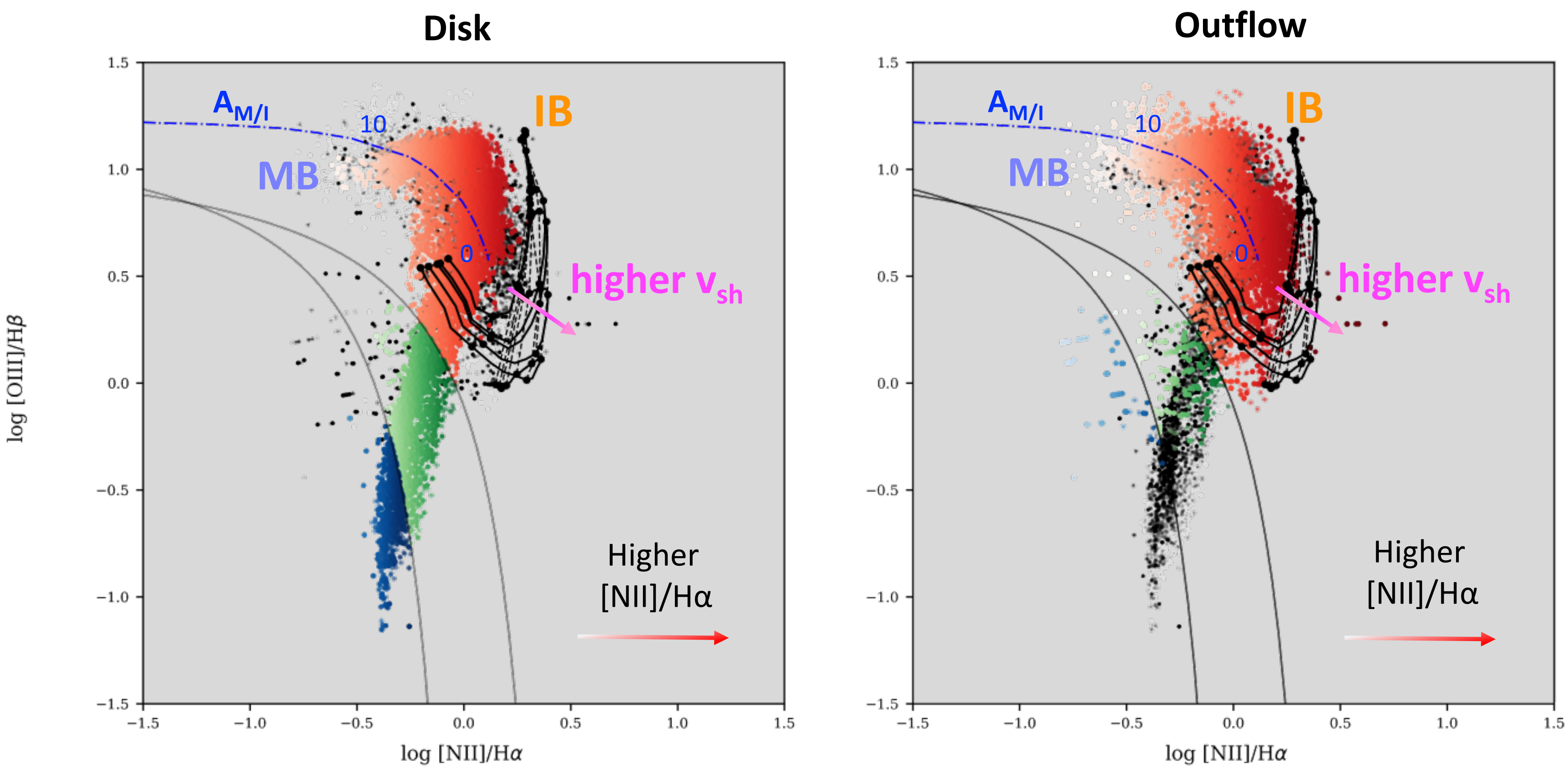
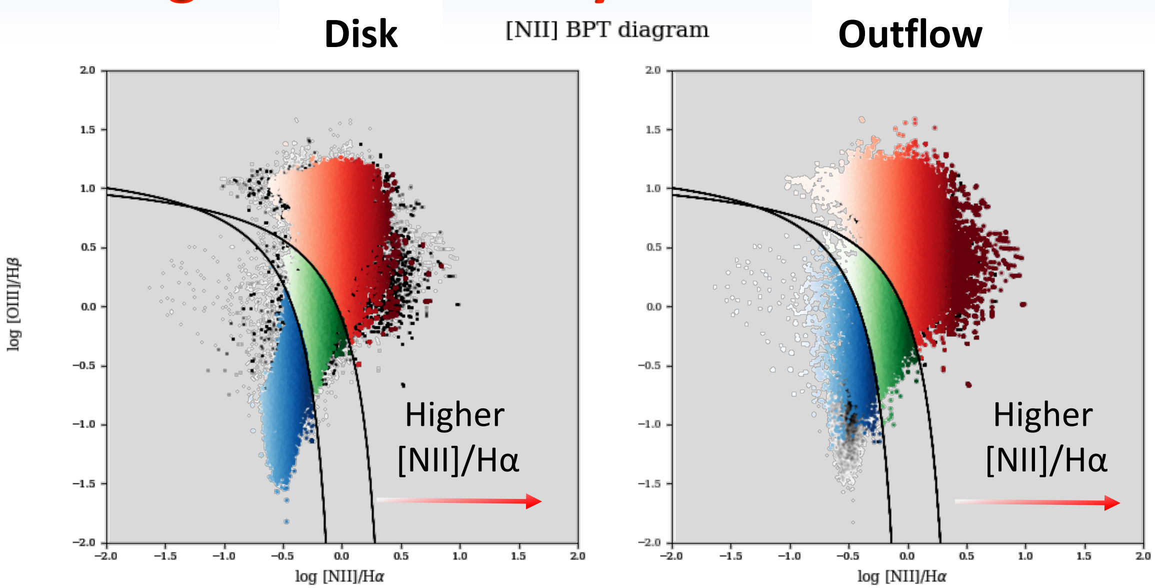
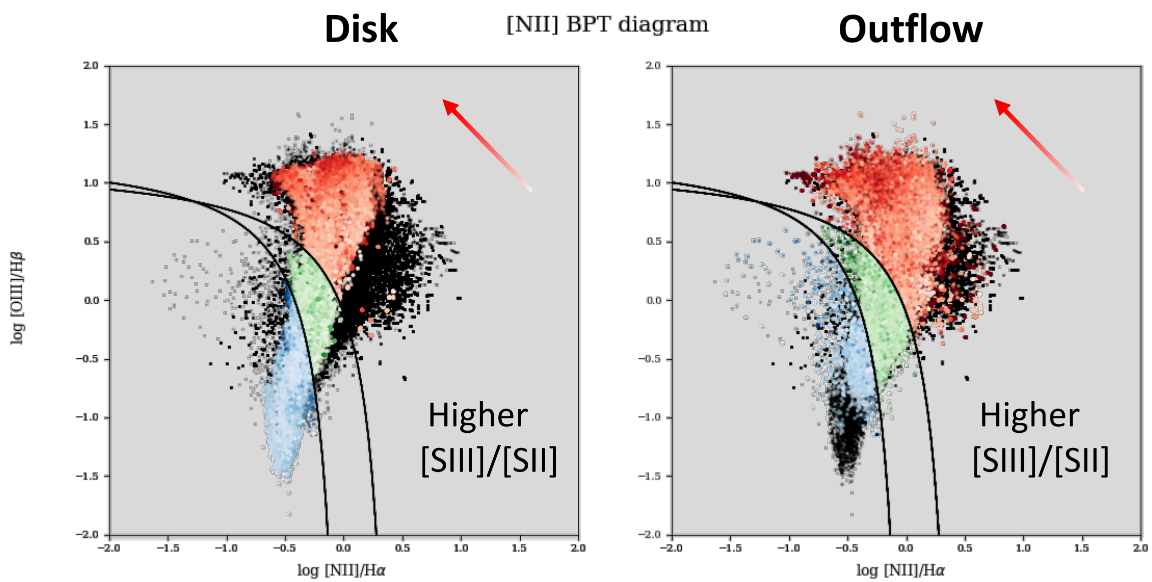


