Radio Core Properties of Radio Quiet BAT AGN

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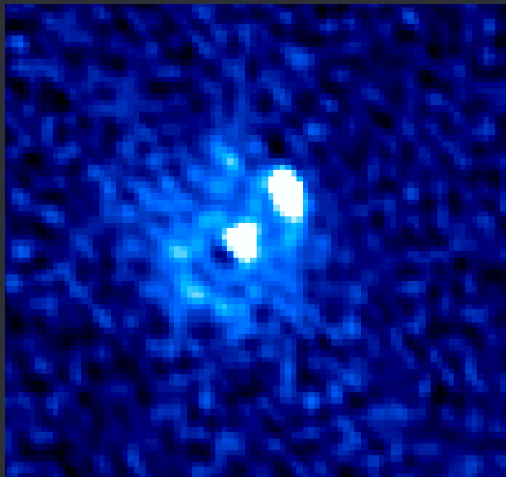## 22 GHz 1" resolution survey of 100 radio-quiet BAT AGN with JVLA

2015: Full BAT Sample → 313 *Herschel*-imaged → 48 radio-quiet AGN
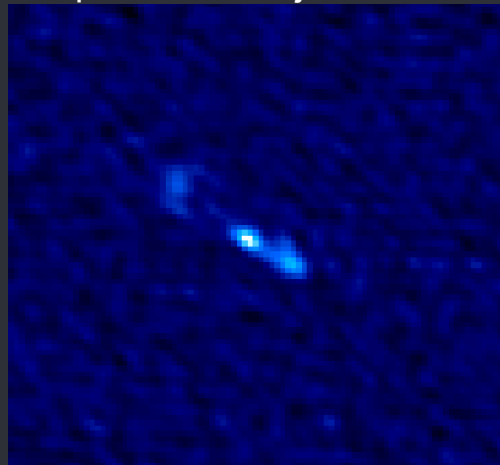
2016: + 22 lower redshift BAT AGN

2017: +30 additional radio-quiet BAT AGN with low SFRs per unit stellar mass
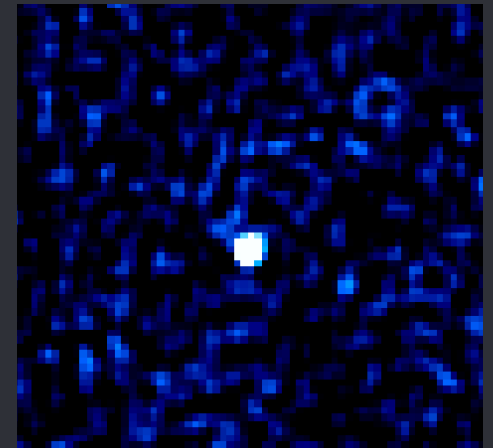
Radio morphologies fell into 3 groups:

