Mohammad Ali Salahshoor Afshar

PhD in Particle Physics, Researcher in Theoretical Physics

m.a.s.afshar@gmail.com

■ DOB: 1977/07/04

■ Marital Status: Married

■ H-index: 21

■ Place of birth: Tehran Iran

Skills

- latex
- Maple
- Wolfram Mathematica
- Microsoft Office
- general computer software
- research & strategy
- physics teacher
- math teacher

Education

Diploma of Mathematics and Physics

Institute/School: "Gostareh Boys' High School"

Tehran, Iran

Bachelor of Physics

Institute/University: Guilan University

Rasht, Gilan, Iran

Master of Theoretical Physics

Institute/University: Azerbaijan Shahid Madani University,

Tabriz, Iran

PhD in Elementary Particle Physics & Field Theory

Institute/University: University of Mazandaran

Babolsar, Mazandaran, Iran

Social Network

GS: https://scholar.google.com/citations?user=INqdvHEAAAAJ&hl=en

Research Gate

https://www.researchgate.net/profile/Mohammad-Ali-Afshar?ev=hdr_xprf

ORCID: https://orcid.org/0009-0001-3133-5992

Web of Science Researcher ID: JZD-6906-2024

Scopus ID: 58305677500

Languages

English

Reading Level ●●●●○

Writing Level ●●●○○

Listening Level ●●●●○

Speaking Level ●●●○○

Persian (Mother tongue)

Reading Level ●●●●●

Writing Level ●●●●●

Listening Level ●●●●●

Speaking Level ●●●●●

Peer Reviewer

The European Physical Journal C

Classical and Quantum Gravity

Physics of the Dark Universe

Physica Scripta

Awards and honors

- **Chosen as the first rank student among doctoral students of particle physics of Mazandaran University (2024).**
- **Selected as an elite student and top provincial researcher in 2024**

Skill and Expertise

Black Hole Physics, Black Hole Thermodynamics, Theoretical High Energy Physics, Relativity, Quantum Field Theory, Mathematical Physics, Classical Physics (Mechanic, Electric and Magnetic, Thermodynamics)

Recommendations

✓ **Mr. Jafar Sadeghi**

Professor of Theoretical and Mathematical Physics, Department of Physics, Faculty of Basic Sciences, University of Mazandaran, Babolsar, Iran

P.O. Box: 47416-95447,

✉ **pouriya@ipm.ir**

✓ **Mr. Adel Rezaei-Aghdam**

Professor of Theoretical and Mathematical Physics, Department of Physics, Faculty of Basic Sciences, Azarbaijan Shahid Madani University, Tabriz, Iran

P.O. Box: 53714-161

✉ **rezaei-a@azaruniv.ac.ir**

✓ **Mr. Mohammad Reza Pahlavani**

professor of physics, Department of Physics, Faculty of Basic Sciences, University of Mazandaran, Babolsar, Iran

P.O. Box: 47416-95447,

✉ m.pahlavani@umz.ac.ir

✓ **Mrs. Tahereh Azizi**

Associate Professor of Physics, Head of Department of Theoretical Physic, Department of Physics, Faculty of Basic Sciences, University of Mazandaran, Babolsar, Iran

P.O. Box: 47416-95447,

✉ t.azizi@umz.ac.ir

✓ **Mr. Hossein Jafari**

Professor, Department of Mathematical Sciences, University of South Africa, UNISA0003, Pretoria, South Africa

