Investigating the influence of radio-faint AGN activity on the SFR-radio luminosity correlation

Based on the work presented in **Peluso et al. 2025b**

The Fifth National Workshop on the SKA Project – November 26, 2025

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In collaboration with Ivan Delvecchio, Jack Radcliff, Francesco Ubertosi, Myriam Gitti, Isabella Prandoni and the AGN-sCAN team

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Ministero dell'Università e della Ricerca

Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

INAF ISTITUTO NAZIONALE DI ASTROFISICA

INAF OAS BOLOGNA

Star formation indicator in galaxies

Tracing the SFR in galaxies is fundamental to understand the galaxy formation and evolution

(e.g., Lilly et al. 1995; Madau et al. 1996; Smolčić et al. 2009; Madau & Dickinson 2014; Driver et al. 2018)

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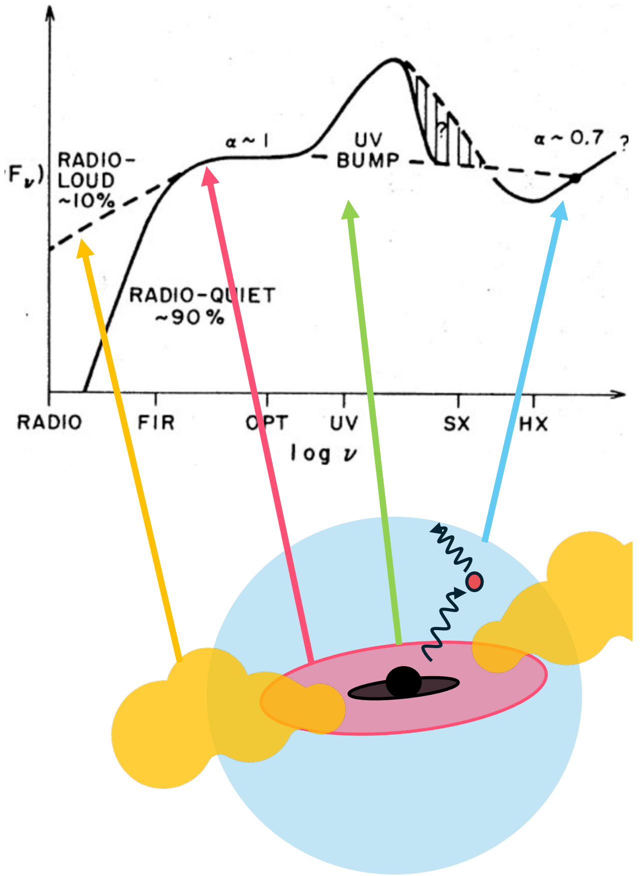
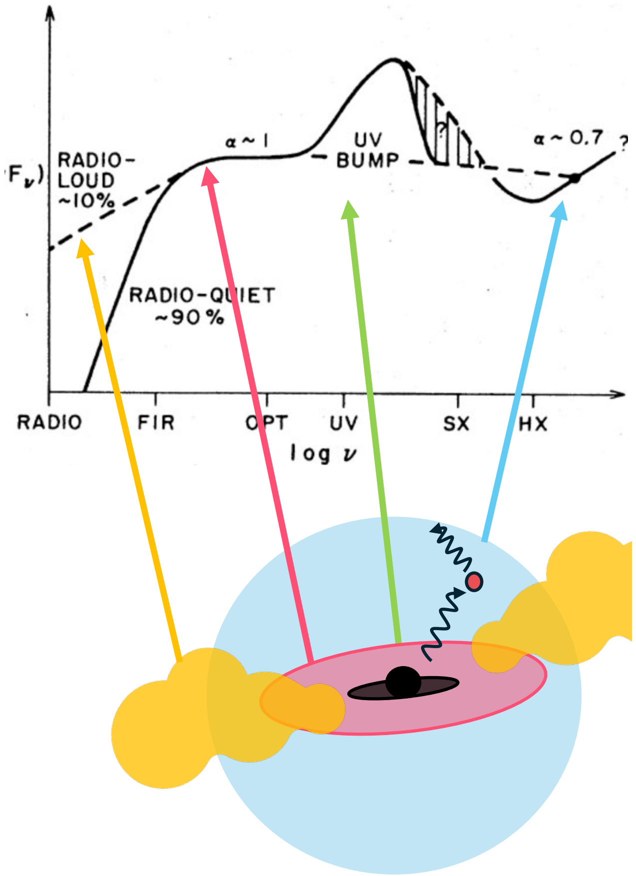
All traditional SFR estimators are suspect
→ AGN contamination



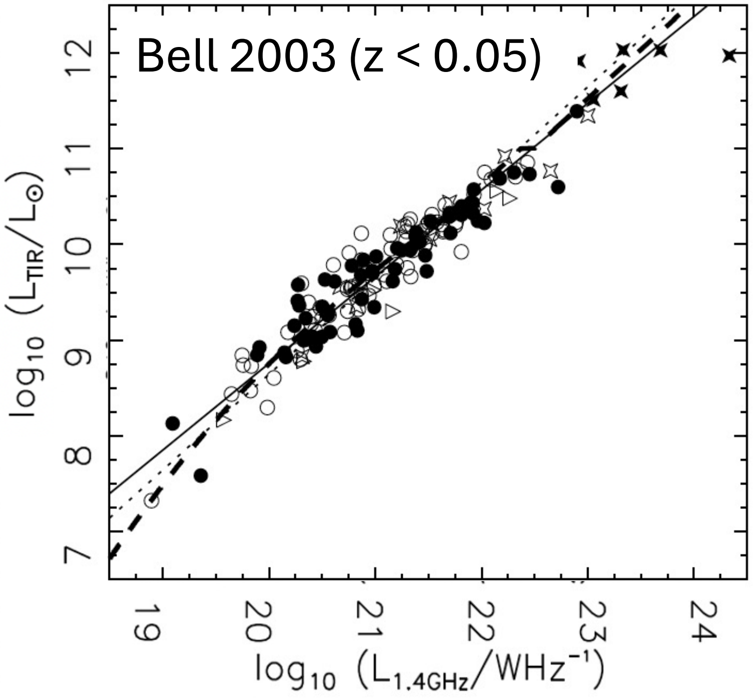
SFR tracers

All traditional SFR estimators are suspect → AGN contamination

	optical		UV	IR
SFR Tracer	**Hα**	**[OII]λ3727, [OIII]λ5007**	L_{UV}	L_{TIR} **(8 - 1000 μm)**
AGN Correction	**BPT**	**BPT**	**Decompose galaxy's SED into stellar, dust and AGN components**	**Scatter from** $L_{TIR} - L_R$
Caveats	**Difficult to observe beyond the local Universe (z > 0.5)/Strong stellar absorption**	**The SFR depend on gas density and metallicity**	**Highly obscured**	**Reliable!**



The radio-IR correlation, $L_{TIR} - L_{1.4GHz}$



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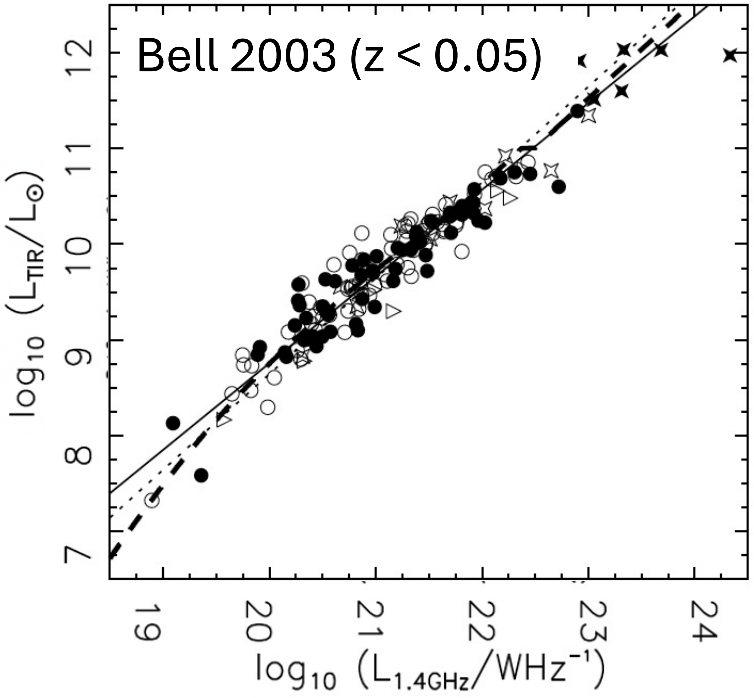

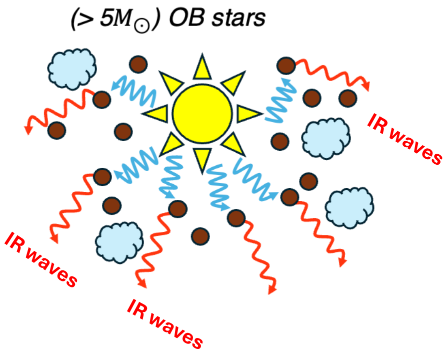

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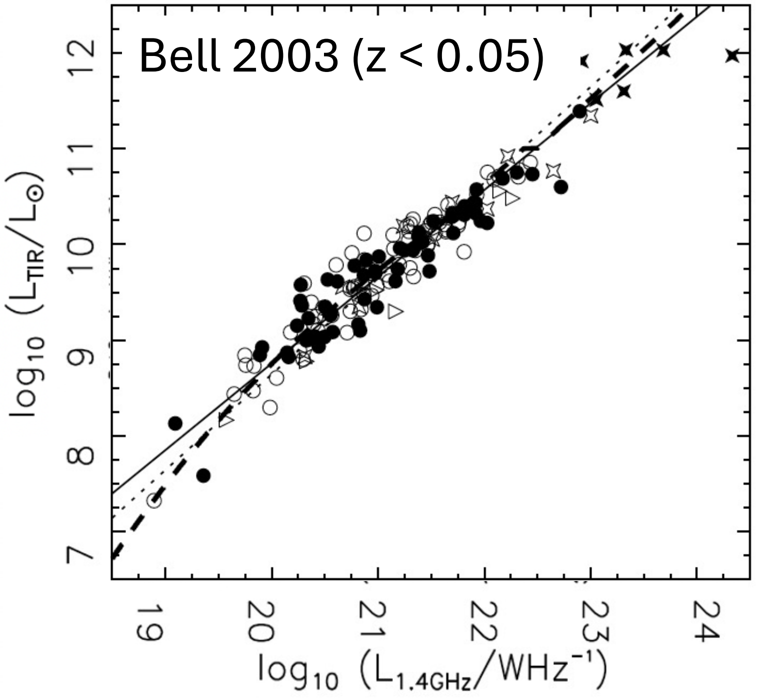

