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December 1, 2024

Search Committee  
Department of Astronomy  
The Ohio State University  
Columbus, OH, USA

Dear Members of the Search Committee,

I am writing to express my interest in the Buckeye Postdoctoral position at The Ohio State University. My research bridges galactic astrophysics and cosmology, leveraging full hydrodynamic cosmological simulations such as IllustrisTNG, EAGLE, and CAMELS to investigate how astrophysical processes in galaxies impact the nature and evolution of dark matter haloes. In addition to performing and analyzing such cosmological simulations, I develop controlled numerical experiments to study the formation of galaxies and their interaction with their host dark matter haloes. These efforts have equipped me with the expertise and independence necessary to design and lead innovative research projects that align with Ohio State's vibrant academic environment. I have also formulated a well-defined research plan to construct a physical description of the response of dark matter haloes to galactic astrophysics, aiming to significantly enhance our inferences about cosmology and dark matter physics from observations.

Currently, I am a Senior Research Scholar at IUCAA, where I have submitted my PhD thesis under the supervision of Prof. Aseem Paranjape. My thesis explores the astrophysical effects of galaxy formation and evolution on dark matter haloes, with a particular focus on their radial density profiles, which are directly relevant to observations such as rotation curves. While this primarily involves analyzing state-of-the-art cosmological simulations that produce realistic galaxies, I also develop tractable semi-numerical experiments to study galaxy-halo interactions in a more controlled manner. Additionally, I am engaged in a data science collaboration utilizing advanced statistical techniques, such as machine learning, to extract insights from the wealth of data produced by cosmological surveys.

Building on this foundation, my proposed research aims to establish a cohesive model for galaxy-halo interactions over cosmic time. A key goal is to quantitatively connect astrophysical feedback, particularly AGN-driven outflows, to the relaxation and structural evolution of dark matter haloes. Leveraging my time-correlated framework and Ohio State's computational resources and collaborations, I plan to advance this effort significantly. This aligns with your department's strengths in cosmology, large-scale structure, and galaxy formation. My prior experience with cosmological inferences using galaxy surveys, such as eBOSS and mock DESI data in collaboration with Prof. Hector Marin, further motivates me to contribute to Ohio State's strong ties with DESI.

Ohio State's extensive observational and computational resources, including its ties to DESI and the Ohio Supercomputing Center, are uniquely suited to support my proposed work. The department's collaborative research environment, particularly the interdisciplinary opportunities provided by CCAPP, would also enrich my development as an independent researcher. I am particularly excited about contributing to the department's legacy of leadership in both theoretical and observational

cosmology.

Beyond research, I am passionate about fostering a diverse and inclusive academic environment, mentoring students in astrophysics and actively participating in outreach activities aimed at making science accessible to broader audiences. As part of the Ohio State community, I look forward to engaging in these efforts and mentoring early-career researchers.

Thank you for considering my application. I have included my CV, publication list, and a detailed description of my past and proposed research. I look forward to the opportunity to contribute to the department's research endeavors and would welcome the chance to discuss my plans in more detail.

Sincerely,  
Premvijay Velmani,  
Senior Research Scholar,  
IUCAA Pune, India