✉ jafarh@unisa.ac.za

Research Interests /Projects

I. Theoretical Investigations into the Structure and Physics of Black Holes:

- **Probing the intrinsic structure of black holes through dynamical analysis of test particles, with emphasis on observational signatures from photon spheres, thin circular orbits (TCOs), and geodesic trajectories.**
- **Developing extended black hole models and characterizing their thermodynamic and optical properties within modified gravity frameworks.**
- **Applying generalized statistical mechanics—via Tsallis, Rényi, Sharma–Mittal, and related non-additive entropies—to black hole spacetimes and thermodynamics.**
- **Exploring chaotic dynamics and stochastic particle motion near black holes using Fokker–Planck and related kinetic equations to model accretion and transport phenomena.**
- **Analyzing quasi-normal modes to constrain theoretical black hole models and extract signatures of quantum gravity effects.**
- **Extending black hole geometry beyond Riemannian frameworks through Finsler and other generalized geometries, and assessing their impact on geodesic structure and thermodynamic behavior.**

II. Quantum Gravity Constraints and Holography in Cosmology and Particle Physics

- **Applying swampland criteria and the Weak Gravity Conjecture (WGC) to constrain effective field theories in cosmological settings and early-universe scenarios.**
- **Leveraging AdS/CFT correspondence to investigate strongly coupled phenomena in particle physics and cosmological structure formation.**

III. Algebraic Structures and Symmetries in Quantum Gravity

Investigating mathematical–physical structures of quantum gravity models through systematic derivation of underlying algebras, with focus on uncovering hidden symmetries and supersymmetries via construction of generator operators and analysis of their commutation relations.

Theses

MSc:

Title:

An introduction to Non-Abelian and Poisson–Lie T-Dualities in String Effective Actions

Supervisors: Professor. Adel Rezaei-Aghdam

Grade: A Mark: 19.5 From 20

Abstract

This research investigates duality symmetries within the string effective action and their applications to string cosmology.

Chapter 1:

Introduces the bosonic sigma model, outlines its covariance symmetries, and proceeds to a semiclassical quantization. The beta functions are computed via the heat kernel method; their vanishing yields generalized Einstein equations in the presence of the dilaton and Kalb–Ramond fields, thereby deriving the string effective action.

Chapter 2:

Examines Abelian and non-Abelian target-space dualities, with particular attention to the role of Weyl anomaly coefficients in preserving the invariance of the effective action under duality transformations.

Chapter 3:

These symmetries are applied to string cosmology: the field equations of the effective action are analyzed under target-space duality maps in the presence of matter sources, and cosmological solutions are constructed using Abelian and non-Abelian duality techniques.

Chapter 4:

Extends this framework to Poisson–Lie duality, a more general structure encompassing non-Abelian dualities, and elucidates its interplay with the string effective action and Weyl anomaly cancellation.

Chapter 5:

Addresses the existence of conformally Poisson–Lie dual models on real six-dimensional Drinfel'd doubles. The path-integral measure for Poisson–Lie symmetric models is formulated, and through a systematic analysis of the algebraic structure of specific Drinfel'd doubles—namely (II, III) and (VII, III)—necessary and sufficient conditions for conformal invariance under Poisson–Lie duality are studied.

Theses

PhD:

Title: A Novel Approach to the Analysis of Photon Sphere Structures and the Thermodynamics of Gravitational Systems: Efforts to find theoretical evidence of the Weak Gravity Conjecture

Supervisor: Prof. Jafar Sadeghi

Grade: A **Mark: 20 From 20**

Abstract:

This study focuses on investigating a prominent behavioral feature in ultra-compact gravitational structures, particularly black holes: the photon sphere.\\Given that light and energy waves are the only tools nature provides for comprehending this vast and inaccessible cosmic domain, it becomes evident that the concept of the photon sphere—serving as undeniable evidence of relativistic and super-gravitational behavior, signifying the trapping of photons within intense gravitational fields—plays a pivotal role in understanding the dynamics of gravitational structures.

The fundamental importance of this phenomenon has motivated us to explore novel applications of the photon-sphere concept in the study of ultra-compact gravitational objects. In this work, employing an innovative approach grounded in a topological charge analysis of the photon sphere, we first utilize the reciprocal link between the necessity of a photon sphere in ultra-compact structures and the gravitational model under consideration to classify the solution's behavior—distinguishing between black holes and naked singularities. This same analysis also enables us to determine the admissible ranges for the parameters appearing in the model's action.

