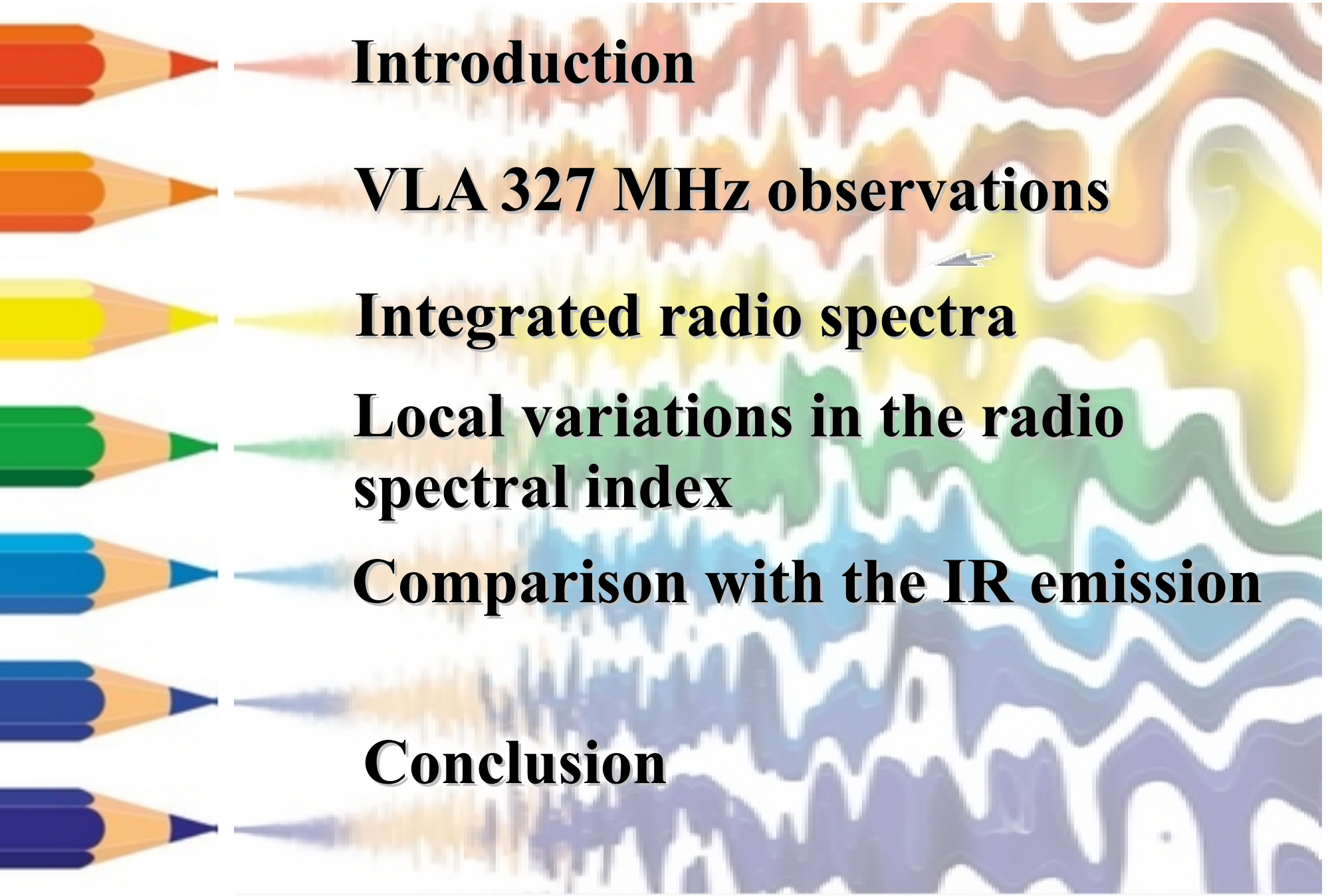
Radio spectral index study of the spiral galaxies NGC 0628, NGC 3627, and NGC 7331

Rosita Paladino[1], Matteo Murgia[2], and Emanuela Orrù[1]

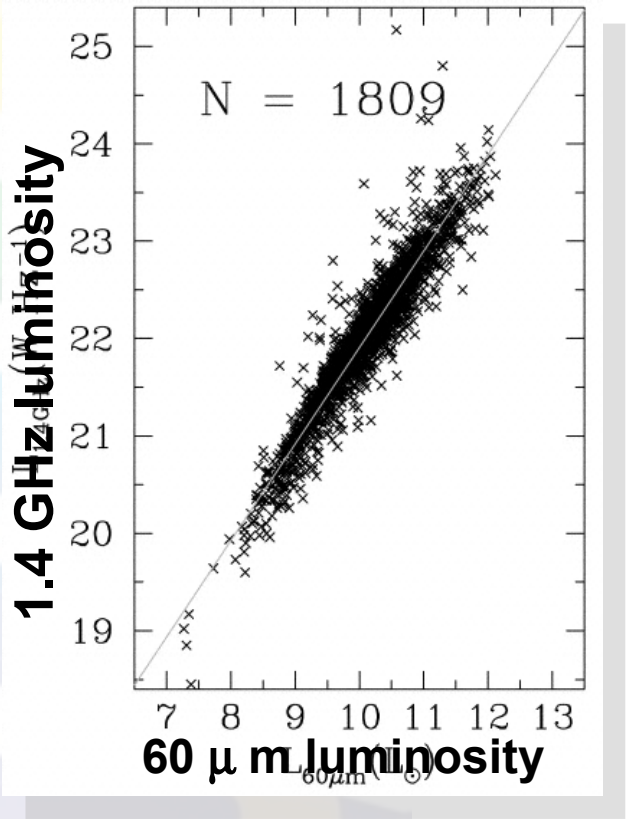
[1]Institüt fur Astro-und Teilchenphysik- Innsbruck
[2]INAF Osservatorio Astronomico di Cagliari

Panoramic Radio Astronomy
2-5 June 2009, Gröningen, the Netherlands

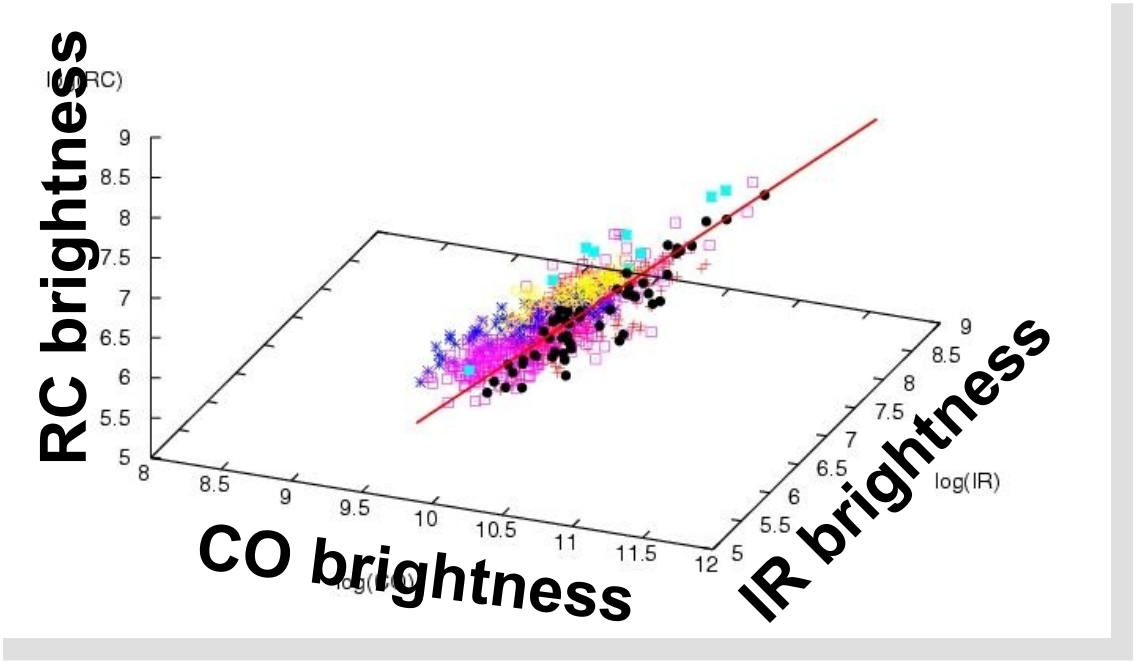

Introduction
VLA 327 MHz observations
Integrated radio spectra
Local variations in the radio spectral index
Comparison with the IR emission
Conclusion

Introduction

Correlations between radio continuum and star formation tracers...



