Dynamics of the ionized gas inside and outside galaxies

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Key questions to be addressed by SITELLE

- In galaxy evolution, how is kinetic energy of the *turbulence* dissipated?

- What is the importance of gas inflows and outflows *(galactic winds)*, and their impact on star formation?

- How do the different phases of the ISM interact? (*ionized gas* / *molecular gas*)

- What is the total mass of *ionized gas* inside and outside galaxies?

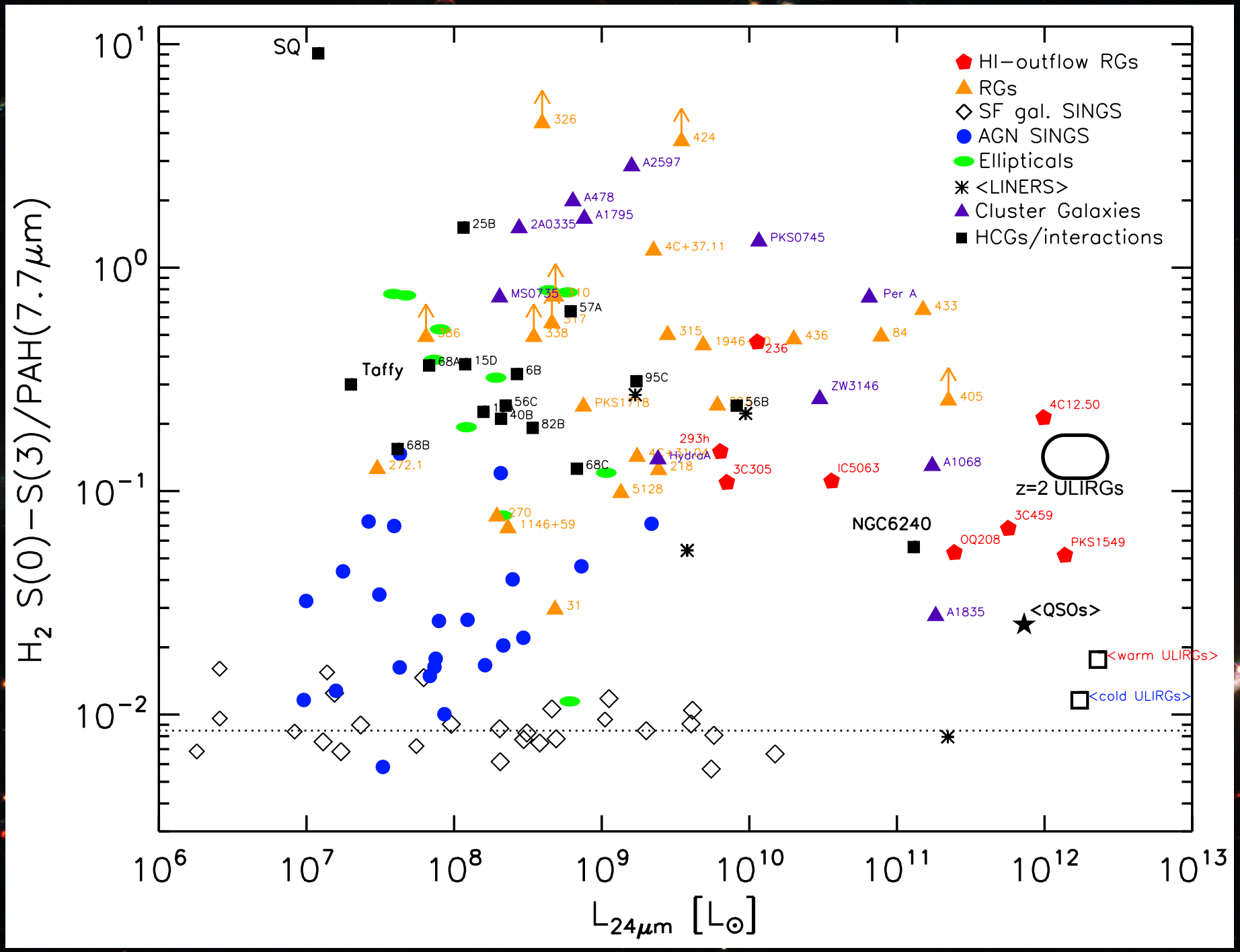
- What is the effect of *galaxy collisions* in the excitation of the gas

I. Observing turbulent galaxies with SITELLE

- Spitzer mid-IR spectroscopy has revealed a population of H_2-bright galaxies, where the H_2-line emission is powered by intense *turbulence* (*Guillard+09, Ogle+10, Guillard+12*).

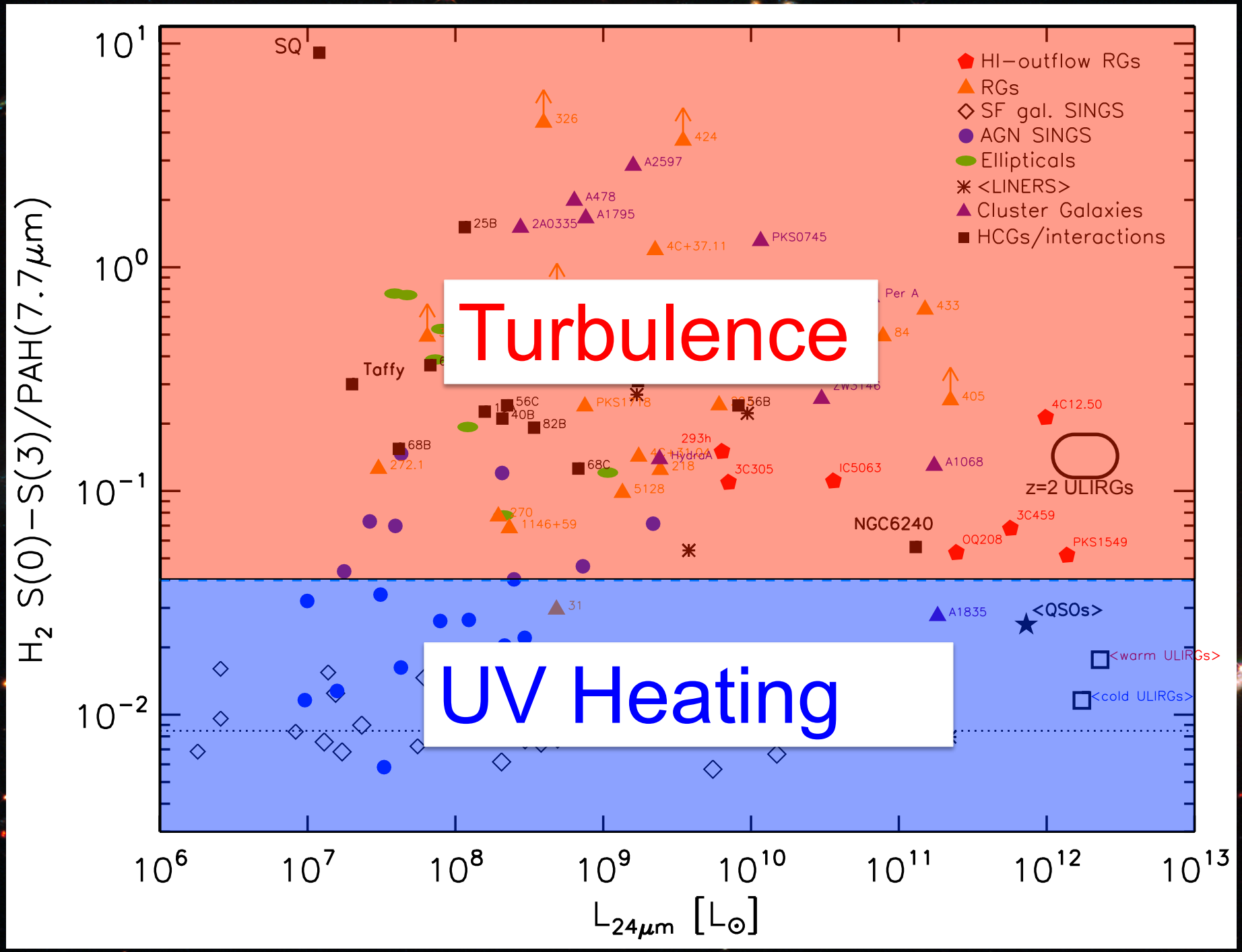
- Need for observations probing the dissipation of kinetic energy in the different phases of the ISM

