Nicola Borghi

Curriculum Vitae

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From Renazzo (Ferrara), Italy, 22 May 1996
Dipartimento di Fisica e Astronomia "Augusto Righi"
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Summary: Post-doc in observational cosmology with expertise in gravitational waves and galaxy evolution. Research experience in data analysis and inference for gravitational wave astrophysics and cosmology and for stellar populations in galaxies to study of the expansion history of the Universe. Developer of two public available codes: `PyLick` to measure spectral features in galaxy spectra; `CHIMERA` to perform joint astrophysical and cosmological parameter inference with gravitational waves and galaxy catalogs. Member of the Einstein Telescope Collaboration and Euclid Consortium. Co-lead of the work package Cosmology - Additional probes for the Wide-field Spectroscopic Telescope. Passionate about science communication and coordinator of various outreach activities.

Current position

2023–*present* ***Post-doc* in Gravitational-wave Cosmology & Galaxy Evolution**.
Department of Physics and Astronomy "Augusto Righi", University of Bologna, Italy
Project: *Gravitational-wave cosmology with future detectors and galaxy surveys*

Education

2020–2023 **PhD, Astrophysics**, *University of Bologna*, Italy.
Thesis: *Unveiling the Expansion History of the Universe with Cosmic Chronometers and Gravitational Waves*. *Link*.
Supervisors: Michele Moresco & (co-) Andrea Cimatti

2018–2020 **Master of Science, Astrophysics and Cosmology (cum laude)**, *University of Bologna*, Italy.
Supervisors: Andrea Cimatti & (co-) Michele Moresco

2015–2018 **Bachelor of Science, Astronomy (cum laude)**, *University of Bologna*, Italy.

2010–2015 **Scientific High School Diploma**, *ISIT Bassi Burgatti, Cento (FE)*, Italy.

Research

Experiences abroad

4–6/2022 ***Statistical methods for cosmology with gravitational waves and galaxy catalogs***, *Département de Physique Théorique*, Univesité de Genève, Genève (CH), with Michele Maggiore & Michele Mancarella.

Computational time grants

2024 PI of **LIGEA**, ISCRA Class-C project: 100.000 core hours on CINECA Leonardo

2025 PI of **LIGEA2**, ISCRA Class-C project: 100.000 core hours on CINECA Leonardo

International Collaborations

2025–*present* Wide-field Spectroscopic Telescope, **co-lead of WP2.2.6**, Cosmology-Additional probes

2025–*present* LIGO-Virgo-KAGRA Collaboration, Standard siren cosmology

2022–*present* Einstein Telescope Collaboration, OSB Div. 2 Cosmology

2022–*present* Euclid Consortium, SWG Gravitational Waves

Scientific service

2023-*present* Referee for the Astrophysical Journal (ApJ), Astronomy & Astrophysics (A&A), and Journal of Cosmology and Astroparticle Physics (JCAP).

2024-*present* Organizer of the GW-BO Meetings. *Website*.

2025 Local Organization Committee Member of the XV Einstein Telescope Symposium Bologna

Publications ORCID ADS

Journal Articles

2025 **Nicola Borghi**, Michele Moresco, Matteo Tagliazucchi, and Giulia Cuomo. Echoes from the Dark: Galaxy Catalog Incompleteness in Standard Siren Cosmology. *arXiv e-prints*, page arXiv:2509.18243, September 2025. DOI: 10.48550/arXiv.2509.18243.

2025 Matteo Tagliazucchi, Michele Moresco, **Nicola Borghi**, and Manfred Fiebig. Accelerating the Standard Siren Method: Improved Constraints on Modified Gravitational Wave Propagation with Future Data. *arXiv e-prints*, page arXiv:2504.02034, April 2025. DOI: 10.48550/arXiv.2504.02034.

2025 Eleonora Di Valentino et al. (incl. **Nicola Borghi**). The CosmoVerse White Paper: Addressing observational tensions in cosmology with systematics and fundamental physics. *Physics of the Dark Universe*, volume 49, page 101965, September 2025. DOI: 10.1016/j.dark.2025.101965.

2025 Adrian Abac et al. (incl. **Nicola Borghi**). The Science of the Einstein Telescope. *arXiv e-prints*, page arXiv:2503.12263, March 2025. DOI: 10.48550/arXiv.2503.12263.

