Star-formation driven galactic winds in UGC 10043

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Mineralnye Vody, Russia, September 25

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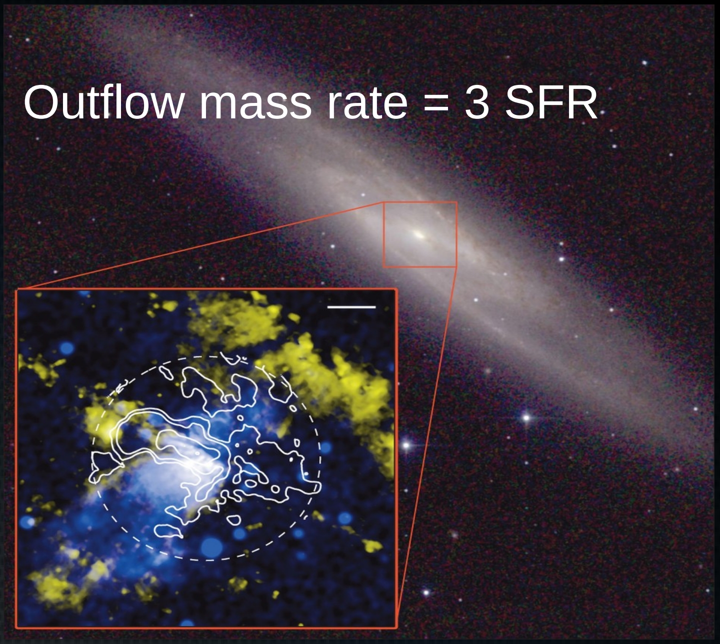
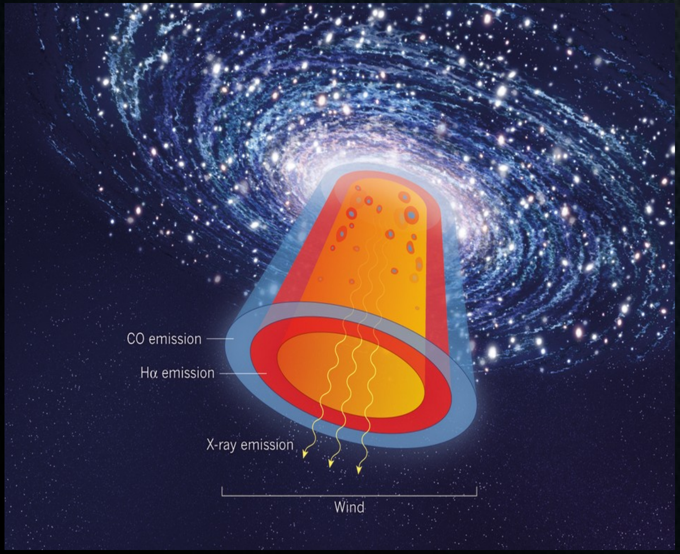
unam

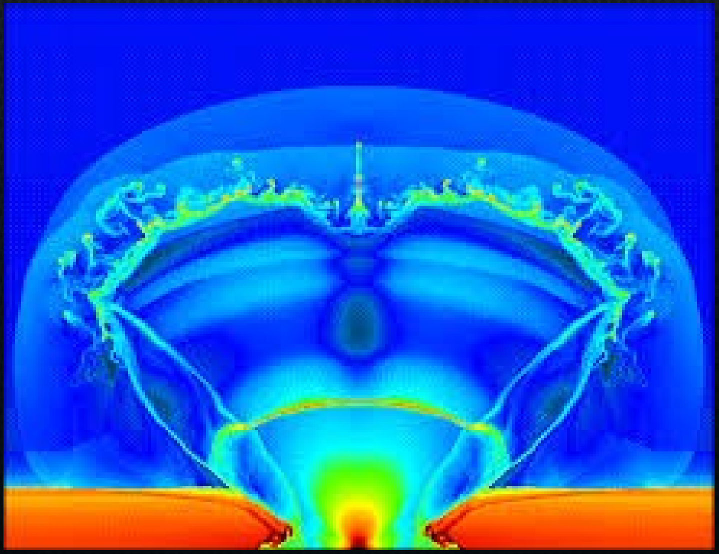
CALIFA Survey

Galactic winds

- Gas moving at different velocities ~ 1000 km s^{-1}
- Very commun at local universe and high redshift in galaxies with > 0.1 Msun yr^{-1} kpc^{-1}
- Driven by combination of SN explotions and stellar winds.
- Different phases: Hot (X-ray), warm (optical) and cold (CO).