H_2-luminous galaxies



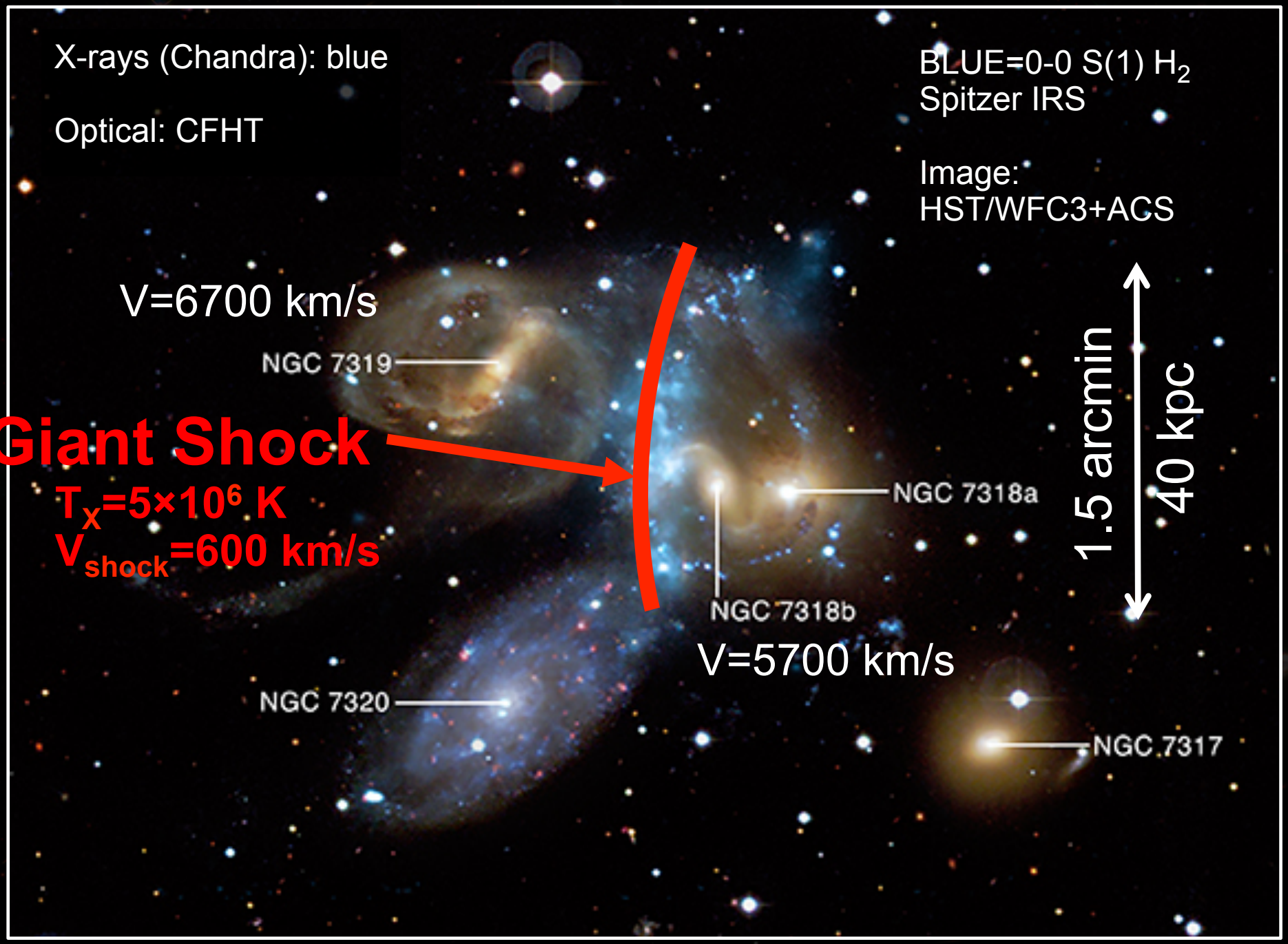
Updated from Guillard et al. 2012a, ApJ, 747, 95

