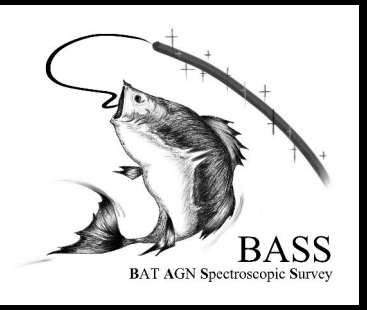

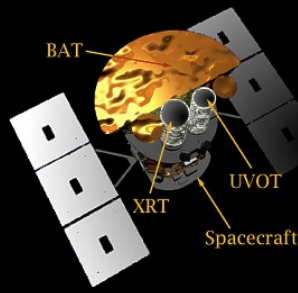

BAT AGN Spectroscopic Survey DR2: An Overview

Mike Koss Eureka Scientific

Claudio Ricci (UDP, Chile), **Benny Trakhtenbrot** (ETH Zürich/Tel Aviv), **Kevin Schawinski, Kyuseok Oh, Isabella Lamperti, Merry Powell,** Richard Mushotzky, Daniel Stern, Meg Urry, Ezequiel Treister, Lia Sartori, Anna Weigel, Rudolf Baer, Alejandra Rojas, Taro Shimizu, Eleonora Sani, Fiona Harrison, Kohei Ichikawa, Eleonora Sani, Alejandra Rojas, Amy Lien, and the **Swift BAT Team**

and many new members!

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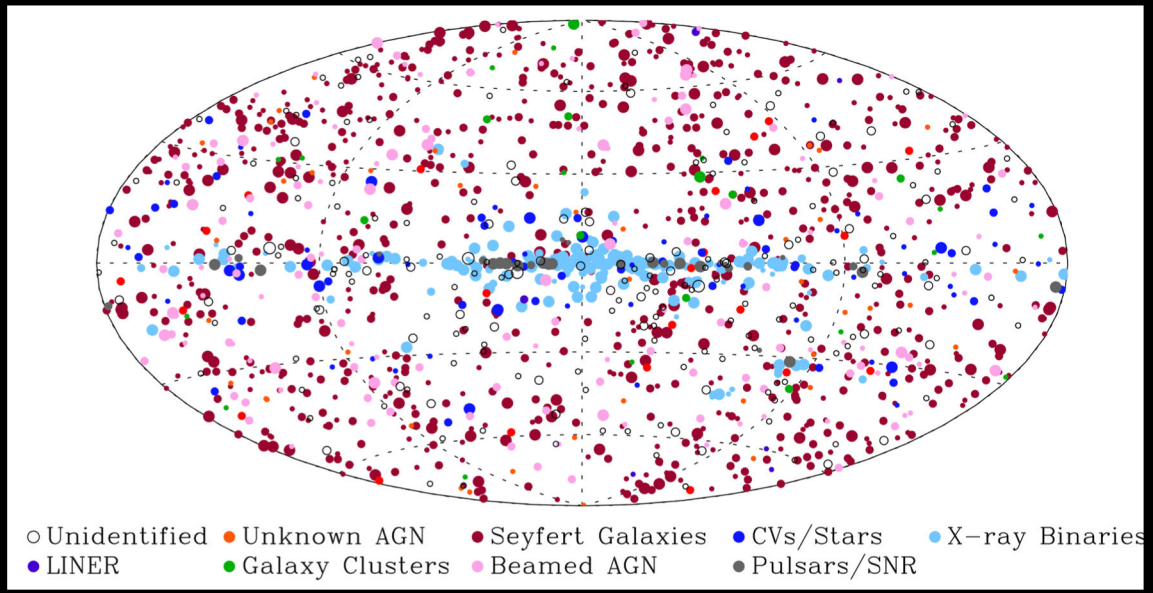
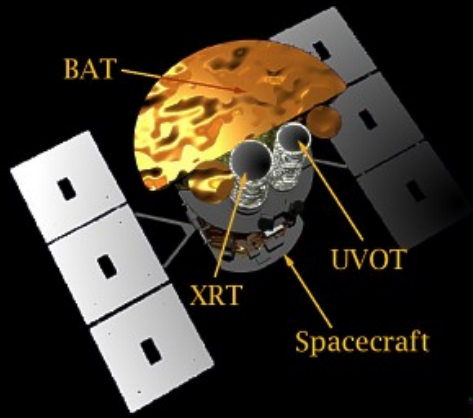
Veilleux, Sylvain
(University of Maryland)

Weigel, Anna
(ETH Zurich)

Wong, Ivy
(International Centre for Radio Astronomy Research)

Swift BAT surveys the whole sky and we stack observations over ten years for a deep full sky survey

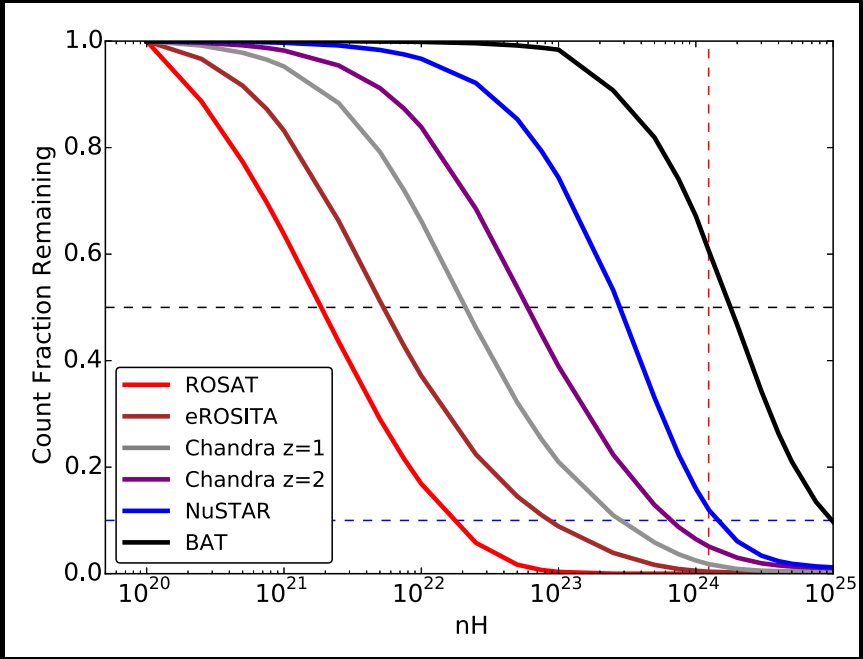




Oh, Koss, et al. 2018 and Swift BAT tear

A total of 1632 sources, of which 1105 are AGN (260 new AGN)

