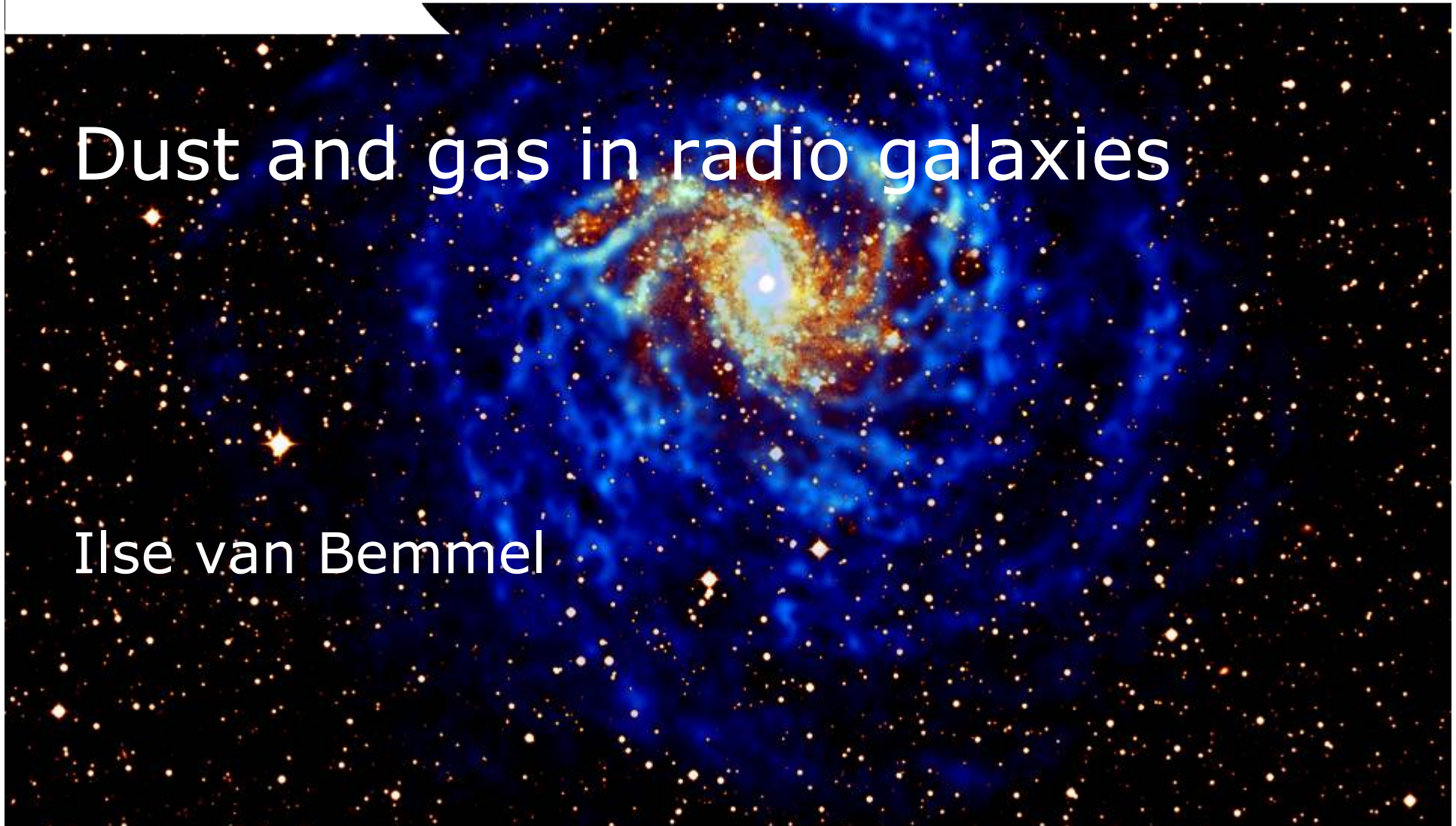


## Dust and gas in radio galaxies

Ilse van Bemmel



# Outline

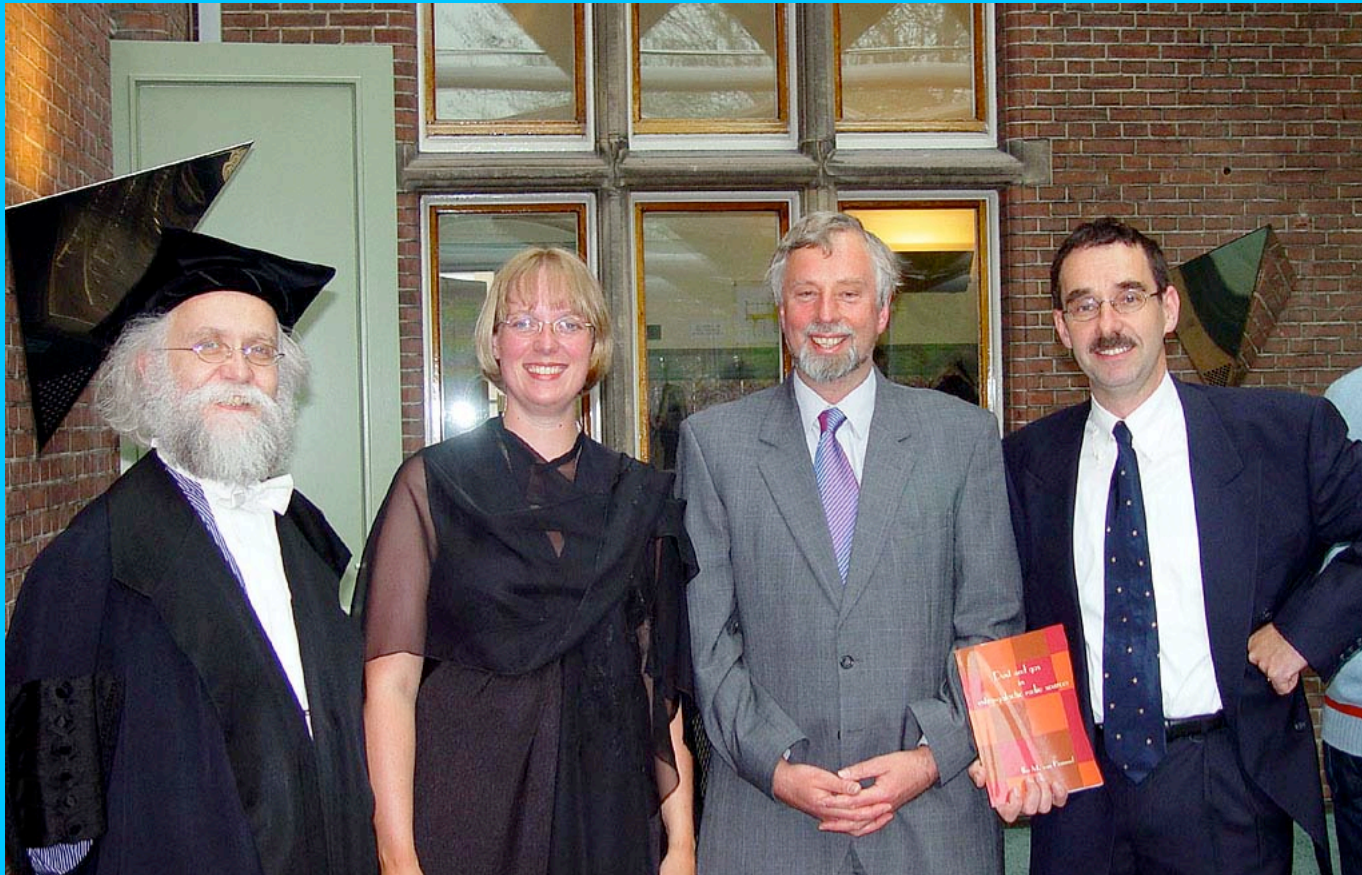
- Why am I here?
- How did I get here?
- What do I do now?





# Why I am here...

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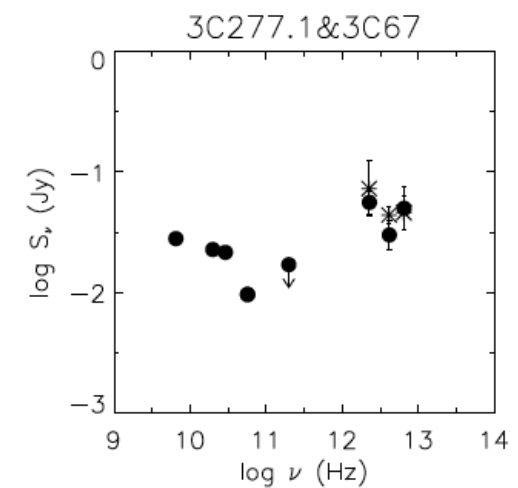
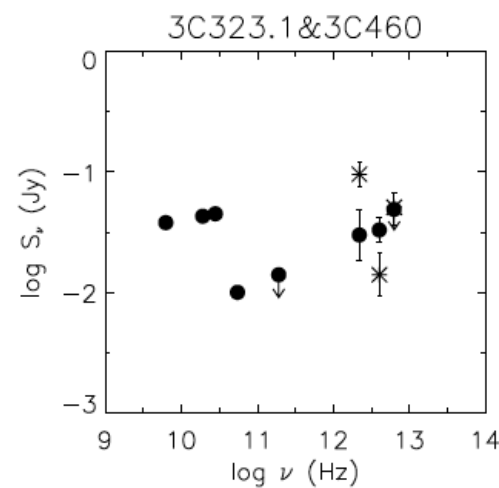
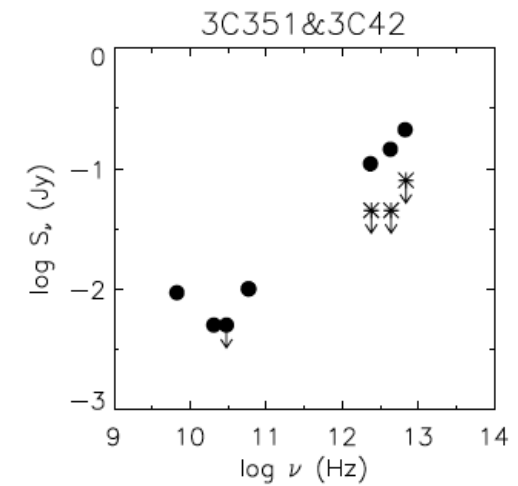
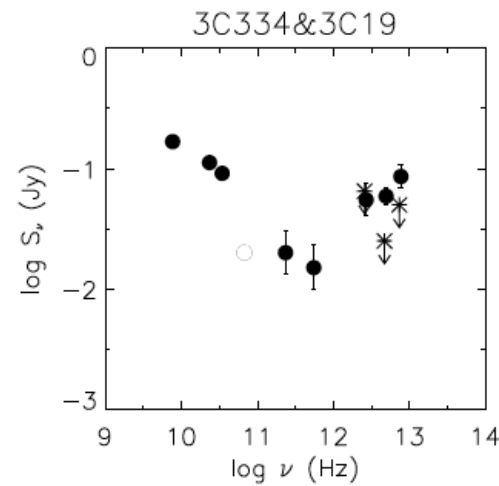
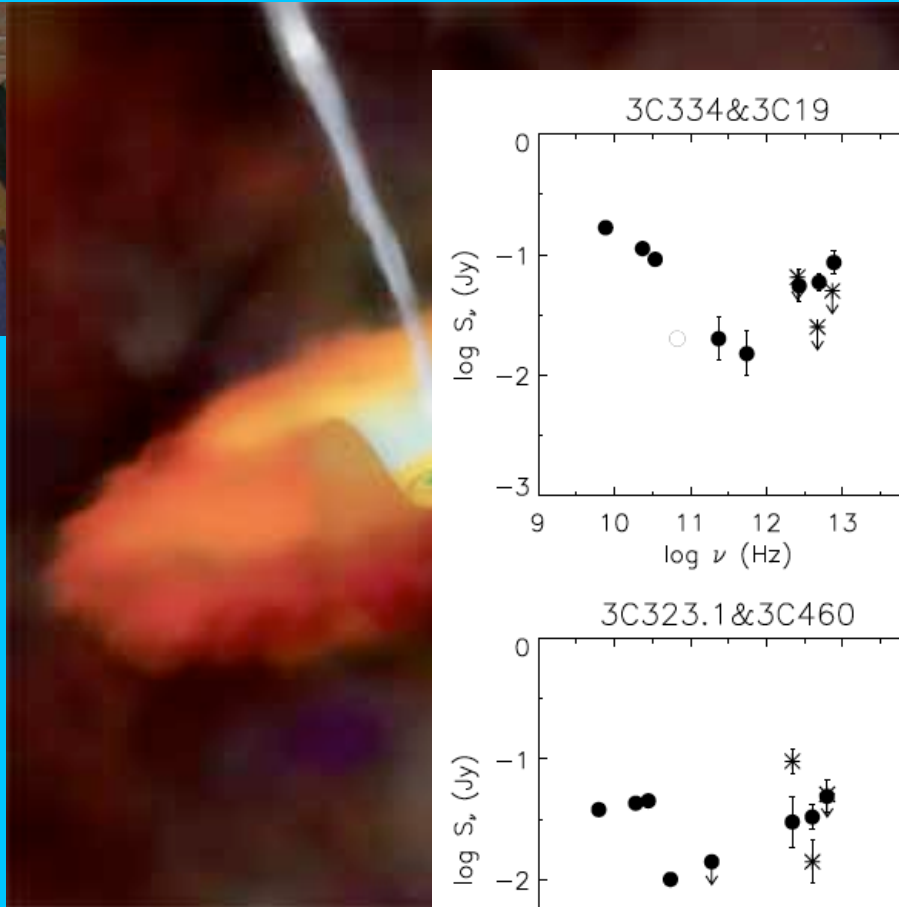


