

Prof. dr. Hedim Osmanović  
Doc. dr. Rifat Omerović  
Prof. dr. Azra Gazibegović-Busuladžić

## VIJEĆU UNIVERZITETA U SARAJEVU - PRIRODNO-MATEMATIČKI FAKULTET

**Predmet:** Izvještaj Komisije za pripremanje prijedloga za izbor nastavnika u zvanje docenta za oblast „Teorijska fizika – fizika visokih energija“ na Univerzitetu u Sarajevu – Prirodno-matematički fakultet, Odsjek za fiziku – 1 (jedan) izvršilac sa punim radnim vremenom

Odlukom Vijeća Univerziteta u Sarajevu – Prirodno-matematičkog fakulteta (br. 01/06-2211/4-2024), donešenoj na elektronskoj 2. sjednici koja je održana 10.10.2024. godine, imenovana je Komisija za pripremanje prijedloga za izbor nastavnika u zvanje docenta za oblast: „Teorijska fizika - fizika visokih energija“, jedan izvršilac sa punim radnim vremenom, u sastavu:

Dr. Hedim Osmanović, redovni profesor Prirodno-matematičkog fakulteta Univerziteta u Tuzli, uža naučna oblast: „Opća i teorijska fizika“, predsjednik;

Dr. Rifat Omerović, docent Prirodno-matematičkog fakulteta Univerziteta u Tuzli, uža naučna oblast: „Opća i teorijska fizika“, član;

Dr. Azra Gazibegović-Busuladžić, redovna profesorica Univerziteta u Sarajevu – Prirodno-matematičkog fakulteta, uža naučna oblast: „Teorijska fizika“, član.

Na konkurs, objavljen 13.09. 2024. godine u dnevnom listu „Dnevni avaz“ i na web - stranici Univerziteta u Sarajevu – Prirodno-matematičkog fakulteta, prijavio se dr. Amel Duraković, postdoktorand na Astronomskoj opservatoriji u Strazburu, Francuska. Nakon pregleda dobijene dokumentacije podnosimo sljedeći

## IZVJEŠTAJ

### Biografski podaci i tok obrazovanja

Amel Duraković je rođen 11.03.1990. godine u Trebinju.

Prvi ciklus studija je završio 04.07.2012. godine na Univerzitetu u Kopenhagenu (*Københavns Universitet*). Naslov diplomskog rada je „*Stochastic Quantization and Complex Langevin Dynamics*“, a mentori su bili prof. dr. Poul Henrik Damgaard i prof. dr. Anders Tranberg.

Drugi ciklus (magistarski studij: *MSc in Quantum Fields & Fundamental Forces*) je završio 30.09.2013. godine na *Imperial College* u Londonu. Naslov magistarskog rada je „*Division Algebras, Magic Squares and Supersymmetry*“, a mentor rada je bio prof. dr. Michael Duff.

Doktorski studiji (*PhD in Physics*) upisuje 2014. godine na Nils Bor Institutu (*Niels Bohr Institute*) Univerziteta u Kopenhagenu (*Københavns Universitet*). Doktorirao je 05.09.2018. godine pod mentorstvom prof. dr. Subir Sarkara sa Univerziteta u Oksfordu, a naslov doktorske disertacije je „*On the Likely Structure and Origin of Primordial Fluctuations*“.

Amel Duraković aktivno koristi engleski i danski jezik, a poznaje njemački, češki i francuski na osnovnom nivou. Posjeduje aktivno i napredno znanje programiranja u programskim jezicima Python, Mathematica i MATLAB, osnovno znanje programiranja u programskim jezicima Fortran, Java i C, te iskustvo korištenja softvera za obradu astronomskih podataka: HEALPix, CAMB, CosmoMC.

## Profesionalno iskustvo

- 01/11/2018 – 01/10/2019. Postdoktorand na Tehničkom Univerzitetu Danske (*Danmarks Tekniske Universitet*), Sekcija za fiziku plazme i energiju fuzije.

- 27/01/2020 – 22/04/2020. Akademska posjeta Kavli Institutu za kosmologiju i Institutu za astronomiju na Kembridž Univerzitetu (*Kavli Institute for Cosmology and Institute of Astronomy, University of Cambridge*). Sponzor: Prof. Anthony Challinor.

