



Workshop INAF Macroarea 4 – 6/7 Giugno 2016

Radio-Quiet AGN



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RADIO QUIET AGN IN INAF

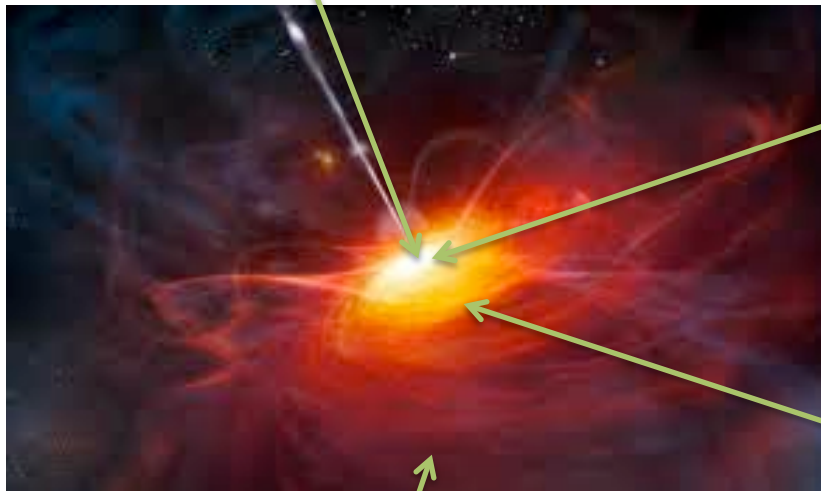


- ✓ ORA BOLOGNA
- ✓ IASF BOLOGNA
- ✓ OSSERVATORIO DI BOLOGNA
- ✓ OSSERVATORIO DI BRERA
- ✓ IAPS ROMA
- ✓ OSSERVATORIO DI ROMA
- ✓ ASDC ROMA
- ✓ OSSERVATORIO DI CAGLIARI
- ✓ OSSERVATORIO DI PADOVA

RQ AGN Hot topics

accretion flow:

- strong gravity
- radiative and accretion mechanisms in the disk/corona system



ejection flow:

- wind/jet production and collimation
- coupling with the accretion flow

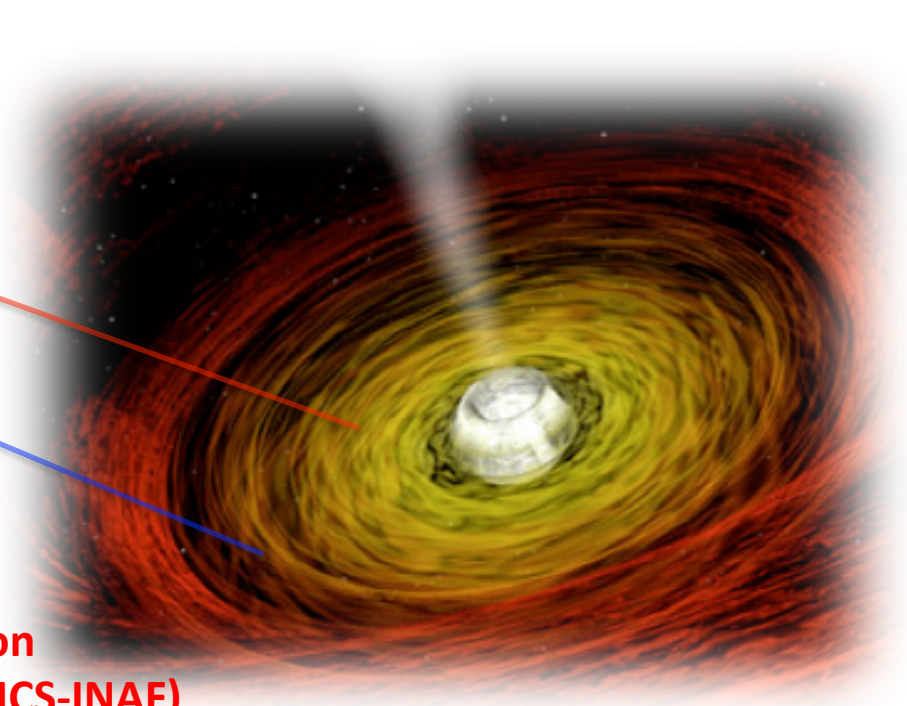
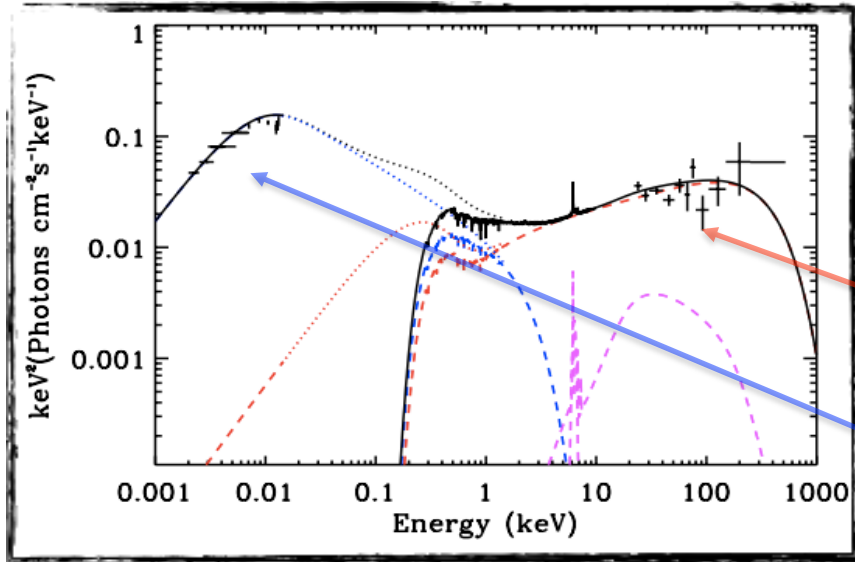
absorption:

- the role of the wind and BLR
- clumpy medium at small scales
- torus at large scale

evolution:

- agn evolution, agn phases and contribution to the XRB
- agn vs galaxy, agn feedback

RQ AGN: inner accretion



CHEESES: Constraining the High Energy Emission Sources in the environment of SMBHs (fund PICS-INAF)

What: derive the physical and geometrical parameters of the regions responsible for the UV and X-ray emission in AGN and the secondary spectral features (Soft excess/reprocessing)

How: A systematic and detailed spectral analysis of the best quality data of a large sample of AGN by using high energy Comptonization models

Who: A. De Rosa (IAPS), M. Cappi, M. Dadina, B. De Marco, G. Ponti (IASFBO), S. Bianchi, G. Matt, F. Ursini (RomaTre/OAR)

multi-band spectral study: NGC5548: Cappi et al. 2016, Di Gesu et al. 2015, Ursini et al. 2015, Arav et al. 2015, Mehdipour, et al. 2015, Kaastra et al. 2014, Kriss et al. 2015. NGC4593: Ursini et a. 2016, NGC7213: Ursini et a. 2016. SED. De Rosa et al. 2015

RQ AGN: inner accretion

NEAR FUTURE:

1. **XMM+Chandra Legacy** multiband projects + archival studies
2. **Athena** (Science and trade-offs activities): see Cappi's talk
3. **Black hole ASTrophysics: BLAST** (under review)



COST is supported by
the EU Framework Programme
Horizon 2020

What: consolidate a pan-European “science driven” community on BHs;

How: organise and facilitate exchanges between scientists across multidisciplinary boundaries: astronomers/physicists/instrumentalists;

Who: More than 50 proposers and 20 EU countries institutions. **INAF PI institution**

FUTURE: eXTP: BH accretion in SFG regime

What: Timing-spectral and polarimetric information to directly access the inner flows of matter around BH into SFG regime.

How: lead by IHEP-Chinese Academy of Science + EU, to be proposed for launch in 2025.

Who: A. De Rosa (IAPS), T. Belloni (OA Brera), P. Casella (OAR), S. Bianchi (UniRomaTre)

inner accretion and absorption

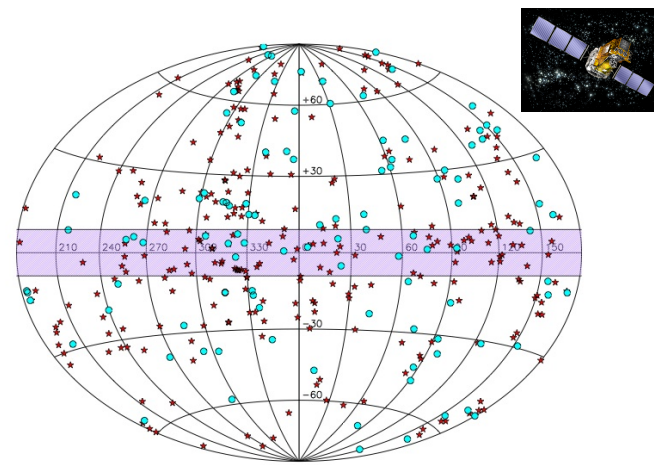
THE INTEGRAL/IBIS AGN: POPULATION STUDIES

What:

- First estimate of the true fraction of CT in the local Universe
- Absorption properties, X-ray vs optical classification and exceptions to the unified model of AGN
- Distribution of the high energy cut-off of the INTEGRAL AGN sample
- Water maser survey of INTEGRAL AGN

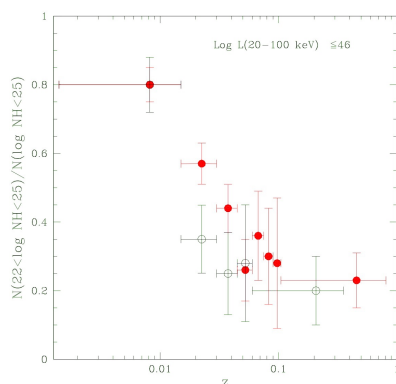
How: INTEGRAL survey from 2002. Horizontal strip between in Galactic latitude is the so called Zone of Avoidance in the Galactic Plane where INTEGRAL plays a key role in detecting new absorbed objects and in particular AGN.

Who: Malizia, Bassani, Molina, Landi, Panessa, Bazzano, Ubertini, Tarchi, Castangia (INAF IASF Bologna, IAPS Roma, OAC)

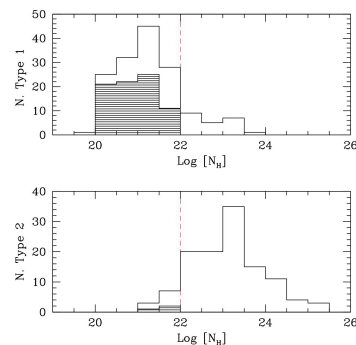


Distribution of all AGN so far detected by INTEGRAL plotted on the sky.

