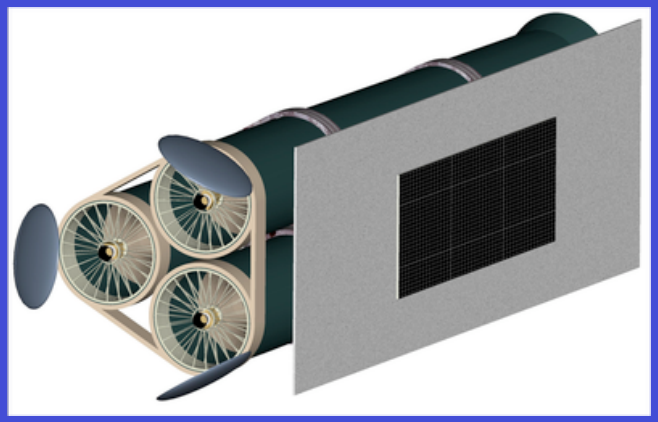

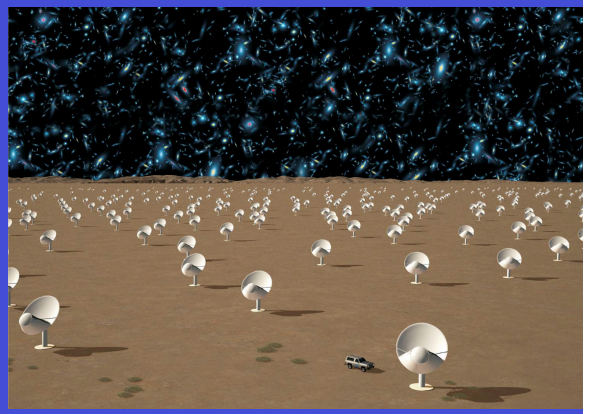

WFXT synergies with next generation radio surveys

Paolo Padovani, ESO, Germany

- The current status of radio surveys
- New and future (mostly high-frequency) radio projects and surveys
- The X-ray – radio synergy: the WFXT case

Current deep radio surveys

- Large area:
  - ✓ NRAO VLA SKY SURVEY (NVSS): 82% of the sky (δ > -40°) @ 1.4 GHz down to 2.5 mJy, 45" resolution
  - ✓ Faint Images of the Radio Sky at Twenty centimeters (FIRST): 22% of the sky (North Galactic Cap) @1.4 GHz down to 1 mJy, 5" resolution
- Small area:
  - ✓ a few Very Large Array (VLA) surveys @ a few GHz below 0.1 mJy, up to 2 deg^2 (VLA-COSMOS: Bondi et al. 2008) and down to 15 μJy (SWIRE: Owen & Morrison 2008)

- Larg
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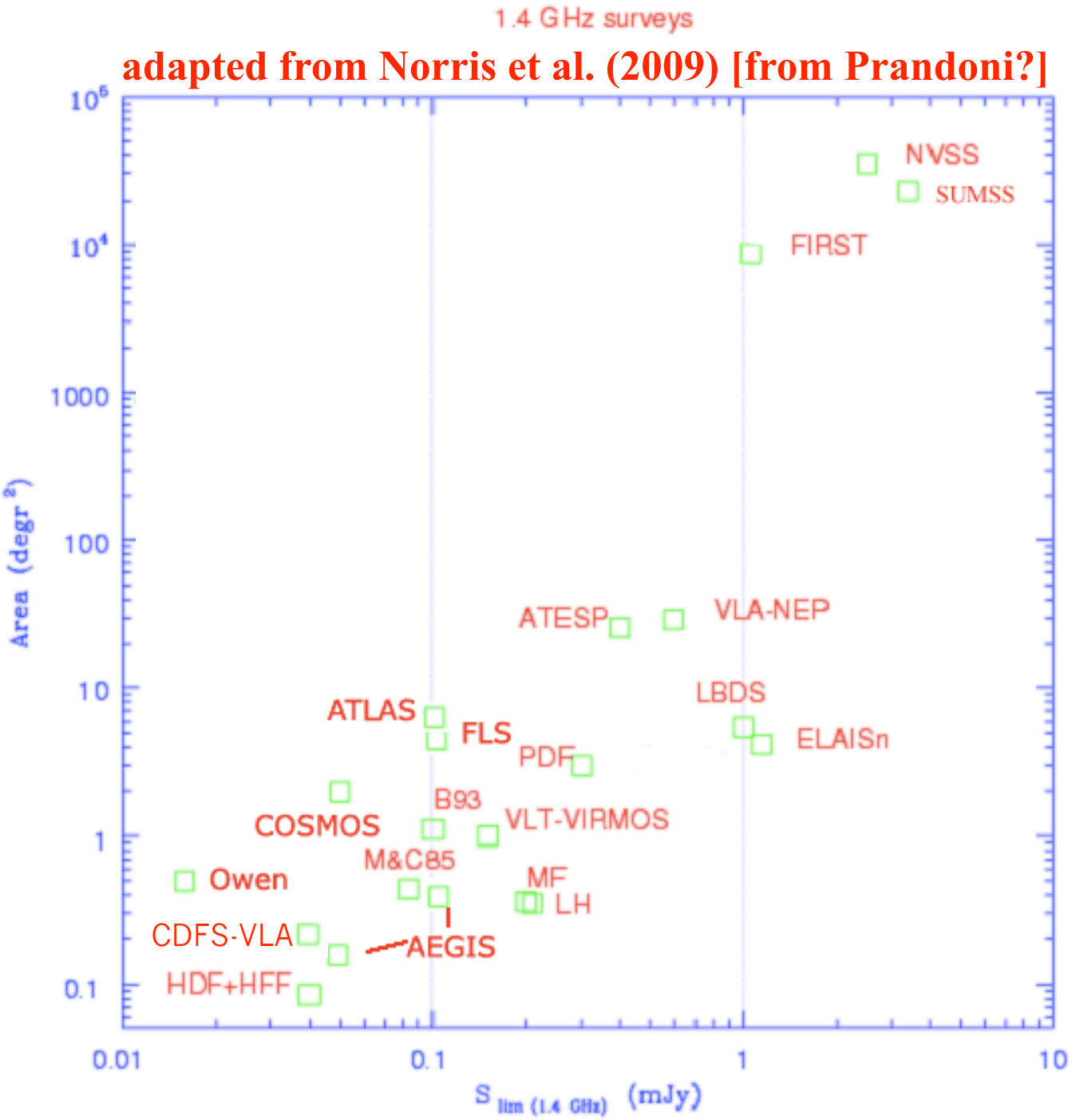

Next generation radio projects/ surveys. 1.

LOw Frequency ARray (LOFAR)

- observing frequencies: 15 – 240 MHz
- flux limit (large area): ≈ 0.5 mJy @ 120 MHz (equivalent to ≈ 0.1 mJy @ 1.4 GHz for $\alpha_r = 0.7$)
- resolution: > 3" (obviously frequency dependent)
- timeline: 2010
- "All-sky" surveys planned @ 15, 30, 60, and 120 MHz
- New region of parameter space at low frequencies; but largely dominated by star-forming galaxies and radio-galaxies (so small overlap with WFXT)

Next generation radio projects/ surveys. 2.

Expanded VLA (EVLA)

- observing frequencies: 2 – 40 GHz
- flux limit: ≈ 1 μJy, 5 – 20 x better than VLA
- resolution: < 5" (configuration dependent)
- timeline: 2012
- Surveys to be carried out by individual teams

Next generation radio projects/ surveys. 3.

