NenuFAR and galaxy evolution

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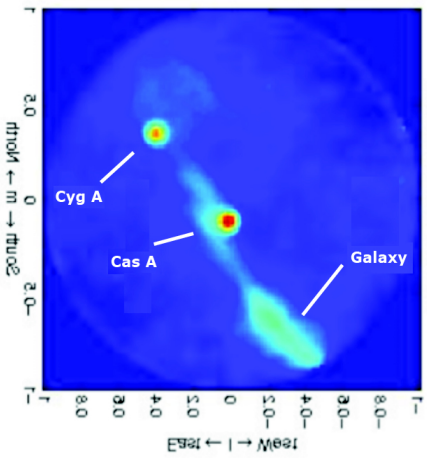
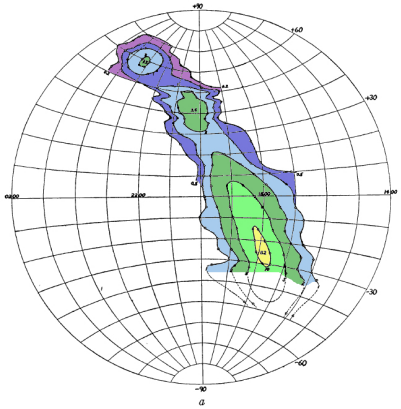
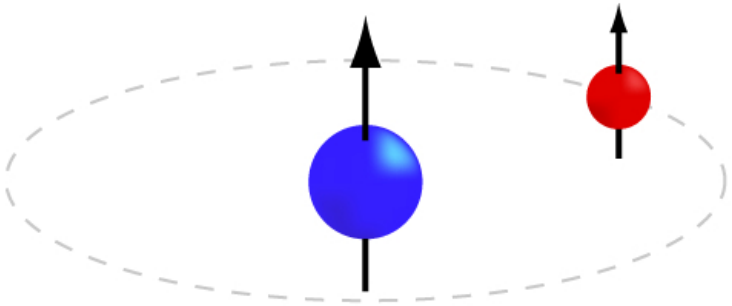
Station de Radioastronomie de Nançay: NRT, Lofar, solar, cosmic rays

Exploration of the unknown : spirit of discovery





It was Grote Reber, however, who decided that this was an important new way of studying the Universe and decided to take some action. He said, "I consulted with myself and decided to build a dish!"



One $\lambda = 21$ *cm photon is emitted when the spins flip from parallel to antiparallel.*

The subject of the 21-cm. line needs no introduction to this audience. Perhaps as an introduction I may mention one moment that belongs to the pre-history of the investigations of this line. In the spring of 1944 Oort said to me: 'We should have a colloquium on the paper by Reber; would you like to study it? And, by the way, radio astronomy can really become very important if there were at least one line in the radio spectrum. Then we can use the method of differential galactic rotation as we do in optical astronomy.'

Van de Hulst (1957, IAU 4, 3)

SKA site on "how do galaxies evolve"
for early galaxies, the questions are:
- where did they get their material?
- what drives their rotation?
- what has shaped them?

Overblown Statements in Press Releases Undermine Science

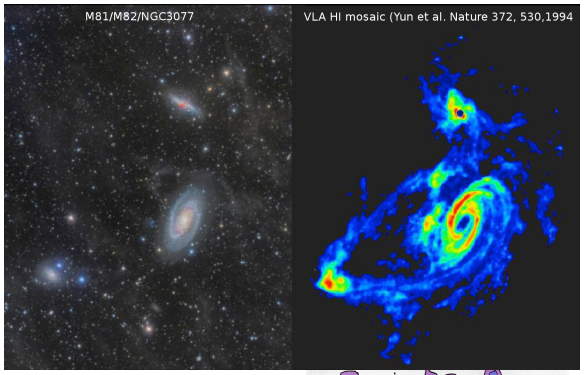
LETTER TO THE EDITOR Wednesday, January 22, 2014 - 14:10 *Scott D. Tremaine, PhD*

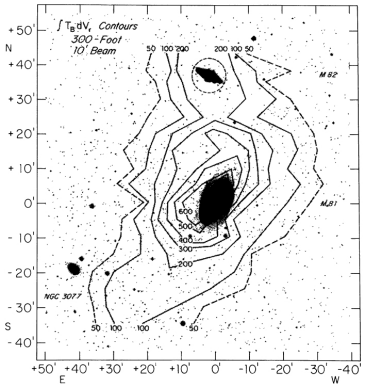
In a recent column, AAS President David Helfand argued correctly that negative public messages about subfields within our own discipline, or even about other disciplines — "shooting inward at each other" — damage all of us.

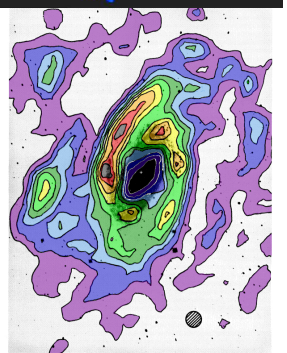
Consider, then, the following public messages:

SKA will track young, newly forming galaxies at high z and, through mapping of the HI distribution, help unravel these key mysteries.