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Galaxies Near and Far

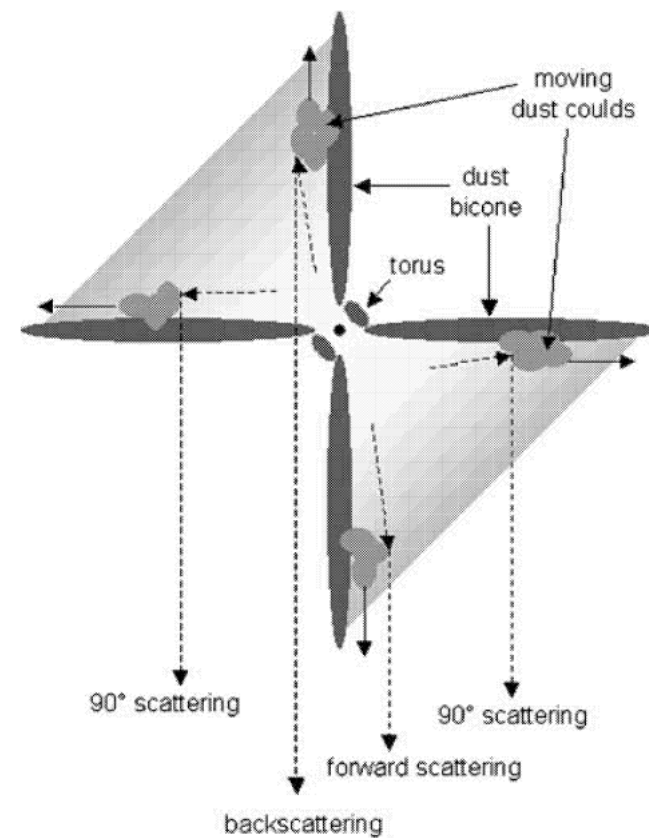
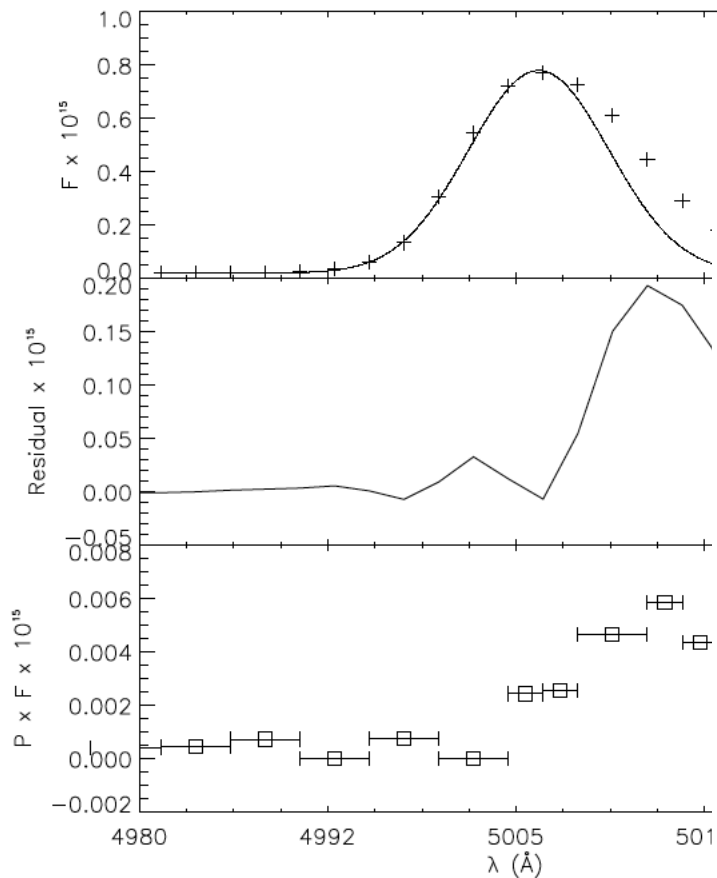
# Step 1: Dust emission

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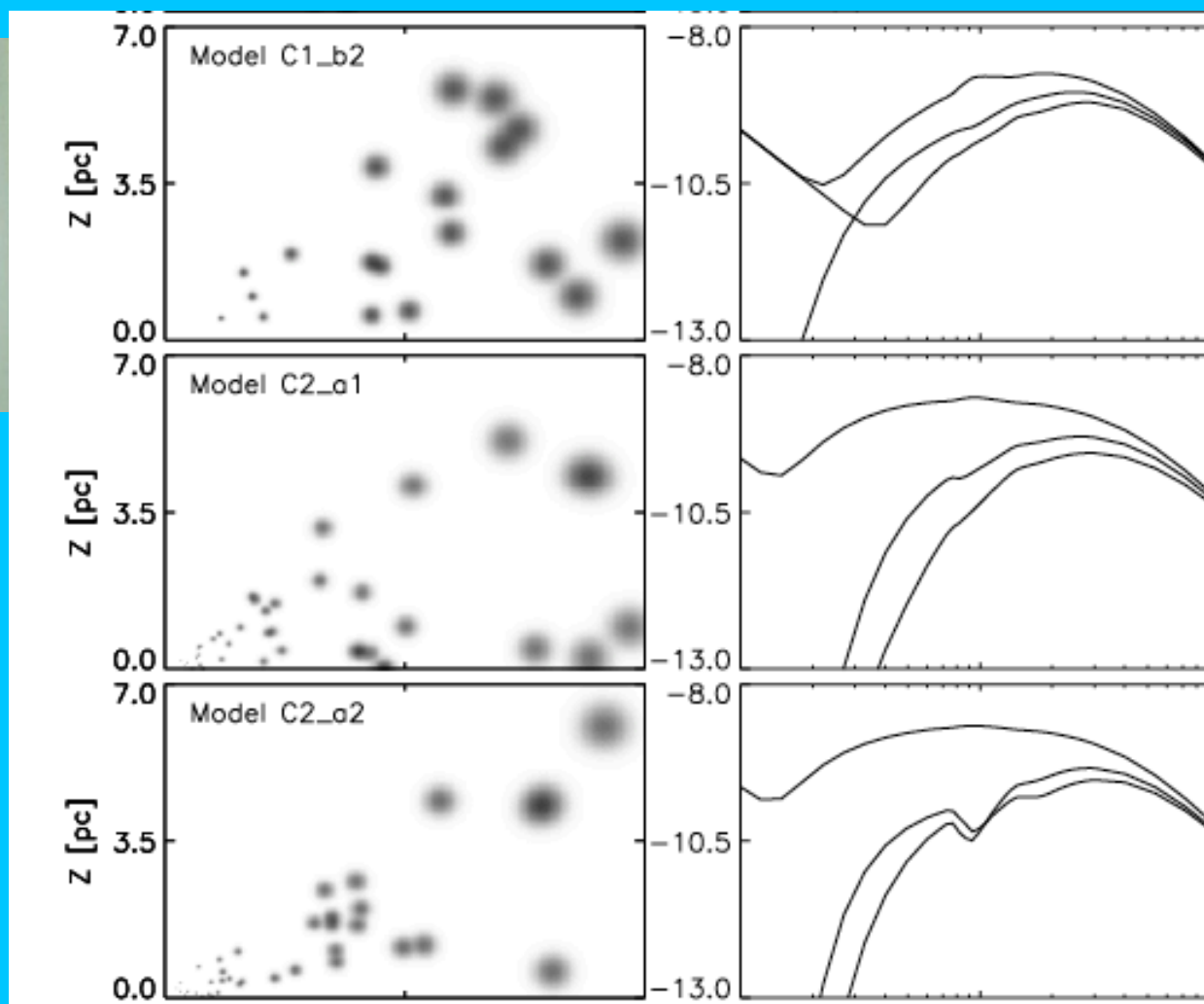


