## Luca Ighina

## Title

Impact of the CMB on the evolution of AGNs and their relativisitc jets at the highest redshifts

## Abstract

Radio-Loud (RL/jetted) AGNs are among the brightest sources at all wavelengths and are usually associated with the densest regions of the Universe. Their relativistic jets can affect both the SMBH growth and the surrounding IGM and have been observed extending up to Mega-parsec scale.
After 20 years from the detection of the first extended kilo-parsec extragalactic jet in the X-rays, the mechanism responsible for their high-energy emission at these scales is still under debate.
At the same time, it was recently found that the cosmological evolution of the jetted AGN population significantly differs when observed in the X-ray or the radio band. Their X-ray space density peaks at much earlier times (z~4) when compared to their radio one (z~2), which would imply a different redshift evolution of the typical X-ray luminosities with respect to the radio ones.
In this talk I will show how the Inverse Compton interaction between the CMB photons and the electrons within relativistic jets (IC/CMB) can nicely solve both these problems. Our results are based on statistical studies performed on the largest well-defined samples available to date (up to z~5) and the detailed study of the most distant X-ray jet resolved to date (z=6.1).
Finally, I will also present our efforts to expand current samples at even higher redshift, where the effect of the CMB is stronger. By exploiting the most recent radio surveys, in less than one year we were able to discover three new RL AGNs at z>6, where only four were known before.

# Luca Ighina

*PhD student in Astrophysics*

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## EDUCATION

### PhD in Astrophysics

Università degli Studi dell'Insubria – INAF-Milano-Brera (Italy) 2020 – on

- Subject: Finding and characterising radio-powerful Quasars at high redshift ($z$>6) in order to study the combined evolution of the first and most extreme supermassive black holes together with their relativistic jets in the early Universe.
- Supervisors: A. Caccianiga and A. Moretti, National Institute for Astrophysics (INAF), Milano–Brera

### M.Sc. in Astrophysics and Physics of Space

Università degli Studi di Milano-Bicocca (Italy) 2018 – 2020

- One semester spent at: *Université d'Aix-Marseille* (France, autumn 2019)
- Internship at the National Institute for Astrophysics (INAF), Milano-Brera (12 months)
- Thesis Title: *"The impact of the CMB on the spatial density of high-$z$ blazars"*, Supervisors: A. Caccianiga, M. Dotti. Final grade: 110 *cum laude* / 110

### B.Sc. in Physics

Università degli Studi di Milano-Bicocca (Italy) 2015 – 2018

- One semester spent at: *Université de Bordeaux* (France, spring 2018)
- Internship at the National Institute for Astrophysics (INAF), Milano-Brera (6 months)
- Thesis: *"X-ray analysis of high redshift blazars"*, Supervisors: A. Caccianiga, M. Dotti. Final grade: 104 / 110

## LANGUAGES

***Italian***
Mother tongue

***English***
Fluent (band 8/C1)
IELTS certification

***French***
Fluent (C1) Univ.
Bordeaux/OLS certification

***Spanish***
Intermediate

## COMPUTER SKILLS

***Operating Systems***
Linux, Unix, Windows

***Programming Languages***
Python, C/C++

***Astro. Softwares***
Xspec, CIAO, IRAF/PYRAF, TopCat, SuperMongo

## PUBLICATIONS

**First Author**

*Constraining the Radio Properties of the $z$=6.44 QSO VIK J2318−3113*. **L. Ighina**, J. K. Leung, J. W. Broderick, G. Drouart, N. Seymour, S. Belladitta, A. Caccianiga, E. Lenc, A. Moretti, T. An, T. J. Galvin, et al., 2021, submitted to A&A.

*Direct observation of an extended X-ray jet at $z$=6.1*. **L. Ighina**, A. Moretti, F. Tavecchio, S. Belladitta, A. Caccianiga, D. Dallacasa, R. Della Ceca, T. Sbarrato, C. Spingola, 2021, submitted to A&A.

*The Impact of the CMB on the Evolution of high-$z$ Blazars*. **L. Ighina**, A. Caccianiga, A. Moretti, S. Belladitta, R. Della Ceca, A. Diana, 2021, MNRAS, 505, 4120.

*Radio Detection of VIK J2318−3113, the Most Distant Radio Loud Quasar ($z$=6.44)*. **L. Ighina**, S. Belladitta, A. Caccianiga, J. W. Broderick, G. Drouart, A. Moretti and N. Seymour, 2021, A&A, 647, L11.