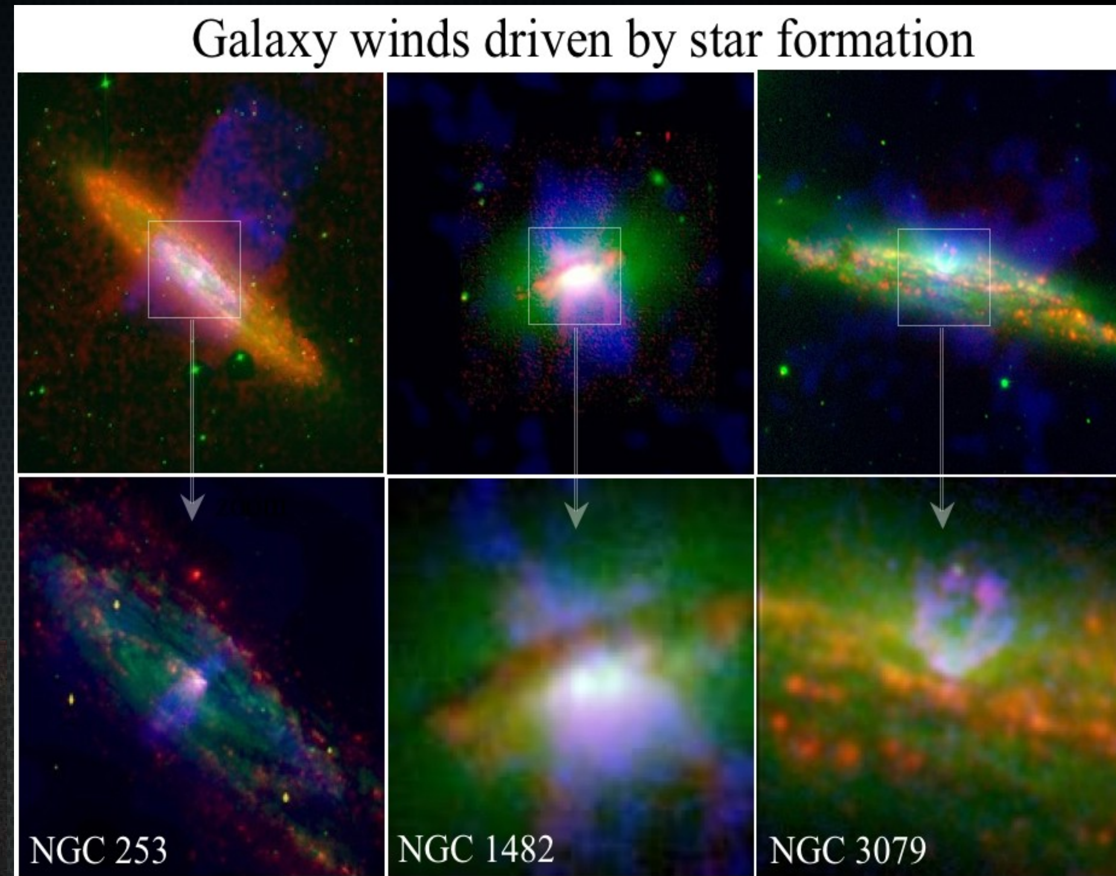


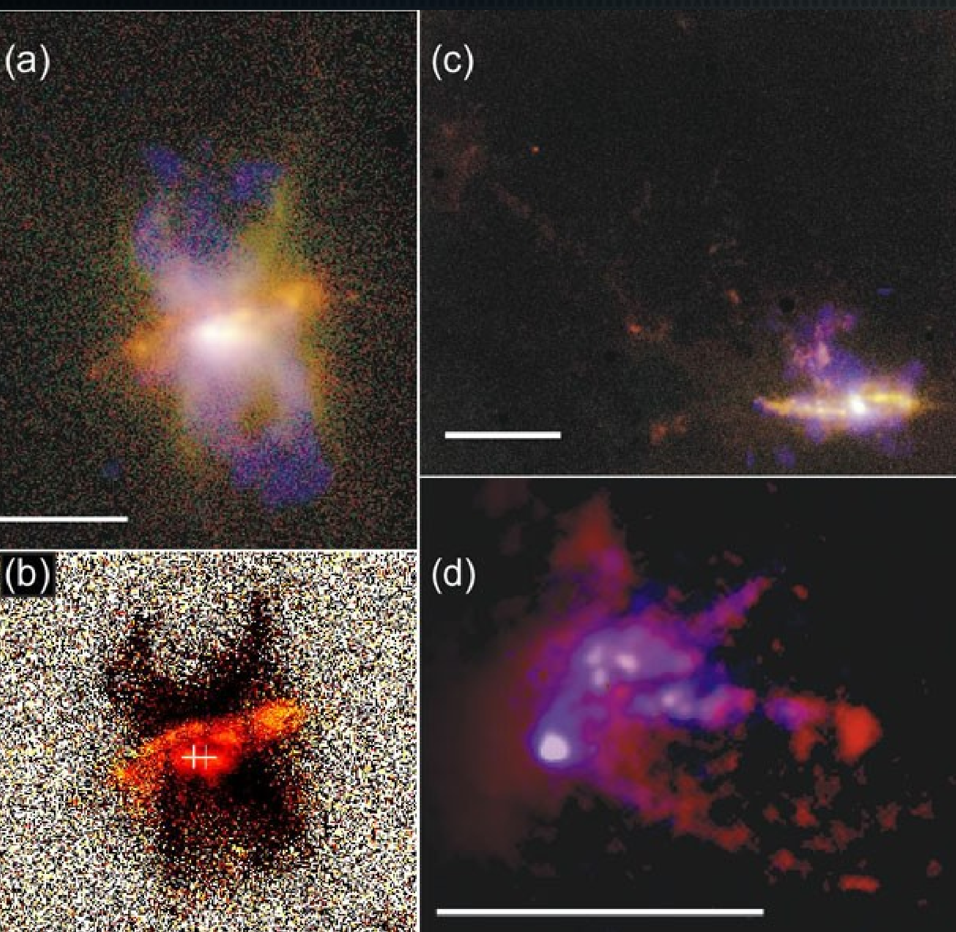


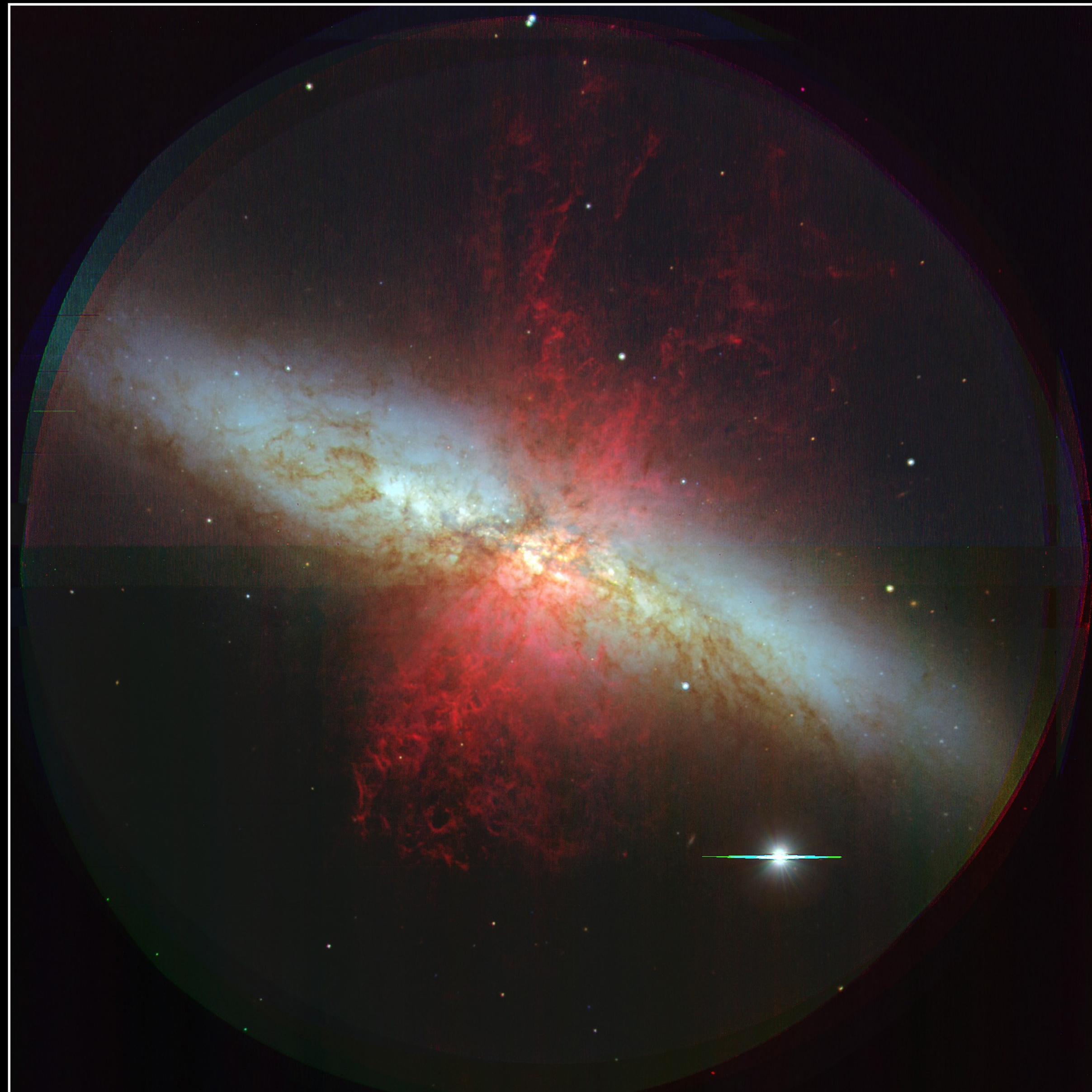


Morphologies

Biconical (or conical) structures collimated respect the minor axis





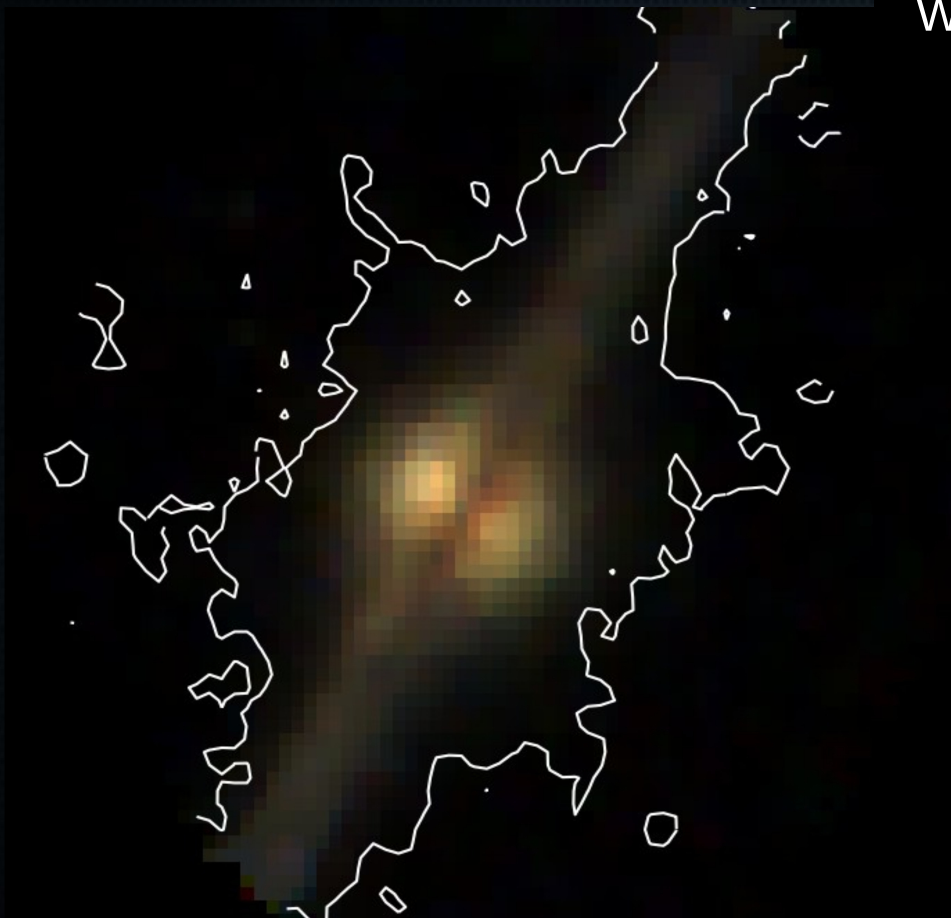


M 82 (NGC 3034) FOCAS (B, V, Hα)

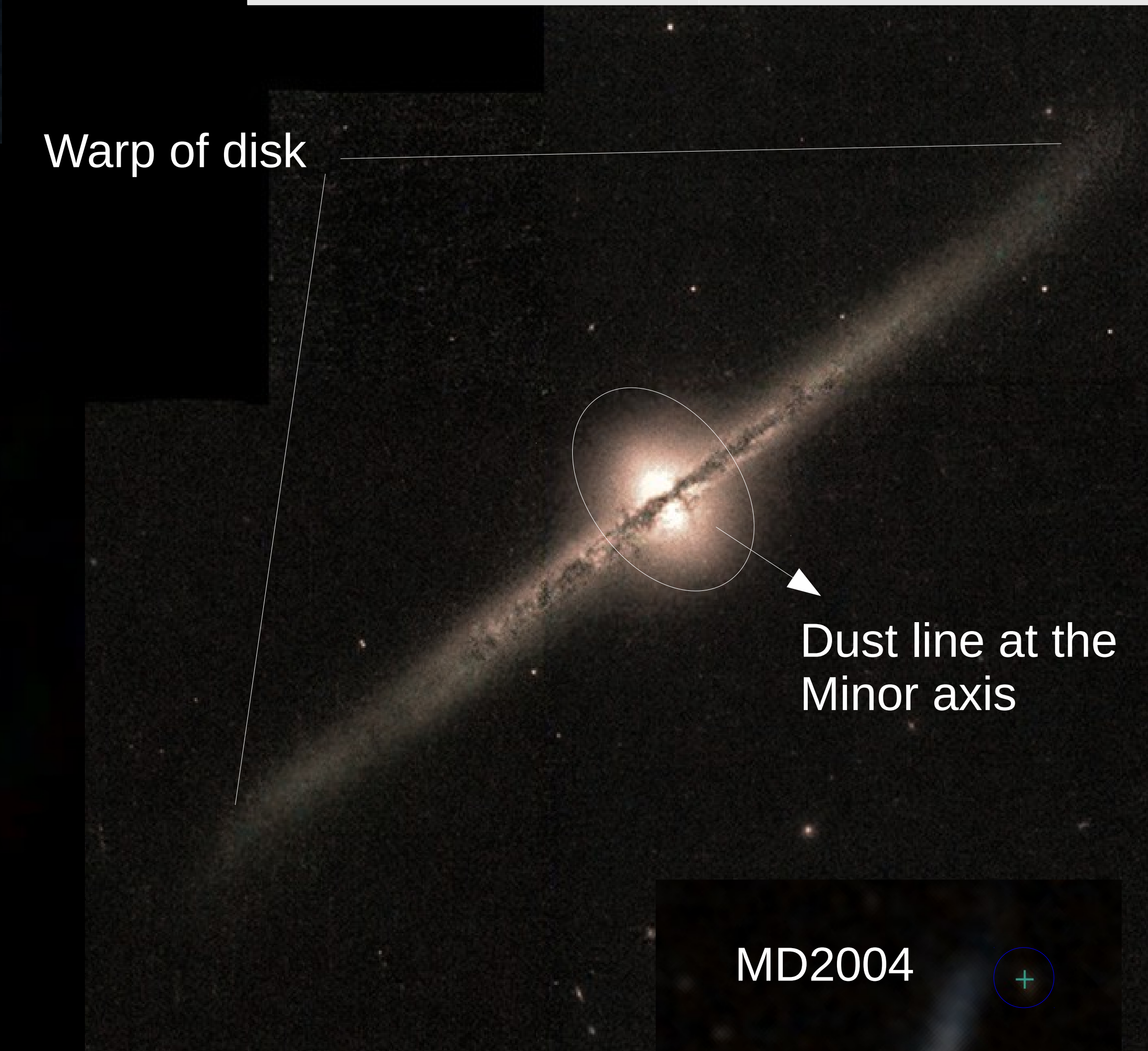
Subaru Telescope, National Astronomical Observatory of Japan March 24, 2000