2024 **Nicola Borghi**, Michele Mancarella, Michele Moresco, Matteo Tagliazucchi, Francesco Iacovelli, Andrea Cimatti, and Michele Maggiore. Cosmology and astrophysics with standard sirens and galaxy catalogs in view of future gravitational wave observations. *ApJ*, volume 964, page 191, 2024. DOI: 10.3847/1538-4357/ad20eb.

2023 Elena Tomasetti, Michele Moresco, **Nicola Borghi**, Kang Jiao, Andrea Cimatti, Lucia Pozzetti, Adam C. Carnall, Ross J. McLure, and L. Pentericci. A new measurement of the expansion history of the Universe at $z = 1.26$ with cosmic chronometers in VANDELS. *A&A*. EDP Sciences, 2023. DOI: 10.1051/0004-6361/202346992.

2023 Kang Jiao, **Nicola Borghi**, Michele Moresco, and Tong-Jie Zhang. New Observational $H(z)$ Data from Full-spectrum Fitting of Cosmic Chronometers in the LEGA-C Survey. *ApJS*, volume 265, page 48, 2023. DOI: 10.3847/1538-4365/acbc77.

2022 **Nicola Borghi**, Michele Moresco, Andrea Cimatti, Alexandre Huchet, Salvatore Quai, and Lucia Pozzetti. Toward a better understanding of cosmic chronometers: Stellar population properties of passive galaxies at intermediate redshift. *ApJ*, volume 927, page 164, 2022. DOI: 10.3847/1538-4357/ac3240.

2022 **Nicola Borghi**, Michele Moresco, and Andrea Cimatti. Toward a Better Understanding of Cosmic Chronometers: A New Measurement of $H(z)$ at $z \sim 0.7$. *ApJ Letters*, volume 928, page L4, 2022. DOI: 10.3847/2041-8213/ac3fb2.

2022 Elcio Abdalla et al. (incl. **Nicola Borghi**). Cosmology intertwined: A review of the particle physics, astrophysics, and cosmology associated with the cosmological tensions and anomalies. *Journal of High Energy Astrophysics*, volume 34, pages 49–211, 2022. DOI: 10.1016/j.jheap.2022.04.002.

In preparation

2026 **Nicola Borghi**, *et al.*, Dark siren cosmology with Euclid and future LVK data.

Other

2024 **Nicola Borghi**. Onde gravitazionali e cronometri cosmici per ricostruire la storia di espansione dell'universo. In *Giornale di Astronomia*. vol. 50, n. 4, p. 9, 2024.

2022 **Nicola Borghi**. Toward an independent reconstruction of the expansion history of the universe. In *Hypatia Colloquium 2022*. Zenodo, 2022.

2022 Michele Mancarella, **Nicola Borghi**, Stefano Foffa, Edwin Genoud-Prachex, Francesco Iacovelli, Michele Maggiore, Michele Moresco, and Matteo Schulz. Gravitational-wave cosmology with dark sirens: state of the art and perspectives for 3G detectors. In *Proceedings of 41st International Conference on High Energy physics - PoS(ICHEP2022)*. Sissa Medialab, 2022.

Talks

Invited

3/2024 SISSA Astrophysics Colloquium - Trieste (Italy)
"Unveiling the Expansion History of the Universe with Cosmic Chronometers and Gravitational Waves"

Contributed

9/2025 Shedding light on dark sirens Workshop - Leiden
3/2025 Wide-field Spectroscopic Telescope - Surveying the Universe in the 2040's and beyond - Napoli
9/2024 110º Congresso della Società Italiana di Fisica - Bologna
6/2024 LXV Congresso della Società Astronomica Italiana - Napoli
5/2023 XIII Einstein Telescope Symposium - Cagliari
9/2022 International conference PUMA22 - Sestri Levante
7/2022 EAS2022 - Galaxies as cosmological tracers - Valencia
7/2022 EAS2022 - ESO@60: A stairway to the Universe - Valencia
6/2022 Université de Genève - Cosmology group meetings
4/2022 Hypatia Colloquium 2022: Early Career Astronomer series at ESO
7/2021 Sixteenth Marcel Grossmann Meeting
6/2021 Massively Parallel Large Area Spectroscopy from Space