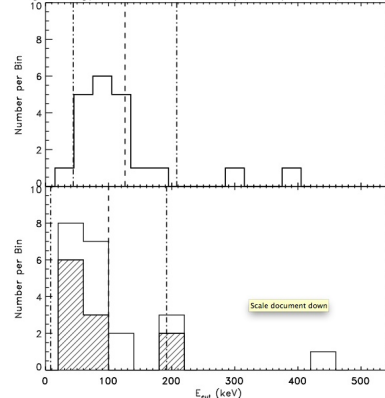
✓ **High Energy Cut-off**



✓ Absorption Studies



High Energy Cut-Off Distribution (bin=30) - Complete Sample

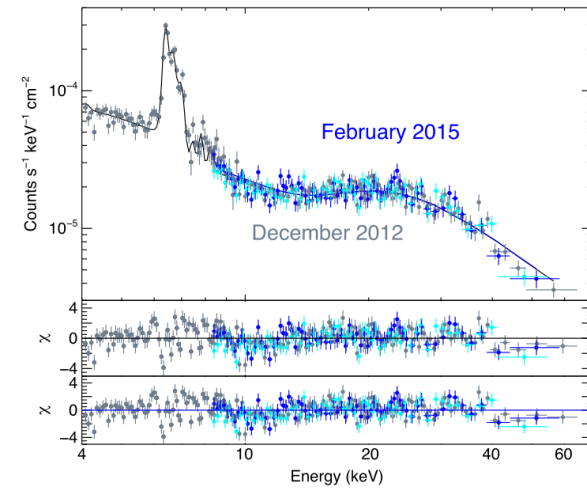
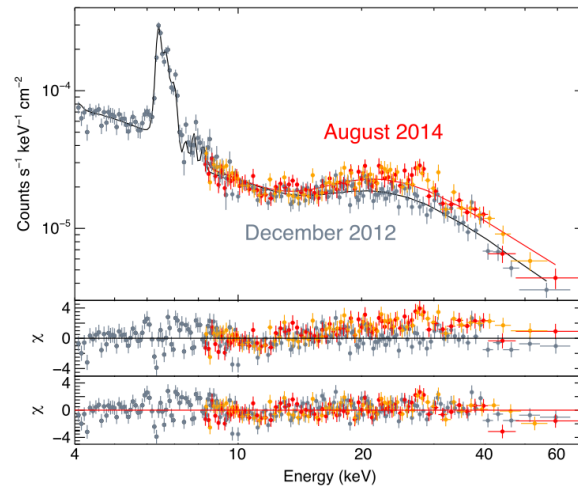
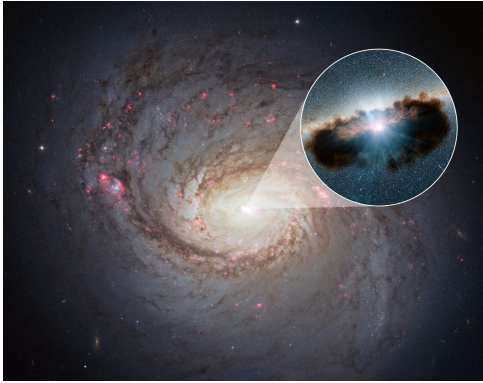


type 1: $\langle E_c \rangle = 128$ keV
($\sigma = 46$)

type 2: $\langle E_c \rangle = 100$ keV
($\sigma = 92$)

inner accretion and absorption

The NuSTAR view of Radio-quiet AGN



What:

- In unabsorbed AGN, physical observables of the accretion disk+corona system such as the electron temperature of the corona, its optical depth and the black-hole spin have been measured thanks to the NuSTAR spectral broadband, and will be topics of further accepted and proposed monitoring campaigns.
- In absorbed AGN, studies about the neutral and ionized circumnuclear material are permitted. In particular, high energy variations due to Compton-thick eclipses and long monitorings of Iron $K\alpha$ changes with respect to the primary continuum have been detected and investigated.

How: NuSTAR is a focusing X-ray satellite launched by NASA in June 2012, which operates between 3 and 80 keV with an unprecedented sensitivity and angular resolution at these energies.

Who: A. Marinucci (Uniroma3), G. Matt (Uniroma3), S. Bianchi (Uniroma3), F. Ursini (Uniroma3, Grenoble), A. Tortosa (Uniroma3), A. De Rosa (INAF-IAPS), E. Piconcelli (INAF-OAR)

Fürst et al., 2016, Marinucci et al., 2016, Puccetti et al., 2016, Bauer et al., 2015, Ursini et al., 2015, Rivers et al., 2015, Keck et al., 2015, Matt et al., 2015, Marinucci et al., 2015, Parker et al., 2015, Balokovic et al., 2015, Kara et al., 2015, Kara et al., 2014, Balokovic et al., 2014, etc.

RQ AGN: absorption

NuSTAR and the Compton Thick AGN

What: Why study CT AGN?

- * Heavy obscuration appears to be quite common in the local Universe (Risaliti et al. 1999)
- * A sizable population of CT AGN is required from the XRB synthesis models (e.g. Gilli et al. 2007)
- * CT obscuration may represent a key phase in the SMBH/host co-evolution

Examples: NGC 4945, NGC 6240, water maser AGN

Work in progress: low z BAT selected sample + deep survey data for searches at high-z

How: *NuSTAR* with its broad and high quality spectral coverage from 3 to 79 keV and an 18'' *FWHM* is suitable for studying the hard X-ray spectra of AGN with high sensitivity, discriminating between the transmitted nuclear emission and the scattered or reflected component.

