Star formation efficiency in the outer filaments of Cen A

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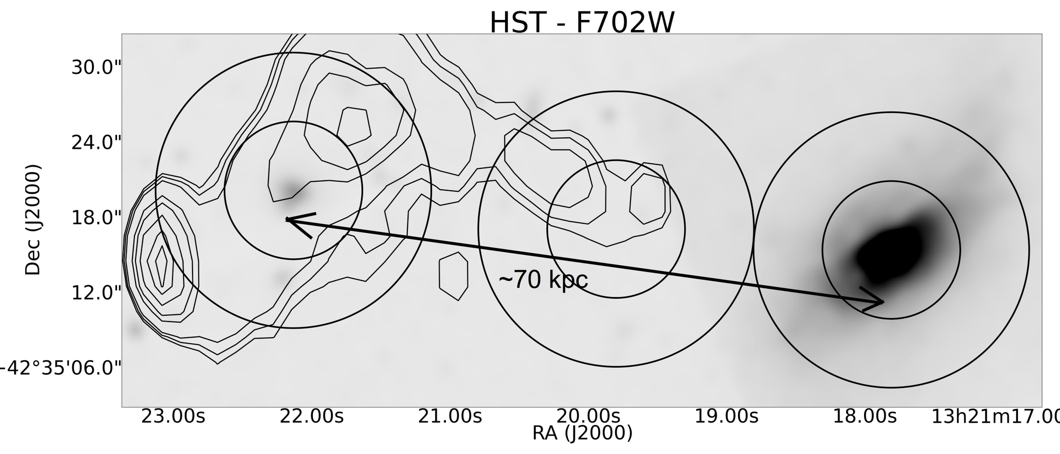
AGN positive feedback

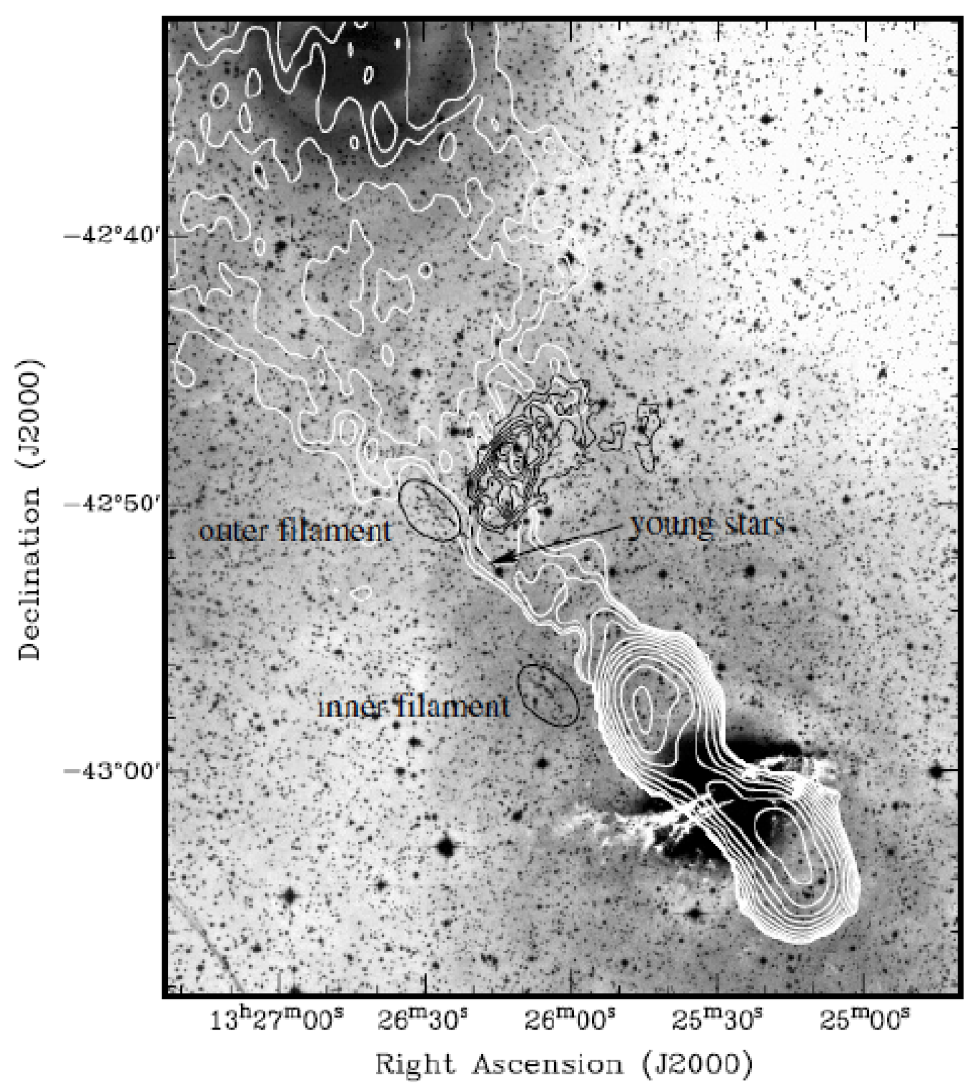
AGN are supposed to regulate gas accretion and thus slow down star formation (negative feedback). However, evidence of AGN **positive feedback** has also been observed in a few radio galaxies.