UGC 10043

Log M/Msun	9.87
Type	Sbc
hz	395 pc

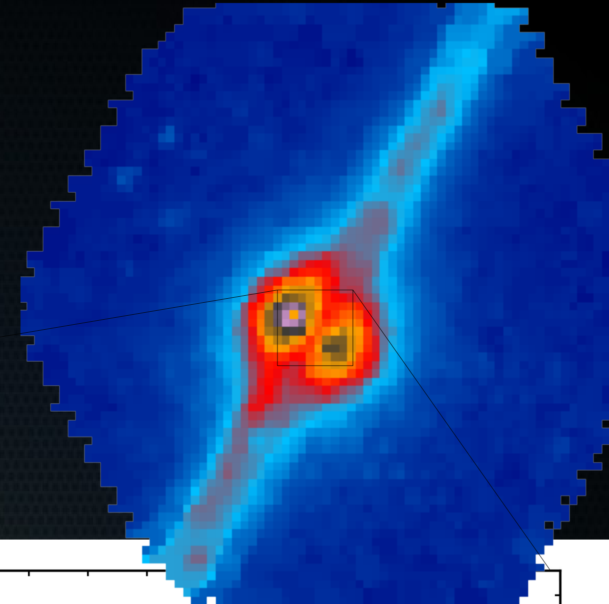


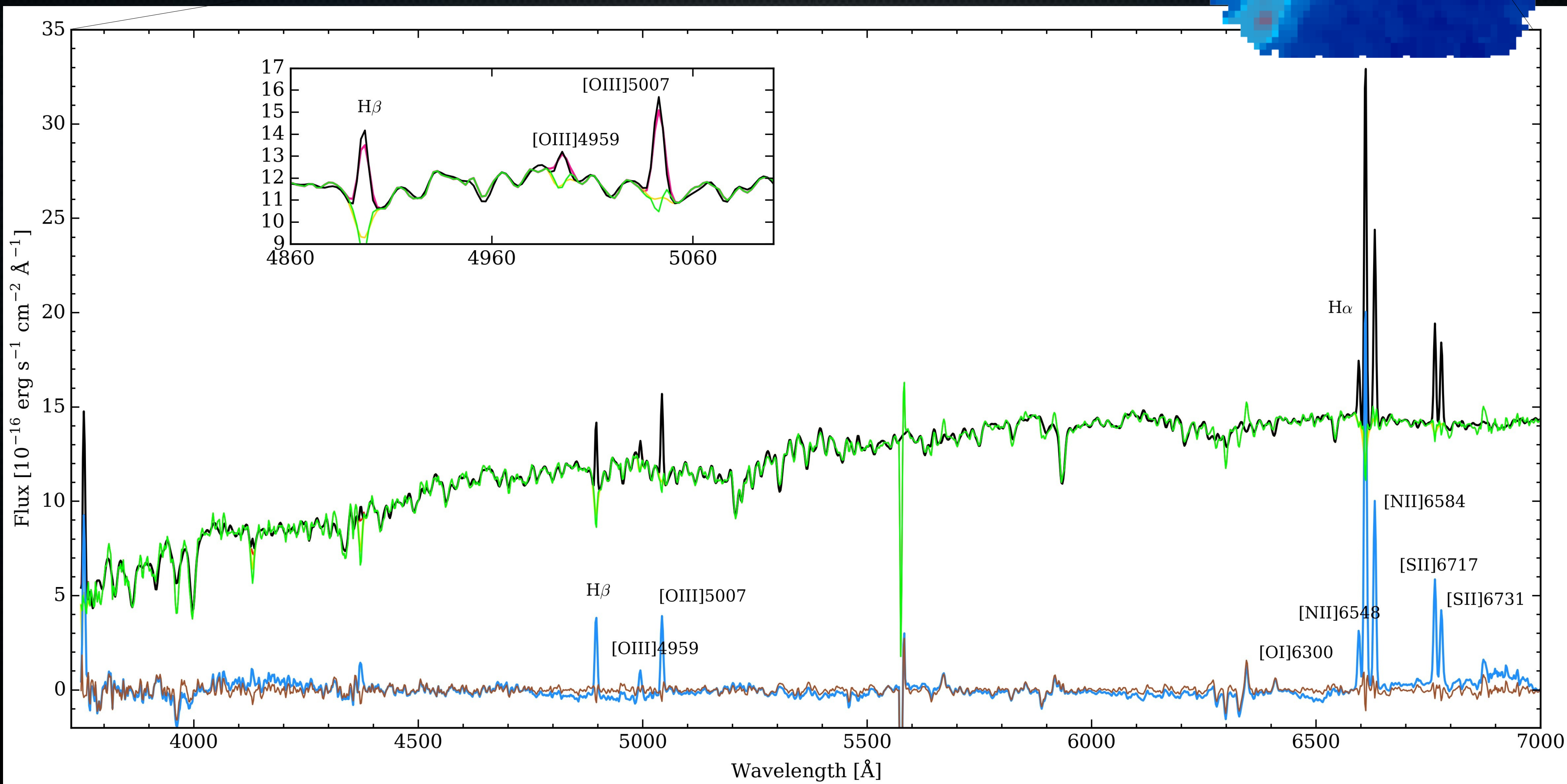
UGC 10043 at the CALIFA resolution



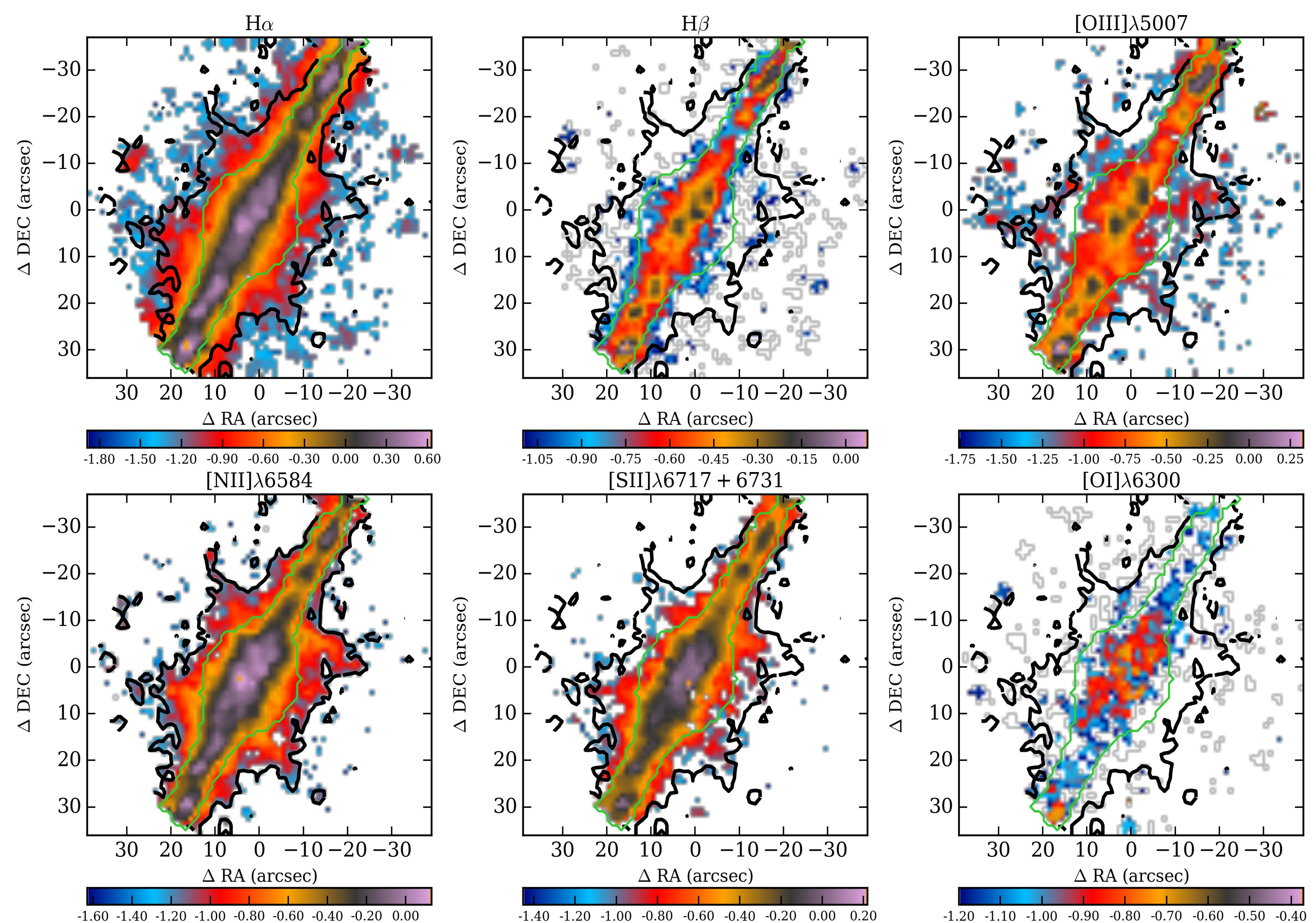
HST image

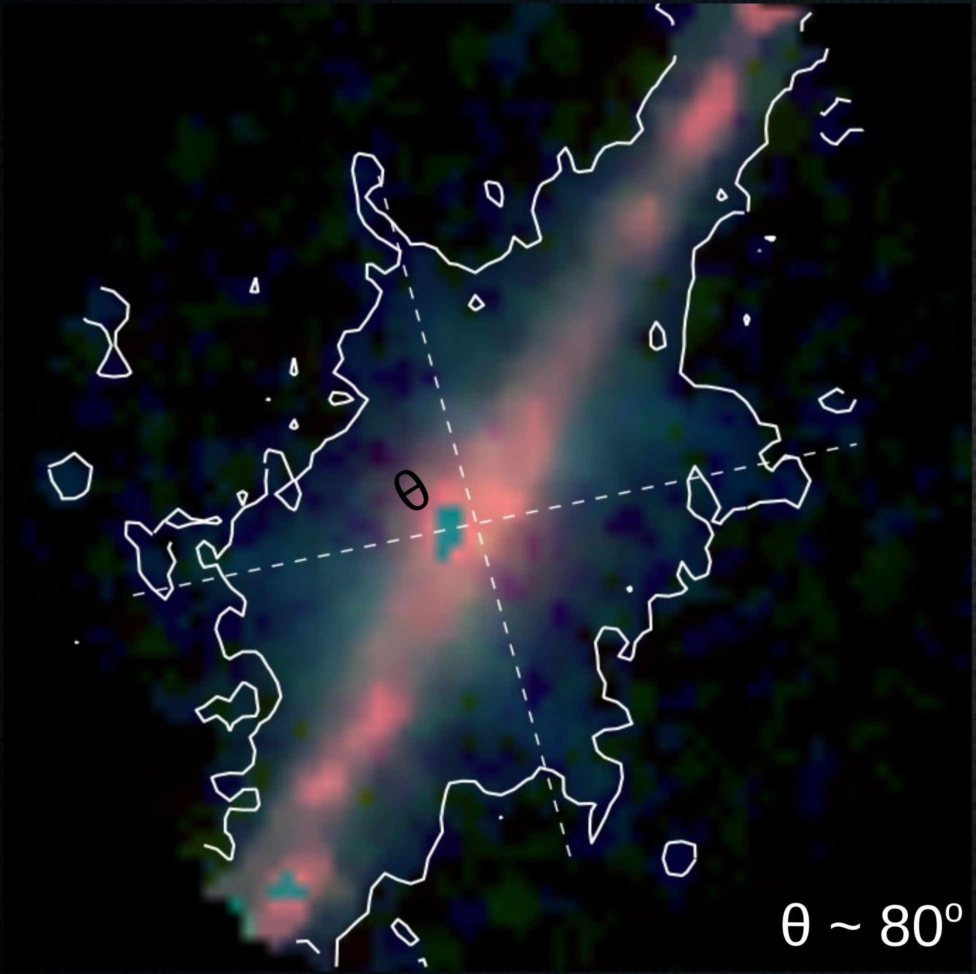