Who: Puccetti, Masini, Zappacosta

Outflows, Feedback and SMBH/Galaxy Co-Evolution

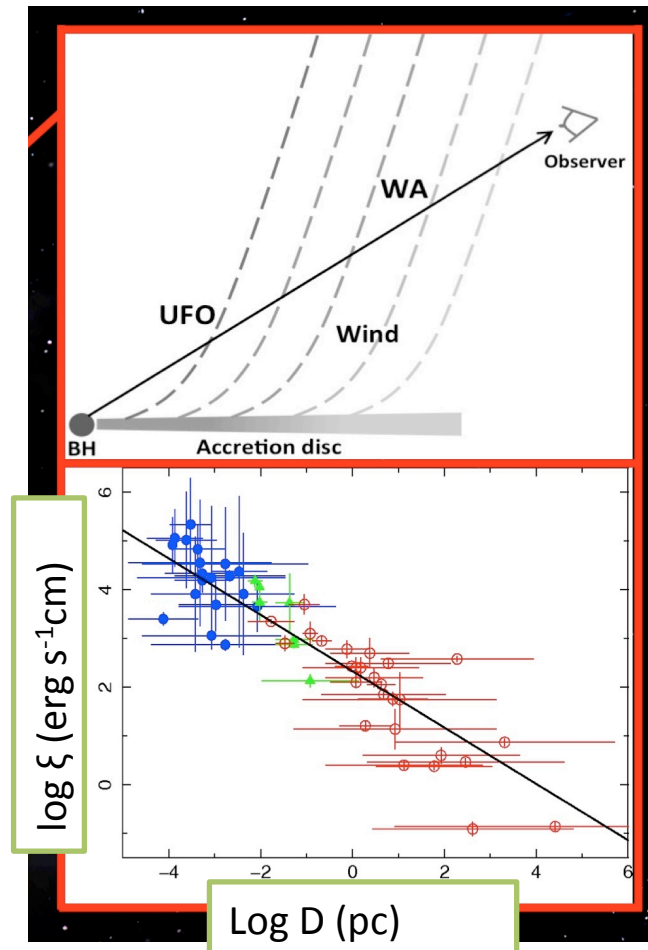
What: study of AGN (gas and molecular) outflows in low-z/L to high-z/L AGN, at all wavelengths (radio, mm, IR, Opt., UV, X-rays) in order to understand:

- i) Astrophysics of winds/outflows, and
- ii) AGN feedback, SMBH/galaxy co-evolution

How: Will require “Legacy-type projects” in most major facilities, in particular: ALMA, MUSE/SINFONI, HST-COS, XMM/Chandra, Athena

Who (in Italy): (mostly, not only, MI+BO+FI+Rome), i.e. Bianchi, Braito, Brusa, Cappi, Comastri, Cresci, De Rosa, Dadina, Fiore, Gilli, Lanzuisi, Morganti, Nicastro, Piconcelli, Prandoni, Risaliti, Vignali, et al.

FUTURE: Final answer will likely require Athena (X-rays probe the highest-ionization/velocity/kinetic energy component), E-ELT IFUs + ALMA + SKA (full)



→ UFOs kinetic energy $>1\%$ of L_{bol}

→ Feedback (potentially) effective!

Jets in RQ AGN

What: Origin of radio emission in RQ AGN: is there a low power jet? Is there thermal emission from a hot corona or from the inner region of a torus? Does it depend on the accretion rate?

How: VLBI observations of RQ AGN of different power, accretion rate and optical class. Exploring multi-frequency luminosity correlations.

Who: Giroletti, Panessa, Orienti, Giovannini

FUTURE:

The Square Kilometre Array (2028):

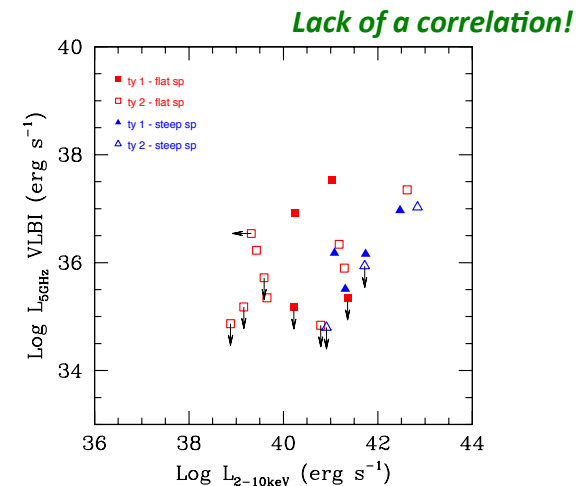
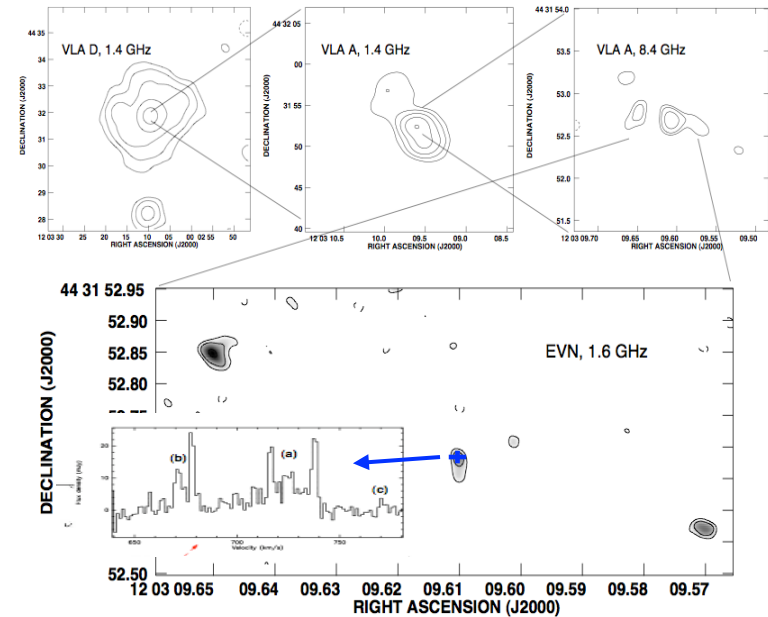
- ✓ SKA 1_mid (2019): survey between 1-3 GHz (100 km baseline)
 - ✓ In 1hr → 1 microJy with 100 mas
 - ✓ 10^3 more LLAGN

