Nikki Arendse

Title

Cosmic Dissonance: new physics or systematics behind a short sound horizon?

Abstract

Persistent tension between low-redshift observations and the Cosmic Microwave Background radiation (CMB) suggests residual systematics or new physics beyond the standard LCDM model. In this talk, I will show results obtained from local observations of supernovae and baryon acoustic oscillations combined with low-redshift distance calibrators, that provide constraints on the Hubble constant and the sound horizon in a cosmologically independent way. When these values are compared to constraints from the CMB, a tension up to 5 sigma arises. Several modifications of LCDM have been put forward to reconcile the tension, but how well do these models actually perform? I will talk about the current status of tensions between the CMB-based and local (based on gravitational time delays and classical distance ladder) distance calibrations. I will also critically review most popular extensions of LCDM proposed to reconcile these measurements.

For more details about this work: https://arxiv.org/abs/1909.07986

Nikki Arendse

Curriculum Vitae

Contact information

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Education

2018-present **PhD in Astronomy**
DARK, Niels Bohr Institute, University of Copenhagen
Advisors: Radek Wojtak & Jens Hjorth

2016–2018 **MSc Astronomy/Data Science**
Kapteyn Institute, University of Groningen

2015 **Erasmus Exchange Program: Physics**
Universitat de València

2012–2015 **BSc Astronomy**
Kapteyn Institute, University of Groningen

Research Work

2020–present **Constraining cosmology with gravitationally lensed supernovae**
DARK, collaborators: Radek Wojtak & Doogesh Kodi Ramanah.
We will simulate a set of gravitationally lensed supernova images to train a deep convolutional neural network and constrain cosmological parameters, such as the Hubble constant, using a simulation-based inference framework to infer the corresponding uncertainties.

2019–2020 **Cosmic Dissonance: new physics or systematics behind a short sound horizon?**
DARK, collaborators: Radek Wojtak & Adriano Agnello.
We used a cosmology-independent method to measure two fundamental cosmological parameters, the Hubble constant H_0 and the sound horizon r_s, from local data. Comparing our results with measurements obtained from the Cosmic Microwave Background radiation, a 5σ tension arises. We investigated if modifications to the standard cosmological model could reconcile the tension.

2020 **Simulation-based inference of dynamical galaxy cluster masses with neural networks**
DARK, collaborators: Doogesh Kodi Ramanah & Radek Wojtak.
We used a deep convolutional neural network in combination with a simulation-based inference technique to infer accurate mass estimates of galaxy clusters with robust uncertainties, fully exploiting information about their observed line-of-sight velocities and positions in the sky.

2017-2018 **Mass contribution of progenitors to the build-up of the Milky Way (master's thesis)**
Kapteyn Institute, advisor: Pratika Dayal.
I used data from the CLUES simulation, a constrained hydrodynamic simulation of our local environment, to infer properties of progenitor galaxies of the Milky Way.

2016–2017 **Noise characterization in a Fourier Transform Spectrometer**
Netherlands Institute for Space Research (SRON), advisor: Gert de Lange.
I carried out a project for the Netherlands Institute for Space Research (SRON) in which I investigated the behaviour of simulated and real interferogram data under Fourier Transforms.

2015 **Calibration of LOFAR data (bachelor's thesis)**

Netherlands Institute for Radio Astronomy (ASTRON), advisor: John McKean.
I extended an existing calibration method for data from LOFAR (The Low-Frequency Array) into multiple directions, taking into account the effects of the ionosphere.

Awards and Scholarships

- Poster prize, Annual Danish Astronomy Meeting 2019.
- DARK PhD Fellowship 2018 at the University of Copenhagen.

Publications

- *'Cosmic dissonance: new physics or systematics behind a short sound horizon?'*
  N. Arendse, R. Wojtak, A. Agnello, G. Chen, C. Fassnacht, D. Sluse, S. Hilbert, M. Millon, V. Bonvin, K. Wong, F. Courbin, S. Suyu, S. Birrer, T. Treu, L. Koopmans.
  (*Astronomy & Astrophysics*, 2020) [publisher][arXiv:1909.07986]
- *'Low-redshift measurement of the sound horizon through gravitational time-delays'*
  N. Arendse, A. Agnello, R. Wojtak.
  (*Astronomy & Astrophysics*, 2019) [publisher][arXiv:1905.12000]
- *'Simulation-based inference of dynamical galaxy cluster masses with 3D convolutional neural networks'*
  D. K. Ramanah, R. Wojtak, **N. Arendse**.
  (*Monthly Notices of the Royal Astronomical Society*, 2020) [publisher][arXiv:2009.03340]
- *'The Young Supernova Experiment: Survey Goals, Overview, and Operations'*
  D. O. Jones, ..., **N. Arendse** et al.
  (*The Astrophysical Journal*, submitted) [arXiv:2010.09724]
- *'Cosmology Intertwined I: Perspectives for the Next Decade'*
  E. Di Valentino, ..., **N. Arendse** et al. [arXiv:2008.11283]
- *'Cosmology Intertwined II: The Hubble Constant Tension'*
  E. Di Valentino, ..., **N. Arendse** et al. [arXiv:2008.11284]
- *'Cosmology Intertwined III: $f\sigma_8$ and S_8'*
  E. Di Valentino, ..., **N. Arendse** et al. [arXiv:2008.11285]
- *'Cosmology Intertwined IV: The Age of the Universe and its Curvature'*
  E. Di Valentino, ..., **N. Arendse** et al. [arXiv:2008.11286]