Decouple stellar population: FIT3D (Sanchez et al., 2016)





Detection of extraplanar emission in the ionized gas



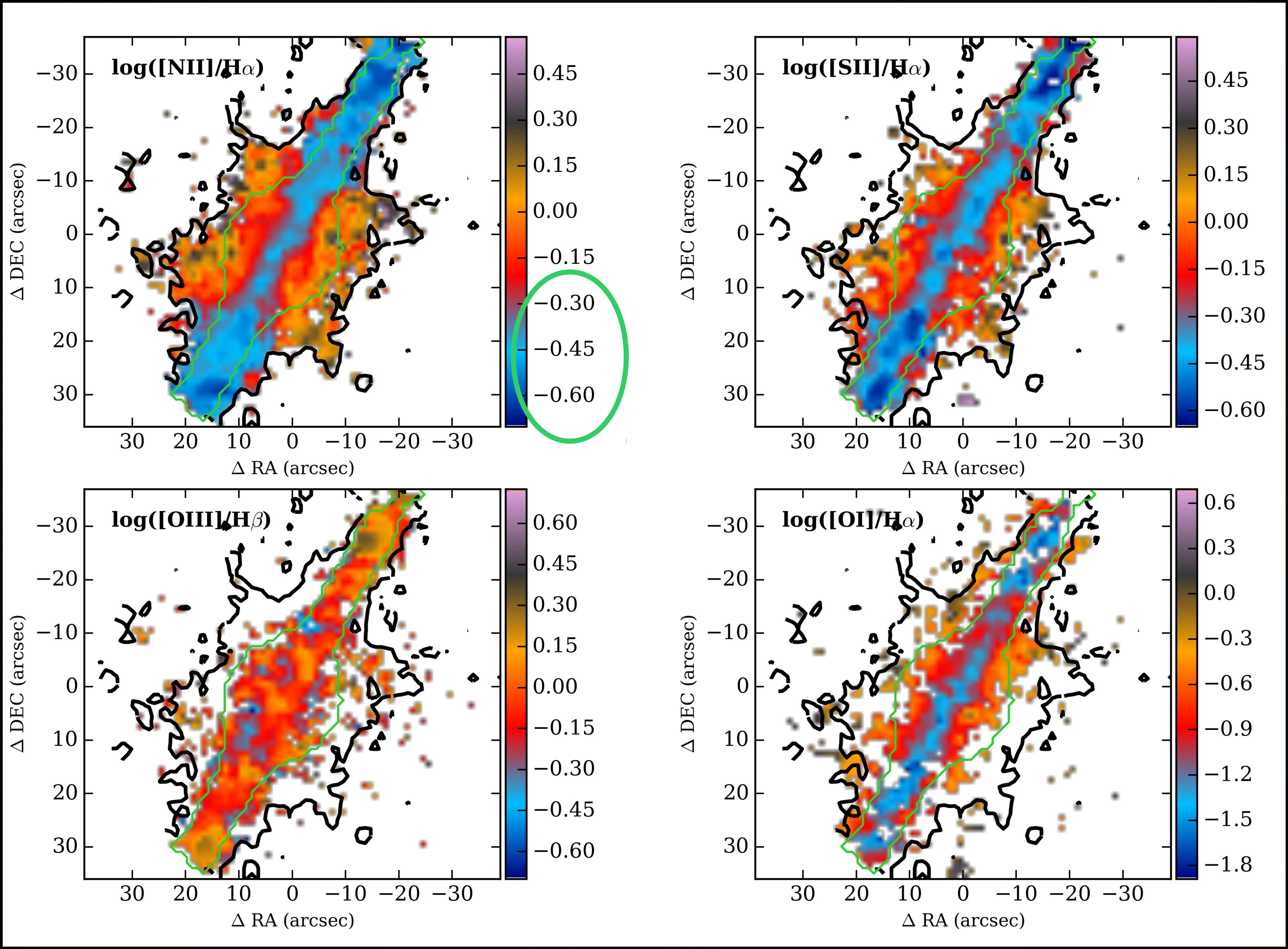


Hα : Red, [NII] : Blue , [OIII] : Green

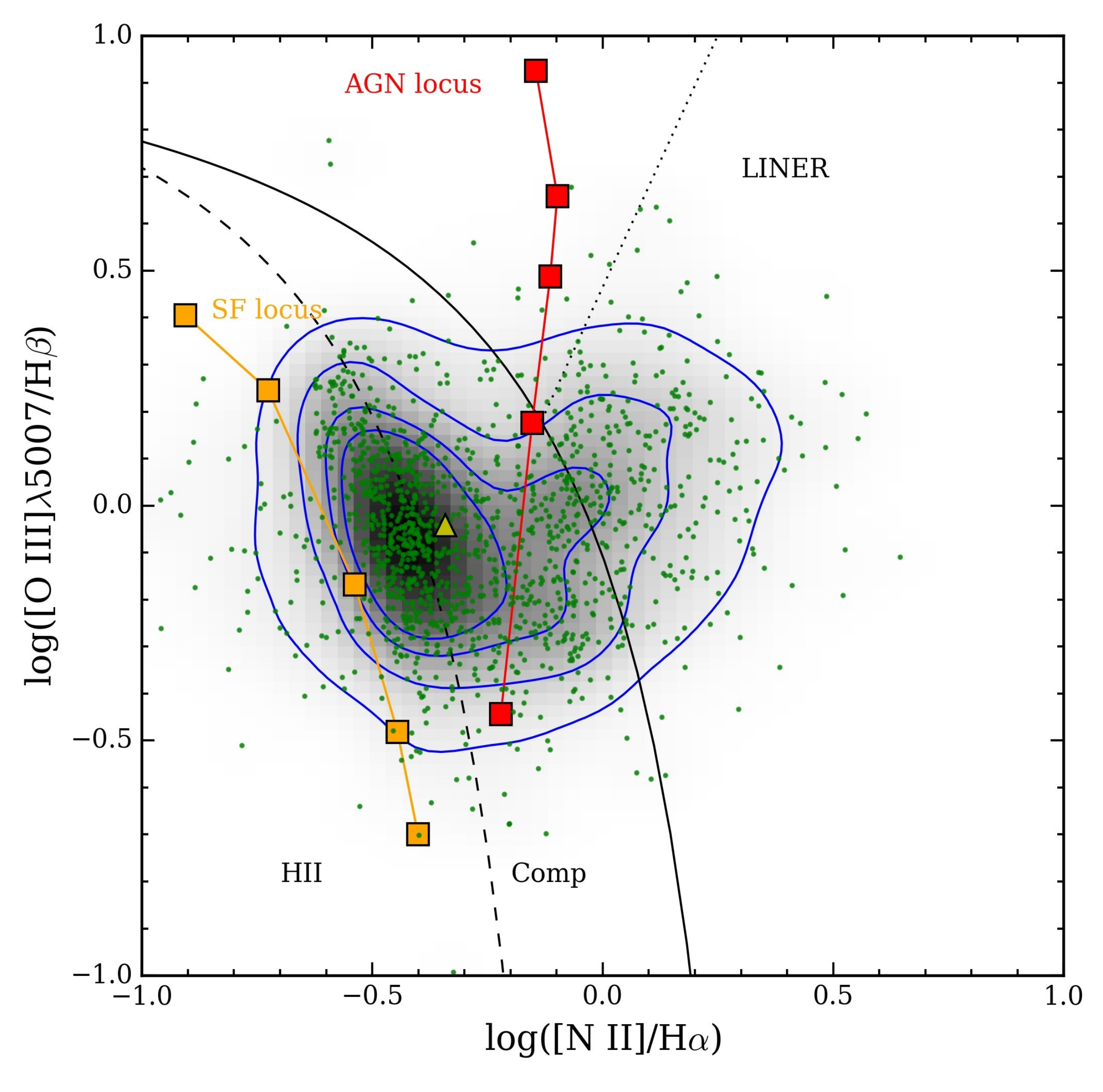
Morphology:

- Optical conical geometry.