Powerful tool to search for weak AGN



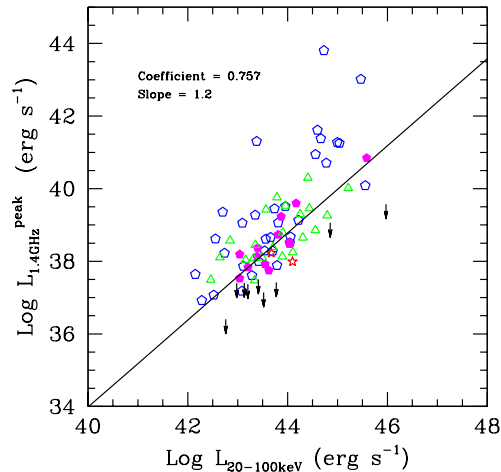
Athena (2028):

- ✓ A factor of 2 XMM in sensitivity (at 6 keV)
 - ✓ X-ray spectra of weak LLAGN at high spectral resolution



disk-Jet coupling in RQ AGN

What: understanding of the radiative mechanisms in the inner region of the accreting black hole and of the connection between the coronal plasma, the accretion disk and the outflowing material in winds and jets.

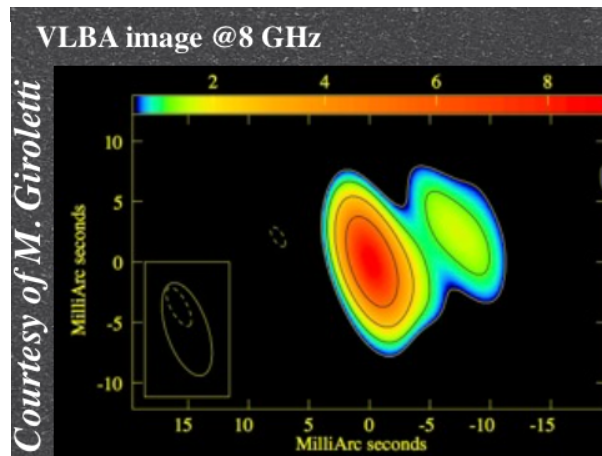
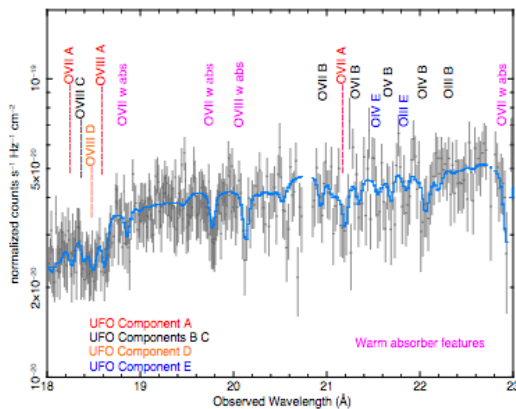
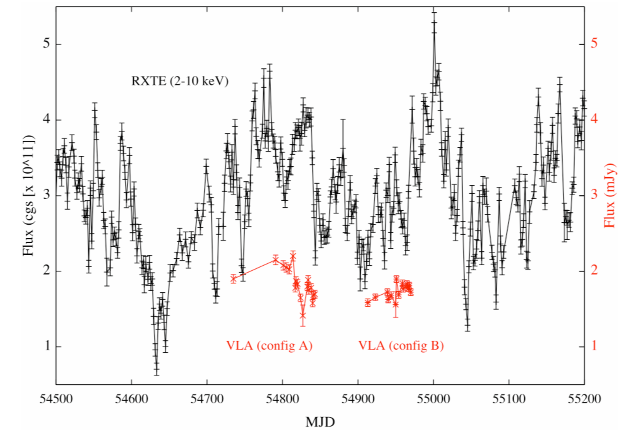


How: radio vs X-ray correlation studies of highly accreting sources

Who: Panessa, Tarchi, Castangia, Bassani, Maiorano, Bazzano, Malizia, Ubertini

How: Simultaneous INTEGRAL/Swift/VLBA observations for cross-correlation studies to look for possible time lags

Who: Panessa, Giroletti, Hernandez-Gonzales, Casella, Bassani, Nicastro, Bazzano, Piro, Malizia, Ubertini, Fiocchi, La Franca, Orienti



How: VLBA observations to investigate the interplay between ultra fast winds and jets

Who: Giroletti, Panessa

Complex absorption

What: Investigation of flux, N_H and ionization changes in large XRT and XMM AGN samples through archival and proprietary data

How: sources with multiple XRT or XMM observations and variable in flux and/or HR.

Who: Ballo, Severgnini, Braito, Della Ceca, Moretti, Caccianiga, Campana, Vignali, Zaino, Wolter (INAF-OABrera and Uni-Bologna)

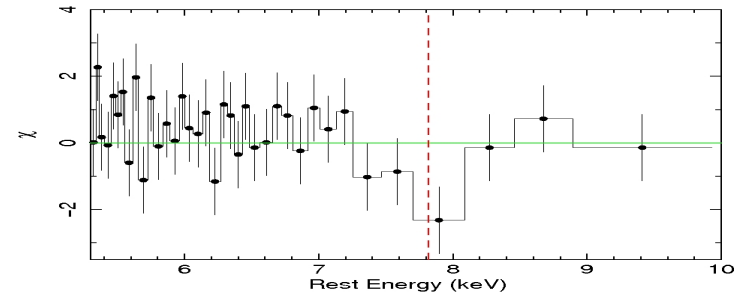
FUTURE

Extend the two SWIFT and XMM pilot samples;
XMM, NuSTAR and possible ASTROSAT follow-up of the most interesting sources;
Proposed ALMA observations of X-ray detected UFO to investigate the disk winds to molecular outflow connection.