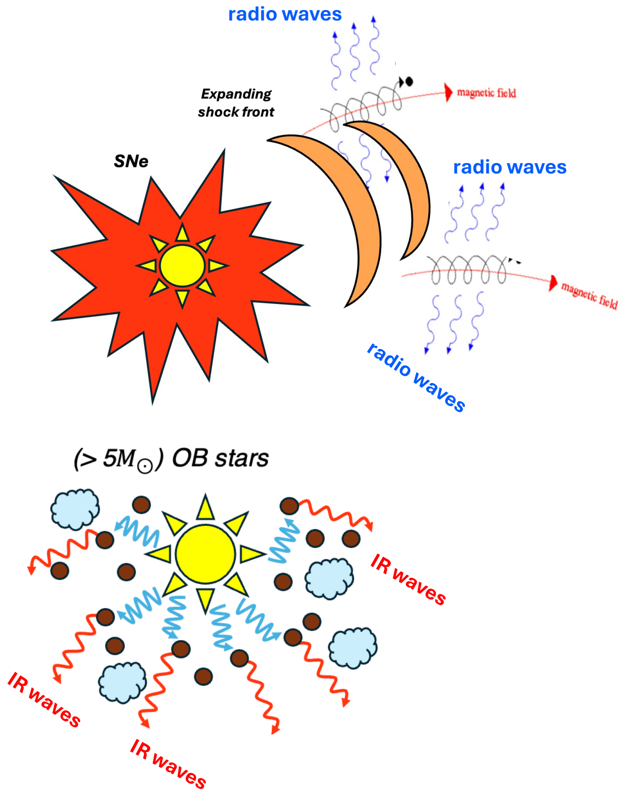

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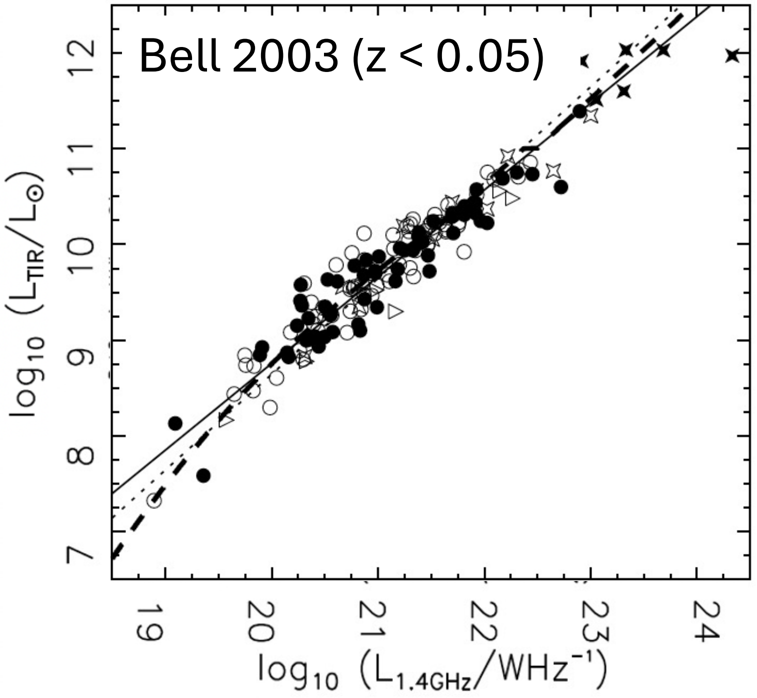
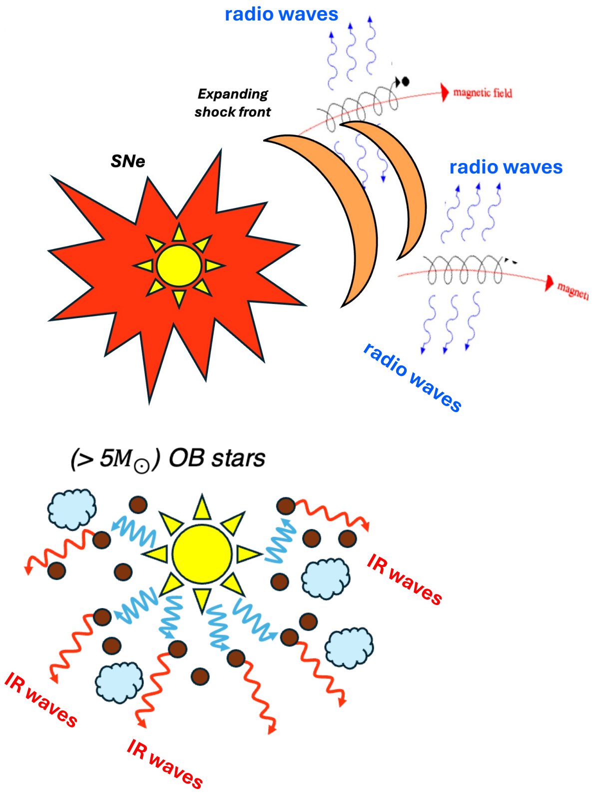
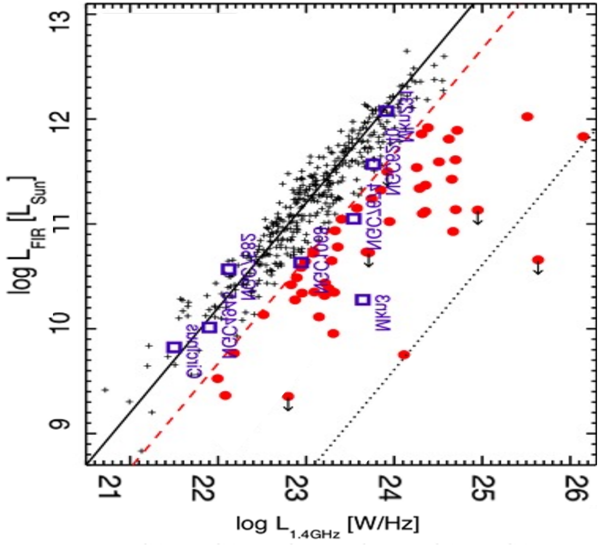




DelMoro+2013, A&A549, A59



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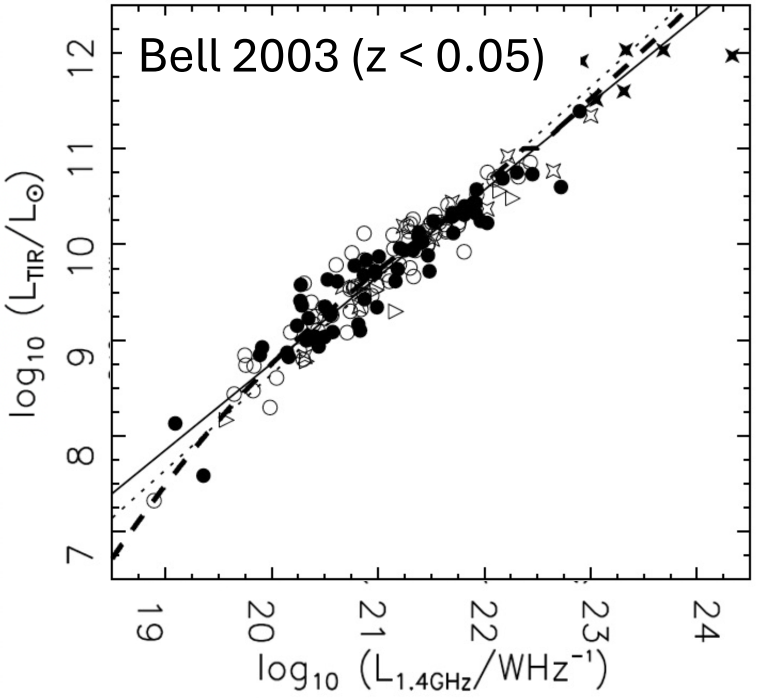