Line ratios sencitive to the ionziation source



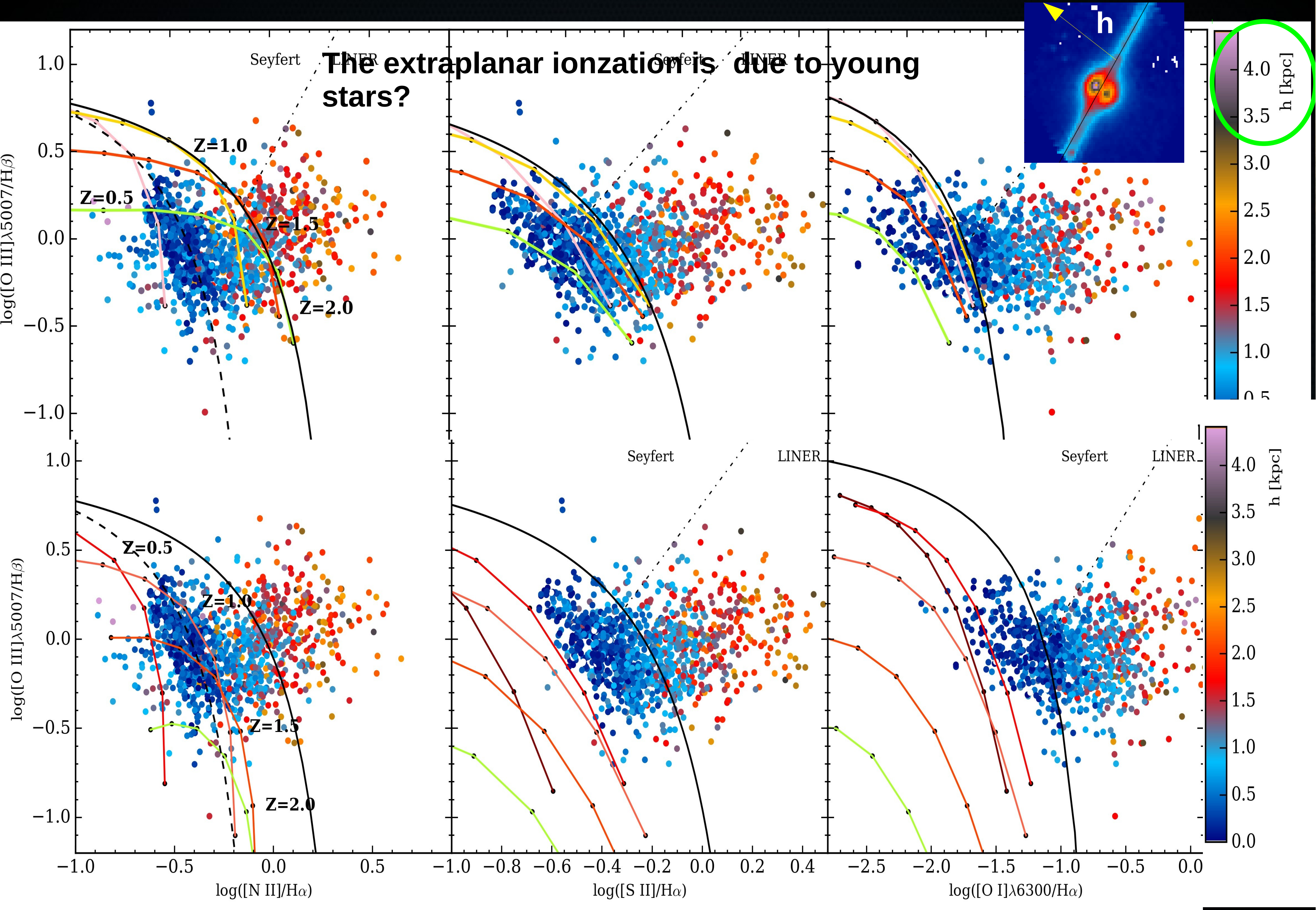
What does the BPT diagram tell us about the ionization source?



A single diagnostic diagram does not tell us much about the ionziation source!!

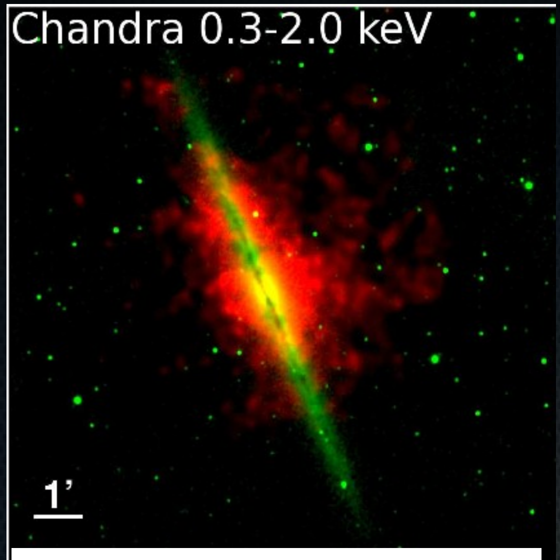
AGN locus and SF locus from Richardson C. T., Allen J. T., Baldwin 2014 & 2016

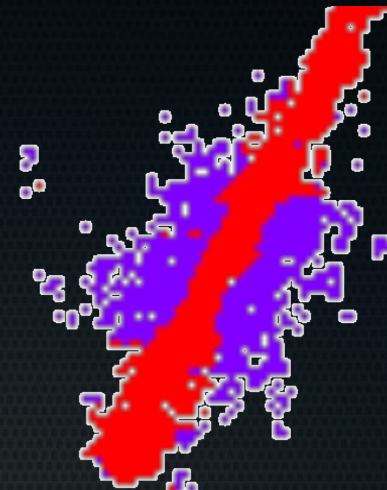
The extraplanar ionzation is due to young stars?

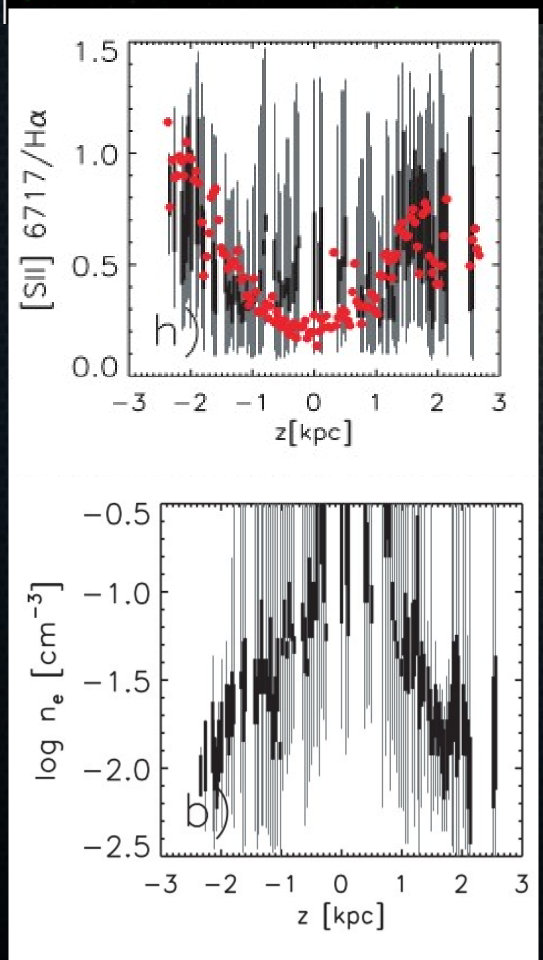


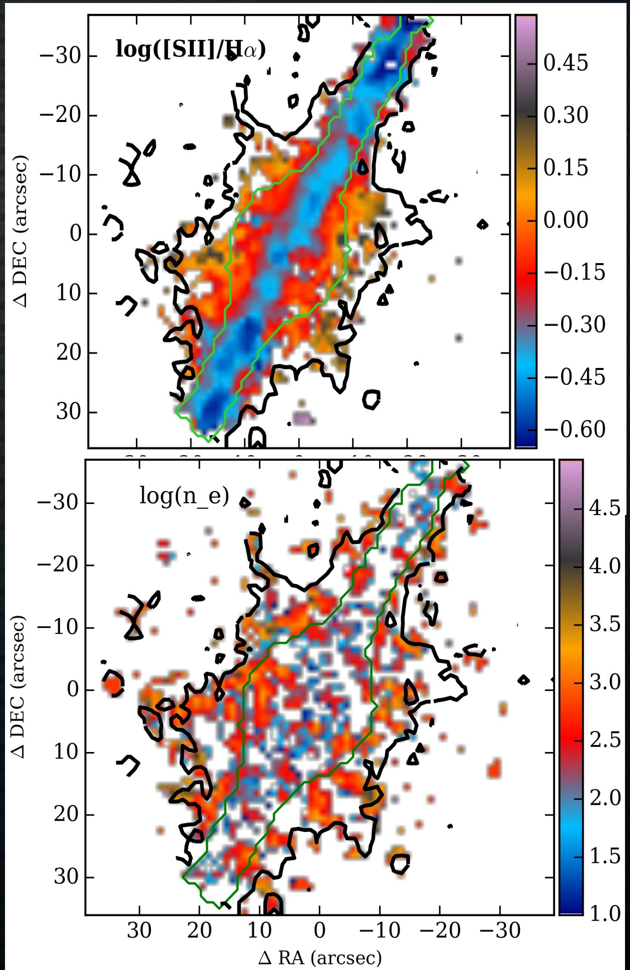
NGC 891 UGC 10043

Could it be a DIG?







