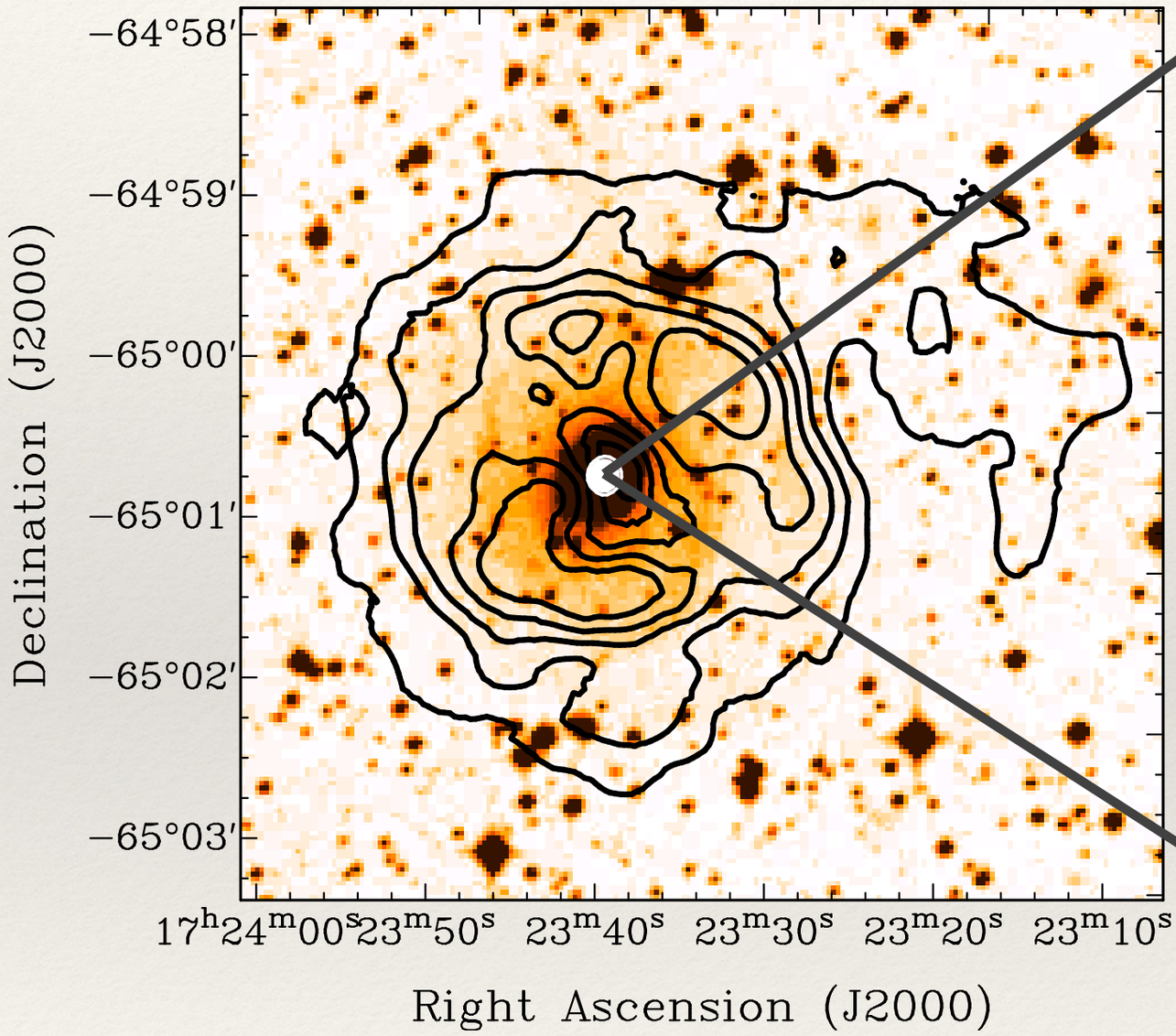
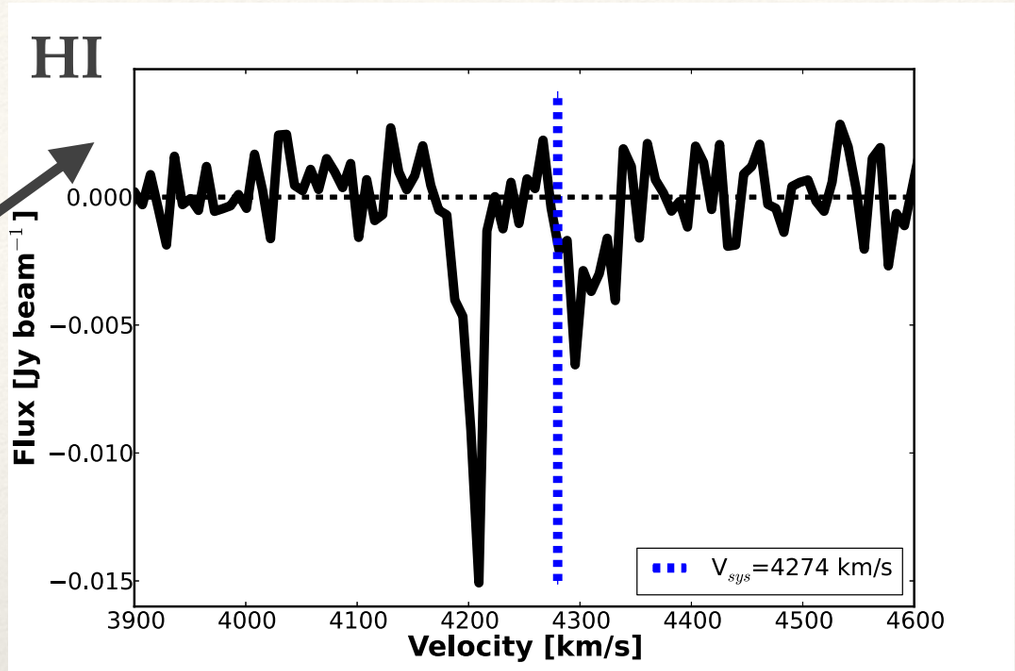
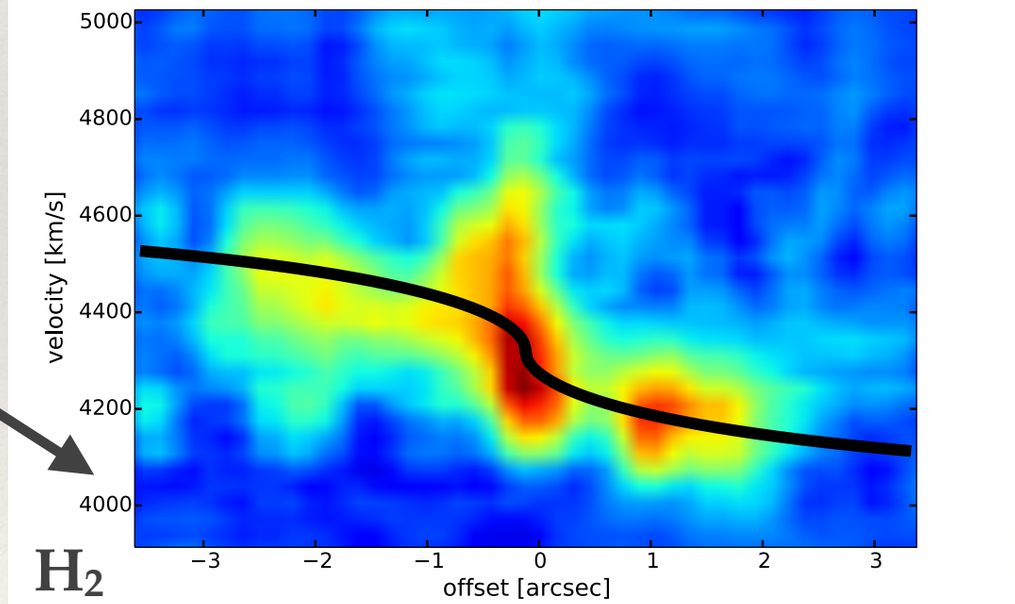
PKSB 1718-649: the triggering of radio AGN