Extended Star Formation
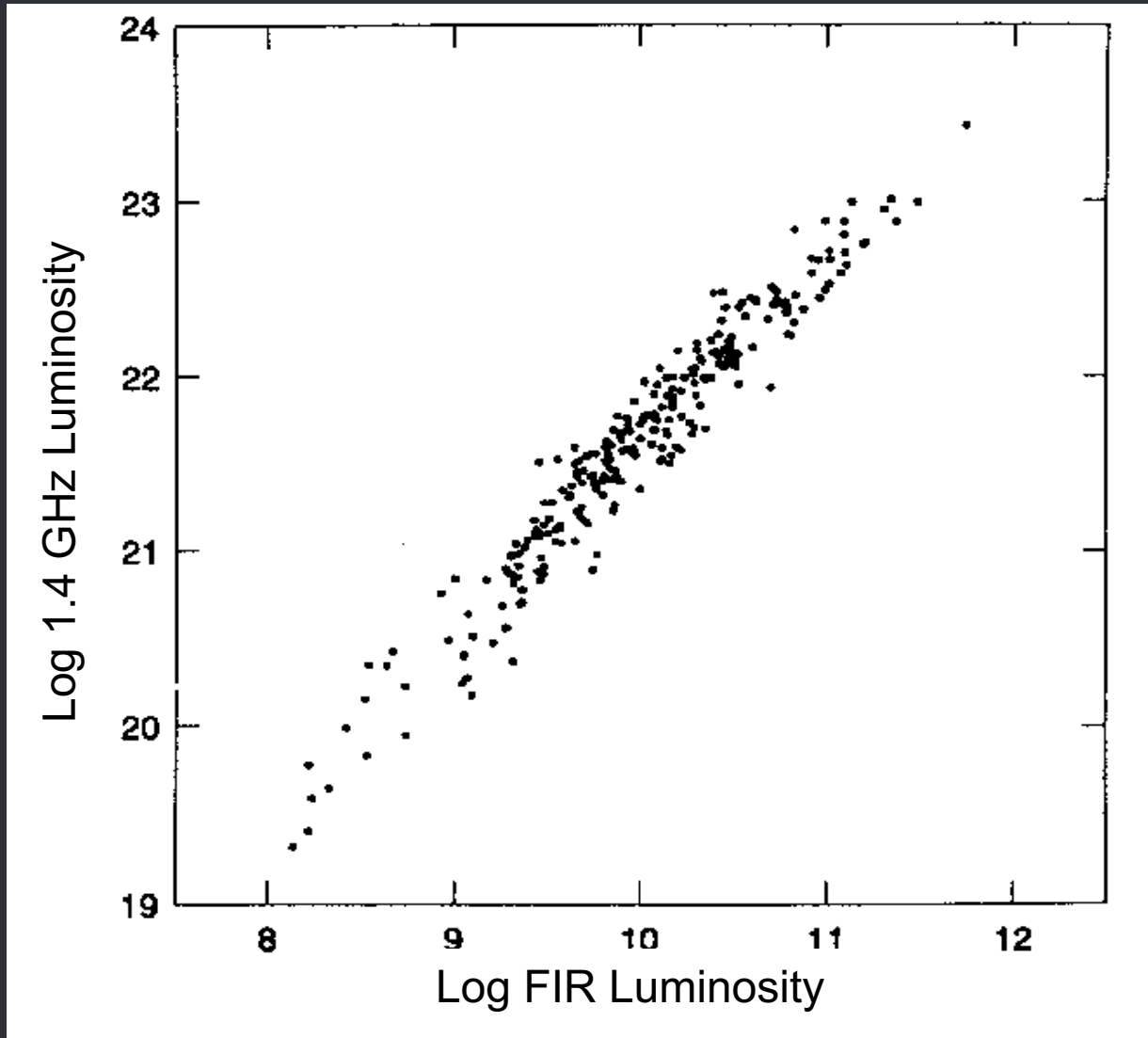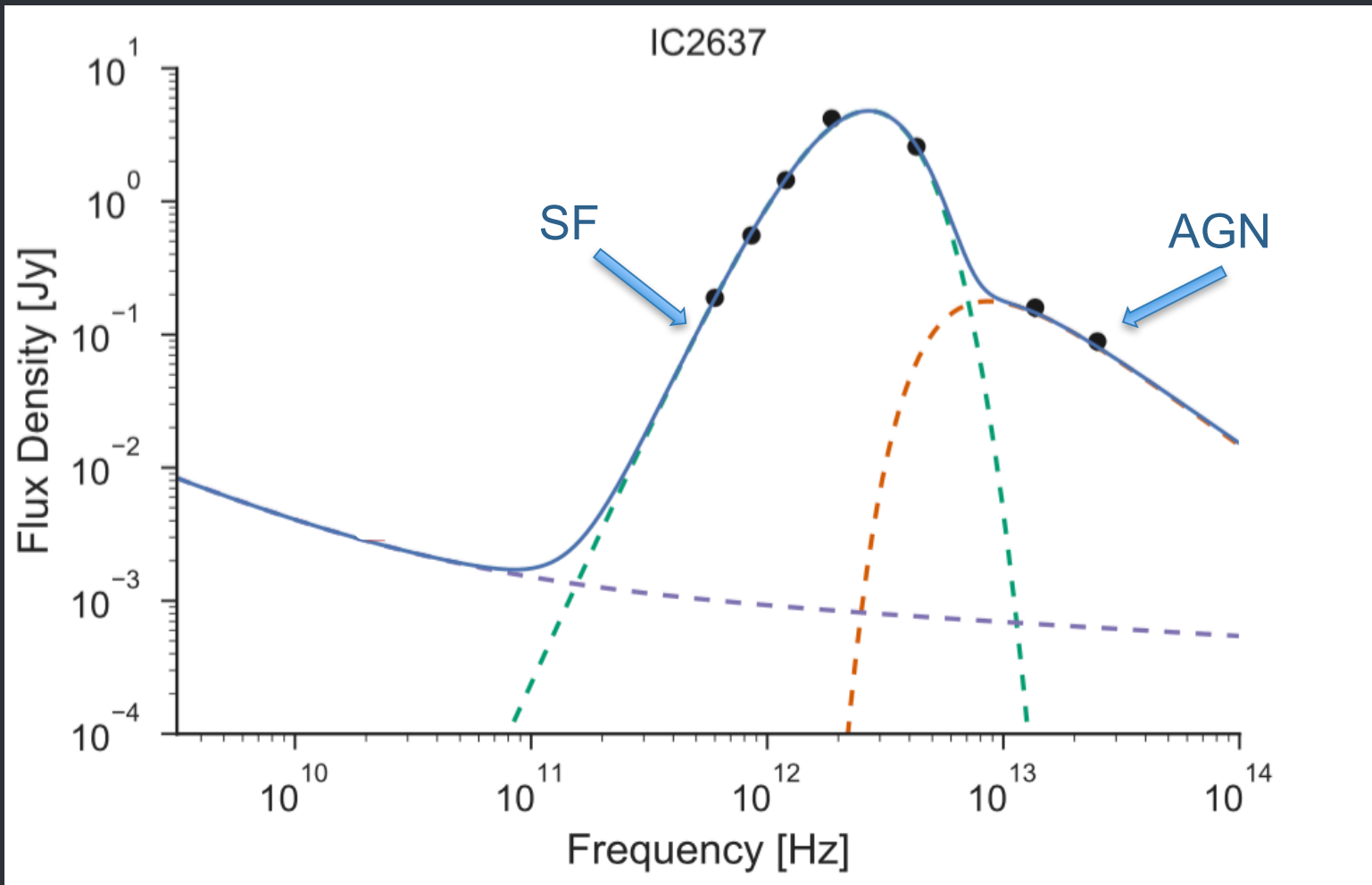
Kiloparsec-scale jets

Unresolved / compact

+ 4 non-detections

Original Motivation: Do SFRs in AGN follow the FIR-Radio Correlation?