- 01/05/2020 – 31/01/2023. Postdoktorand na Centralnoevropskom Institutu za kosmologiju i fundamentalnu fiziku (*Central European Institute for Cosmology and Fundamental Physics*) i Institutu za fiziku Akademije nauka Češke Republike (Fyzikální ústav Akademie věd České Republiky).

- 01/02/2023 – trenutno, Postdoktorand na Astronomskoj opservatoriji u Strazburu (Observatoire astronomique de Strasbourg) i Institutu za fiziku Akademije nauka Češke Republike (Fyzikální ústav Akademie věd České Republiky) preko *Johannes Amos Comenius Operational Programme*.

## Učešće na skupovima i konferencijama

- ICHEP 2024, 17.07.2024-24.07.2024.
- CosmoVerse@Kraków, 09.07.2024-11.07.2024.  
<https://indico.oa.uj.edu.pl/event/3/registrations/participants>
- Journées SF2A 2024, 04.06.2024-07.06.2024.
- News from the Dark 8, 11.09.2023-13.09.2024.  
<https://indico.in2p3.fr/event/28968/registrations/participants>
- SubirFest70, 11.09.2023-13.09.2023, <https://subirfest.web.ox.ac.uk/participants>
- 31st Texas Symposium on Relativistic Astrophysics, 12.09.2022-16.09.2022.
- Corfu2022: Workshop on Tensions in Cosmology, 07.09.2022-12.09.2022.
- Simons Program: New Ideas in Cosmology, 17.06.2022-20.05.2022.  
<https://indico.nbi.ku.dk/event/1331/registrations/participants>
- SYNERGIES@PRAGUE: 08.12.2021-11.12.2021, <https://synergies-prague.fzu.cz/>
- The Unbearable Lightness of the Universe, 16.09.2021-18.09.2021, <https://lightness-prague.fzu.cz/>
- 15th Rencontres du Vietnam, 11.08.2019-17.08.2019.  
<http://vietnam.in2p3.fr/2019/Cosmology/participants.php>
- Vacuum 2018, 04.06.2018-06.06.2018.
- Current Themes in High Energy Physics and Cosmology 2017, 21.08.2017-25.08.2017, <https://indico.nbi.ku.dk/event/971/registrations/participants>

- Current Themes in High Energy Physics and Cosmology 2016, 15.08.2016-26.08.2016, <https://indico.nbi.ku.dk/event/851/registrations/participants>
- Current Themes in High Energy Physics and Cosmology 2015, 17.08.2015-21.08.2015, <https://indico.nbi.ku.dk/event/751/registrations/participants>
- NBIA-Oxford Colloquium on Theoretical Physics, 13.04.2015-15.04.2015, <https://indico.nbi.ku.dk/event/781/registrations/participants>
- Measuring B-mode Polarization from Greenland, 02.02.2015-04.02.2015, [https://indico.nbi.ku.dk/event/759/timetable/?view=standard\\_numbered](https://indico.nbi.ku.dk/event/759/timetable/?view=standard_numbered)
- Primordial Universe After Planck, 15.12.2014-19.12.2014.
- 2nd NBIA-APCTP Workshop on Cosmology and Astroparticle Physics, 18.08.2014-22.08.2014, <https://indico.nbi.ku.dk/event/696/registrations/participants>

## LISTA NAUČNOISTRAŽIVAČKIH RADOVA

*Radovi u Web of Science Core Collection*

**1. Reconstruction of a direction-dependent primordial power spectrum from Planck CMB data;** *Amel Durakovic; Paul Hunt; Suvodip Mukherjee; Subir Sarkar; Tarun Souradeep;* JCAP 02 (2018) 012; arXiv:1711.08441; DOI: 10.1088/1475-7516/2018/02/012; <https://iopscience.iop.com/article/10.1088/1475-7516/2018/02/012>

JCR Kvartil: Q1 (4/30, Physics, Particles & Fields; 12/84, Astronomy & Astrophysics)