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ASTRON

Triggering mechanisms: let's look at Young AGN

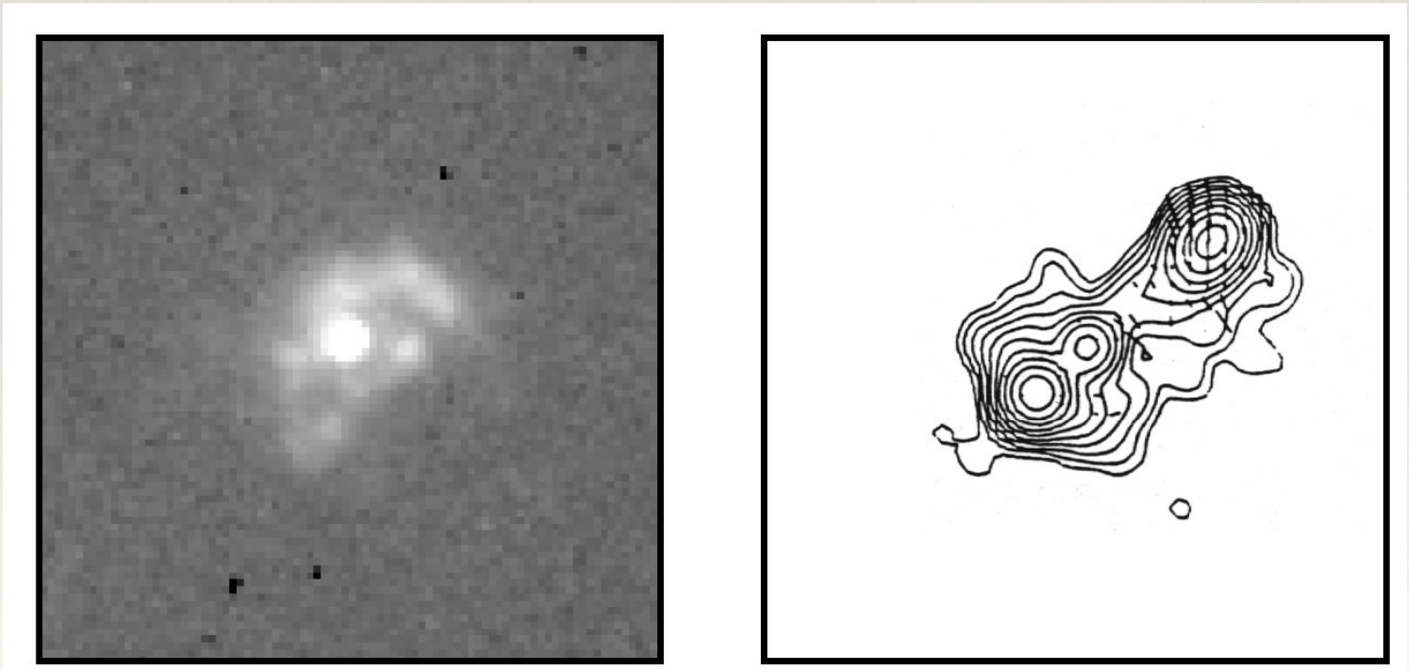
- The age of an AGN can be estimated from the radio emission:
  - Compact steep spectrum sources = Young Radio AGN

Compact sources strongly interact with the surrounding ISM at all phases:

- Gas rich, in particular of HI [Emonts et al. 2010; Geréb et al. 2015].
- The gas (neutral, molecular, ionised) is commonly unsettled, more than in other kinds of AGN.

What we do: <u>study the kinematics of the multi-phase gas close to the radio source.</u>

Goal: <u>understand which physical phenomena trigger and fuel radio AGN.</u>



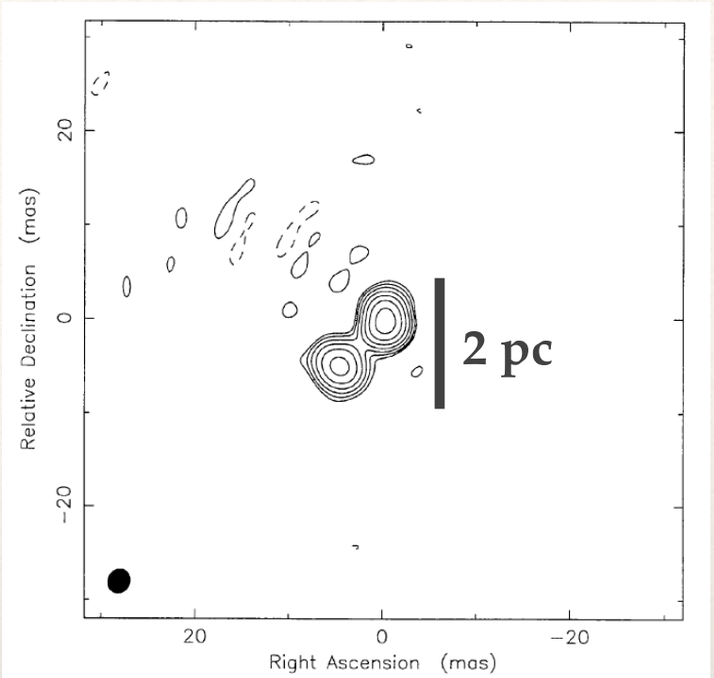
HST narrow line imaging [Axon et al., 2000]

PKSB 1718-649: an ideal candidate

- Compact source: R = 2 pc
- Young source: 10^2 years
- Closest young radio AGN: z=0.014428 (62 Mpc)

PKSB 1718-649 is a low efficient radio galaxy:

- Radio power: 1.8 x 10^{24} W/Hz
- Accretion: jet-mode/hot-mode (L/L_{Edd}~0.003)
- Optical properties: LINER

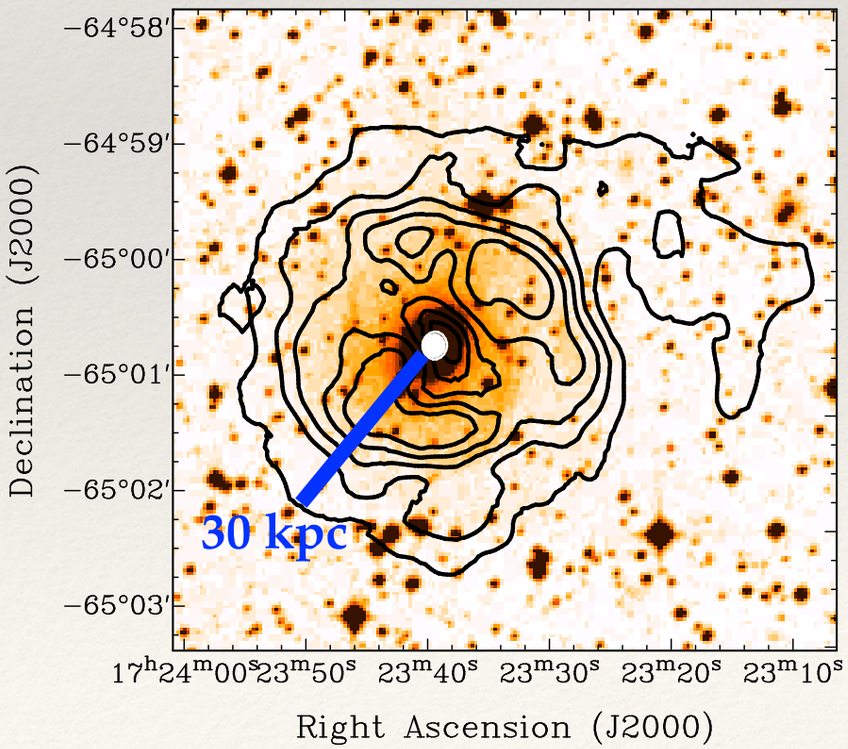


Extended HI disk

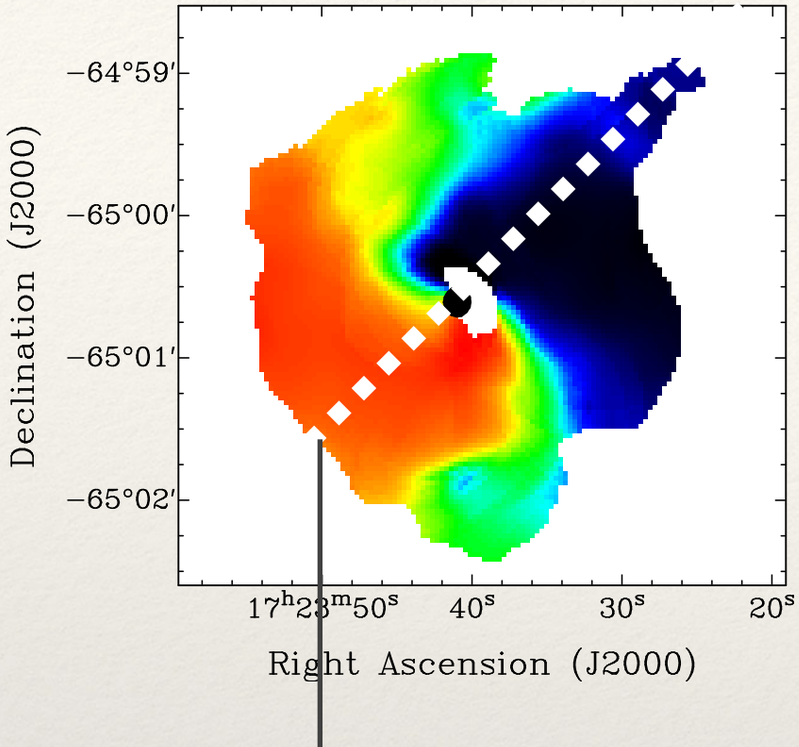
- The neutral hydrogen kinematics allow us to trace the interaction history of the galaxy.
  - i.e. possible triggering events unsettling the gas.