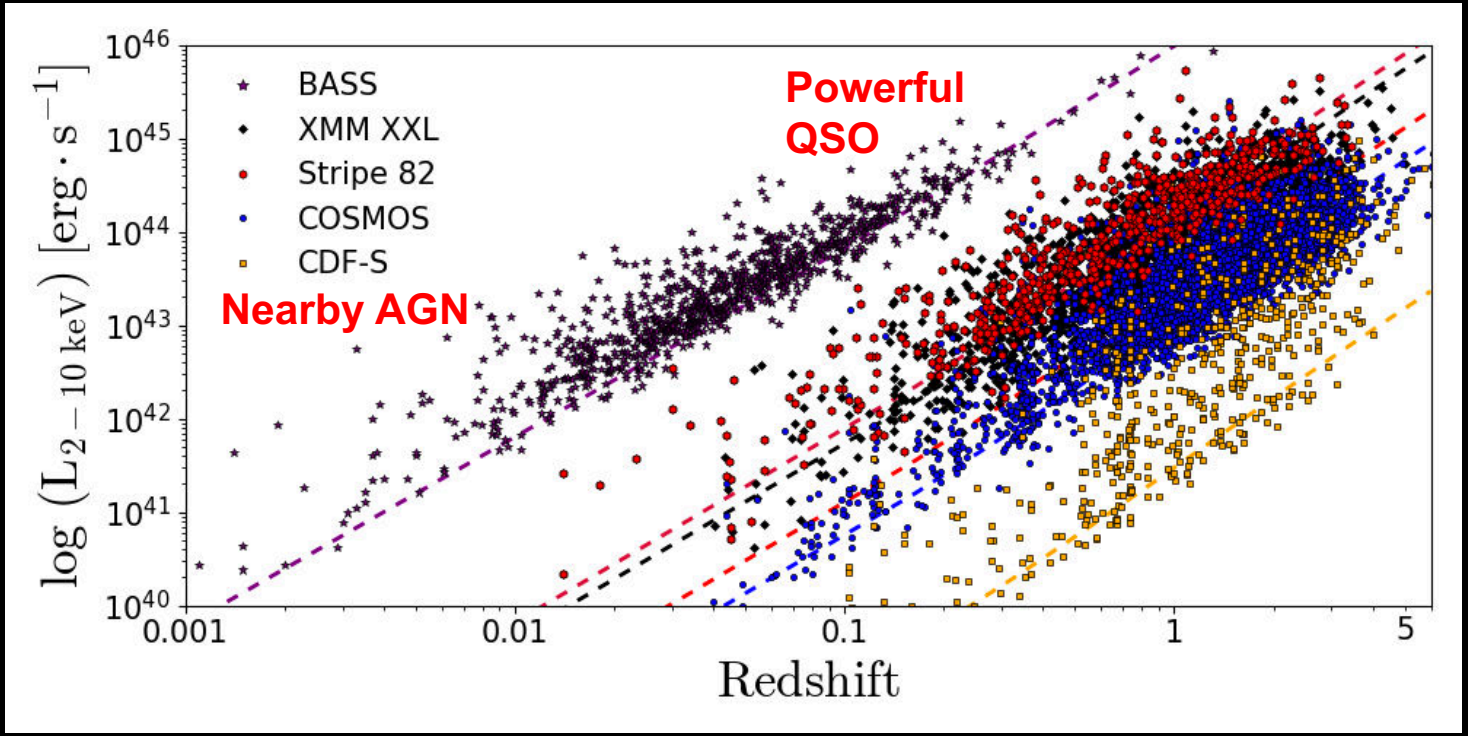
Motivation: *the need for high-energy selection*



Koss et al. 2016b

Swift/BAT *relatively unbiased sample of unobscured and obscured AGN*
Up to Compton-thick levels

Motivation: *benchmark for high-redshift X-ray surveys*



Koss et al. 2017a

Similar luminosities to those of “peak AGN epoch” surveys

BASS First Data Release: *public catalogs*

Optical Spectra

BASS I: Koss, Trakhtenbrot, Ricci et al. (ApJ 2017), 642 AGN

- Optical counterparts
- Redshifts
- Emission lines props
- Stellar velocity dispersions
- BH Masses and Edd. Ratios

X-ray Spectra

BASS V: Ricci, Trakhtenbrot, Koss et al. (ApJS 2017) 836 AGN

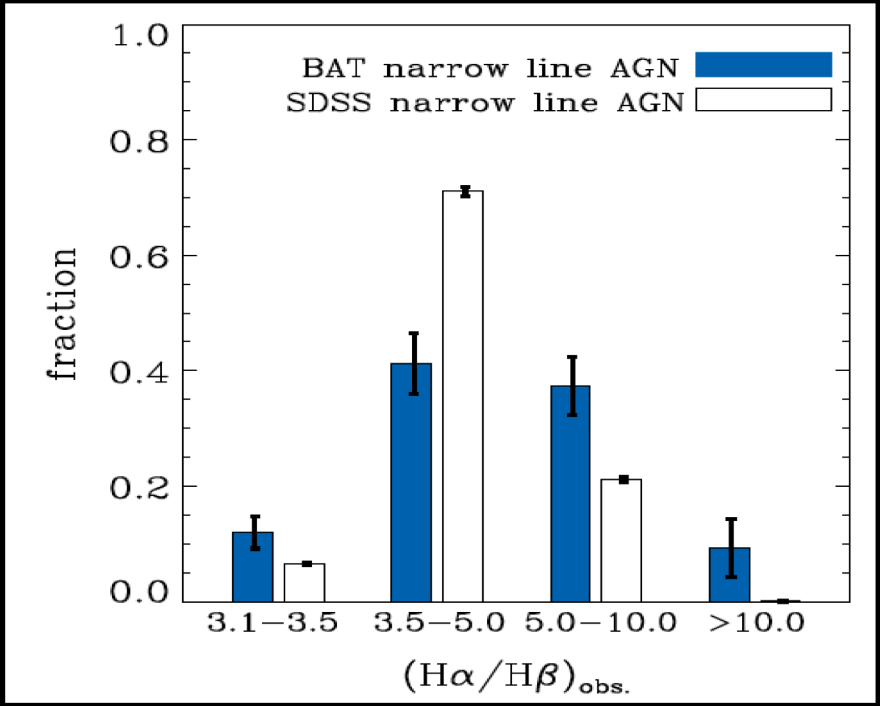
- Column densities
- Photon indices
- Corrected luminosities
- Reflection parameters
- Cutoff energies