H_2-luminous galaxies

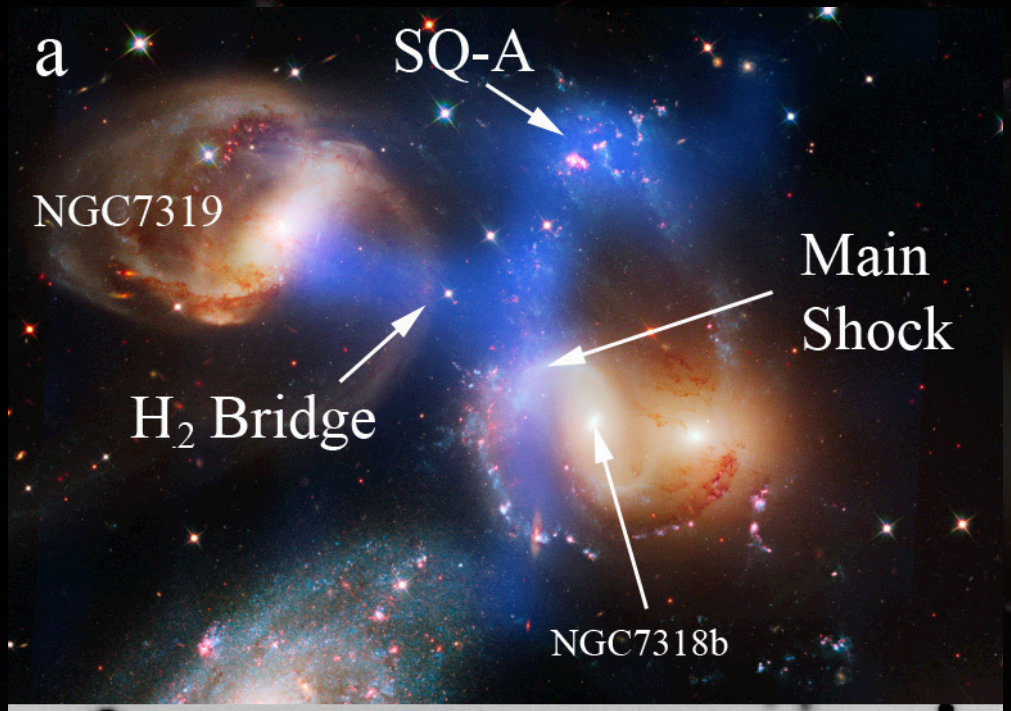


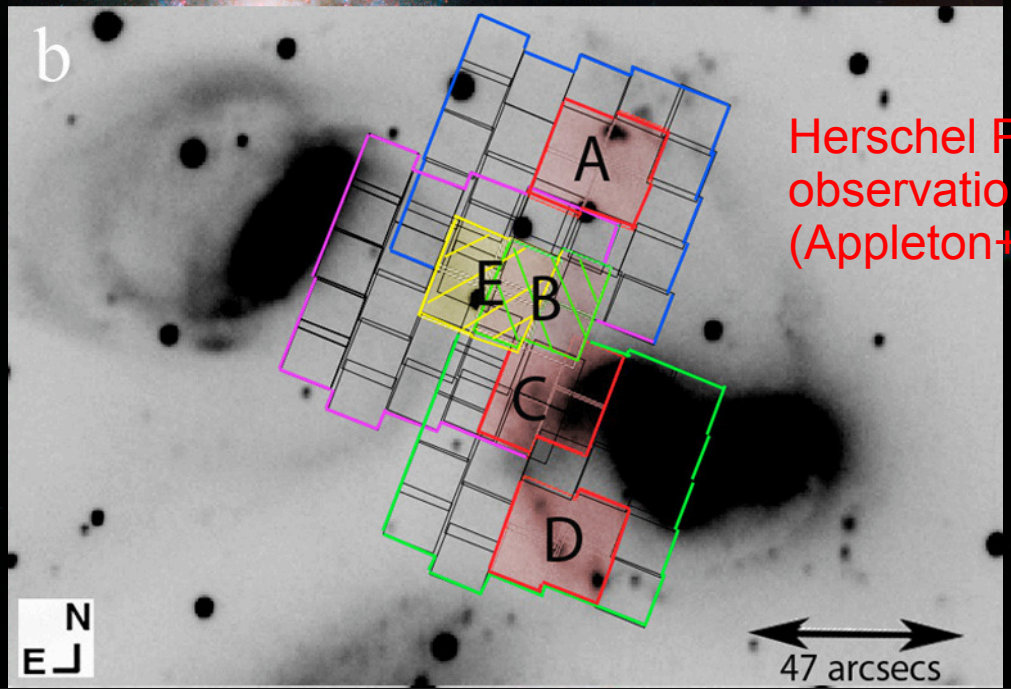
Updated from Guillard et al. 2012a, ApJ, 747, 95