Shock models (Mappings III - Allen 2008) – n = 100 cm^{-3}

responsible for the highest [NII]/Hα

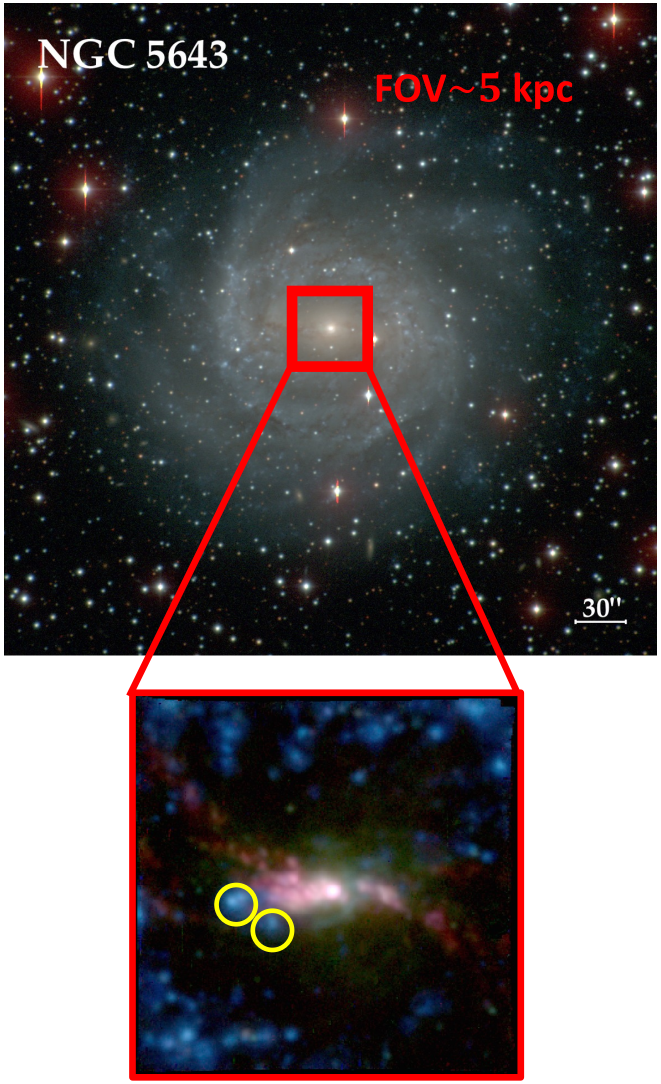
MAGNUM galaxies: velocity resolved [NII] BPT diagram



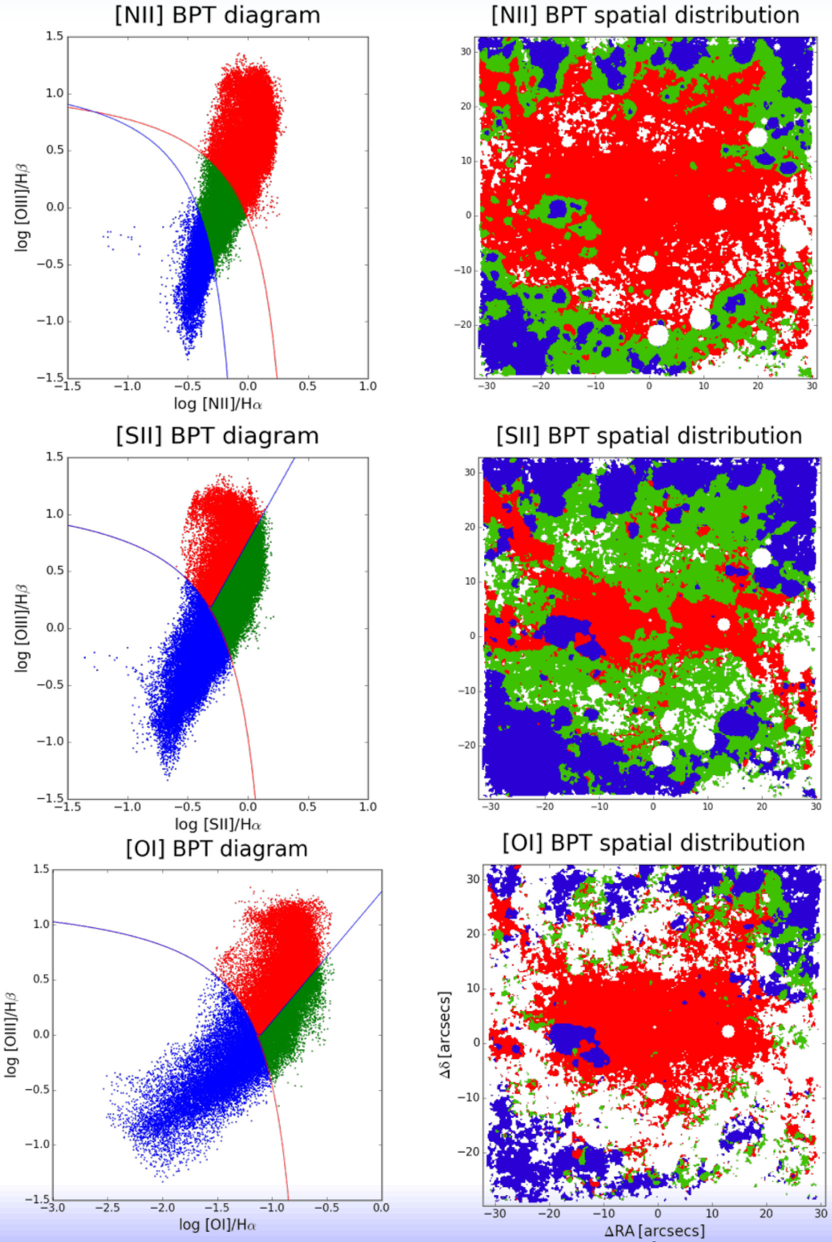


Nuclear outflow in NGC5643

Cresci+ 15b



[NII] – Hα – [OIII]



