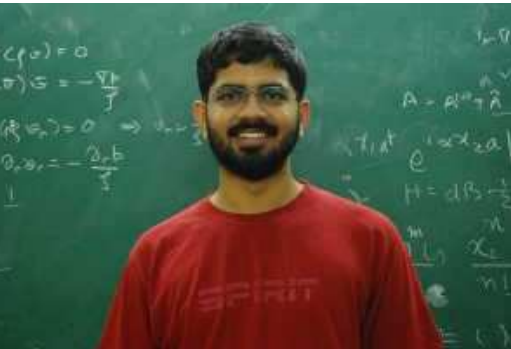


# Curriculum Vitæ: Girish Kulkarni



## Personal Information

Girish Pramod Kulkarni, born September 19, 1983;  
Indian citizen. Single.

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## Academic History

Harish-Chandra Research Institute, Allahabad (Homi Bhabha National Institute, Mumbai);  
Ph. D. (Physics); Thesis supervisor: Prof. Jasjeet S. Bagla; 2007–.

Harish-Chandra Research Institute, Allahabad (Homi Bhabha National Institute, Mumbai);  
M. Sc. (Physics); First Class with Distinction with 76.89% marks; April 2007.

Fergusson College, Pune (University of Pune); B. Sc. Physics; First Class with Distinction  
with 77.16% marks; April 2004.

Somalwar Junior College, Ramdaspath, Nagpur; (Maharashtra Board for Secondary and  
Higher Secondary Education, Nagpur division); Higher Secondary School Certificate Ex-  
amination (HSSC); First Class Distinction with 93.5% marks (93% in Mathematics and  
100% in Physics); March 2001.

Somalwar High School, Ramdaspath, Nagpur (Maharashtra Board for Secondary and Higher  
Secondary Education, Nagpur division); Secondary School Certificate Examination (SSC);  
Second in Nagpur division of Maharashtra state with 92.26% marks; March 1999.

## Research Interests

Epoch of reionization, galaxy formation and evolution, and 21cm cosmology.

- Semi-analytic models of reionization: sources of reionization; observational probes
- Semi-analytic models of galaxy formation based on N-body dark matter simulations;  
merger histories; outflows and chemical enrichment; implications for reionization;
- Halo model description of large scale structure; halo mass function and universality;  
applications to semi-analytic astrophysics
- Radiative transfer: algorithms; application to hyperfine line astrophysics and reionization

## Thesis work

The Epoch of Reionization—a period in the Universe’s history in which much of the baryonic content of the Universe was ionized due to electromagnetic radiation produced by small-scale structure—has been a focus of considerable amount of research in the last decade. This topic has now become a frontier of astrophysical research. This is primarily because newer, better

data are now available from the epoch of reionization in the form of high-redshift quasar absorption spectra, CMB data, Lyman- $\alpha$  galaxy statistics, etc.

My research interest centres in astrophysical cosmology. I started work in this field in 2008. My current projects deal with the epoch of reionization. Reionization is interesting firstly because it is caused by, and strongly influences, formation of gravitationally bound structure. Secondly, the epoch of reionization in the history of the Universe is now opening up to observations thanks to better telescopes. This demands better theoretical understanding.

Almost all theoretical work on reionization has been done in the last one decade. Much of it has focussed on modelling the process of reionization in various cosmological and structure formation scenarios. With this in mind I am currently working on the following issues: (1) the inverse problem of drawing constraints on early star formation and small scale structure formation from reionization-related observations; (2) developing semi-analytic models of galaxy formation that will use N-body dark matter simulation to study reionization and chemical enrichment; (3) developing radiative transfer codes to study reionization and observational constraints using hyperfine transition; (4) studying the role of high-redshift AGNs by using semi-analytic models of reionization and SMBH formation.

### Completed work

1. *Metal Enrichment and Reionization Constraints on Early Star Formation*: We use a simplified approach for studying the formation of stars in collapsed haloes and the resulting ionization of the intergalactic medium (IGM). We consider a set of LCDM models allowed by observations of cosmic microwave background temperature and polarization anisotropies for this study. We constrain parameters related to star formation with the help of observations.

We constrain subsets of these parameters independently by using the observed metallicity of the IGM at  $z \sim 5$  and the requirement that the Thomson scattering optical depth due to an ionized IGM as determined for the model from CMB observations be reproduced. We consider a range of initial metallicities for star-forming gas, and some variations of the initial mass function (IMF) of stars.

We find that a ‘normal’ IMF may satisfy these two constraints with a raised efficiency of star formation as compared to that seen in the local universe. Observations require a significant fraction of metals to escape from haloes to the IGM. We can also place constraints on the ratio of escape fraction for metals and ionizing photons, and find that this ratio is of order unity for most models. This highlights the importance of using the constraints arising from enrichment of the IGM.

Ultrahigh mass stars or active galactic nuclei may not simplify models of reionization in that these may produce more ionizing photons but these do not contribute to the production of metals and hence help in reducing only the escape fraction for ionizing photons. However, suppression of very low mass stars is helpful in that it increases the production of metals as well as ionizing photons, and hence leads to a reduction in both escape fractions. Such a change is also warranted by observations of metal poor halo stars in the Galaxy. We also discuss correlations in parameters like the efficiency of star formation and the two escape fractions with cosmological parameters.