rotation and dark matter: as in 1970s
origin of gas and satellite galaxies







Linear Resolution 2 kpc at z ~ 0.25

Linear Resolution 9 kpc at z ~ 1.4

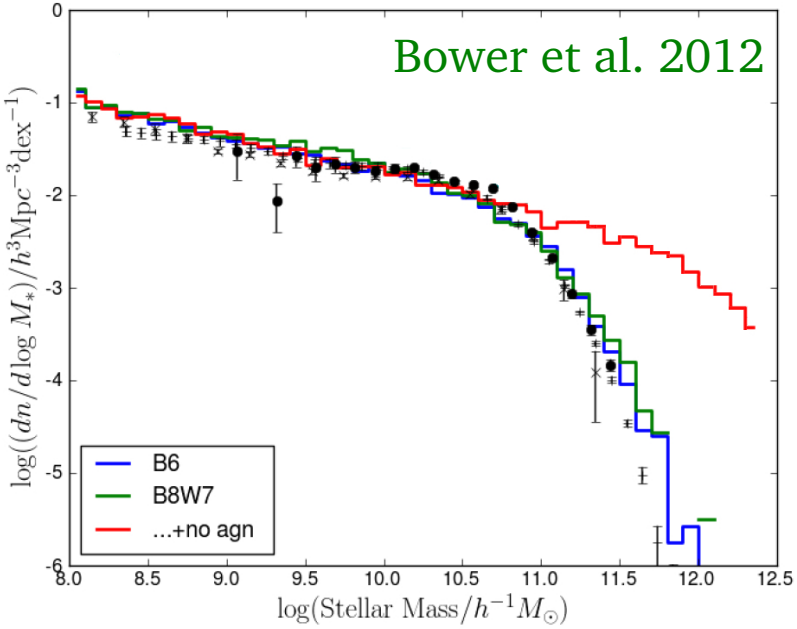


Figure 1. Comparison of the stellar mass function of the Bow06 model (blue line) with the base-line B8W7 model used in this paper (green line). This is based on the WMAP7 cosmology and includes AGN "hot halo" feedback following Bower et al. 2008.

Nearby radiogalaxies : fossil radiolobes at low frequency

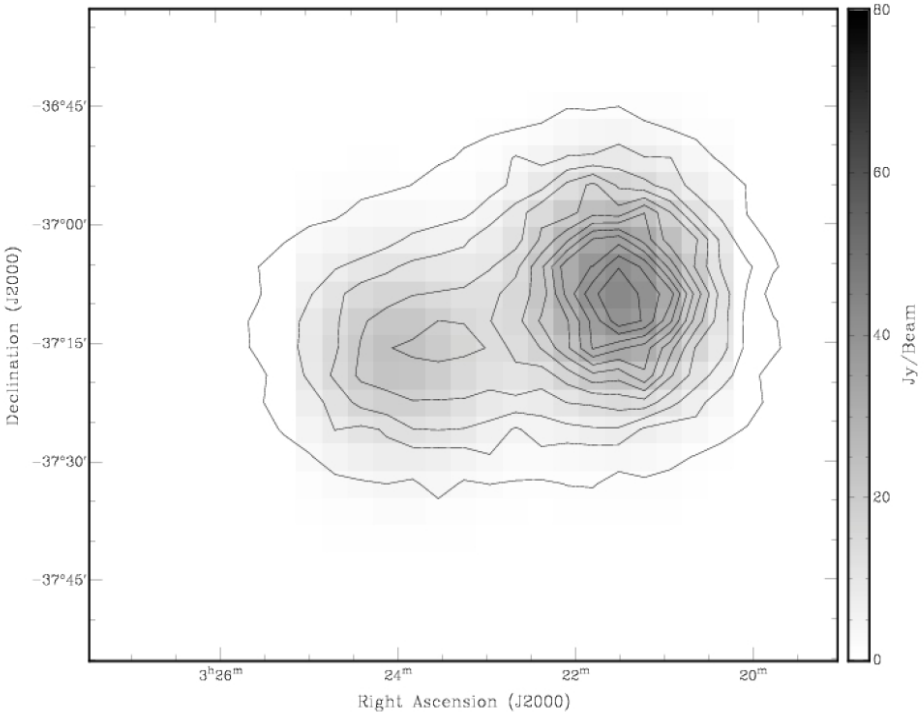
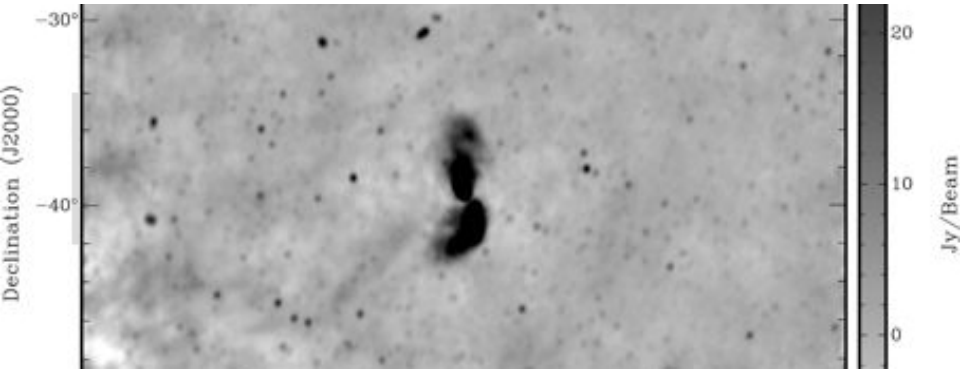
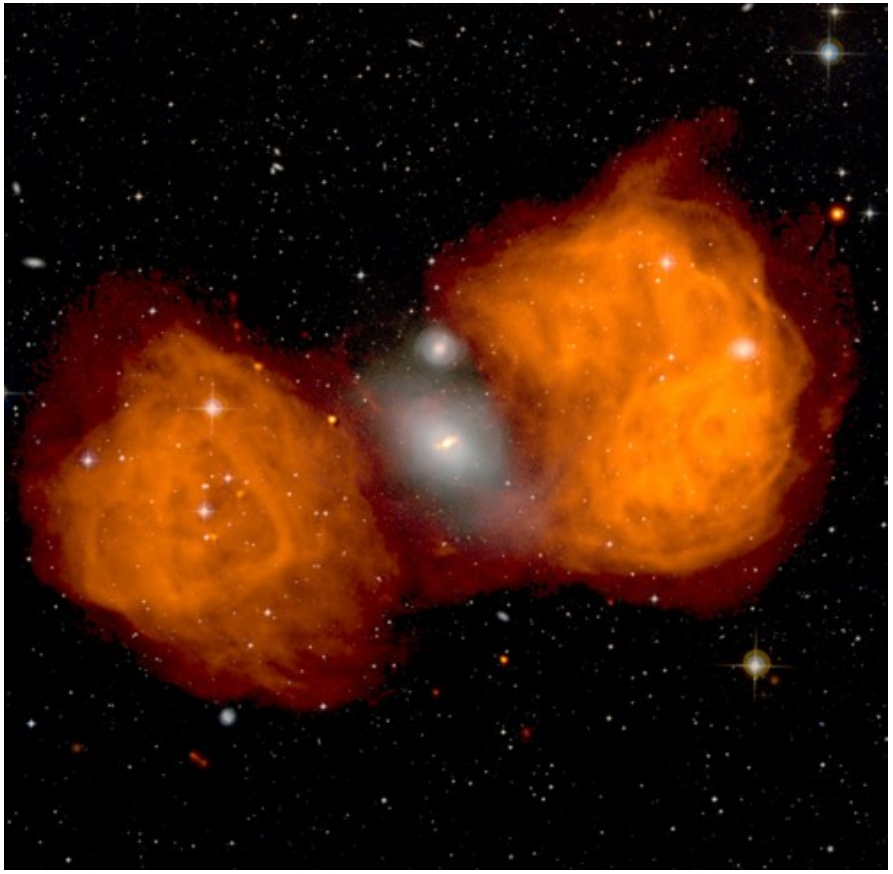
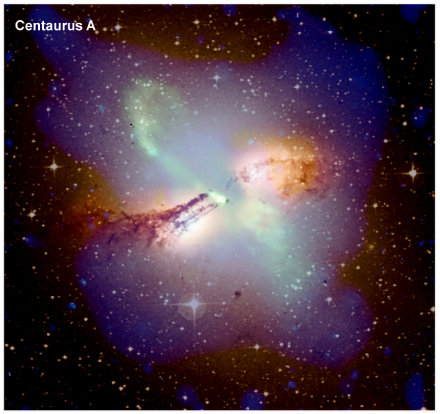
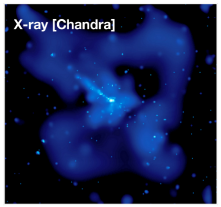