*X-ray properties of $z$>4 blazars*. **L. Ighina**, A. Caccianiga, A. Moretti, S. Belladitta, R. Della Ceca, L. Ballo and D. Dallacasa, 2019, MNRAS, 489, 2732.

**Co-Author**

*The central engine of the highest redshift blazar*. S. Belladitta, A. Caccianiga, A. Diana, A. Moretti, P. Severgnini, M. Pedani, L. P. Cassarà, C. Spingola, **L. Ighina**, A. Rossi, and R. Della Ceca, A&A (submitted).

*The evolution of the heaviest super-massive black holes in jetted AGNs*. A. Diana, A. Caccianiga, **L. Ighina**, S. Belladitta, A. Moretti and R. Della Ceca, 2021, (submitted).

*Minute-timescale variability in the X-ray emission of the highest redshift blazar*. A. Moretti, G. Ghisellini, A. Caccianiga, S. Belladitta, R. Della Ceca, **L. Ighina**, T. Sbarrato, P. Severgnini and C. Spingola, 2021, ApJ, 920, 15.

*Quest to find Changing Look Quasars*. T. Pursimo, **L. Ighina**, N. Ihanec, N. Mandarakas, K. Skillen and S.Terefe, 2019, CAOSP, 49, 539 (proceedings).

*An extremely X–ray weak blazar at z=5.0*. S. Belladitta, A. Moretti, A. Caccianiga, G. Ghisellini, C. Cicone, T. Sbarrato, **L. Ighina** and M. Pedani, 2019, A&A., 629, A68.

*The space density of z>4 blazars*. A. Caccianiga, A. Moretti, S. Belladitta, R. Della Ceca, S. Antón, L. Ballo, C. Cicone, D. Dallacasa, A. Gargiulo, **L. Ighina**, M. J. Marchã and P. Severgnini, 2019, MNRAS, 484, 204.

## AWARDED TIME AS PRINCIPAL INVESTIGATOR

- **Chandra telescope**, 23rd Cycle:
  *Uncovering the X-ray Properties of a z∼6.5 Radio-Powerful Quasar*, 70 ksec allocated.
- **Gemini-South telescope**, DDT time:
  *Spectroscopic confirmation of two z>6 Radio-Loud Quasar candidates*, 3.9 hours allocated.

## CONFERENCES AND SUMMER SCHOOLS PARTICIPATION

- 2nd IAA-CSIC Severo Ochoa School on Statistics, Data Mining and Machine Learning (29–3 December 2021), organised by the Instituto de Astrofísica de Andalucía, Granada.
- The Third National Workshop on the SKA Project - The Italian Route to the SKAO Revolution (4–8 October 2021), organised by the Italian National Institute for Astrophysics (INAF). Online event, talk contribution: Exploring the population of Radio-Loud AGNs at high redshift with the RACS survey.
- GROWTH Astronomy School 2020 (17–21 August 2020), online summer school on multi-wavelength observations, organised by Caltech and the GROWTH collaboration.
- X-ray Astronomy 2019: current challenges and new frontiers in the next decade (8–13 September 2019), Bologna, Italy. *Poster contribution*: X-ray properties of z>4 blazars.
- School on High Energy Astrophysics (5–16 August 2019), International Center for Theoretical Astrophysics South American Institute for Fundamental Research (ICTP-SAIFR), São Paulo, Brazil (poster contribution).
- Astrosoma, summer school on modern astrophysics, Cosmology (1–12 July 2019), Moscow Institute of Physics and Technology and P. N. Lebedev Physical Institute, Moscow, Russia (with talk contribution).
- Observational Astrophysics: from proposals to publication (17–27 June 2019), Astronomical Institute of Slovak Academy of Sciences (SAS), Tatranská Lomnica, Slovak Republic. Organised by Opticon and Erasmus+.
- AGN13: Beauty and the Beast: The 13th Italian meeting on Active Galactic Nuclei (9–12 October 2018), Milano, Italy. *Poster contribution*: An X-ray analysis of high-z blazar candidates.

## TEACHING EXPERIENCE

- **Introduction to Statistics and Informatics** at the Università degli Studi di Milano Statale (2021–2022): 28 hours of practical exercises dedicated to second year bachelor students in Earth Science. Head professor: V. Cotroneo.

## AWARDS AND RECOGNITION

- Honorable mention in the first edition of the *Geppina Coppola* prize (2021) for the best master thesis in physics and astrophysics. Organised by the Capodimonte Observatory and the Geppina Coppola Association (Naples, Italy). Invited for a talk. Newspaper article (in Italian) *here*.