Supervision and Teaching

Co-supervision of Master's Theses, *University of Bologna.*

2025 C. Ciapetti, *Standard siren cosmology with weakly parametric BBH mass functions*
2025 M. Mori, *Trade-off analysis for future LVK dark sirens*
2025 G. Cuomo, *Astrophysical and cosmological contraints with LVK/GWTC-3 data*
2025 M. Friebig, *Forecasting contraints on modified gravity with upcoming LVK observing runs*
2024 N. Passaleva, *Enhancing the potential of gravitational waves as standard sirens: a statistical analysis*
2022 E. Tomasetti, *Vincoli sulla storia di espansione dell'Universo tramite cronometri cosmici nella survey VANDELS*
2022 M. Schulz, *Gravitational Waves as Dark Sirens: an Astrophysical and Cosmological Analysis*

2025–2026 **Teaching assistant, Elements of Informatics (INF/01)**, *Astronomy*, University of Bologna.
2024–2025 **Teaching assistant, Elements of Informatics (INF/01)**, *Astronomy*, University of Bologna.
2022–2023 **Teaching assistant, Elements of Informatics (INF/01)**, *Astronomy*, University of Bologna.
2020–2021 **Teaching assistant, Astrophysics Laboratory (FIS/05, optical/near-IR module)**, *Astrophysics and Cosmology*, University of Bologna.

Technical skills

Main developer:
- **CHIMERA** (*github.com/CosmoStatGW/CHIMERA/*): Python code to perform gravitational wave cosmology with standard sirens and galaxy catalogs based on the Hierarchical Bayesian formalism.
- **PyLick** (*pylick.readthedocs.io*): Python tool to measure spectral absorption features on galaxy spectra.

Languages: Python (*advanced*), Julia, FORTRAN, C++, RStudio

Other: Experience in high-performance scientific computing, cloud computing, Linux/Unix OS, OpenOffice, MS Office & Visual Studio, HTML5 & CSS, LaTeX, Single-Board Computers & Microcontrollers (Arduino), Adobe Creative Cloud.

Awards

2024 **Tacchini Prize for the best PhD Thesis**, *Società Astronomica Italiana*.

2021 **Best MS Thesis prize**, *Department of Physics and Astronomy "Augusto Righi", University of Bologna*.

2021 **Best poster prize**, *ISAPP Summer School on Gravitational Waves*.

2015 **Riconoscimento "Francesco Viviani"**, *Ferrara, Italy*.

2012 **Italian Astronomy Olympiad**, *(finalist in the national competition)*, Macerata, Italy.

Outreach

Public engagement

2016–present **Public lectures and stargazing nights**, *Gruppo Astrofili Persicetani & Museo del Cielo e della Terra*, San Giovanni in Persiceto (BO) and surrounding areas, (50+ events, topics: *nicoborghi.github.io/#outreach*).

2017–2023 **Laboratory activities for high schools**, *Museo del Cielo e della Terra - FisicLab*, Agen.Ter., San Giovanni in Persiceto (BO).

Press and media

2024 **Giornale di Astronomia**, *Onde gravitazionali e cronometri cosmici per ricostruire la storia di espansione dell'Universo*, Article, 2024, vol. 50, n. 4, p. 9.

2022 **Media INAF**, *Cronometri cosmici per la costante di Hubble*, *Article*, 08/04/2022.

University's "Third-Mission"

Department of Physics and Astronomy "Augusto Righi", University of Bologna

2021–2025 **Fisica Experience museum**, *Scientific advisor for the cosmology section (with N. Semprini)*, *fisicaexperience.it*.

2019–2025 **Notte dei Ricercatori**, *Le Meraviglie del Tempo e dello Spazio (with R. Serra)*.

2021–2025 **Officina Laboratorio**, *Earth's motions and the concept of time (with L. Fabbri)*.

2022 **Piano Lauree Scientifiche**, *Measuring the Universe*.

2021–2022 **Podcast**, *Dottorato et al.*, role: post-production, *listen on Spotify*.

Books

2023 **Nicola Borghi**, Marco Cacciari, Thomas Mazzi, Romano Serra, Sandro Zannarini, *Meteoriti Storiche, un metodo per indagare il passato: Il caso Renazzo*, In riga edizioni, Bologna, ISBN: 8893644398, *link*.

Other Activities

2024–present **Elite National Commissaire**, *Italian Cycling Federation*, (*national* since 2022, *regional* since 2017).

2016–present **Volunteer amateur astronomer**, *Gruppo Astrofili Persicetani*, www.gapers.it.

Languages

- English: Fluent (C1)
- French: Basic user
- Emiliano (ISO 639-3: egl): Native speaker
- Italiano: Native speaker