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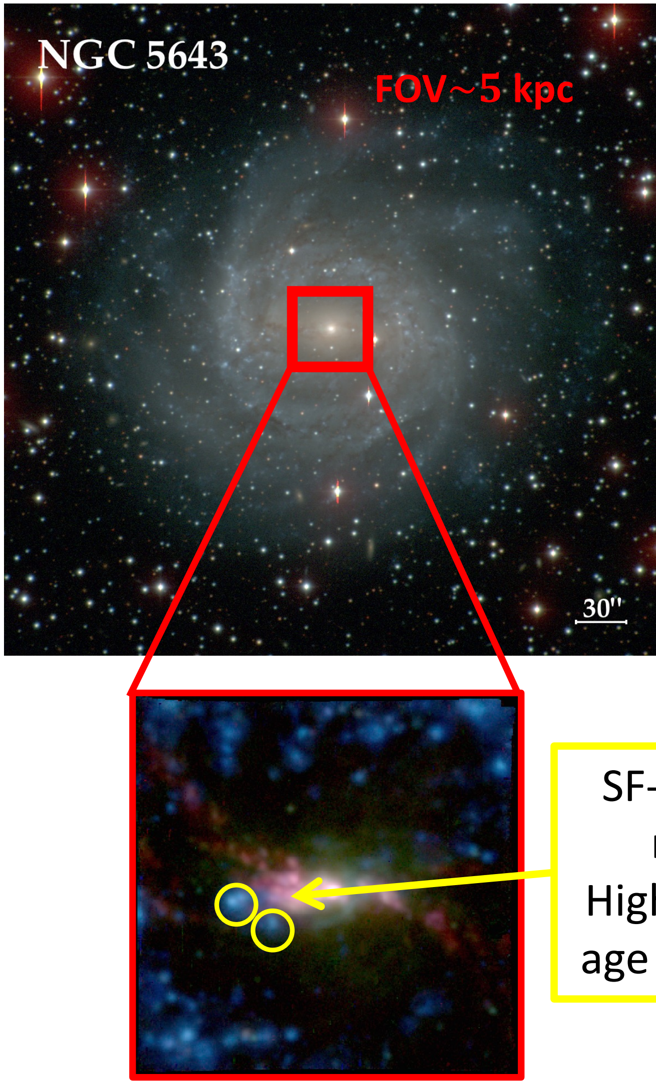
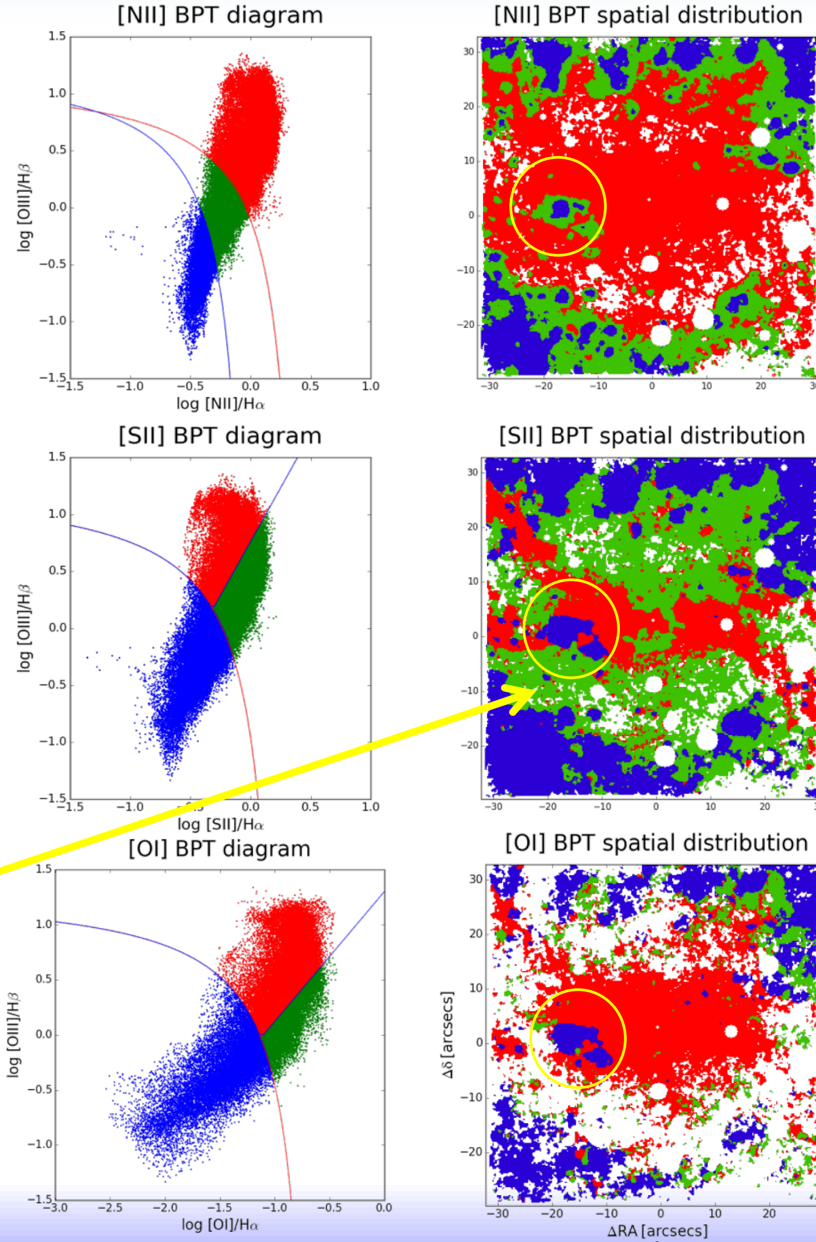


[NII] – Hα – [OIII]

SF-like line ratios
High Hα EW,
age $\sim 10^7$ yr

Cresci+ 15b



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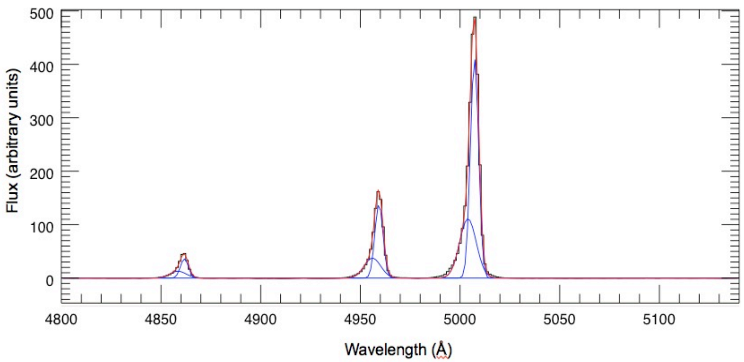
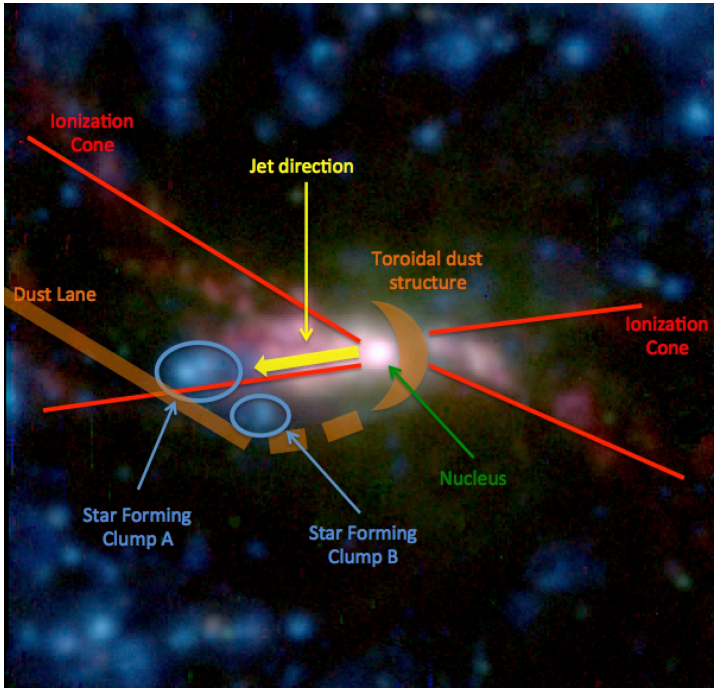
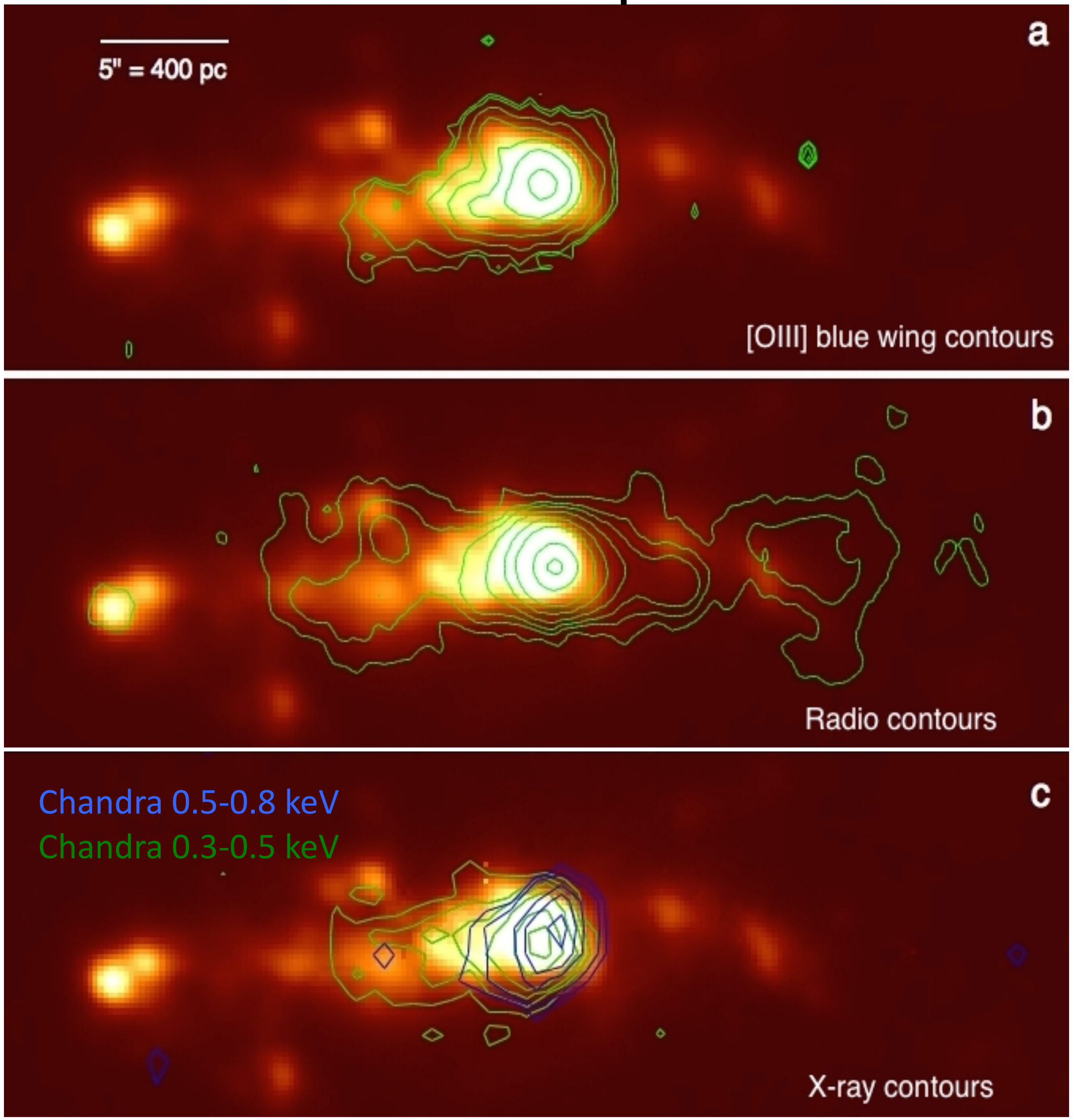