Yun et al., 2001

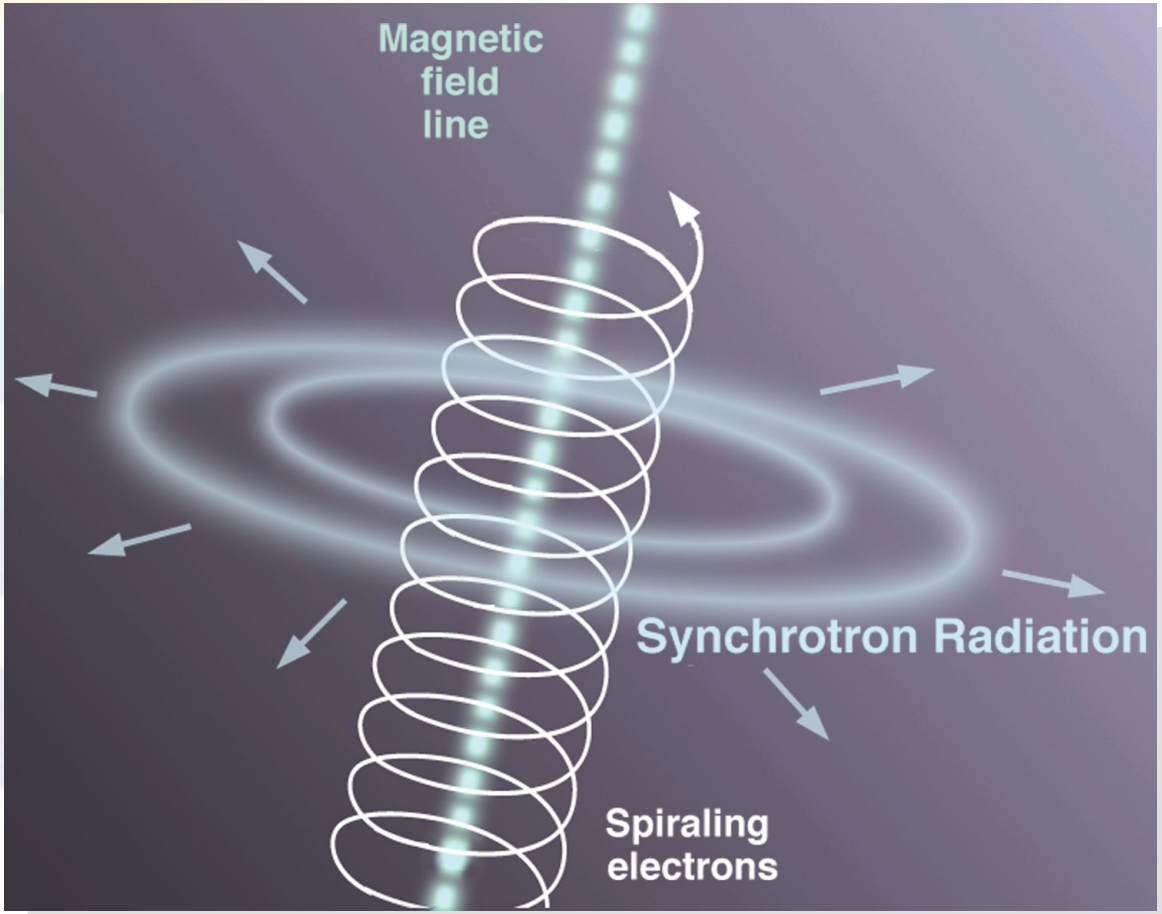


Paladino et al., 2008

... physical mechanisms not completely understood

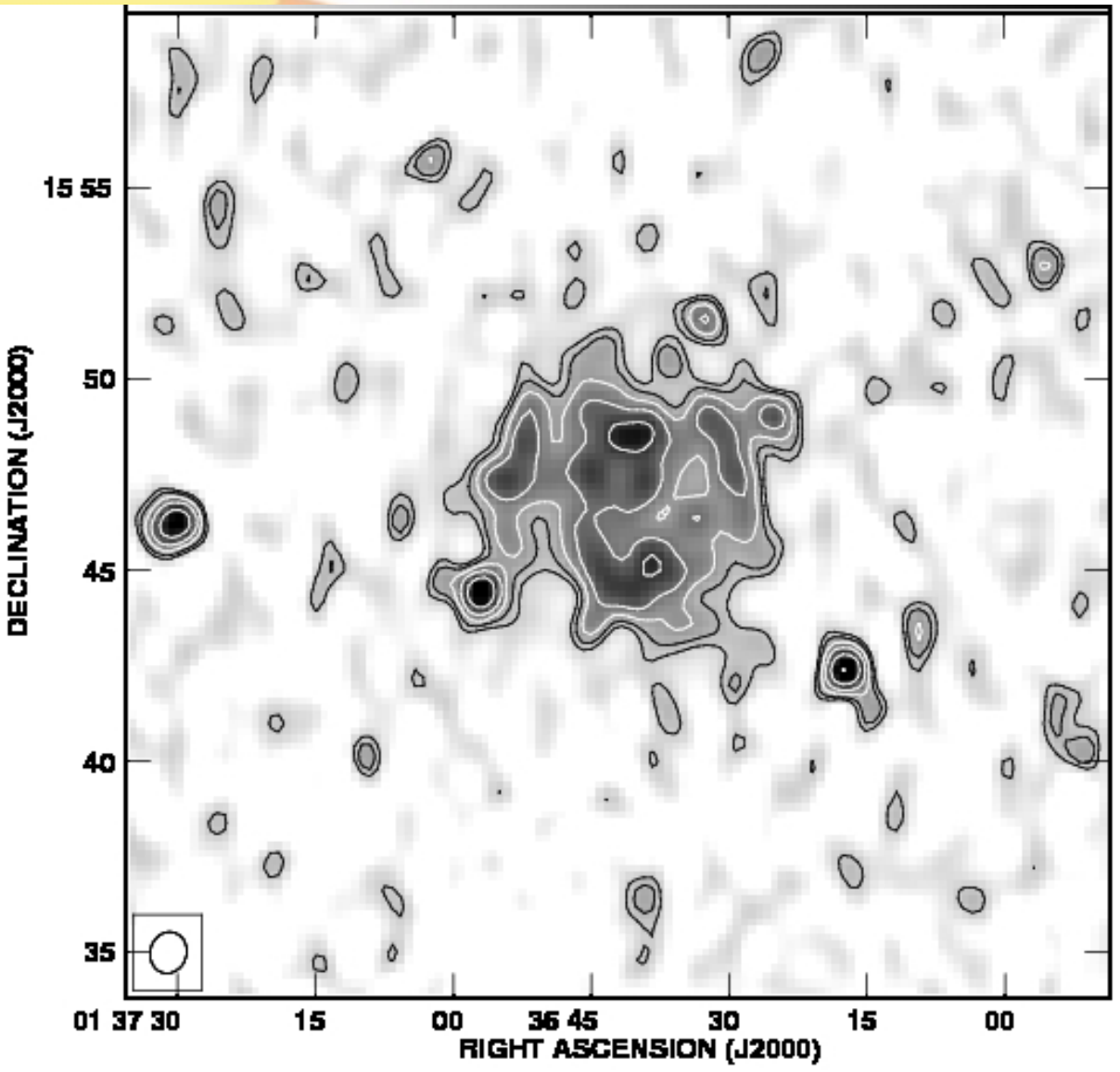
Introduction

Synchrotron radiation traces the product of cosmic rays and magnetic field energy densities...
propagation of electrons is poorly known...



