Mohammadreza (Reza) Ayromlou

Independent Argelander Fellow
University of Bonn, Germany

Webpage: www.ayromlou.com
Email: ayromlou@uni-bonn.de
Citizenship : German

Education and Employment

- **Argelander Inst. for Astronomy (AIfA), University of Bonn** — Oct 2024 - Present
  Independent Argelander Fellow and BCGS Lecturer — *Bonn, Germany*
- **Center for Astronomy (ZAH), Heidelberg University** — Dec 2021 - Sep 2024
  Postdoctoral Researcher — *Heidelberg, Germany*
- **Max Planck Institute for Astrophysics and LMU Munich** — Jul 2017 - Nov 2021
  Ph.D. in Physics (Astrophysics and Cosmology) and Short Postdoc — *Munich, Germany*
  - Thesis: Physical processes that determine the clustering of different types of galaxies on large scales, under the supervision of Prof. Guinevere Kauffmann and Prof. Simon D. M. White
- **Sharif University of Technology** — Sep 2014 - Aug 2016
  M.Sc., Physics (Astrophysics and Cosmology Concentration) — *Tehran, Iran*
  - Thesis: The study of cosmological structure formation by physics of stochastic processes
- **University of Tehran** — Sep 2009 - Aug 2014
  B.Sc., Theoretical Physics — *Tehran, Iran*

Research Interests and Methods

- **Research: Interplay between Galaxy Evolution and Large-Scale Structure**
  - Galaxy formation and evolution within haloes, in halo outskirts, and beyond
  - Baryon (re)distribution and kinematics in and around haloes, out to the **"Closure Radius"** and in the intergalactic medium (IGM)
  - High-redshift galaxy evolution and quenching mechanisms
  - Supermassive black hole (AGN) feedback
  - The environmental dependence of galaxy evolution
  - Correlations between galaxy properties from small to large scales (Galactic Conformity)
- **Method: Numerical Simulations Informed by Observations**
  - Developing, running, and analyzing semi-analytical models and hydrodynamical simulations. Recent projects that I have led or to which I have contributed substantially include:
    - **L-Galaxies** semi-analytical model (a main developer)
    - **FRONTIER** project (PI): A series of cosmological and zoom hydrodynamical simulations, devising a new set of sophisticated AGN feedback models.
    - **iCluster** project (co-PI with Rahul Ramesh): Highest-resolution cosmological hydrodynamical zoom simulations of galaxy clusters to date
    - TNG-Cluster hydrodynamical simulations (core member)
    - DECODE semi-empirical galaxy formation model (collaborator)
  - Analyzing observational data and applying statistical methods in cosmology and astrophysics

Publications

First-author papers

1. An Atlas of the Gas Motions in the TNG-Cluster Simulation: from Cluster Cores to the Outskirts (A&A, 2024)
2. Feedback reshapes the baryon distribution within haloes, in halo outskirts, and beyond: the closure radius from dwarfs to massive clusters (MNRAS, 2023)
3. The Physical Origin of Galactic Conformity: From Theory to Observation (MNRAS, 2023) - Data
4. Galaxy formation with L-GALAXIES: Modelling the environmental dependency of galaxy evolution and comparing with observations (MNRAS, 2021) - Data
5. Comparing galaxy formation in the L-GALAXIES semi-analytical model and the IllustrisTNG simulations (MNRAS, 2021) - Data
6. A New Method to Quantify Environment and Model Ram-Pressure Stripping in N-Body Simulations (MNRAS, 2019) - Data

Papers by my students

7. Environmental Quenching of High-Redshift Galaxies: Interpreting JWST Observations with Simulations (Submitted to A&A, 2026)
   - A. Döven, **M. Ayromlou**, C. Porciani
8. The abundance and origin of cool gas in galaxy clusters in the TNG-Cluster simulation (A&A, 2025)
   - M. Staffehl, D. Nelson, **M. Ayromlou** et al.
9. Probing galaxy evolution from z = 0 to z = 10 through galaxy scaling relations in three L-Galaxies flavours (MNRAS, 2025)
   - A. Vani, **M. Ayromlou**, G. Kauffmann, V. Springel