NIR Spectra

BASS IV: Lamperti, Koss et al. (2017, MNRAS, 467, 540) 102 AGN

- Paschen and coronal line props.
- BH masses (for “hidden BLRs”)

BASS DR1 Results: *the Balmer decrement as host dust tracer*

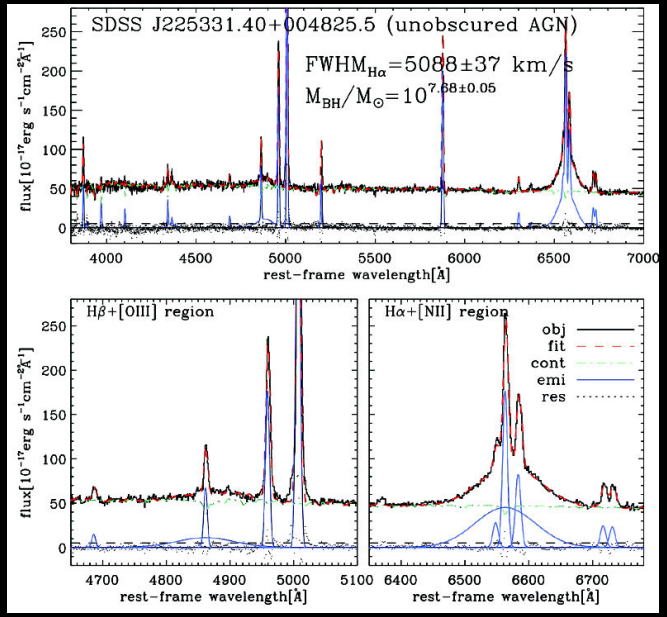


X-ray selected AGN reside in dustier galaxies than optically selected AGN

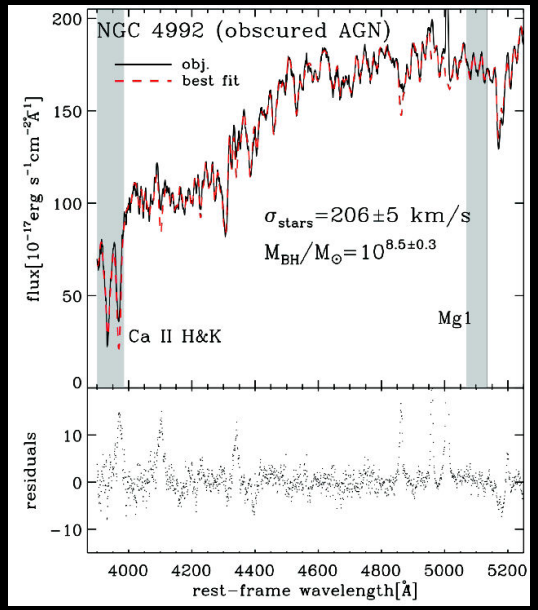
BASS I: Koss et al. 2017a

BASS First Data Release: *Black Hole mass estimates in AGN*

Broad-line AGN:
width of Balmer lines + luminosity



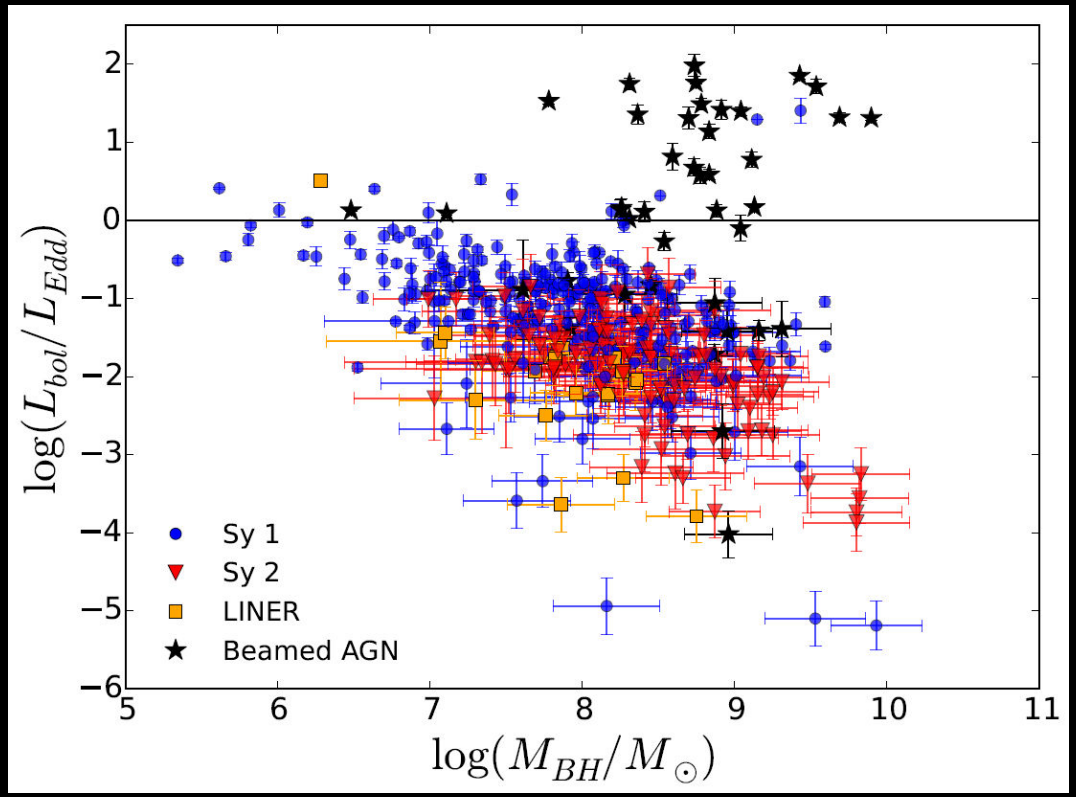
Narrow-line AGN:
stellar velocity disp. + $M_{\rm BH}$ - σ_*