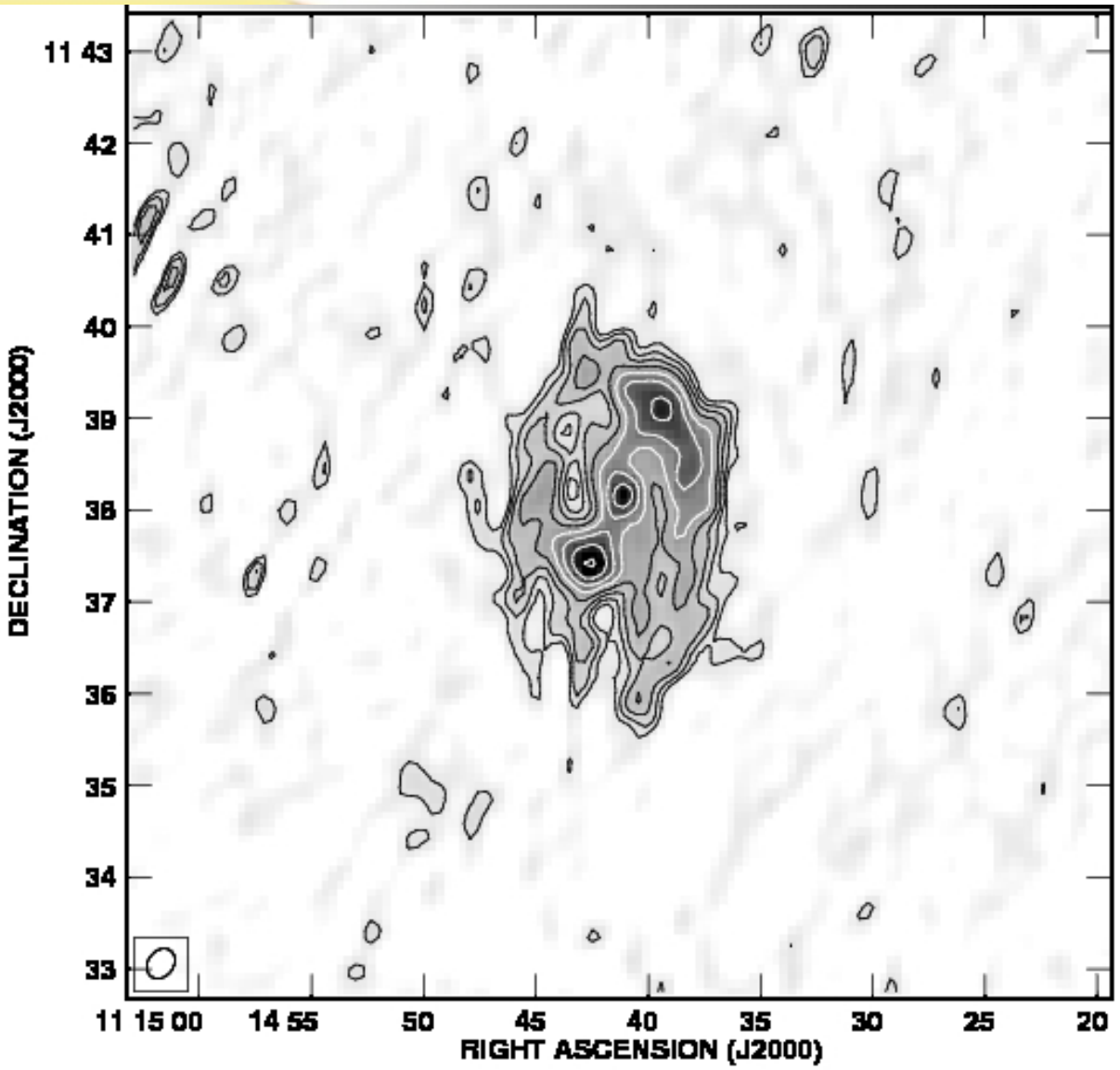
We compare spatially resolved radio spectral index images of galaxies and their IR distributions to understand the correlation between cosmic rays propagation mechanism and the sites of intense star formation ...

NGC 0628: 327 MHz image



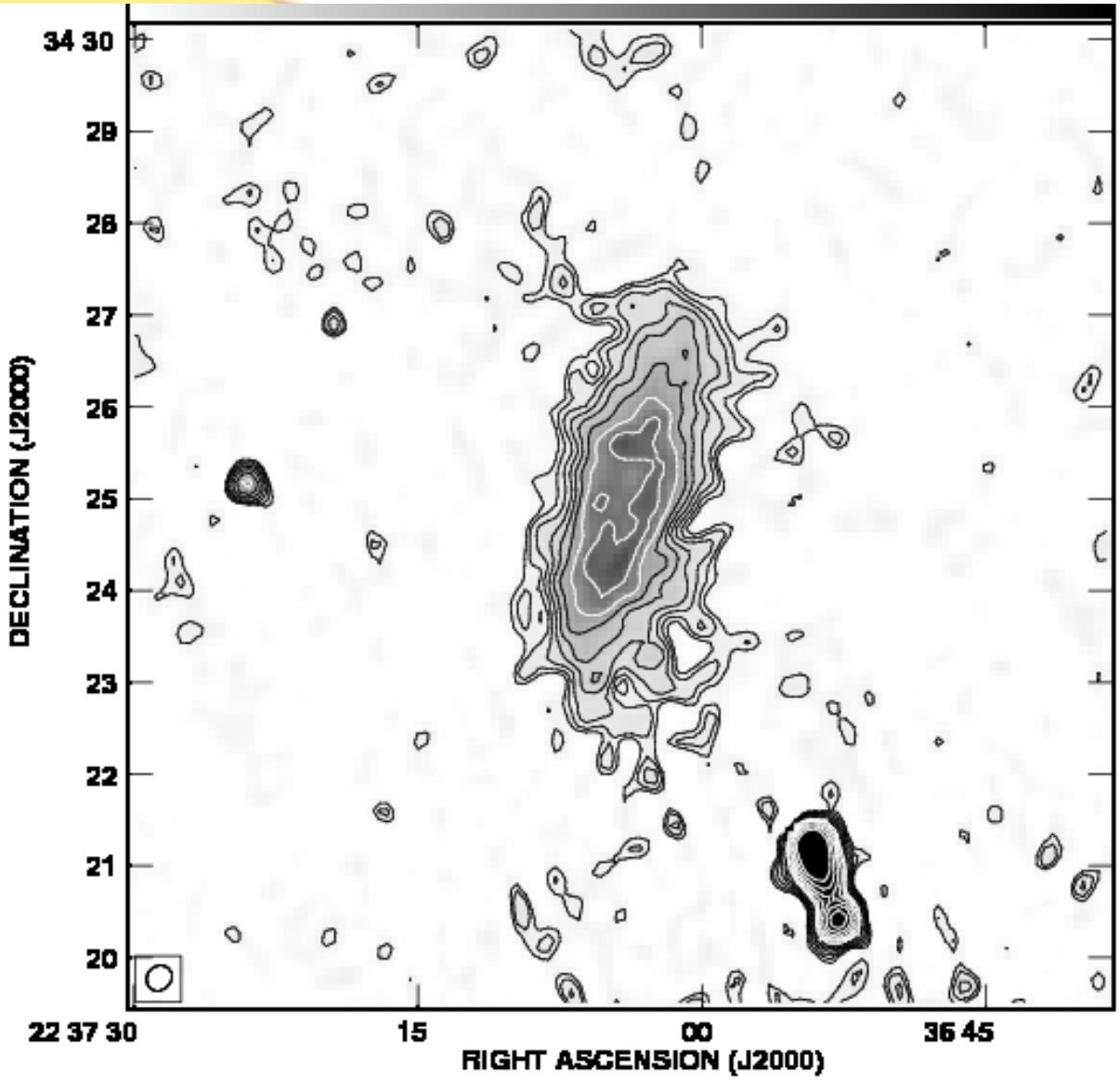
VLA	**C Array**
Date	**05 sept 05**
Frequency MHz	**321.5-327.5**
Bandwidth MHz	**3.125**
HPBW	**65 " x 57 "**
RMS mJy/beam	**2.3**