Condon 1992

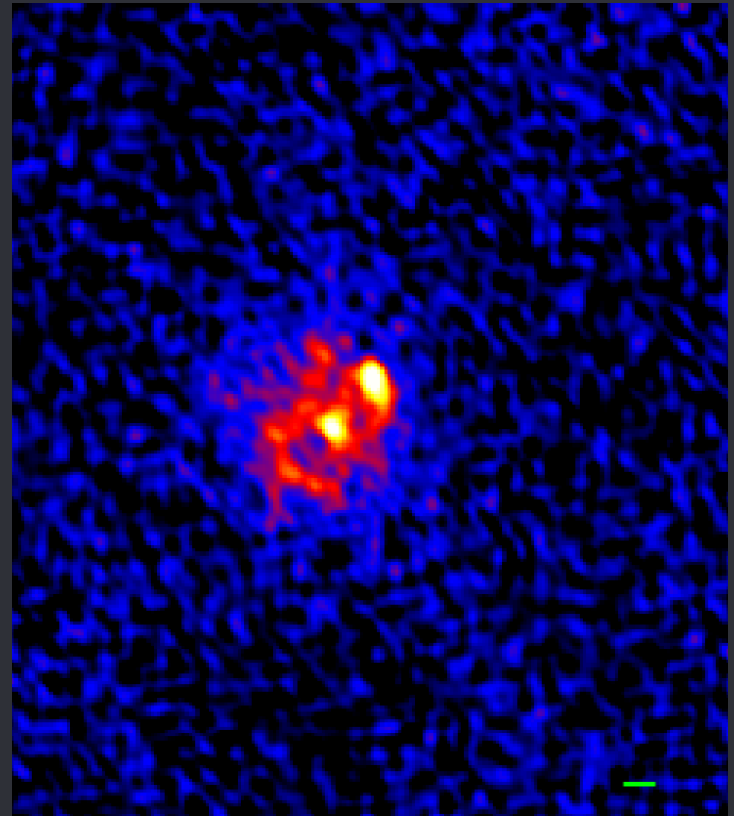# Original Motivation: Do SFRs in AGN follow the FIR-Radio Correlation?

T. T. Shimizu et al., 2015

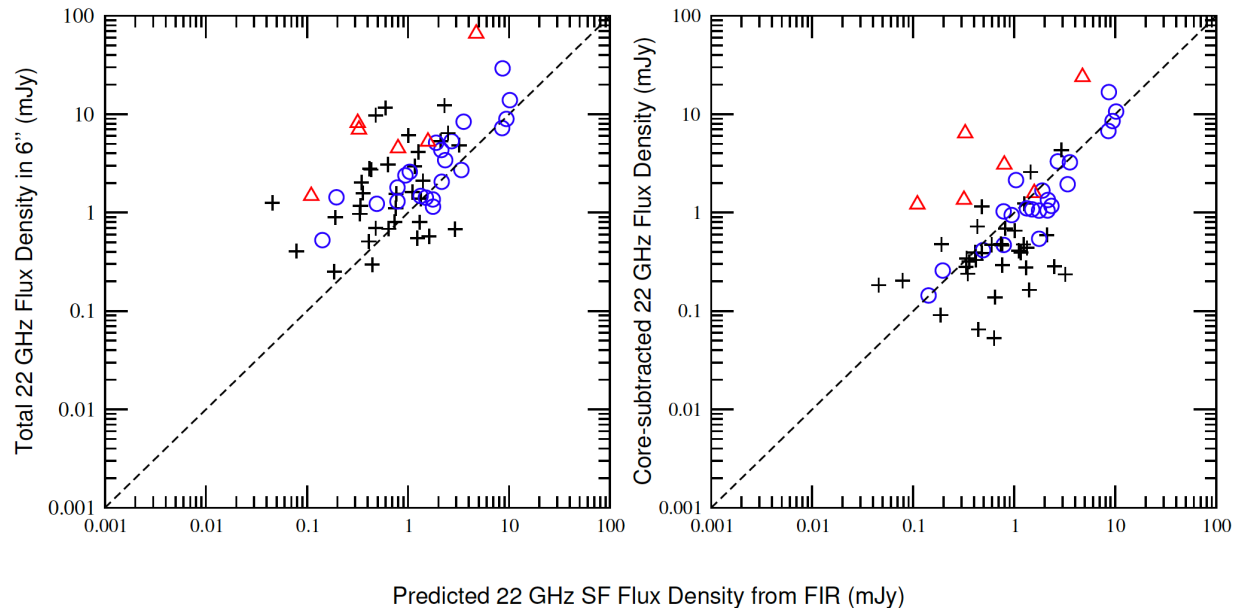## Herschel (FIR)

VLA C-Array

NGC 7679

SFRs in AGN *do* follow the FIR-radio correlation once the SF components are removed in *both* wavebands.