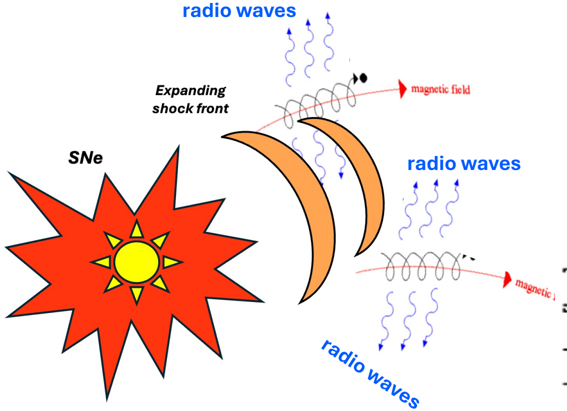

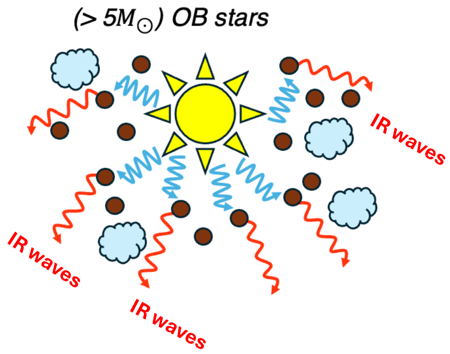

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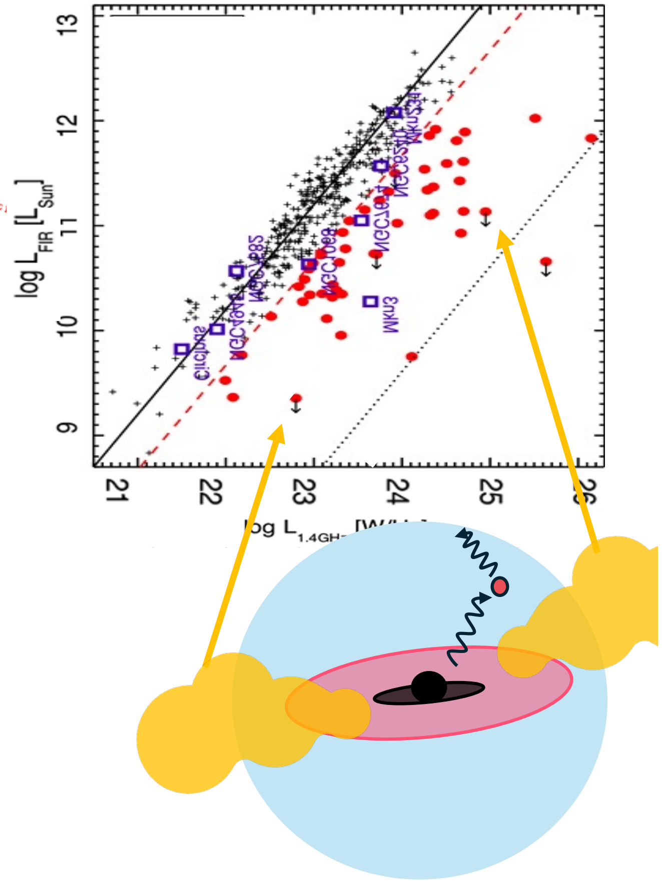
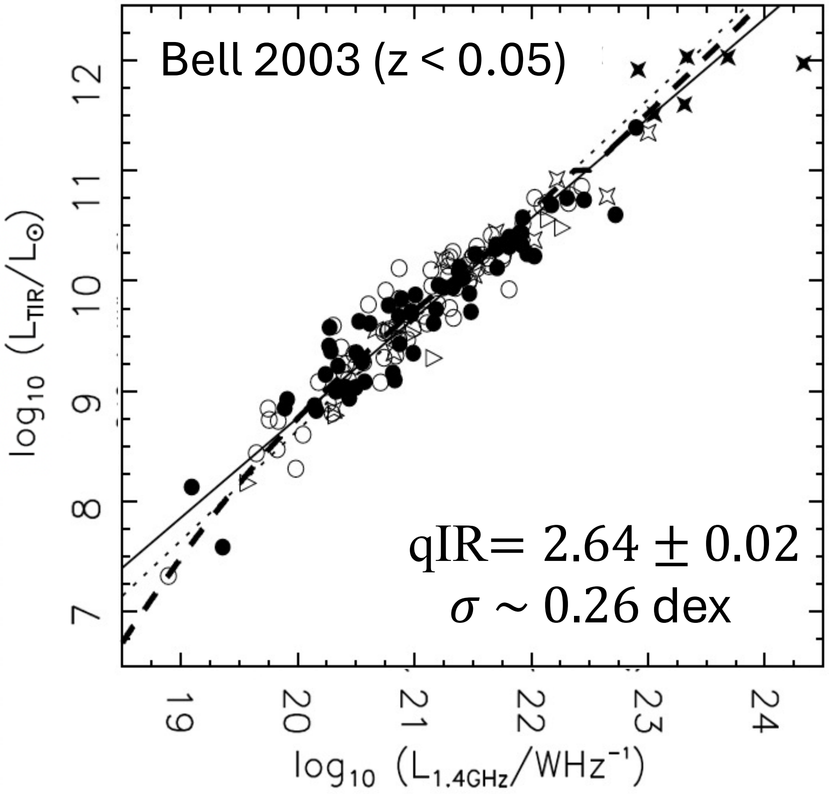


Open question: is there a residual contamination from faint AGN?



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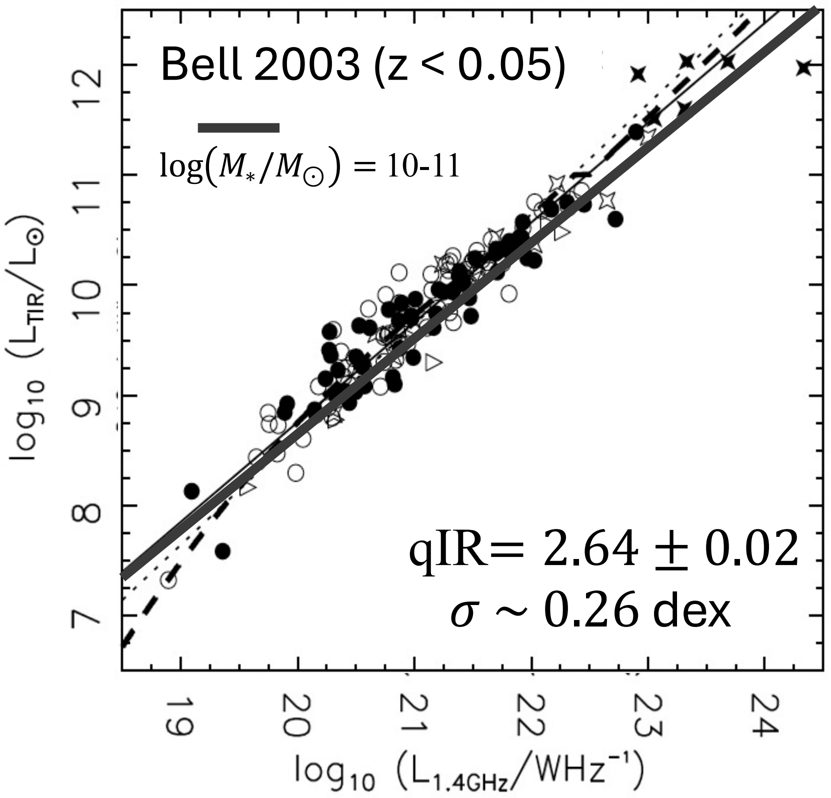

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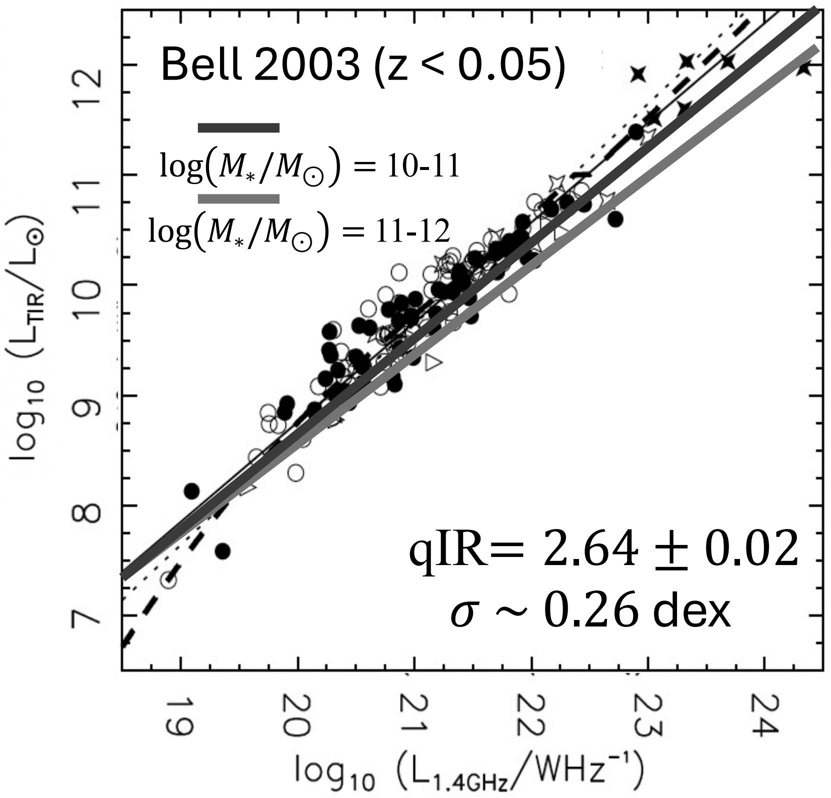

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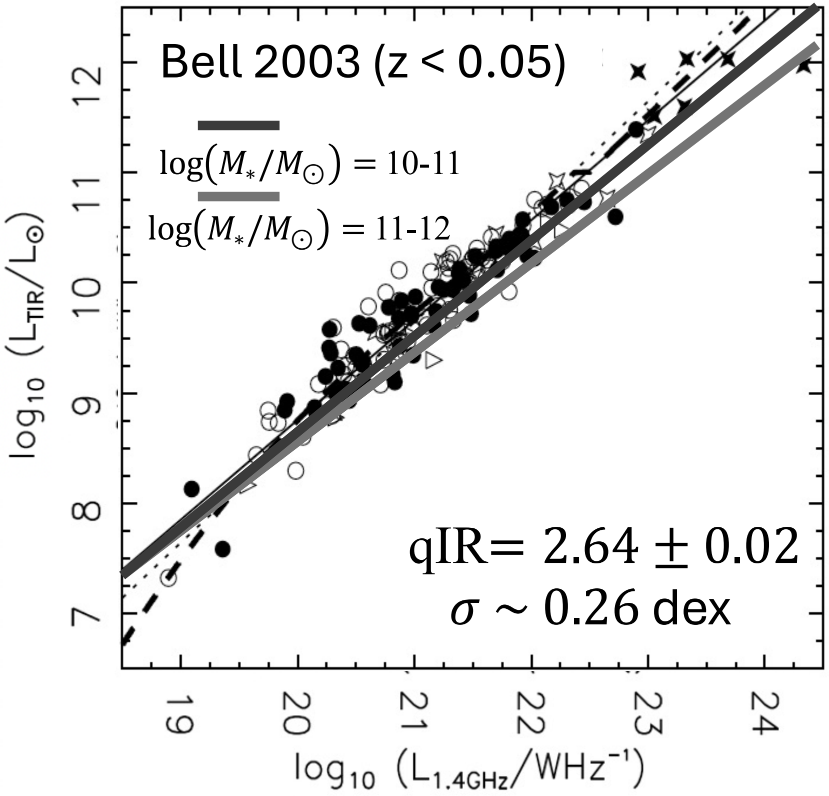