Other second- and third-author papers

10. Unveiling the (in)consistencies among the galaxy stellar mass function, star formation histories, satellite abundances and intracluster light from a semi-empirical perspective (MNRAS, 2024)
    - H. Fu, F. Shankar, **M. Ayromlou** et al.
11. Introducing the TNG-Cluster Simulation: overview and physical properties of the gaseous intracluster medium (A&A, 2024)
    - D. Nelson, A. Pillepich, **M. Ayromlou**, et al.
12. Testing the key role of the stellar mass-halo mass relation in galaxy merger rates and morphologies via DECODE, a novel Discrete statistical sEmi-empiriCal mODEl (MNRAS, 2022)
    - H. Fu, F. Shankar, **M. Ayromlou** et al.
13. Excursion set approach: Stratonovich approximation and Cholesky decomposition (MNRAS, 2018)
    - F. Nikakhtar, **M. Ayromlou** et al.

Co-author papers

14. How galaxies acquire their stellar mass at high redshift: High star formation efficiencies and the relative roles of dust and initial mass function (H. Fu et al., A&A, 2026)

15. ERGO-ML: A continuous organization of the X-ray galaxy cluster population in TNG-Cluster with contrastive learning (U. Chadayammuri et al., MNRAS, 2026)
16. The role of black hole feedback on galaxy star formation and the degeneracy with halo quenching (H. Fu et al., A&A, 2025)
17. Jellyfish galaxies with the IllustrisTNG simulations – Supermassive black hole activity in dense environments with ram-pressure stripped satellites (S. Kurinchi-Vendhan et al., MNRAS, 2025)
18. Extreme AGN feedback in the fossil galaxy group SDSSTG 4436 (D. Eckert et al., A&A, 2025)
19. Cross-correlations between X-ray clusters and the general galaxy population (J. Comparat et al., A&A, 2025)
20. Shedding light on the star formation rate-halo accretion rate connection and halo quenching mechanism via DECODE, the Discrete statistical sEmi-empiriCal mODEl (H. Fu et al., A&A, 2025)
21. The cooler past of the intracluster medium in TNG-Cluster (E. Rohr et al., MNRAS, 2025)
22. The hot circumgalactic media of thousands of massive cluster satellites with the TNG-Cluster simulation, and how to detect them (E. Rohr et al., A&A, 2024)
23. X-ray inferred kinematics of the core ICM in Perseus-like clusters: insights from the TNG-Cluster simulation (N. Truong et al., A&A, 2024)
24. MUSE-ALMA Haloes IX: Morphologies and Stellar Properties of Gas-rich Galaxies (A. Karki et al., MNRAS, 2023)
25. A Virgo Environmental Survey Tracing Ionised Gas Emission (VESTIGE) XV. The Halpha luminosity function of the Virgo cluster (A. Boselli et al., A&A, 2023)
26. Jellyfish galaxies with the IllustrisTNG simulations – When, where, and for how long does ram pressure stripping of cold gas occur? (E. Rohr et al., MNRAS, 2023)
27. Exploring chemical enrichment of the intracluster medium with the Line Emission Mapper (F. Mernier et al., LEM IGM Science Paper, 2023)
28. Line Emission Mapper (LEM): Probing the physics of cosmic ecosystems (R. Kraft et al., LEM, 2022)

Academic Distinctions

- 20 million CPU hours awarded for the iCluster project (PI) on LRZ supercomputers (equivalent to more than 800,000 euros in funding, 2026-2027)
- Independent Argelander Fellowship ($\sim$ 200,000 euros), University of Bonn (2024-2027)
- Offered an independent postdoctoral fellowship in the U.S. (2024; declined in favor of the Argelander Fellowship)
- Ernst Patzer Prize for introducing the Closure Radius, MPIA Heidelberg (2023)
- Offered a Canadian independent postdoctoral fellowship (2021; declined due to COVID-19 visa and travel restrictions and accepted competitive offer in Heidelberg)
- Fully funded IMPRS Ph.D. position, MPA Garching (2017; declined competitive offers in EU and North America)
- Highest distinction for M.Sc. thesis in Physics, Sharif University of Technology, Iran (2016)
- Ranked in the top 10 among 8,000 participants in the national M.Sc. physics exam (2014)