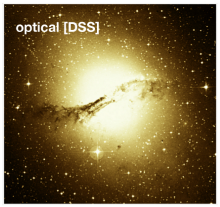
FIG. 7.— Fornax A at 189 MHz (contours) overlaid on the VLA 1.51 GHz image (Fomalont et al. 1989). The VLA image was smoothed to the MWA 32T resolution of 15.6 arcmin. Contours are drawn between 10 and 220 Jy beam^{-1} in steps of 17.6 Jy beam^{-1}.

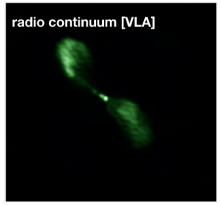


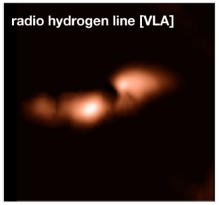








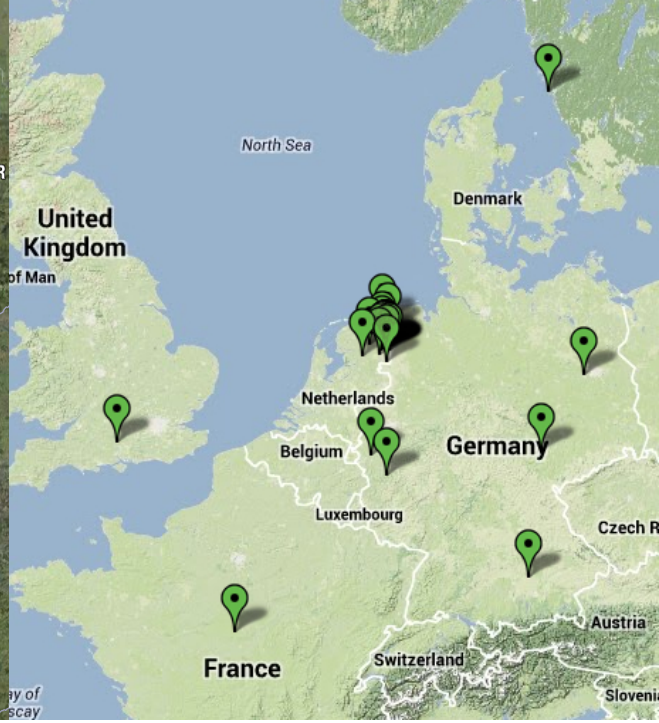




LOFAR

Besluit subsidies Investeringen Kennisinfrastructuur (Bsik)
Agentschap NL
Ministerie van Economische Zaken

