

## **Atul Kedia - Statement of Purpose**

Applying for a PhD in Astronomy at Yale University

I am applying for a PhD in Astronomy at Yale University to pursue my interest in theoretical cosmology and astrophysics. I am interested in the large-scale structure of the universe, the cosmological reionization, the intergalactic medium, and the influence of dark matter halos and dark energy on the universe. I am also interested in the dynamics of astronomical objects like galaxies, quasars and black holes. Along with these I am keen to explore the fields of observational astronomy and theoretical high energy physics.

I developed my interest in astrophysics and cosmology over my high school and undergraduate years through both popular science and research. My first professional engagement with cosmology began when I started working on the “Scale of Homogeneity of the Cosmos using Quasars” with Prof. Subhabrata Majumdar and researcher Prakash Sarkar<sup>1</sup>. The work was aimed at calculating the length scale at which the universe is homogeneous. Our calculations using fractal dimensions show that this is achieved at a length scale of about  $150 h^{-1}\text{Mpc}$ . I started working on the project during the summer of 2014 and continued it during my junior year until I went for an exchange semester. I am continuing it now as a part of my Bachelors thesis. We are writing a paper describing our results which should be completed by the end of January.

At first the thought that advancements in observational technology have enabled us to view astronomical objects millions of light-years away boggled me. I was past my second year of undergraduate education when I started working on this project and had to pick up many intricate concepts quickly. I absorbed many creative ideas of modern cosmology like comoving distance, i.e. the distance at one epoch, fractal-like structured universe, and the use of fractal dimensions for inspection. This helped me develop maturity of thought and get a much bigger and clearer picture of the universe. Ideas like the  $\Lambda\text{CDM}$  model and about humongous pseudo structures fascinate me and inspire me to explore our cosmic wonders and to pursue cosmology as a career.

I have had the unique opportunity to explore my scientific and cultural interests in a new environment through an exchange semester at the University of Toronto, Canada. I gained an open-minded and practical perspective towards science by observing different viewpoints of scientists from a different part of the world. This, I believe, is critical for the overall development of a student of science.

The experiments that I performed there under the Advanced laboratory course and those that I performed in the electronics labs at IIT Bombay are some of my best experiences as an undergraduate. By myself I understood the theory and instrumentation behind the experiments, and finally experimented on them. This helped me understand every aspect of the experiments and by the end I found I could explain every bit. This gave me an extraordinary feeling of having learnt the art of experimentation. This experience in the field on experimental physics adds to my skill-set and I would like to explore this domain of physics further.

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<sup>1</sup>At the Tata Institute of Fundamental Research(TIFR), India.

In the summer of 2015, I worked in Prof. Dinshaw Balsara's group<sup>2</sup> on the "Stability of non-Relativistic Magnetized Astrophysical Jets". The idea of how astrophysical jets can be understood as the reverse phenomenon of a droplet's energy dispersing through ripples was ingenious to me. During the project I studied the non-relativistic magnetohydrodynamic equations and solved them numerically for a jet-like structure by linearizing them. I did this for jets with different velocity profiles in both the presence and absence of a magnetic field. During the project I was given the freedom to understand the modelling technique used in the literature and to come up with a code to implement this; this lead me to learnt how to approach and go about a research problem individually.

I also have a keen interest in teaching because it results in a structured and coherent thought process, apart from being a way to share my knowledge and understanding of science. I was a teaching assistant for an online course on Engineering Physics run by IIT Bombay for physics teachers in engineering colleges across India and have taken up a tutorial session for the same.

Since IIT Bombay does not offer any cosmology and astrophysics courses, research outside the curriculum was the only way I could learn about them. Due to this, throughout my undergraduate years, I have had to overload myself, which taught me how to manage my time and resources efficiently. I have taken courses on general relativity, quantum field theory, statistical mechanics, non-linear dynamics, continuum mechanics and computational fluid dynamics, which have given me a broad theoretical and computational background in physics.

My extra-curricular interests include sports, music, trekking and learning geography. I enjoy playing football(soccer), badminton, table-tennis and pool. These interests help me in both keeping myself fit and maintain my focus in my academics.

In the first four terms at Yale I would like to work with *Prof. Frank van den Bosch*, *Prof. Nikhil Padmanabhan*, *Prof. Charles Baltay*, *Prof. Priyamvada Natarajan* or *Prof. Daisuke Nagai*, based on which I would decide upon my PhD topic. *Prof. Van den Bosch's* work to address the cuspy-halo problem for dwarf galaxies greatly interests me. *Prof. Pandmanabhan's* work on the increase of certainty of physical properties due to reconstruction of baryon acoustic oscillations interests me too. The detection of dark energy is currently one of the most challenging astronomy problem and I would like to work on this fields with *Prof. Baltay*. *Prof. Natarajan's* work on the upper limits on black hole mass inspires me to explore this field. On the computational front, *Prof. Nagai's* work on modelling anisotropy in CMB and hydrodynamical cluster simulations needed to probe dark matter by gravitational lensing interests me thoroughly.

Being a PhD student at Yale would benefit me because I think I can make the most of the resources available, like the Keck Observatory, SDSS and the Palomar Observatory, for doing interesting cosmology and astrophysics. The intellectually stimulating environment at Yale will foster my overall growth and thus, I feel, Yale would be the right place for my research. I feel confident that with my research experience, my enthusiasm in astronomy and extra-curricular interests I will be able to contribute positively to the advancement of human understanding of our universe.

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<sup>2</sup>At the University of Notre Dame, United States