About 450 AGN with reliable $M_{\rm BH}$ and $L/L_{\rm Edd}$ estimates

BASS I: Koss et al. (ApJ 2017)

BASS First Data Release: *basic Black Hole properties*



BASS I: Koss et al. (2017)

https://share.phys.ethz.ch/~blackhole/BASS/

Apps gmail הארץ ADS Clock Calendar home ETH IfA Astro-I HS17 general press papers sup_data obs. consts future conf Other bookmarks

BASS project

Home Team News Data Publications

www.bass-survey.com

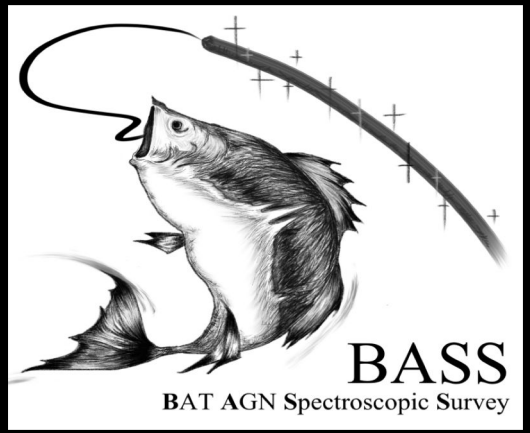
The BAT AGN Spectroscopic Survey

An all-sky study of the brightest and most powerful hard X-ray detected AGN

BASS: *current and upcoming publications*

Published Papers:

1. **Initial Catalog – DR1: 650 AGN with BH masses (Koss+2017)**
2. X-ray emission – large scatter (Berney+2016)
3. Accretion rates vs. Line Ratio (Oh+2017)
4. NIR Spectra/Coronal Lines (Lamperti+2017)
5. **X-ray Catalog (Ricci+2017)**
6. Gamma vs. Accretion Rate (Trakhtenbrot+2017)
7. X-ray Obscuration vs. Accretion Rate (Ricci+2017, *Nature*)
8. Type 1 AGN with massive absorbing columns (Shimizu+2018)
9. Clustering environments (Powell+2018)
10. BAT 105m Survey (Oh+2018)
11. The Covering Factor of Dust and Gas from IR (Ichikawa+2018)
12. X-ray Coronal and Eddington Ratio (Ricci+2018)
13. Hidden Mergers (Koss+, *Nature)*
14. Luminous Seyfert 2 (Baer, Submitted)



In prep.:

15. Submillimetre Excess in AGN (Rahimi)
16. Covering factor of dust versus Eddington ratio (Ricci)
17. Narrow line outflows (Rojas)
18. XLF/BHMF/ERDF (Weigel)
19. IFU data for BASS/Voorwherps (Lia Sartori/Robin)
20. MIR X-ray (Asmus)
21. CO(3-2)/CO(2-1) (Lamperti)
22. Molecular Gas (Koss)
22. SCUBA-2 Catalog Paper (Rahimi
23. Changing look AGN (Kamraj)
24. Dwarf galaxies (Blecha)
25. X-ray outflows (Laha)
26. Radio correlations (Ivy Wong)
27. Stellar masses (Secrest)
28. Beamed AGN (V. Paliya)

And Many More …

So, what’s next?

BASS DR2:Overview of surveys

Optical Spectra (Oh, Koss, Mejía-Restrepo

- Thousand new spectra
- High spectral/Resolution
- Emission lines props
- Stellar velocity dispersions
- BH Masses and Edd. Ratios

6 months

Molecular Gas (M. Koss, T. Shimizu)

- 400 AGN
- JCMT, APEX, IRAM
- CO single dish

6 months

Radio (K. Smith)

- JVLA Survey 200 AGN

NIR Spectra (F. Ricci, J. den Brock)

- Magellan-VLT Xshooter ~350 AGN

MIR Spectra (D. Asmus)

- 250 AGN

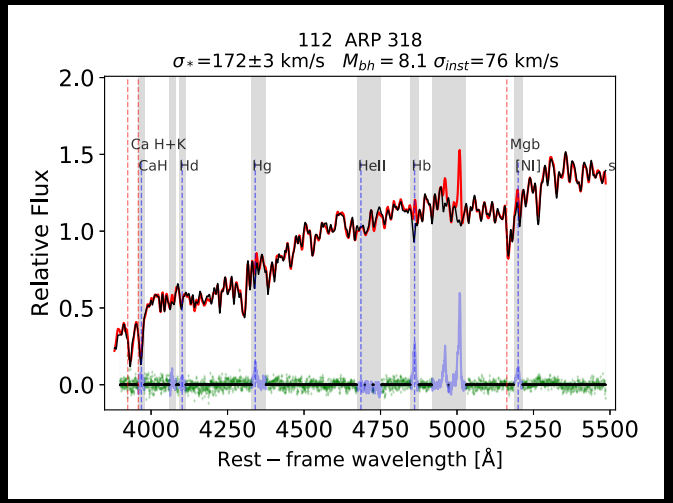
X-ray Spectra (C. Ricci, M. Koss)