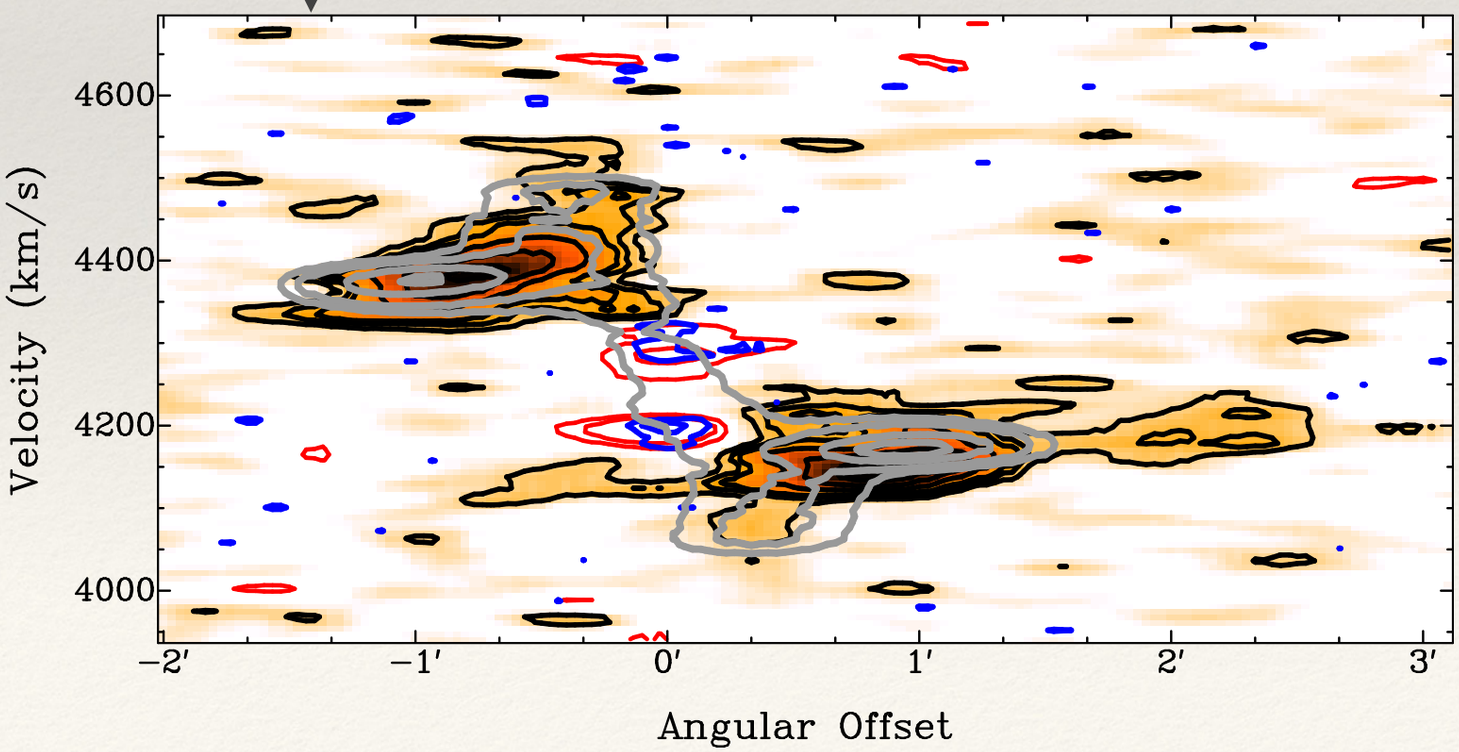
Absorption features:

- probe gas in front of the radio source, possibly in the innermost region of the galaxy
  - i.e. gas possibly interacting with the radio source.



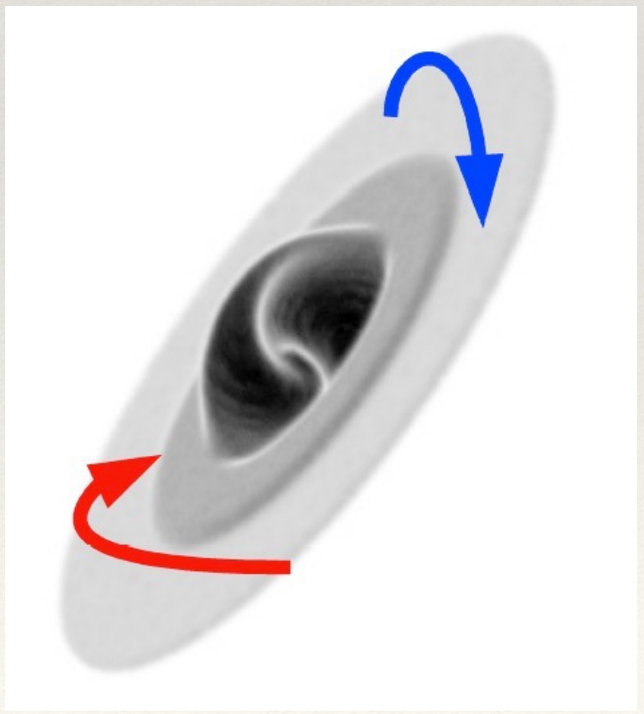
The HI emission



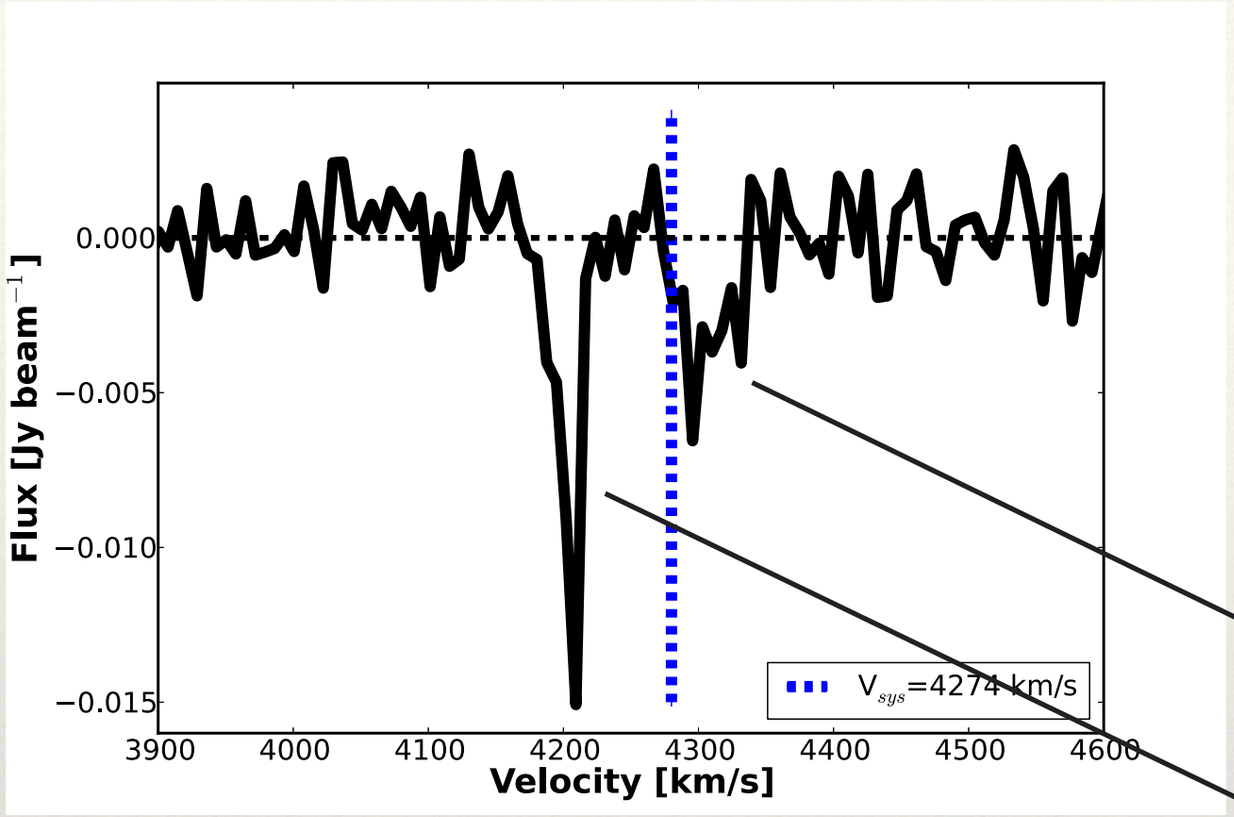


[Maccagni et al.; 2014]

- Model the kinematics of the HI:
  - Disk **regularly rotating** warped, in the center
  - The galaxy has not interacted with a companion within the lifetime of the radio source.
- **2 Separate Absorption lines:**
  - detected against the very compact continuum [2 pc]
  - do not fit with the model
    - trace gas not regularly rotating.



