

Nearby Galaxies ...

Rob Beswick (JBCA/eMERLIN) et al..

'Thoughts' about Legacy programs

- Should be ...(?)
 - Large, coherent scientific investigations - not realizable as series of smaller Programs - get the best science out of the instrument
 - Programs whose data are of general and lasting importance to the broad community and also stimulate follow-up science
 - Programs to fit within the framework of other 'legacies' both e-MERLIN & elsewhere
 - Deliver **value-added** science products from the project and support of the instrument
 - data bases, catalogs, atlases, complimentary ancillary data etc for distribution to the wider community.
 - i.e. Bequeath a scientific LEGACY of data that will be utilized in the future.
 - Rapid science results for e-MERLIN
 - Provide resource/support for e-MERLIN (help!)
 - Pipe-lines, analysis methods, software? etc
 - Extend the user-base.

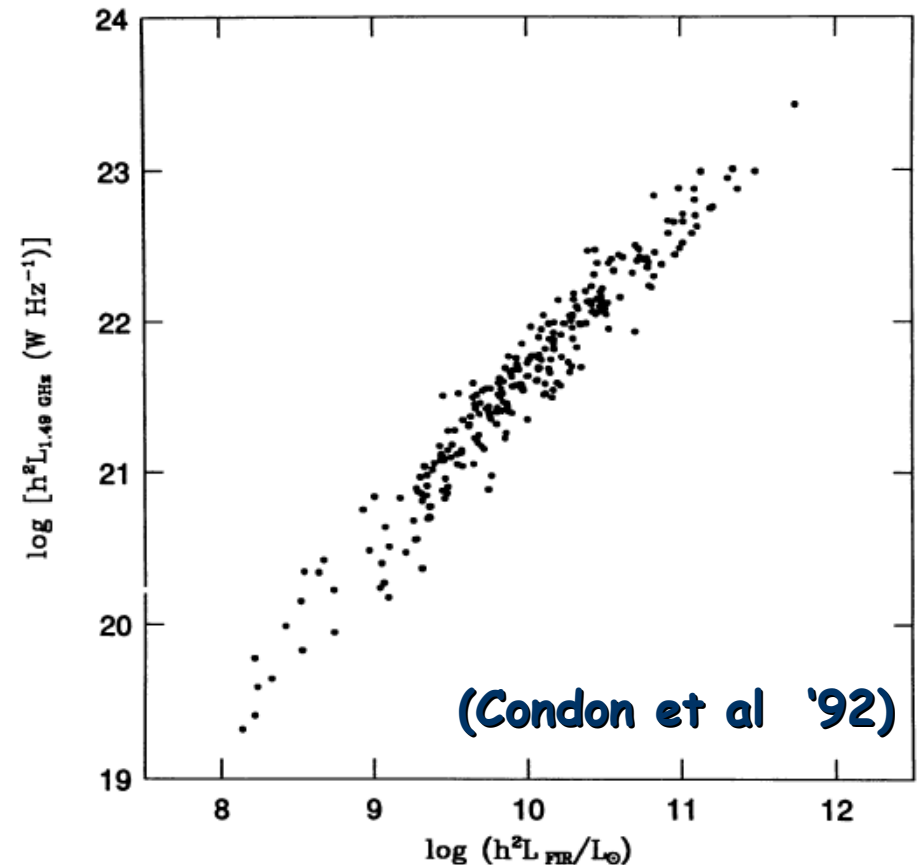
Science from e-MERLIN nearby galaxies survey

- eMERLIN Science core themes would provide
 - .. *an unobstructed view of the inner workings of galaxies*
 - .. *decompose the constituent parts of galaxies*
 - .. *investigating both the causes and consequences of activity in the nearby Universe*
 - .. *provide a detailed local Universe anchor point to studies of the high-z Universe (e.g. deep-field legacy projects)*
 - .. *Link our understanding of galactic SF (galactic legacies and a like) with nearby galaxies and ultimately the distant Universe*
- By
 - Characterising the details of the radio emission (consequences of activity) in a range of galaxy types and environments
 - Such as, star-formation products/indicators (SNe, SNRs, XRBs, ULXs, HII regions, PNe etc)
 - nuclear activity
 - Surveying the cold gas at high resolution address the fuelling environment of this activity