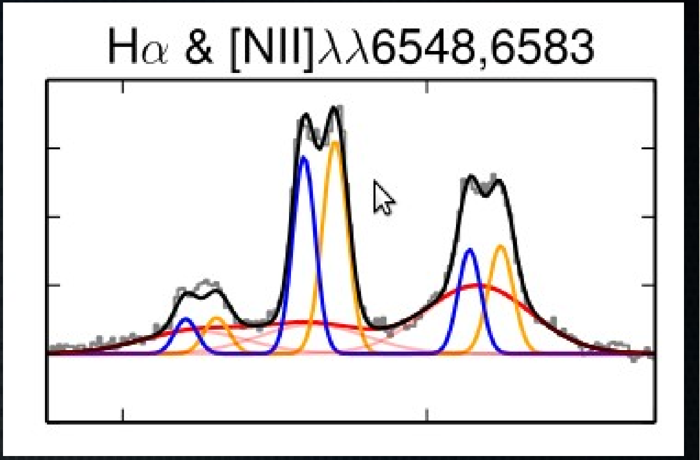


Flores-Fajardo, C.
Morisset et al., 2011

Ionization by shocks:

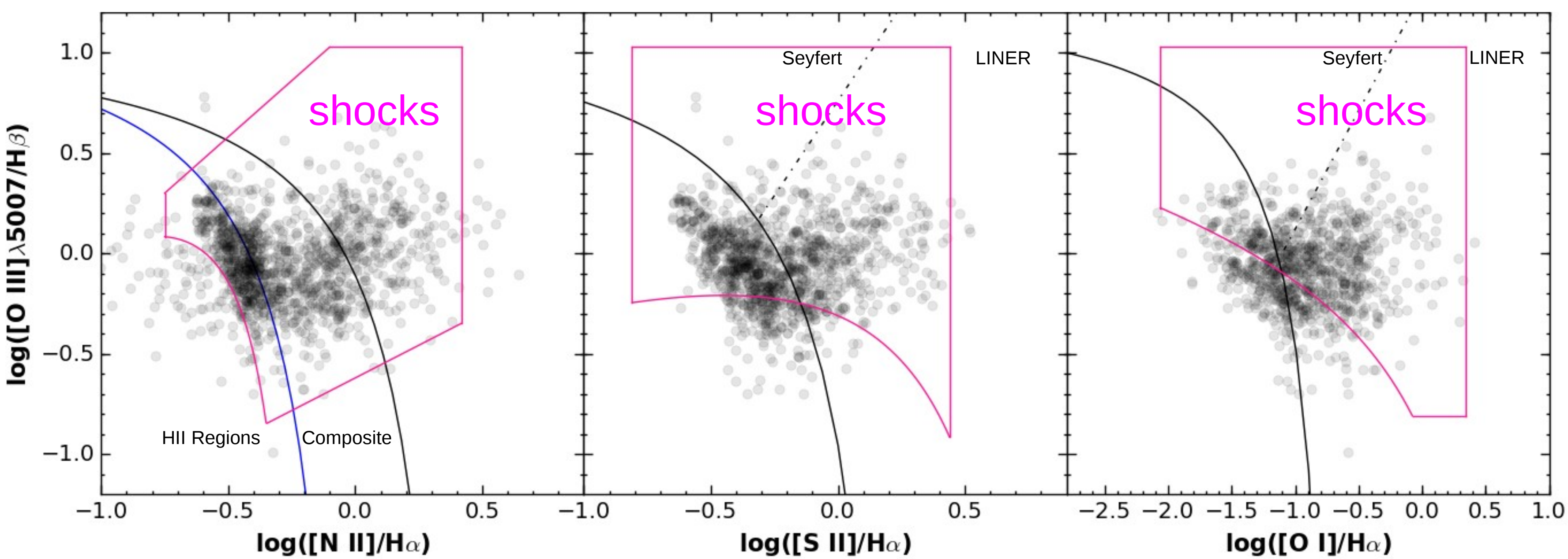
Double picks in the velocity dispersion of Hα and [N II] with SAMI , **R ~ 4500**

-Morphology of the ionization.
-Electron density
-Increase of the line ratios vs extraplanar distance
- Increase of line ratios



We implement the shock models from MAPPINGS. Free parameters:B, n (pre-shock), $\upsilon_{\mathrm{shock}}$, Z.

*The location of shocks is **not** obvious!!*



Ionization by shocks:

Double picks in the velocity dispersion of Hα and [N II] with SAMI, **R ~ 4500**

The SAMI Galaxy Survey: shocks and outflows in a normal star-forming galaxy

I-Ting Ho,[1★] Lisa J. Kewley,[1,2] Michael A. Dopita,[2,3] Anne M. Medling,[2]
J. T. Allen,[4,5] Joss Bland-Hawthorn,[4] Jessica V. Bloom,[4,5] Julia J. Bryant,[4,5,6]

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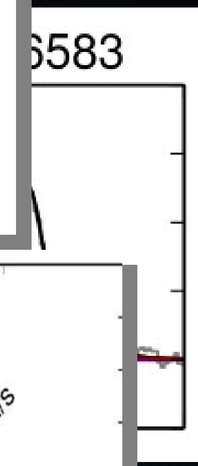
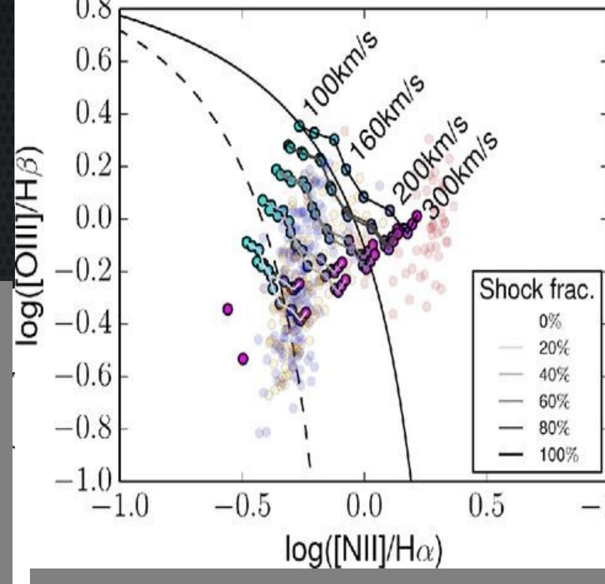
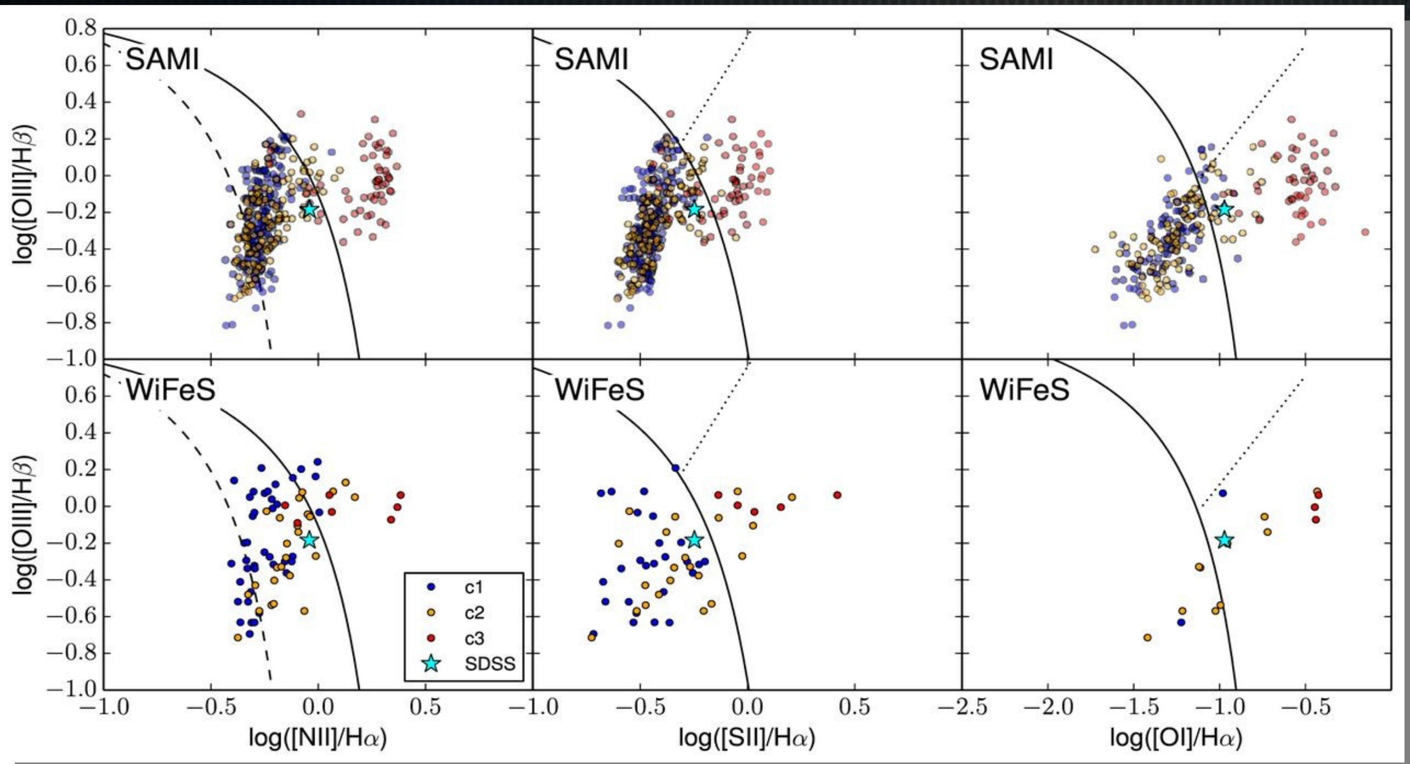
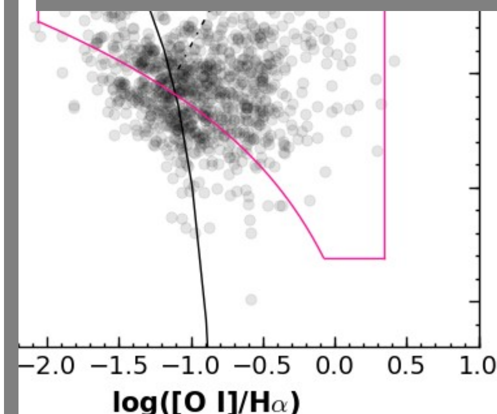
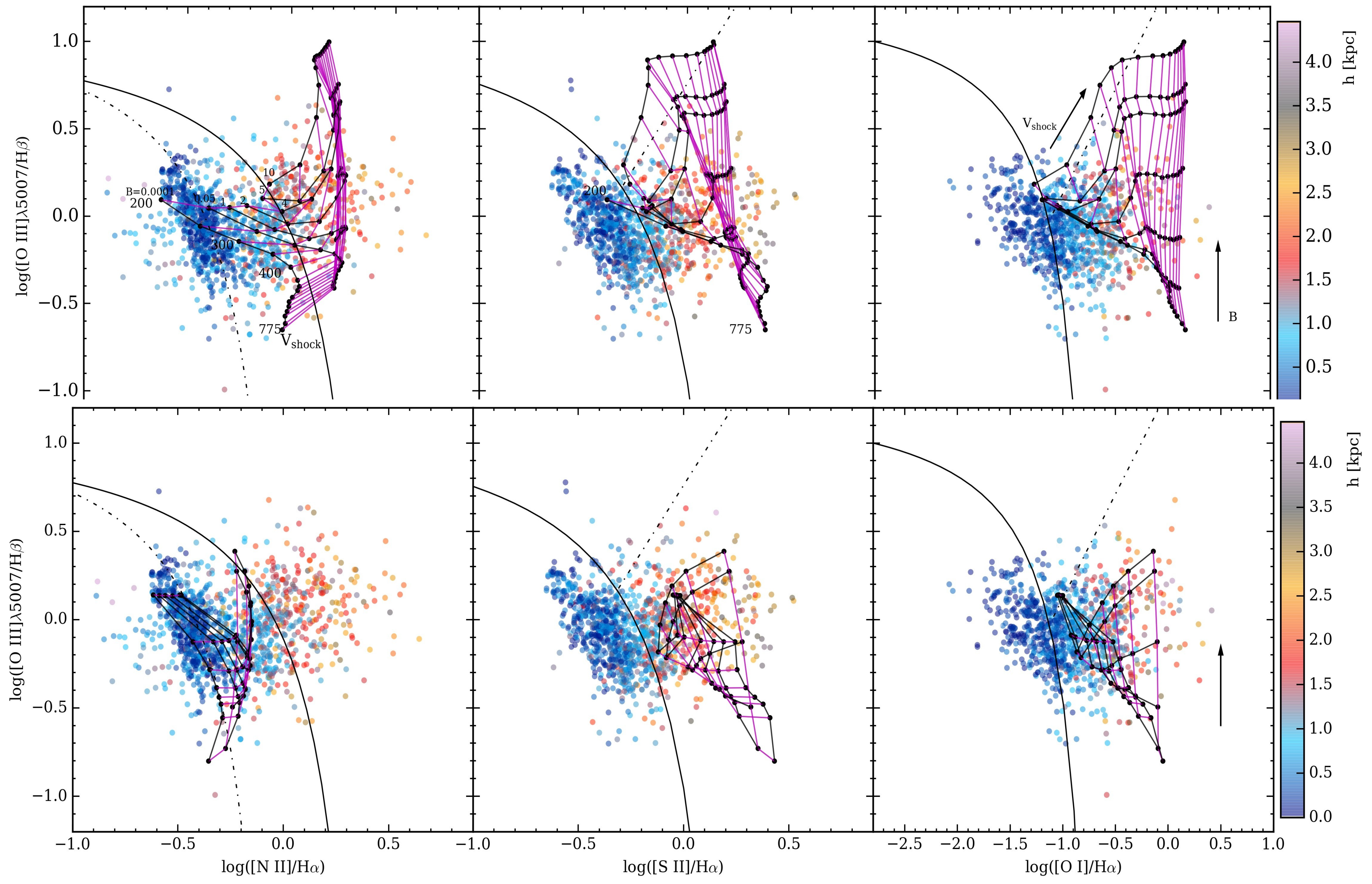