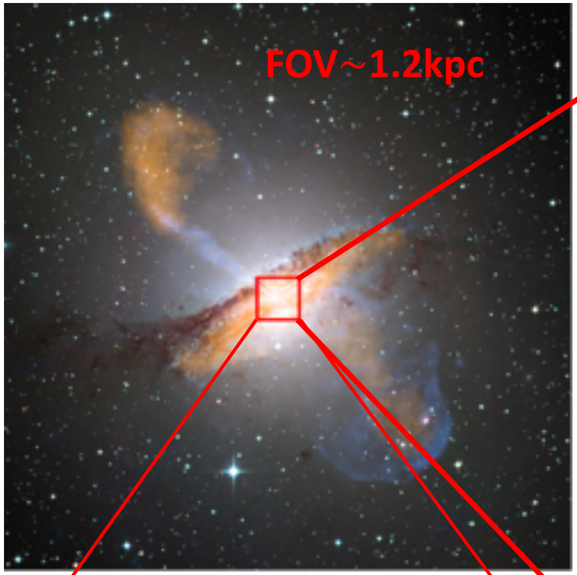


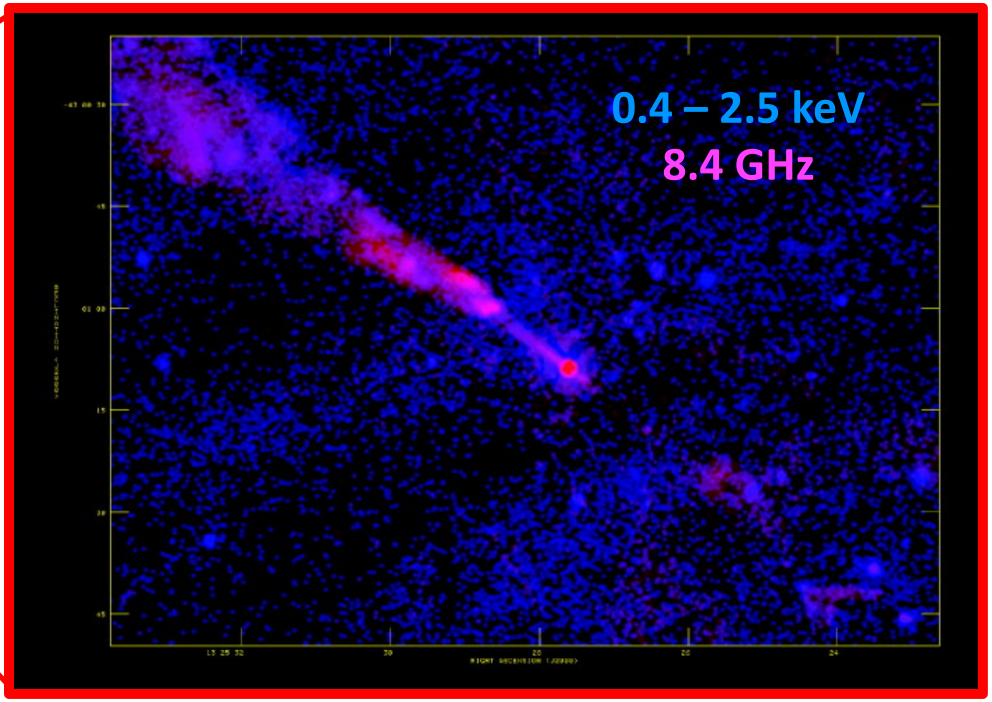
Hα maps



Cresci+ 15b

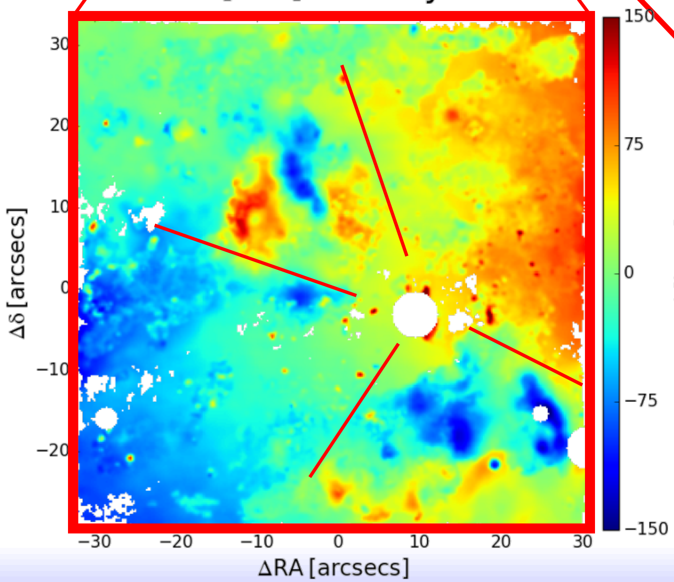
Nuclear outflow in Centaurus A





Hardcastle+2003

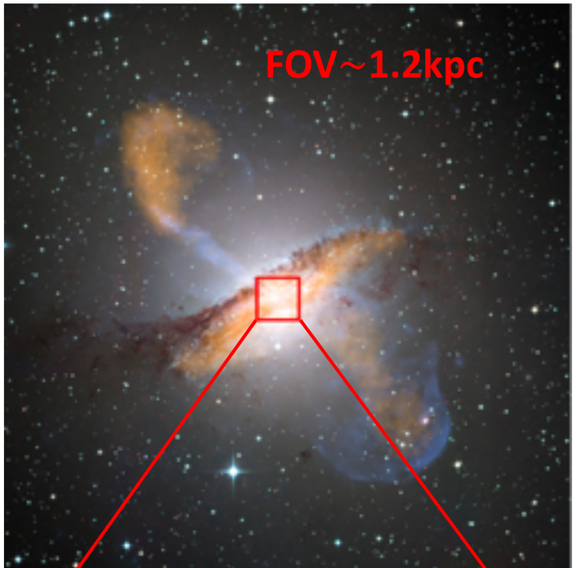
[OIII] velocity

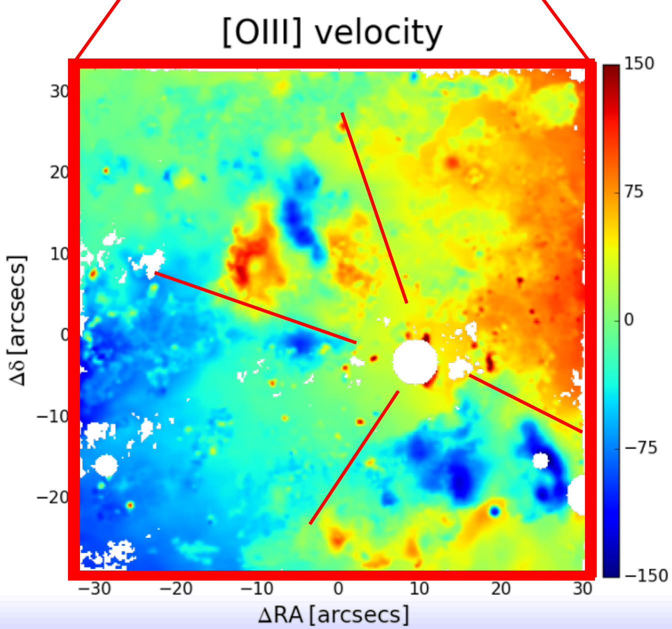