Stephan's Quintet: Star formation in an *extremely* turbulent medium

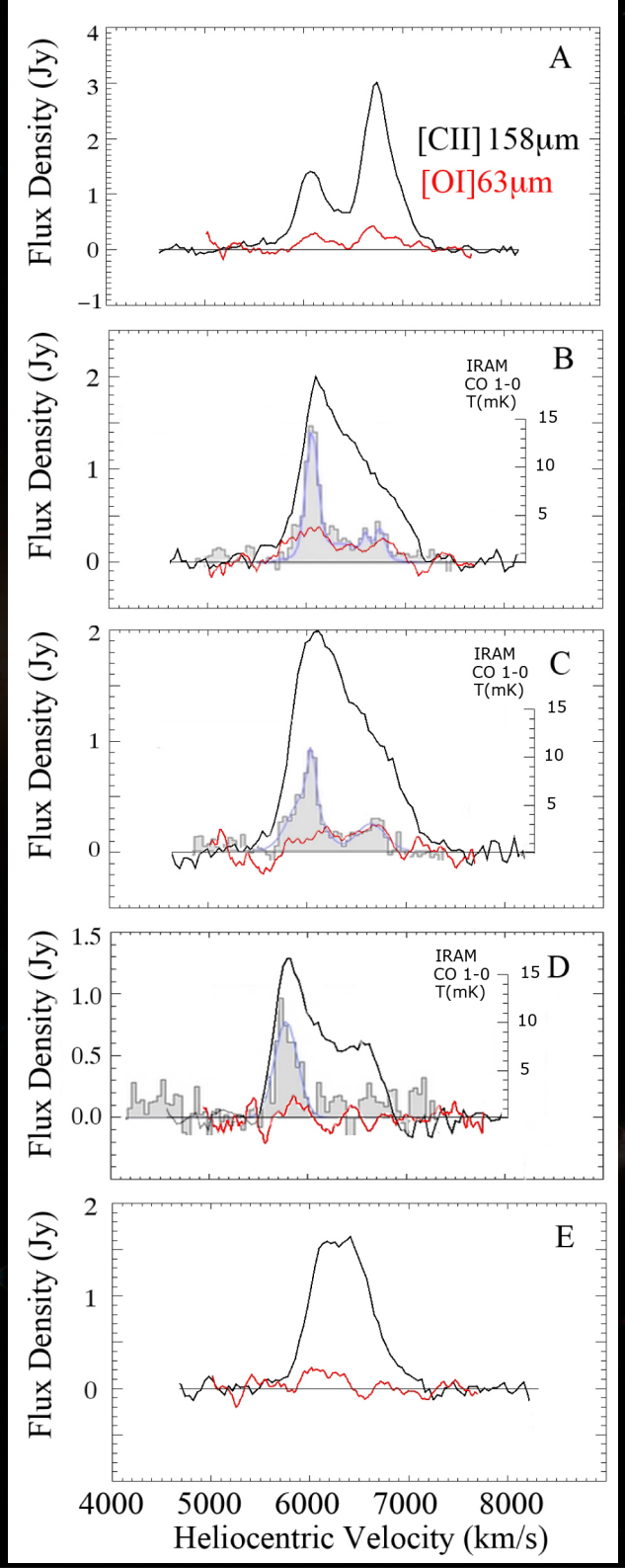


Extremely turbulent [CII]158μm and CO line emission

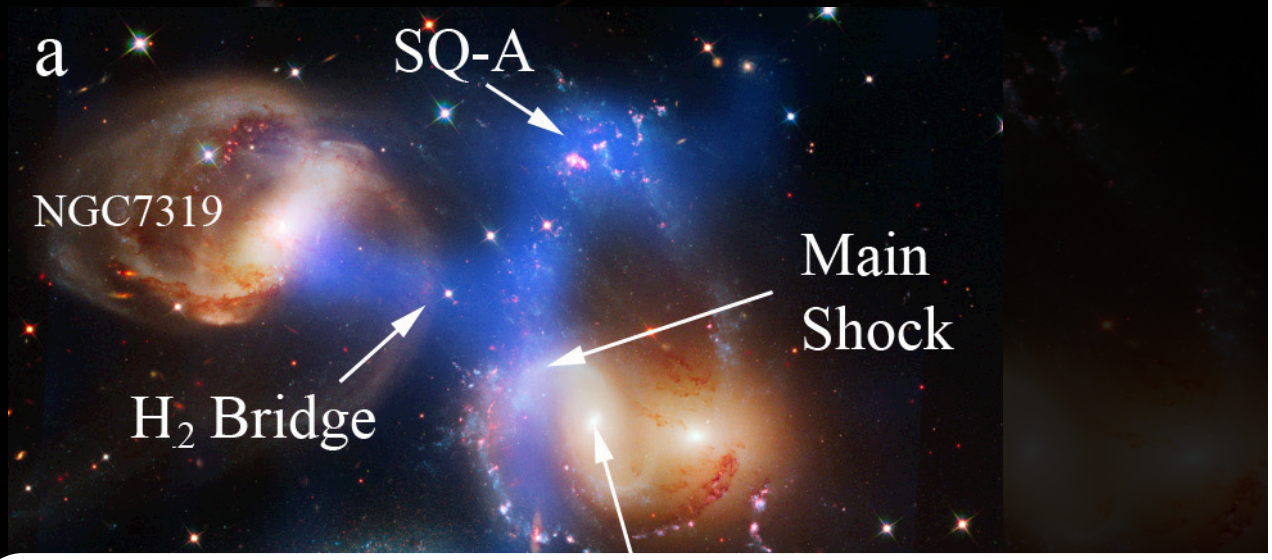


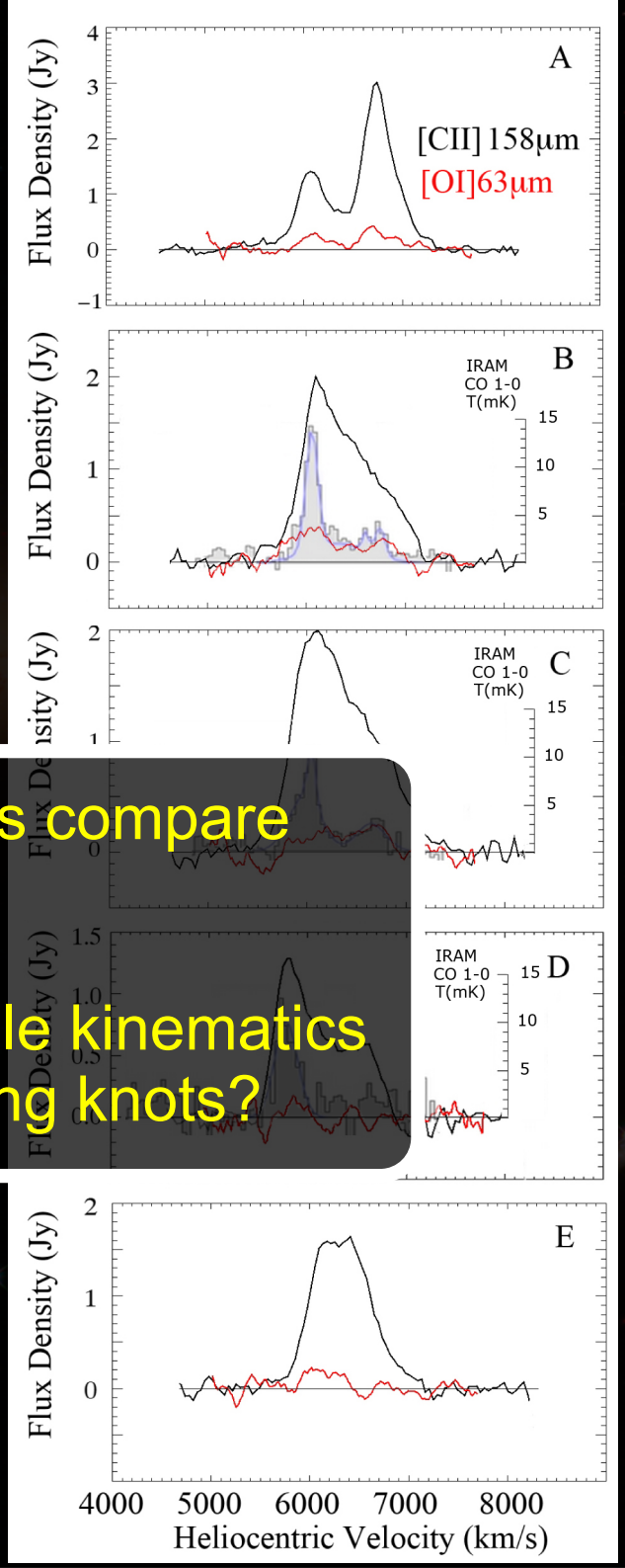


Herschel PACS observations (Appleton+13)



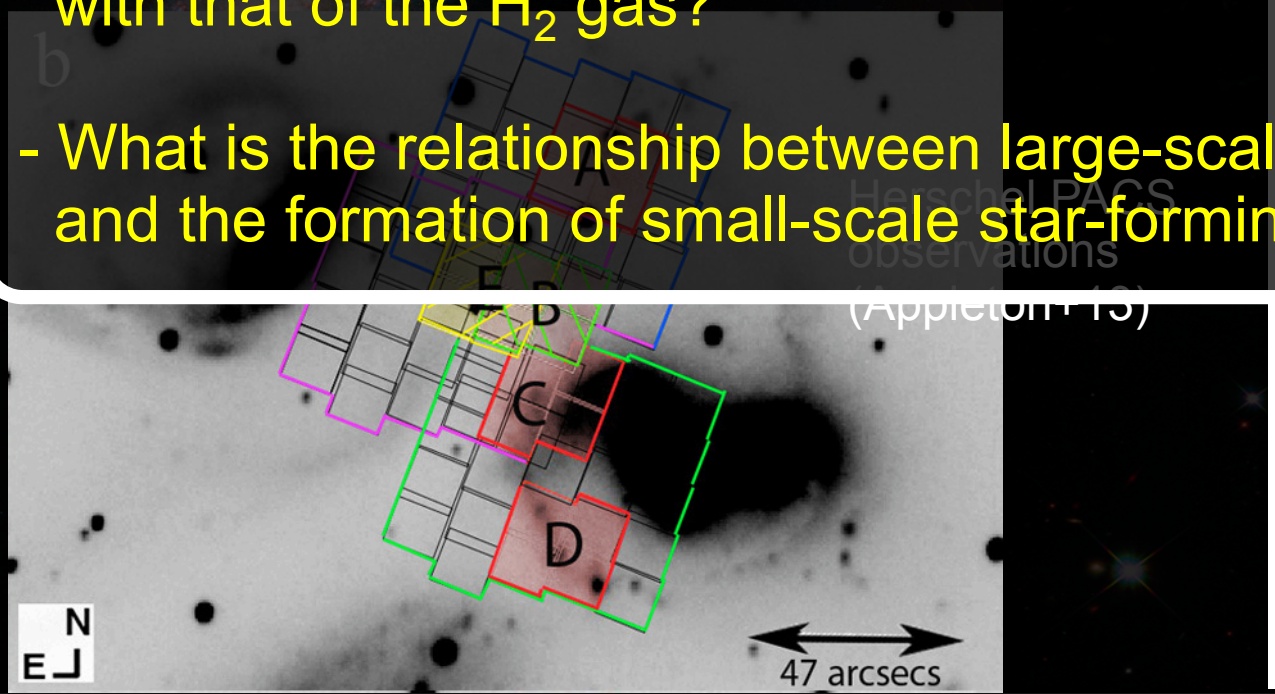
Extremely Turbulent [CII]158μm and CO line emission





- How does the kinematics of the ionized gas compare with that of the H_2 gas?