Evolutionary Map of the Universe (EMU) with the ATCA SKA Pathfinder (ASKAP)

- observing
- flux limit y (45 x better th
- resolution
- timeline: e)
- Similar g lio surveys as WFXT in the X-ray band

Next generation radio projects/ surveys. 3.

Evolutionary Map of the Universe (EMU) with the ATCA SKA Pathfinder (ASKAP)

- observing frequency: 1.4 GHz
- flux limit: ≈ 50 μJy over 75% of the sky (45 x better than NVSS)
- resolution: 10"
- timeline: > 2013 (> 2015 for the catalogue)
- Similar gain with respect to previous radio surveys as WFXT in the X-ray band

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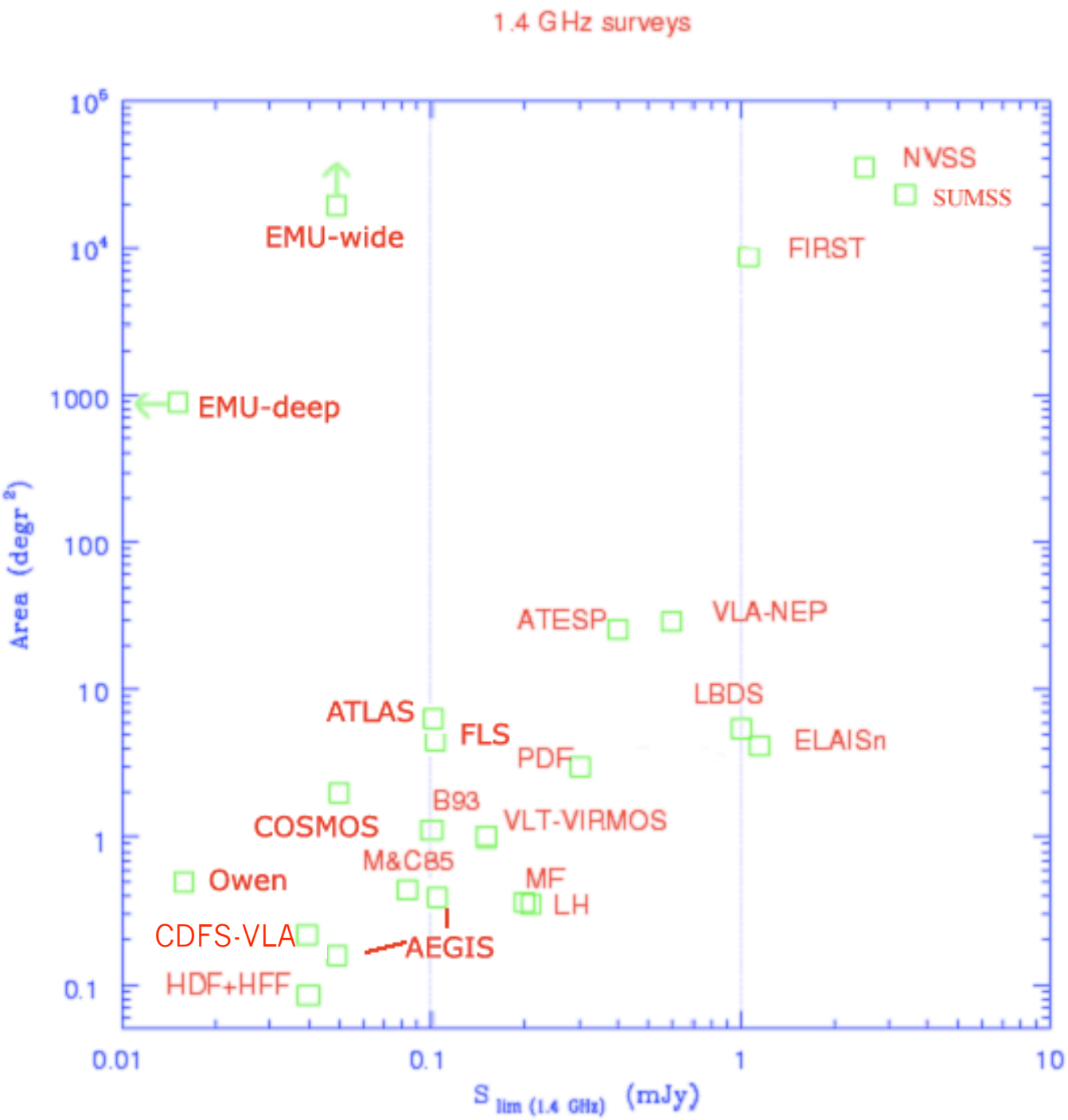
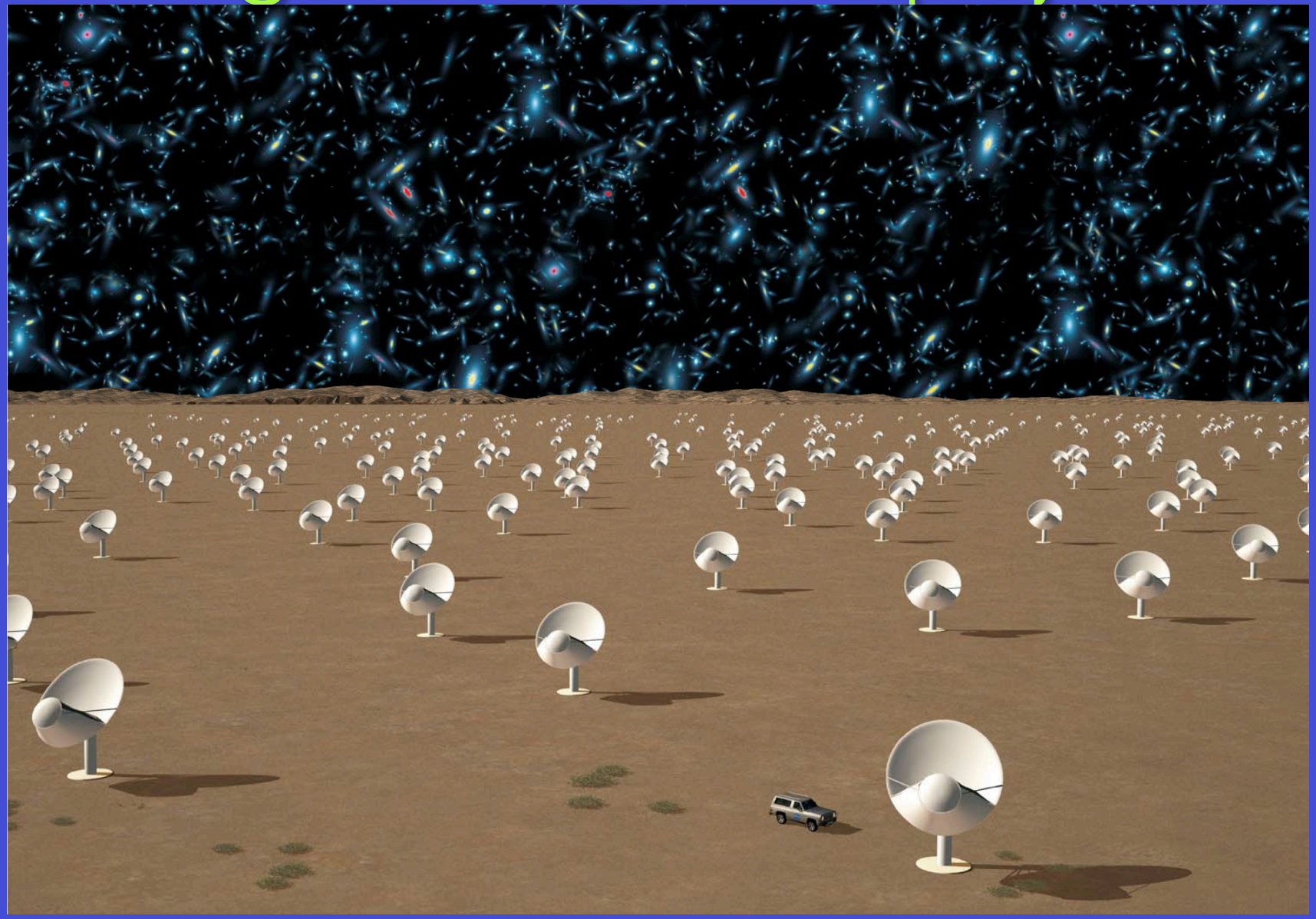


Next generation radio projects/ surveys. 4.