## Step 2. Dust scattering



Van Bemmelen+ 2003

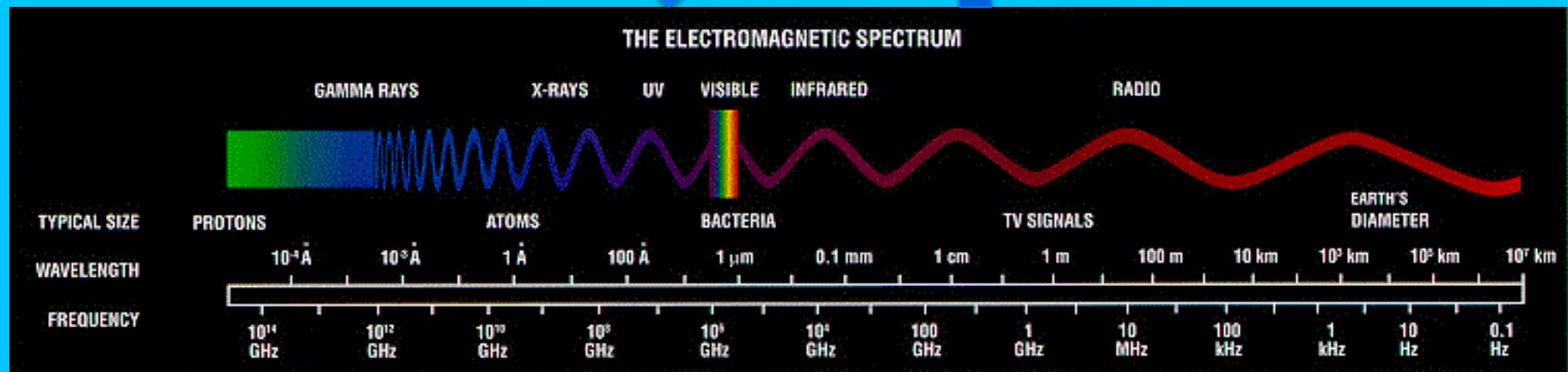
## Step 3. Dust models





# How did I get here?

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Galaxies Near and Far

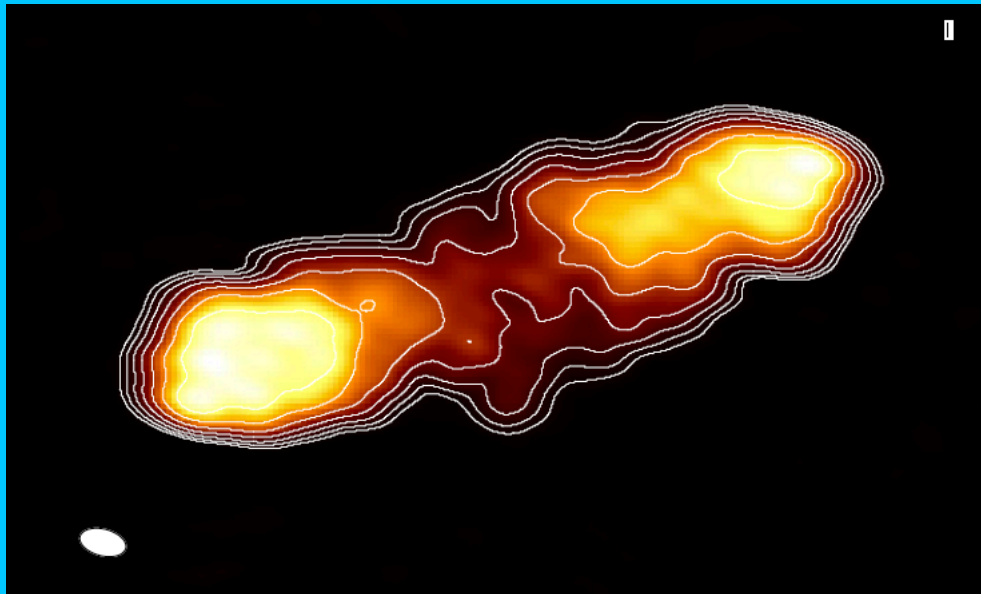
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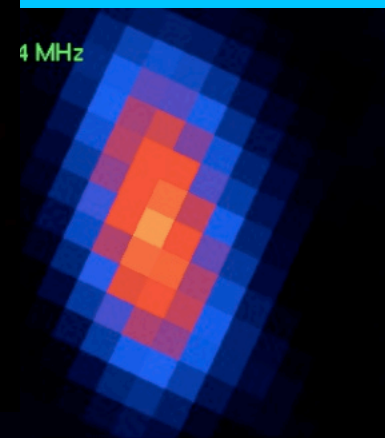
# LOFAR glances at radio galaxies

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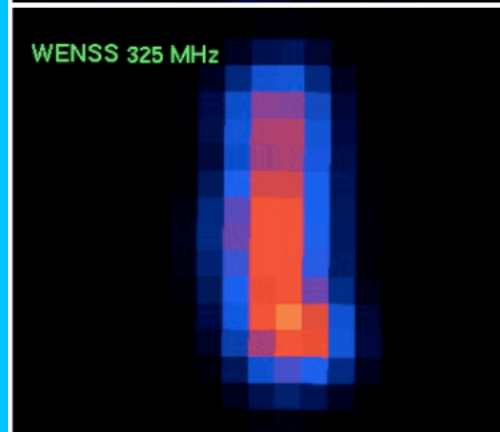
McKean



4 MHz

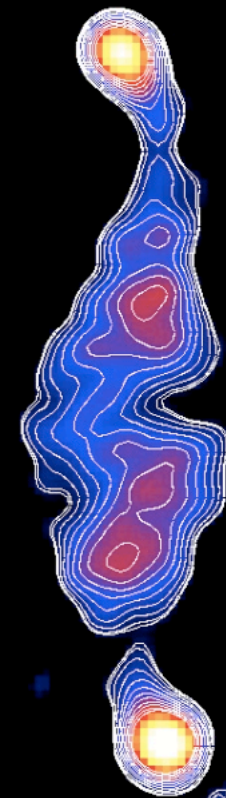


WENSS 325 MHz



Van Weeren

LOFAR 173 MHz  
detailed version with contours

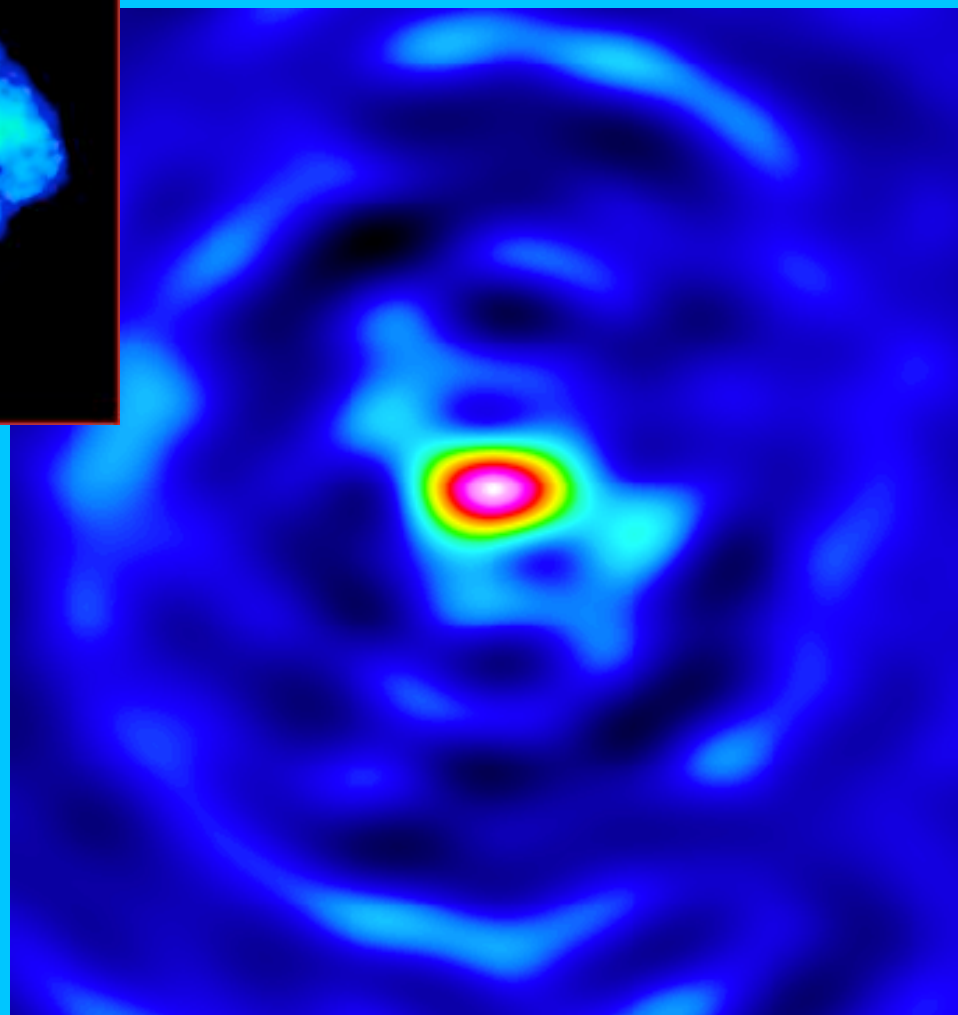
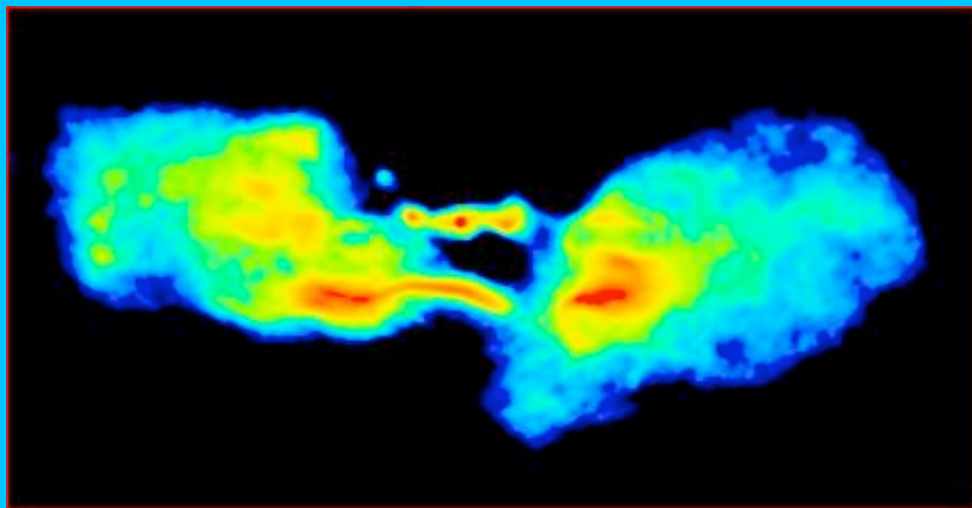


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# First glances at radio galaxies