SNN



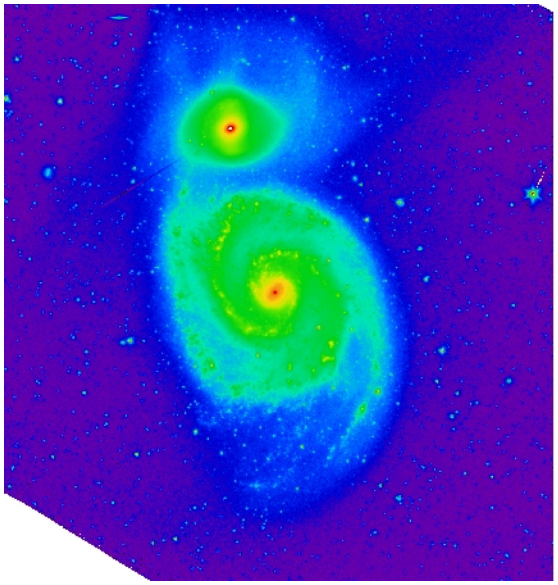
water, energy, sensors

The IBM computer in Groningen is an integral part of LOFAR

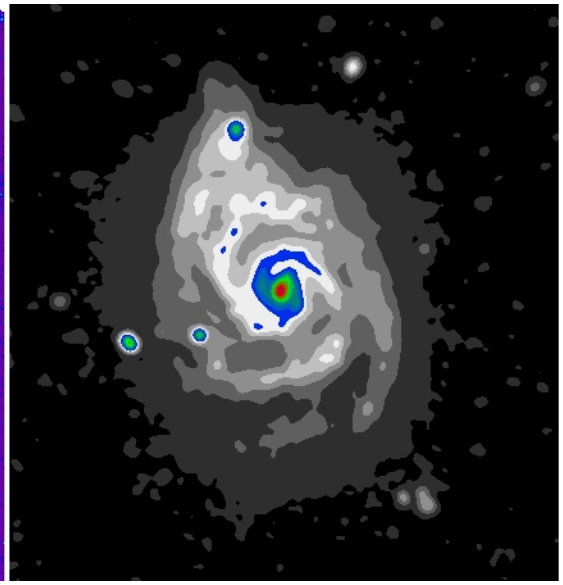
The key science projects of LOFAR are:

- Epoch of Reionisation — De Bruyn RUG+Astron
- Deep extragalactic surveys — Röttgering RUL
- Transient sources — Weijers UA, Fender, Stappers
- Ultra high energy cosmic rays — Falcke RUN
- Solar science and space weather — Mann AIP (D-Potsdam)
- Cosmic magnetism — Beck MpfR (D-Bonn)

M51 IRAC1



20cm VLA



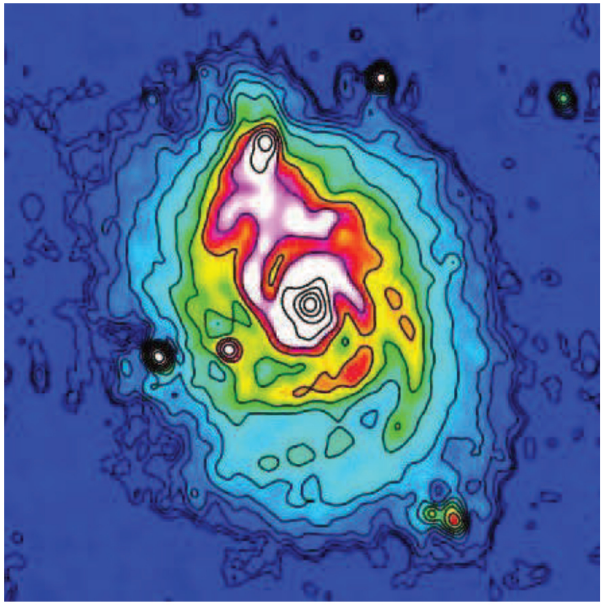
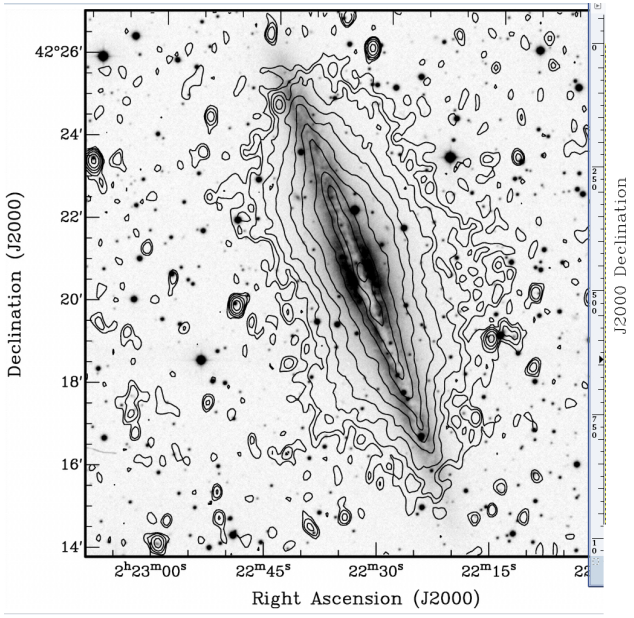
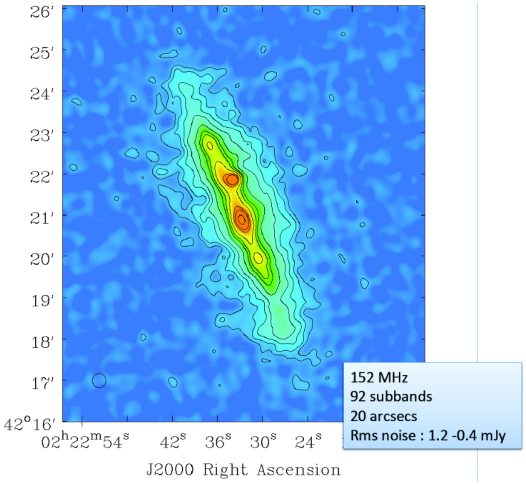