Square Kilometer Array (SKA)

- observing frequencies: 70 MHz – 10 GHz
- flux limit: < 0.1 μJy
- resolution: < 1" @ 1.4 GHz to avoid confusion
- timeline: ≈ 2020
- "All-sky" 1 μJy survey planned
- In the southern hemisphere (either Australia or South Africa)!

Next generation radio projects/



The deep radio and X-ray skies

- Deep radio and X-ray surveys are detecting somewhat different populations:
  - ✓ X-ray surveys:
    - $F_{2-10\ keV} > 10^{-14}$ c.g.s.: ~ 97% AGN (≈ 10% radio-loud) (Polletta et al. 2007)
    - CDFS 1 Ms: ~ 75% AGN, ~ 22% galaxies (Szokoly et al. 2004) [optically brighter sources]
    - plus many other authors, most of them in the audience!
  - ✓ Radio surveys:
    - $S_{1.4\ GHz} > 42$ μJy: >40% AGN (≈ 50% radio-loud), <60% star-forming galaxies (Padovani et al. 2009)

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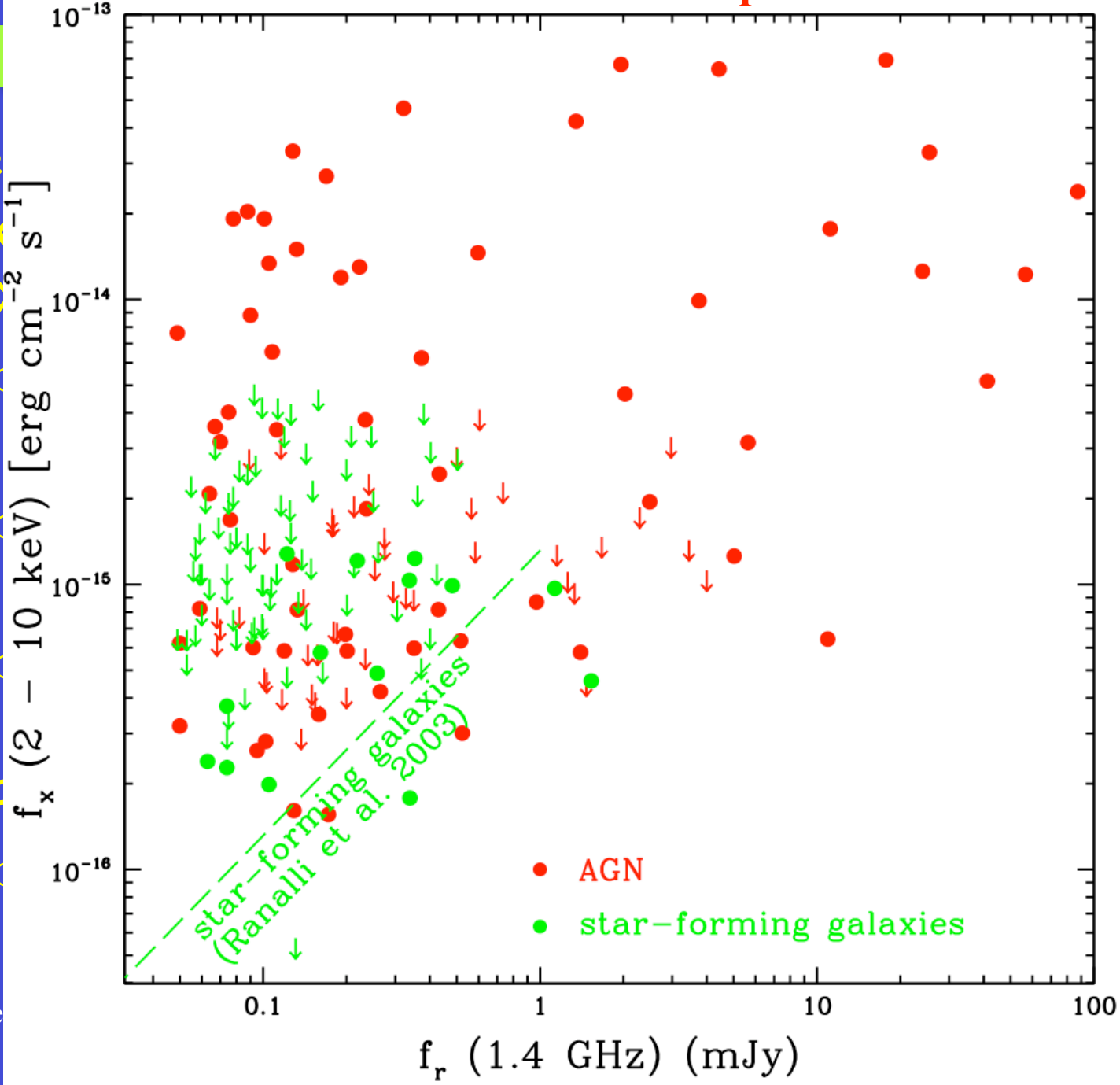
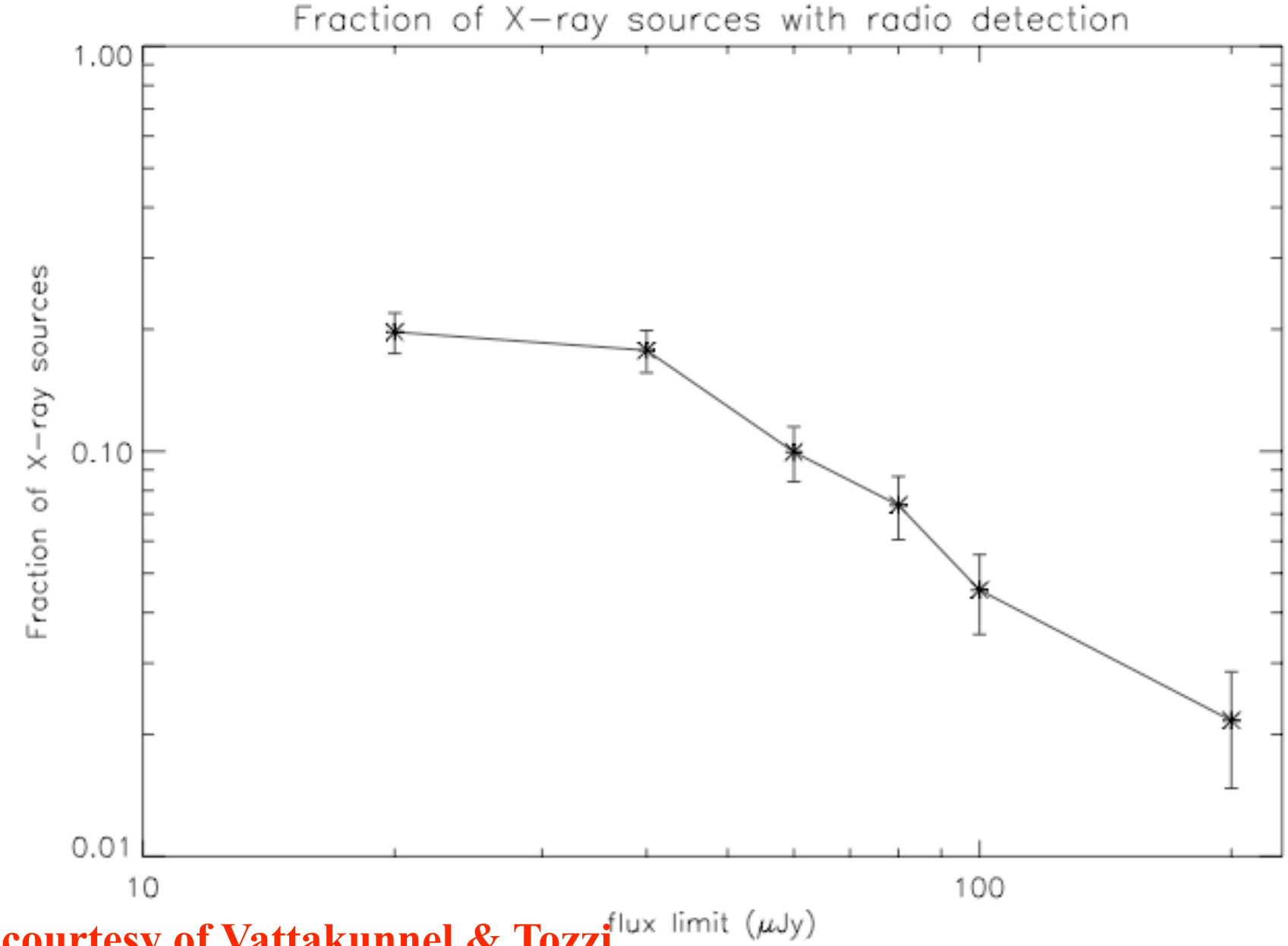


