Thermal and non thermal components of interstellar medium at sub-kiloparsec scales in galaxies*

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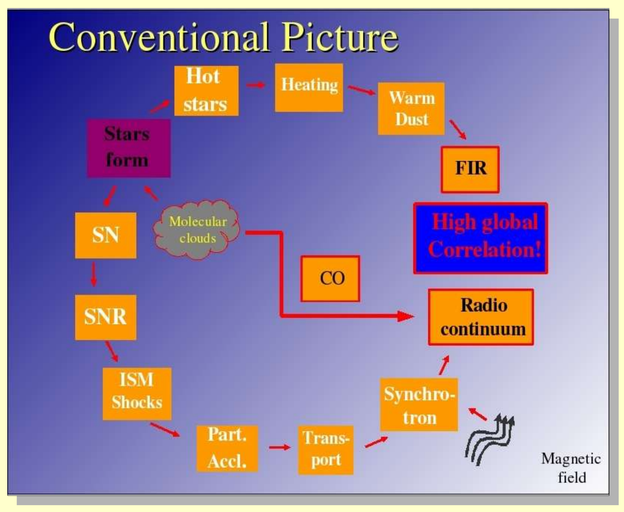
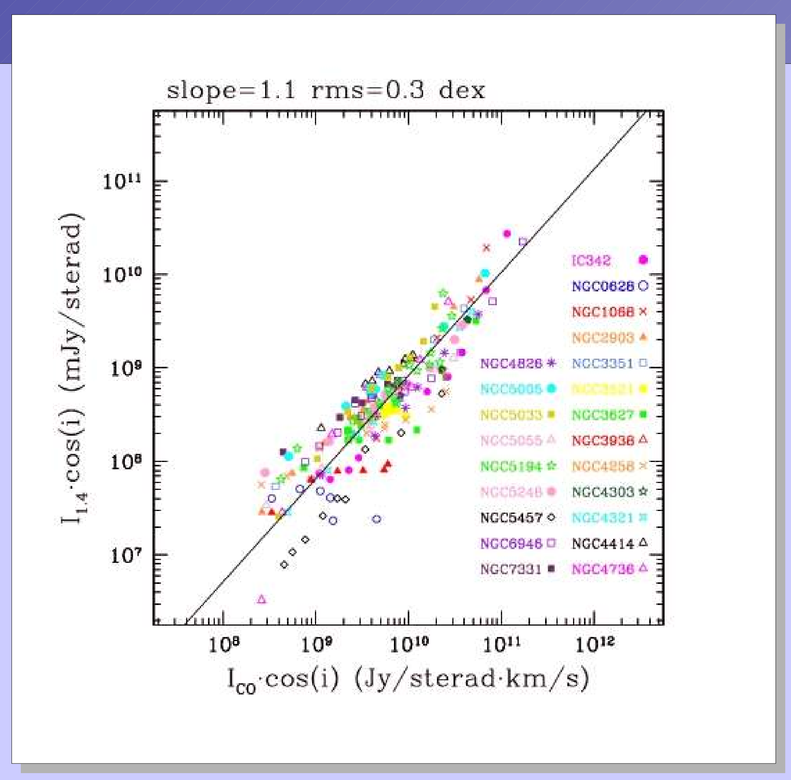
The tight correlations between far-infrared (FIR), CO and radio continuum (RC) emission in galaxies (*e.g. Yun et al., 2001, Murgia et al., 2002*) require a coupling between thermal and non-thermal emission processes that remains poorly understood.

The "conventional" model does not plausibly explain the tightness of the correlations given the entirely different processes and timescales involved. Detailed studies of individual objects at high spatial resolution are essential to understanding whether there is a common physical process behind the observed correlations and possibly synthesizing the various empirical descriptions.