<u>From the [OIII] velocity map</u>:

Bi-conical nuclear outflow corresponding to the X-ray and radio emission of the jet

Positive feedback in Centaurus A?





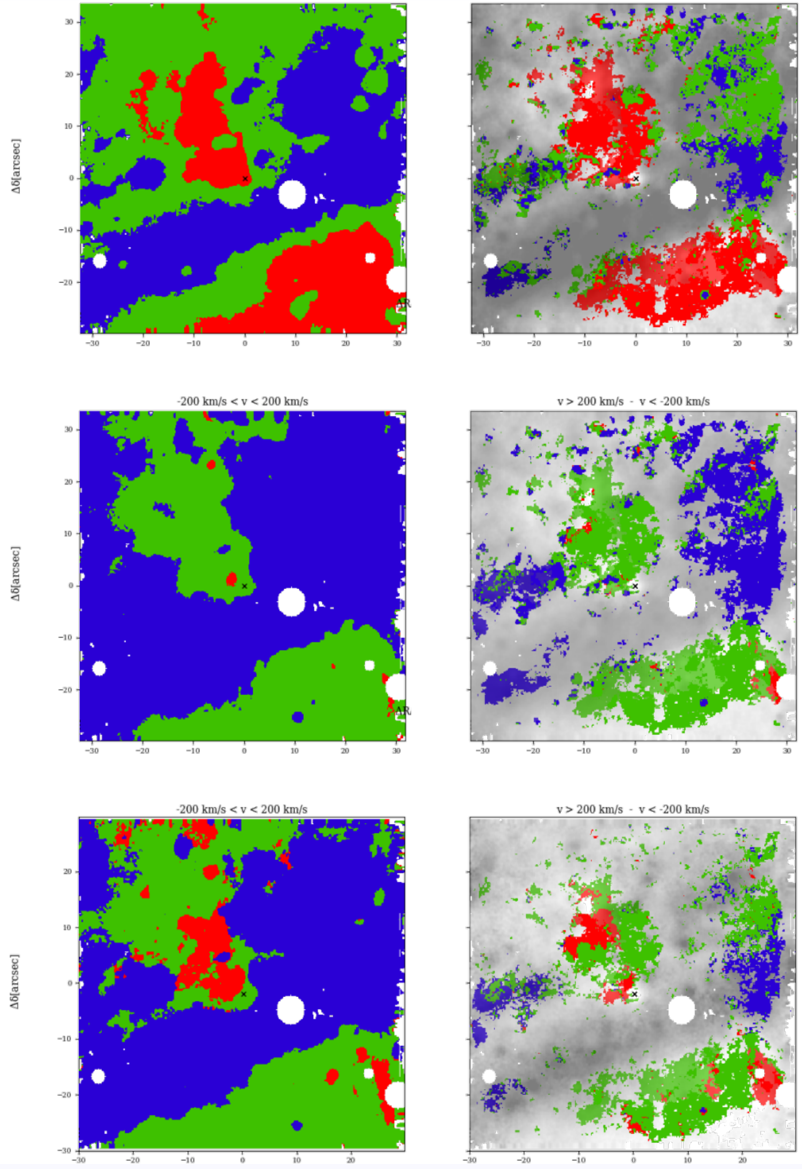
Disk

Outflow

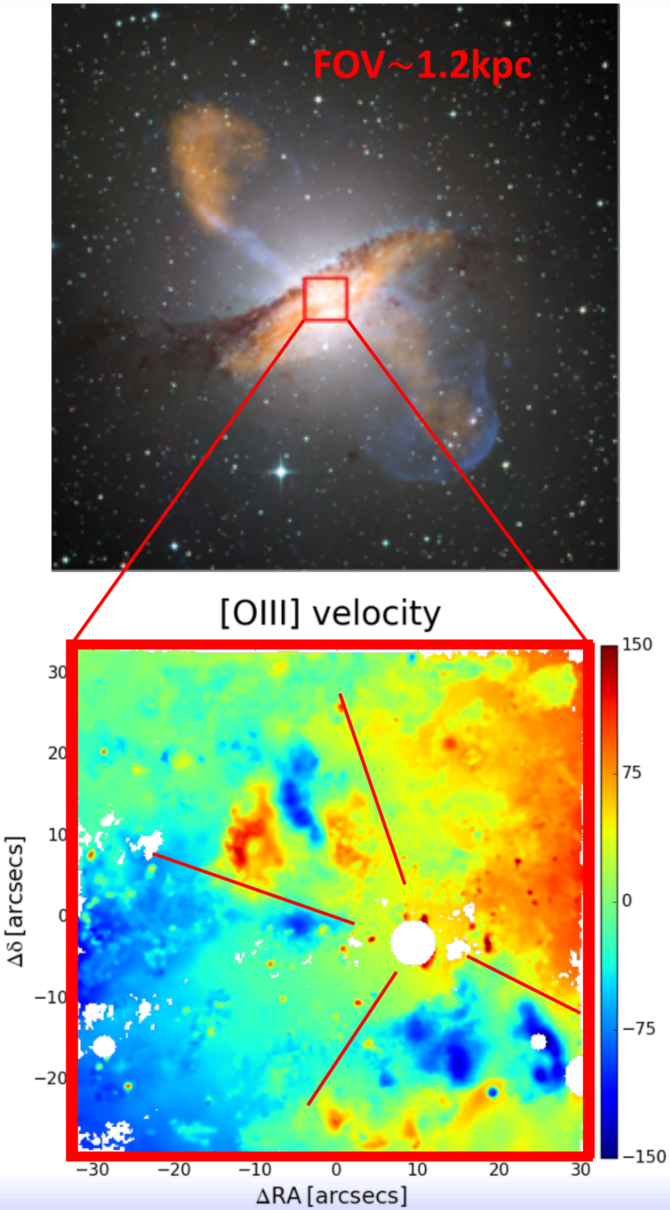
BPT [NII]