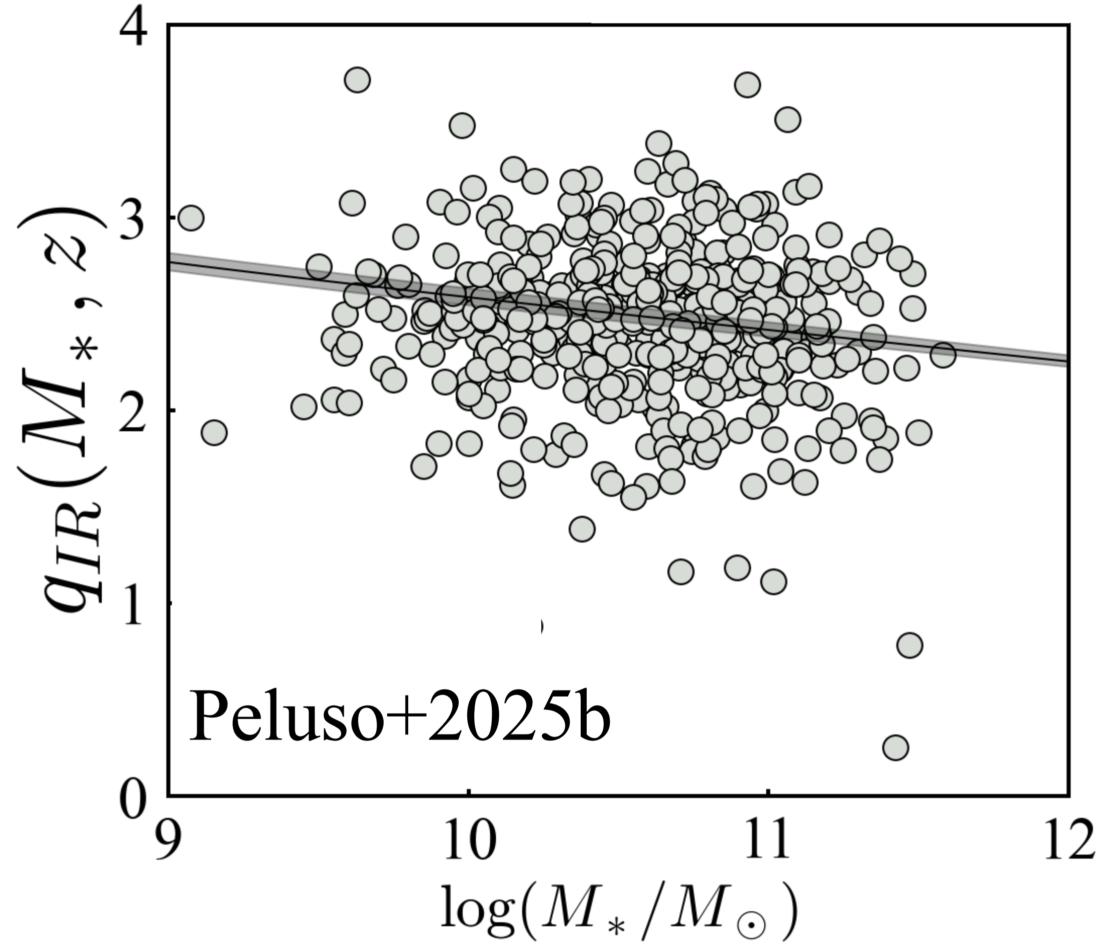

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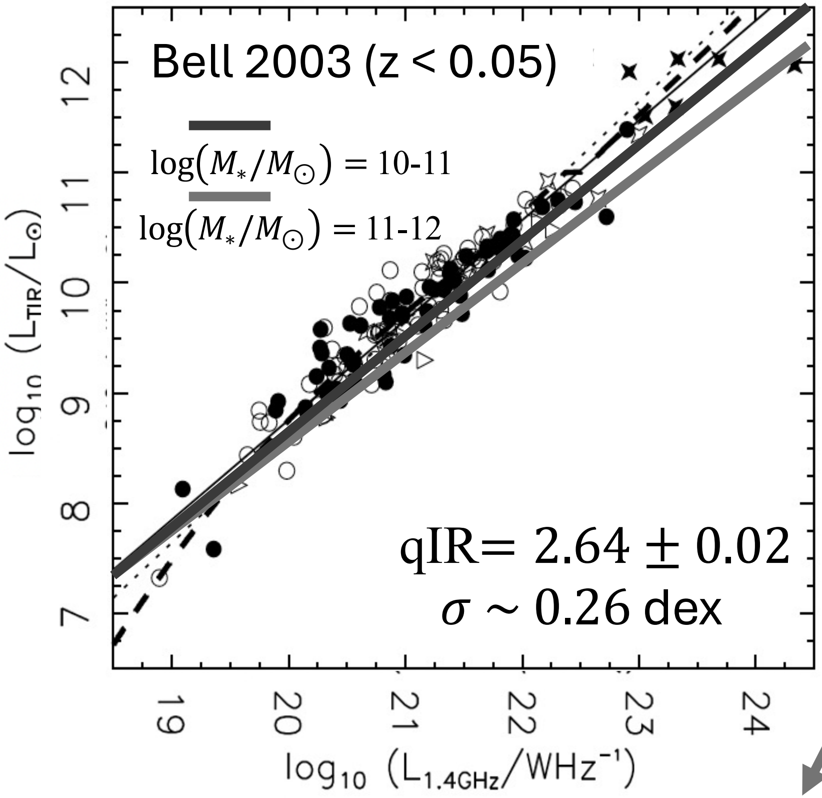
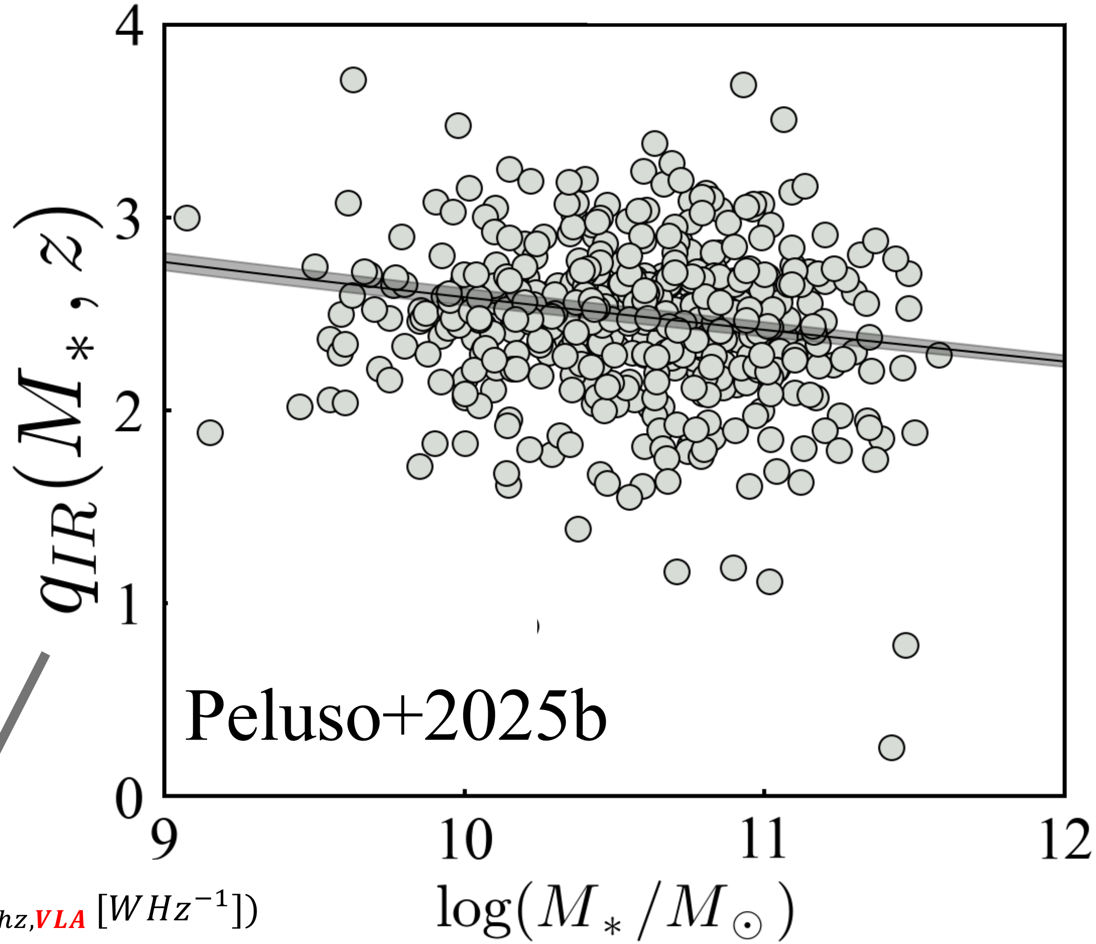
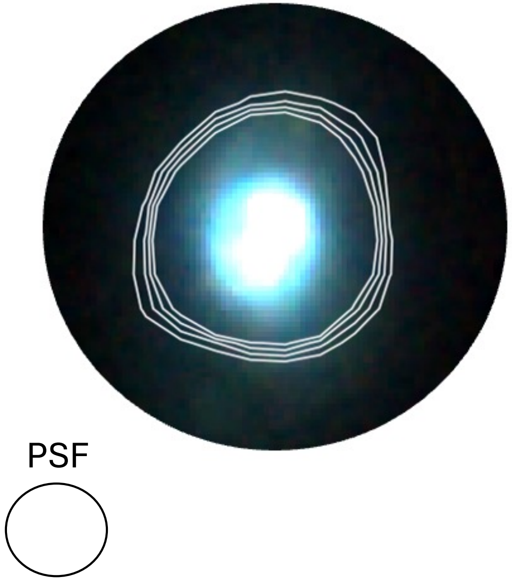




$$qIR(M_*, z) = \log\left(\frac{LIR\ [W]}{3.75 \times 10^{12} Hz}\right) - \log(L_{1.4\ Ghz,\mathbf{VLA}}\ [W Hz^{-1}])$$