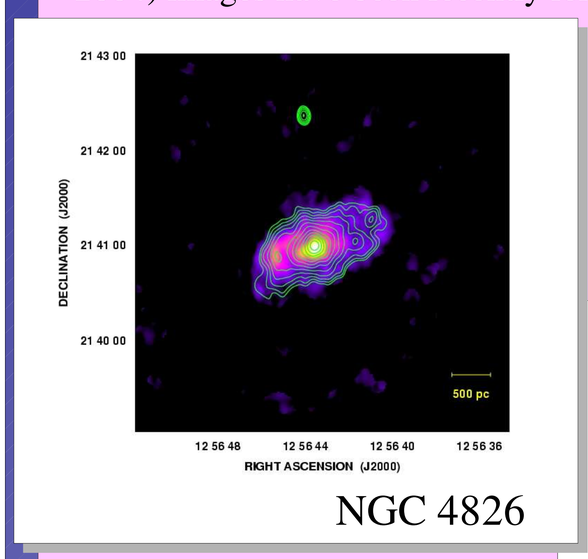
From illustration of Ekers 1991



Correlation between the RC and CO emission in 22 galaxies. Each point represents the average value of the brightnesses in an annulus. The solid line is a weighted fit to the points shown, which takes into account the errors in both coordinates.

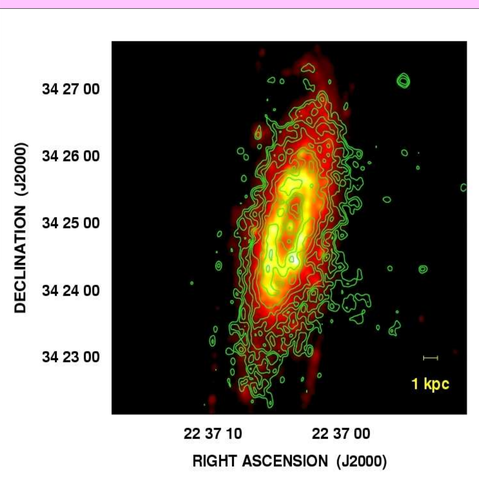
The resulting correlation has a slope of 1.1 and a rms of 0.3 dex, i.e. the RC-CO correlation is linear with a dispersion less than a factor of two.
We note that this figure shows distance-indipendent intensity measurements, not luminosity measurements, and intensities extend over 4 order of magnitude.This CO-RC correlation appears to be a general characteristic for spiral galaxies whose radio emission is dominated by star formation activity.

We analysed:
the point-by-point correlation between the RC and CO intensities from kpc to sub-kpc scales in 22 BIMA SONG (*Helfer et al., 2003*) galaxies and the point-by-point correlations at sub-kpc scales between the RC, CO and 24 μm-IR emissions in 6 galaxies for which *Spitzer* (*Werner et al.*, 2004) images have been recently released.