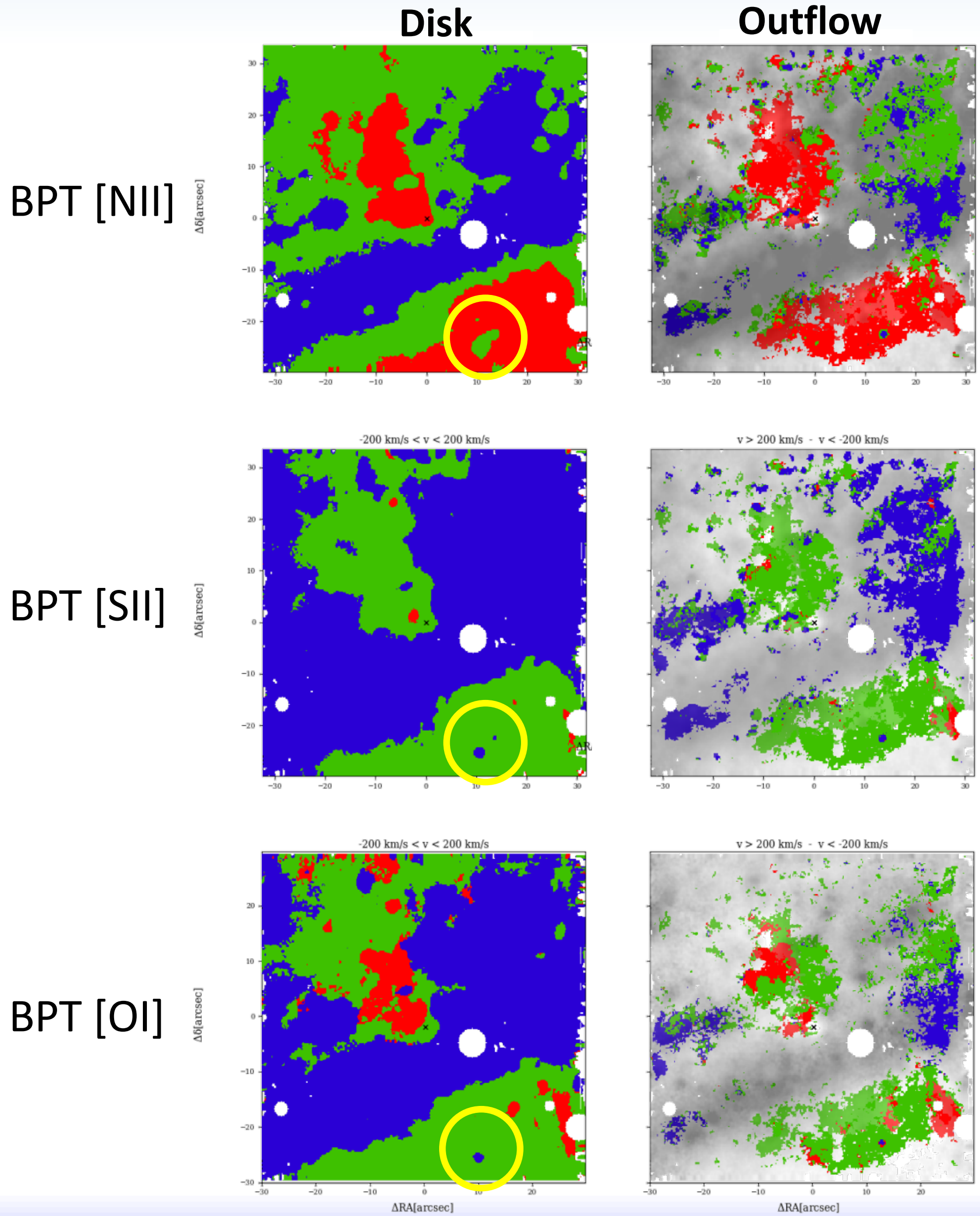
BPT [SII]

BPT [OI]