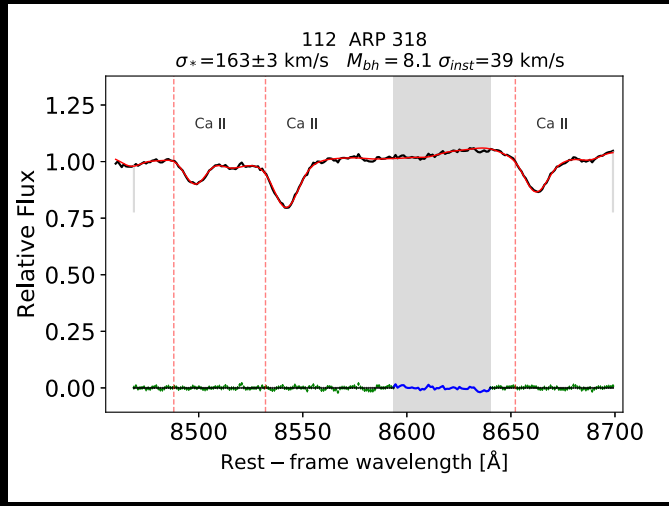
- Additional 30—50 AGN, 400 NuSTAR

Full SED Analysis

- UV+Opt+NIR+MIR+FIR

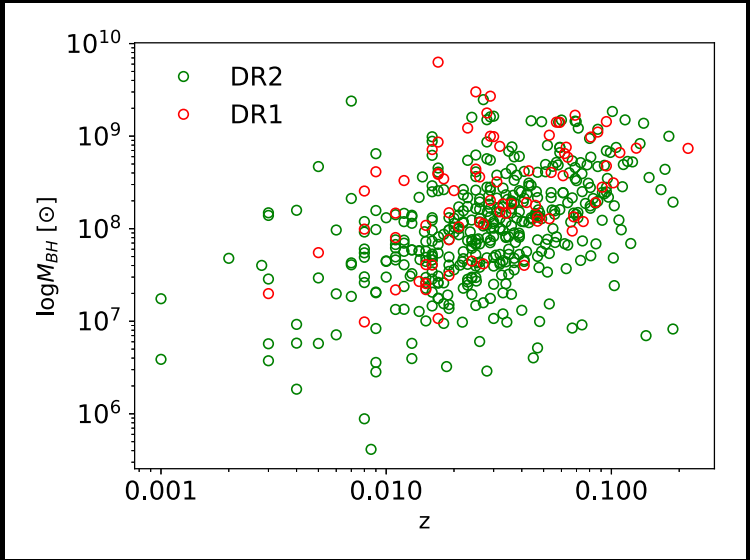
BASS DR2: *A thousand new spectra from Palomar Doublespec and VLT/Xshooter.*





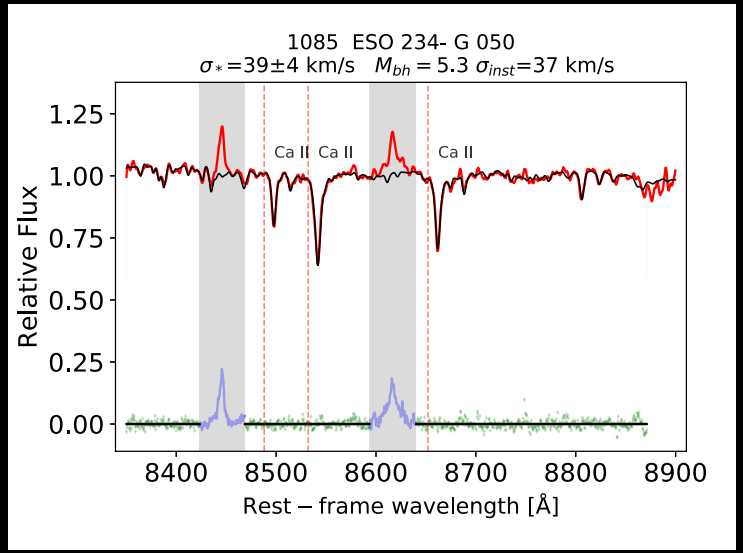
Roughly half are obscured requiring vdisp

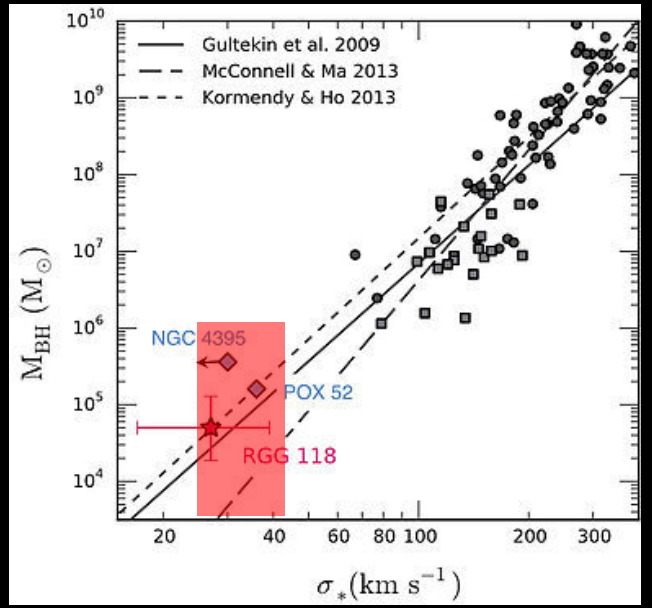
DR2 velocities dispersions are major improvement.



- Median M_{BH}=8.0 (DR2) vs. M_{BH}=8.25 (DR1)
- DR2 90% Complete at z<0.05, 82% for all (outside Galactic plane)
- <10 km/s high quality (212/326 DR2 vs. 59 DR1)