Activities in the Research System

- Referee for scientific journals (e.g., **Nature**, MNRAS, ApJ, A&A), around 5 papers/year (2021-present)
- External committee member and reviewer for postdoctoral fellowship applications at the *Graduate School of Physics, Université Paris-Saclay* (2025)
- PI of the FRONTIER simulation project (2025-present)
- Co-PI of the iCluster project (together with Rahul Ramesh), awarded 20 million CPU hours on LRZ supercomputers (2025-present)
- One of the main developers of the L-Galaxies semi-analytical model of galaxy formation (2017–present)
- Chair of the L-Galaxies large-scale structure working group
- Co-organizer of semi-analytic meetings (Munich, 2021), L-Galaxies Day (2022), the annual L-Galaxies meeting (Berlin, 2025), and the joint semi-analytic meeting (Trieste, 2026)
- Presented 60 invited and contributed talks at international events
- Provided tutorials and lectures for early career scientists and students
- Bonn-Cologne Graduate School of Physics and Astronomy (BCGS) Lecturer (2024–present)
- Reviewing and grading M.Sc. applications for the BCGS scholarship, Bonn (2024–present)
- Supervising students in the Astronomy Seminar Course, University of Bonn (2024-present)
- **Outreach:** Presented several public talks on astronomy; member of the DEI committee at the Argelander Institute of Astronomy; co-organizer of "**Girls' Day**" for female high-school students (2022–present); co-organizer of "Scientists Meet Students (AIM)", Heidelberg (2022–2023).

Student Supervision and Teaching Experiences

- **Ph.D. Students:**
  - **Akash Vani** (2023-2027), co-advised with Profs. Guinevere Kauffmann and Volker Springel - Max Planck Institute for Astrophysics
    - *Thesis: Processes that quench star formation in high-redshift galaxies*
    - *Paper 1: Probing galaxy evolution from $z = 0$ to $z = 10$ through galaxy scaling relations in three L-Galaxies flavours (Published in MNRAS, 2025)*

- **M.Sc. Students:**
  - **Eugene Lee** (2026-2027), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Thesis: The distribution of metals in and around galaxy groups and clusters*
  - **Laksh Gupta** (2026-2027), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Thesis: The interplay of various physical processes in the evolution of galaxies*
  - **Aleyna Döven** (2025-2026), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Thesis: The impact of proto-cluster environment on galaxy evolution at high redshift*
    - *Paper: Environmental Quenching of High-Redshift Galaxies: Interpreting JWST Observations with Simulations*
  - **Amanda Sabovic** (2025-2026), co-advised with Prof. Thomas Reiprich and Dr. Florian Pacaud - University of Bonn
    - *Thesis: The role of mergers in the evolution of galaxy clusters using machine learning*

- **David Leonhard** (2025-2026), co-advised with Prof. Thomas Reiprich - University of Bonn
  - *Thesis: The impact of AGN feedback on large-scale gas redistribution using machine learning*
  - *Paper: Uncovering the Gas Redistribution out to the Closure Radius Using Simulation Informed Machine Learning Techniques*
  - *Position afterward: → Ph.D. student at Lamarr Institute for Machine Learning and AI*
- **Milan Staffehl** (2023-2024), co-advised with Dr. Dylan Nelson - Heidelberg University
  - *Thesis: Exploring the origin of the cold gas in galaxy clusters and galaxy groups*
  - *Paper: The abundance and origin of cool gas in galaxy clusters in TNG-Cluster*
  - *Position afterward: → Ph.D. student at the University of Bonn*
- **Finlay Taylor** (2023), co-advised with Dr. Dylan Nelson - Heidelberg University
  - *Thesis: Discovering the impact of supermassive black hole feedback on low-mass galaxies*

- **B.Sc. Students:**
  - **Emmanouela Gerakaki** (2023-2024), co-advised with Dr. Dylan Nelson - Heidelberg Uni.
    - *Thesis: The complexity of galaxy evolution in the cosmic web*
    - *Position afterward: → Internship in Porto → M.Sc. student at Heidelberg University*

- **Ph.D. and M.Sc. Internships:**
  - **Luca Saewe** (2026), co-advised with Prof. Thomas Reiprich - University of Bonn
    - *Project: Using machine learning to predict the evolution of galaxy groups*
  - **Eugene Lee** (2026), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Thesis: The distribution of cold gas and metals in cosmological simulations*
  - **Laksh Gupta** (2026), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Project: Solving galaxy evolution as a multiphysics problem*
  - **Aleyna Döven** (2025), co-advised with Prof. Cristiano Porciani - University of Bonn
    - *Project: The impact of proto-cluster environment on galaxy evolution in the early universe*
  - **Shera Jafaritabar** (2024) - Heidelberg University
    - *Project: The hot gas distribution in clusters and groups in simulations and observations*
    - *Position afterward: M.Sc. and Ph.D. student at Heidelberg University*
  - **Akash Vani** (2022-2023), co-advised with Profs. Guinevere Kauffmann and Volker Springel - Max Planck Institute for Astrophysics
    - *Project: Scaling relations in the L-Galaxies model and comparison with observations*
    - *Position after internship: Ph.D. student at the Max Planck Institute for Astrophysics*