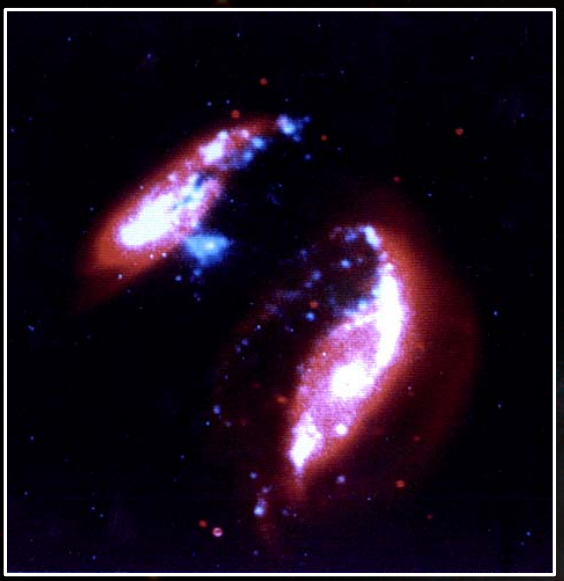
- What is the relationship between large-scale kinematics and the formation of small-scale star-forming knots?



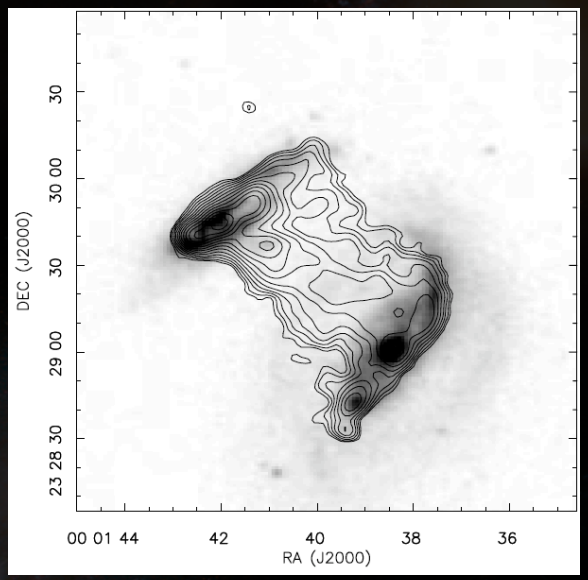
Herschel PACS observations (Appleton+13)

II. Observing head-on collision between two galaxies: powerful H_2 turbulent heating in **Taffy galaxies**

- collision between two galaxies creates a common radio halo
– magnetic field of galaxies pulled out like Taffy candy!

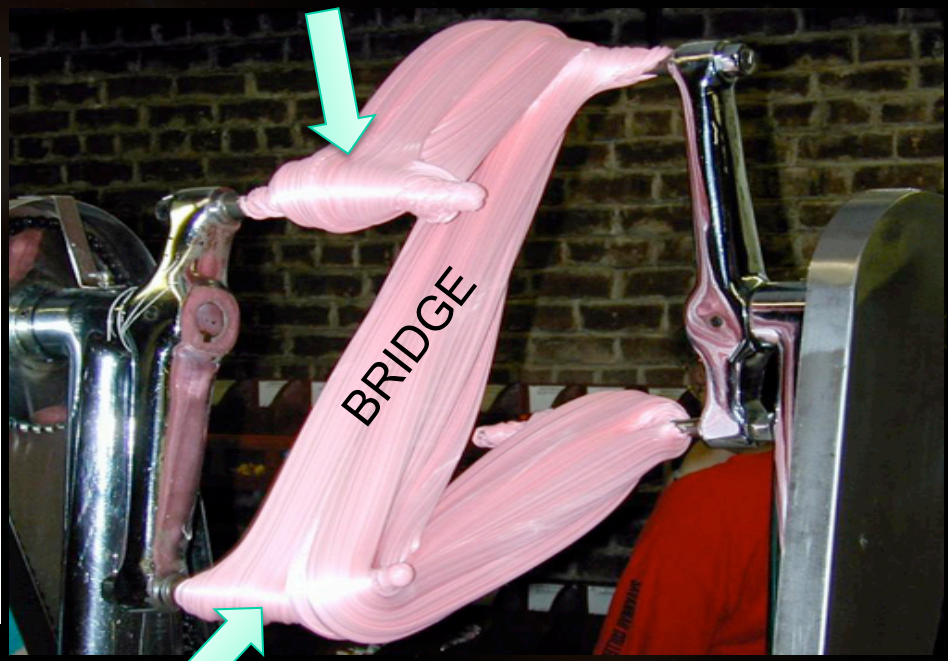


R-band (Red) + H-alpha (Blue)