✓ Ultra-Fast Outflows:

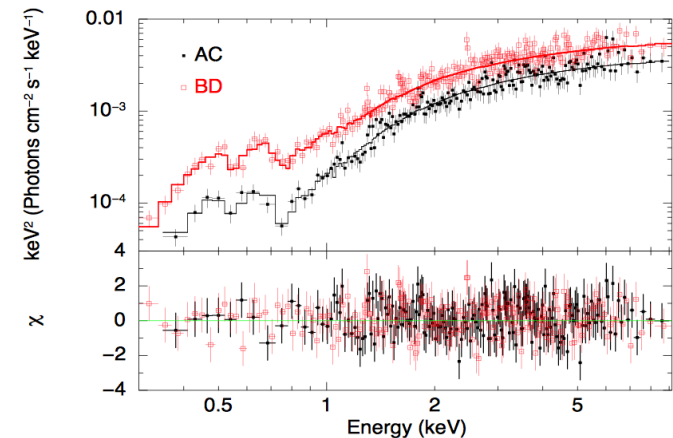
1SXPS J0508+1721:

72 ksec Swift observation



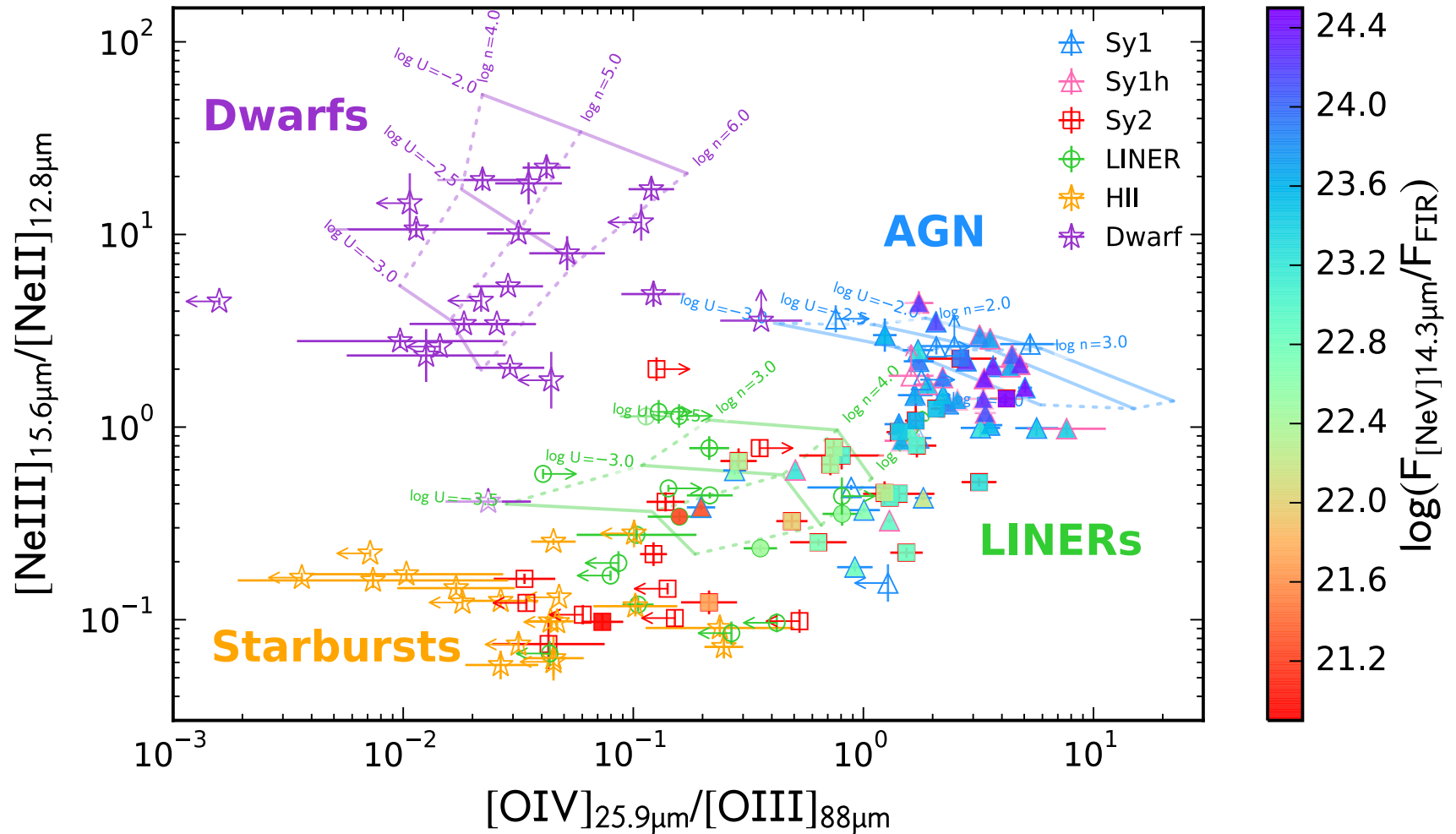
✓ Variable Warm-Absorber:

Mrk 915: 76 ksec Swift observation



AGN Classification

The Infrared BTP diagram



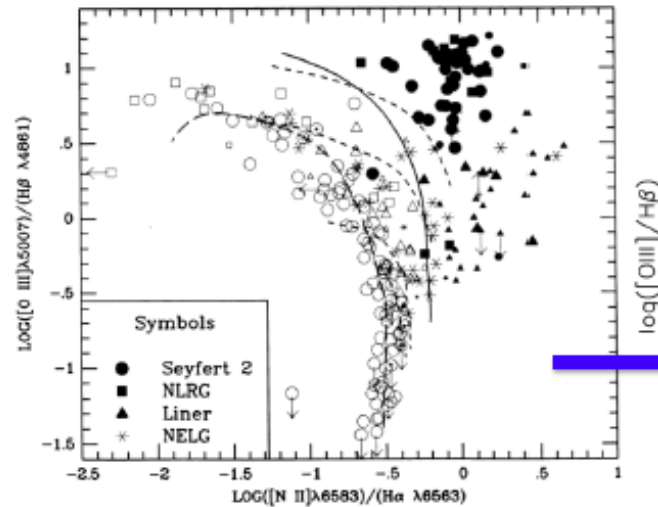
What: IR line ratios are a powerful tool to separate the different galaxies because of the differences in the primary ionising spectra, due to AGNs or stars or possibly to shocks in the ISM (J.A. Fernandez-Ontiveros, LS, in press. 2016)