AGN identification with VLBI

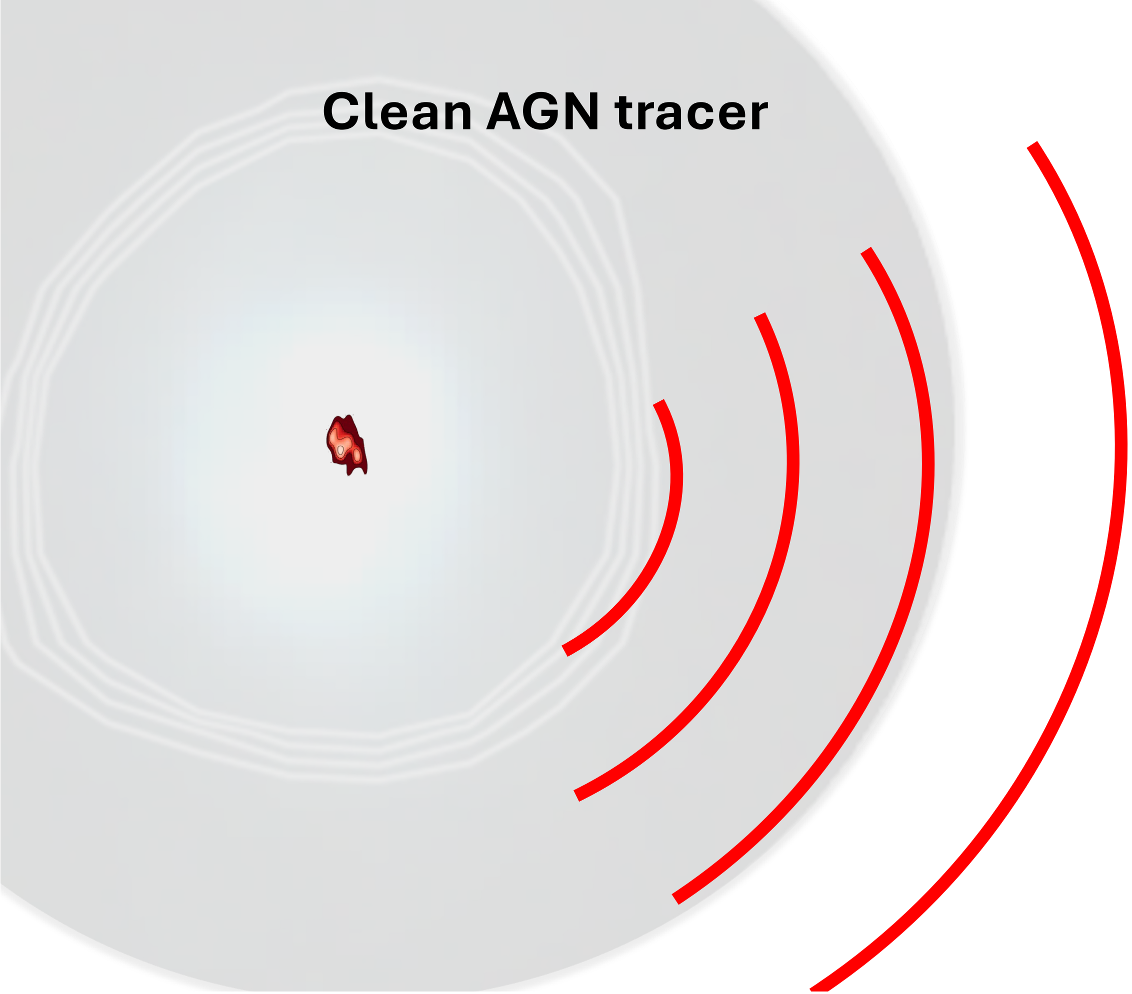
$spatial\ resolution \sim 0.75\ ''$



SF + AGN

VLA

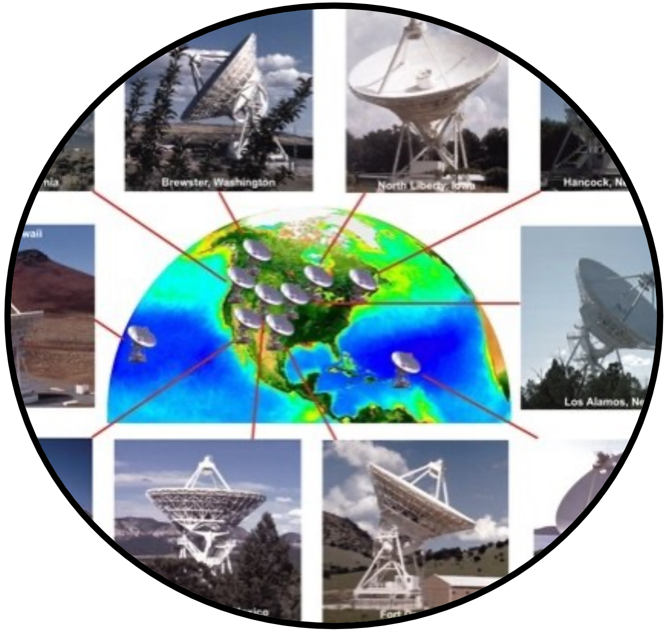
AGN identification with VLBI



$spatial\ resolution \sim 26 \times 7\ mas$

$$T_b \geq 10^5\ K$$

VLBA



Lurking for radio-faint AGN: AGN-sCAN survey

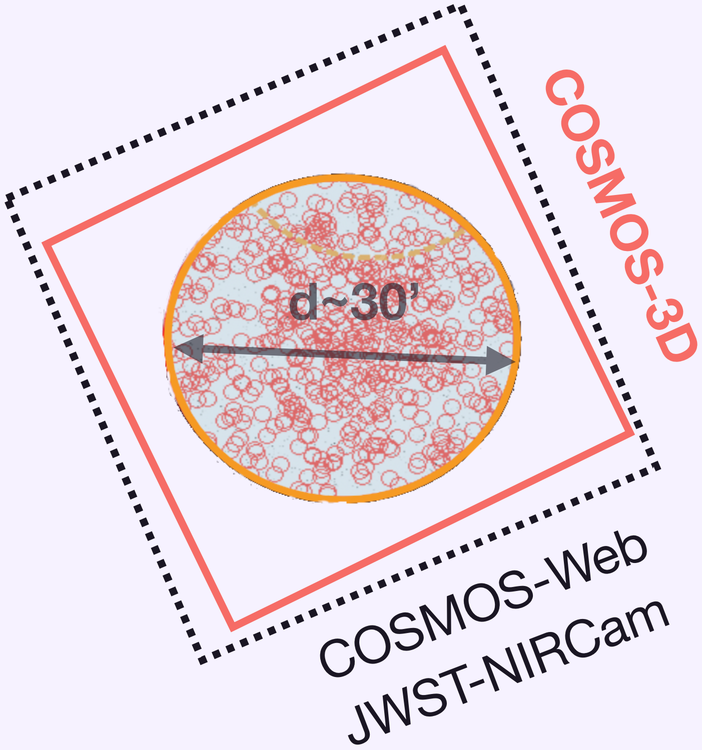
AGN-sCAN in a nutshell

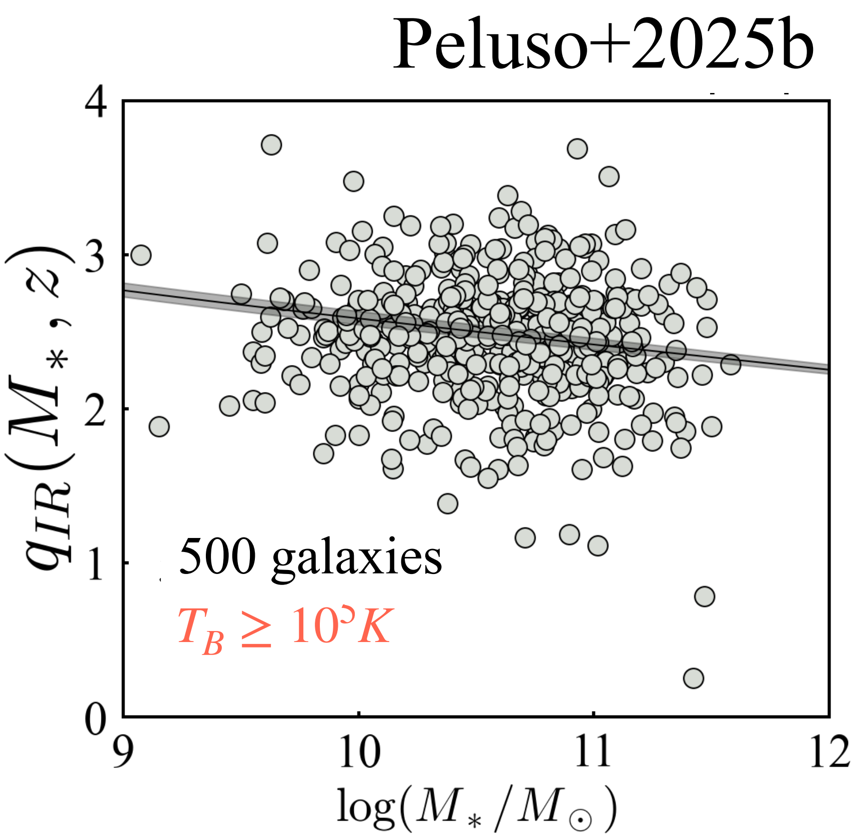
120h in L-band (1.4 GHz)