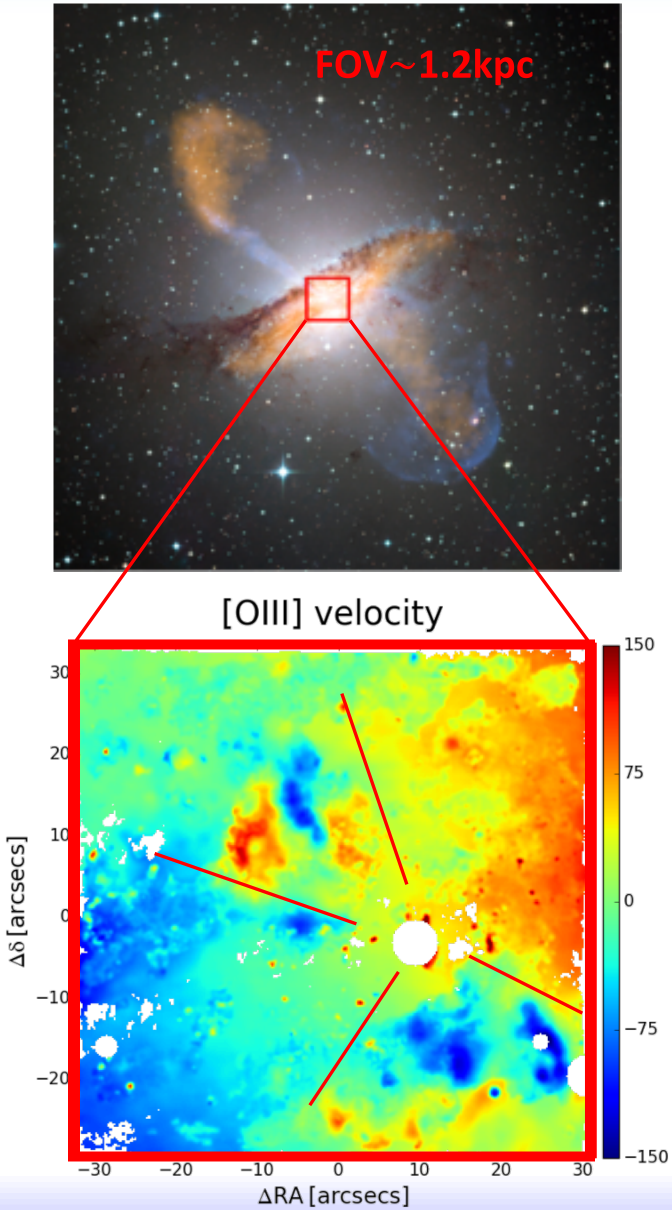


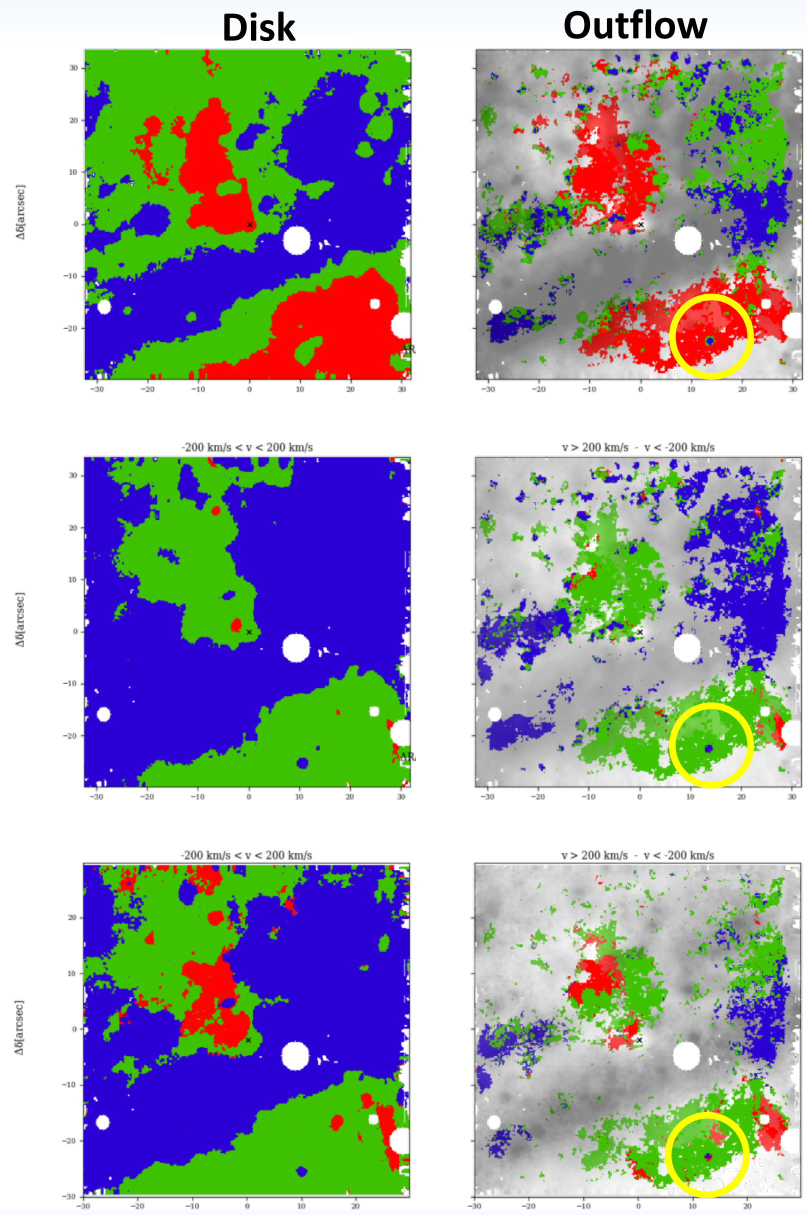
Positive feedback in Centaurus A?



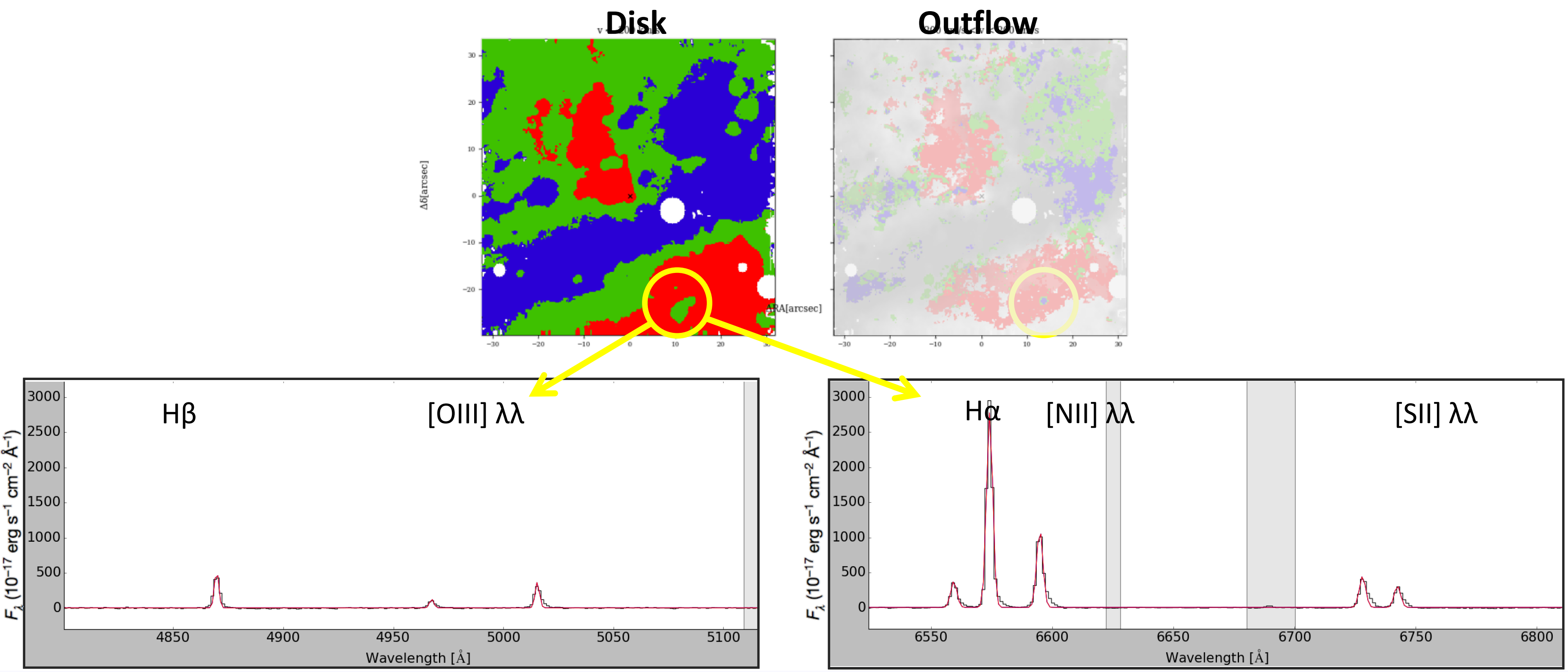


Positive feedback in Centaurus A?

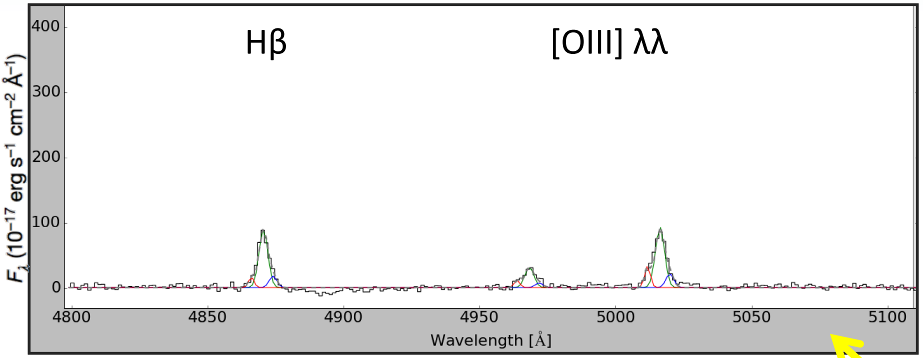


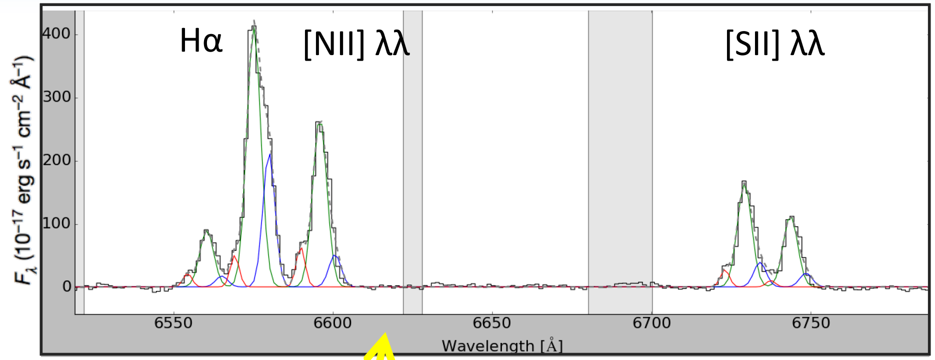


Positive feedback in Centaurus A?