Total flux in image: Extended flux only:

Smith, Mushotzky, Vogel, Shimizu, & Miller (2016)

But all those nice high-res images also gave us an isolated radio core!

And the origin of radio emission in radio-quiet AGN is an open debate:

Dense star formation?
Tiny, scaled-down jets?
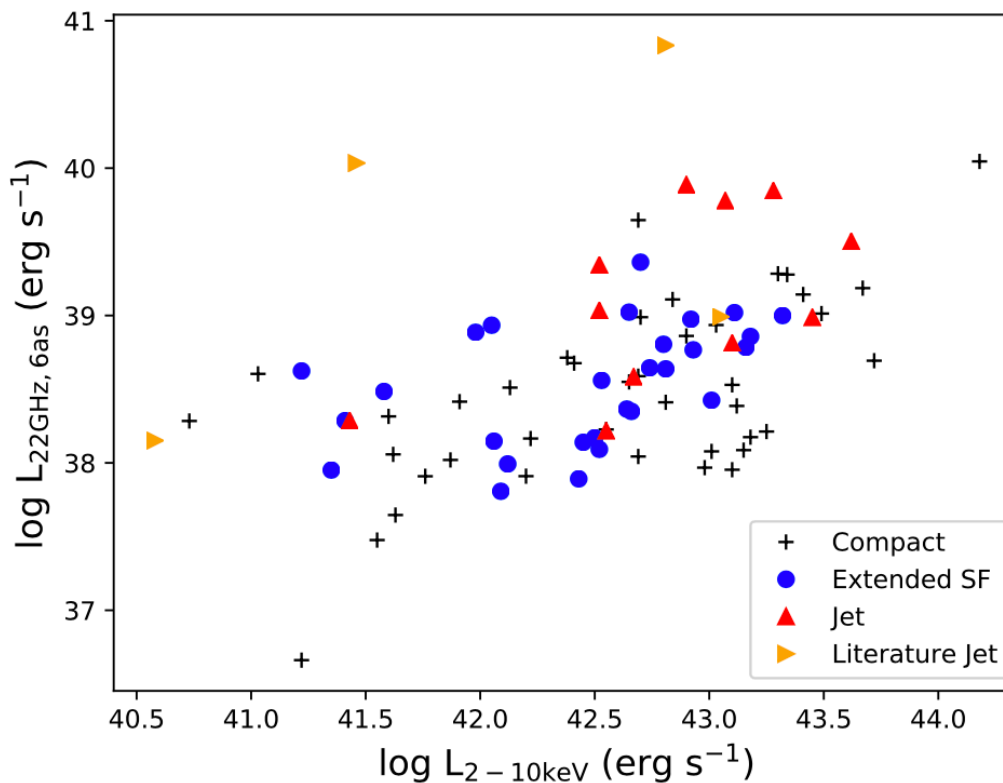*A stellar-like corona?*