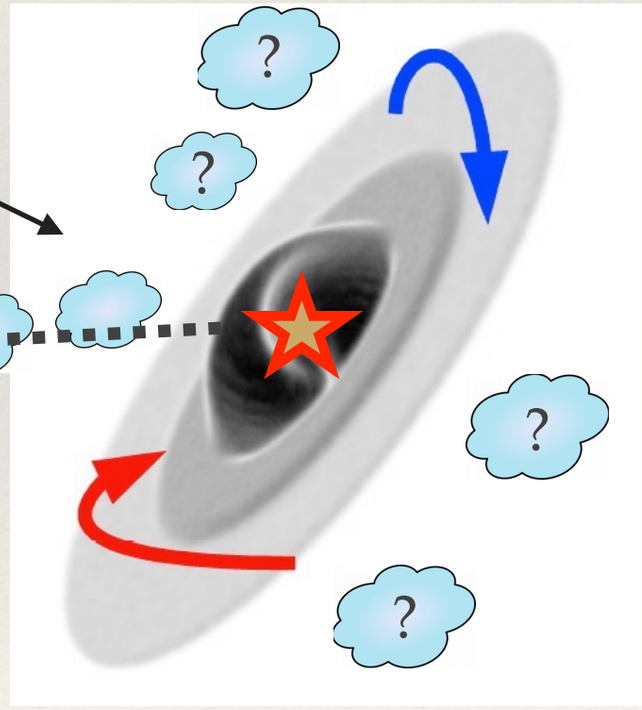
The HI absorption lines



2 Absorption lines:
narrow line blue-shifted
broad line red-shifted
w.r.t systemic velocity (4274 km/s)

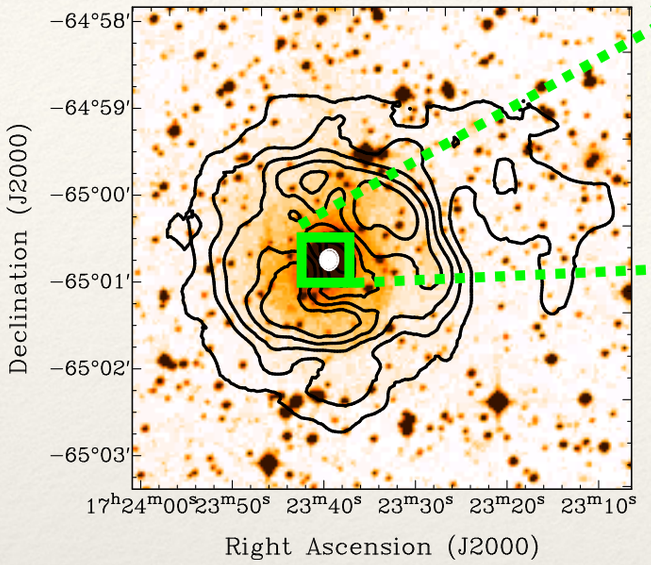
- the distinct kinematics suggest the presence of a population of clouds of cold gas potentially fuelling the AGN

line of sight



In PKSB 1718-649, free-free absorption by small clouds around the AGN is responsible for the variability of the radio peak.
[Tingay et al., 2015]

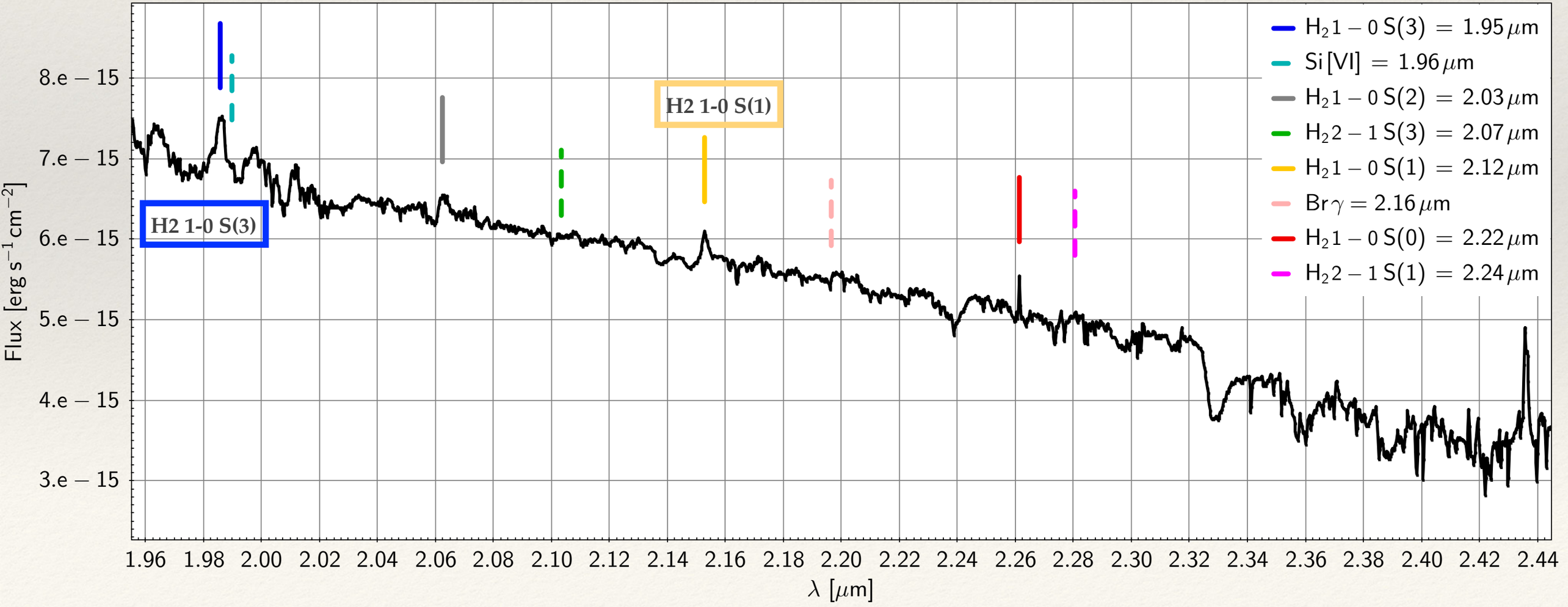
PKSB 1718-649: let's look at the centre!



SINFONI FOV: 8″x8″ (2.5x2.5 kpc)

Spatial resolution: 0.125″ (37 pc)

Resolve the kinematics of the **Molecular Gas** in the **proximity** of the radio source.



SINFONI IFU: observations of the multi-phase gas

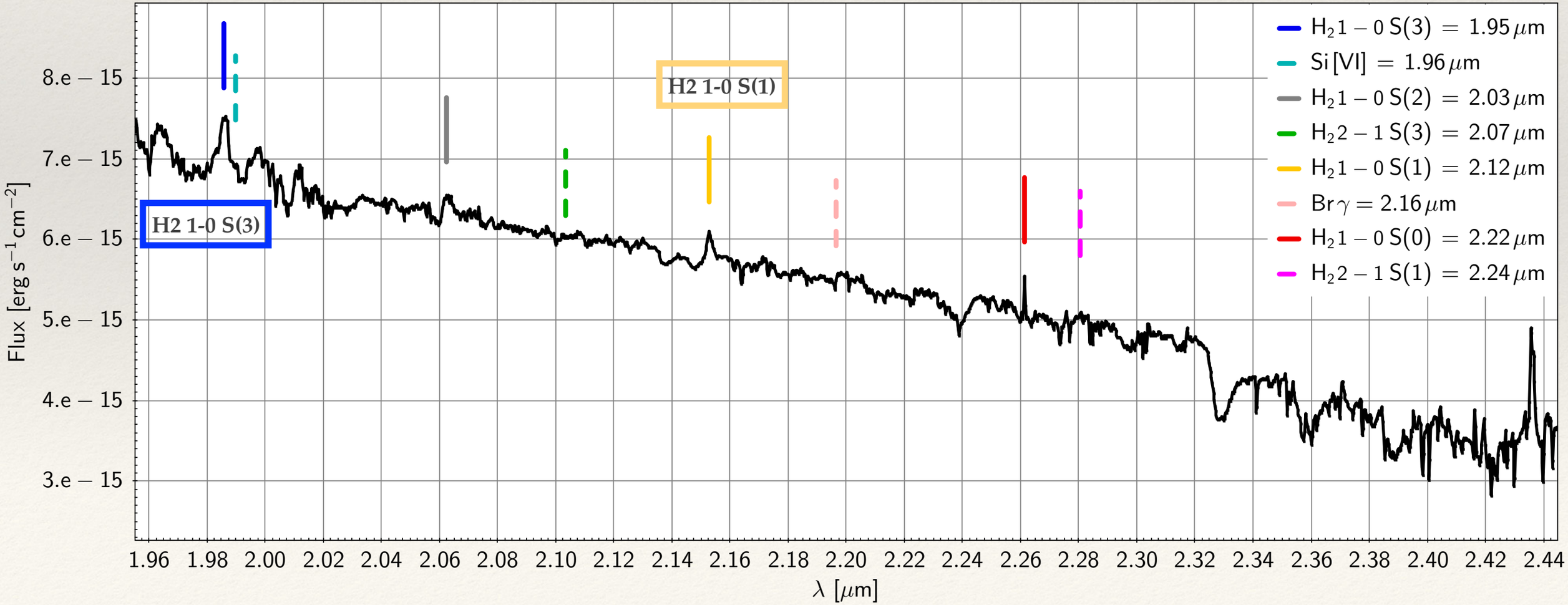
Resolve the kinematics of the **Multi-Phase GAS close to the radio source.**

Detected lines: lowest roto-vibrational states of H2 (i.e. warm molecular gas).