The deep radio and X-ray skies

- Radio sources in VLA-ECDFS sample (> 32 μJy) with X-ray detections in 2 Ms data: ~ 34%

- X-ray sources in 2 Ms CDFS with radio detections in VLA-ECDFS: ~ 20%

2 Ms **ECDFS**



courtesy of Vattakunnel & Tozzi

X-ray detections of faint radio sources

- X-ray data are fundamental in establishing the nature of faint (sub-mJy) radio sources

- Astrophysical implications:
  - ✓ star-formation history in the Universe
  - ✓ AGN (low radio-power) and star-forming galaxies evolution
  - ✓ black-hole – host galaxy relationship

X-ray detections of faint radio

- X-ray d… the nature …
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  - ✓ star-…
  - ✓ AGN…
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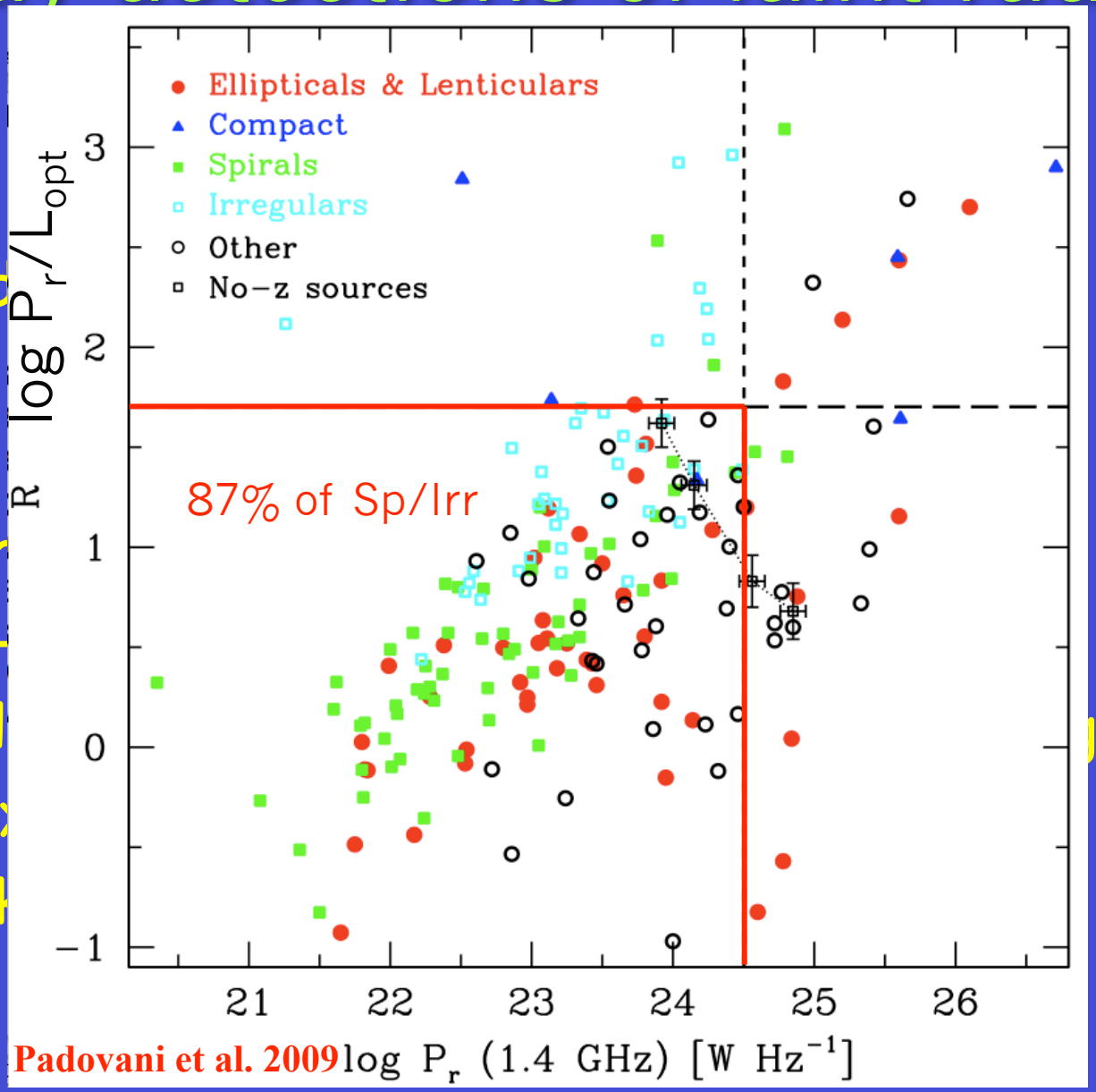