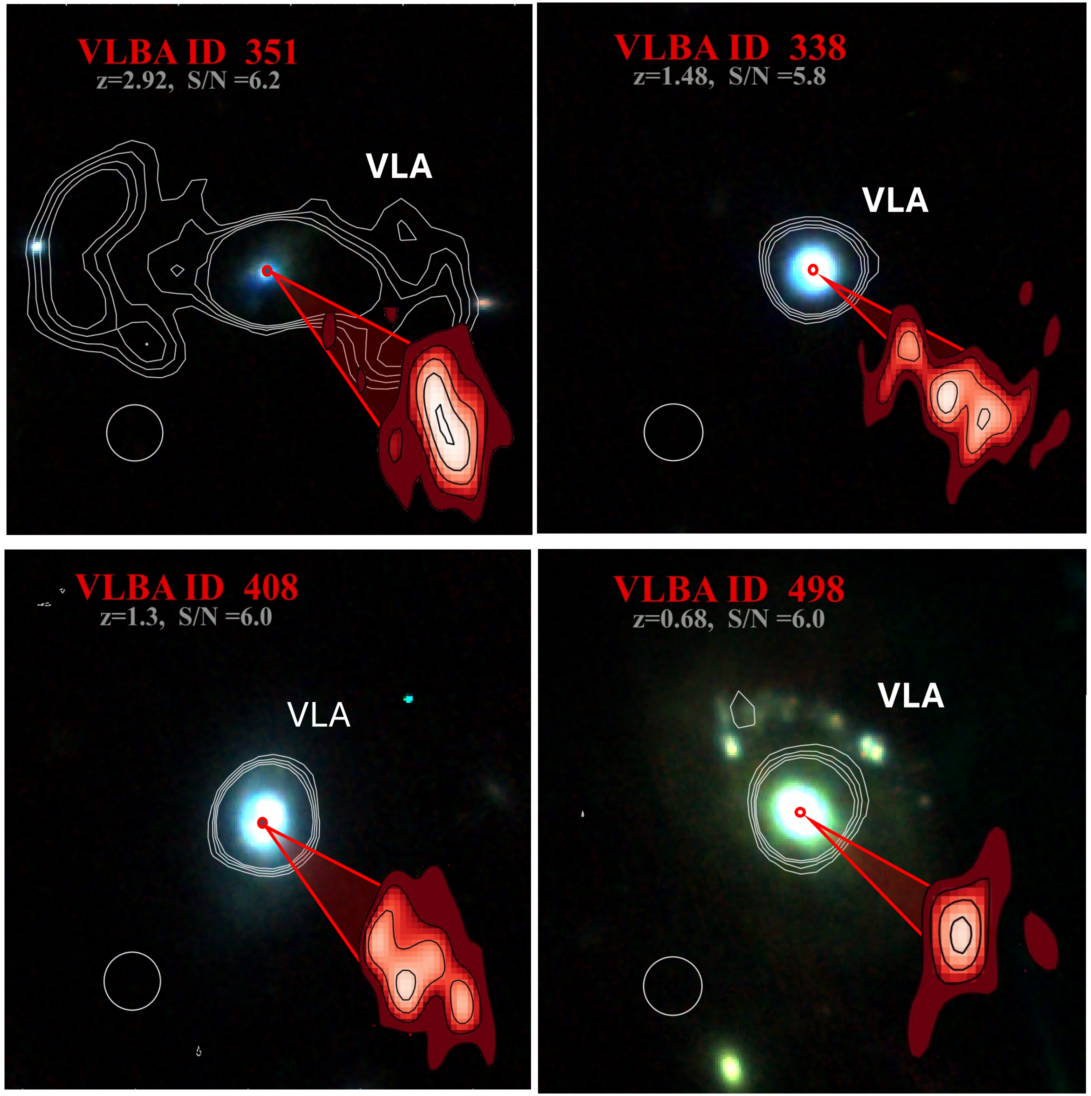
Sensitivity limit of $5\sigma \sim 25\mu Jy$/bm

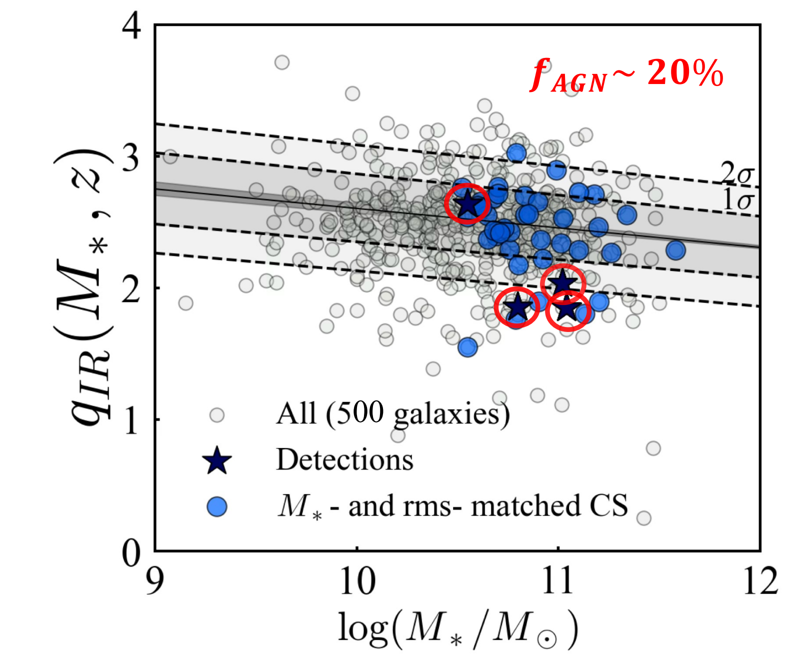
$0.5 < z < 4.5$

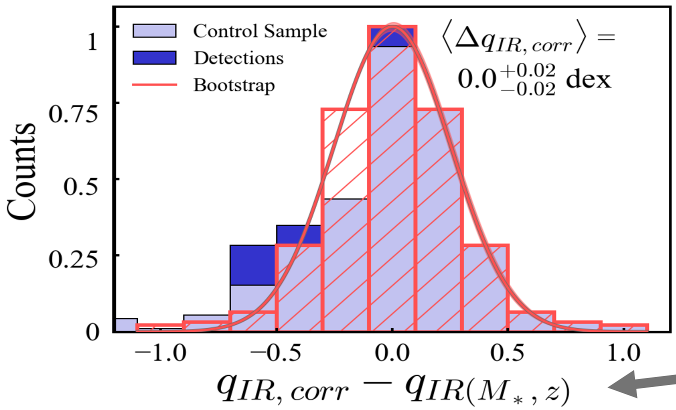
26 mas x 7 mas beam size (200 x 50 pc at z~1)