- 1-0 S(1) , 1-0 S(3)
- 1-0 S(2), 1-0 S(0)

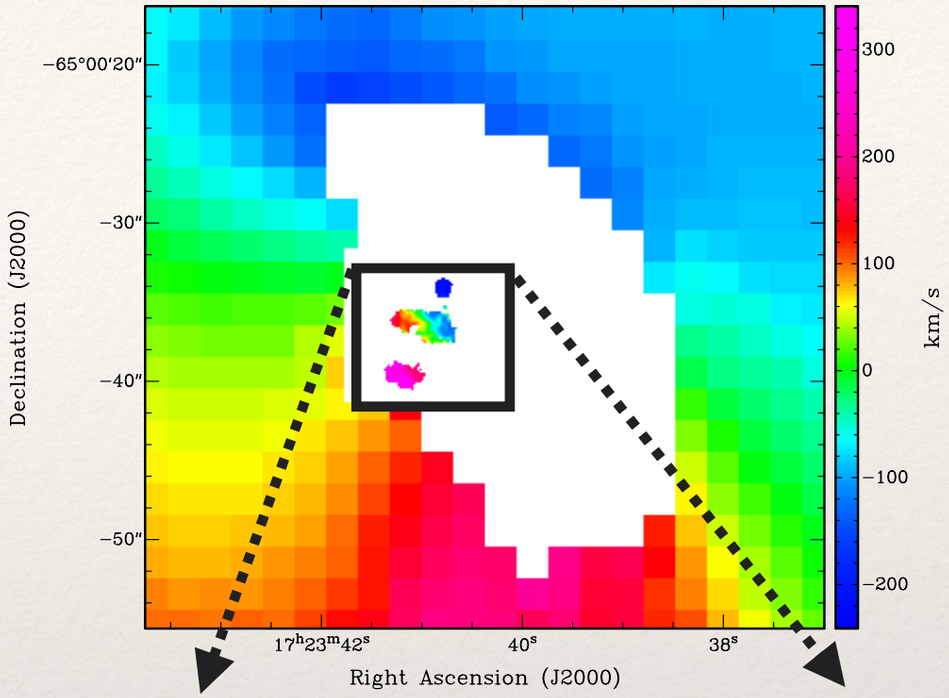
Undetected lines:

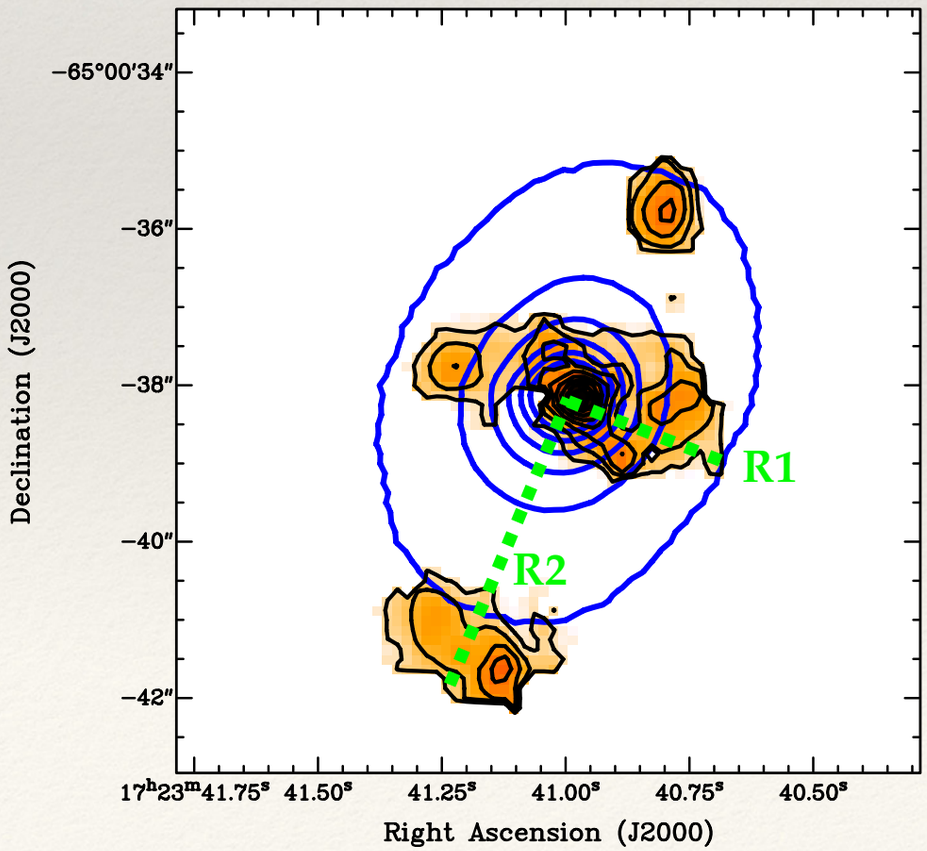
- Higher roto-vibrational states (2-1).
- Br γ: narrow line region tracer.
- Si [VI]: hot coronal gas tracer.

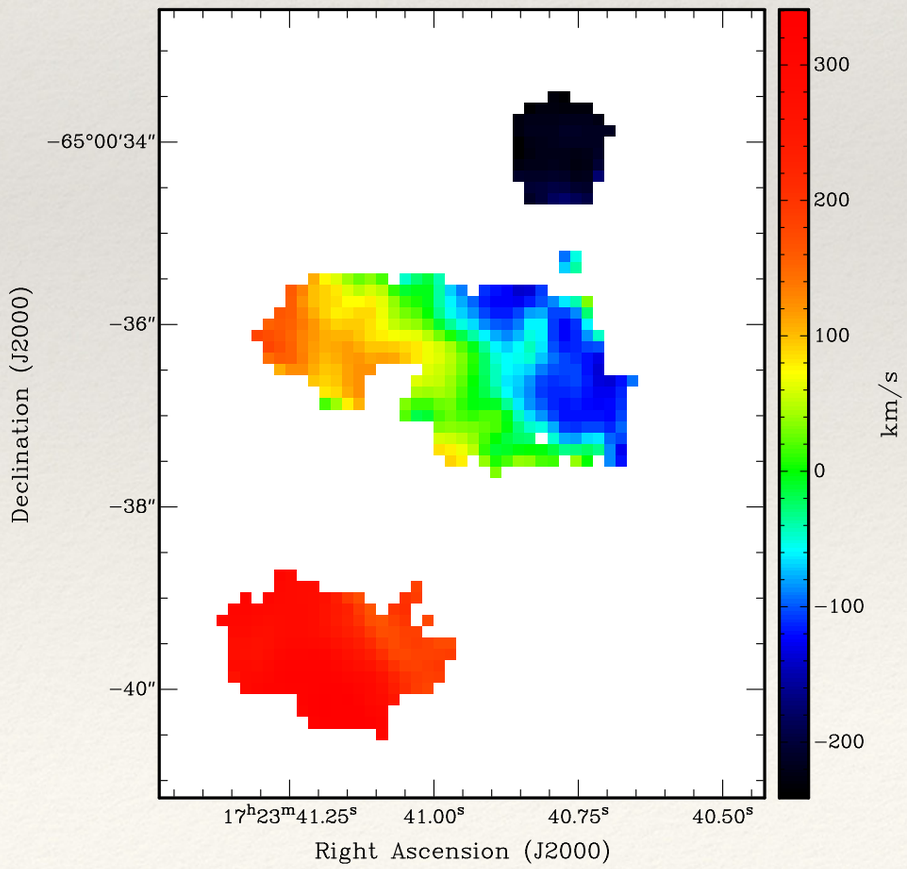


The kinematics of the Molecular Gas

- **H2 1-0 S(1) line** = strongest line
  - M_{H2} ~ 120 M_{Sun}
  - Trace the distribution and the kinematics
    - Outer radii (R1 < r < R2 ~ 1.2 kpc):
      - Follows rotation of HI.
    - **Inner radii (r < R1 ~ 700 pc):**
      - **Major axis perpendicular to outer disk.**
      - **Higher density and velocity dispersion**