Scientific presentations [* indicates invited]

- *** Talk** – *Perspectives of gravitationally lensed supernovae*
  Snowmass telecon, December 2020.
- *** Talk** – *Cosmic Dissonance*
  Online Summit on Astrophysics and Space Research (CASR), November 2020.
- **Talk** – *Cosmic Dissonance: new physics or systematics behind a short sound horizon?*
  Cosmology from Home (online conference), August 2020. [video]
- *** Talk** – *The Hubble tension: new physics or systematics?*
  Cosmology & Gravity group meeting, Oskar Klein Centre, Stockholm University, February 2020.
- *** Talk** – *Cosmic Dissonance: new physics or systematics behind a short sound horizon?*
  Kapteyn lunch talk, University of Groningen, October 2019.
- **Talk** – *Cosmic Dissonance: new physics or systematics behind a short sound horizon?*
  DARK cake talk, University of Copenhagen, September 2019.
- **Poster** – *Cosmic Dissonance: new physics or systematics behind a short sound horizon?*
  Matera Oscura, Italy, September 2019.
- **Talk** – *Cosmographic tests of the Standard Cosmological Model*
  Alpine Cosmology Workshop, La Berarde, France, July 2019.
- **Poster** – *Cosmographic tests of the Standard Cosmological Model*
  Annual Danish Astronomy Meeting, May 2019 [won the poster prize].

Outreach presentations

- **Talk** – *Our Dark Universe*
  Astronomy on tap Copenhagen, Halloween edition, October 2020. [video]
- **Talk** – *Hubble Trouble: a crisis in cosmology?*
  Astronomy on tap Groningen, online edition, September 2020. [video]

Conferences/workshops/courses attended

- Cosmology from Home, August 2020.
- ESO H_0 2020 e-Conference, June 2020.
- Matera Oscura, Matera, Italy, September 2019.
- Alpine Cosmology Workshop, La Berarde, France, July 2019.
- European Week of Astronomy and Space Science (EWASS), Lyon, France, June 2019.
- Course at University of Copenhagen: *Applied Machine Learning & Big Data Analysis* (7.5 ECTS).
- Annual Danish Astronomy Meeting, Nyborg, May 2019.
- Course at University of Copenhagen: *Advanced methods in Applied Statistics* (7.5 ECTS).

Teaching

2019-present **Teaching Assistant** – *Niels Bohr Institute, University of Copenhagen*
I have taught exercise sessions and helped with grading for the masters courses Applied Statistics & General Relativity.

2018 **Mathematics teacher** – *StudyGroup*
I have taught international pre-Bachelor students higher level mathematics, where I was responsible for lecturing a class and giving the students individual explanation.

2014–2018 **Teaching Assistant** – *University of Groningen*
I have taught exercise sessions to first year undergraduate students and corrected their homework and exams, for the following courses: Calculus 1, Calculus 2, Mechanics & Relativity 1, Mathematics & Statistics for Pharmacy, Calculus for Chemistry.

2012–2016 **Assistant teacher Physics and Mathematics** – *Stichting Studiebegeleiding Leiden (SSL)*
At SSL, I taught secondary school students the basics of physics and mathematics and prepared them for their final exams.

2012–2015 **Mathematics, Physics, Chemistry and English tutor** – *Studeer Slim Groningen*

Academic Service & Outreach

- Member of the Particle Physics Community Planning Exercise (Snowmass).
- Member and social media responsible of Astronomy on Tap Copenhagen.
- Member of the Cake Talk Team: organising colloquia at DARK.
  DARK, University of Copenhagen
- Member of the organisation committee for the annual Christmas party (2018 & 2019).
  DARK, University of Copenhagen
- External Relations & Event Planner of the Foreign Excursion to Austria and Slovenia (2017).
  Study association for Applied Physics in Groningen (T.F.V. 'Professor Francken')
- Member of the Kapteyn Food Committee.
  Study association for Astronomy in Groningen (Sirius A)
- Student member of the Program Committee Astronomy (2012 - 2015): evaluating the quality of courses and the curriculum in the study Astronomy.
  Kapteyn Institute, University of Groningen
- Secretary of the Symposium Committee (2015). Symposium theme: "Light Matters": about topics in Applied Physics related to photonics.
  Study association for Applied Physics in Groningen (T.F.V. 'Professor Francken')
- Organization Committee of the introduction week (2013).
  Student travel association in Groningen (AEGEE)

Technical skills

- **Programming language:** Python 3.
- **Operating Systems:** Mac OS, Windows, Linux.
- **Tools:** LaTeX, Matplotlib, Photoshop, Illustrator, Inkscape.
- **Data analysis skills:** Bayesian inference methods, Markov Chain Monte Carlo techniques, hypothesis testing, likelihood-free inference/simulation-based inference, nested sampling techniques, autocorrelation functions, kernel density estimation and several supervised and unsupervised machine learning techniques (such as convolutional neural networks, Gaussian Processes, XGBoost and t-SNE).

Languages

Dutch	Native
English	Fluent
Danish	B2 (followed evening education at Studieskolen, Copenhagen)
Spanish	B1 (followed a minor program at the University of Groningen)
French	Intermediate