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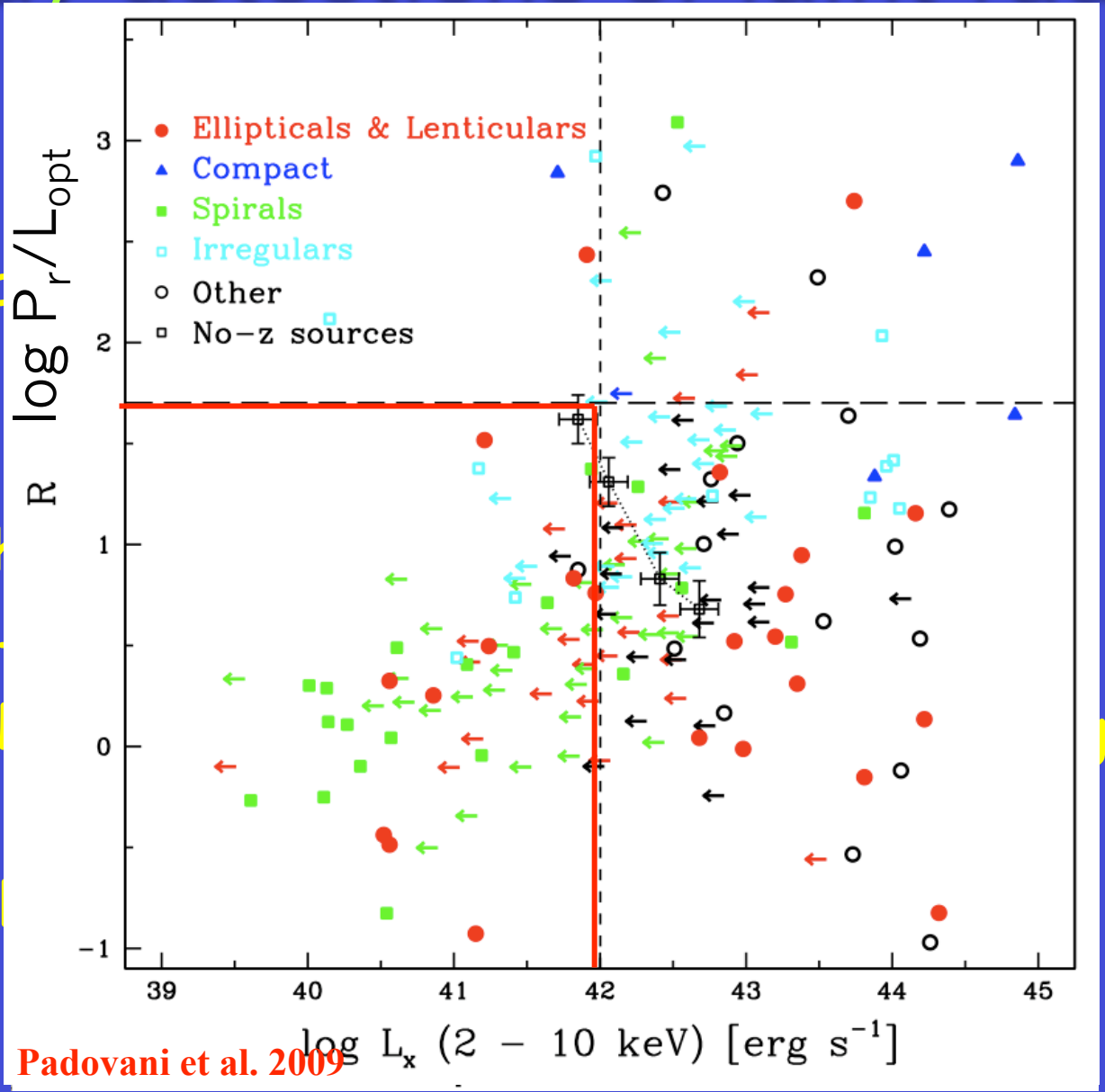
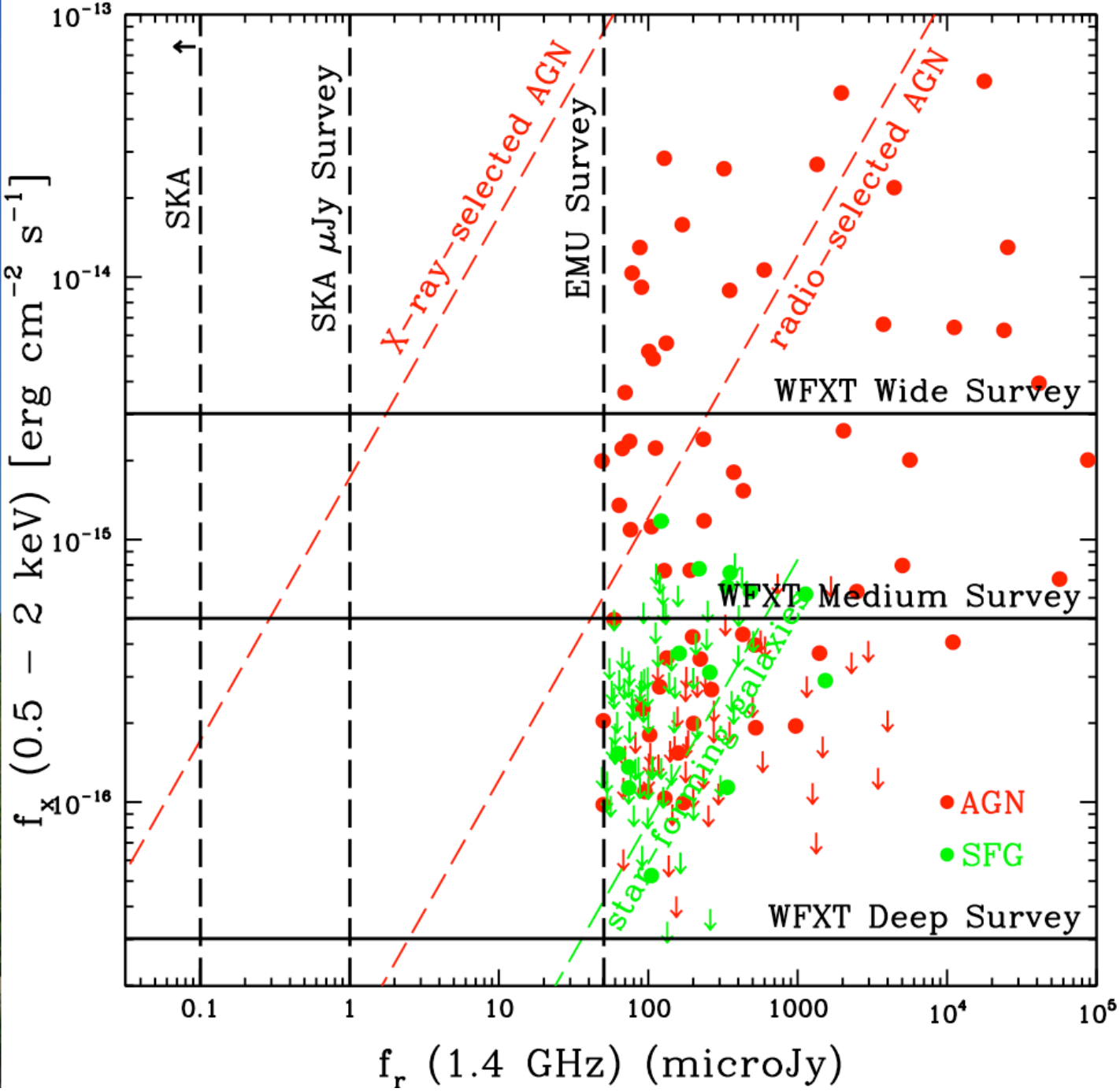