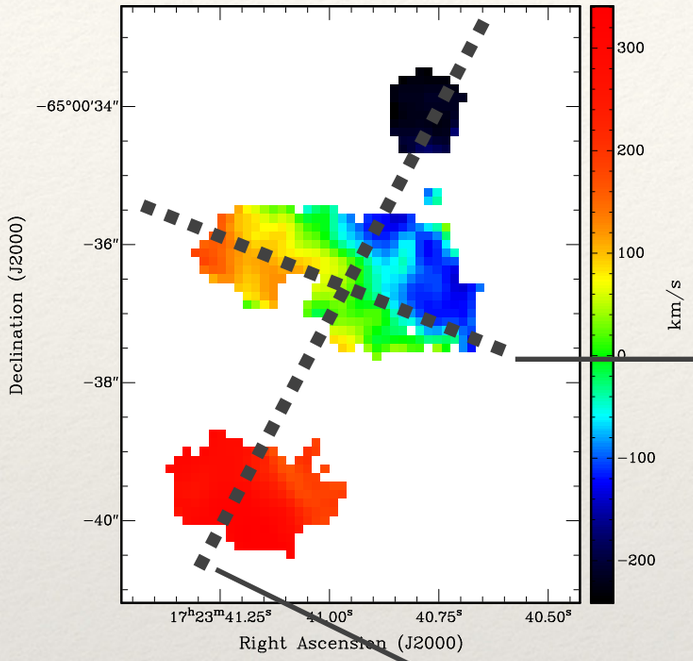


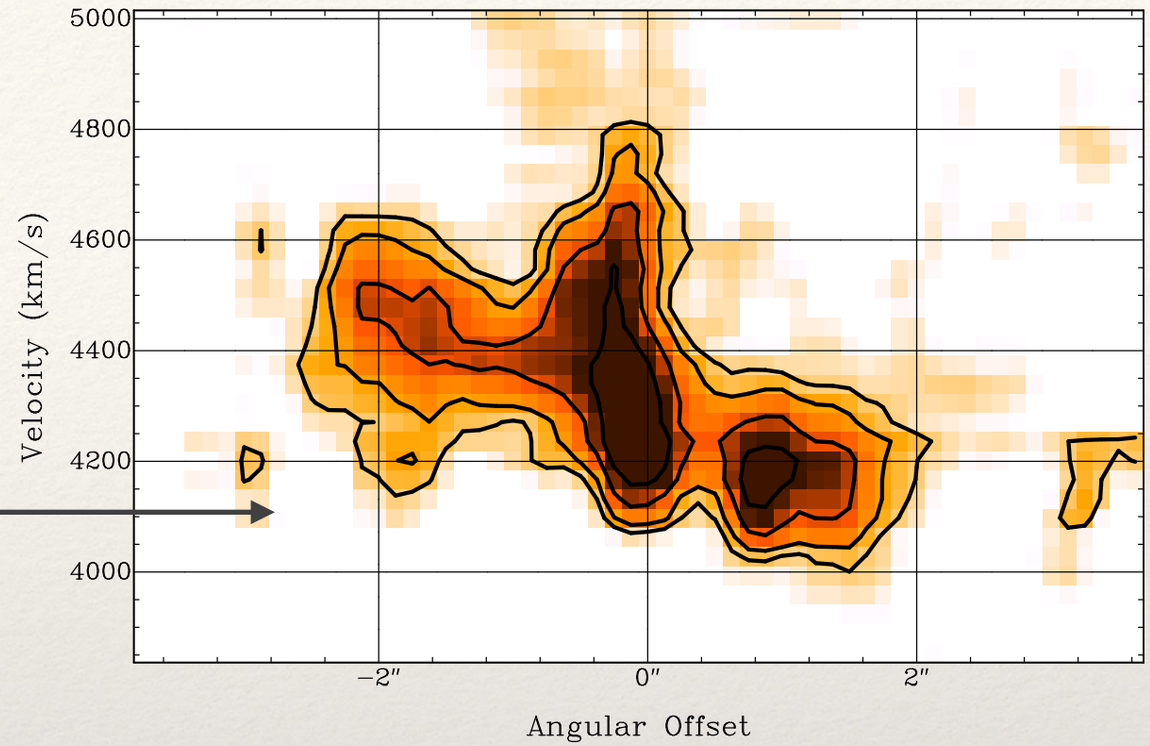


H2 in the centre of PKSB 1718-649

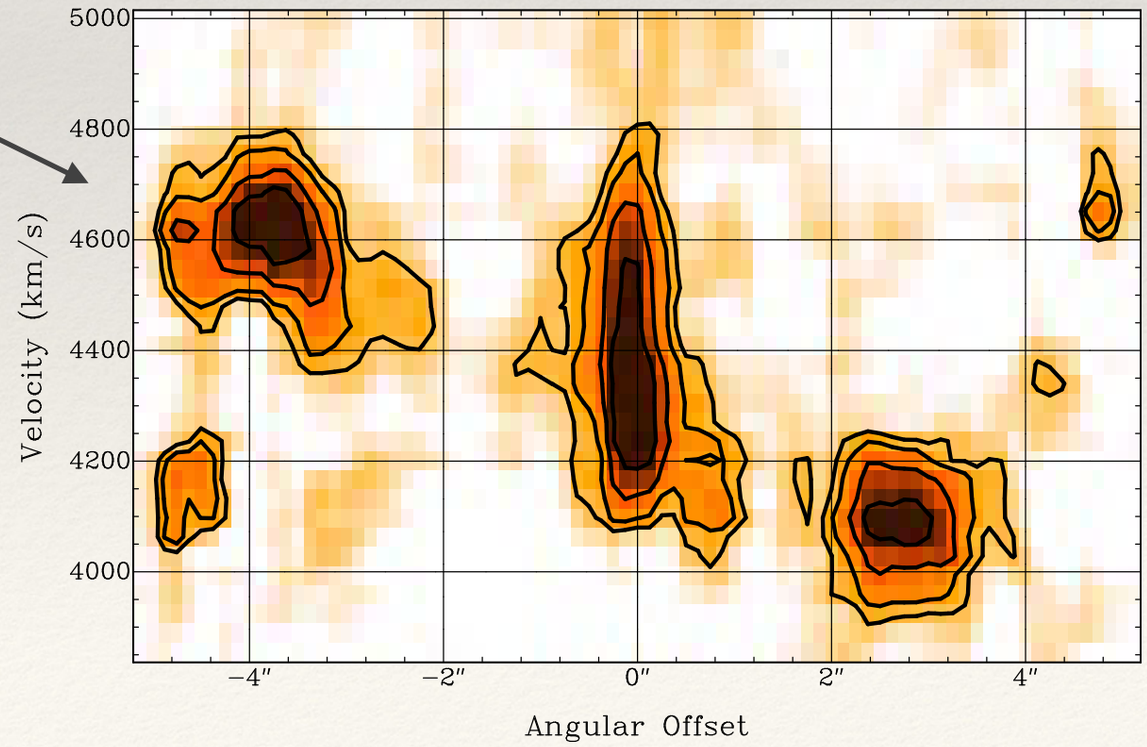
2 disks oriented perpendicularly

- cut along the 2 major axis

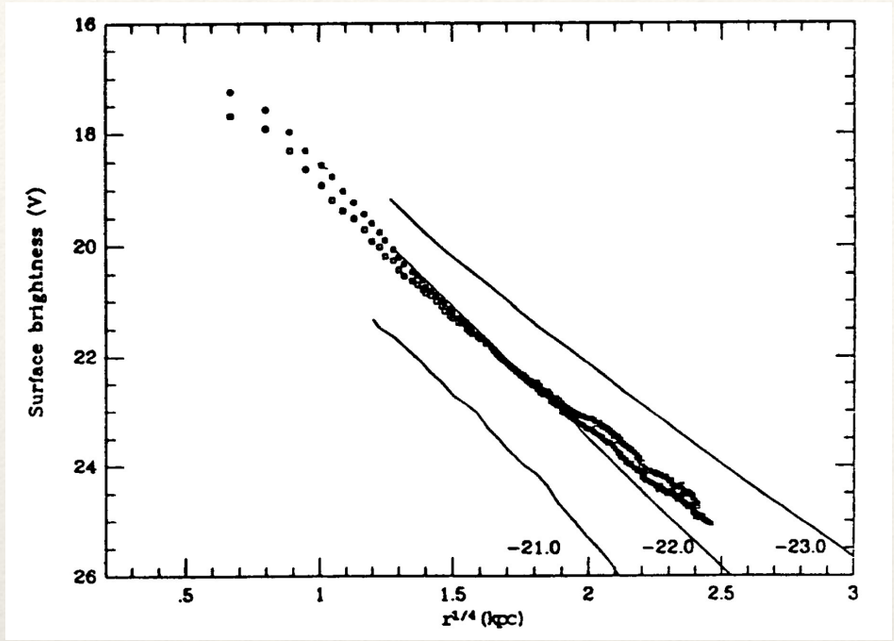




- Both pv-plots show 2 Components:
  - Smooth velocity gradient (i.e. rotation)
  - Centre: highly redshifted velocities
- Do we observe only H2 rotating?
- Is there a link between the high dispersion gas and the radio activity?



Analysis of the kinematics



PKS 1718-469 is hosted by an early type galaxy:

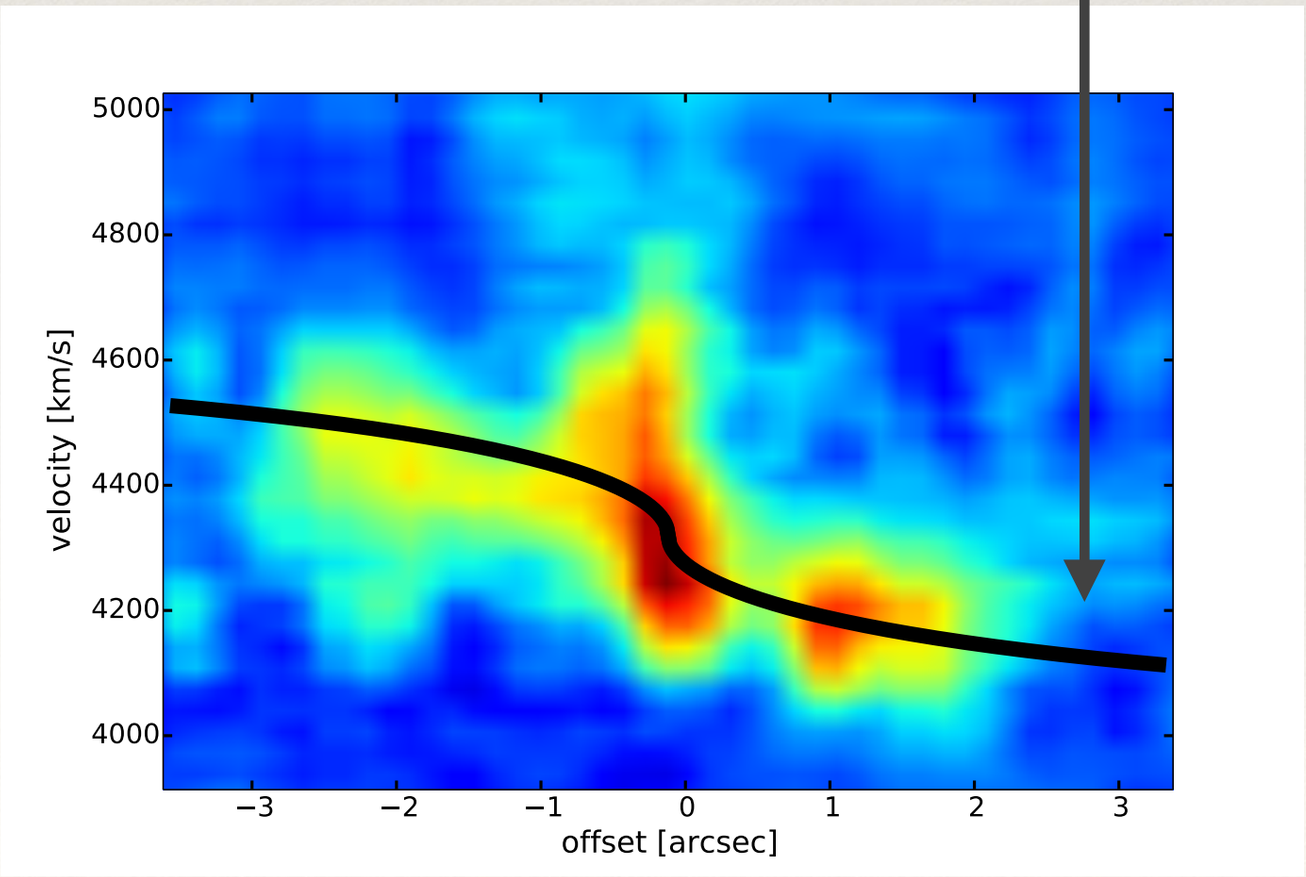
- de Vaucouleurs surface brightness profile
  - Hernquist mass distribution profile

$M = 4.9\ 10^{11}\ M_{sun}$

$r_{eff} = 9.7$ kpc

$$v_c(r) = \sqrt{\frac{GMr}{r + r_{eff}}}$$

- Smooth velocity gradient of the H2 matches with rotation in an ETG.
- The redshifted velocities cannot be explained by rotation.
  - In proximity of this newly borne radio source the kinematics of the molecular gas are highly disturbed.

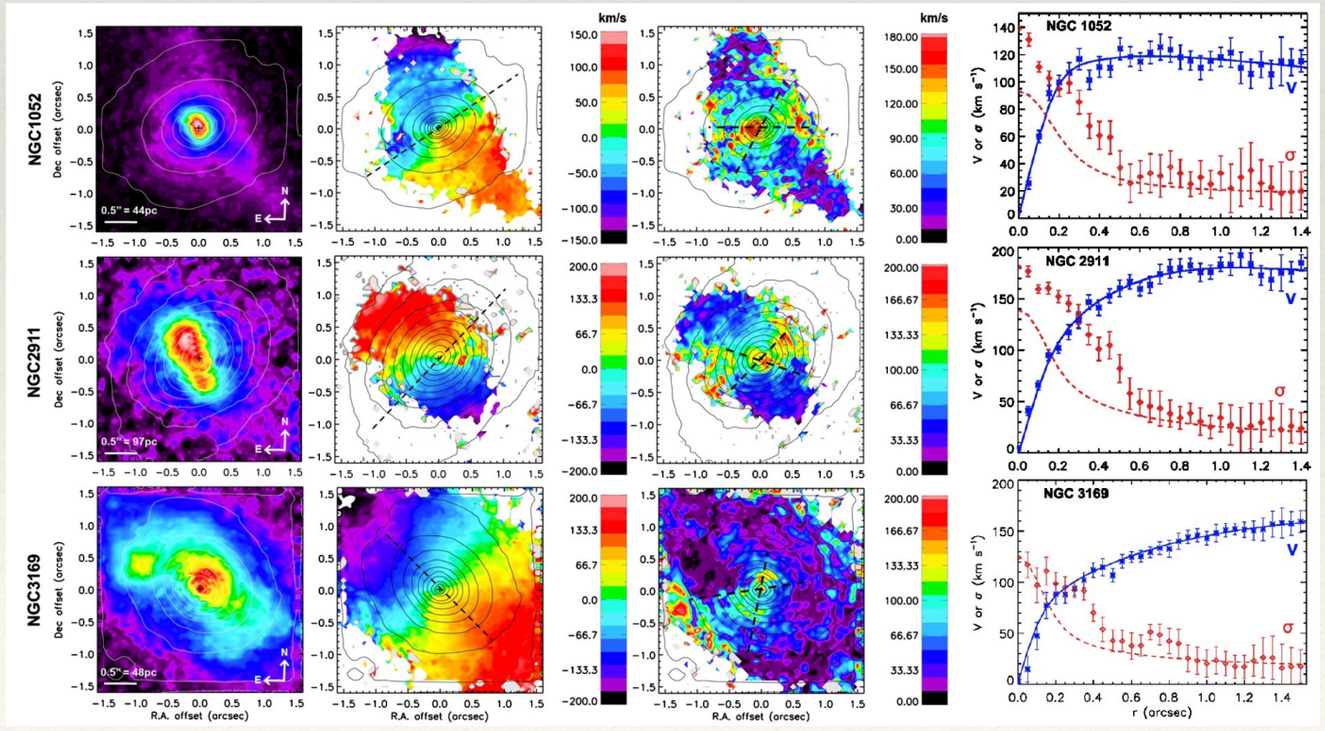


PKSB 1718-649 is not alone!

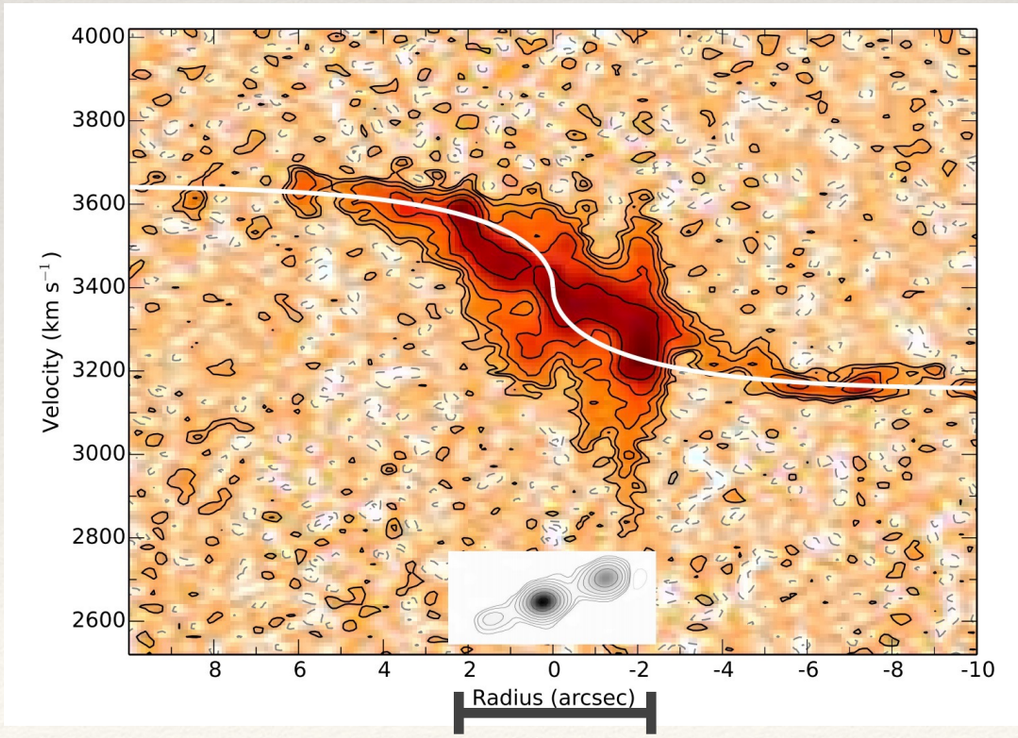
Similar kind of AGN to PKSB 1718-649 (low efficiency accretor) show similar features:

- LINER galaxies: low efficiency accretors [Muller-Sanchez, et al.; 2013]
  - H2 regularly rotating + high velocity dispersion in the centre.
  - No hot coronal lines: dense and cold
  - Dispersed gas linked to the fuelling of the AGN.
- IC 5063 [Morganti et al. 2015; Tadhunter et al. 2015]
  - Cold H2 [CO 2-1] separated in 2 components in the innermost 1 kpc
  - Regularly rotating disk + gas strongly affected by the radio jet.