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Van Bemmelen

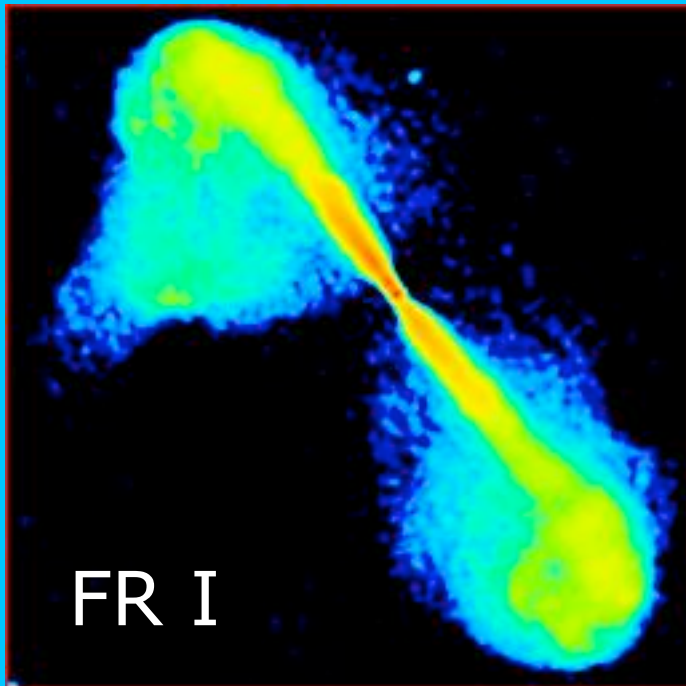


Galaxies Near and Far

24 May 2011

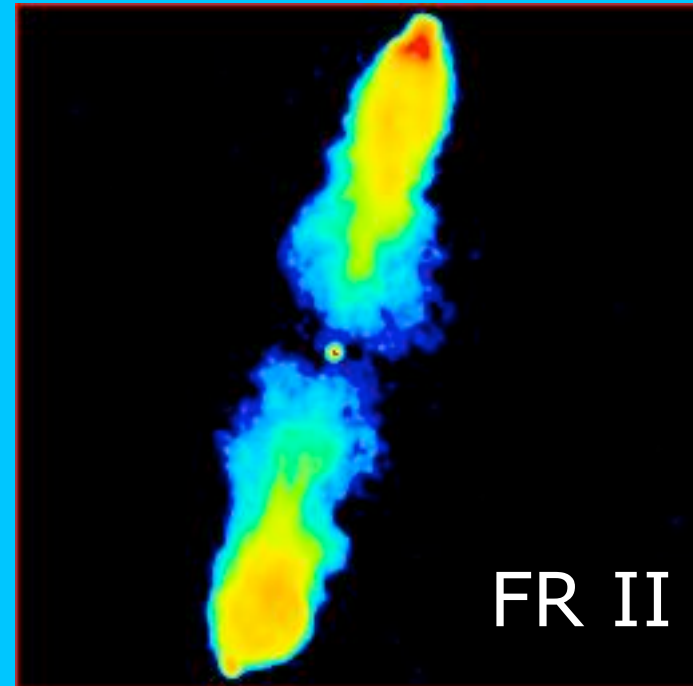


## Back to radio galaxies



FR I

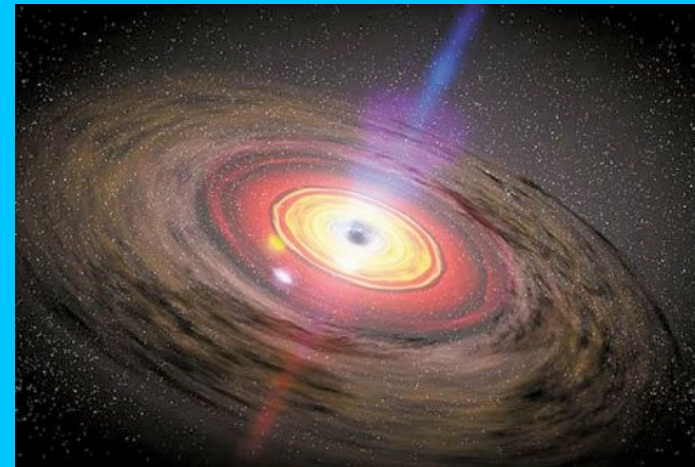
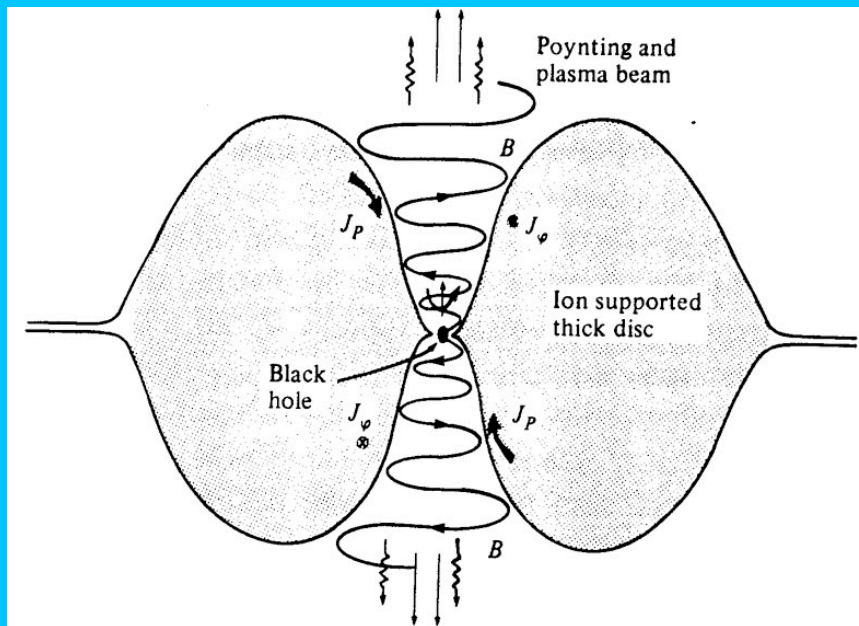
Low(er) power



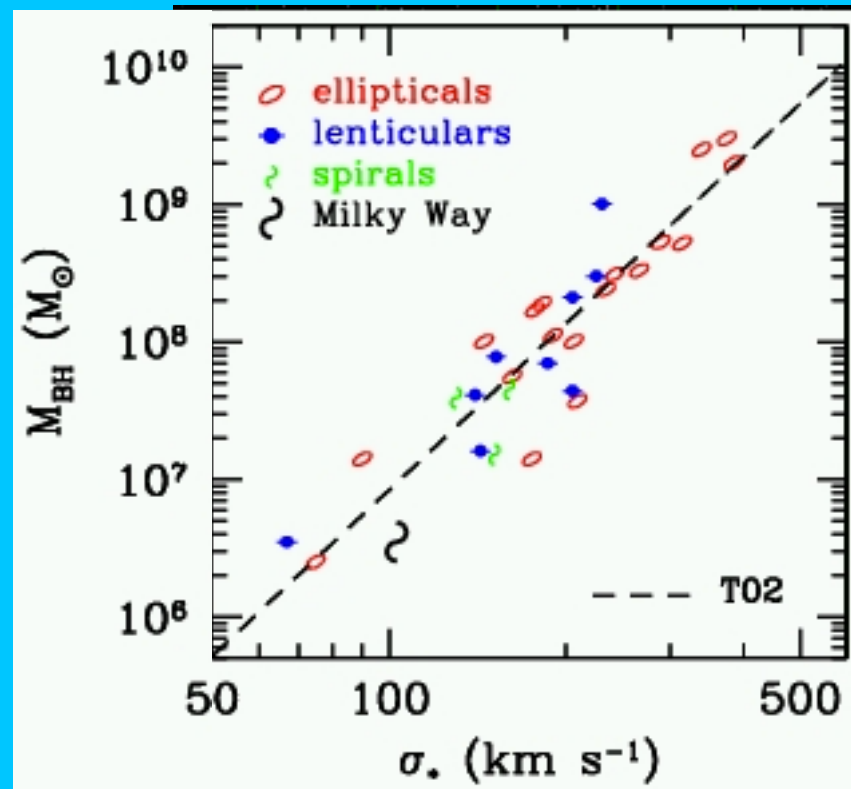
FR II

High power

# Different accretion mechanisms



# Massive galaxy formation



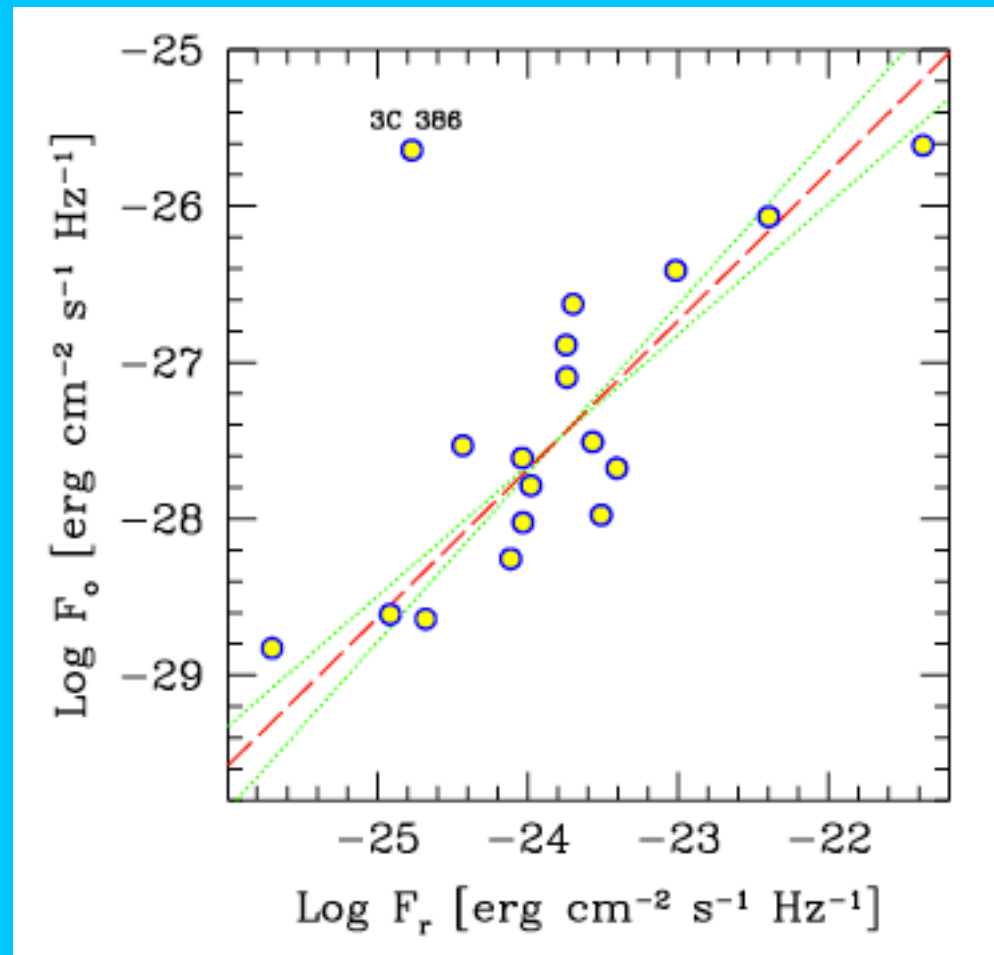
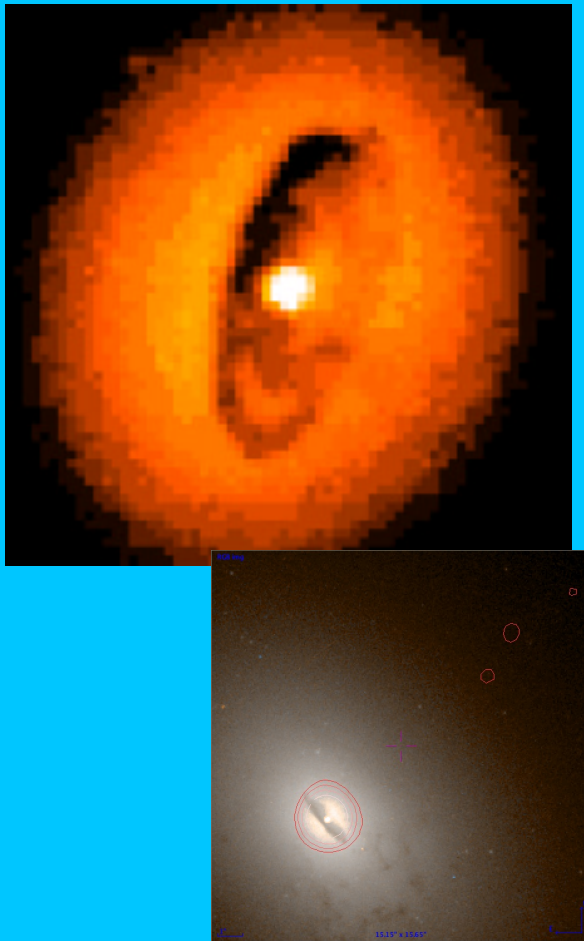
Tremaine+ 2002