Figure Credit: *David Mulcahy*



NGC 891



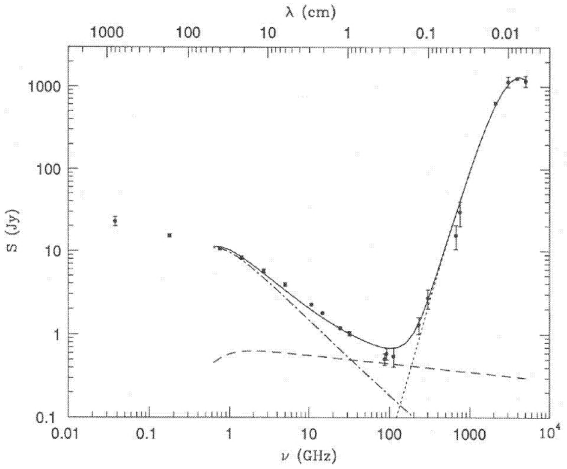
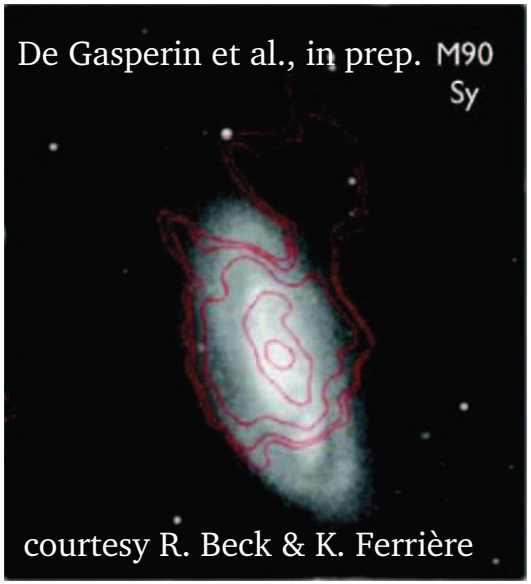
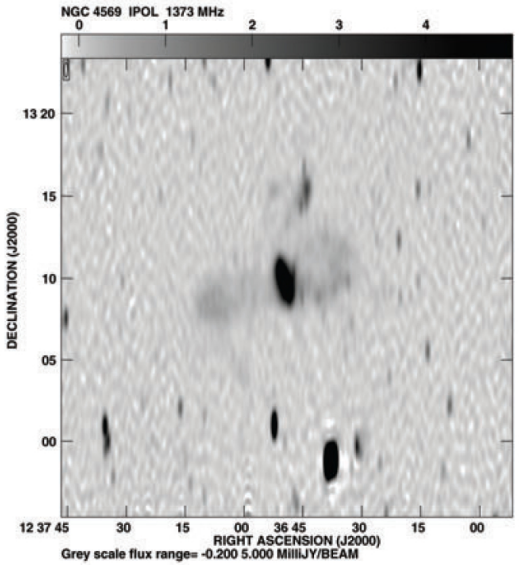


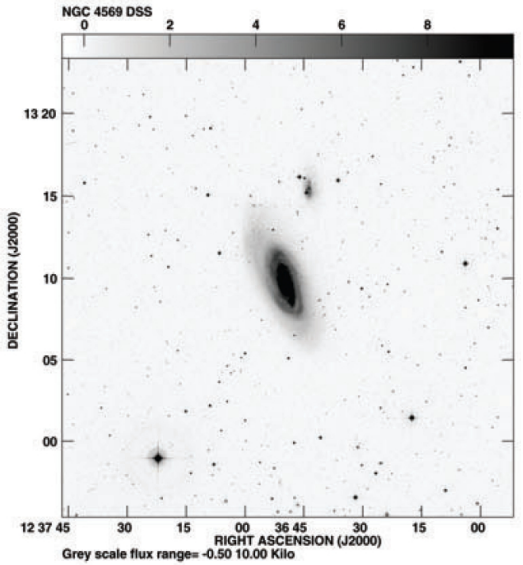
Figure 12. The radio spectrum M82 (Condon 1992) and most other spiral galaxies is the sum of contributions from steep-spectrum synchrotron radiation (dot-dash line), free-free emission (dashed line), and thermal radiation from dust (dotted line). Free-free absorption flattens the overall spectrum at low frequencies.

Condon 2005

For edge-on galaxies at 57.5 MHz, Israel & Mahoney (1990) claim free-free absorption is important