BASS DR2 Highlights : Uncovering Undersized Black Holes



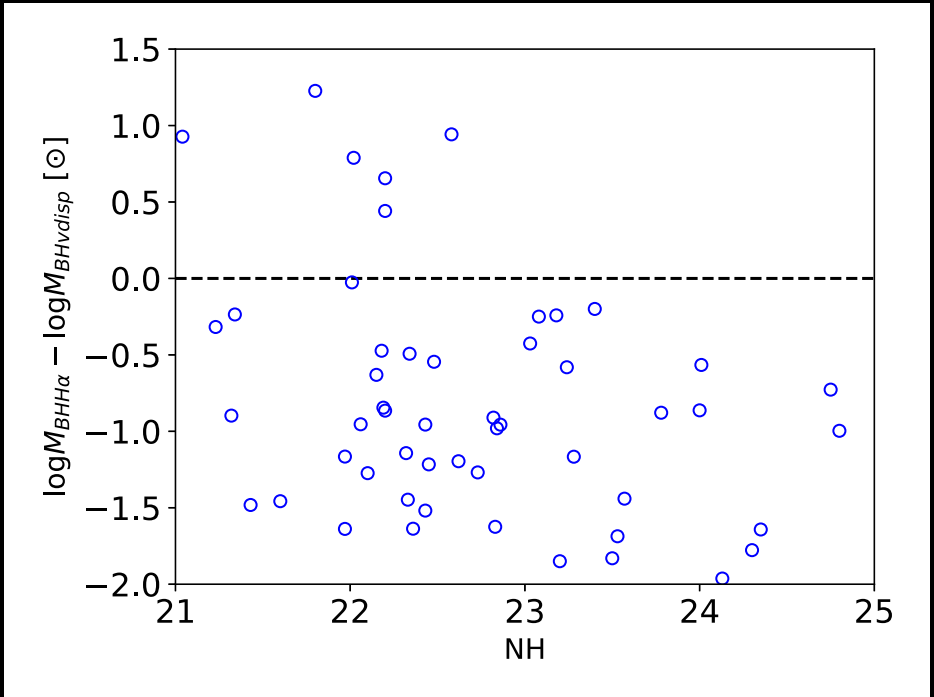


Baldassare et al. 2015

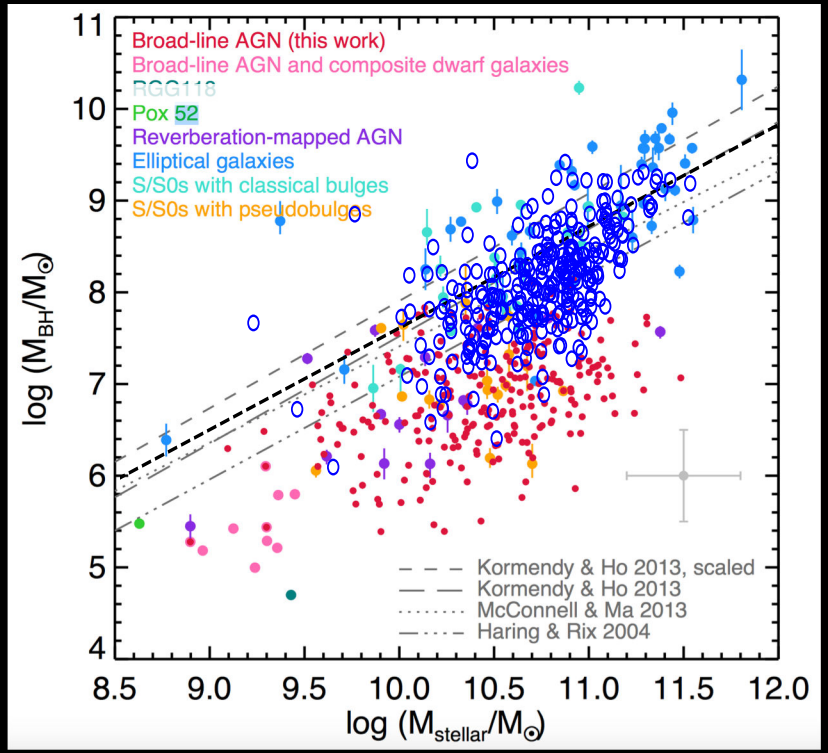
How do you get a massive galaxy that doesn't grow a correspondingly massive black hole?

Large systematic survey can measure frequency of outliers

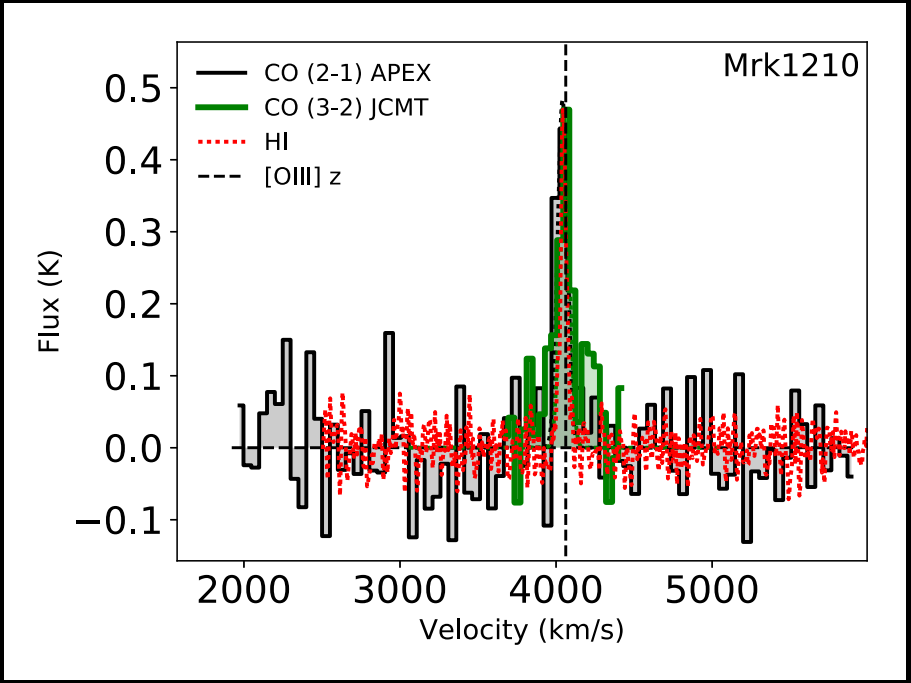
M_{BH} from velocity dispersion is below broad line M_{BH} at high N_H



M_{BH} comparison don't find significantly undermassive black holes.



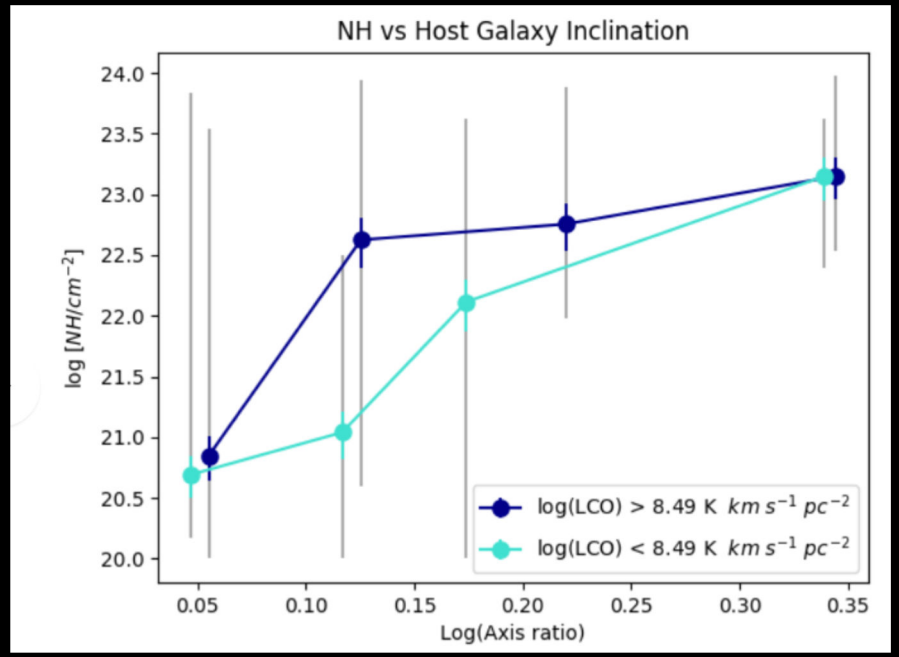
BASS DR2: *A large survey of molecular gas in AGN host galaxies*