# Problem 1:

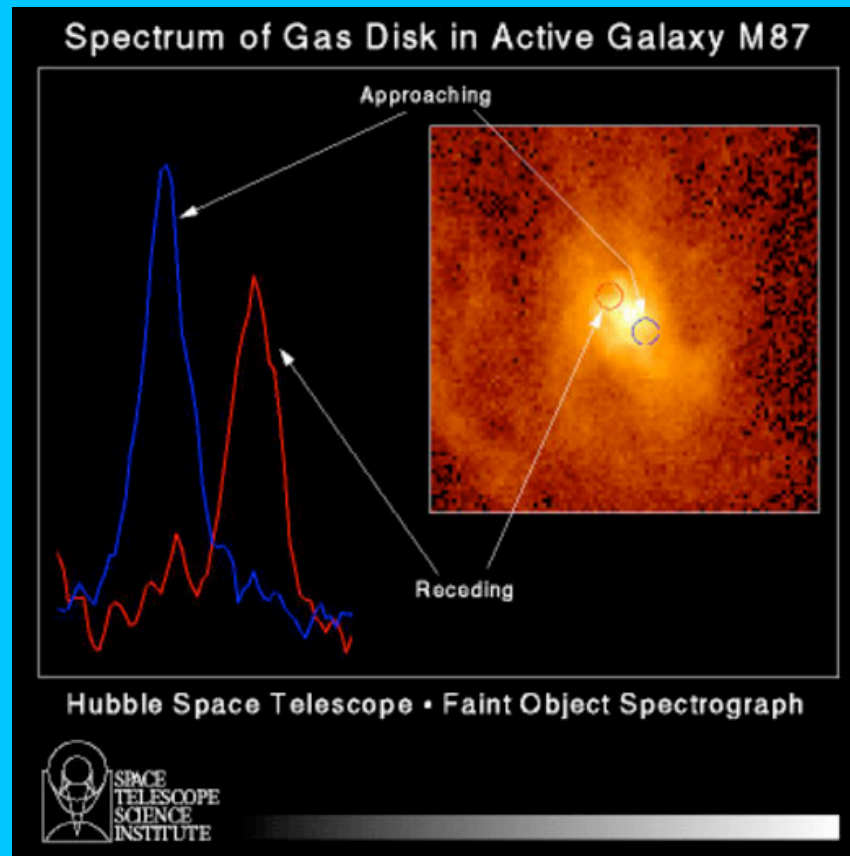
## Optical cores in FRI radio galaxies

ASTRON



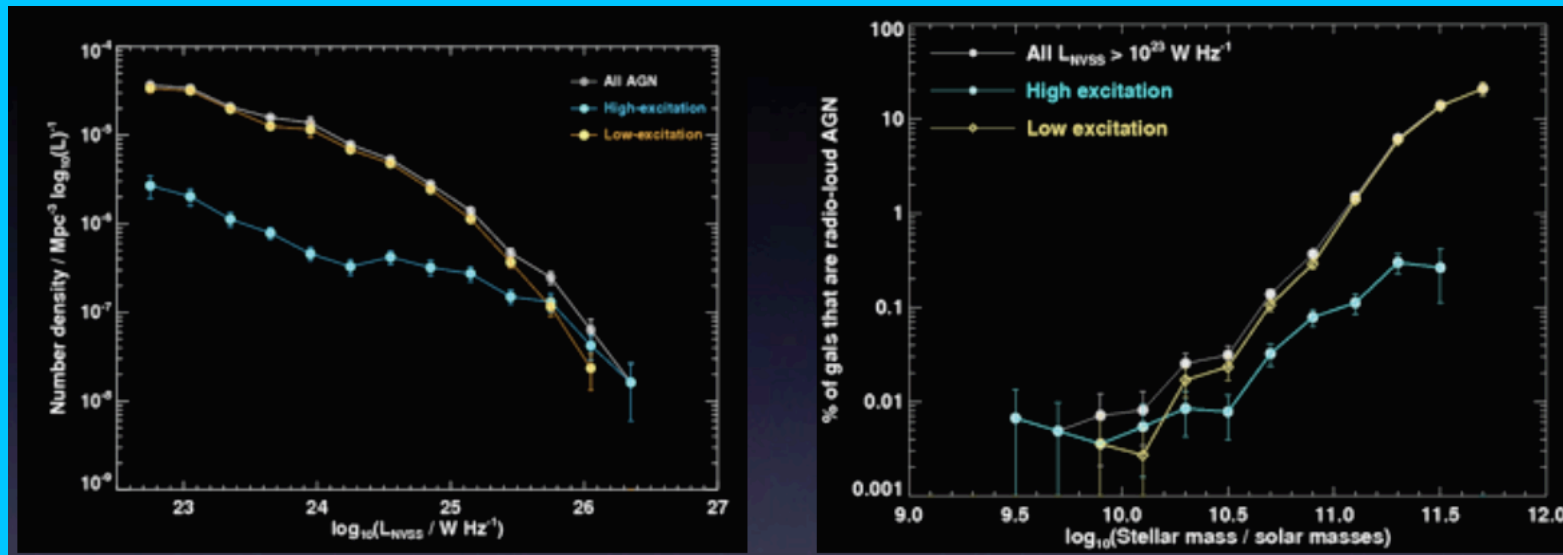
Chiaberge+ 1999

## Problem 2: Hot gas disks



## Problem 3, 4, 5...

- Recurrent activity → blue ellipticals: not seen
- Time delays between AGN and SB
- FRII seen in different merger phases

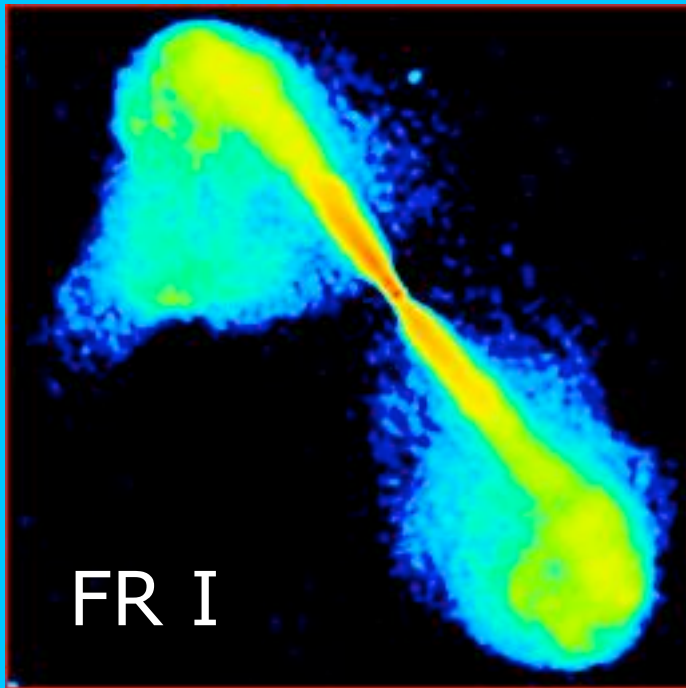


LEG dominate energy output (e.g. Best+ 06)

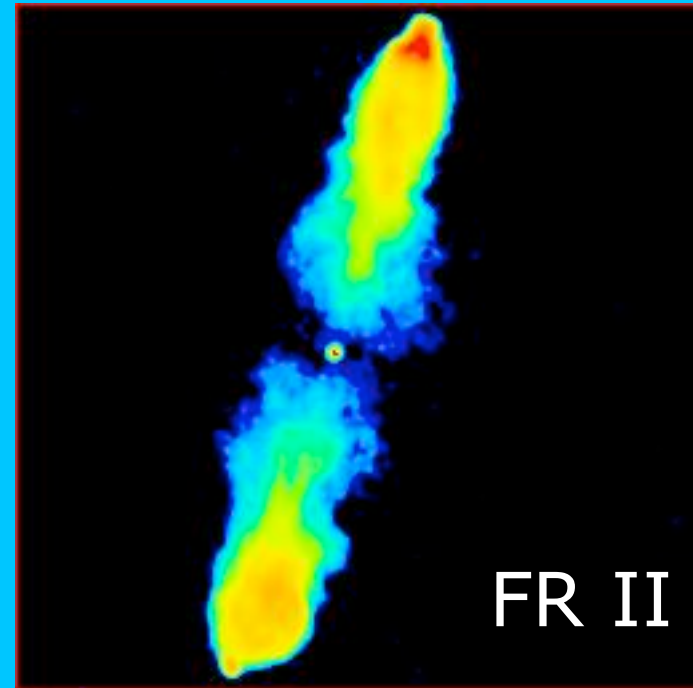


There is more to it!

ASTRON



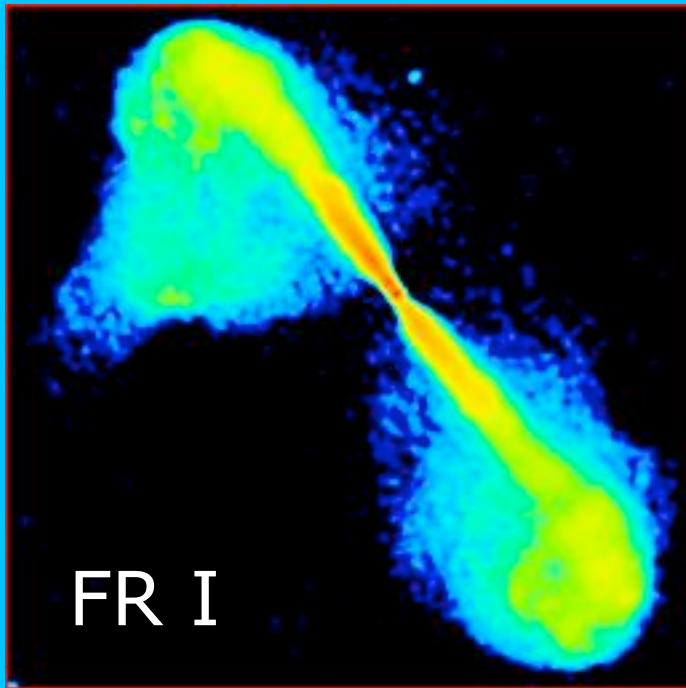
Low(er) power



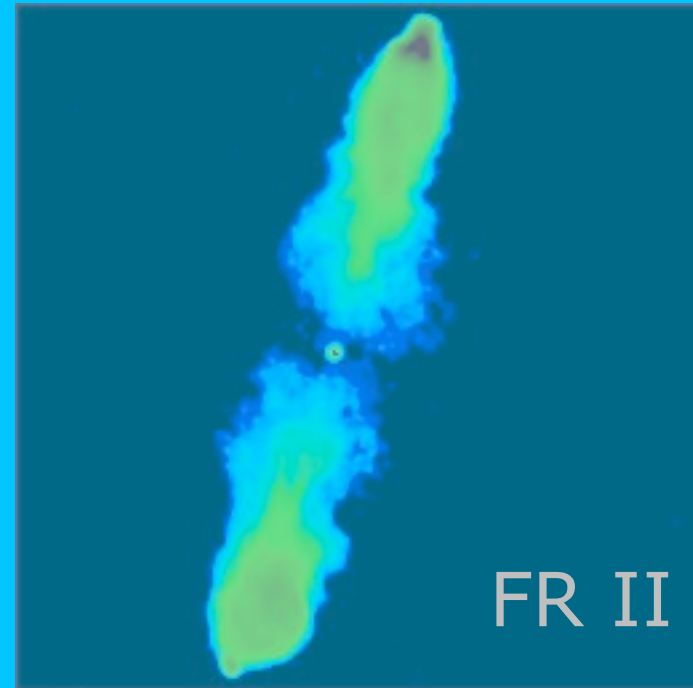
High power

There is more to it!