- **Teaching and Other Activities:**
  - **Lecturer at the Bonn-Cologne Graduate School of Physics and Astronomy (BCGS)** (2024-present)
  - **Astronomy Seminar Course** (2024-present) - University of Bonn
    - *Supervised students during their seminar presentations*
    - *Evaluated seminar presentations for 20–30 students per semester*
  - **Invited Tutorial** (2022): Cosmological simulations: DAWN Winter School (Feb 2022)

Presentations and (Invited) Talks

- **Invited Talk**: The impact of outflows on the large-scale distribution of baryons and galaxy evolution: University of Cologne (Mar 2026)
- BEYOND the halo boundary: Baryon redistribution from dwarfs to clusters, Ringberg Conference (Nov 2025)
- L-Galaxies for large-scale structure and galaxy evolution: L-Galaxies workshop, Berlin (Oct 2025)
- **Invited Talk**: Understanding Galaxy Evolution in the Context of Large-Scale Structure: IFPU, Trieste (Sep 2025)
- Large-Scale Baryon Redistribution (18th Potsdam Thinkshop, Potsdam, July 2025)
- Baryon Redistribution and its Implications for Galaxy Formation and Evolution: Quo Vadis Galaxy Evolution Conference, Heidelberg (Jun 2025)
- An overview of the connections between galaxy evolution and large-scale structure: AIfA and MPIfR joint Colloquium, Bonn (Apr 2025)
- Gas redistribution out to the closure radius and its impact on the physics of galaxy formation and evolution: MIAPbP meeting, Munich (Mar-Apr 2025)
- **Invited Talk**: Galaxy formation and evolution: An overview from the interplay of theory and observations, Shiraz University (Feb 2025)
- Galactic Conformity: Large-Scale Correlations between Galaxy Properties, Virgo Meeting, Sussex (Jan 2025)
- **Invited Talk**: Galaxy formation and evolution: Overview from a Theoretical Perspective, IMPRS Symposium, Munich (Nov 2024)
- The Missing Baryon Problem: A New Perspective from Simulations and Observations, EAS meeting, Padova (Jul 2024)
- The Fate of the CGM Gas: Insights from Simulations and Observations, EAS meeting, Padova (Jul 2024)
- From Cores to Outskirts: Understanding Galaxy Clusters and Groups through Simulations, EAS meeting, Padova (Jul 2024)
- Galaxy Evolution Meets Large Scale Structure: MIAPP meeting, Munich (May 2024)
- **Invited Talk**: How Galaxy Evolution and Large Scale Structure Influence Each Other: University of Oslo (Apr 2024)
- Introducing the TNG-Cluster Simulations: Galaxies from Scratch Conference, Vienna (Feb 2024)
- Galaxy Evolution Meets Large Scale Structure: DIPC seminar, Spain (Jan 2024)
- Progress and Prospects in the L-Galaxies model: L-Galaxies annual developers meeting, DIPC Spain (Jan 2024)
- **Invited Prize Talk**: The Closure Radius, a theoretically reliable, empirically testable solution to the missing baryon problem: Patzer Prize talk (Nov 2023)
- **Invited Talk**: AGN feedback redistributes gas from small to large scales: Instituto de Astrofísica de Canarias (Oct 2023)
- TNG-Cluster simulation: The velocity structure of galaxy clusters from the cores to outskirts: MPE Garching (Sep 2023)
- Feedback, baryon redistribution, and the Closure Radius: EAS meeting, Krakow (Jul 2023)
- The interplay between galaxy evolution, gas, and large-scale structure: Multiphase gas conference, Kochel am See (Jun 2023)

