Nicola Borghi

Title

Toward an independent reconstruction of the expansion history of the Universe

Abstract

A cosmological-model independent reconstruction of the expansion history of the Universe can help to shed light on the dark sector and the current cosmological tensions. I will discuss past, present, and future efforts to constrain the Hubble parameter H(z) using two optimal astrophysical probes: cosmic chronometers and gravitational waves. The differential aging of massive and passive galaxies can be used to obtain direct measurements of the Hubble parameter without any cosmological assumptions. However, robust dt estimates require deep spectroscopy to break internal degeneracies between stellar population parameters (e.g., age and chemical content). I present a recent analysis of the stellar ages, [Z/H], and [α/Fe] of 140 cosmic chronometers at z∼0.7 from the LEGA-C survey using an optimized set of Lick indices (arXiv:2106.14894). From the age-z relation of this population, a new measurement of H(z) is derived, assessing in detail its robustness and dependence on systematic effects (arXiv:2110.04304). Finally, I will discuss the prospects for gravitational wave cosmology in the context of future surveys and third-generation detectors.

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NICOLA BORGHI

Contact Information

From Renazzo (Ferrara), Italy, 22 May 1996
Dipartimento di Fisica e Astronomia "Augusto Righi"
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EDUCATION

University degrees

***Ph.D.* in Astrophysics** *11/2020 – Present*
Department of Physics and Astronomy "Augusto Righi", University of Bologna, Italy
Project: "Cosmology with gravitational waves and combination with other probes"
Advisors: Dr. Michele Moresco & Prof. Andrea Cimatti

***Laurea magistrale* in Astrophysics and Cosmology (cum laude)** *9/2018 – 10/2020*
University of Bologna, Italy
Advisors: Prof. Andrea Cimatti & Dr. Michele Moresco

***Laurea triennale* in Astronomy (cum laude)** *9/2015 – 7/2018*
University of Bologna, Italy

Scientific High School Diploma *9/2010 – 7/2015*
ISIT Bassi Burgatti, Cento (FE), Italy

Other courses

ISAPP Summer School on Gravitational Waves *6/2021*
Topics: gravitational wave theory, sources and detectors (current and upcoming)
Project: gravitational wave data analysis

Asiago Multi-Messenger Astrophysics School *1/2020*
Department of Physics and Astronomy (DFA) of the University of Padova, Italy
Topics: astrophysical neutrinos, GWs, cosmic rays and detectors
Project: broadband spectral fitting of blazars

SperimEstate - Summer Internship *6/2014*
INAF OAS - National Institute for Astrophysics, Bologna, Italy
Topic: study of soft γ-ray selected giant radio galaxies (see Bassani et al. 2016)

RESEARCH ORCID ADS

First-author publications

1. 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 (accepted)*, October 2021a. URL https://ui.adsabs.harvard.edu/abs/2021arXiv210614894B

2. 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 (accepted)*, December 2021b. URL https://ui.adsabs.harvard.edu/abs/2021arXiv211004304B

Contributed talks

Sixteenth Marcel Grossmann Meeting 7/2021
A new measurement of the expansion history of the Universe from cosmic chronometers in the LEGA-C survey

Massively Parallel Large Area Spectroscopy from Space 6/2021
Robust constraints on the physical properties of individual passive galaxies from Lick indices in the LEGA-C survey

TEACHING ACTIVITY

Teaching assistant

Astrophysics Laboratory (optical/near-IR module) *A.Y. 2021–2022*
Master Degree Course, Astrophysics and Cosmology, DIFA, University of Bologna

OUTREACH ACTIVITY

Public engagement

"Astroversi" - university podcast *since 2021*
Department of Physics and Astronomy "Augusto Righi", University of Bologna

- Science outreach podcast structured in four different programs covering general and more advanced astrophysical topics, with a focus on the Ph.D. life, state-of-the-art research, and spin-offs. Role: pre & post-production. Listen on Spotify.

Public lectures and stargazing events *since 2016*
Gruppo Astrofili Persicetani, San Giovanni in Persiceto and surrounding areas

- Lecturer at the Planetarium (20+ talks, see the topics)
- Stargazing nights (20+)

Schools

Museo del Cielo e della Terra - FisicLab *since 2017*
Agen.Ter., San Giovanni in Persiceto (BO), Italy

- Laboratory activities for high school students

University's "Third-Mission"
Department of Physics and Astronomy "Augusto Righi", University of Bologna

- Officina Laboratorio 2021 - *Earth's motions and the concept of time*
- Piano Lauree Scientifiche 2022 - *Measuring the Universe*
- Officina Laboratorio 2022 - TBD

OTHER INFORMATION

Extra-curricular activities

Regional Commissaire, Italian Cycling Federation since 2017

Volunteer amateur astronomer, Gruppo Astrofili Persicetani (www.gapers.it) since 2016

Awards

Best MS Thesis prize, DIFA, University of Bologna 2021

Best poster prize at the ISAPP Summer School on Gravitational Waves 2021

Riconoscimento "Francesco Viviani", Ferrara, Italy 2015

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

Languages

English · Fluent (C1)
IELTS Academic 8 (listening 8.5, reading 9, writing 6.5, speaking 7)

Italian · Native speaker

French · Basic user

IT Skills

Python (advanced) · **C++** · **Julia** · **FORTRAN** · **RStudio** · **Linux/Unix OS** **HTML5 & CSS** · **LaTeX** · **OpenOffice** · **MS Office & Visual Studio** · **Mathematica** **Single-Board Computers & Microcontrollers** (Arduino) **Adobe Creative Cloud**

Interests

Observational Cosmology · **Gravitational Waves** · **Cosmic Chronometers** · **Galaxy Evolution** · Theoretical Cosmology · Multi-messenger Astronomy · Computer Science & Electronics · Stargazing · Photography · Science Outreach · Travelling · Cooking