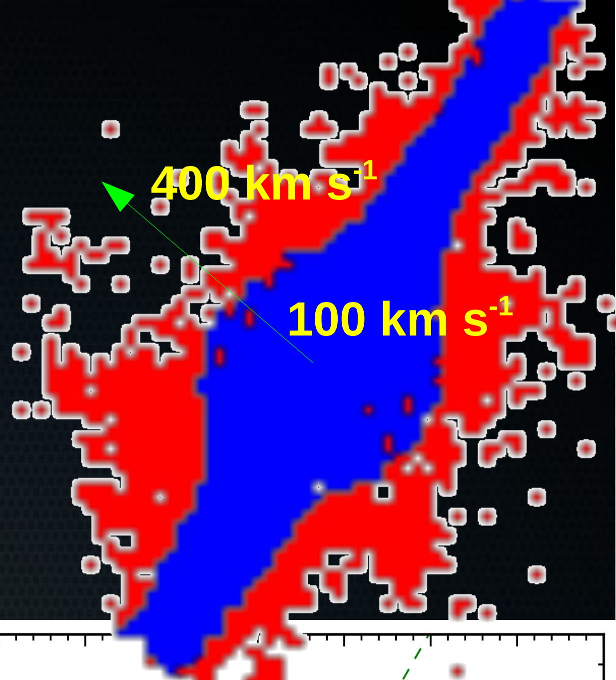




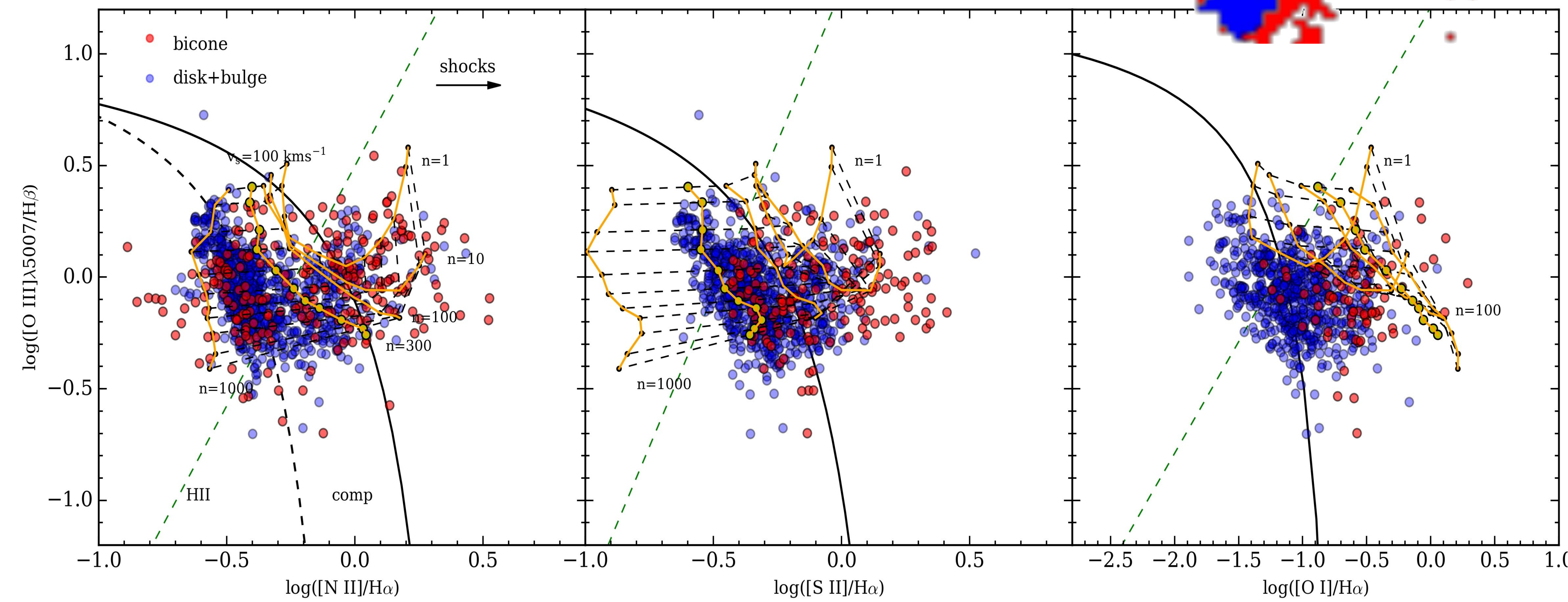
We need to implement shock models

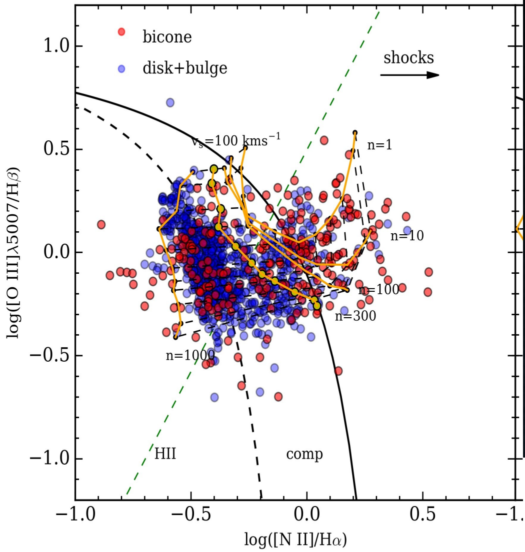


The model



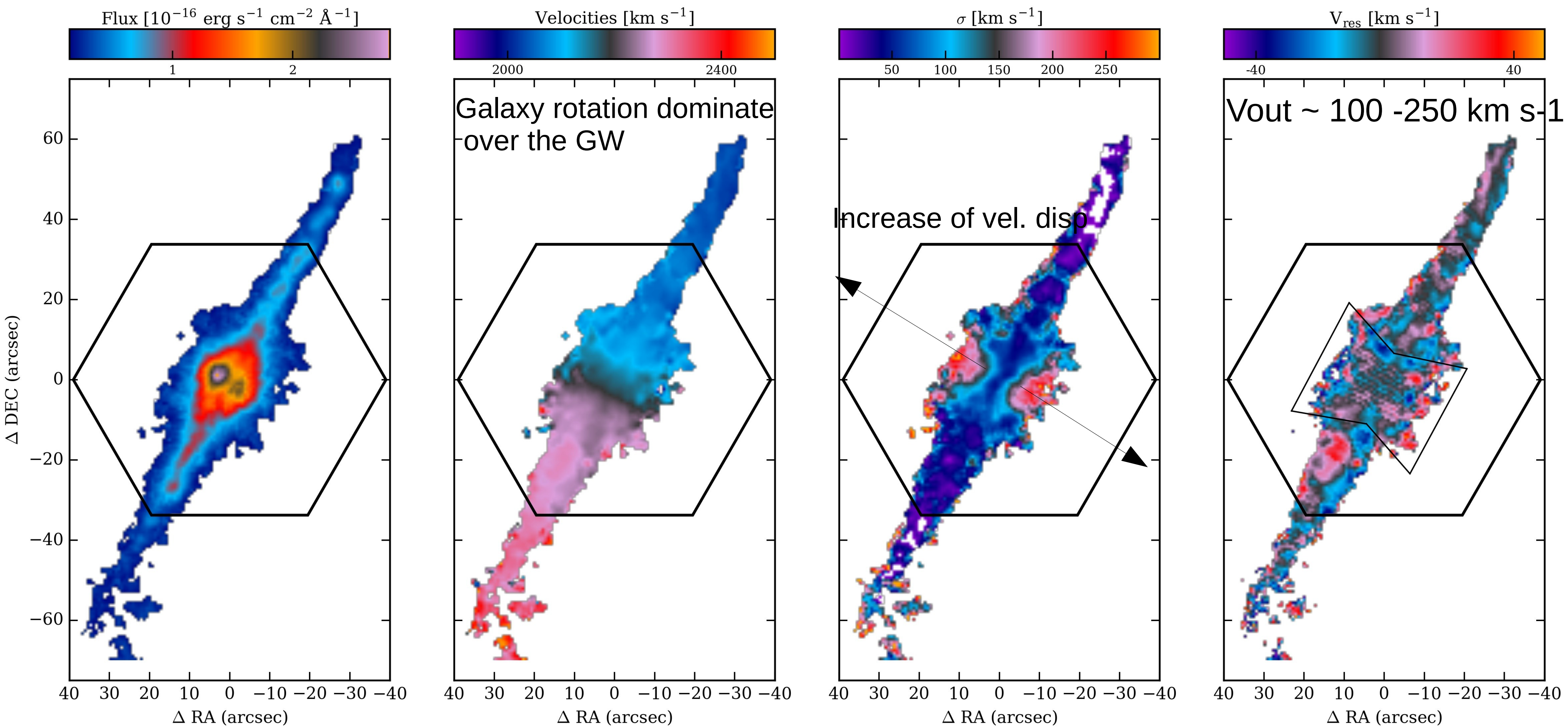
Separation between shock ionization and AGN photoionization,
Sharp & Bland-Hawthorn, 2010.