- The Closure Radius: What physical processes impact the large-scale redistribution of baryons across different halo mass ranges: MPIA, Heidelberg (May 2023)
- The large-scale distribution of baryonic matter: MPA Garching (Mar 2023)
- Baryon redistribution due to Feedback and applications for future X-ray surveys: LEM Meeting CfA, Massachusetts (remote, Mar 2023)
- Feedback reshapes baryon distribution within haloes, in halo outskirts, and beyond: the closure radius from dwarfs to massive clusters: HERA Meeting, ORIGINS, Garching (Feb-Mar 2023)
- The Closure Radius: MMC conference, ESO Garching (Dec 2022)
- Galaxy evolution meets large-scale structure, from dwarfs to clusters: UCL, London (Nov 2022)
- **Invited Talk**: Galactic Conformity, environmental effects and the future of L-Galaxies, the Munich semi-analytical model of galaxy formation: L-Galaxies workshop, Hertfordshire-London (Nov 2022)
- The interplay between galaxy evolution, gas, and large-scale structure of the universe: ISSI meeting, Bern (Oct 2022)
- Recent developments of the Munich semi-analytical model: L-Galaxies day, MPA (July 2022)
- Galaxy evolution meets large-scale structure; Galactic Conformity: MPA, Munich (July 2022)
- The distribution and kinematics of baryonic and dark matter out to large scales: Virgo Meeting (July 2022)
- **Invited Tutorial**: IllustrisTNG simulations: DAWN Winter School (Feb 2022)
- Galaxy Formation in the L-Galaxies and IllustrisTNG models: INO conference (Feb 2022)
- **Invited Talk**: Galaxy formation meets large-scale structure: IPM (Jan 2022)
- Galaxy formation with L-Galaxies: KooGiG Conference, Peking (Nov 2021)
- The Physical Origin of Galactic Conformity: From Theory to Observation: Ringberg Meeting, Tegernsee (July/Aug 2021)
- **Invited Talk**: L-Galaxies: Modelling hundreds of millions of galaxies, public data release: INAF - Osservatorio Astrofisico di Arcetri (July 2021)
- L-Galaxies: Modelling the environmental dependency of galaxy evolution: Sharif University of Technology (July 2021)
- **Invited Talk**: L-Galaxies: Physics and Public data release: UMass Lowell (Apr 2021)
- **Invited Talk**: The formation and evolution of the Universe: Public talk at AstroZoom (Apr 2021)
- How galaxies are influenced by their environment up to large scales: Virgo meeting (Jan 2021)
- The role of environment in galaxy evolution: Durham University (Dec 2020)
- Modeling the properties of galaxies in different environments: LMU Munich (Dec 2020)
- The environmental dependency of galaxy evolution from theory to observations: ESO (Dec 2020)
- Galaxy formation with L-Galaxies: Modelling the environmental dependency of galaxy evolution and comparing with observations: Leiden Observatory (Nov 2020)
- A new method to quantify environment in simulations: MPIA Heidelberg (Nov 2020)
- Modelling the environmental dependency of galaxy evolution: University of Groningen (Nov 2020)
- Beyond the halo boundary: Properties of galaxies in the infall regions: Garching (Oct 2020)
- Galaxy evolution in L-Galaxies and IllustrisTNG: MPIA Heidelberg (Oct 2020)
- Modeling the environmental dependency of galaxy evolution in simulations: AIfA Bonn (Oct 2020)
- The role of environment in galaxy evolution: AIP Potsdam (Sep 2020)
- Distribution of baryons inside and around haloes: 9th IMPRS, MPE (July 2020)
- A method to quantify environment and model ram-pressure stripping: EAS meeting (Jun 2020)
- L-Galaxies vs. IllustrisTNG simulations: University of Southampton (Jun 2020)
- The role of environment in galaxy formation and evolution: MPA (Apr 2020)

- Comparing galaxy formation in the L-Galaxies semi-analytical model and the IllustrisTNG simulations: Virgo meeting Durham (Jan 2020)
- Removing the artificial halo boundary: MPA Cosmology Seminar (Oct 2019)
- No Place for the Halo Boundary: CosmoGold Conference IAP, Paris (Jun 2019)
- Local Background Environment of galaxies: 6th IMPRS Symposium, MPE (Apr 2018)
- Markovianity in Structure Formation: Cosmology Conference, IASBS, Zanjan, Iran (Feb 2017)
- Structure Formation as a Stochastic Process: Sharif University of Technology (Sep 2016)
- Halo Merger Trees and Bias: Sharif University of Technology (Jan 2016)
- Excursion Set Theory (EST): Sharif University of Technology (Aug 2015)

Last updated: May 2026
See www.ayromlou.com for more info.