NGC 3627: 327 MHz image



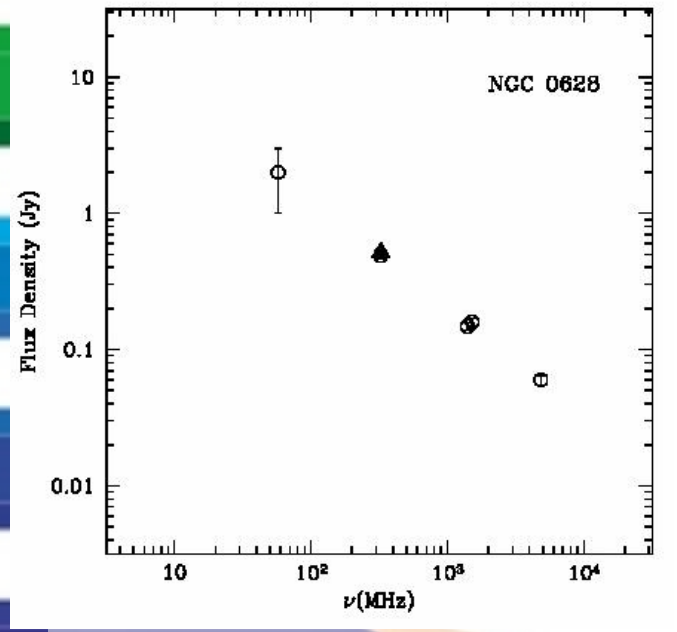
VLA	**B Array**
Date	**30 oct 07**
Frequency MHz	**323.1-329.1**
Bandwidth MHz	**6.250**
HPBW	**20 " x 17 "**
RMS mJy/beam	**2**

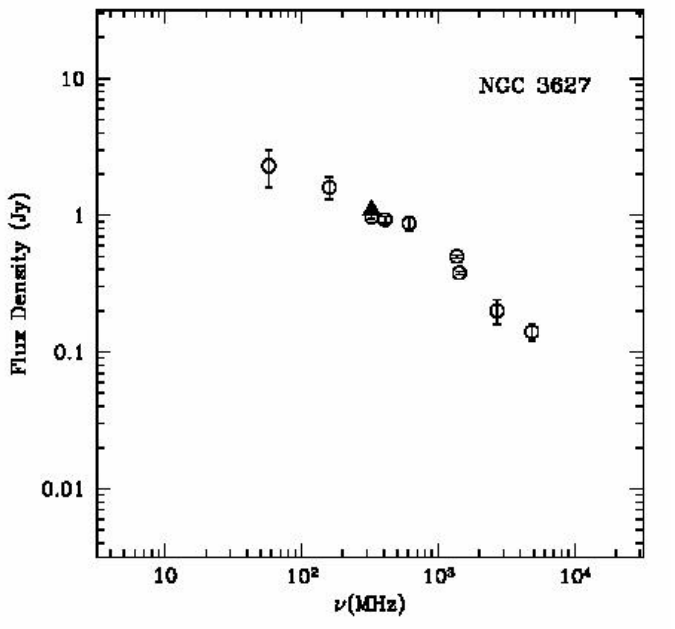
NGC 7331: 327 MHz image

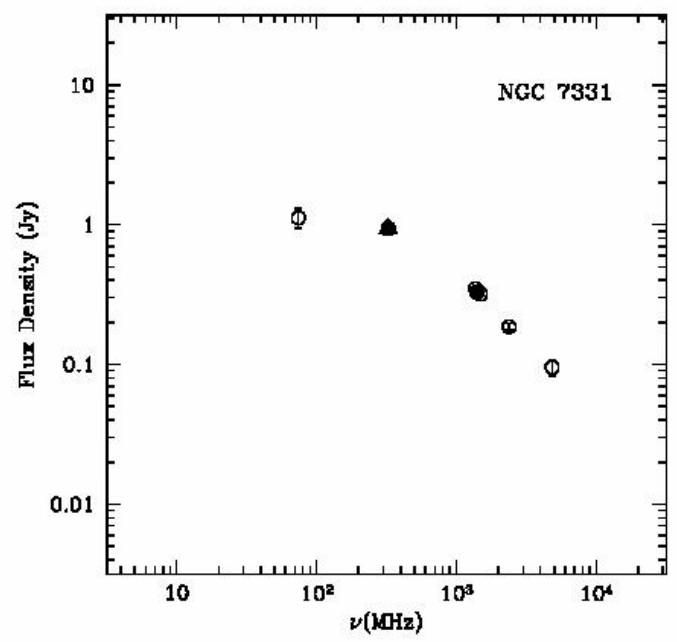


VLA	**B Array**
Date	**02 nov 07**
Frequency MHz	**323.1-329.1**
Bandwidth MHz	**6.250**
HPBW	**17 " x 15 "**
RMS mJy/beam	**1**