Sopp & Alexander 1991
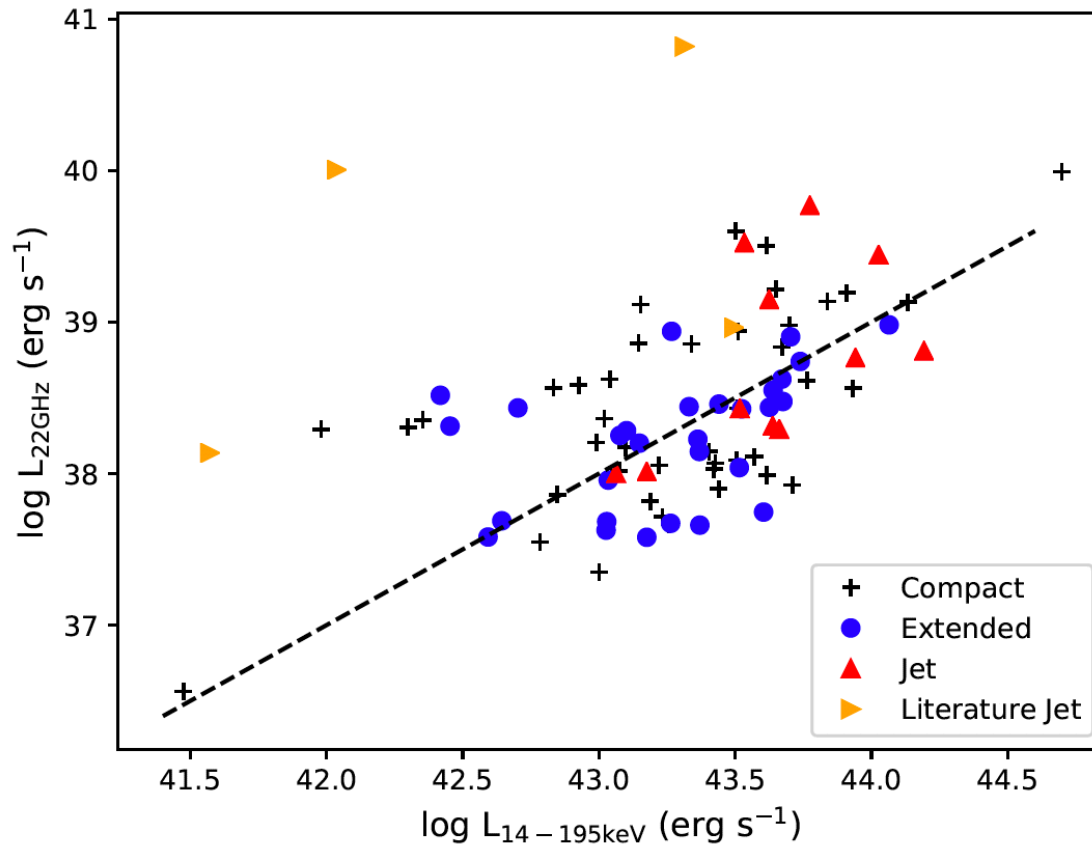Terlevich 1992

Heinz & Sunyaev 2003
Miller et al. 1993

Laor & Behar 2008

People often use L_R / L_X as a diagnostic in low-resolution observations

There is *no diagonal line* above which you can confidently say that the radio emission within a 6" beam definitively comes from a jet.
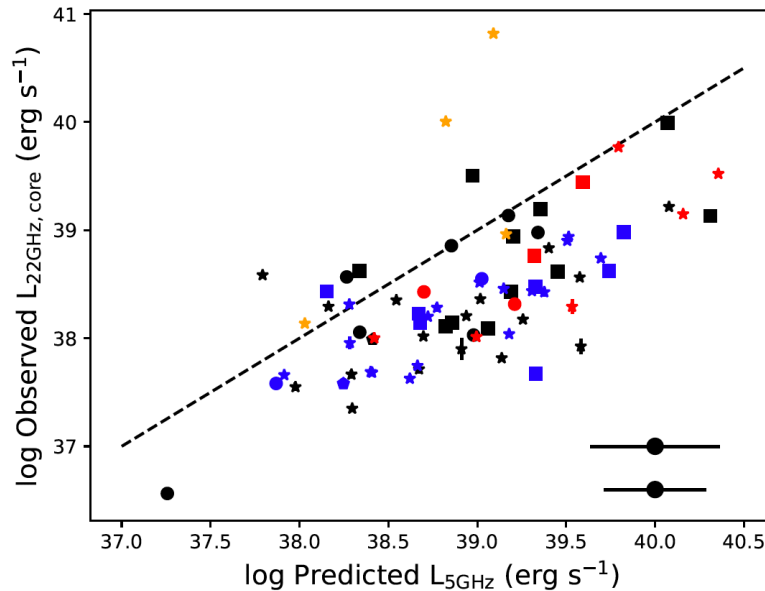
The core L_R / L_X is consistent with ~10^{-5}, the same as coronally active stars.
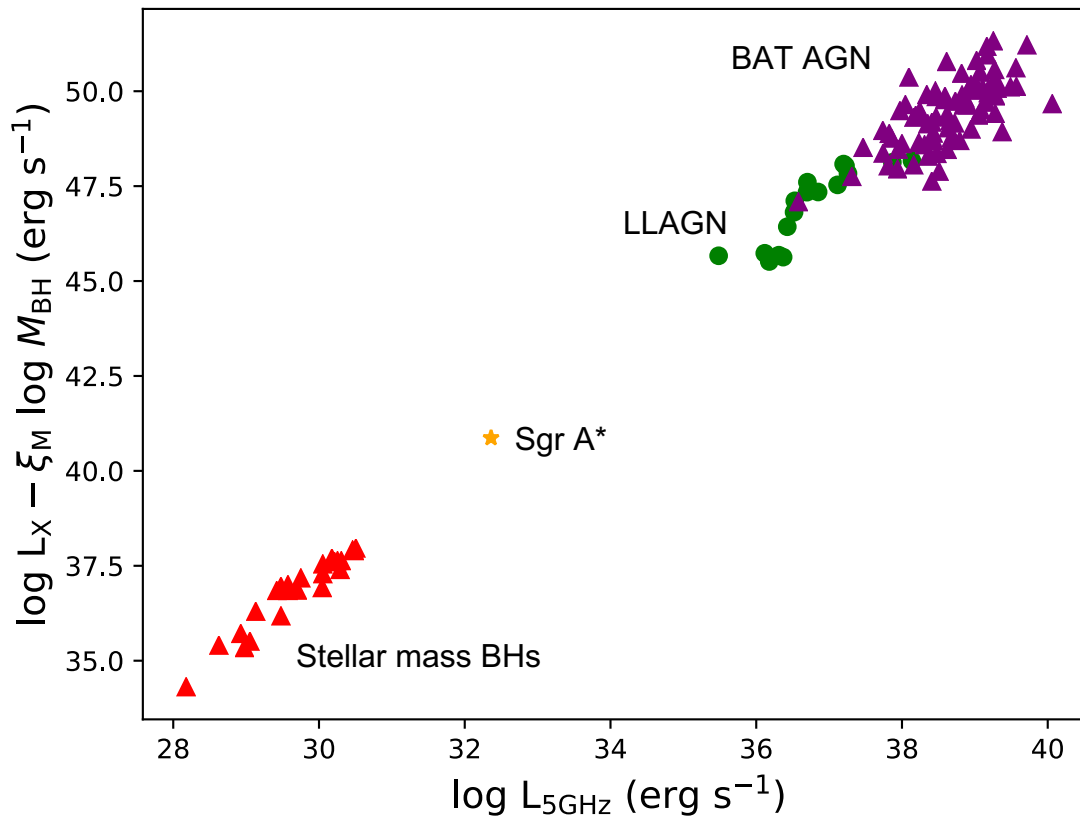
The "Fundamental Plane of Black Hole Activity"