In a previous work [1], we studied two of the most famous example of **jet-induced star formation**: 3C 285/09.6 [2] and Minkowski's Object [3]. Both star forming regions stand at least on or even above the KS-law when using a standard CO/H_2 conversion factor. The depletion time is found to be < 1 Gyr in 3C285/09.6 and down to < 20 Myr for the Minkowski's object.



Here we present a **multi-wavelength analysis** of the outer filaments of Centaurus A.

Multi-wavelength data

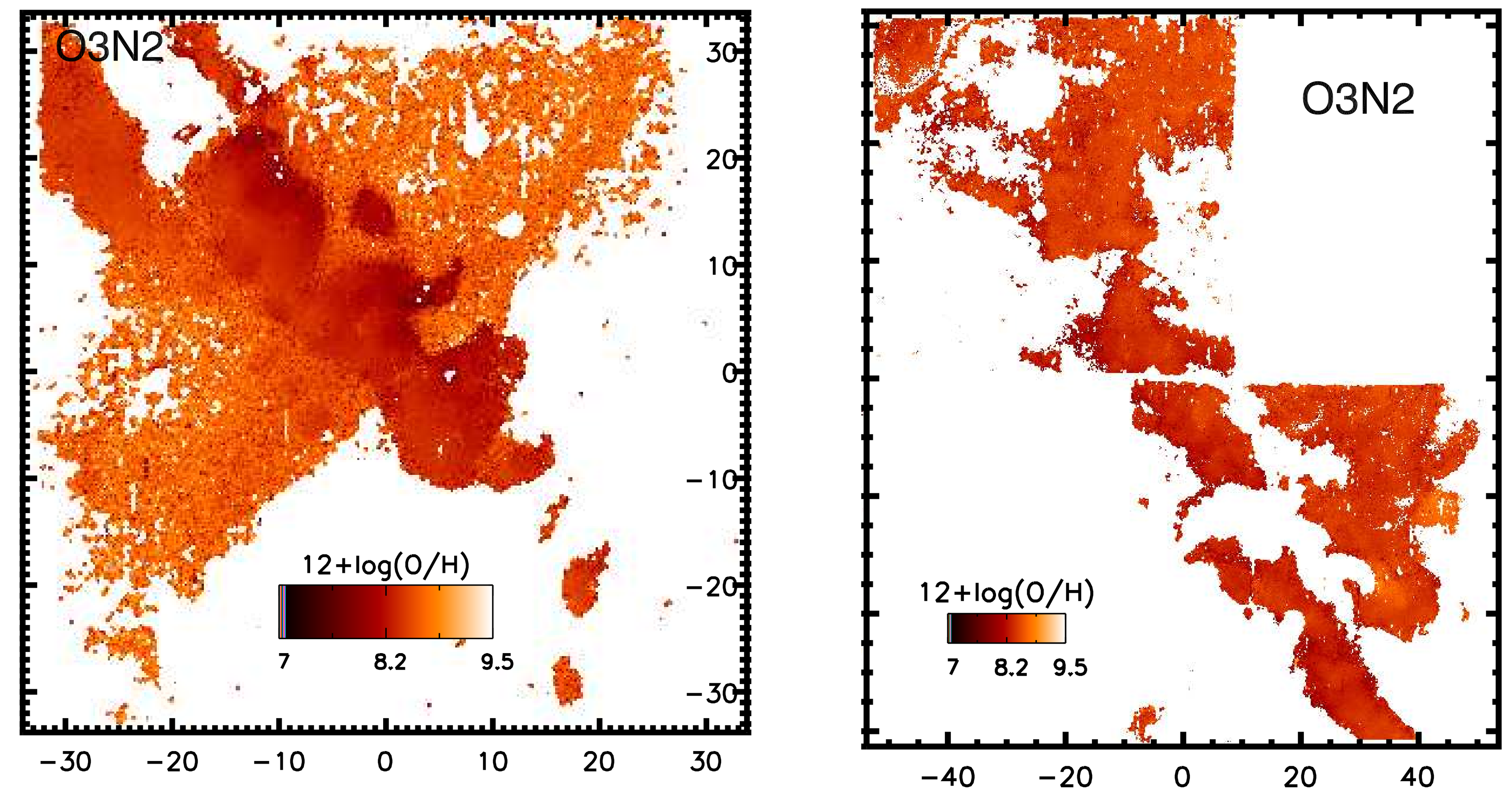


For this work, we observed the outer filaments at a distance of ~ 15 kpc from the galaxy, at the intersection of possible jet-cloud interaction.

- **CO(1-0) and CO(2-1)** with SEST [4]: a ~ $2' \times 2'$ map covers the intersection of the outer filament with a HI shell.
- **FIR data** from Herschel with PACS and SPIRE: flux extraction following the method of [5].
- **FUV emission** with GALEX [6].
- **HCN(1-0) and HCO$^+$(1-0)** with ATCA on June 2014: synthesized beam width of ~ 3.1″; data reduction with mirias; rms of ~ 1.0 mJy (not detected).
- **MUSE observations** on the VLT [7]: two fields; optical excitation lines
- **ALMA archive** CO(2-1) data: synthesized beam width of ~ 2″