*Abstract*

*We consider the possibility that the primordial curvature perturbation is direction-dependent. To first order this is parameterised by a quadrupolar modulation of the power spectrum and results in statistical anisotropy of the CMB, which can be quantified using 'bipolar spherical harmonics'. We compute these for the Planck DR2-2015 SMICA map and estimate the noise covariance from Planck Full Focal Plane 9 simulations. A constant quadrupolar modulation is detected with  $2.2\sigma$  significance, dropping to  $2\sigma$  when the primordial power is assumed to scale with wave number  $k$  as a power law. Going beyond previous work we now allow the spectrum to have arbitrary scale-dependence. Our non-parametric reconstruction then suggests several spectral features, the most prominent at  $k \sim 0.006 \text{ Mpc}^{-1}$ . When a constant quadrupolar modulation is fitted to data in the range  $0.005 \leq k/\text{Mpc}^{-1} \leq 0.008$ , its preferred directions are found to be related to the cosmic hemispherical asymmetry and the CMB dipole. To determine the significance we apply two test statistics to our reconstructions of the quadrupolar modulation from data, against reconstructions of realisations of noise only. With a test statistic sensitive only to the amplitude of the modulation, the reconstructions from the multipole range  $30 \leq \ell \leq 1200$  are unusual with  $2.1\sigma$  significance. With the second test statistic, sensitive also to the direction, the significance rises to  $6.9\sigma$ . Our approach is easily generalised to include other data sets such as polarisation, large-scale structure and forthcoming 21-cm line observations which will enable these anomalies to be investigated further.*

**2. Reconstructing the EFT of Inflation from Cosmological Data;** *Amel Durakovic, Paul Hunt, Subodh Patil, Subir Sarkar*; SciPost Phys. vol. 7 no. 4, 2019; arXiv:2312.00889; DOI: 10.21468/SciPostPhys.7.4.049; <https://scipost.org/SciPostPhys.7.4.049>

JCR Kvartil: Q1 (20/110, Physics, Multidisciplinary)

*Abstract*

*Reconstructions of the primordial power spectrum (PPS) of curvature perturbations from cosmic microwave background anisotropies and large-scale structure data suggest that the usually assumed power-law PPS has localised features (up to  $\sim 10\%$  in amplitude), although of only marginal significance in the framework of  $\Lambda$ CDM cosmology. On the other hand if the underlying cosmology is assumed to be Einstein-de Sitter, larger features in the PPS (up to  $\sim 20\%$ ) are required to accurately fit the observed acoustic peaks. Within the context of single clock inflation, we show that any given reconstruction of the PPS can be mapped on to functional parameters of the underlying effective theory of the adiabatic mode within a 2nd-order formalism, provided the best fit fractional change of the PPS,  $\Delta PR/PR$  is such that  $(\Delta PR/PR)^3$  falls within the  $1\sigma$  confidence interval of the reconstruction for features induced by variations of either the sound speed  $c_s$  or the slow-roll parameter  $\epsilon$ . Although there is a degeneracy amongst these functional parameters (and the models that project onto them), we can identify simple representative inflationary models that yield such features in the PPS. Thus we provide a dictionary (more accurately, a thesaurus) to go from observational data, via the reconstructed PPS, to models that reproduce them to per cent level precision.*

**3. Towards galaxy cluster models in Aether-Scalar-Tensor theory: isothermal spheres and curiosities;** *Amel Durakovic, Constantinos Skordis*; JCAP 04 (2024) 040; arXiv:1911.05838; DOI: 10.21468/SciPostPhys.7.4.049; <https://iopscience.iop.org/article/10.1088/1475-7516/2024/04/040>

JCR Kvartil: Q1 (20/110, Physics, Multidisciplinary)