Merloni et al. 2003, Falcke et al. 2004

$$\log L_R = \xi_{\mathrm{RX}} \log L_X + \xi_{\mathrm{RM}} \log M + K$$

The BAT AGN sample lies below the plane, consistent with the smaller Smith+2016 sample and with Wong+ 2016.
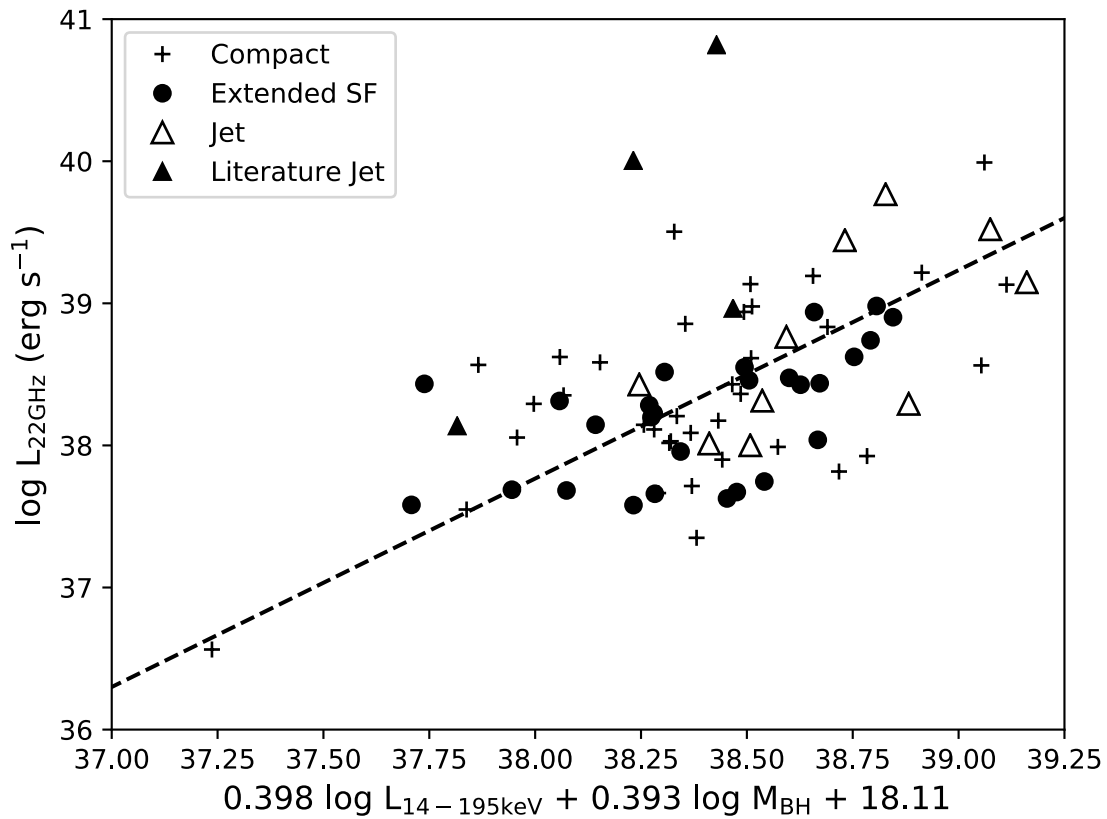
But if you zoom way out…

Plotkin et al. (2012) + core BAT AGN data

◦May probe the true radio core better than lower frequencies:

- Synchrotron self-absorption region size scales as $R_{pc} \sim \nu^{-7/4}$ (Behar 2018)