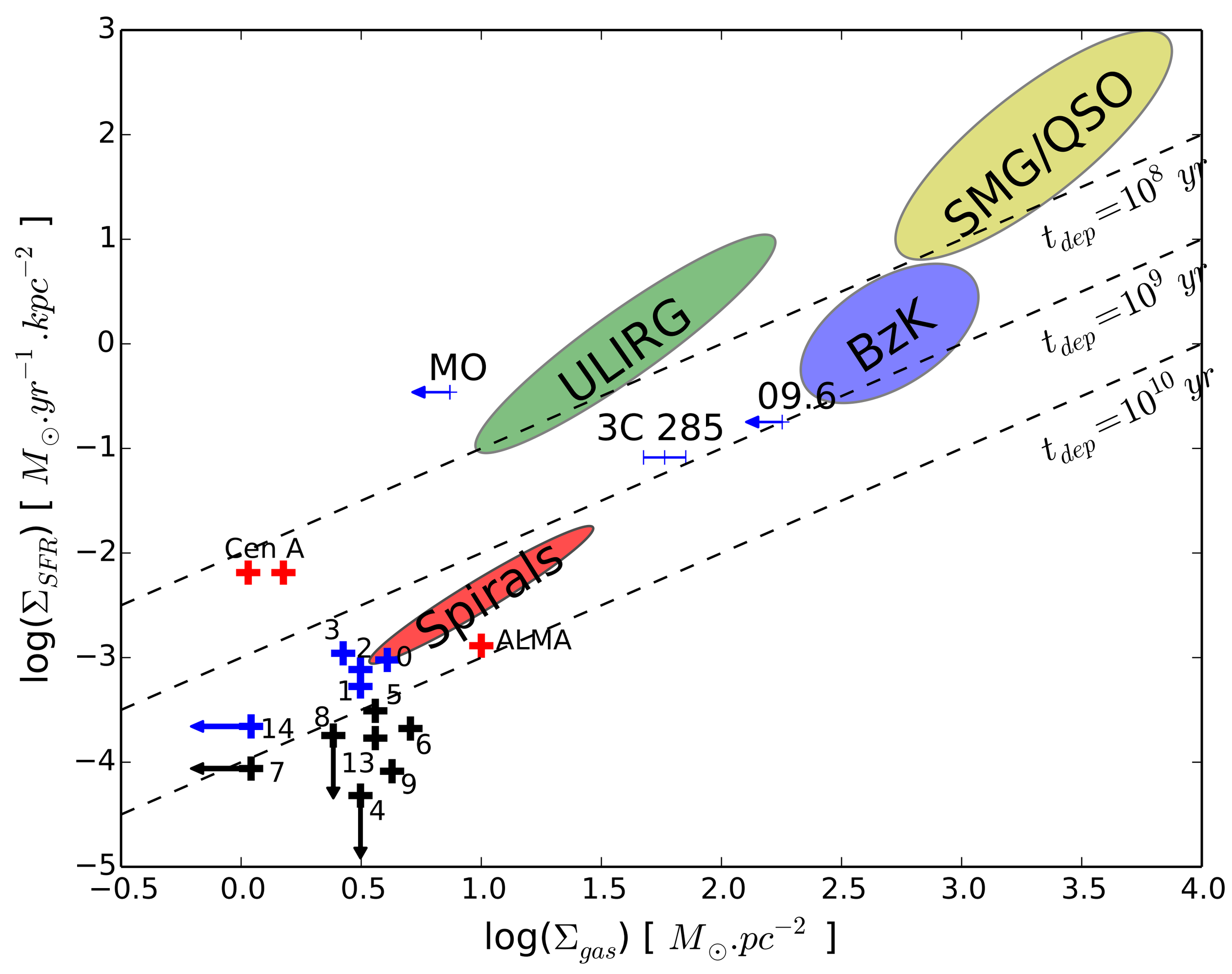
MUSE - Metallicity maps

We used excitation lines from MUSE, to estimate the oxygen abundances in