1.49 GHz contours from Condon et al. (1993) overlaid on DSS image (Jarrett et al. 1999)

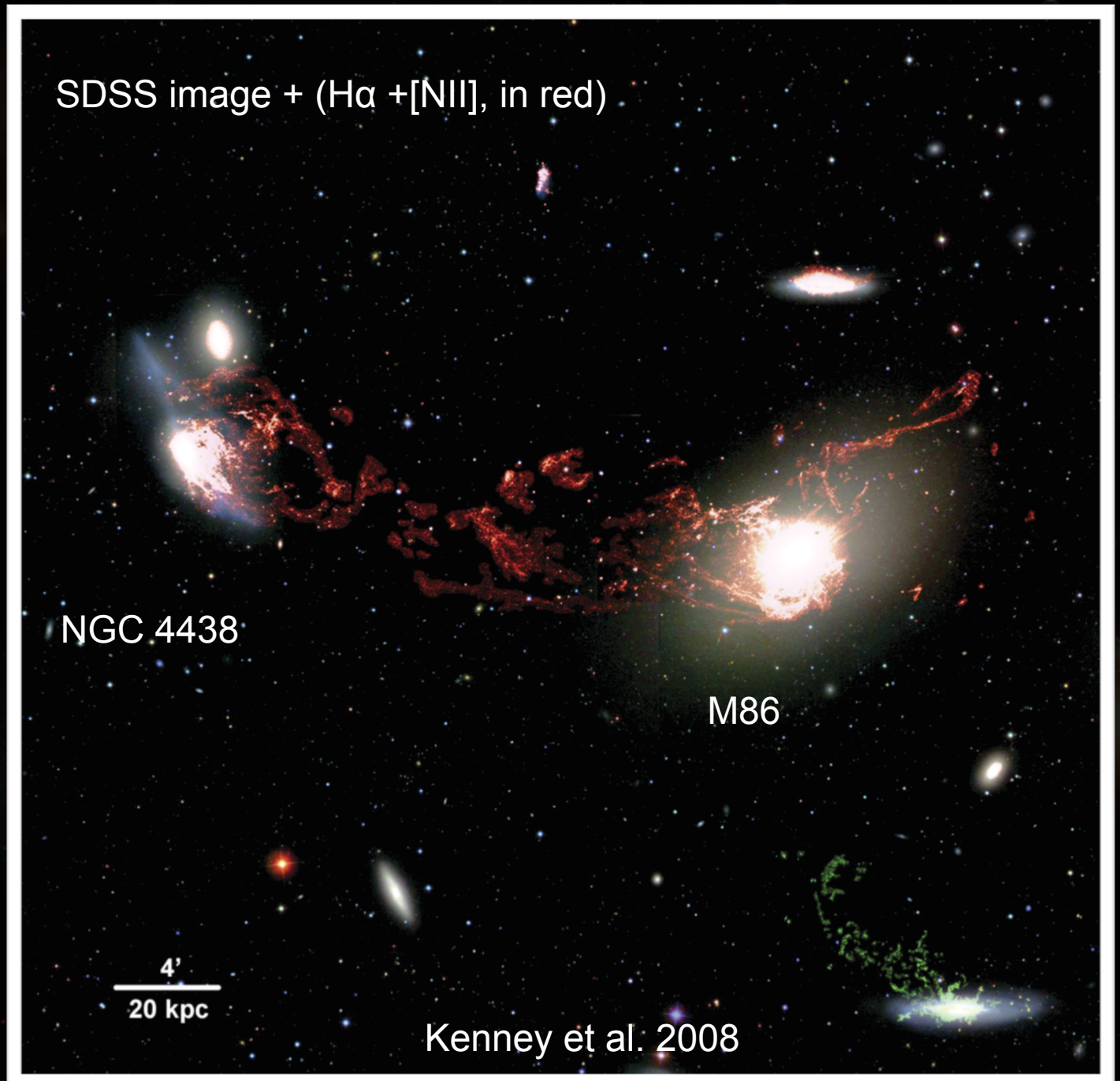
UGC 12915



UGC 12914

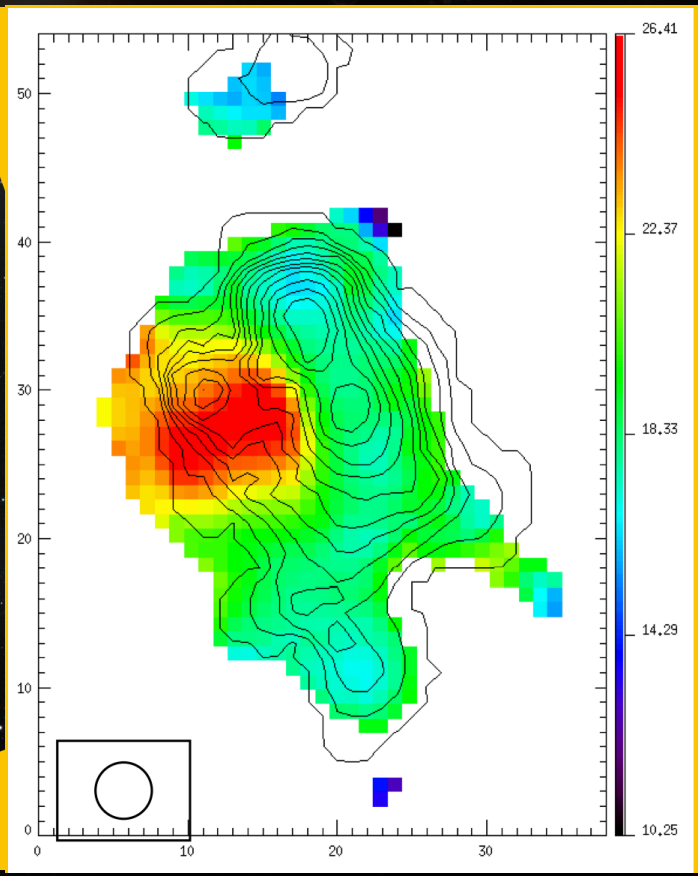
Realistic Simulation

Gas and dust stripped out of a galaxy due to a galaxy-galaxy collision (1/2)

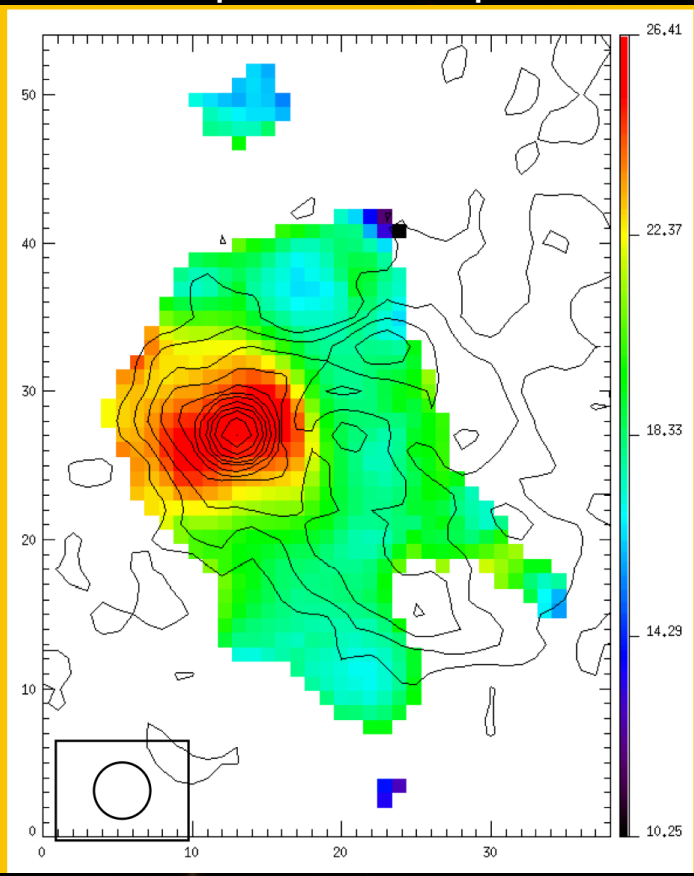


Gas and dust stripped out of a galaxy due to a galaxy-galaxy collision (2/2)