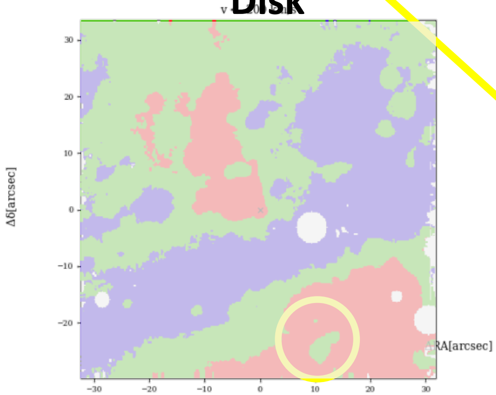


Positive feedback in Centaurus A?

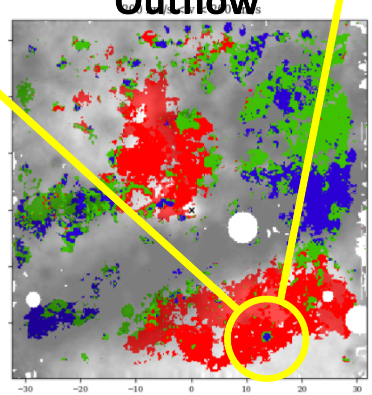




Disk

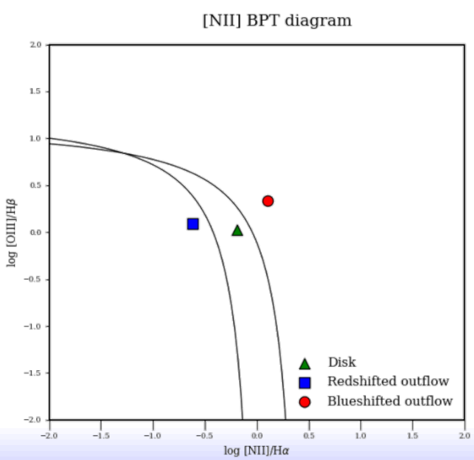


Outflow

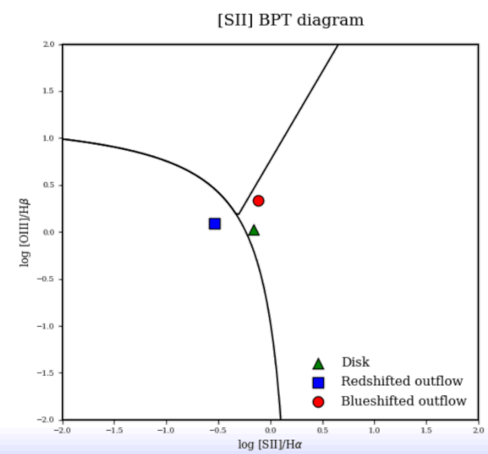


The **disk** and the **blueshifted component** are **higher** for **[NII]**, **[SII]** and **[OIII]**

Hα has an **enhanced redshifted component** with respect to [NII], [SII] and [OIII]

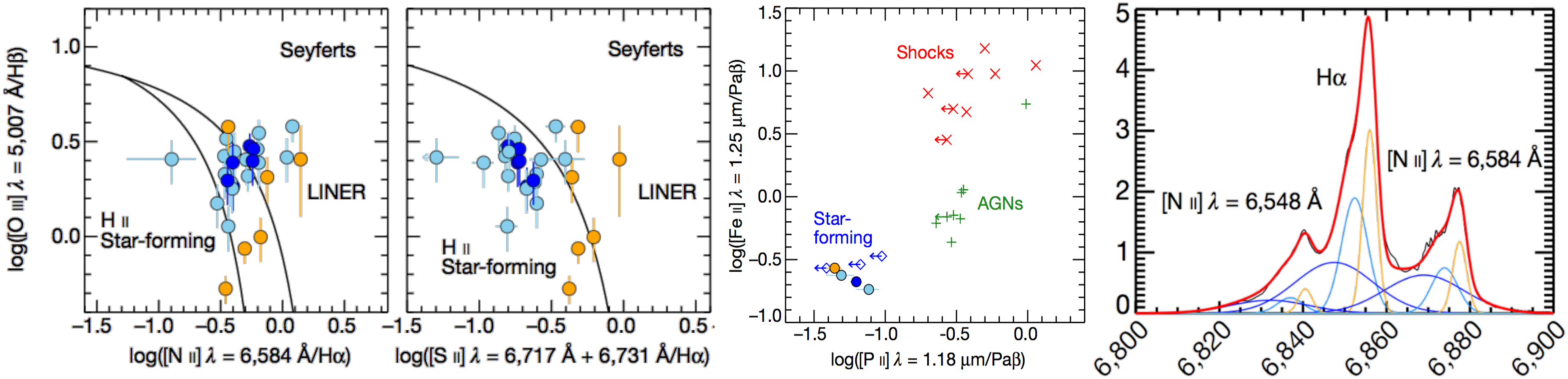


→ **BPT diagrams for each component**



Similar to SF inside the outflow in IRAS F2318-5919

- Outflow is traced by nebular components, located in the SF locus of the BPT diagrams



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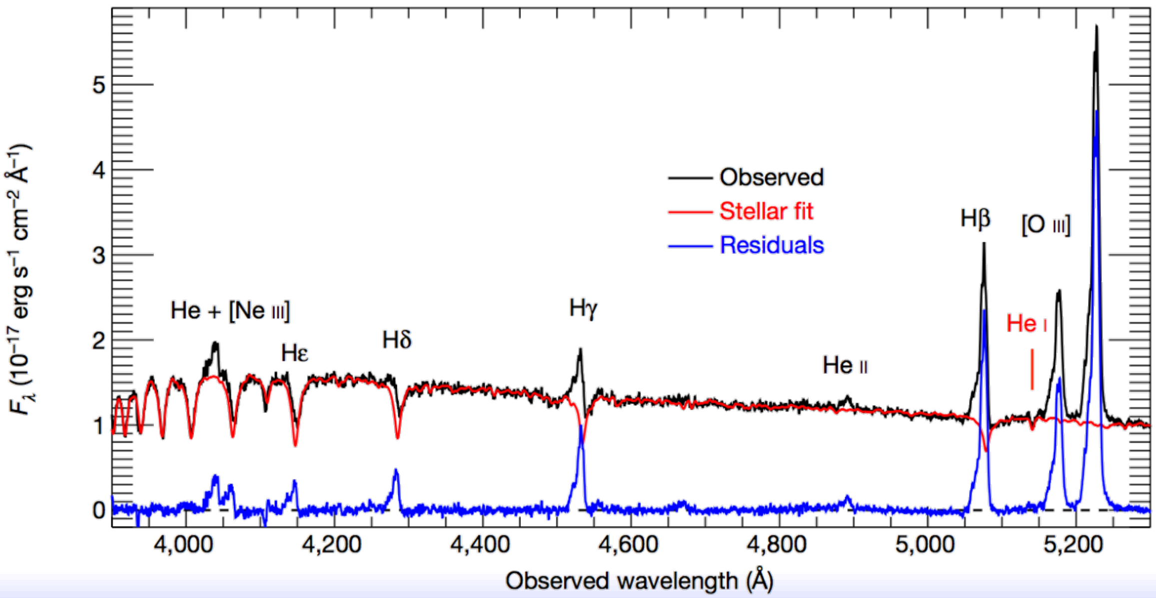

- Outflow inconsistent with shock excitation or with AGN photoionization ([FeII]λ=1.25μm/Paβ diagram)
- Velocity of the stellar features in the outflow are blueshifted too

Summary

MUSE data of **nearby AGN** provide **huge amount of information** on the **physics of the nuclear regions of galaxies**:

- Infer different ionization conditions in the central region of galaxies (resolved BPT)
- Understand the ionizing structure of the outflow (velocity resolved BPT)
- Investigate the relation between AGN and SF (positive feedback in NGC5643 and CenA?)
- Detailed kinematic study of outflow structure in the ionization cone *see G. Venturi talk*

Work in progress

- Cloudy photoionization models to reproduce the observed velocity resolved BPT
- Investigate in details what's really happening in CenA (X-shooter proposal)