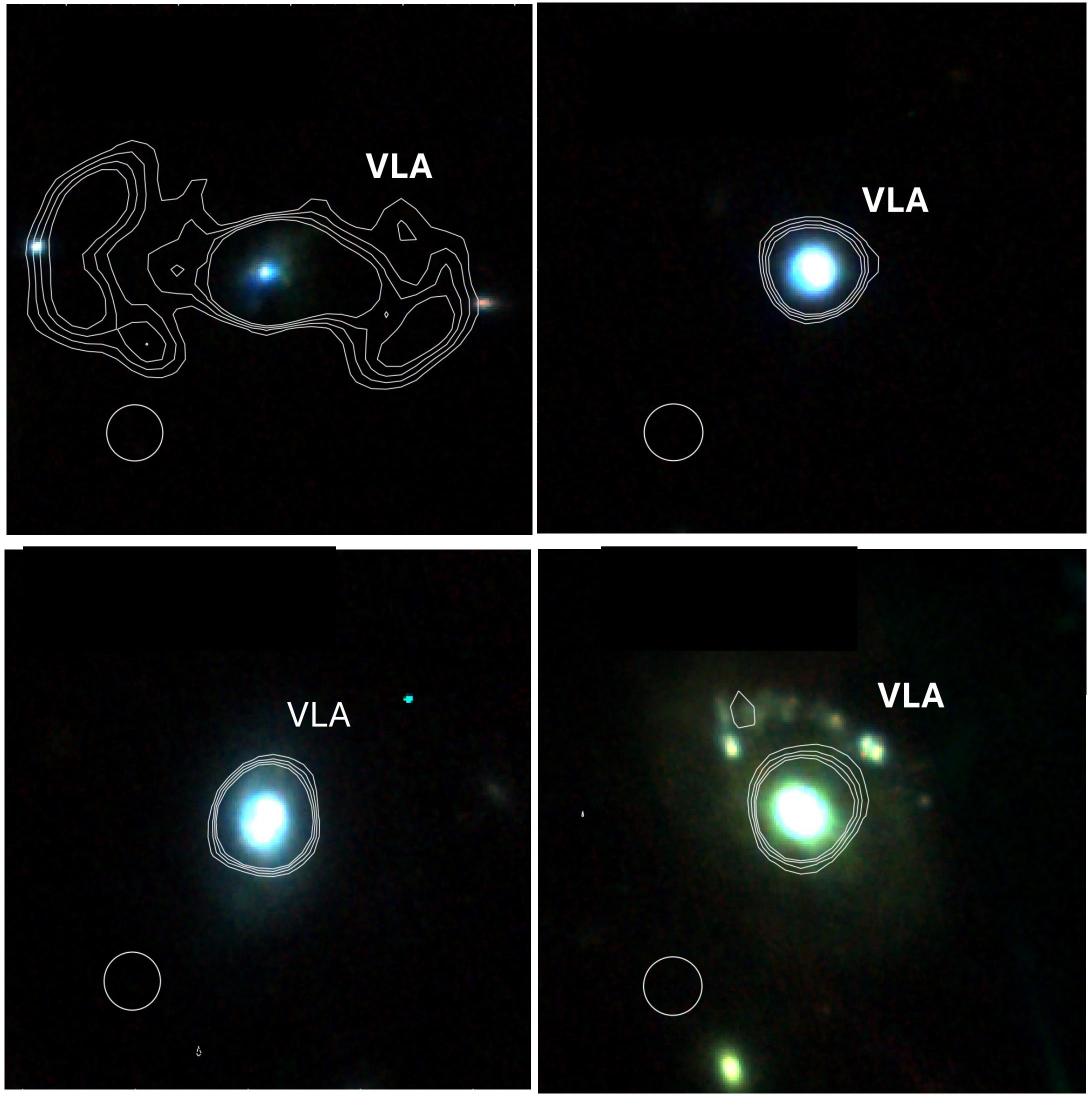


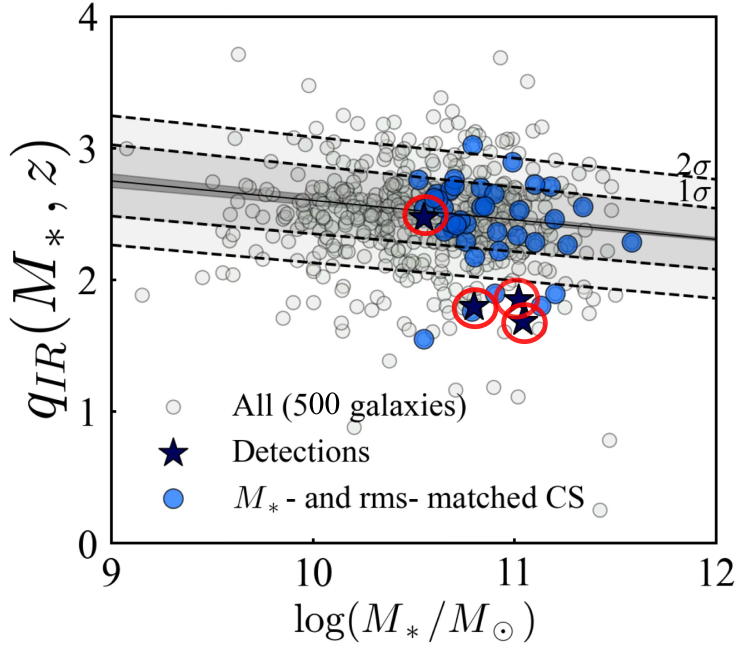


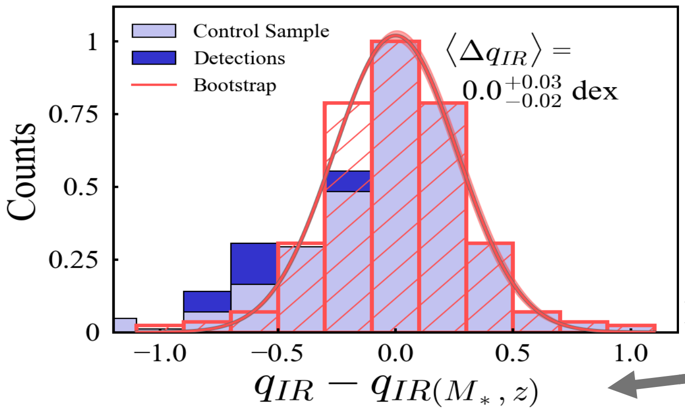




Predicted qIR from Delvecchio+2021 based on the galaxy mass







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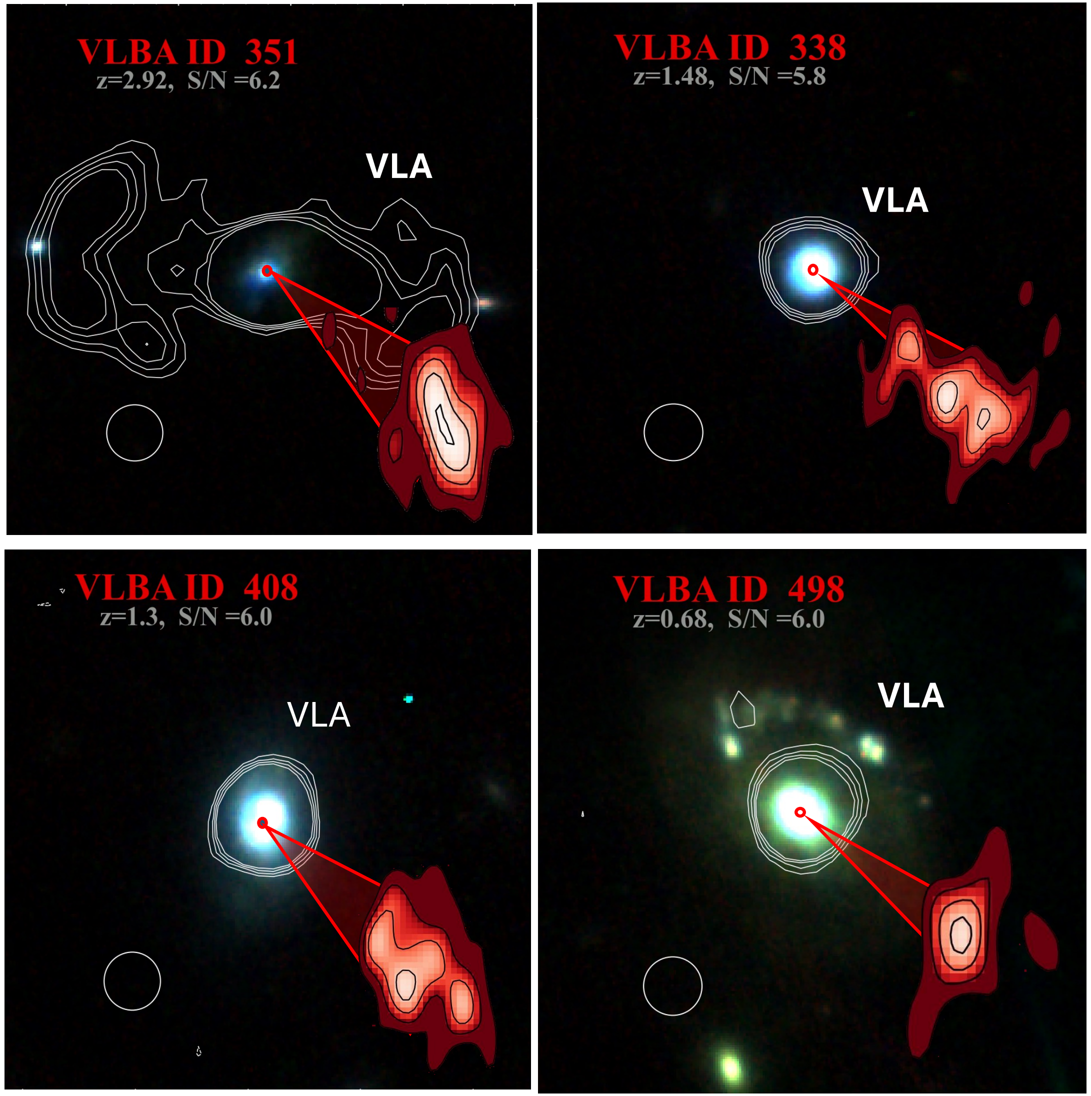
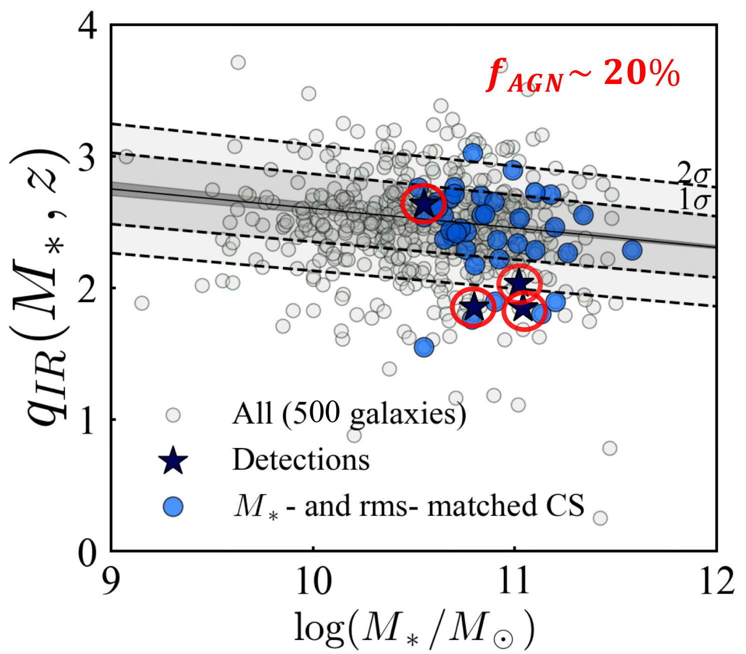


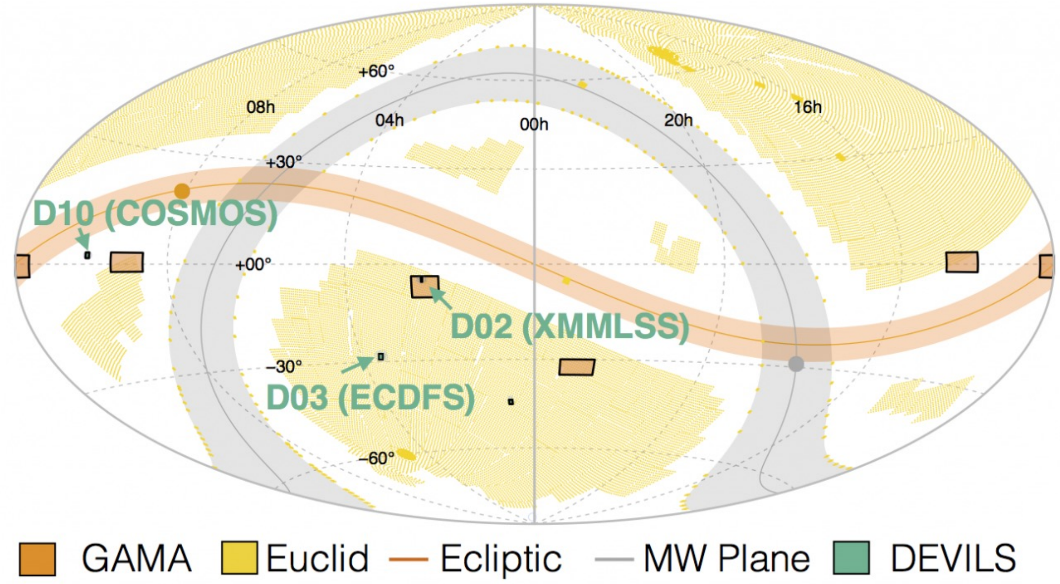


Peluso+2025b

In this paper, we demonstrate that the IR-radio correlation is robust against AGN contamination

What can SKA do?