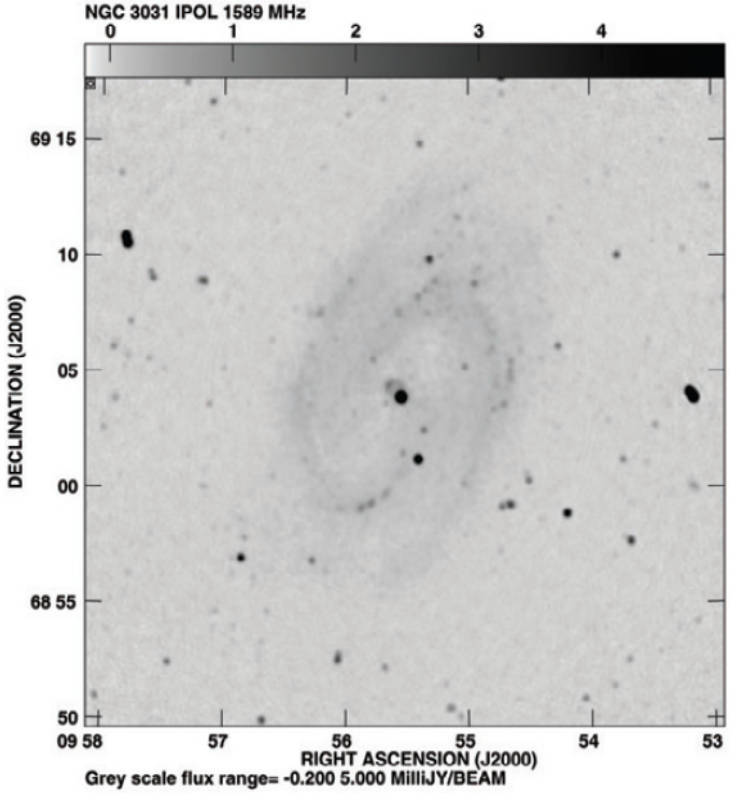


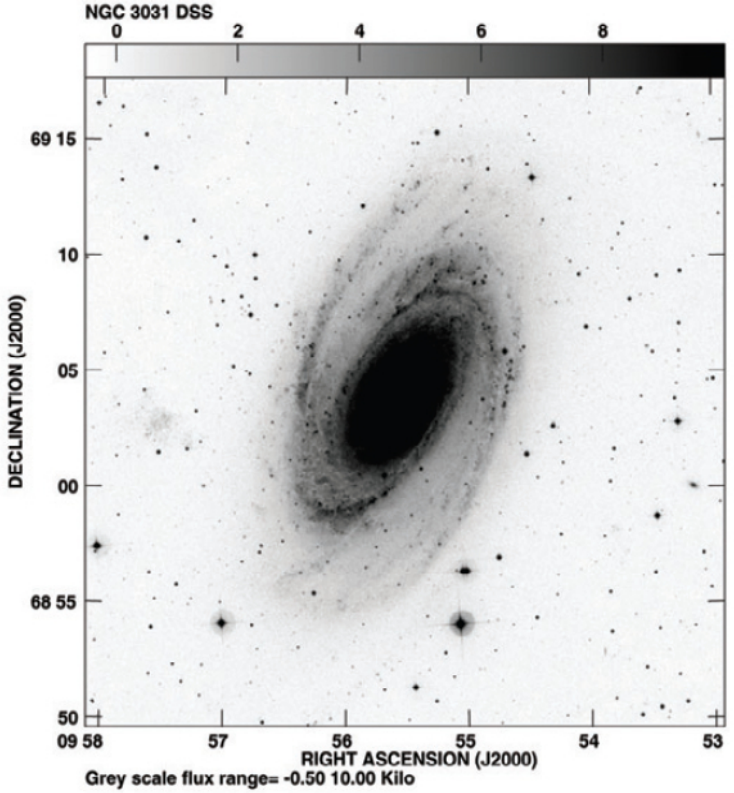


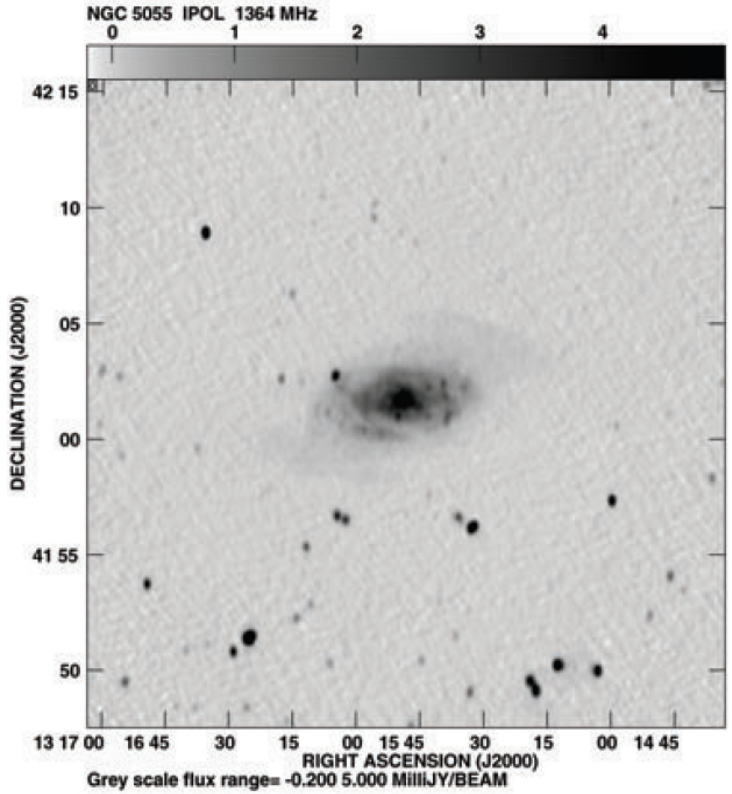
Braun et al. 2007

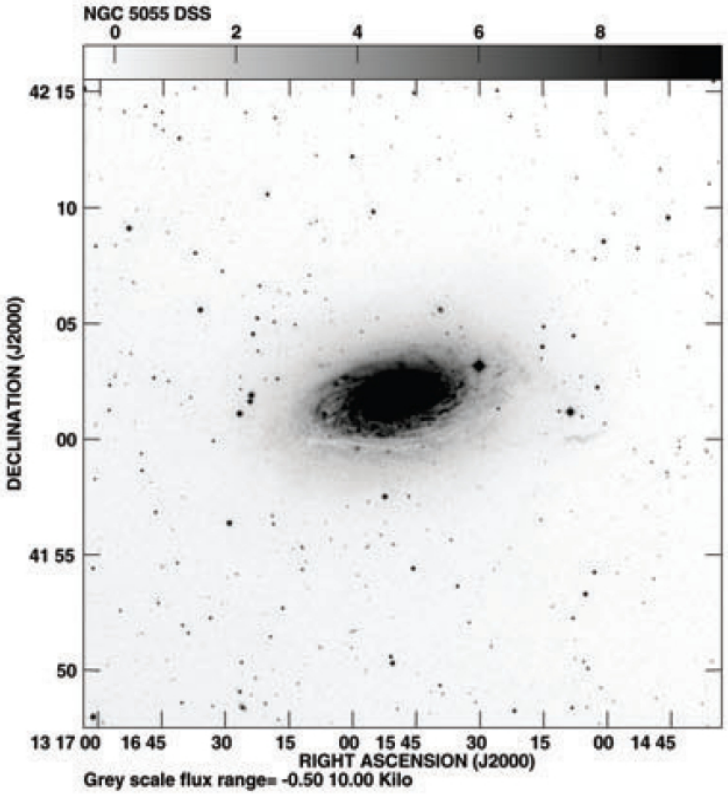
WSRT survey of SINGS Galaxies

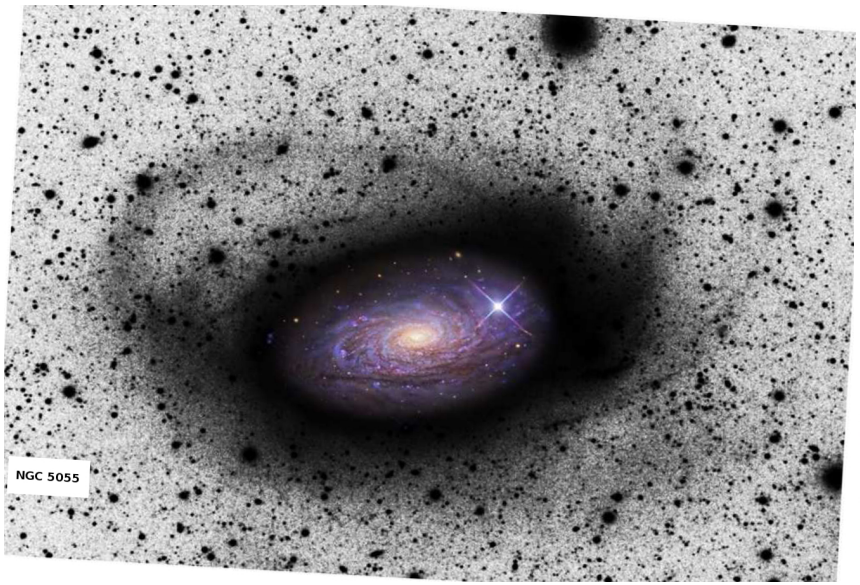
18 cm
22 cm
132 MHz
wide - 8 subbands

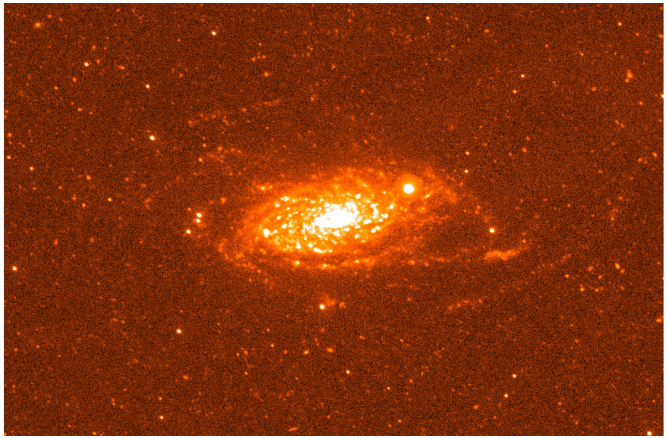