All of which can be done with linear resolutions of <few parsecs in nearby galaxies

Characterizing the radio properties of star-formation in nearby galaxies

- Size of star-forming (starburst) regions ~ 100 kpc
- Radio steep-spectrum synchrotron emission (SNR expanding to form an SNR)
- Strong FIR emission from ULS
- SFR can be estimated from radio emission
- found to be correlated over large scales



- Used to calibrate our models $\rightarrow$ move to high z

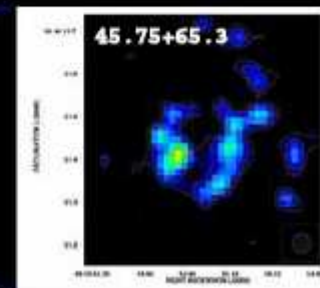
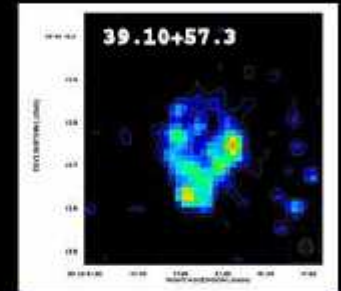
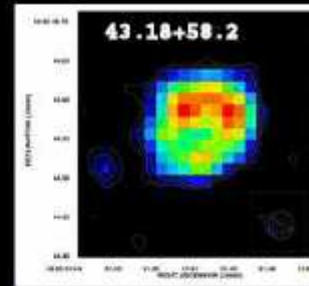
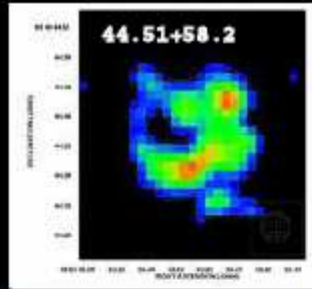
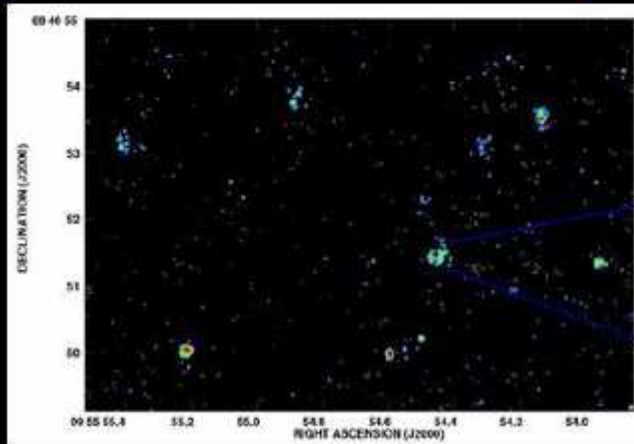
e-MERLIN Legacy kick-off meeting

17th July 2007

Example 1: M82 - nearby supernovae factory Current 'state-of-the-art'

Background = 5GHz VLA+MERLIN

>50 SNR & HII regions detected



Inserts: MERLIN 5GHz
- deep 8 day integration
rms~17microJy/bm

A Nearby galaxy sample

- Choosing a sample
 - Complementary to other wavelength data & other samples - synergies with other projects/observations
 - Selection Criteria??
 - Dist limited eg $<30\text{Mpc}$
 - Dec limited
 - Flux limited ?? (probably not)
 - Targets:-
 - Specific types of sources eg.. Sey, SB, 'normal', or
 - General list covering a range of source types..?