Who: Spinoglio, Fernandez-Ontiveros

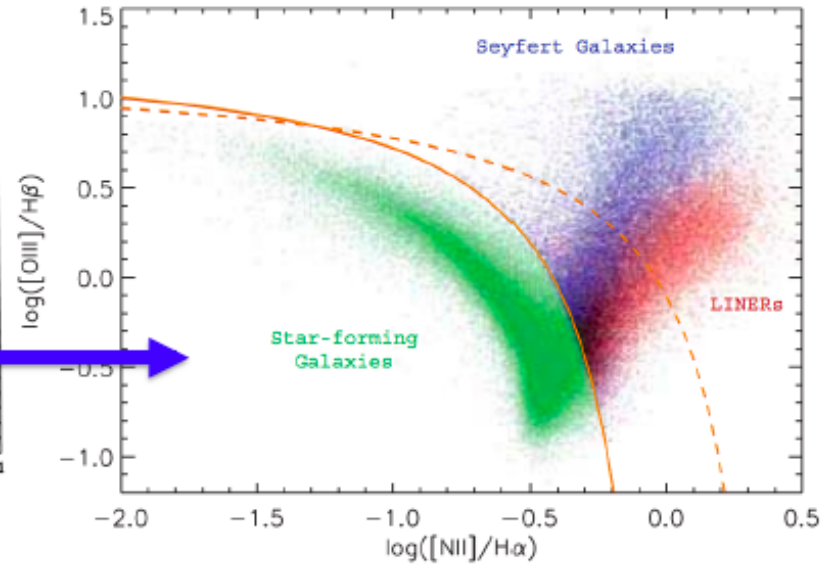
AGN Classification

Veilleux & Osterbrock **1987** (~100 galaxies)

OPTICAL
SPECTROSCOPY

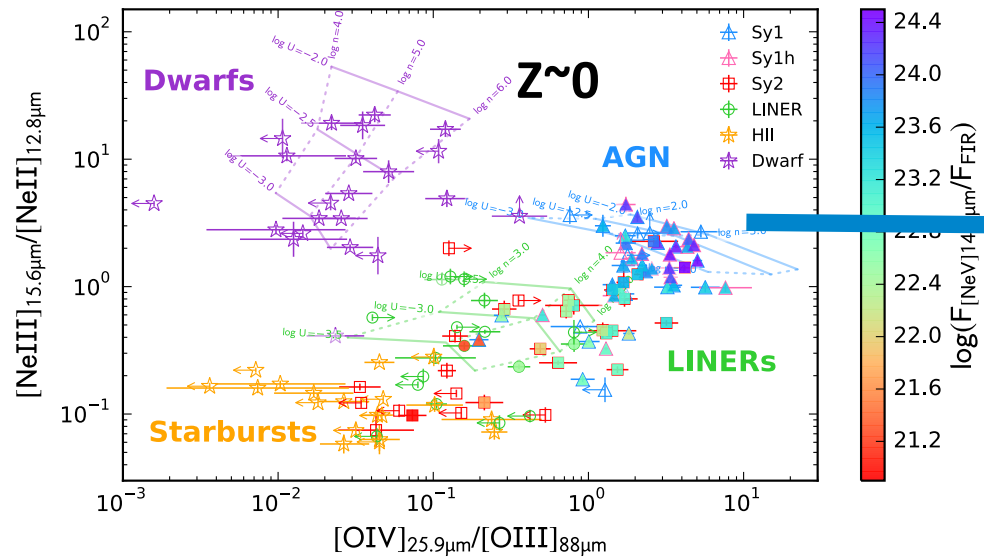


Groves+ **2006** ($>10^5$ galaxies)



Tommasin+ **2010** (~60 galaxies)

