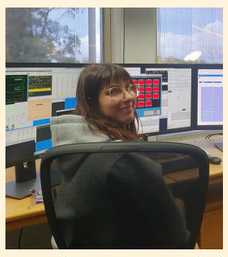

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Serendipitous H-ATLAS fields Observations of Radio Extragalactic Sources

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ABSTRACT

SHORES is a multi-wavelength pencil beam radio survey of FIR-selected fields performed with the ATCA, comprising 27 shallow and 2 deep fields observed at 2.1 GHz. The deep fields benefit from 5.5 and 9 GHz follow-up. This nested approach targets diverse radio populations, useful to explore the radio number counts over a wide range of fluxes. Further, combining this multi-band coverage with FIR and SKA-pathfinder data allows us to reconstruct radio SEDs and exploit the FIR-Radio Correlation to possibly disentangle Star-Forming Galaxies from AGN.

Read the paper here!

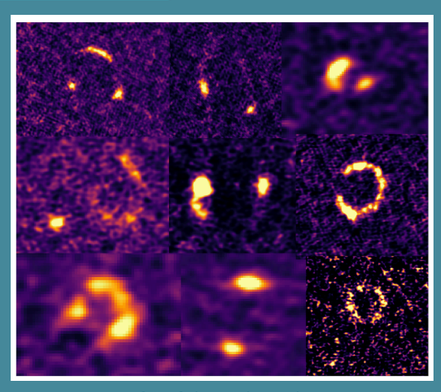
AROUND 30 LENSED GALAXIES FAR FAR AWAY....

H-ATLAS is a FIR survey conducted in both the NGP and the SGP with Herschel.

Negrello+17 identified **30 candidate lensed galaxies** basing on their flux at 500 um.

These 30 lensed galaxies were observed at 2.1 GHz with **ATCA** in Giulietti+22.

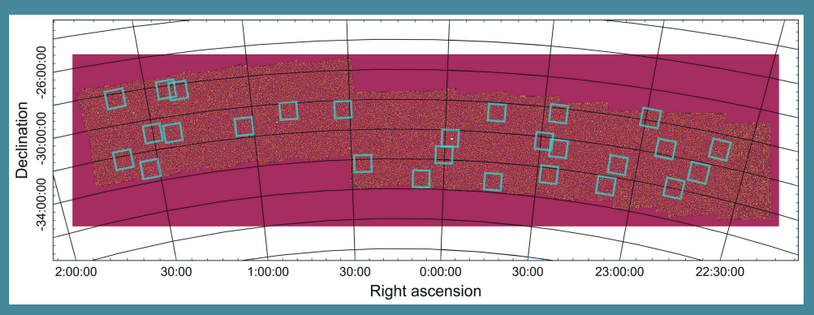
In the 2.1 GHz snapshots of the lensed galaxies there were also other interesting serendipitous sources.



ALMA images of 9 of the 30 lensed candidates. Credits: M. Torsello, G. Gururajan

...THERE WERE MANY OTHER FAINT GALAXIES

But to study them we needed to improve our radio observations, so we applied for time at hte ATCA and observed the fields for more than 200 hours. The Serendipitous H-ATLAS fields Observations of Radio Extragalactic Sources (SHORES) was born!



TO STUDY THEM WE USED A COMPOSITE STRATEGY

SHORES is composed by a shallow survey, covering 27 fields, and a deep survey, covering two fields at 2.1 GHz. The deep fields have been also observed at 5.5 and 9 GHz.