HI contours on dust temperature map



0.3 – 2 keV contours on dust temperature map



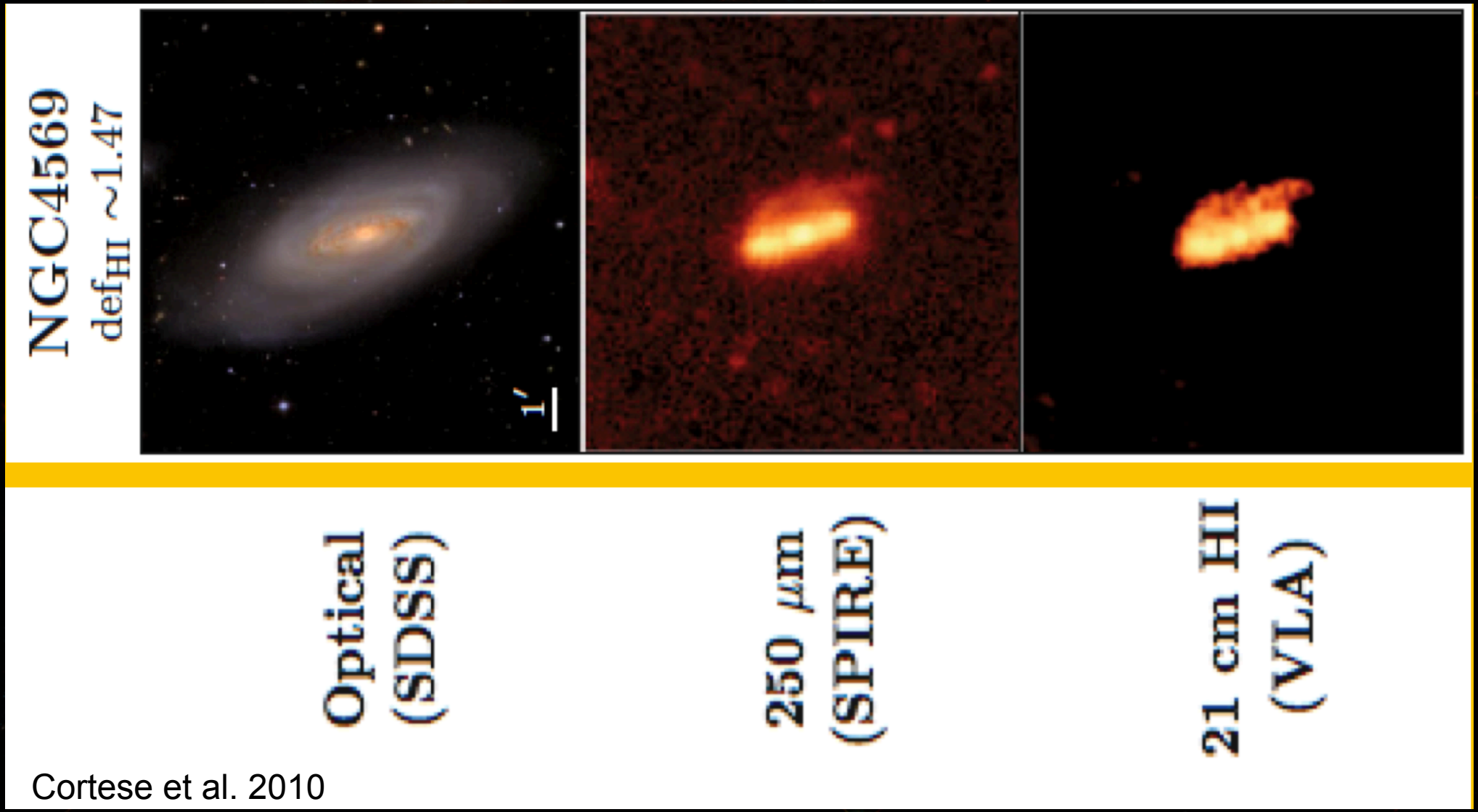
Maps: Courtesy of Marco Bocchio

→ Offset between gas and dust spatial distribution: the dust is heated by the X-ray emitting gas

→ Need for high-resolution morpho-kinematics of the ionized gas

III. Ram-pressure stripping in galaxy cluster

Asymetry in the gas and dust profiles (in Virgo)



Cortese et al. 2010

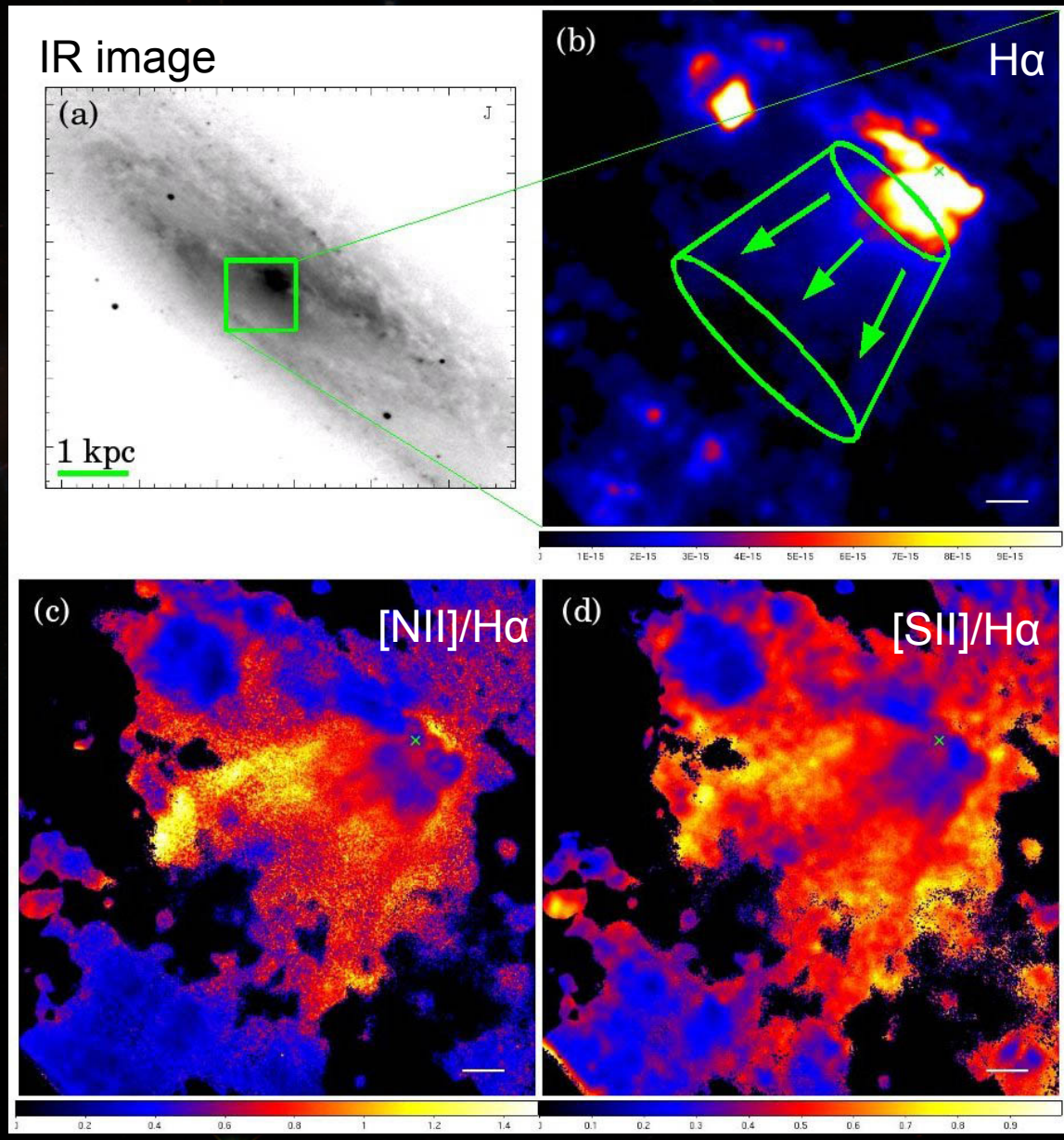
IV. Galactic winds

- Important tracer of the feedback processes that regulate star formation and galaxy growth
- Mainly observed at UV, optical wavelengths (ionized/atomic gas).

- What is the total mass of ionized gas entrained in the outflow?
- How is the gas cooling?