LINER Galaxies



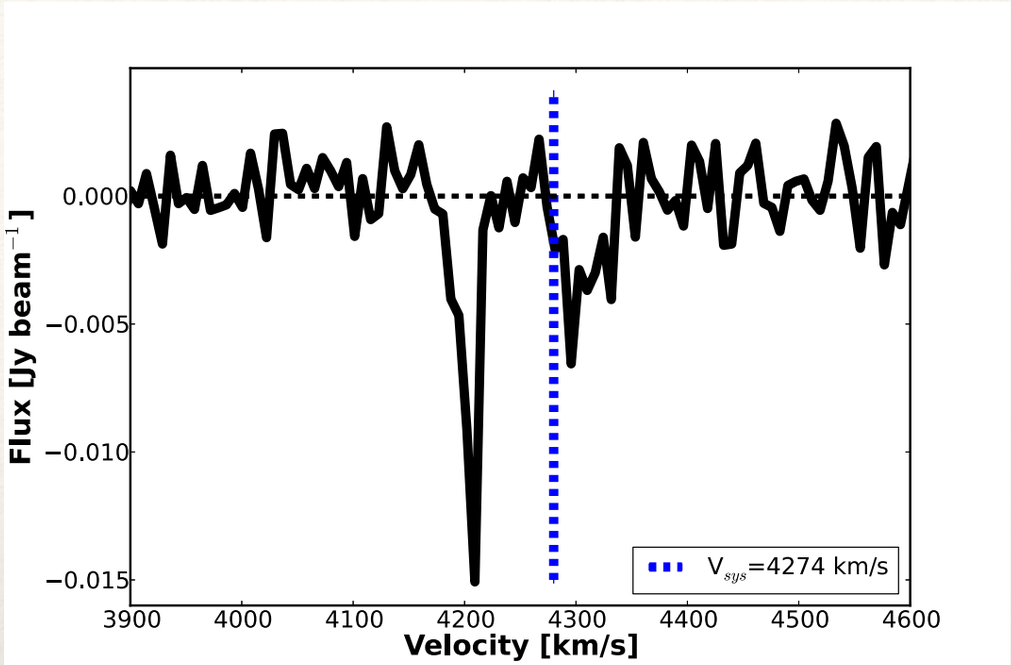
IC 5063



Conclusions

PKSB 1718-649 is a newly born low-efficiency radio AGN in an old, non-interacting galaxy.

- **HI absorption suggests a population of clouds of cold gas close to the AGN, not regularly rotating.**
- **Warm H2 suggests that only close to the AGN the gas deviates from rotation.**

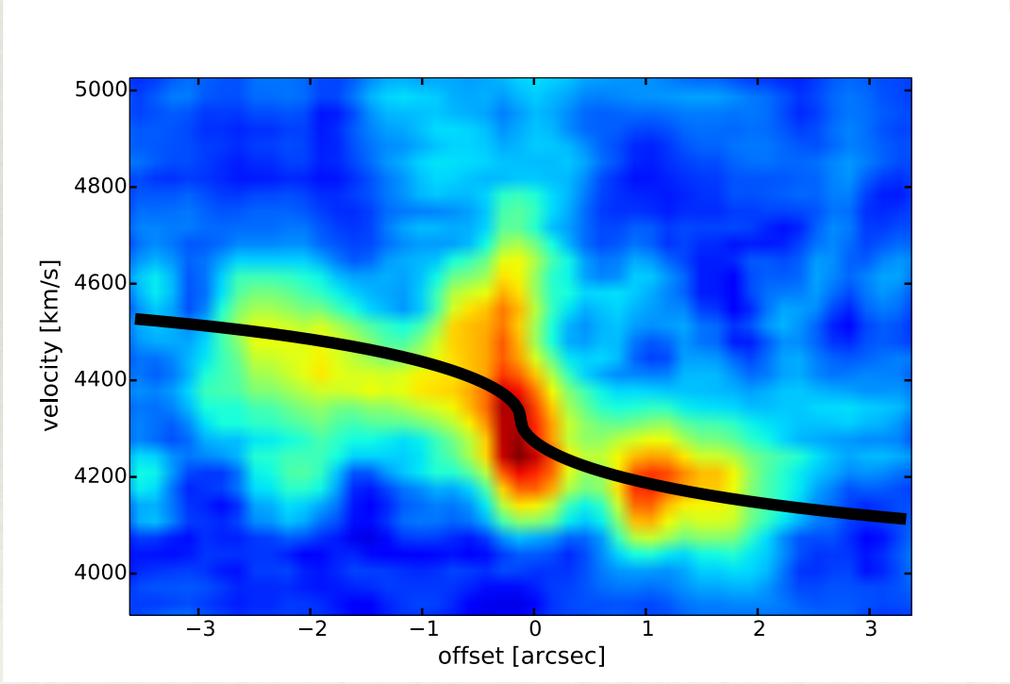


What has triggered it?

A physical phenomenon originating in the very centre which perturbs the neutral and molecular gas.

What is fuelling it?

The HI clouds and the highly dispersed H2 dispersed gas are massive and are close enough to fuel a low efficiency AGN.

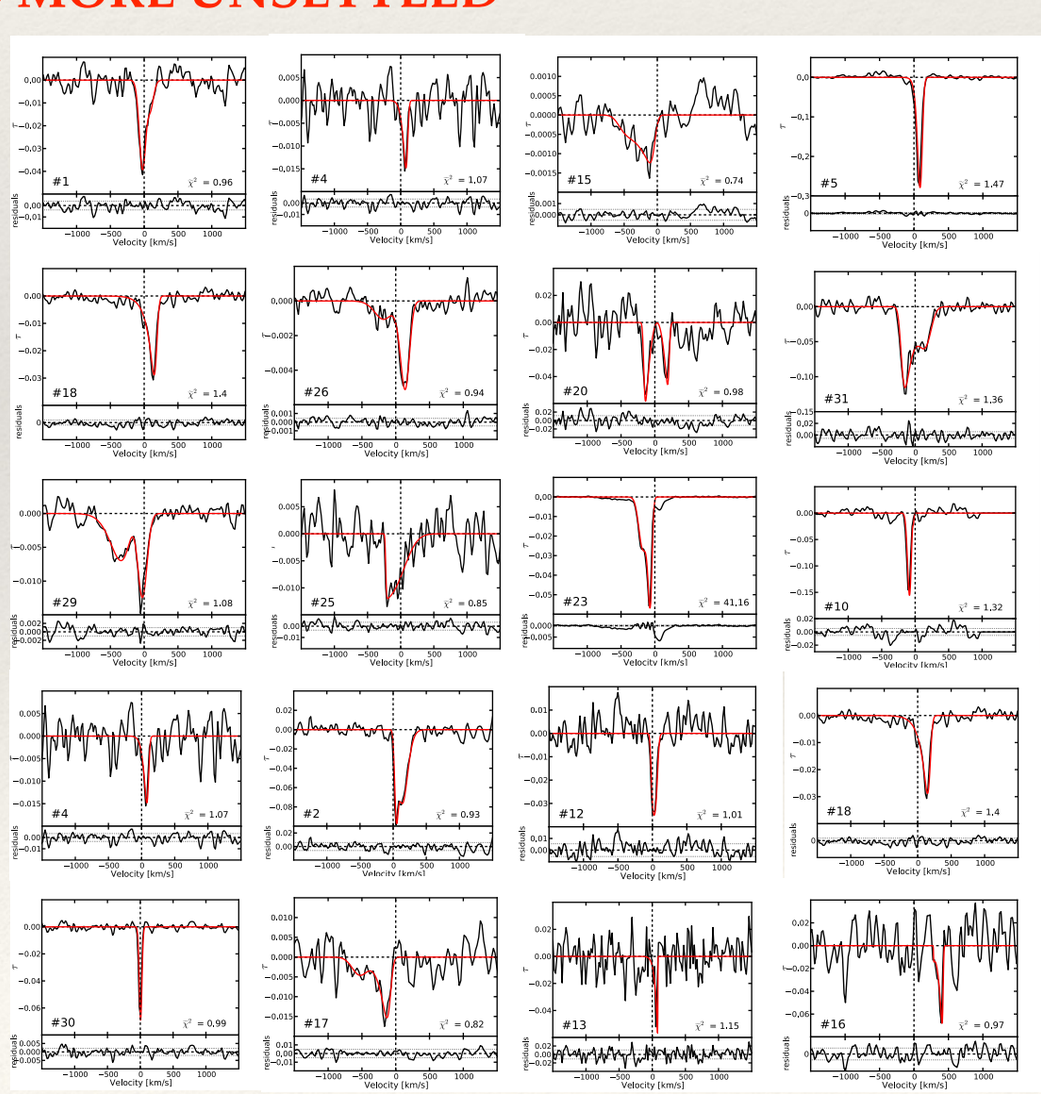


HI Absorption Zoo: building a Survey

Shallow WSRT absorption survey in preparation for APERTIF [Geréb, Maccagni, et al.; 2015]

- Flux (and Redshift) limited sample:
  - $S_{1.4GHz} > 50$ mJy
  - $0.025 < z < 0.25$
- 4-6 hours of observation: 30% detection rate of HI absorption lines
- Stacking experiments + Individual analysis
- **IN COMPACT SOURCES THE NEUTRAL HYDROGEN IS MORE UNSETTLED**

Raffaella's Talk!!!



HI Absorption Zoo: CSS and GPS