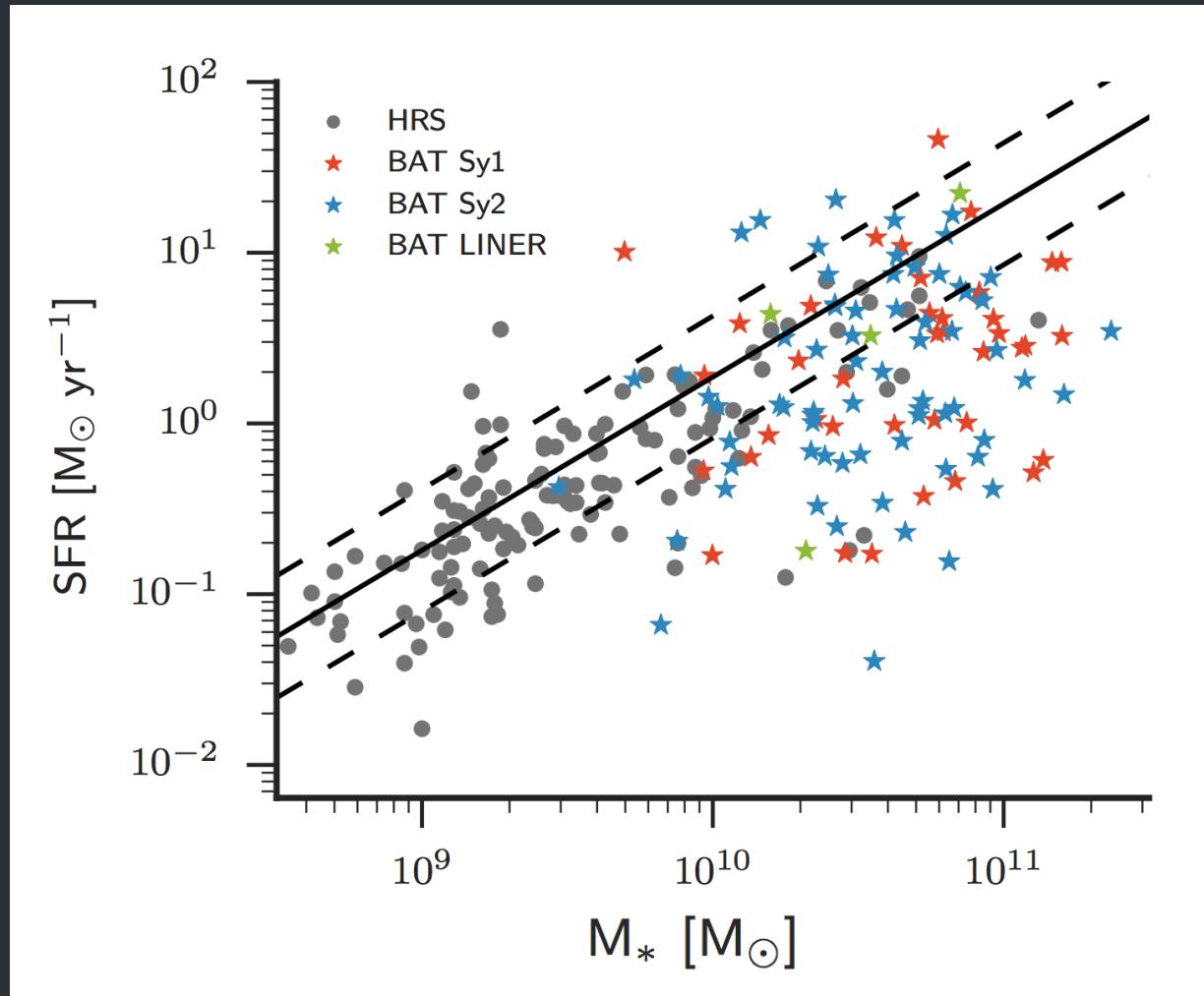- Ultra-hard X-rays are guaranteed to come from the AGN itself
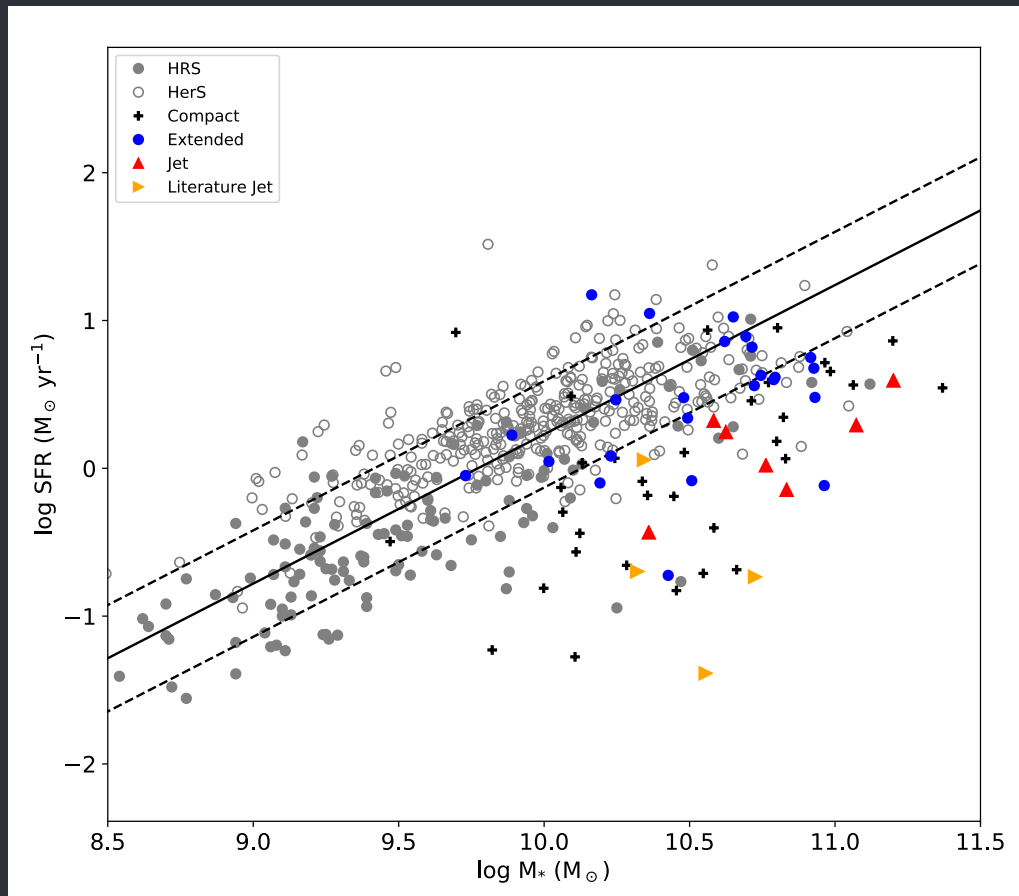
A 22 GHz, UHX Fundamental Plane

Back to star formation for a moment…

Global star formation rate is suppressed in the BAT AGN.