### Past Research

Electromagnetic properties of stratified materials with Prof. S. Dattagupta, Hyderabad Central University, Hyderabad; May 2004.

Gravitational wave physics with Prof. Patrick Das Gupta, Delhi University, Delhi; June 2003.  
Number theory and its application in cryptography with Prof. C. E. Venimadhavan, Scientific  
Analysis Group, Defence Research and Development Organization, New Delhi; May 2002.

### **Tutoring**

Introduction to Astrophysics (Instructor: Prof. J. S. Bagla); HRI graduate school, August–  
December, 2007.

### **Skills**

- Semianalytic modeling, numerical methods, analysis of algorithms
- Computer programming: Fortran 77, Fortran 90, C, HTML, CSS,  $\text{\LaTeX}$ , Mathematica
- Scripting: Bash, Awk, Sed, Make, PGPLOT
- Computer administration: GNU/Linux, FreeBSD system and network administration, CVS
- Languages: Fluent spoken/written English, Hindi and Marathi; beginner spoken/written Bengali

### **Honours and Awards**

Saha Institute of Nuclear Physics, Kolkata; Undergraduate Research Associate; 2002–2004.  
Indian Institute of Science, Bengaluru; National Science Fellowship, *Kishore Vaigyanik Prot-  
sahan Yojana* 2000–2004.  
Indian Association of Physics Teachers, Pune; Placed in the top 1% of all national candidates in  
the National Graduate Physics Examination 2004. Placed in the top 1% of all Maharashtra  
state candidates in 2003 and 2002.  
Indian Physics Association, Pune; Awarded the first prize in a Physics quiz for undergraduates;  
2001.  
Indian Institute of Technology Bombay, Mumbai; Placed in the top 20 of all candidates in the  
Physics Olympiad; 2002.  
Indian Institute of Technology Kanpur, Kanpur; Awarded the first prize in an Astrophysics  
quiz; 1998.  
Hinduja Foundation, Mumbai; Hinduja Foundation Scholarship; 1999.  
Maharashtra Board for Secondary and Higher Secondary Education; ranked second in Nagpur  
division of Maharashtra state in school-leaving examination, 1999.

### **Participation in Significant Programs**

Meeting titled Cosmological evolution in diffuse baryons: Reionization epoch to the present  
day, Indian Academy of Sciences, Bengaluru; 2008.  
Program on Cosmology with the CMB and LSS, Inter-University Center for Astronomy and  
Astrophysics, Pune; 2008.  
International Conference on Gravitation and Cosmology, Inter-University Center for Astron-  
omy and Astrophysics, Pune; 2007.  
Indian Conference on Cosmology and Galaxy Formation, Harish-Chandra Research Institute,  
Allahabad; 2007.  
International Conference on Teichmuller Spaces, Harish-Chandra Research Institute, Alla-  
habad; 2005.  
Bhaskaracharya Pratishthana, Pune; Year-long mathematics training program for undergrad-  
uates with focus on linear algebra and real analysis; 2002–2003.

Introductory school on Astronomy and Astrophysics, Inter-University Center for Astronomy and Astrophysics, Pune; 2002.

Mathematics Training and Talent Search, Indian Institute of Technology Bombay, Mumbai; 2001.

CSIR Programme on Youth for Leadership in Science, National Environmental Engineering Research Institute, Nagpur; 1999.

### Talks in schools, workshops and conferences

Early star formation and reionization, in meeting titled Cosmological evolution in diffuse baryons: Reionization epoch to the present day, Indian Academy of Sciences, Bengaluru; 2008.

Reionization constraints on early star formation, in program on Cosmology with the CMB and LSS, Inter-University Center for Astronomy and Astrophysics, Pune; 2008.

Effects of features in power spectrum at non-linear scales, in International Conference on Gravitation and Cosmology, Inter-University Center for Astronomy and Astrophysics, Pune; 2007.

### Visits to other institutions

Raman Research Institute, Bengaluru; February 2008.

### Membership of Organizations

Bombay Natural History Society, Mumbai 400 001; Member; 1998–.

Saha Institute of Nuclear Physics, Kolkata 700 064; Undergraduate Research Associate; 2002–2004.

### Publications and Preprints

Bagla J. S., Girish Kulkarni, T. Padmanabhan; *Metal Enrichment and Reionization Constraints on Early Star Formation*, Monthly Notices of the Royal Astronomical Society **397** 2009, 971–978.

Bagla J. S., Nishikanta Khandai, Girish Kulkarni; *Mass function of haloes: scale invariant models*, Preprint, arXiv:0908.2702.

### References

Prof. J. S. Bagla Harish-Chandra Research Institute Chhatnag Road, Jhansi Allahabad 211 019 India	Prof. Dileep Jatkar Harish-Chandra Research Institute Chhatnag Road, Jhansi Allahabad 211 019 India
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Dr. L. Sriramkumar Harish-Chandra Research Institute Chhatnag Road, Jhansi Allahabad 211 019 India	Dr. T. R. Seshadri Department of Physics and Astrophysics University of Delhi Delhi 110 007 India
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December 13, 2009.