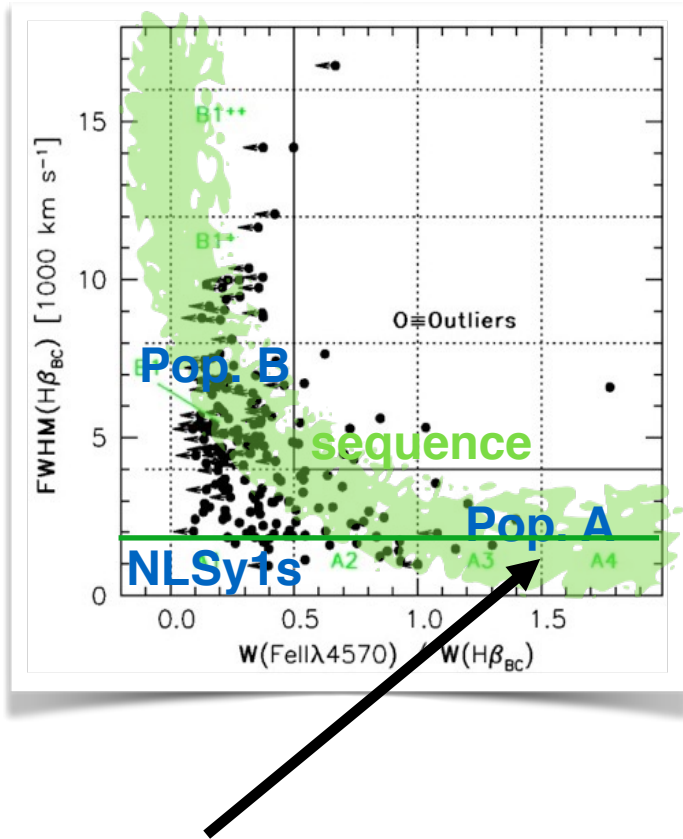
MIR-FIR
SPECTROSCOPY



Z up to 3-4

SPICA ~ 2028

A MAIN SEQUENCE FOR QUASARS



Extreme Pop. A sources are highly accreting sources, of interest for cosmology

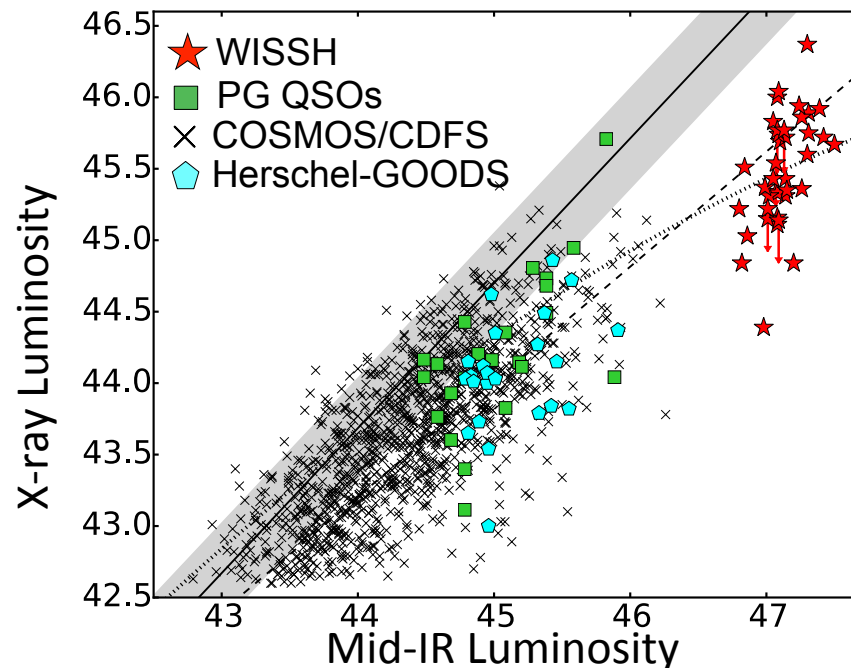
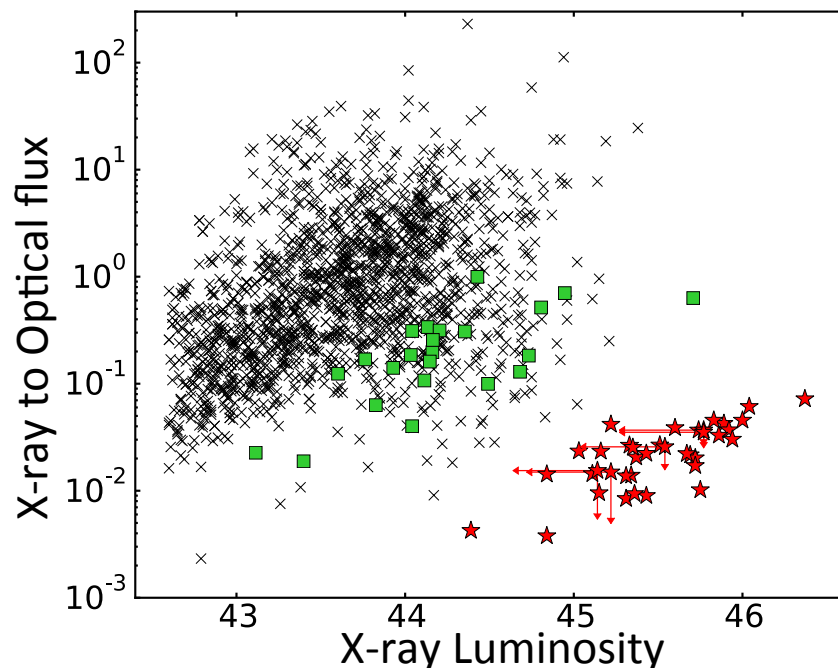
Who: Paola Marziani (PD), Giovanna M. Stirpe (BO), Mauro D'Onofrio (UniPD, INAF ass.), Paola Mazzei (PD)

What: Diagram has revealed a principal sequence of quasars distinguished by Eddington ratio. Thus while stellar differences are primarily driven by the mass of a star, quasar differences are apparently driven by the ratio of luminosity-to-mass.

The main sequence at low z allows the definition of spectral types.

- Two populations, A (wind dominated) and B (disk dominated, large fraction radio-loud) associated with a critical Eddington ratio and probably to different accretion modes.
- The sequence is a starting point to connect observational parameter spaces to theoretical parameter spaces of quasars seen as accreting systems

The WISE/SDSS selected hyper-luminous (WISSH) quasars project



What: Studying extreme & unexplored regions of parameter space involving X-ray vs. multi-band properties
 “X-ray weak” wrt to “standard” AGN typically sampled so far

How: The WISE/SDSS selected hyper-luminous (WISSH) quasars project:

- Extensive multi-band (from mm to X-rays) observing program to investigate the role of AGN power and outflows in regulating the evolution of massive galaxies.
- Unique sample of 86 quasars at the brightest end of the AGN LF ($L_{\text{Bol}} > 10^{47}$ erg/s) @ $z \approx 2.5-4.5$ (analogs of $z \approx 6-7$ quasars currently observed)

Who: Piconcelli, Fiore, Martocchia, Zappacosta, Brusa, Bongiorno, Vignali et al.