ASTRON

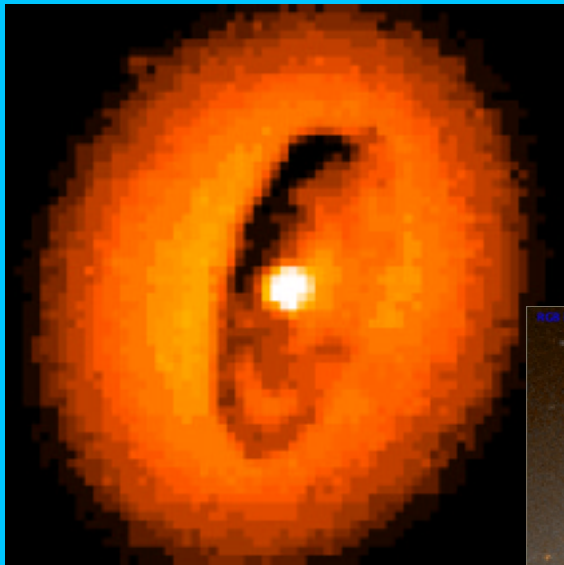


Low(er) power



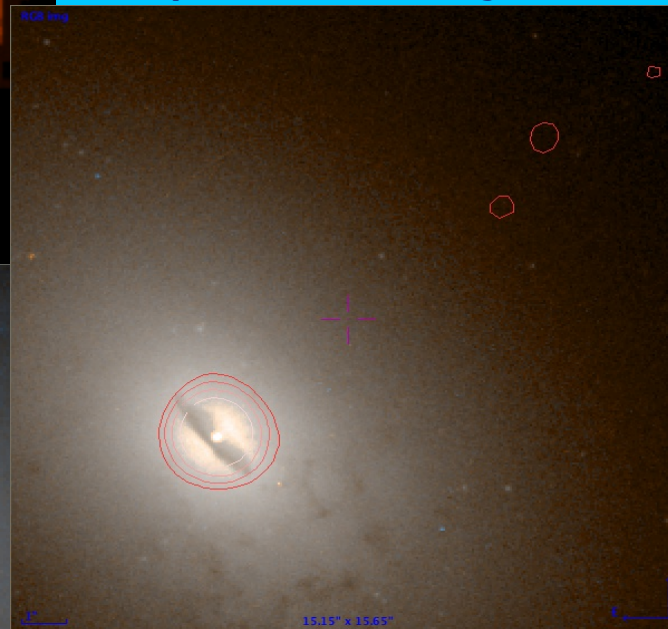
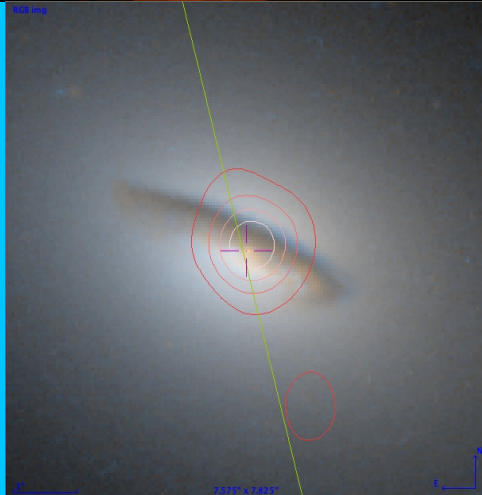
High power

# Dusty disks



Low-power radio galaxies:  
 $\sim 50\%$  disks

(Verdoes-Kleijn+ 2002, de Koff+ 2000)

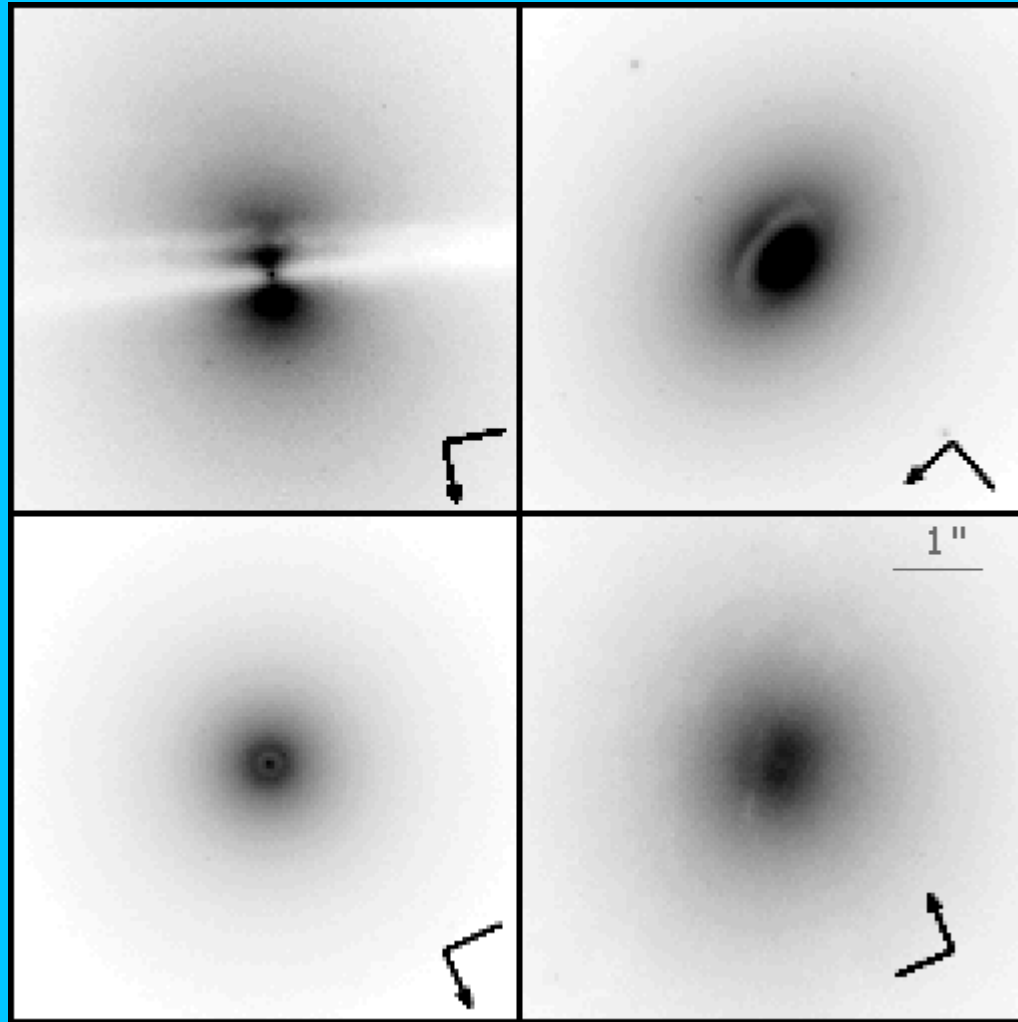


Galaxies Near and Far



# Dusty disks

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Quiescent ellipticals:  
~20% disks

(Tran+ 2001)

# Kinematical fossils?

## SAURON & ATLAS-3D

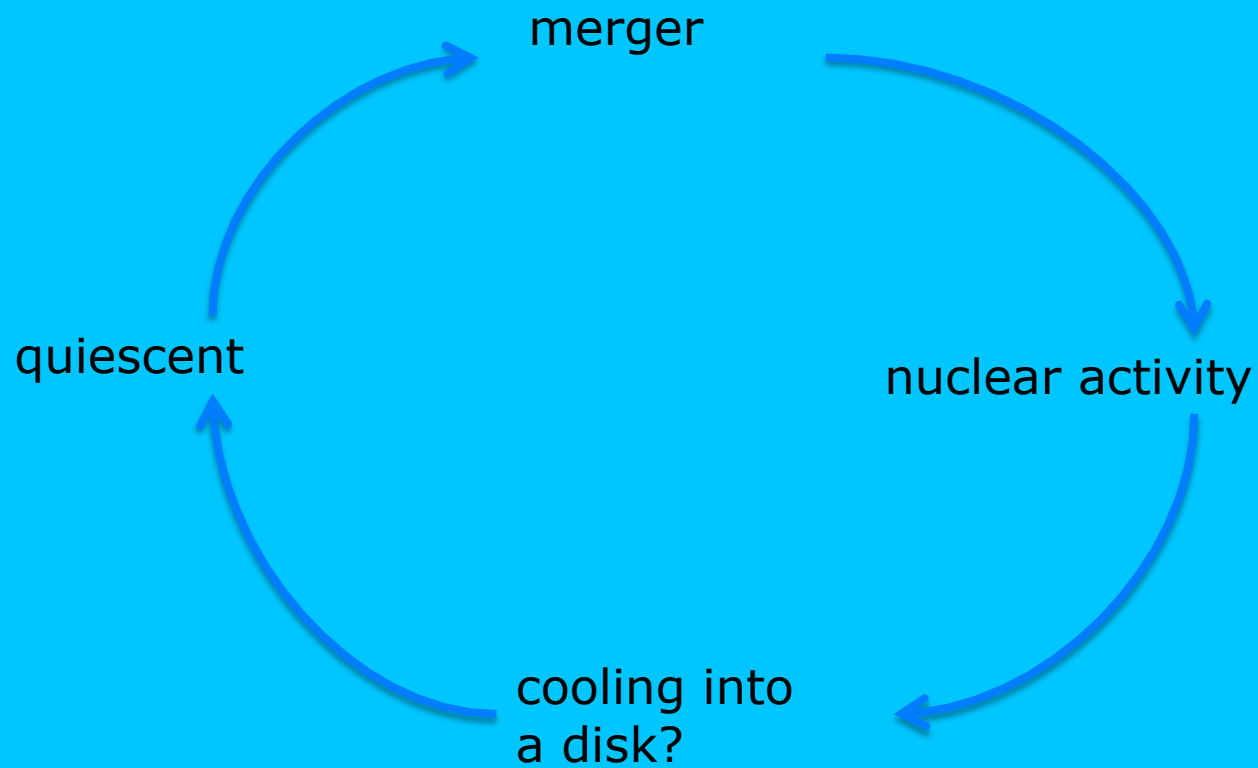
- Boxy vs disky ellipticals
- Misalignment of gas and stellar kinematics
- Counter-rotating cores

Are these residuals from merger events?

Dust disks in boxy hosts (Tremblay+ 2007)

Boxy isophotes linked to specific merger (Naab+ 2006)

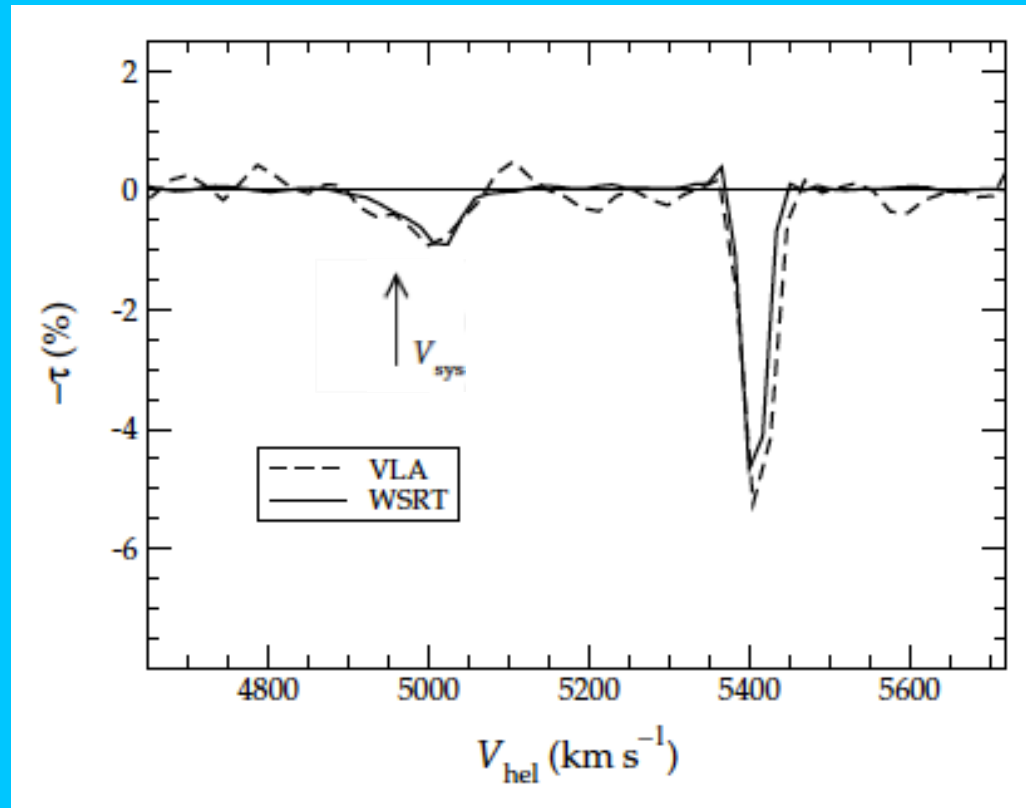
# Where does the dust enter?