1) Spatial coverage



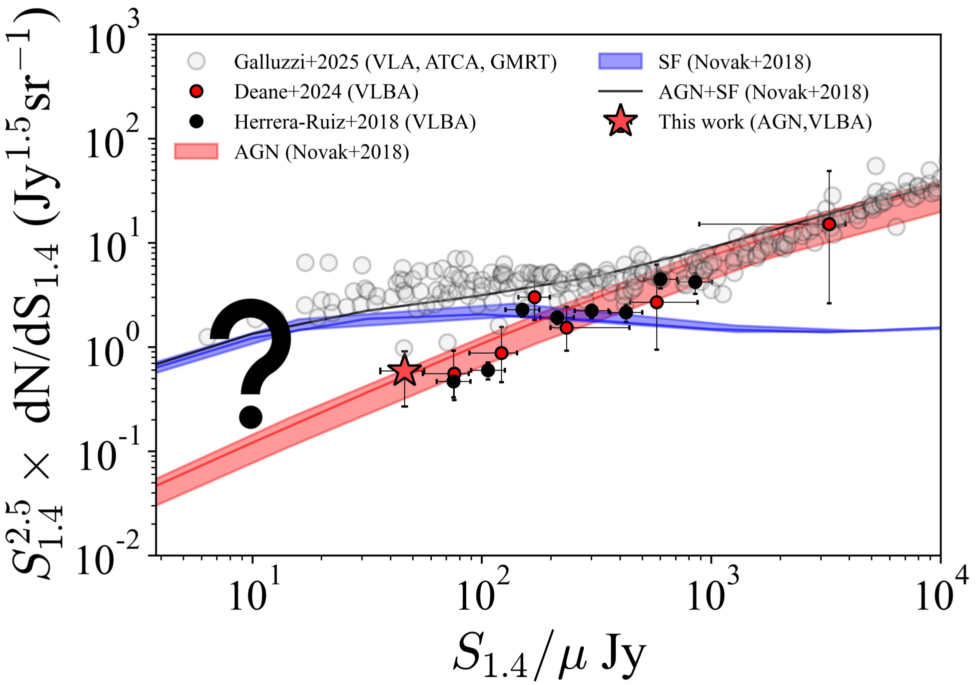
Survey speed of SKA:

$10^5\ m^4/K^2deg^2$ at 1.4 GHz with SKA1-MID
$10^7\ m^4/K^2deg^2$ at 1.4 GHz with SKA 2

Considering the small FoV of the VLBA, SKA2 will be **tens of thousands of times “faster”** in its survey mode

What can SKA do?

2) Sensitivity



Sensitivity of SKA 2:

In 1 hour, SKA – VLBI will achieve a flux limit of 1.2 μJy at 1.4 GHz (Li+2024 *RAA,* 24,7), compared to ~ 25 μJy (120h, AGN-sCAN) with VLBA ➔ **~20x improvement!**

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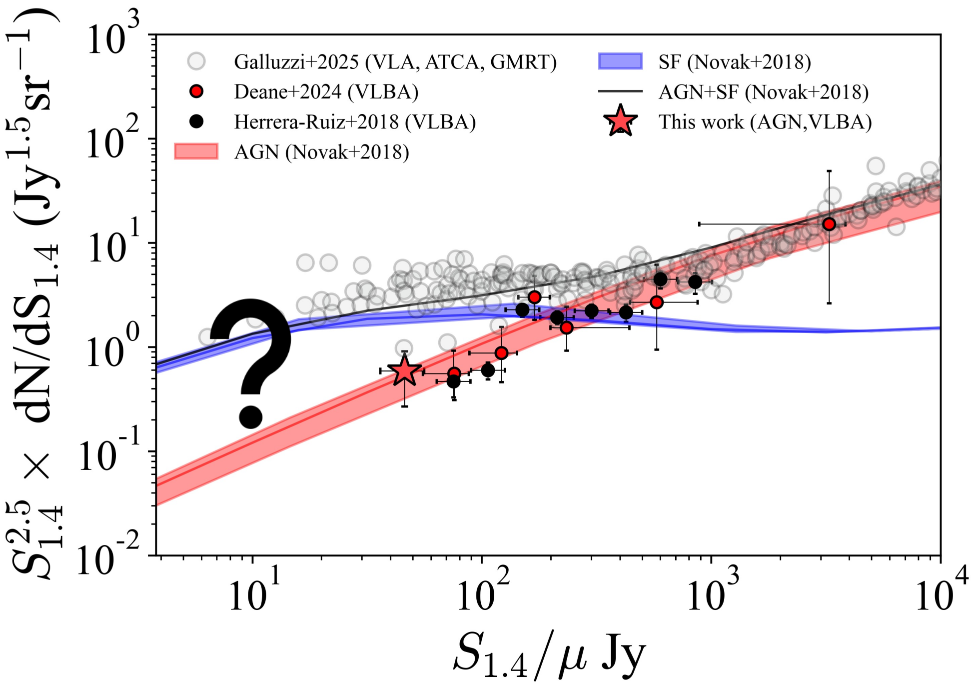

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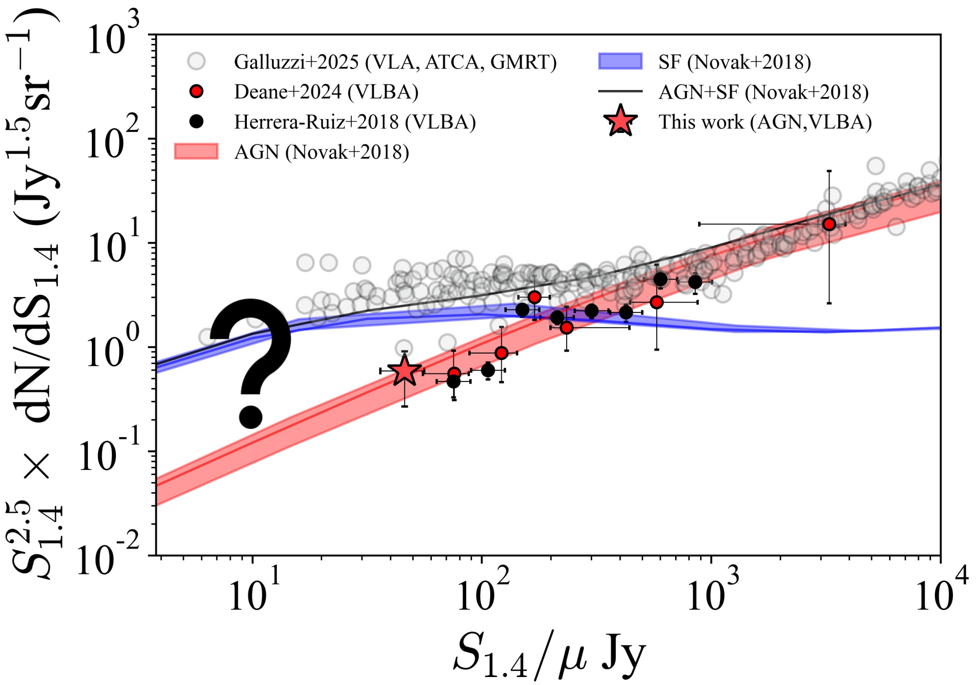

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→ *Test AGN number counts prediction in the sub-µJy regime*

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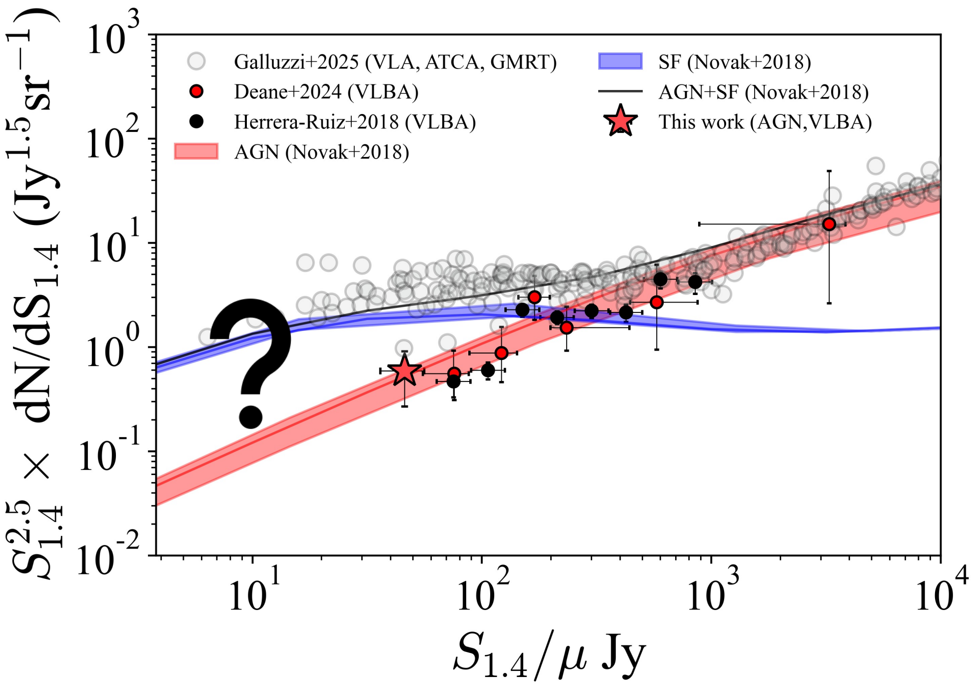

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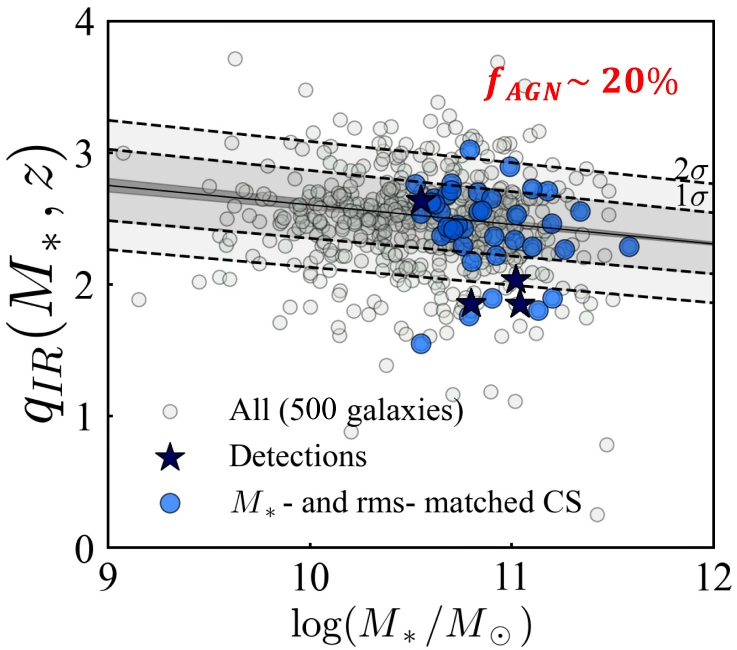
The spatial resolution of VLBA and SKA2 are similar:
$\theta_{beam} = \lambda/b$ = 4 mas for $\lambda = 1.4\ GHz$

⟶ **high- T_b criterium**

Summary



The infrared-radio correlation is robust against AGN contamination. SKA will allow to extend this analysis on (potentially) the entire southern sub-μJy radio sky.

SKA – VLBI (Phase 2) will capture the faintest AGN and test number counts prediction at the lowest flux densities.