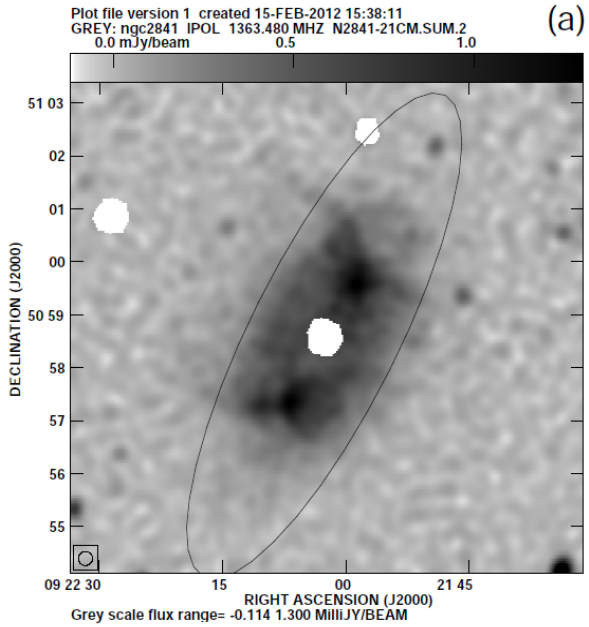
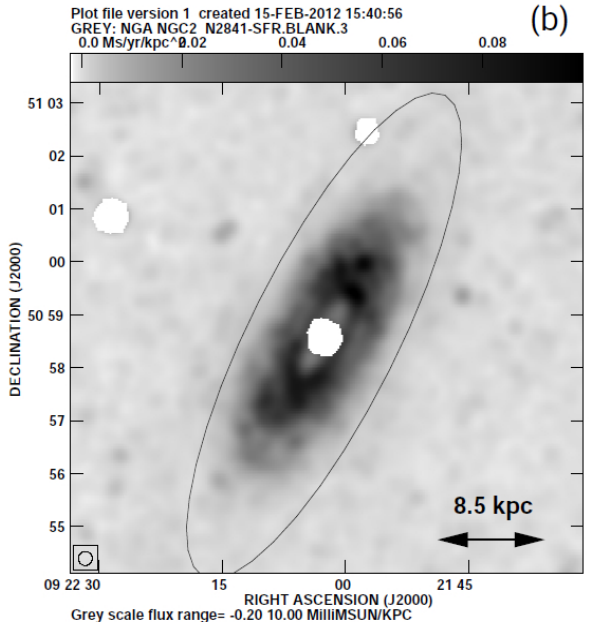
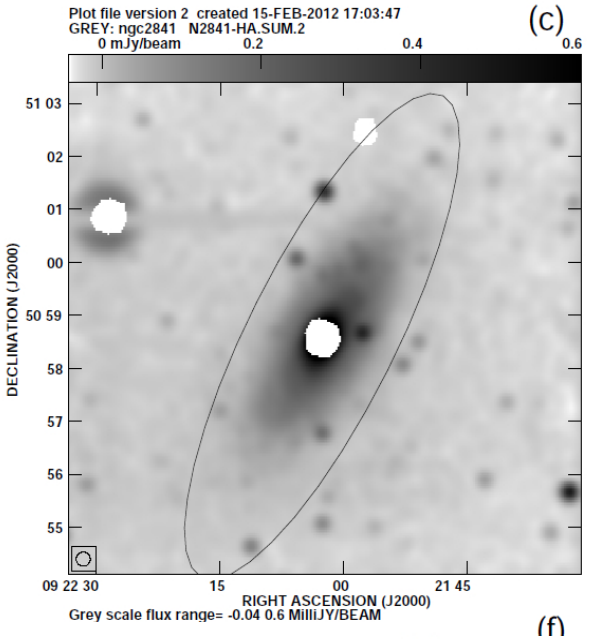
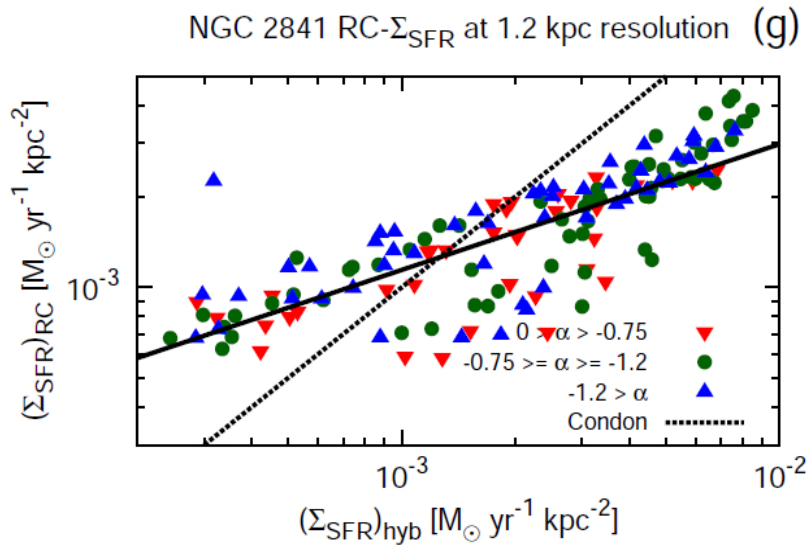
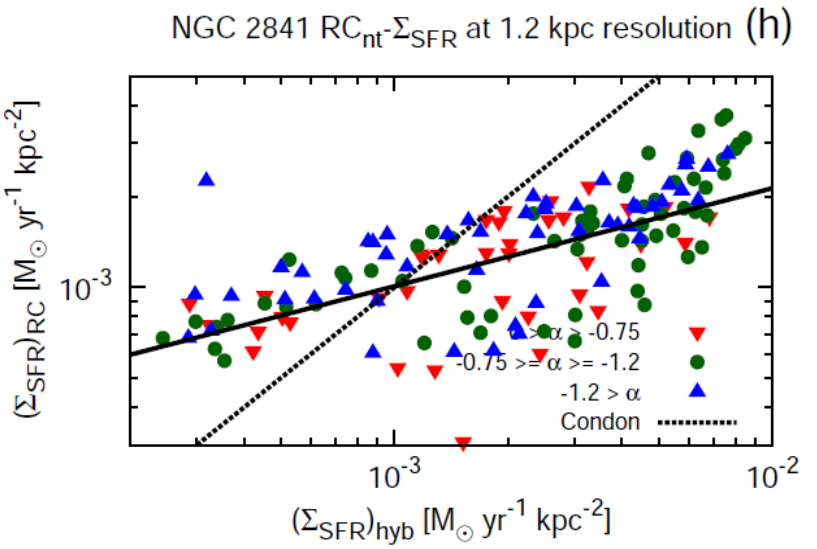





NGC 5055 IPOL 1364 MHz
0 1 2 3 4
42 15
10
05
00
41 55
50
DECLINATION (J2000)
13 17 00 16 45 30 15 00 15 45 30 15 00 14 45
RIGHT ASCENSION (J2000)
Grey scale flux range= -0.200 5.000 MilliJY/BEAM


NGC 5055 DSS
0 2 4 6 8
42 15
10
05
00
41 55
50
DECLINATION (J2000)
13 17 00 16 45 30 15 00 15 45 30 15 00 14 45
RIGHT ASCENSION (J2000)
Grey scale flux range= -0.50 10.00 Kilo


NGC 5055



Heesen et al. 2014 arXiv 1402.1711 - 17 SINGS galaxies with WSRT radiocontinuum data