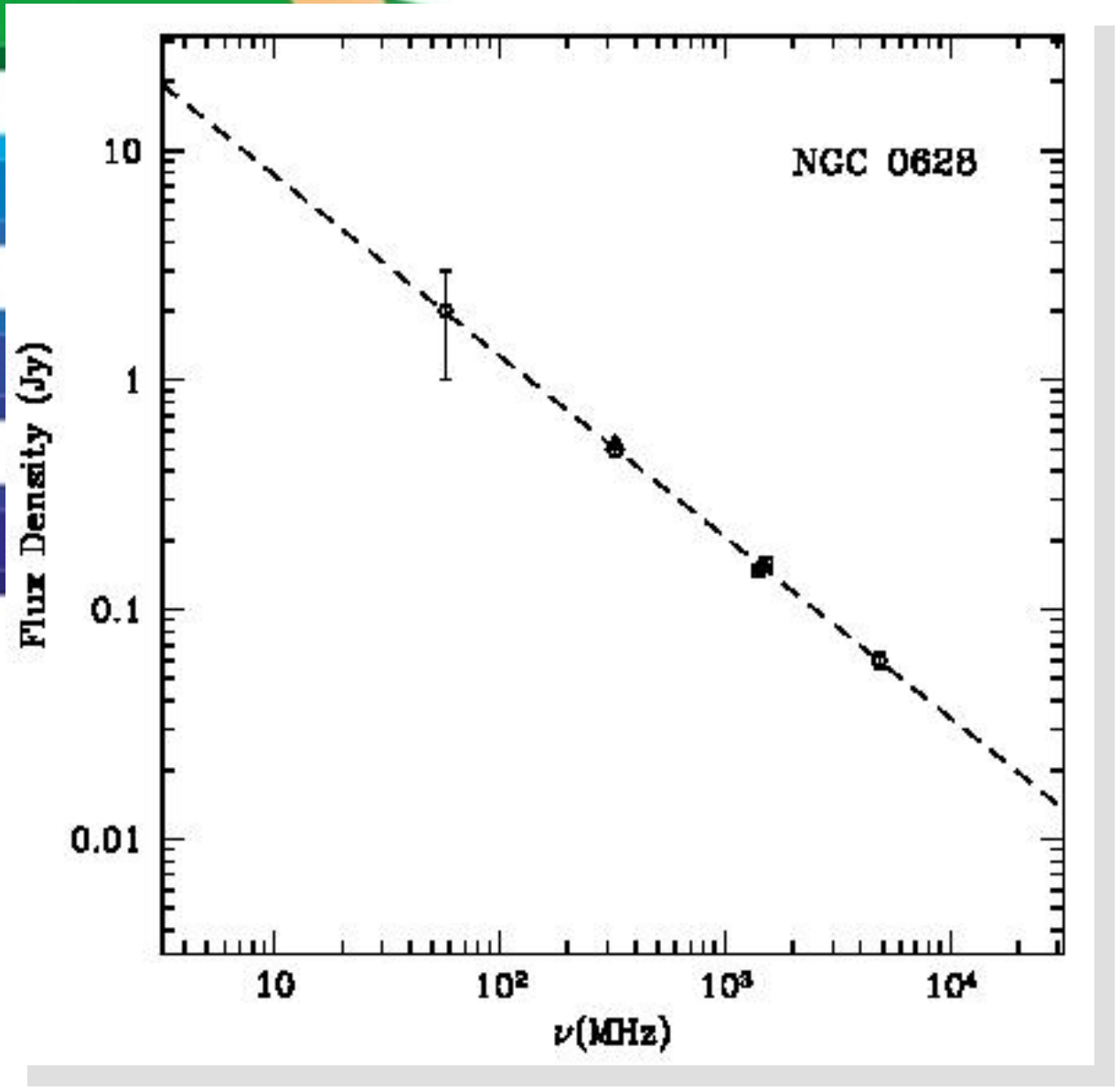
Integrated radio spectra







NGC 0628: integrated spectrum

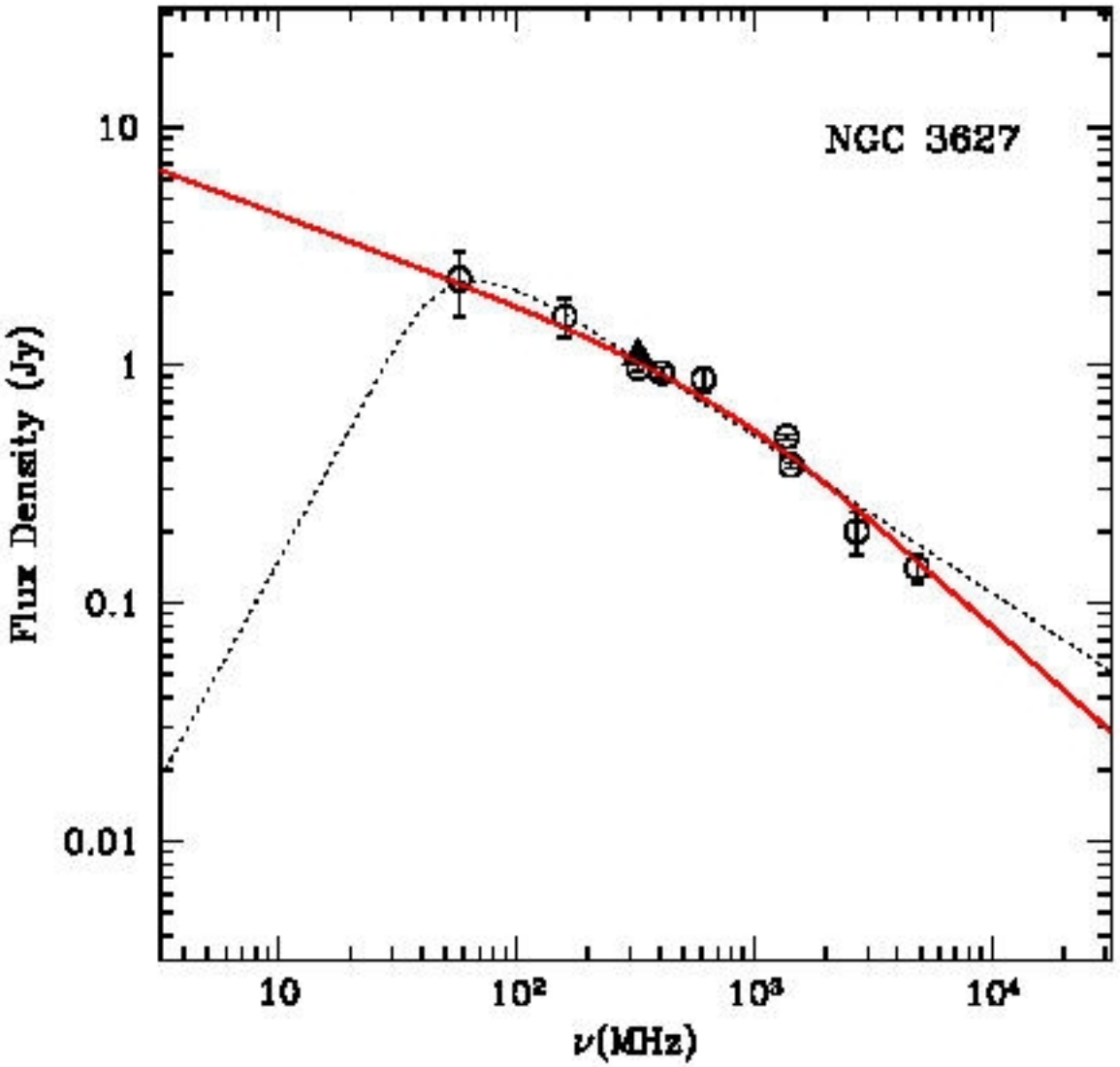


Data fitted
with a power law

$S(\nu) \propto \nu^{-\alpha}$

α 0.78

NGC 3627: integrated spectrum



Data fitted with:

Pow+SSA

$$\propto (\nu/\nu_{peak})^{\alpha+2.5}\left(1-e^{(\nu/\nu_{peak})^{\alpha+2.5}}\right)\cdot S_{pow}$$

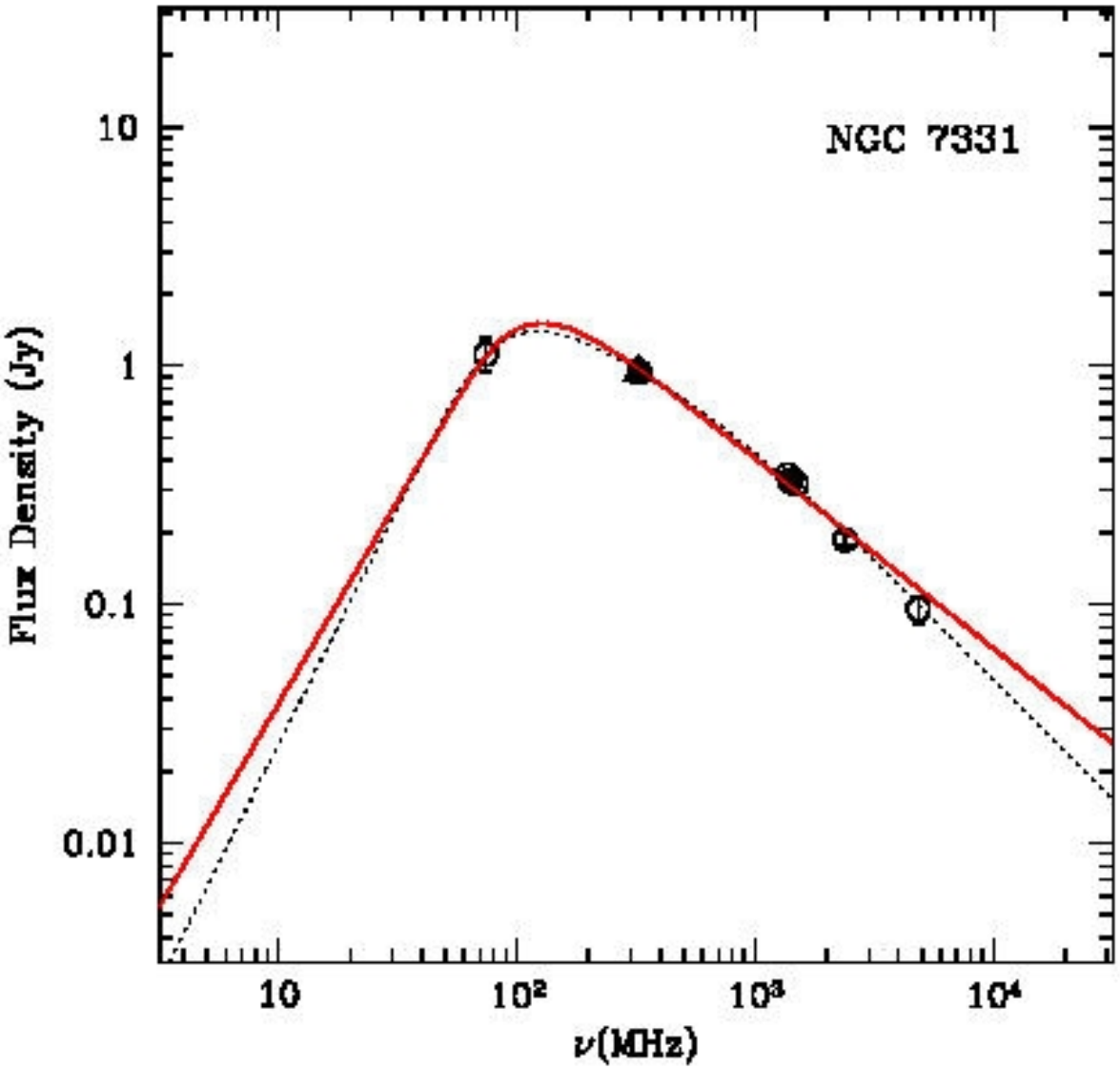
(Pacholczyk, 1970)

