X-RAY SELECTED AGN: SELECTION AND CLASSIFICATION IN THE DARK ENERGY SURVEY

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Treasures Hidden in High Energy Catalogue – IRAP, May 2018
4MOST & DES: Overview

- **DES (Dark Energy Survey)**
  - 5 years observations (start Aug 2013)
  - Wide area survey (5000\,deg$^2$) in the southern sky
  - Five optical filters, final depth in grizY[AB]: 25.5; 25.0; 24.5; 23.5; 22.5 (no u-band)
  - DR1 (Abbott+2018): 3-years of data

- **4MOST (4m Multi-Object Spectroscopic Telescope)**
  - Initial 5 years survey in the southern sky
  - Galactic & Extragalactic wide-field surveys (> 15,000 \,deg$^2$)
    - **AGN Survey**: e-ROSITA X-ray selected AGN (z < 6) + optical and IR AGN selection criteria
  - Spectrograph: simultaneously spectra of ~2400 objects over 4 \,deg$^2$
  - Start of operation: 2021
The XMM-XXL Catalogue

- XMM-XXL north field (XXL)
- X-ray point-sources catalogue (8445 sources; Liu+ 2016) with cross-matched counterparts in SDSS and WISE (Menzel+ 2016)
  - 4075 (48%) X-ray sources with a SDSS counterparts
  - 2570 (63%) have a reliable SDSS BOSS redshift
  - 4844 (57%) X-ray sources with a WISE counterparts
XXL-SDSS sources in DES

- XXL-SDSS $\otimes$ DES ($r_{SDSS,DES} = 1''$) → 1497 sources
  - 1072 sources (~70%) have a SDSS spectroscopic redshift

- Spectroscopic classification (Menzel+ 2016):
  - 723 BL AGN
  - 244 NL AGN
  - 77 Galaxies
  - 28 'not classifiable'
  - 32 stars
Colour Selection of QSO

- Different optical-IR SED between quasars and stars → different regions of the colour-colour diagram

- \((g - i)\ vs\ (i - W1)\) (Tie+2017): designed to reduce contamination by stars \((z < 4)\)
  - Quasar region = 501 sources (64%)
    - 467 (93%) are BL AGN (main contaminants are NLAGN)
    - Completeness: 90% of the BLAGN

Tot: 782 sources (522 BL AGN)
The star-galaxy separation in DES

1. CLASS_STAR

- standard SExtractor star-galaxy classifier
- works for intermediate magnitude
- point-source $\rightarrow$ CLASS_STAR > 0.8
  - Low completeness (60% of the BL AGN are classified as point-source)
  - Purity: 95% of the point-sources objects are BL AGN

661 BL AGN
2. spread_model

- SExtractor parameter: best fit between a local PSF model and an extended exponential disk model (Desai+2012)

- $w_{avg\_spread\_model\_i} - err < 0.003$ (Tie+2016)
  - 538 spectroscopic BL AGN
    - purity: 97\% of the point-source objects are BL AGN
    - completeness: 81\% of the BL AGN are point-sources
3. psf and model magnitudes

- S/G classifier used by SDSS
  - $i_{\text{psf}} - i_{\text{model}} < 0.1$:
    - 535 are spectroscopic BL AGN
      - Purity: 97% of the point-source objects are BL AGN
      - Completeness: 81% of the BL AGN are point-sources
  - Similar to spread_model classification

![Graph showing distribution of PSF and model magnitudes](image)
Treasures Hidden in HE Catalogue - Toulouse 2018

Completeness vs purity

- colour + morphological selection:
  - 76% of the spectroscopic BL AGN are point-source and have QSO colours
  - Very low contamination (1.5%)

- spectroscopic target strategy
  → relax / restrict the point-source selection
Completeness vs purity for $i_{\text{psf}} - i_{\text{model}}$

- Cleaner sample at high completeness (95%) compared to *spread_model*
Quasars colours selection: giW1
• purity = 93%, completeness = 90%

Star vs galaxy morphology:
• CLASS_STAR: purity = 95%, completeness = 60%
• Spread_model / i_{psf} − i_{model}: purity = 97%, completeness = 81%

Morphology and colours selection
• Completeness: reselect 76% of the spectroscopic BL AGN
• Purity: only 1.5% of the point-source objects with quasars colours are not BL AGN

On-going work: Predicted number of DES QSO (z<4). To be compared with XMM/eROSITA observations/predictions