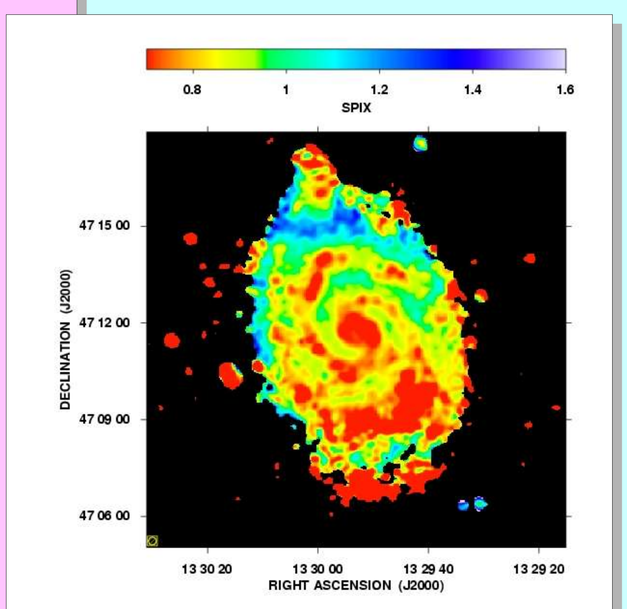
NGC 4826

1.4 GHz contours superposed on false color BIMA CO image of NGC 4826 at 6″ (120 pc) resolution.



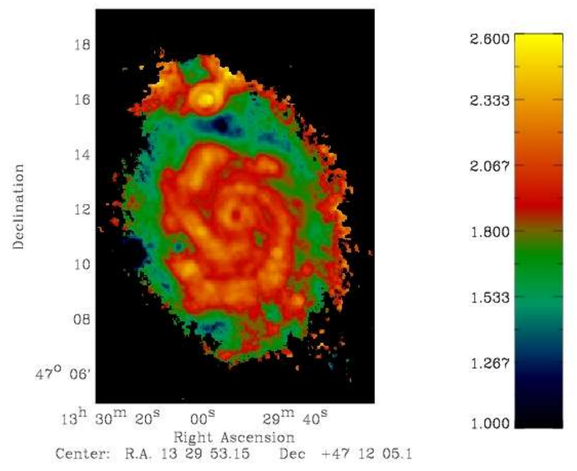
NGC 7331

1.4 GHz contours superposed on false color Spitzer 24 μm image of NGC 7331 at 6″ (400 pc) resolution.

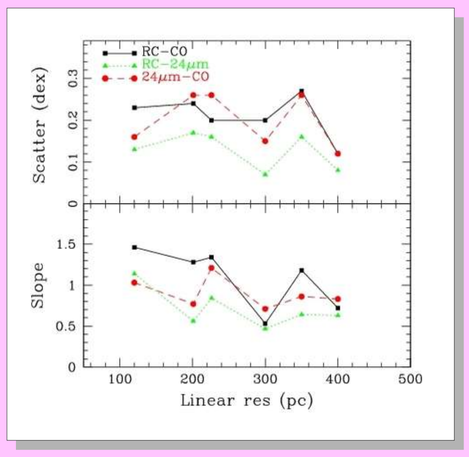


Spectral index image measured between 4.9 and 1.4 GHz, at a resolution of ~ 16″

Image of the ratio between 70 μm and RC emission at a resolution of ~ 16″



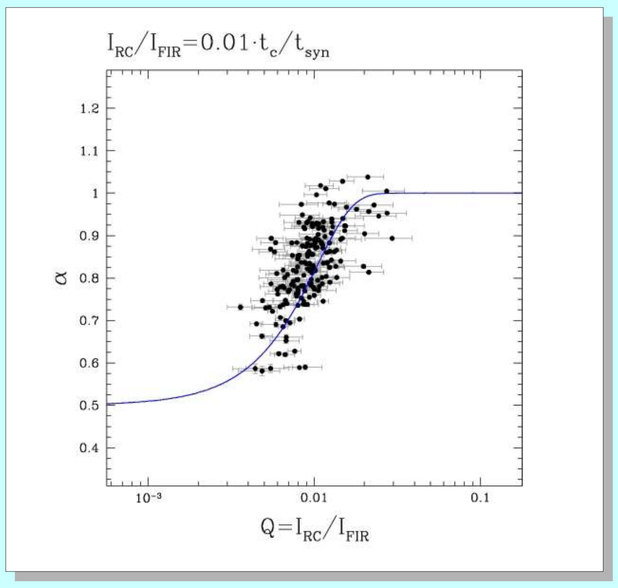
From Murphy et al., 2006



Rms scatter (*top panel*) and slope (*bottom panel*) of RC-CO, RC-24 μm and 24 μm-CO correlations versus linear resolution for six galaxies.

There is no significant variation of the slope and the scatter of the correlations at this spatial resolution. All three correlations are comparably tight with scatter of less than a factor of two.

For the galaxy M 51, using the *Spitzer* 70 μm image, we found a relation between the RC spectral index and the FIR emission. The spectral index decreases in regions of high FIR emission. This indicates that electron diffusion is efficient in these regions of high star formation rate. Indeed a mechanism compensating the leakages of the synchrotron electron should exist.



* **Paladino, R., Murgia, M., Helfer, T. T. et al., 2006**
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