α	ν_{peak}	χ_2/ndf
0.66	54 MHz	4.3

CI

α	ν_{br}	χ_2/ndf
0.4	937 MHz	2.9

NGC 7331: integrated spectrum



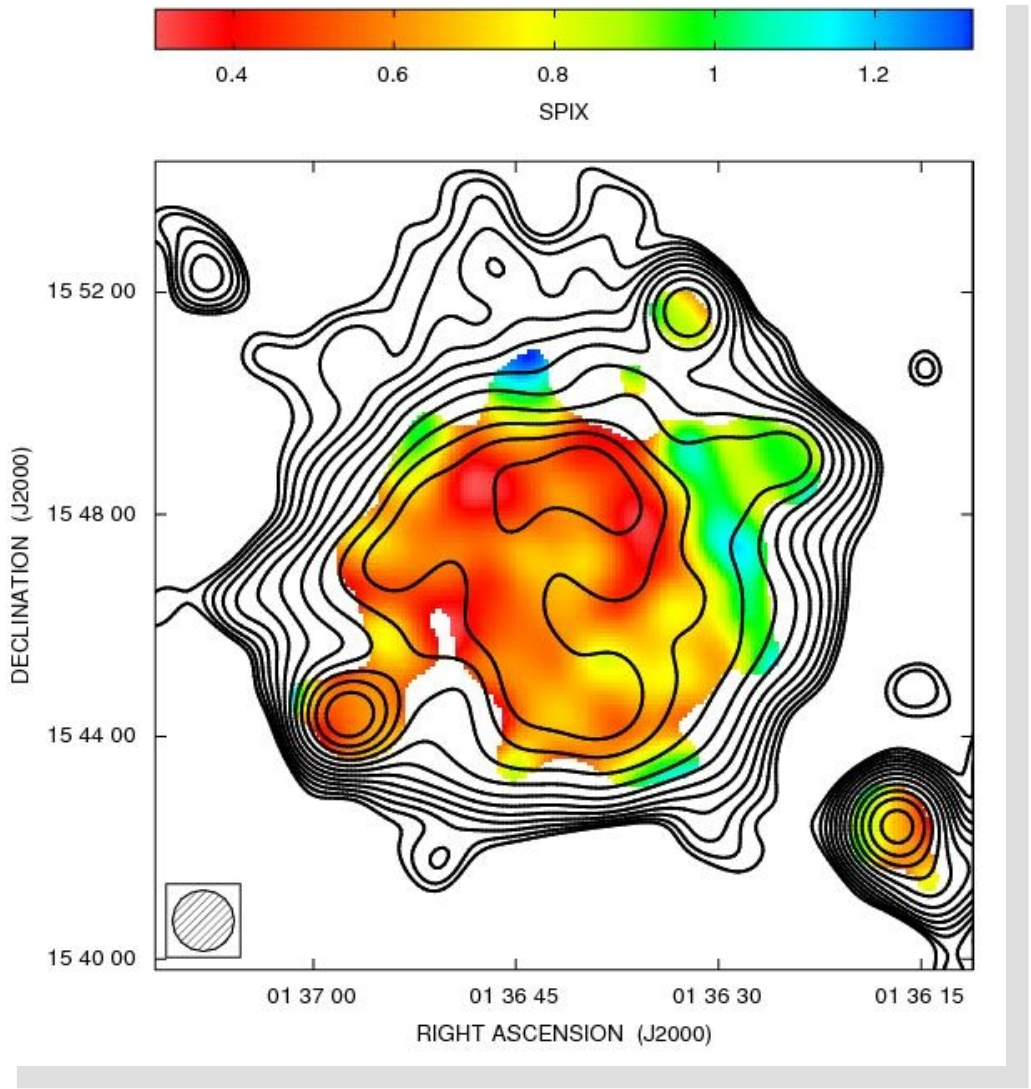
Data fitted with
Pow+SSA

α	ν_{peak}	χ_2/ndf
0.79	112 MHz	2.5

CI+SSA

α	ν_{br}	ν_{peak}	χ_2/ndf
0.5	1025	92	0.98

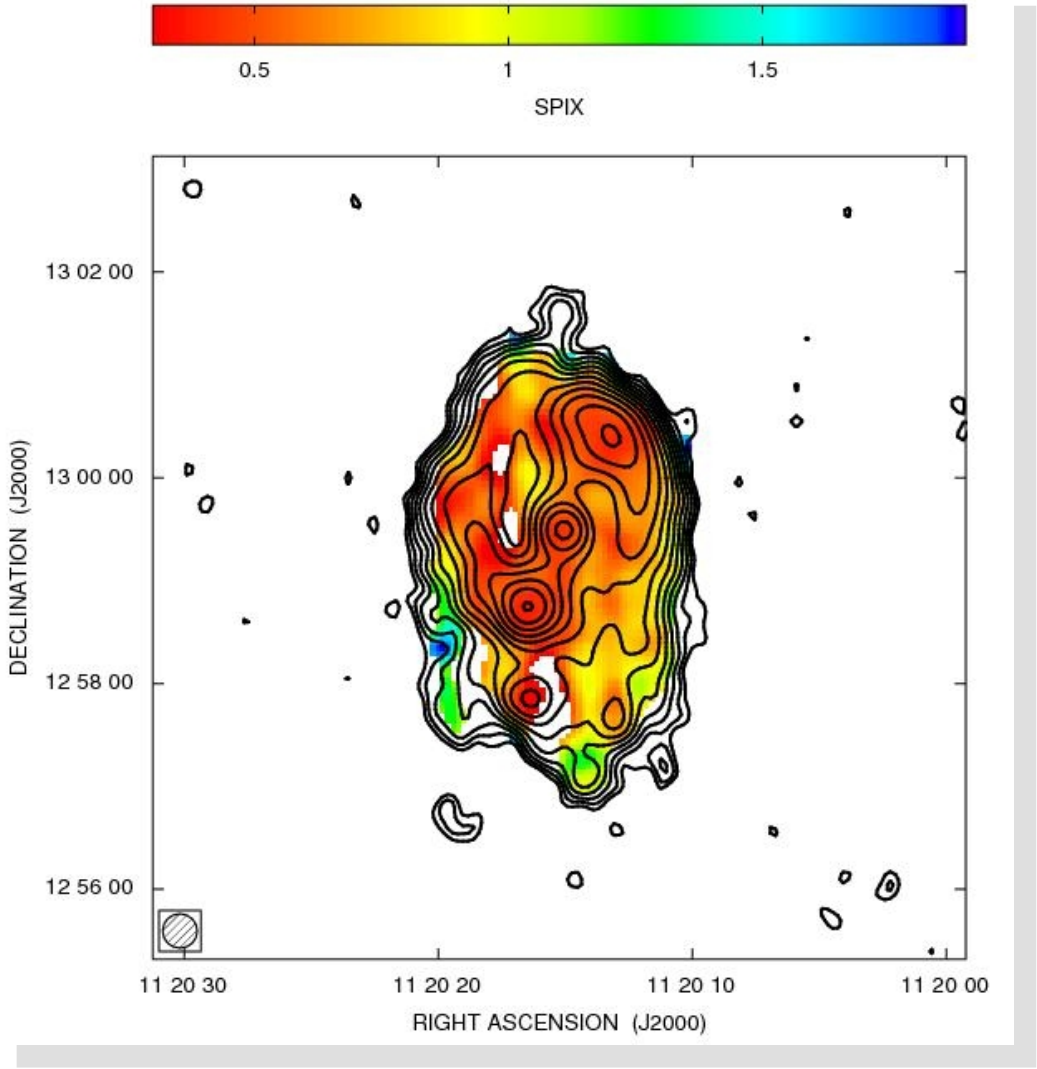
NGC 0628: spectral index image



Color scale= image of the spectral index measured between 327 MHz and 1.4 GHz

Contours = radio image at 1.4 GHz, starting from 3σ (150 μJy/beam) and scaling by a factor of $\sqrt{2}$