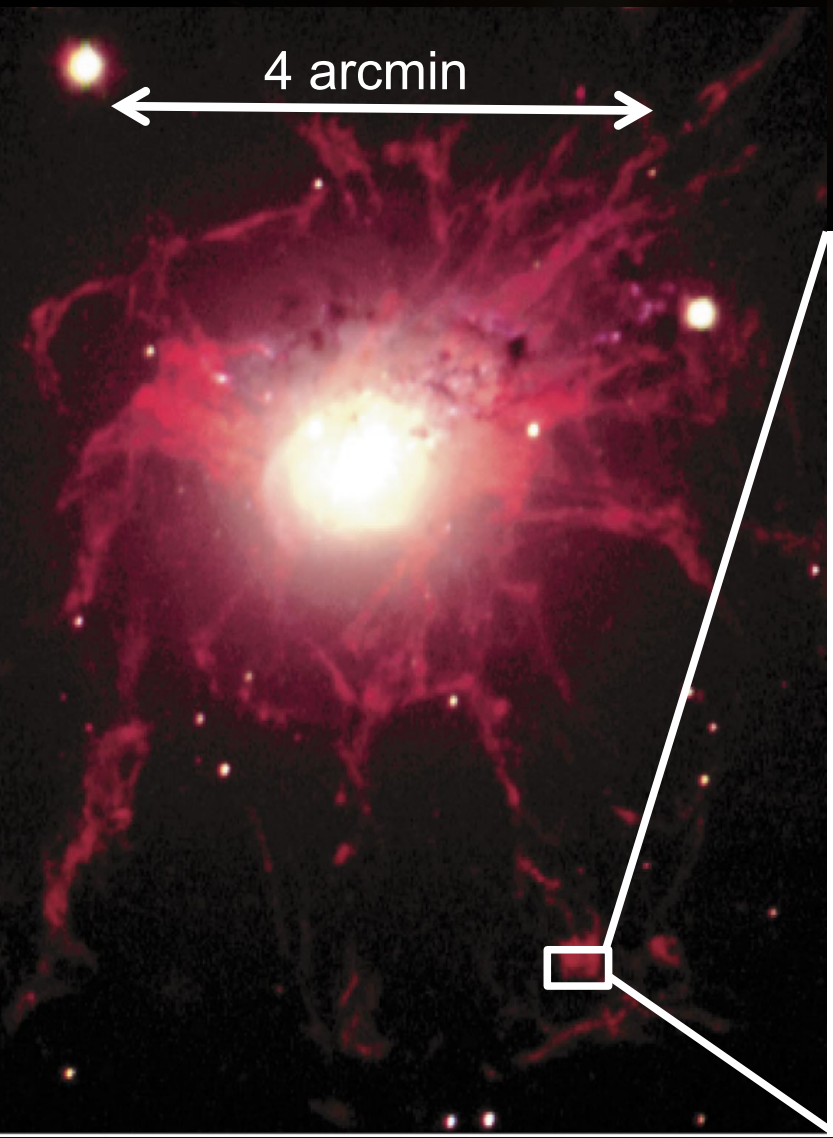
Need to study the kinematics of the multiphase gas in AGN-driven or starburst-driven winds on large spatial scales, and high spatial/spectral resolution

NGC 253

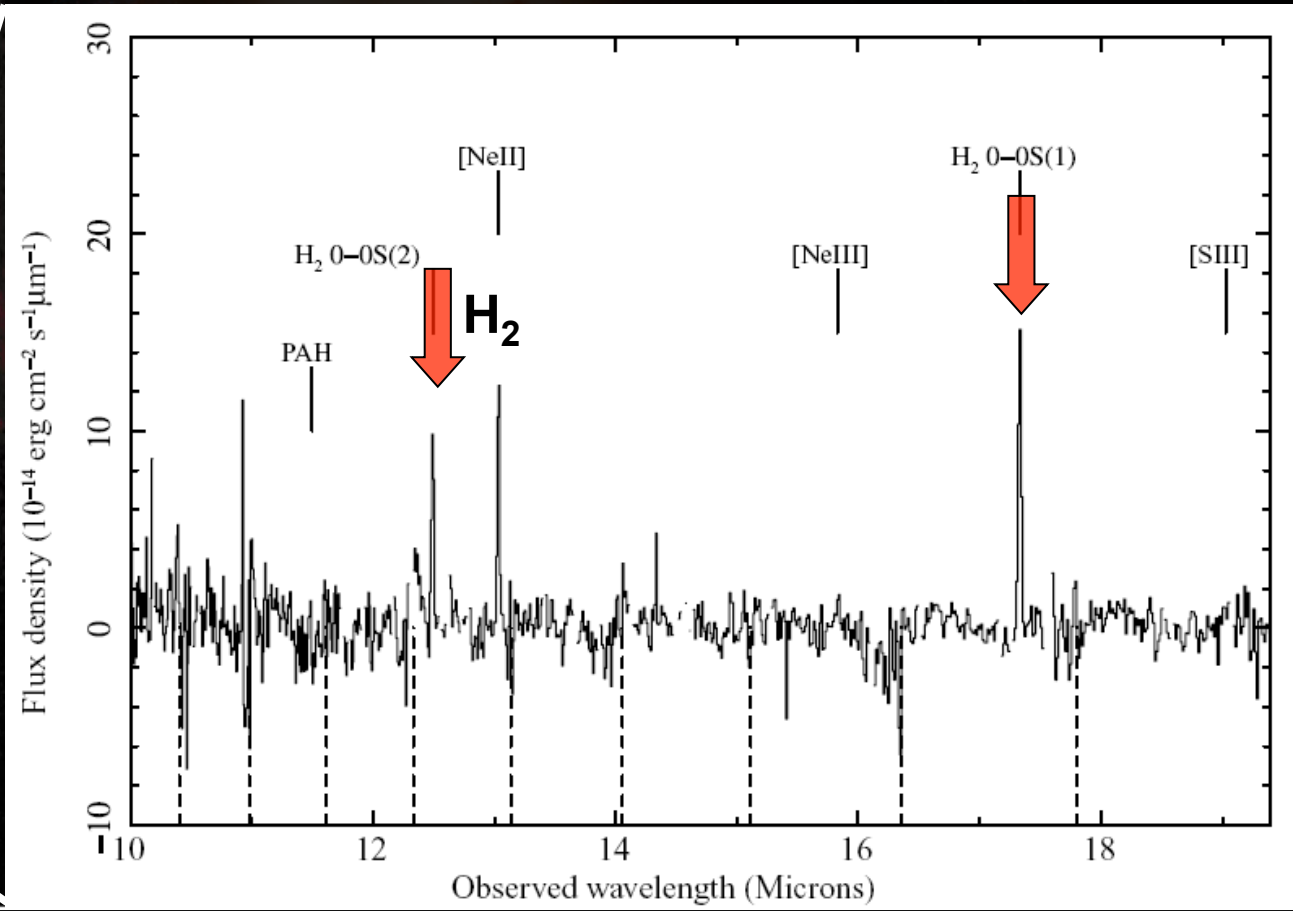


H_2 in cooling flows: example of the Perseus Cluster

H_α image: Conselice et al. 2001



Spitzer IR spectrum (Johnstone et al. 2007)



Conclusions

- SITELLE will be able to adress key questions about the role of turbulence and in/outflows on the self-regulation of star formation.

- Need for high spatial and spectral resolution of the morpho-kinematics of the ionized gas inside and outside galaxies in turbulent environments such as:
  - galaxy collisions
  - galaxy clusters
  - ram-pressure stripping
  - AGN or starburst driven winds

Observing conditions:

- standard Hα filter (*Hα, [NII], …)*
- maximum spectral resolution (≈ 15,000) for kinematics studies