ESO Large APEX, IRAM , JCMT 400 AGN ⟶ gas masses & fractions
Excess Gas Fractions compared to inactive galaxies

Koss et al. (in prep), Shimizu et al. (in prep)

Molecular gas: More obscuration in gas-rich edge on galaxies



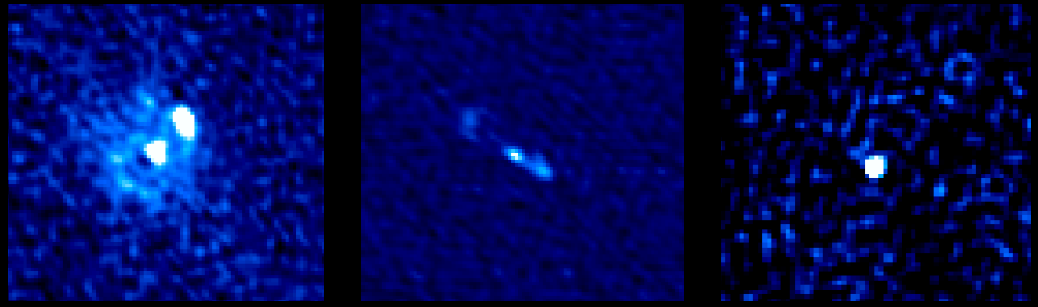
Obscuration

Edge-on

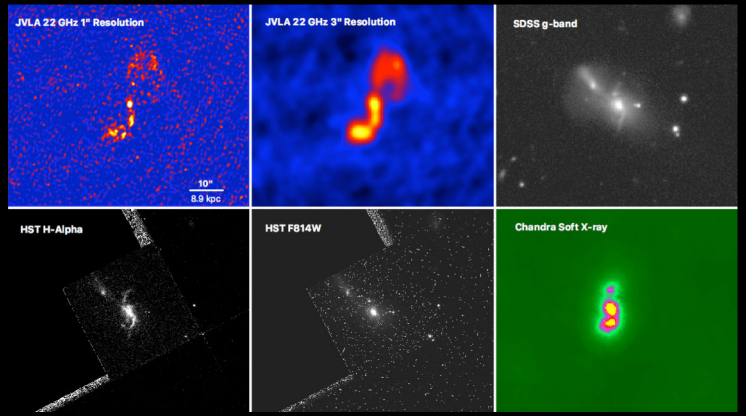
JVLA Radio Imaging Survey

Krista Lynne Smith
(Stanford)

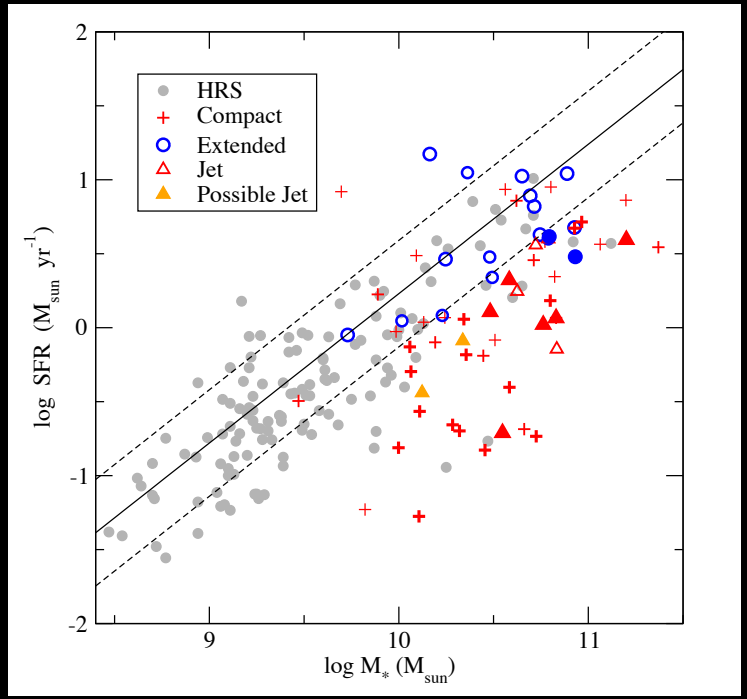
1" resolution 22 GHz imaging of 200 radio-quiet Swift-BAT AGN



Star formation, mini-jets, and unresolved morphologies.

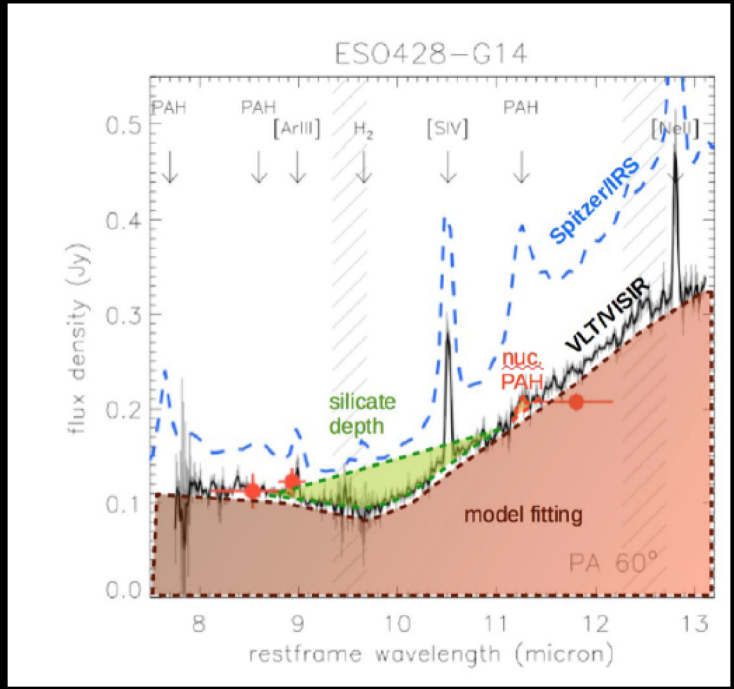


Multi-wavelength synthesis of individual galaxies as feedback laboratories: 2MASXJ 0423+0408