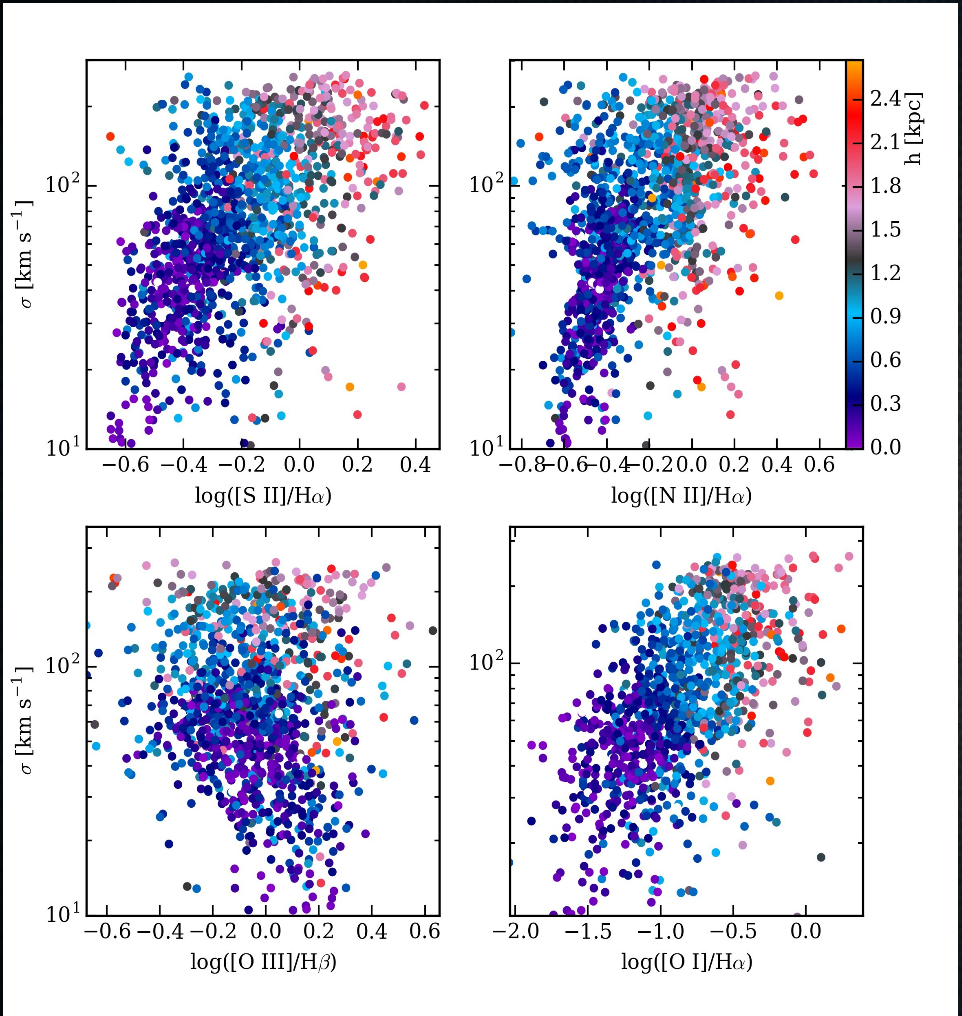


FPI observations at the SAO RAS using SCORPIO-2 (Alexei & Oparin)

Kinematics of UGC 10043



Correlations between line ratios and velocity dispersion in shocks

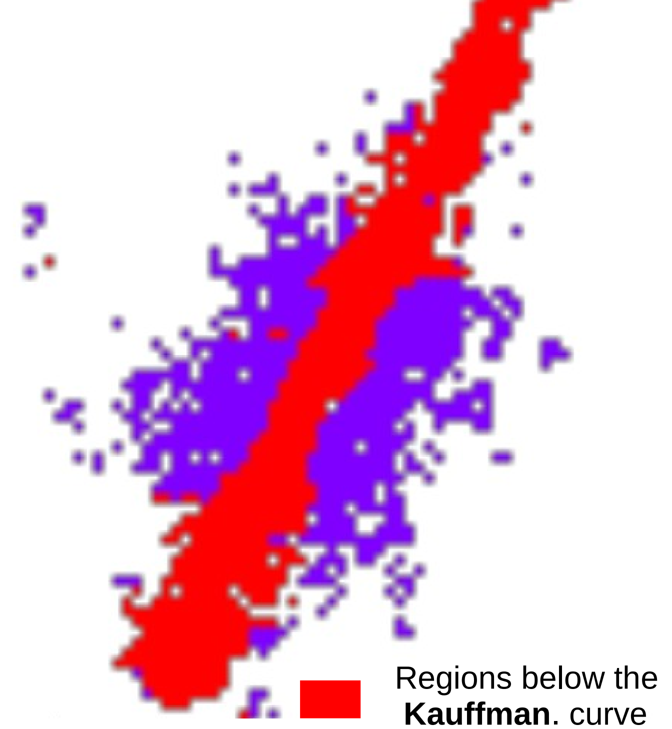


- Regions dominated by ionization by shocks shows high emission line ratios and high velocity dispersions.

Correlations observed, Rich, Kreley & Dopita 2011, Monreal Ibero et al., 2006, Ho et al 2014.

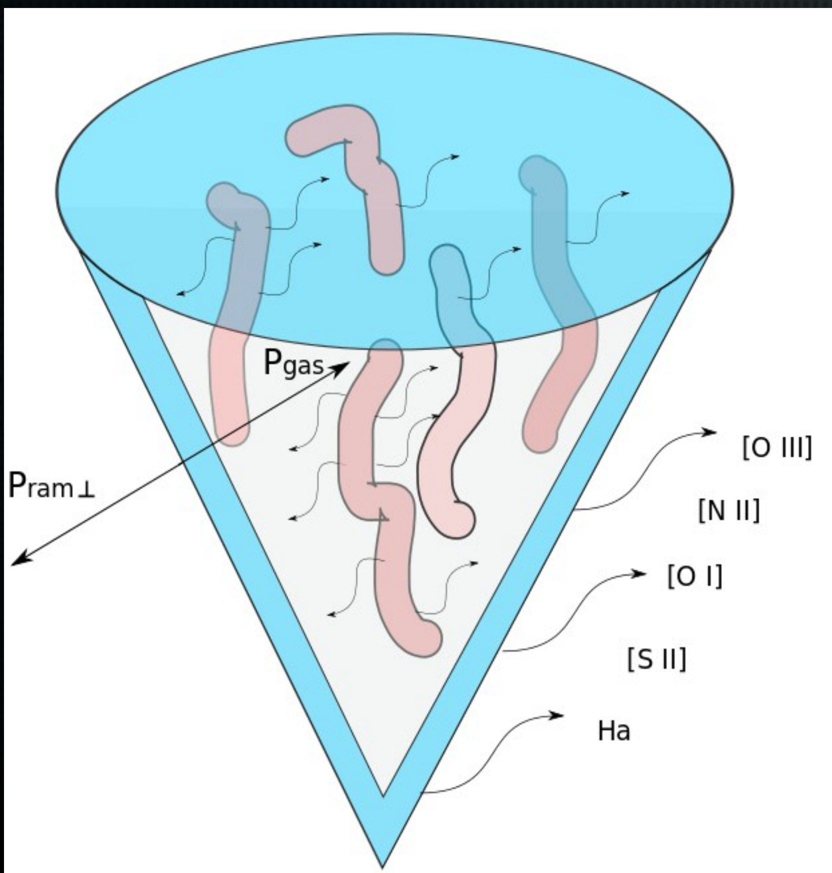
Energetic conditions

$$\mathrm{SFR}(M_\odot\ \mathrm{yr}^{-1}) = \frac{L(\mathrm{H}\alpha)}{1.26\times10^{41}\mathrm{erg\ s}^{-1}} = 0.355\ \mathrm{Msun\ yr}^{-1}$$



Where is the ionization observed?

In the walls of the cone or in fillamentary structure?



Dopita & Sutterland 2004

$$E_{wind} = 0.5 P_{ram}(r)\ v_{wind}\ r^2\ (\Omega/4\pi)$$

Veilleux et al., 2005

$$\dot{E}_* = 7\times10^{41}\frac{\mathrm{SFR}}{M_\odot \mathrm{yr}^{-1}}$$

$E_*(\mathrm{SFR} = \mathrm{Halpa}) = 2.5\mathrm{x}10^{41}$ erg s-1

$E_*(\mathrm{SFR}=\mathrm{IR}) = 1.1\mathrm{x}10^{42}$ erg s-1

Importance of the filling factor

The energy of the wind depends directly in the gas ocuped in the cone (*filling factor* f)

$0 < f < 1$

$f > 10^{-4}$ *Heckman, 2000*

$n_e \sim f\, n_{[SII]}$

In order to make compatible the energy observed we need filling factor values:

If emission at walls

$f = 0.005 - 0.02$ If SFR of Hα is considered

$f = 0.02 - 0.08$ If SFR of IR is considered

If emission clumpy

$f = 0.06 - 0.2$ If SFR of Hα is considered

$f = 0.2 - 0.5$ If SFR of IR is considered

Thanks for your atention