Padovani et al. 2009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EMU Survey
X-ray-selected AGN
radio-selected AGN
WFXT Wide Survey
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star-forming galaxies
AGN
SFG
f_x (0.5 – 2 keV) [erg cm^-2 s^-1]
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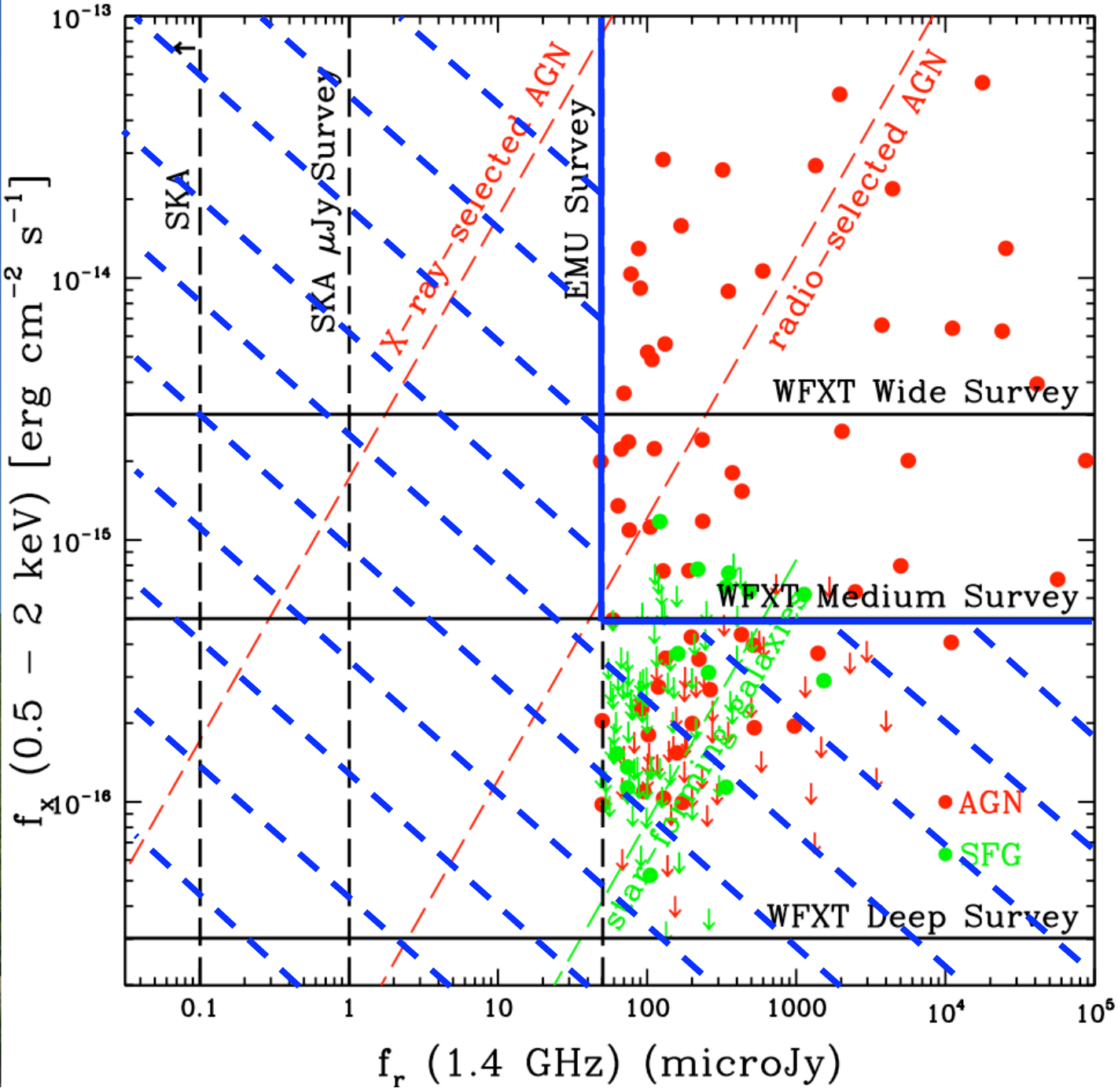
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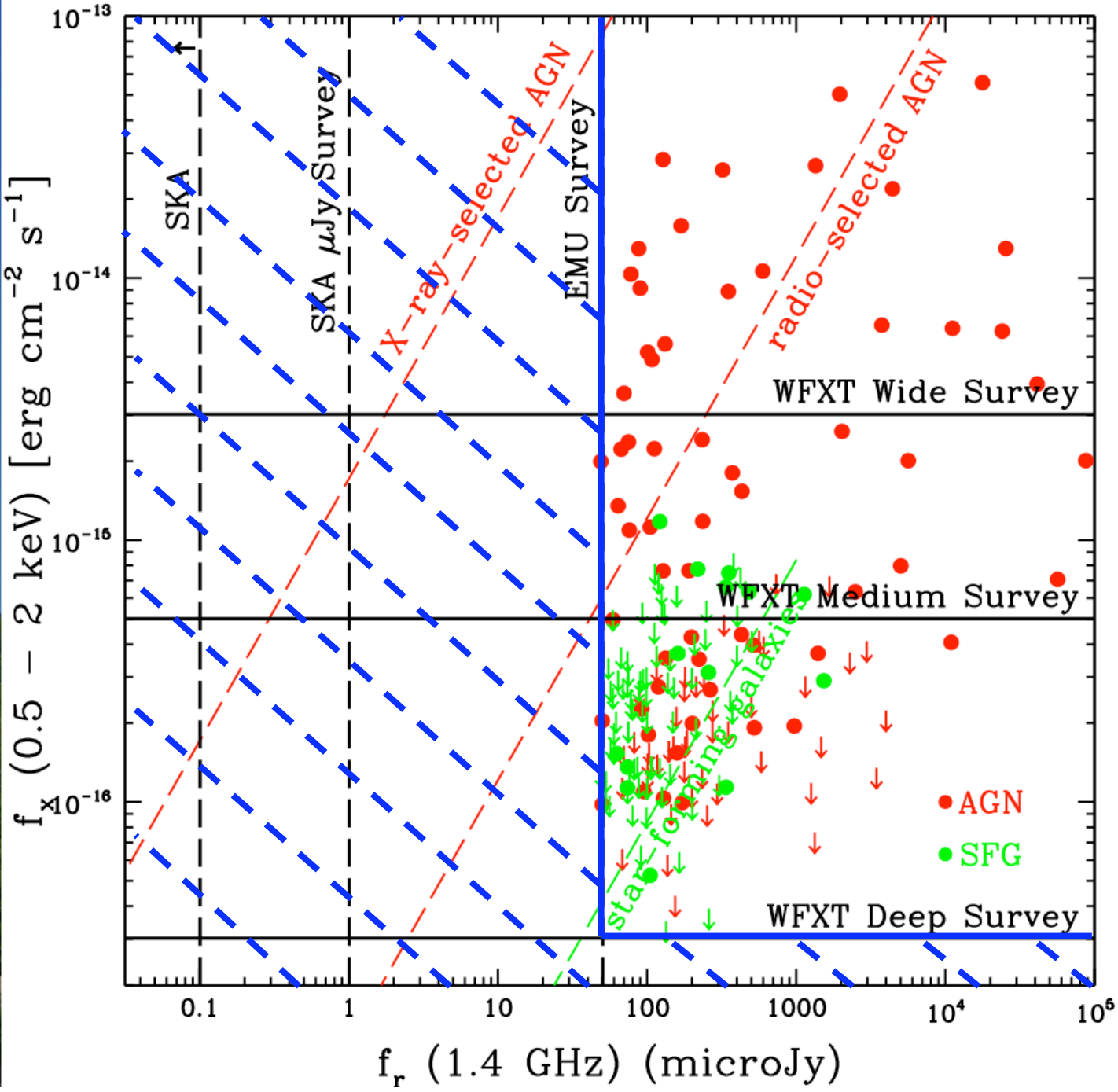