*Abstract*

*The Aether-Scalar-Tensor (AeST) theory is an extension of General Relativity (GR) which can support Modified Newtonian Dynamics (MOND) behaviour in its static weak-field limit, and cosmological evolution resembling  $\Lambda$ CDM. We consider static spherically symmetric weak-field solutions in this theory and show that the resulting equations can be reduced to a single equation for the gravitational potential. The reduced equation has apparent isolated singularities at the zeros of the derivative of the potential and we show how these are removed by evolving, instead, the canonical momentum of the corresponding Hamiltonian system that we find. We construct solutions in three cases: (i) in vacuum outside a bounded spherical object, (ii) within an extended prescribed source, and (iii) for an isothermal gas in hydrostatic equilibrium, serving as a simplified model for galaxy clusters. We show that the oscillatory regime that follows the Newtonian and MOND regimes, obtained in previous works in the vacuum case, also persists for isothermal spheres, and we show that the gas density profiles in AeST can become more compressed than their Newtonian or MOND counterparts. We construct the Radial Acceleration Relation (RAR) in AeST for isothermal spheres and find that it can display a peak, an enhancement with respect to the MOND RAR, at an acceleration range determined by the value of the AeST weak-field mass parameter, the mass of the system and the boundary value of the gravitational potential. For lower accelerations, the AeST RAR drops below the MOND expectation, as if there is a negative mass density. Similar observational features of the galaxy cluster RAR have been reported. This illustrates the potential of AeST to address the shortcomings of MOND in galaxy clusters, but a full quantitative comparison with observations will require going beyond the isothermal case.*

## Naučna i stručna izlaganja i prezentacije kandidata

- „Beyond MOND: advances in the search for a viable alternative to dark matter“ (19.09.2024); Carnegie Mellon University, Pittsburgh
- „Towards galaxy cluster models in Aether-Scalar-Tensor theory“ (12.09.2024); Case Western Reserve University, Cleveland
- „Beyond MOND: advances in the search for a viable alternative to dark matter“ (29.02.2024); University of Basel, Basel
- „In Search of Relativistic Extensions of Modified Newtonian Dynamics“ (20.09.2023); Richard Hills seminar; University of Cambridge, Cambridge
- „Recent Developments in Relativistic Embeddings of MOND“ (11.09.2023); News from the Dark 8, Brisel
- „Galaxy clusters in a new relativistic theory of MOND: preliminary results“ (14.04.2023); Observatoire astronomique de Strasbourg, Strasbourg
- „Galaxy clusters in a new relativistic theory of MOND: preliminary results“ (25.11.2022); JH-meeting on stellar populations, gravitational dynamics and MOND-based cosmology, Jindřichův Hradec
- „A Map Between Primordial Power Spectra and the Effective Field Theory of Inflation“ (18.11.2020); University of Helsinki and University of Jyväskylä. Online
- ‘Reconstructing the EFT of Inflation from Cosmological Data’ (15.08.2019); 15th Rencontres du Vietnam, Quy Nhon
- ‘Reconstruction of the Direction-dependent Primordial Power Spectrum’ (04.06.2018); Vacuum 2018. The vacuum of the Universe: from cosmology to particle physics, Barcelona
- Poster prezentacije: ‘Towards galaxy cluster models in Aether-Scalar-Tensor theory’; CosmoVerse@Kraków 2024, Krakov, ICHEP 2024, Prag.

## NASTAVNO – PEDAGOŠKI RAD

Kandidat ima iskustvo realizacije nastavnog procesa na visokoškolskoj ustanovi. Konkretno, uz prijavu je priložena potvrda shodno kojoj je bio asistent na Univerzitetu u Kopenhagenu, na predmetima:

- Introduction to Mathematics for the Chemical Sciences (2013)
- Linear Algebra and Classical Mechanics (2014)
- Electromagnetism theory (exercises) (2014)

Također, kandidat u biografiji navodi, ali ne potkrepljuje potvrdom, da je 2018. godine držao online-nastavu „studentima algebre i statistike“ na Alfaisal University, Riad, Saudijska Arabija.

Amel Duraković je bio ko-supervizor (zajedno sa dr. Will Barkerom) na tri *Part III* projekta na Cambridge University.

Radio je na svom akademskom usavršavanju kroz sudjelovanje na većem broju postdoktorskih pozicija, te naučnih skupova i konferencija, što je zasigurno doprinijelo i usavršavanju njegovih kompetencija za nastavno-pedagoški rad.