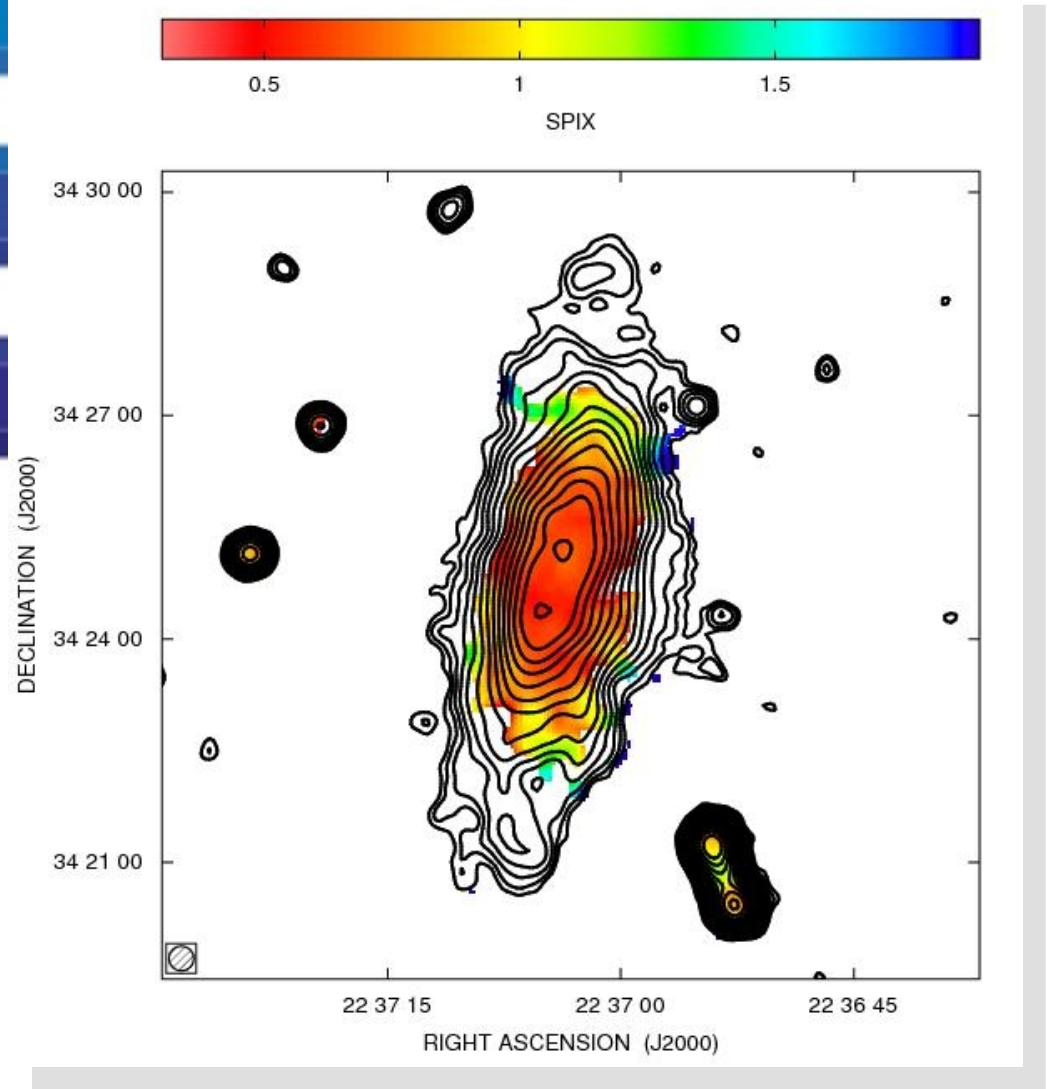
NGC 3627: spectral index image



Color scale= image of the spectral index measured between 327 MHz and 1.4 GHz

Contours = radio image at 1.4 GHz, starting from 3σ (400 μJy/beam) and scaling by a factor of $\sqrt{2}$

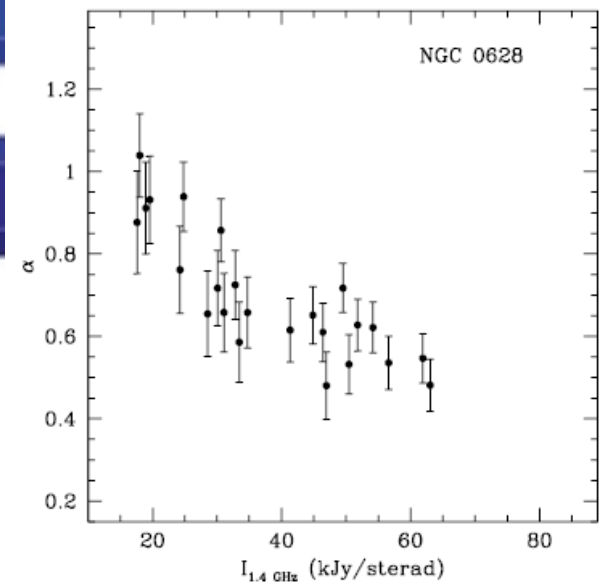
NGC 7331: spectral index image

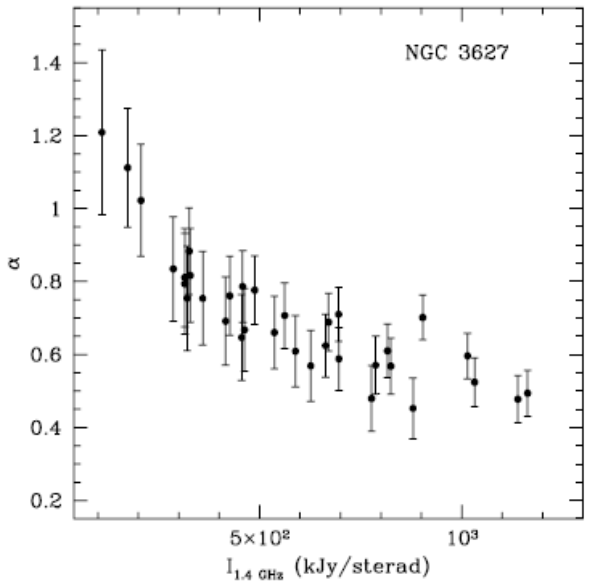


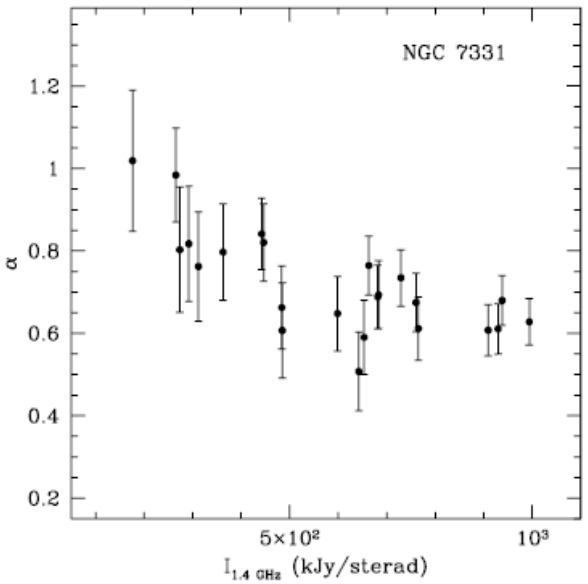
Color scale= image of the spectral index measured between 327 MHz and 1.4 GHz

Contours = radio image at 1.4 GHz, starting from 3σ (120 μJy/beam) and scaling by a factor of $\sqrt{2}$