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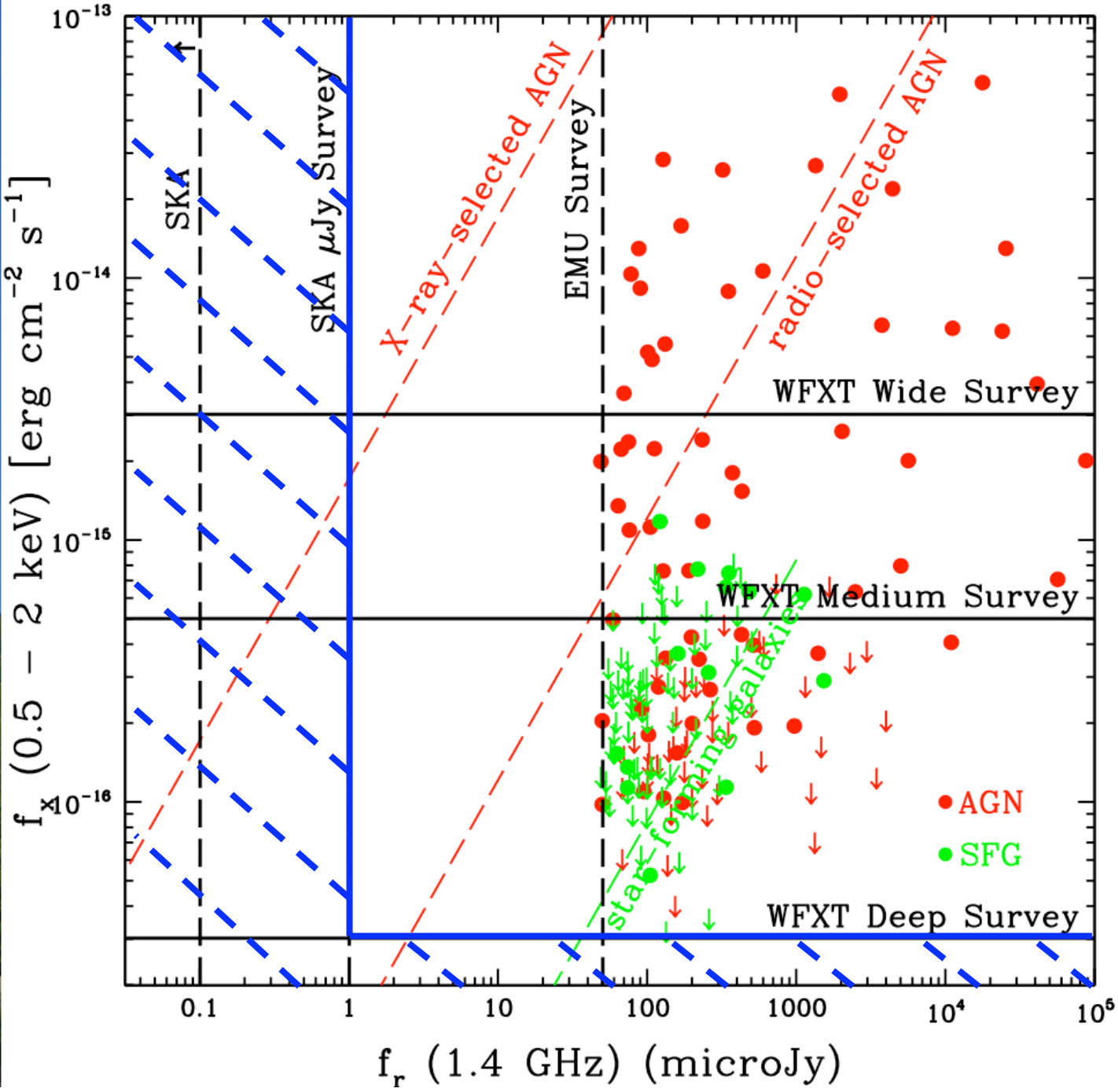
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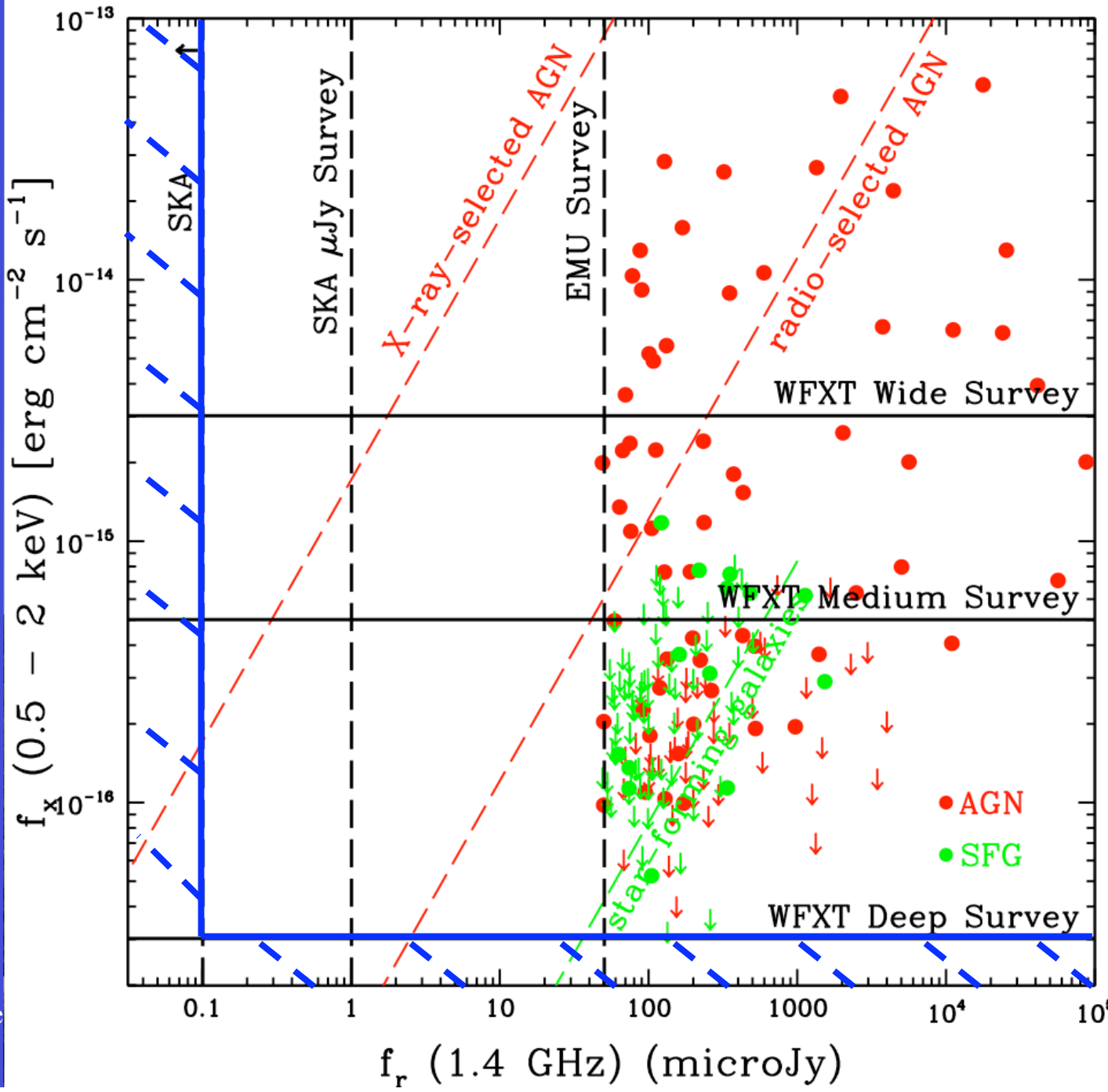
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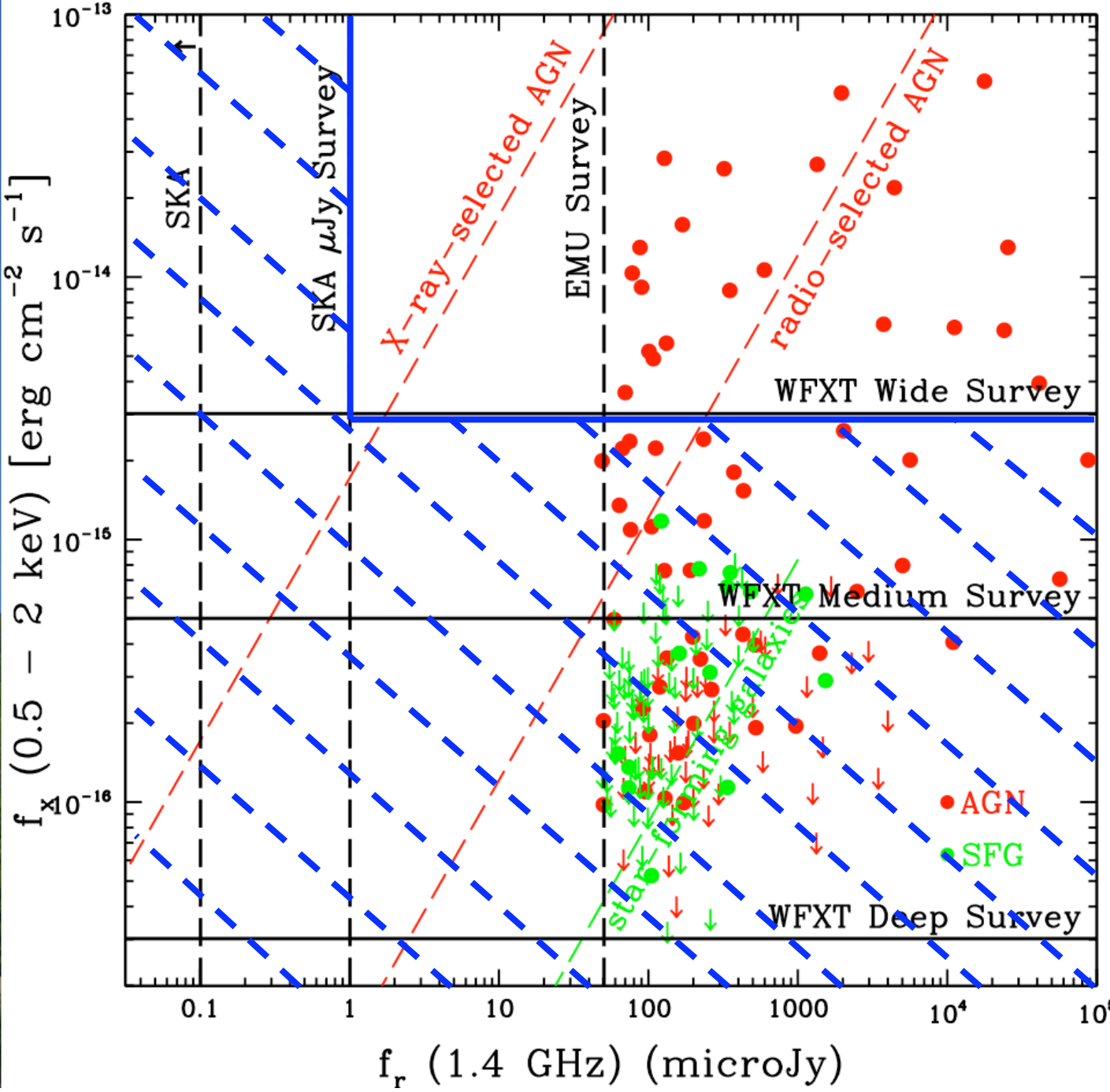
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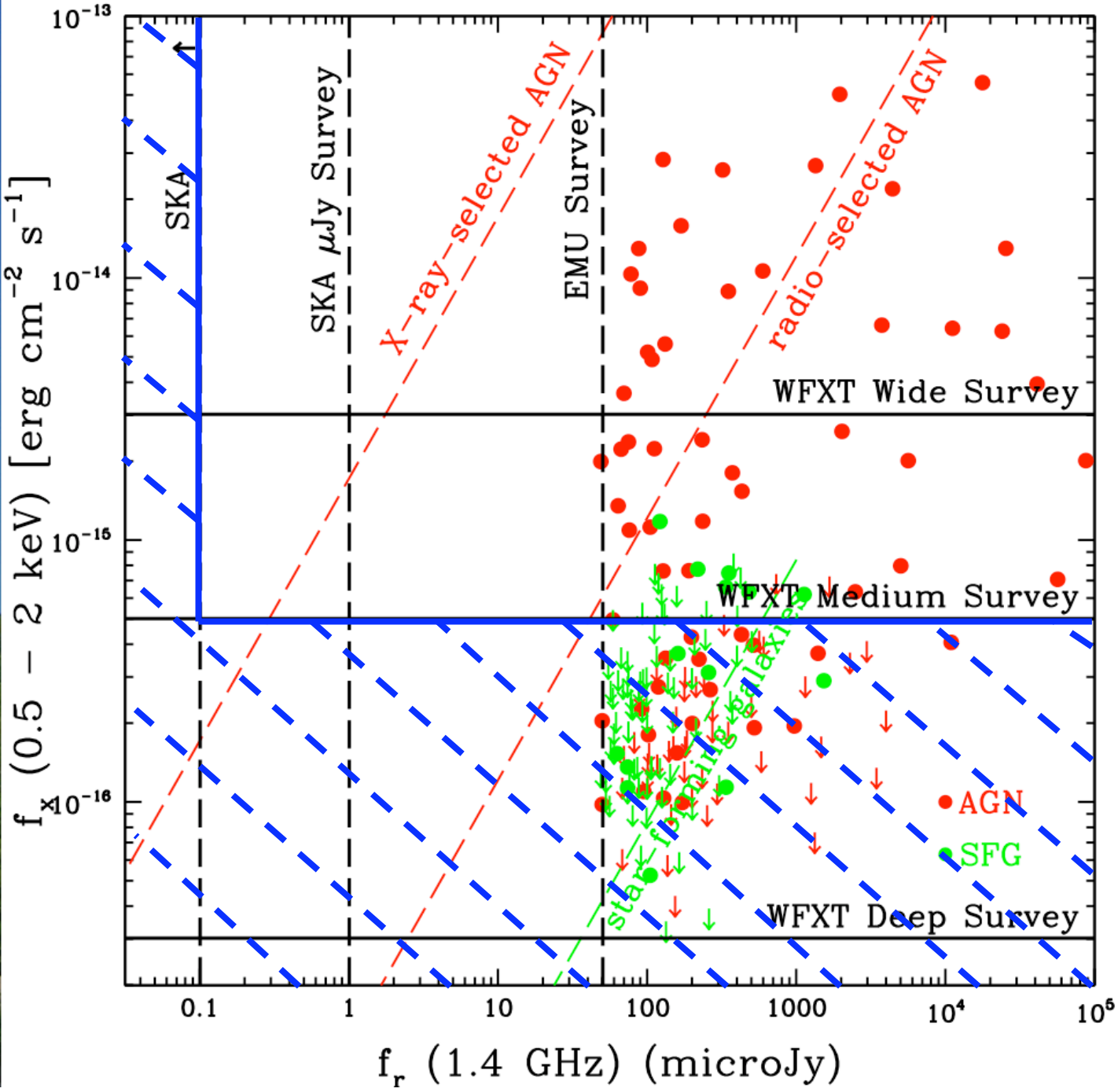
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Summary

- Radio astronomy is at the verge of revolutionary advances
- At present deep radio and X-ray surveys detect somewhat different sources; still, X-ray information is vital to establish nature of faint radio sources
- The combination of future deeper radio surveys with WFXT will shed light on the nature of *extremely* faint radio sources (> 100 x fainter than present limits), down to the faintest AGN
- Radio data will also be very important for the identification of X-ray sources