Radio Core Properties of Radio Quiet BAT AGN

Krista Lynne Smith
KIPAC @ SLAC
Stanford University

Mike Koss, Rich Mushotzky, Claudio Ricci, Benny Trakhtenbrot, Ivy Wong, Franze Bauer
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
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T. T. Shimizu et al., 2015
HIGH RESOLUTION DECONVOLVES AGN FROM STAR FORMATION

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 $\sim 10^{-5}$, the same as coronally active stars.
The “Fundamental Plane of Black Hole Activity”

Merloni et al. 2003, Falcke et al. 2004

\[ \log L_R = \xi_{RX} \log L_X + \xi_{RM} \log M + K \]

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 \( R_{pc} \sim v^{-7/4} \) (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.
Results from the 100-object survey suggest that kiloparsec-scale jets may play an important role.
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KL Smith +, in prep
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?