Meera Patel

February 22, 2026
Prof. Sijing Shen
University of Oslo

Dear Prof. Shen,

I am writing to apply for the PhD position in extragalactic astrophysics within your group at the University of Oslo, working on numerical galaxy formation in the context of the ESA ARRAKIHS mission. I am currently completing my Master's in Physics and Astronomy at the University of Amsterdam, where I have focused on experimental physics, data analysis, and computational methods. While my research experience to date has been in experimental detector physics rather than astrophysical simulations, I bring strong computational skills, a deep interest in dark matter and structure formation, and a genuine passion for contributing to space science that I would be eager to channel into this work.

I grew up in the United States on stories of NASA missions, and the dream of contributing to space science has stayed with me since childhood. The opportunity to be involved with ESA through the ARRAKIHS mission, using faint substructures around disk galaxies to constrain dark matter models, connects directly to what I find most exciting in physics: understanding the dark universe and how large-scale structure emerges from it. My coursework in cosmology and general relativity at the University of Amsterdam has given me a foundation in the theoretical framework underlying structure formation, and I am motivated to develop the simulation expertise needed to tackle these questions.

My strongest asset for this position is my computational background. I am experienced in Fortran, C/C++, Python, and Bash, and I am comfortable working in Linux environments with version control. As a personal project, I have been developing a Kerr black hole ray-tracing visualizer in Fortran, implementing a fourth-order Runge-Kutta integrator for geodesic equations around rotating black holes, currently simulating light paths with thin-disk accretion and with plans to incorporate gravitational lensing effects. While this is not hydrodynamical simulation, it demonstrates my ability to independently write physics simulations from scratch, work with numerical methods for differential equations, and generate and post-process large sets of simulation output. During my Bachelor's at Boston University, I developed particle extrapolation algorithms in C++ for the Fermilab g-2 experiment, optimizing performance by 4x. In my current master's thesis at Nikhef, I have refactored data processing pipelines and implemented signal processing techniques such as matched filtering. I also have experience with PyTorch through coursework in machine learning for physics, which may be useful for ML-augmented analysis of simulation data. I also have practical experience working on computing clusters, having used the Fermilab cluster for my Bachelor's research, the Nikhef computing infrastructure for my thesis work, and the national Snellius supercomputer for machine learning coursework. While these were not in the context of astrophysical simulations, they have made me comfortable with remote computing environments, batch job submission, and managing large-scale computational workflows.

I recognize that I do not yet have direct experience with astrophysical hydrodynamical simulations specifically, but I have a strong computational foundation including HPC experience

across multiple clusters, and I am genuinely excited about developing simulation expertise in this area. The chance to design and run cosmological simulations, model baryonic processes and dark matter physics, and compare simulation output with multi-wavelength observations from ARRAKIHS is exactly the kind of work I want to dedicate the next years of my career to.

Thank you for considering my application. I would welcome the opportunity to discuss how my computational skills and enthusiasm for this field could contribute to your group's research.

Sincerely,
Meera Patel

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