A possible example.. 'LeMMINGs' 'Legacy eMERLIN Multi-band Imaging of Nearby Galaxies'

- 'Piggy-back' on other Legacy programs at in other wavebands. Thus immediately providing a wealth of complimentary ancillary data and interest!
 - value-added, quick science returns, wide interest in data
- e.g. SINGS (75 nearby galaxies, $D < 30 \text{ Mpc}$)
 - Physically-based galaxy sample selected to
 - Sample wide range of parameter space of type (SFR, gas fraction), mass (luminosity, Z/Z_0), $L_{\text{IR}}/L_{\text{B}}$
 - Represented range of galaxy properties (inclinations, bars, spiral structure, nuclear type, IGM environment)
 - Choose well studied objects within the above selection.

Sample

- If you Piggy-back on SINGS
 - Cut sample in Dec $\rightarrow$ ~ 50 source $\delta > 0^\circ$
 - All with deep Spitzer imaging + other ancillary data (H α , H1, CO, dust, RC)
- LeMMINGS would then provide
 - Very sensitive, pc-scale radio observations.
 - Detect and resolve the components of the galaxies rather than just the galaxies
 - Provide a large statistical sample of these components within a range of different physical environments

Possible e-MERLIN observations..

- Deep multi-band (L+C) continuum imaging
 - For specific cases aim to combine with data from EVLA (short spacing data - esp at 5GHz) and EVN (at 1.4/6GHz longer spacing data)
- Plus simultaneous line survey
 - Use the flexibility of the correlator to place side-bands with high velocity resolution of key lines (eg H1, OH in L-band) - in essence get this for free..
 - only a small loss (few %) in sensitivity of continuum

'True' Legacy of such a project

- A data resource:
 - Provide the 'definitive' high resolution multi-frequency radio images & catalogues of the sample chosen.
 - Uniform data products, both images & catalogues
 - Piggy-back spectral line survey data
 - (H1 abs, OH masers, H₂CO abs etc)
 - Link with ancillary archival data
 - Other bands : mm, IR, optical, X-ray, CO, H1 emission
 - More radio : LOFAR, GMRT, EVLA+e-MERLIN, EVN+e-MERLIN
- This legacy project would tap only part of the rich scientific potential of data and provide a future scientific resource.
 - Well studied galaxies → archival interest → e-MERLIN interest
 - Value-added data products quickly available to the community (i.e. project would push for a very short proprietary period. Thus rather than taking the cream from smaller potential standard programmes would help to facilitate their science, by providing good quality data in a digestible form with added value)

Relationships with other projects: past, current & future

- Past:
 - Match sample with previous surveys (e.g. SINGS and associated programmes) - thus providing naturally providing a critical mass of ancillary data from other wavebands.
 - Sample designed to exploit existing archival data resources
- Current:
 - Synergies with other potential E-MERLIN legacy areas
 - Provide an essential near-Universe anchor for deep-field legacies
 - Imaging SF-regions and compact sources (SNe, XRBs etc) - comparisons with galactic equivalents in a wide variety of environments
 - Likewise for equivalent EVLA legacies
- Future:
 - Provide definite high resolution cm-radio data to complement studies with new instruments - complimented rather than surpassed
 - E.g. Extended-LOFAR, ALMA, Hershel etc etc etc ++

Some General Issues...

- Sample choice? - maximise initial science & legacy products
- Observing strategy (a day 1 legacy project?)
- Consortia would need providing resource to assist in e-MERLIN (people's time, technique developments etc) as well a science exploitation
 - Management structure
 - Consortia memberships & roles
 - Science membership
 - Links with other projects & data sources
 - wide range of astrophysical applications → broad range of science expertise needed
 - Team of conduits heading areas rather free-for-all?!
 - Multi-wavelength expertise, observational and theoretical
 - Strong technical team
- Data product archives
 - Data release policies to maximise scientific impact & benefit to e-MERLIN
 - Facilitate single source-type studies (both internal & external to project)
 - Short proprietary rights for team - release data to community quickly
- Early science exploitation via legacy team