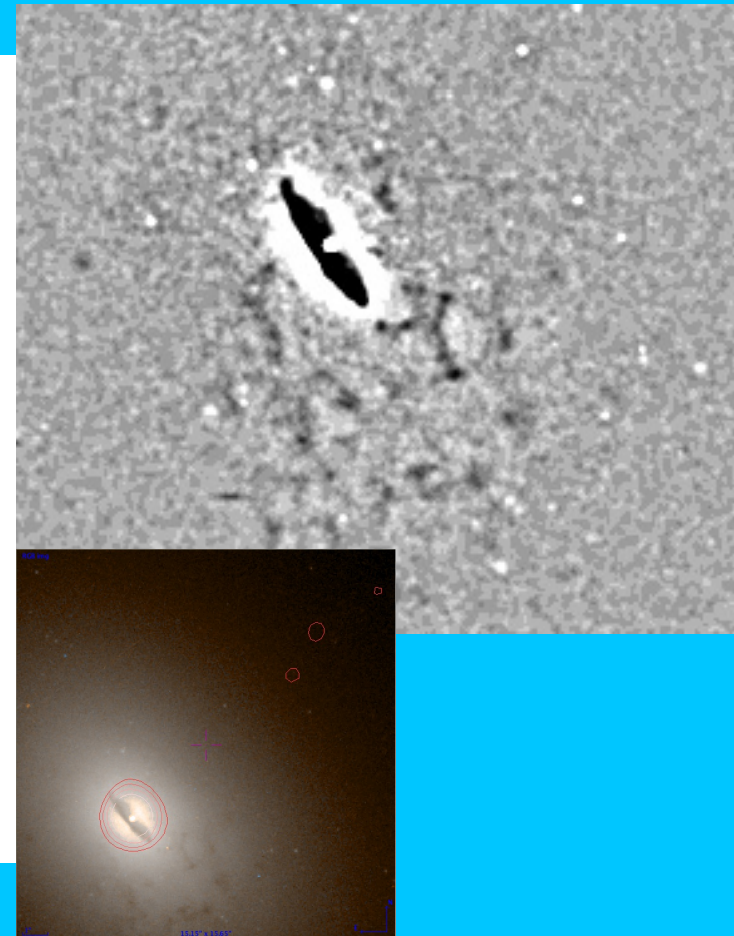


# Look into the inner kiloparsec

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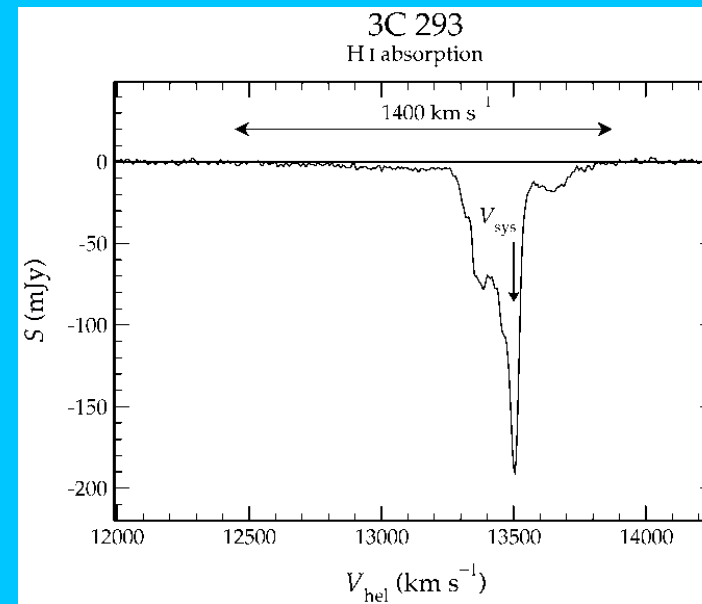
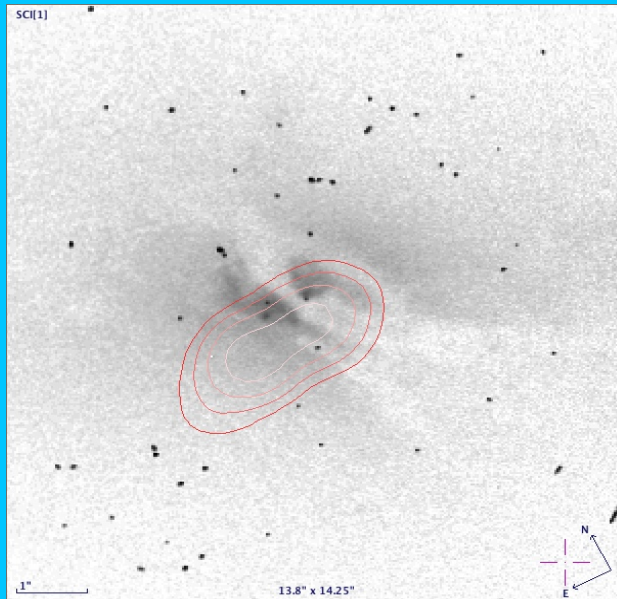


Morganti+ 2009



# Coincidence?

- ~85% not detected in HI
  - ~85% have optical core
- } obscuration = dust + HI ?



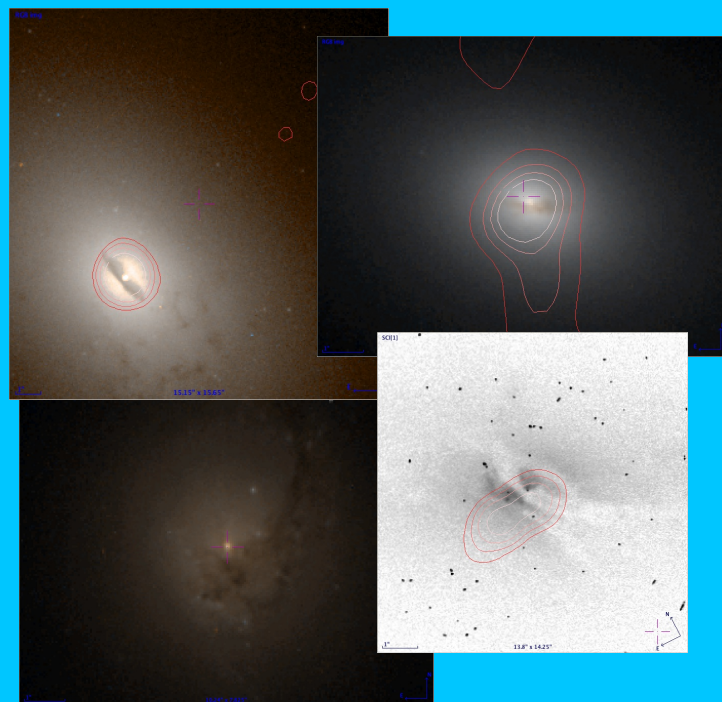
Morganti+ 2003

# Observations

- High spatial resolution data:
  - HST imaging (XMM, Chandra, Spitzer)
  - HI observations
- 26 sources in HI & HST: 12 absorptions & 14 non-detections

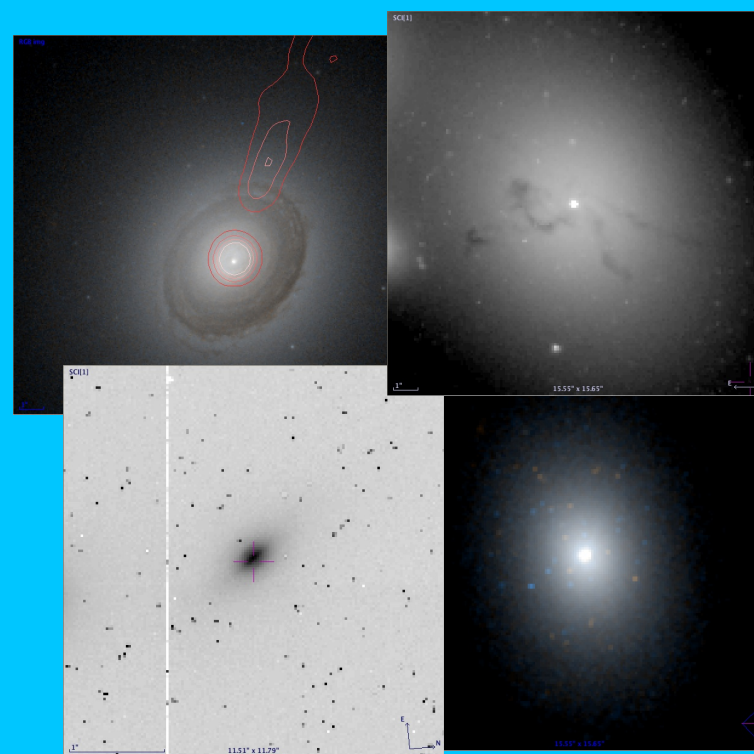
# HI and dust properties

## HI detections



Visible core:  $N_H < 10^{21}$   
Obscured core:  $N_H > 10^{21}$

## HI non-detections



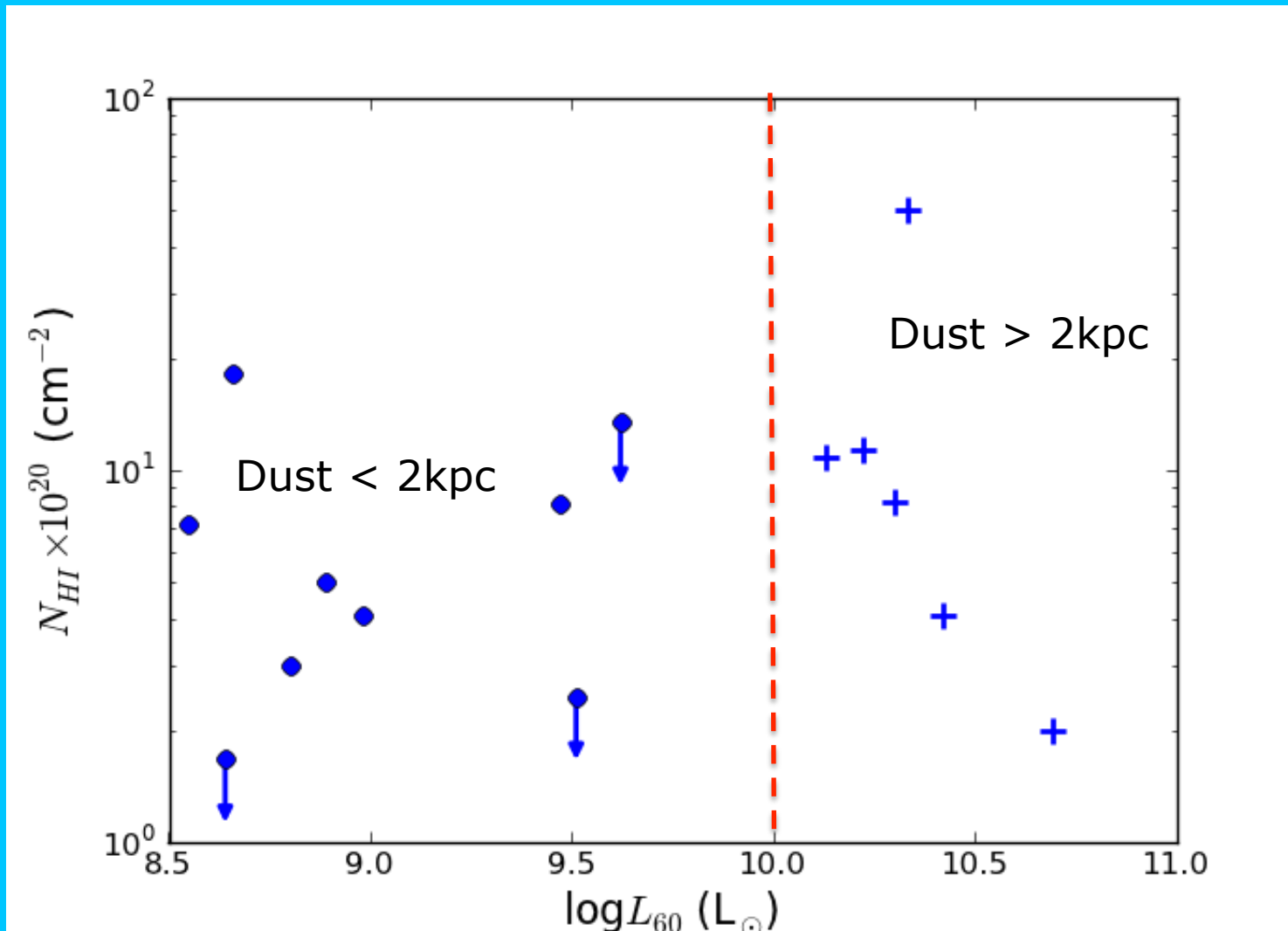
# Results

- HI absorption with  $N_{\text{H}} < 10^{21} \rightarrow$  dust close to the optical core
- HI absorption with  $N_{\text{H}} > 10^{21} \rightarrow$  obscured optical core
- No dust  $\rightarrow$  no HI absorption