T. T. Shimizu et al., 2015

Results from the 100-object survey suggest that kiloparsec-scale jets may play an important role.

KL Smith +, in prep

Results from the 100-object survey suggest that kiloparsec-scale jets may play an important role.
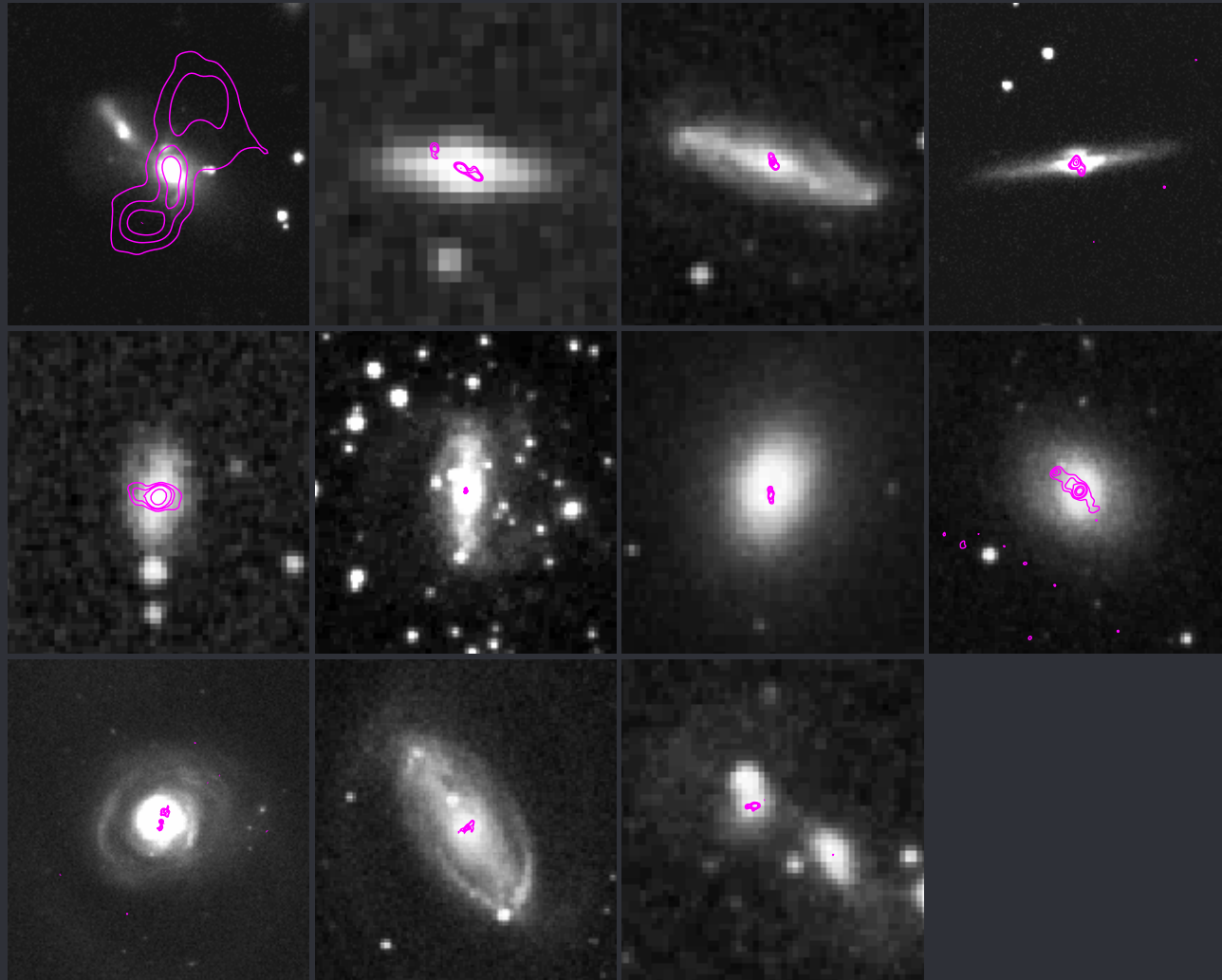
Status: Core paper in final internal review phase, submission in February.

Letter on jet / feedback result in drafting phase

The remainder of BAT AGN with _Herschel_ imaging approved by JVLA with A-priority.

Phase I: 65 objects, completed December 2018

Phase II: 63 objects, propose in September

Result: A 22 GHz 1'' resolution atlas of the BAT AGN

Questions?