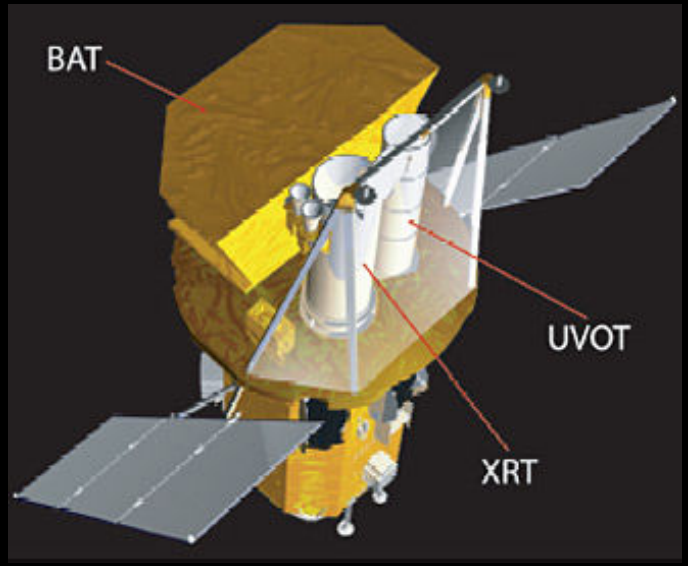
AGN Feedback SF with Jets

High Resolution MIR Spectroscopy



Currently observed 240 BAT AGN (D. Asmus)
Torus model degeneracy (polar dust, clumpiness, outflows)

BASS X-ray: Legacy Projects



Dear BAT Survey Follow-up Team Member,

The following targets were observed on 2018-069:

TargID	Name	Exptime	RA	Dec	Roll	UVOTmode	XRTmode
85655	Swift J1127.7-5322	705	171.94	-53.32	175.28	0x30ed	PC
85657	Swift J1732.6-4408	1985	263.17	-44.13	97.17	0x018c	PC
85663	Swift J0958.2-5732	530	149.51	-57.53	194.92	0x30ed	PC
85699	Swift J2112.4-4249	580	318.11	-42.85	40.12	0x018c	PC
85704	Swift J2056.5-7315	4275	314.23	-73.26	44.77	0x018c	PC
87165	Swift J1833.1-4522	850	278.29	-45.37	89.00	0x018c	PC
87173	Swift J1937.5-4013	535	294.40	-40.24	62.28	0x018c	PC
87177	Swift J2038.1-4006	755	309.53	-40.11	68.12	0x018c	PC
87194	Swift J2234.5-8435	2360	338.72	-84.59	6.16	0x30ed	PC

1-3 AGN observed per day with Swift XRT/UVOT.
NuSTAR and Chandra legacy filler targets (~2 per week)
XMM for 30 confused/faint sources

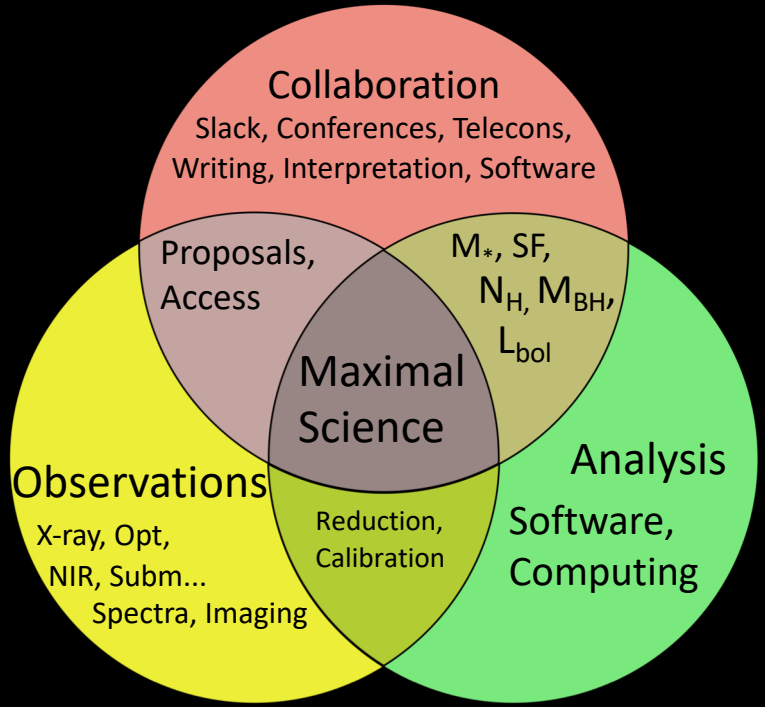
DR3 progress

- 105-month catalog (250 more fainter AGN)
- 75% complete with spectroscopy (100 vdisp)
- XRT follow-up ongoing to 10 ks per source
- Some NIR spectra (~50)

DR4-BAT 157 month catalog up to Jan 2018 finished in Jan 2019.

- Main processes:
  - Stage 1: Construct BAT images for each snapshot observations via the deconvolution technique and find all the bright sources.
  - Producing pattern maps: Estimate the long-term averages of the residual BAT count rates of each individual detector, after subtracting the contribution from those bright sources and diffuse background.
  - Stage 2: Re-process the survey data (i.e., construct the images again) after removing these residual pattern.
- Stage 2 process finished (i.e., process that includes pattern maps)
  - Main reprocess begin with data from 2009/01 to includes the updated gain changes.
  - Contain 2113 known sources
  - Total pointings since 2009/01: 103697
  - Total data size since 2009/01: 10.612 TB
- Final Process:
  - Mosaic images
  - Create monthly light curves of known sources
  - Search for detections in the full-survey (157 month) image for both known and unknown sources.

BASS Collaboration Goals-Overcome complexity, maximize science, and rewrite our understanding of black hole growth in AGN.



Most deep science questions can't be answere in a single proposal/team/instrument.

Many deep science questions are easy to state but terribly complex to answer requiring, multi wavelength-resolution.

Humans are happiest in social environments.

Lets work together!

BASS Future

BASS

- Large census of local X-ray AGN least biased to heavily obscured AGN
- Combines detailed optical, IR, molecular, X-ray spectral analyses.
- DR2
  - 850 AGN spectral coverage 3200A to 10,000A (95% of BH masses)
  - High levels of obscuration in sources with broad Hα and high N_H
  - Additionally, molecular gas, radio, X-ray, MIR survey level products

Great work everyone!