## **DRUŠTVENI DOPRINOS**

Društveni doprinos kandidata se ogleda u sljedećem:

- Recenzent u naučnim časopisima:
  - Physical Review D
  - Monthly Notices of the Royal Astronomical Society
  - Physics Letters B
  - Physics of the Dark Universe
  - Zeitschrift für Naturforschung A
  - Astronomische Nachrichten
  - Nuclear Physics B.
- Suorganizator multi-institucionalnog ‘arXiv [gr-qc] scrolling club’ (online sastanci), <https://talks.cam.ac.uk/show/index/176425>
- Suorganizator workshopa SYNERGIES@PRAGUE 2021.
- Bio član žirija 3MT BH Futures Foundation 2022. i 2023. godine.
- Održao online predavanje „U potrazi za nedostajućom materijom“ za „*International ALICE Masterclass on Particle Physics*“ za srednjoškolce iz BiH 2022. godine.
- Održao tri predavanja „*Himlenes Mysterier*“/“*Mysteries of the Heavens*“ za danske srednjoškolce, učenike Tehničke gimnazije ZBC HTX.
- Online predavanje ‘Research Exposure’ za peruanske srednjoškolce (Tacna, Peru).
- Finalista Falling Walls Czech Republic eventa s prezentacijom „*Breaking the Wall of the Dark Matter Paradigm*“.
- Održao četiri YouTube live predavanja (april-maj 2020) „*Celestial Lessons*“ za Cambridge Muslim College.

## **DOPRINOS PROCESU INTERNACIONALIZACIJE**

Kandidat je diplomirao i doktorirao na Univerzitetu u Kopenhagenu, magistrirao na Imperial College u Londonu, imao postdoktorske studije u Danskoj, Češkoj i Francuskoj. Pri tome je ostvario kontakte i saradnju sa vodećim stručnjacima iz oblasti astrofizike. Kao kontakte za potvrdu svog naučnog rada je naveo: prof. Subir Sarkar, Oxford University, [subir.sarkar@physics.ox.ac.uk](mailto:subir.sarkar@physics.ox.ac.uk); dr. Benoît Famaey, Observatoire astronomique de Strasbourg, [benoit.famaey@astro.unistra.fr](mailto:benoit.famaey@astro.unistra.fr) i dr. Subodh Patil, Leiden University, [patil@lorentz.leidenuniv.nl](mailto:patil@lorentz.leidenuniv.nl)

Kao što je vidljivo iz ranije predočene liste međunarodnih konferencija i naučnih izlaganja, kandidat je ostvario posjete i predavanja na velikom broju renomiranih naučnih ustanova iz cijelog svijeta.

## PRIJEDLOG SA OBRAZLOŽENJEM

Na osnovu Zakona o visokom obrazovanju Kantona Sarajevo („Službene novine Kantona Sarajevo broj 36/22“), Izvoda iz Statuta Univerziteta u Sarajevu i Podsjetnika za pisanje referata za izbor nastavnika i saradnika Univerziteta u Sarajevu, prijavljeni kandidat, **dr. Amel Duraković** postdoktorand na Astronomskoj opservatoriji u Strazburu ispunjava sve zakonske uslove za **izbor** u zvanje **docenta** za oblast „**Teorijska fizika – fizika visokih energija**“, jer:

- posjeduje naučni stepen doktora fizičkih nauka,
- je objavio tri (3) naučna rada iz oblasti za koju se bira, u priznatim publikacijama koje su indeksirane u relevantnim bazama podataka (sva 3 u Q1 WoS CC),
- ima iskustvo realizacije nastavnog procesa na visokoškolskoj ustanovi,
- je kandidat kroz sudjelovanje u aktivnostima koje doprinose popularizaciji fizike dao značajan društveni doprinos,
- je kroz svoj dosadašnji naučni rad ostvario izrazito vrijednu međunarodnu suradnju.

Pored toga, kandidat je postdoktorand na Astronomskoj opservatoriji u Strasburgu, te cijenimo da ima potrebna znanja i vještine za pružanje ekspertske podrške implementaciji projekta obnove Astronomске opservatorije Trebević.

S obzirom na navedene činjenice, sa zadovoljstvom predlažemo Vijeću Univerziteta u Sarajevu – Prirodno-matematičkog fakulteta da **izabere** dr. Amela Durakovića, **u zvanje docenta za oblast „Teorijska fizika – fizika visokih energija“** na Univerzitetu u Sarajevu – Prirodno-matematičkom fakultetu.

U Sarajevu, 21.10.2024. godine

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Dr. Hedim Osmanović, redovni profesor

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Dr. Rifat Omerović, docent

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Dr. Azra Gazibegović-Busuladžić, redovna profesorica