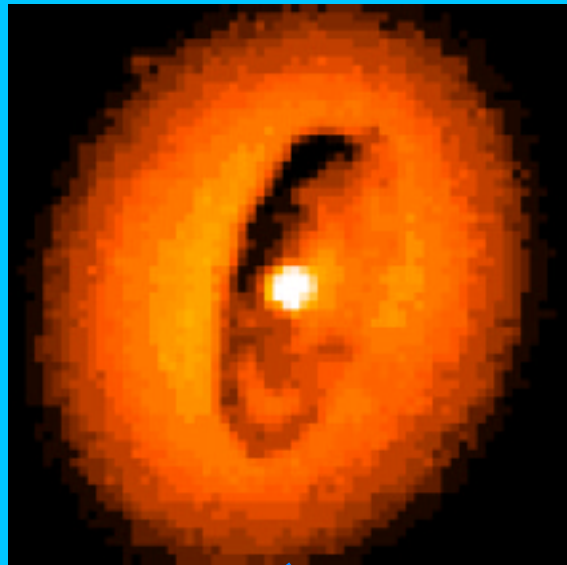




# Spitzer data: thermal infrared

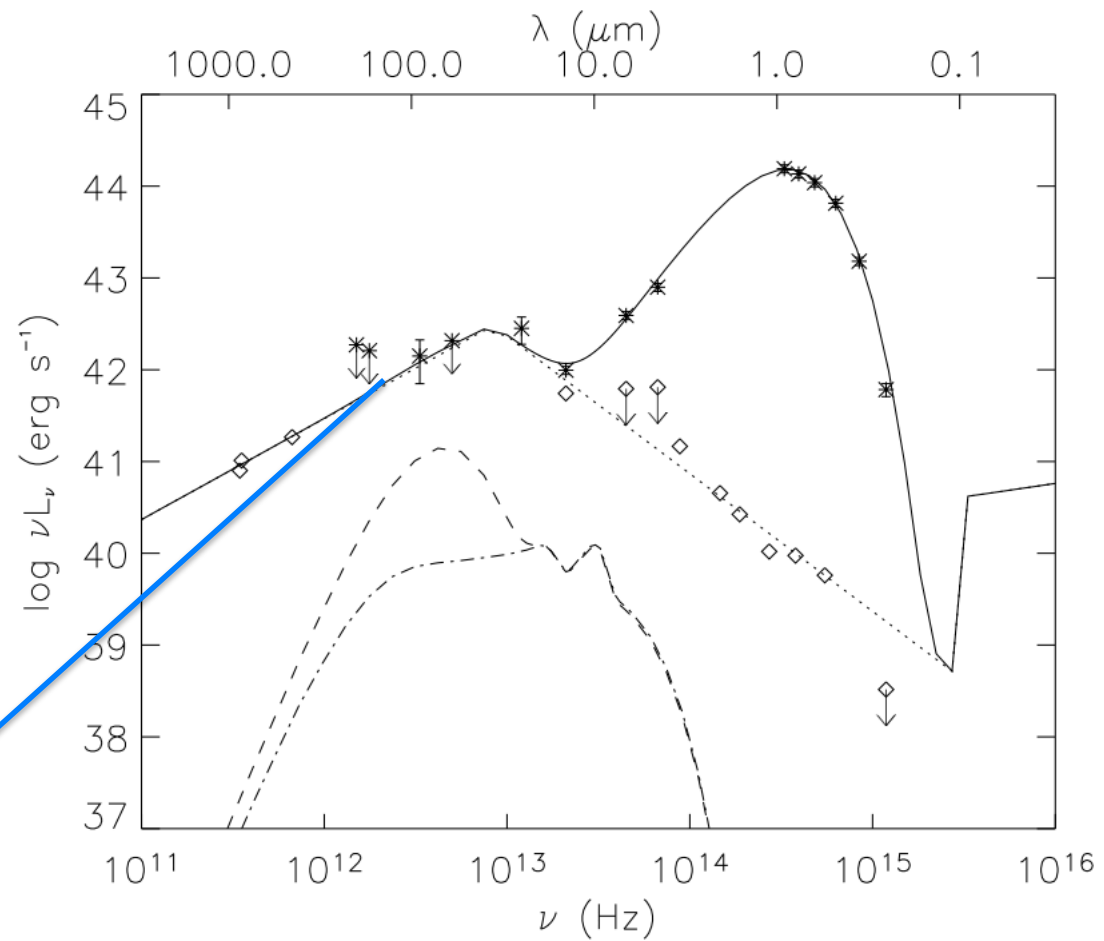


# Where is the dust?

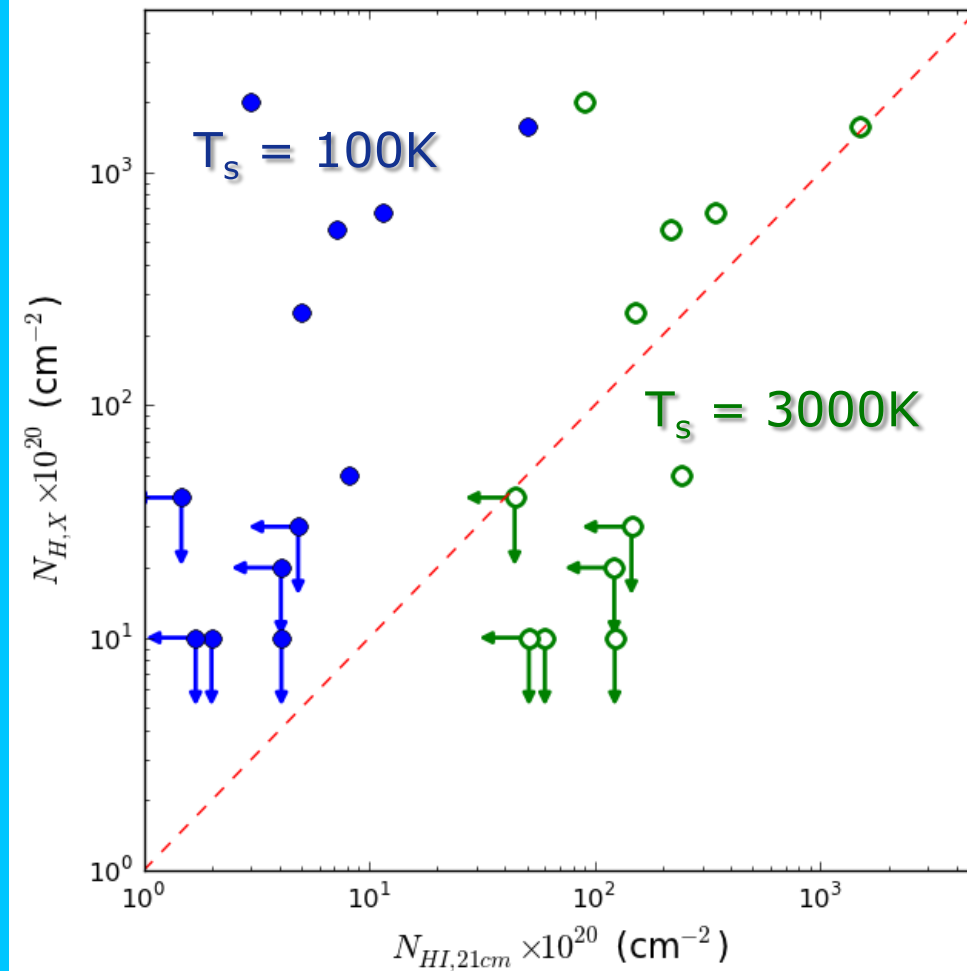


$\sim 10^5 M_{\odot}$

$\sim 10^7 M_{\odot}$



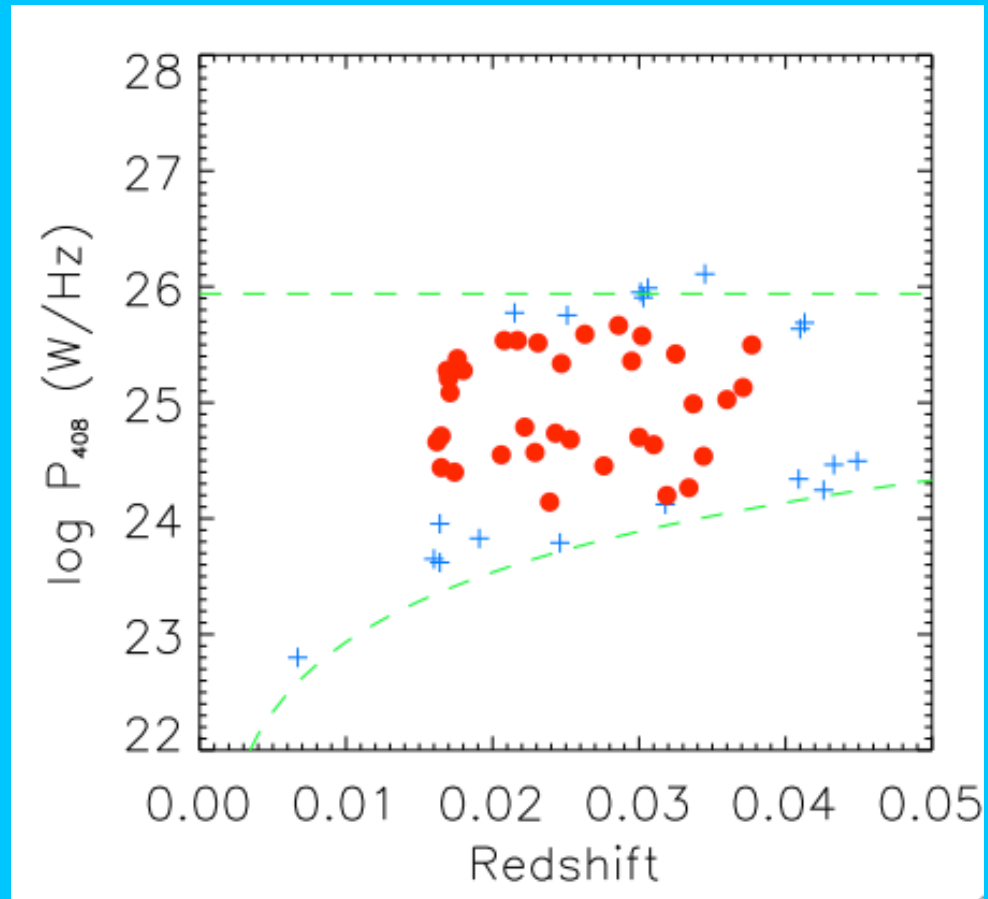
# XMM & Chandra data



# Summary & open questions

- Dust and HI live in the same region
- Two-phase medium: cool dust and warm neutral gas
- Role of dusty disks in massive galaxy formation?
- The answer lies in the inner 100pc
- Where is all the cool dust?

## Future work



... but wait, there's more!



# What did I learn from Bob

- Spectropolarimetry is fun
- You're never too old to be curious
- Science is everywhere
- Science is beautiful
- You can live in Bavaria without speaking German



24 May 2011

Thanks!

ASTRON



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**THANKS!**