Subsequently, we will demonstrate how the existence of a stable photon sphere, manifesting as a potential minimum in static black holes, can lead to unusual behaviors in the velocity of particles near the event horizons of these black holes. This mechanism can reproduce the dynamical pattern of rotating black holes without requiring frame-dragging.

Finally, by invoking the Weak Gravity Conjecture (WGC), we will utilize the photon sphere as evidence indicating that a black hole retains its characteristic properties even in the final stages of evolution towards an extremal state. This reveals an inherent tendency of black holes to preserve their prior structure, and may provide stronger grounds for the fulfillment of the conditions postulated by this conjecture.

Thesis articles:

- ✓ **Sadeghi J, Afshar MA. The role of topological photon spheres in constraining the parameters of black holes. Astroparticle Physics. 2024 Oct 1; 162:102994.**
- ✓ **Afshar MA, Sadeghi J. Effective potential and topological photon spheres: a novel approach to black hole parameter classification. Chinese Physics C. 2025 Mar 1;49(3):035107.**
- ✓ **Afshar MA, Sadeghi J. Mechanisms behind the Aschenbach effect in non-rotating black hole spacetime. Annals of Physics. 2025 Mar 1; 474:169953.**
- ✓ **Afshar MA, Sadeghi J. Mutual influence of photon sphere and non-commutative parameter in various non-commutative black holes: Towards evidence for WGC. Physics of the Dark Universe. 2025 Feb 1; 47:101814.**
- ✓ **Afshar MA, Sadeghi J. WGC as WCCC protector: The synergistic effects of various parameters in non-commutative black holes for identifying WGC candidate models. Nuclear Physics B. 2025 May 1; 1014:116872.**

✓ Journal of High Energy Physics (JHEP)

1. Overcoming Barriers: Kramers' Escape Rate Analysis of Metastable Dynamics in First-Order Multi-Phase Transitions

✓ The European Physical Journal C (EPJC)

2. From minimal Higgs inflation with (R 2) term in palatini gravity to Swampland conjectures under ACT constraints
3. Kramer's escape rate and phase transition dynamics in AdS black holes
4. Topological insights into black hole thermodynamics: non-extensive entropy in CFT framework
5. Weak gravity conjecture in ModMax black holes: weak cosmic censorship and photon sphere analysis
6. Weak gravity conjecture validation with photon spheres of quantum corrected Reissner–Nordstrom–AdS black holes in Kiselev spacetime

✓ Fortschritte der Physik

7. A Deep Dive into classical and Topological CFT Thermodynamics in Lifshitz and Hyperscaling Violating Black Holes

✓ Journal of High Energy Astrophysics

8. The interplay of WGC and WCCC via charged scalar field fluxes in the RPST framework
9. Weak cosmic censorship and weak gravity conjectures in CFT thermodynamics

✓ Physics Letters B

10. Probing the weak gravity conjecture: Novel Aschenbach signatures in superextremal non-linear charged AdS black holes

✓ Physics of the Dark Universe

11. Frolov–AdS black holes immersed in a string fluid: Harmonic oscillations, phase structure, and topological classification
12. Mutual influence of photon sphere and non-commutative parameter in various non-commutative black holes: Towards evidence for WGC
13. Phase transition dynamics of black holes influenced by Kaniadakis and Barrow statistics
14. Thermodynamic scalar curvature and topological classification in accelerating charged AdS black holes under rainbow gravity
15. Topological classification and black hole thermodynamics
16. Topological thermodynamics and observable signatures of charged black holes in modified gravity

✓ Astroparticle Physics

17. The role of topological photon spheres in constraining the parameters of black holes
18. Thermodynamic topology and photon spheres in the hyperscaling violating black holes