the Centaurus A filaments.



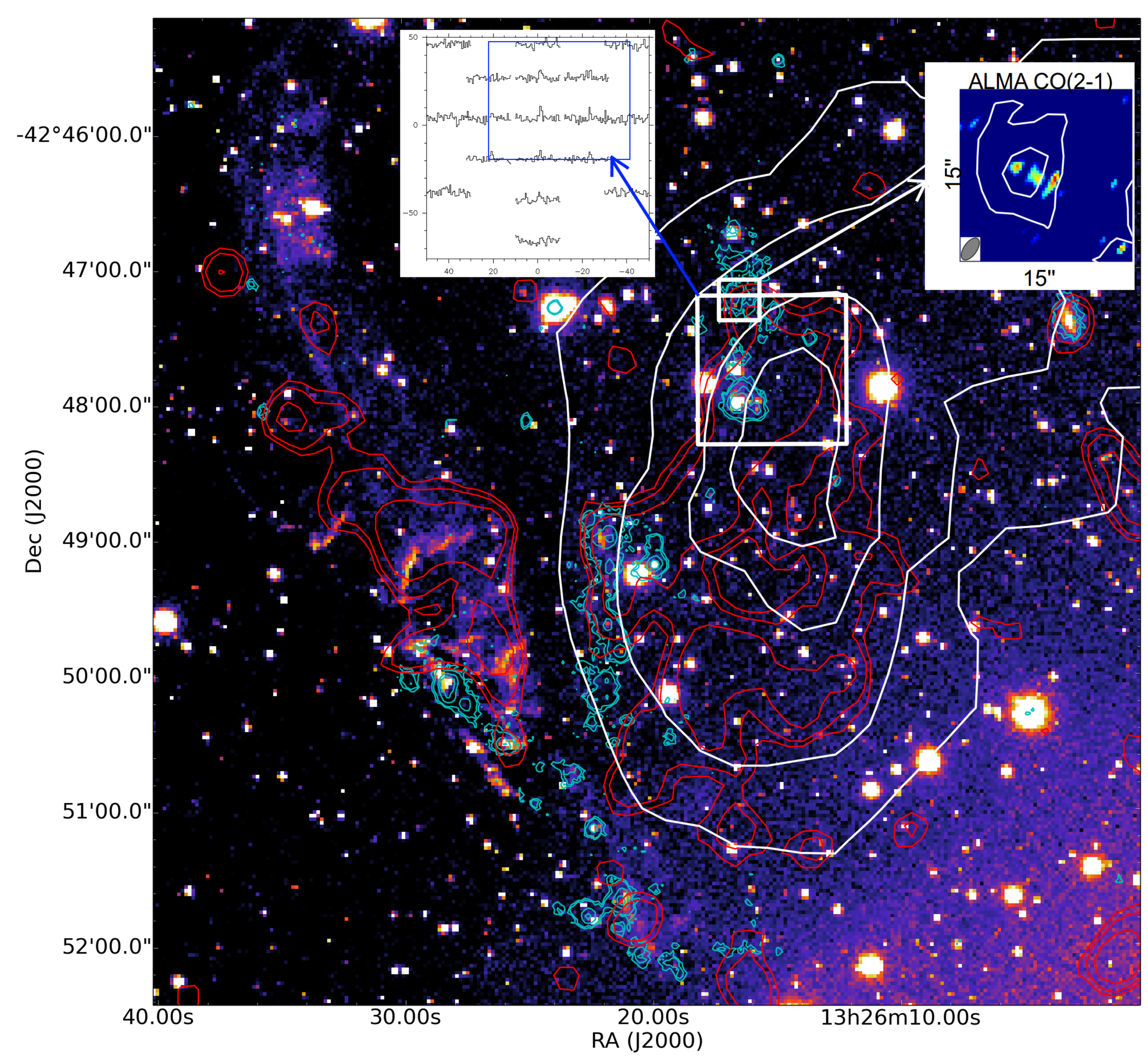
Herschel/Galex SFR - Kennicutt-Schmidt law and jet-cloud interaction