Point-to-point comparison: spectral index vs 1.4 GHz brightness

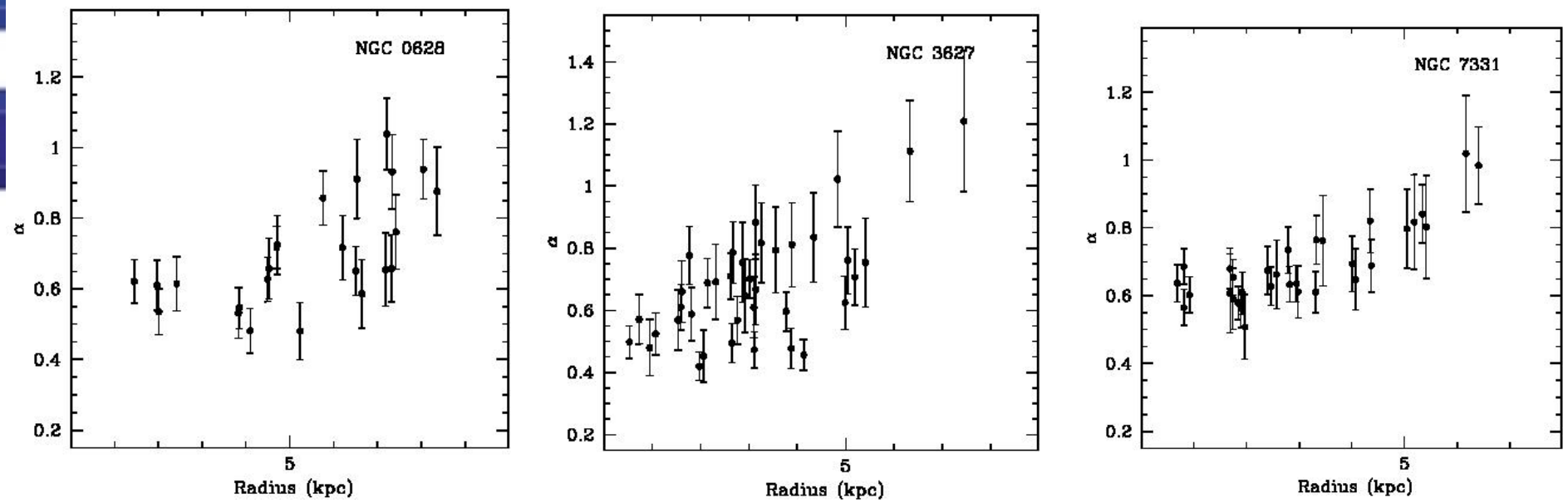






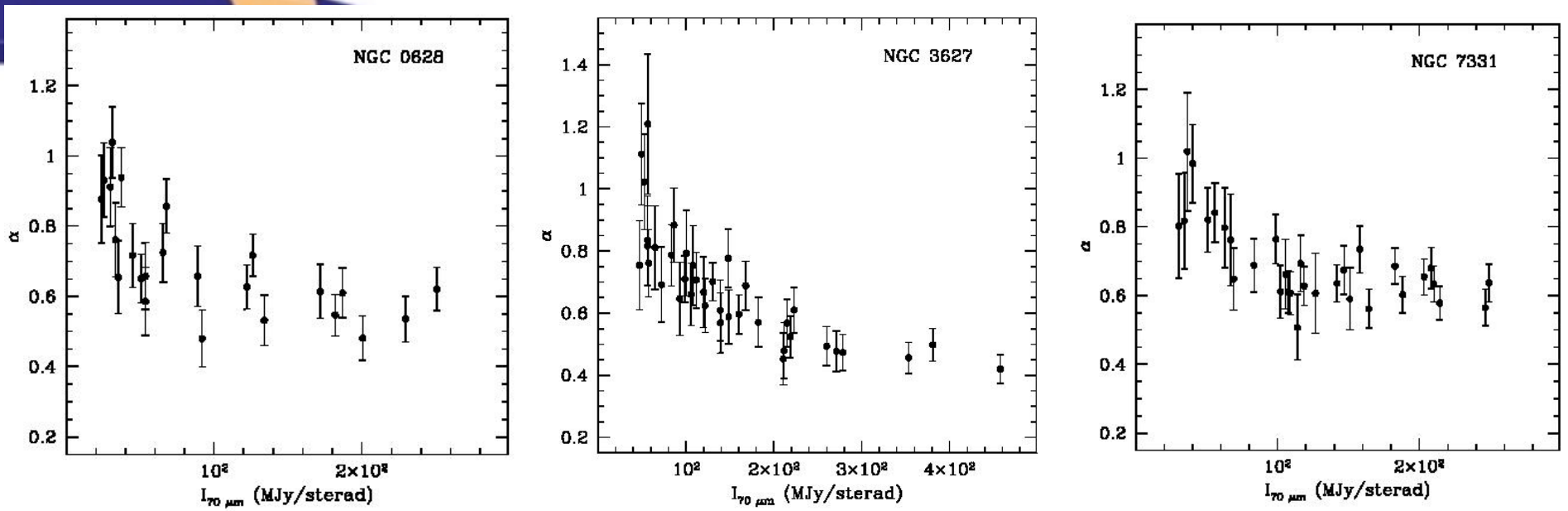
A common feature is that the spectral index is anticorrelated with the radio brightness

Point-to-point comparison:
spectral index vs distance from center



...a systematic steepening of the radio spectrum with the increasing distance from the center, where typically brightest regions are located

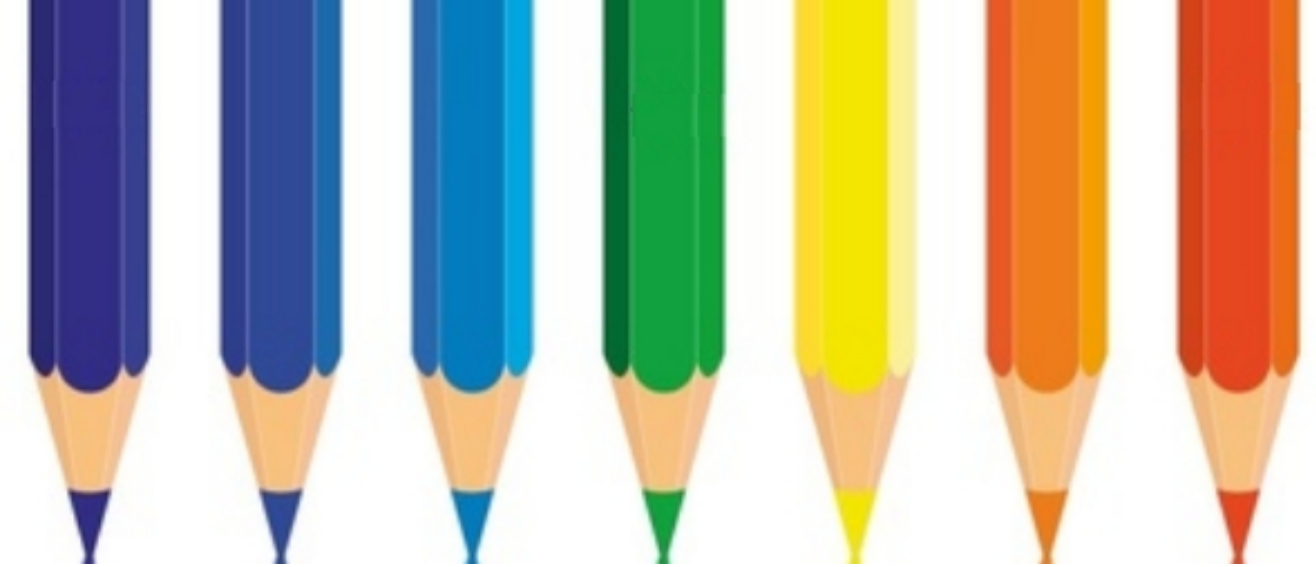
Point-to-point comparison:
spectral index vs 70 μm brightness



...regions in which the IR emission is higher tend to have a flatter spectrum than their surroundings.
This result is consistent with the idea that the cosmic rays confinement time in the star forming regions is shorter than their radiative lifetime.

Conclusion

Importance of high resolution, low frequency observations of a large sample of galaxies, as a tool to study the physical mechanisms of production and propagation of cosmic rays and their connection with star formation processes....



Thank you!