✓ Annals of Physics

19. Bardeen black hole thermodynamics from topological perspective
20. Mechanisms behind the Aschenbach effect in non-rotating black hole spacetime
21. Thermodynamic topology of black holes from bulk-boundary, extended, and restricted phase space perspectives

✓ General Relativity and Gravitation

22. Cooling and heating regions of Joule-Thomson expansion for AdS black holes: Einstein-Maxwell-power-Yang-Mills and Kerr Sen black holes
23. Exploring the phase transition in charged Gauss–Bonnet black holes: a holographic thermodynamics perspective

✓ Nuclear Physics B

24. AdS-Schwarzschild-like black hole thermodynamics: Loop quantum gravity impact on topology and universality
25. Analyzing WGC and WCCC through charged scalar fields fluxes with charged AdS black holes surrounded by perfect fluid dark matter in the CFT thermodynamics
26. Thermodynamic insights into ModMax-AdS black holes: A bridge between electrodynamic corrections and black hole physics
27. Thermodynamic signatures in black hole geometry and harmonic oscillations with nonlinear electromagnetic fields and phantom global monopole
28. WGC as WCCC protector: The synergistic effects of various parameters in non-commutative black holes for identifying WGC candidate models

✓ Chinese Physics C

29. Bulk-boundary and RPS thermodynamics from topology perspective

30. Effective potential and topological photon spheres: a novel approach to black hole parameter classification
31. Noncommutativity and its role in constant-roll inflation models with non-minimal coupling constrained by swampland conjectures
32. Thermodynamic topology of Kiselev-AdS black holes within f (R, T) gravity
33. Thermodynamic topology of quantum corrected AdS-Reissner-Nordstrom black holes in Kiselev spacetime

✓ **International Journal of Geometric Methods in Modern Physics**

34. Thermodynamic topology of black holes in $F(R)$-Euler-Heisenberg gravity's Rainbow.
35. Thermodynamic Signatures and Insights into Horava–Lifshitz AdS Black Holes

✓ **International Journal of Modern Physics A**

36. Investigation of hidden symmetry in AdS5 black hole with Heun equation

✓ **International Journal of Theoretical Physics**

37. Swampland conjectures and noncommutative phase space in the constant-roll inflation with Brans-Dicke cosmology

✓ **Physica Scripta**

38. Topology of Hayward-AdS black hole thermodynamics

✓ **International Journal of Modern Physics D**

39. Energy conditions of traversable wormhole in the deformed gravitational model

✓ **Iranian Journal of Astronomy and Astrophysics**

40. Dark energy evolution: non-interacting and interacting cases

✓ **Journal of Holography Applications in Physics**

41. Exploring the Parameter Space of Inflation Model on the Brane and its Compatibility with the Swampland Conjectures.

✓ **arXiv preprint**

42. Can Static Black Holes in Massive Gravity Serve as Candidates for Aschenbach-Like Phenomena?
43. Can black holes cause cosmic expansion?
44. The Influence of Stable Photon Sphere Advent on Orbital Precession in moving towards the Extremality: Periapsis Shift as a Gateway to the Weak Gravity Conjecture

Teaching Records

University	Date and duration	Lessons/ Bachelor's degree	Row
Qazvin Azad University	2003 - 2014	1.Mechanic 2. Electric and Magnetic 3. Thermodynamics	**1**
Tehran Azad University, Central Branch	2011-2014	1. Mechanic 2. Electric and Magnetic 3. Thermodynamics	**2**
Varamin Azad University	2011-2014	1. Introduction to astronomy 2. Physics of the sun 3. Cosmology 4. Celestial mechanics 5. Philosophy of science 6. Thermodynamics 7. Mechanic 8. Electric and Magnetic	**3**
Karaj Azad University	2011	Modern physics	**4**
Saveh Azad University	2012	Heat Physics	**5**
Samapran Aviation University	2003 - 2008	1. Introduction to Electronic 2. Introduction to Electrical circuit 3. Electric and Magnetic	**6**