ID Card SHALLOW FIELDS

# of fields: 27
Area: 26.1 sqdeg
Rms: 33 uJy/beam
Bands: 2.1 GHz
Sensitivity: 148.5 uJy/beam
# of sources: 2294

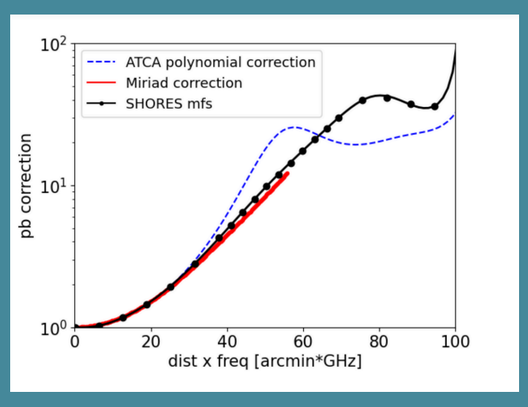
ID Card DEEP FIELDS

# of fields: 2
Area: 2.2 sqdeg
Rms: 9 uJy/beam
Bands: 2.1, 5.5 & 9 GHz
Sensitivity: 45 uJy/beam
# of sources: 545

AND MAXIMIZED THE DETECTION AREA OF EACH FIELD

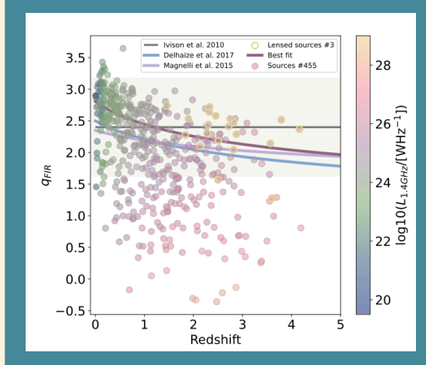
SHORES is a pencil beam survey

Goal: To maximize the survey efficiency, SHORES images out to 3 times the FWHM from the phase center.
Issue: At these large distances, standard corrections fail to account for the beam shape variation across the wide 2 GHz bandwidth.
Method: We observed the bright quasar PKSJ0537-441 at 20 different offset positions (0–45 arcmin) to empirically map the beam profile.
Result: A polynomial fit was calculated for the multi-frequency synthesis maps
Validation: This custom correction successfully recovers accurate fluxes at large radii, validated by comparing corrected MFS fluxes with spectral fits from individual sub-bands.



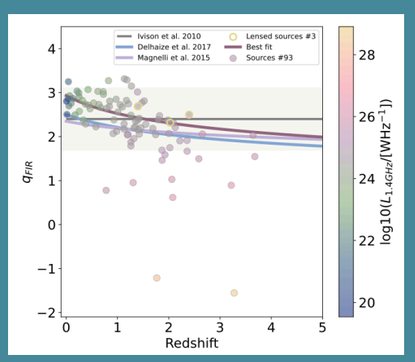
SCIENTIFIC RESULTS: WHEN RADIO MEETS FIR

We use the parameter q_{FIR} to quantify the correlation between infrared and radio emission



Shallow fields:
Median $q_{FIR} \approx$ 2.36, consistent with Ivison et al. (2010).
A population of sources exhibits high radio luminosity ($L_{1.4GHz}$) but appreciably low q_{FIR} values, clearly separating them as AGN dominated.
We confirm that the radio emission in candidate **strongly lensed galaxies** is dominated by star formation. The survey doubled the number of lensed candidates with a radio detection compared to pilot studies.

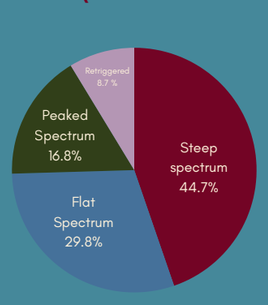
Deep fields:
Median $q_{FIR} \approx$ 2.13, consistent with Ivison et al. (2010)
81% of our sources fall within 1σ of the expected range for star-forming galaxies (SFGs)
18% have $q_{FIR} < 1.8 \rightarrow$ likely AGN-dominated
Deep fields show higher qFIR than shallow fields → consistent with lower AGN fraction
We observe mild redshift evolution: $q_{FIR} \propto (1+z)^{-0.22}$

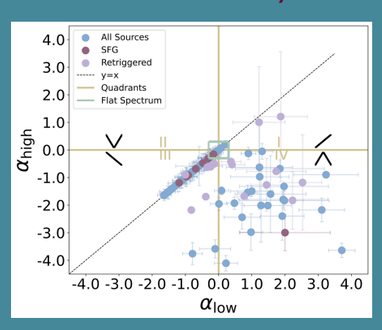


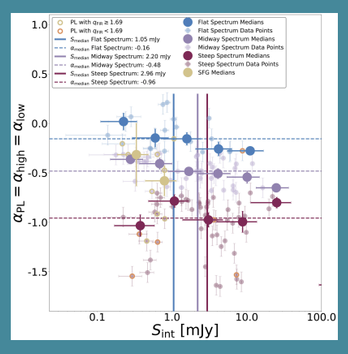
SCIENTIFIC RESULTS: SHORES AND SKAO PRECURSORS AND PATHFINDERS

We performed a bayesian SED fitting using RadioSED (Kerrison+24) of SHORES + SKAO pathfinders and precursors data (ASKAP RACS and MWA GLEAM-X)

Colour-Colour Diagram (α_{low} vs α_{high})
Most sources follow a simple power-law, clustering along the diagonal ($\alpha_{low} \approx \alpha_{high}$).
SFG Validation: Sources with confirmed FIR counterparts (maroon circles in the plot) tightly group in the steep spectrum region, validating the synchrotron origin of their radio emission







The Flux-Index Trend
We observe a non-monotonic evolution of the median spectral index:

1. Flattening at intermediate fluxes (∼1 mJy), indicating the emergence of AGN cores.
2. Steepening at the faintest levels, tracing the transition to a population dominated by Star-Forming Galaxies and high-z AGN.

RADIO NUMBER COUNTS

We present differential radio number counts from the SHORES shallow and deep fields, that complement each other

- **Bright End ($S > 1$ mJy)**: The 27 shallow fields (∼ 26.1 deg^2) robustly constrain the AGN-dominated population, significantly reducing cosmic variance compared to single-beam surveys
- **Faint End ($S \lesssim 1$ mJy)**: The 2 deep fields (∼ 2 deg^2) probe the sub-mJy regime, effectively sampling the turnover dominated by Star-Forming Galaxies and radio-quiet AGN.