We estimated the L'_{CO} with the formula from [8] and derived molecular gas masses of a few $10^5 - 10^6\,M_\odot$ in each of the 44″ (~ 0.72 kpc) SEST beam; for a total molecular gas mass of $\sim 1.4 \times 10^7\,M_\odot$.
The UV and TIR luminosities can be interpreted as measures of the star formation rate [9]. The derived SFR have values of a few $10^{-5} - 10^{-4}\,M_\odot.yr^{-1}$, for a total SFR of $\sim 2 \times 10^{-3}\,M_\odot.yr^{-1}$ in the whole region.



Star formation seems to take place in the outer filament exactly like inside normal star forming galaxies, but with a very small SFR, likely due to the small molecular gas amount.
Some regions have a standard star formation efficiency with depletion time scales of ~ 1Gyr, whereas other are less efficient (depletion times of ~ 10 Gyr).
There is a hint of morphologically-driven star formation in the filaments.

ALMA - Resolved molecular gas mapping



3 clumps (d = 2″ ~ 30 pc) in CO(2-1): $S_{CO}\Delta v \sim 3.0$ Jy.km.s^{-1} ⇒ $M_{H_2} \sim 9.9 \times 10^4\,M_\odot$.
SFR is estimated from FUV+FIR emission: $\sim 1.3 \times 10^{-5}\,M_\odot.yr^{-1}$
⇒ depletion time of ~ 7.6 Gyr.

Clump	v_0 (km.s^{-1})	S_{CO} (Jy.km.s^{-1})
1	~ 230	1.15 ± 0.53
2	~ 220	0.95 ± 0.51
3	~ 210	0.87 ± 0.47

Clump	M_{H_2} ($10^4\,M_\odot$)	offset
1	3.8 ± 1.7	5.5″, −17.25″
2	3.1 ± 1.7	4.25″, −18.5″
3	2.9 ± 1.5	2.25″, −19.5″

HCN was not detected: $S_{HCN}\Delta v < 67$ mJy.km.s^{-1} ⇒ $L'_{HCN} < 3.2 \times 10^3$ K.km.s^{-1}.pc^2 ($f_{dense} \lesssim 6.7\%$).

References

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