

# Ph.D Brochure

## Department of Physics

*Year 2022*

- Introduction
- High Energy Physics and Astrophysics
- Optics, Spectroscopy and Laser-Plasma Physics
- Computational Condensed Matter Physics (Quantum/Classical)
- Experimental Condensed Matter Physics
- Eligibility Criterion and Application Procedure



भारतीय प्रौद्योगिकी संस्थान हैदराबाद  
Indian Institute of Technology Hyderabad

# Introduction

Thank you for your interest in the Ph.D program in Physics at IIT Hyderabad! We hope that you will carefully review the information provided here to help you find out about the exciting opportunities we offer to pursue doctoral research in some of the most current and dynamic areas of physics and [how you can apply](#).

The Indian Institute of Technology, Hyderabad (IITH) was established in 2008, and is now functioning from its permanent campus in Kandi village of Telangana State. The Department of Physics at IIT Hyderabad is a rapidly growing department, presently we have 23 permanent faculty members, a number which we actively seek to increase, more than 75 Ph.D. students and a large number of MSc. and B.Tech (in Engineering Physics) students. The department has several groups pursuing research in diverse areas of physics. Presently their efforts are concentrated mainly in the the following fields:

- High Energy Physics and Astrophysics
- Optics, Spectroscopy and Laser-Plasma Physics
- Computational Condensed Matter Physics (Quantum/Classical)
- Experimental Condensed Matter Physics

**Ph.D Curriculum:** The IITH Physics Department is dedicated to providing the Ph.D students with both a broad background and in-depth training in their area of specialized research. Once admitted to the Ph.D program, the student has to earn 12 credits to complete his or her coursework requirements for a PhD. We offer intensive training in the fundamental topics of Physics through the core courses to prepare our Ph.D students for the challenges that lie ahead in their academic journey. The range of core courses offered include Classical Physics and Quantum Physics. In addition to the core courses, specialized elective courses are offered to the Ph.D students in their respective areas of research. Following the coursework, the Ph.D program is focused on full-time research. Students will work closely with their supervisors, and also interact with other members of their group, and also other groups. Further information on the elective courses offered and research of the various groups are provided in the following pages of this brochure. PhD students come into contact with an array of faculty and other members of the Physics community through journal clubs, public lectures and weekly seminar series (organized by research areas). Students will also have an opportunity to travel abroad for an international conference to present research papers.

**Ph.D Qualification Process:** Please check out the page detailing the [eligibility criterion and details of application procedure](#) if you are interested in pursuing a Ph.D at IITH Physics Department.



# High Energy Physics and Astrophysics

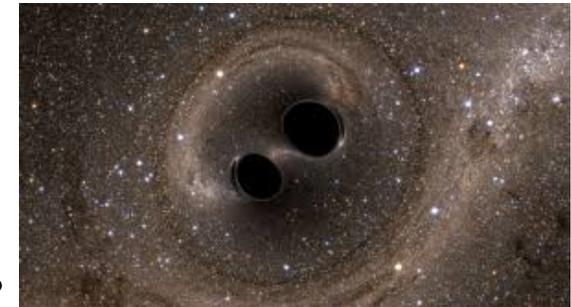
At the **HEP** group, we are looking for motivated Ph.D students to join us on a range of exciting projects. High Energy Physics is poised on the verge of a revolution with the LHC soon to attain peak energy and luminosity and a whole new generation of cosmological and gravitational experiments coming up. This means we are certain to cross over into unexplored territory beyond the standard model of particles and the standard model of cosmology, into supersymmetry, dark matter, dark energy, astrophysical cosmology, astrostatistics, hidden sectors and extra dimensions.

At our group, there is scope to do research both in formal aspects of theory (Quantum Chromodynamics, String Theory) and phenomenology targeting the latest collider searches (beyond the standard model, neutrinos, dark matter, Higgs). The HEP group is also a part of the NOvA Neutrino collaboration at Fermilab, USA; Belle collaboration at KEK, JAPAN. To find out more details please visit the IITH HEP group webpage [http://physics.iith.ac.in/HEP\\_Physics/](http://physics.iith.ac.in/HEP_Physics/) which also contains the research profiles of individual faculty members.

Specialized elective courses are offered by the group faculty to prepare students for research in high energy. Such electives include, Quantum Field Theory, General Relativity, Particle Physics, Cosmology, Group Theory. Following the course work, the Ph.D program is focused on full-time research. Students will work closely with their supervisors, and also interact with other members of the HEP group, participating fully in the life of the group including **HEP Journal Clubs**, **Remote Seminar Series**, **HEP gym**, **GIAN courses**, Workshops and Conferences (e.g. **FFCP'18**).



The Large Hadron Collider



Collapse of Black Hole Binary



NOvA Experiment



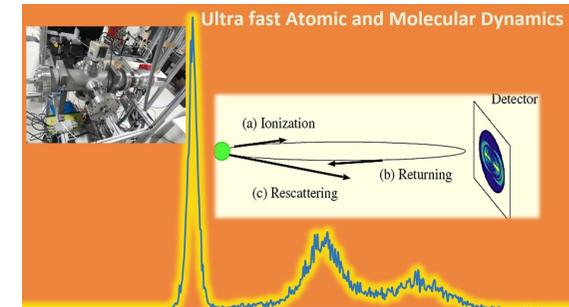
# Optics, Spectroscopy and Laser-Plasma Physics

We are looking for strongly motivated students with a keen interest to learn and develop exciting experiments and theoretical understanding. Our group is dedicated to achieving excellence in research and innovation, driving forward areas of research, which have a positive impact on society. The interaction of laser pulses with matter is opening up new frontiers in physics, which is enabled by advances in ultrashort pulse laser technology, which have enabled new regimes ranging from probing electronic structure of atoms and molecules, transient spectroscopy towards the development of tabletop accelerator technology, astrophysical plasma modelling & fusion power.

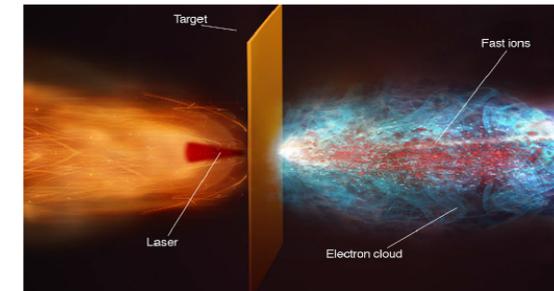
Our group has opportunities in aspects of experimental and theoretical investigation such as:

- ultrafast dynamics of atoms and molecules,
- ultrafast nonlinear optics and time-resolved spectroscopy,
- table top X-ray source,
- ultrashort electron source,
- exciton dissociation dynamics at a donor/acceptor interface in an organic photovoltaic system,
- astrophysical & intense laser plasmas,
- table top ion accelerators - Medical applications (ion cancer therapy).
- nonlinear Optics and Photonics, Fiber lasers.

The group has active collaborations in various central laser, FEL and synchrotron facilities in the UK, US and Europe; Tohoku and Osaka University



Atomic and Molecular Dynamics



Plasma and Laser interaction

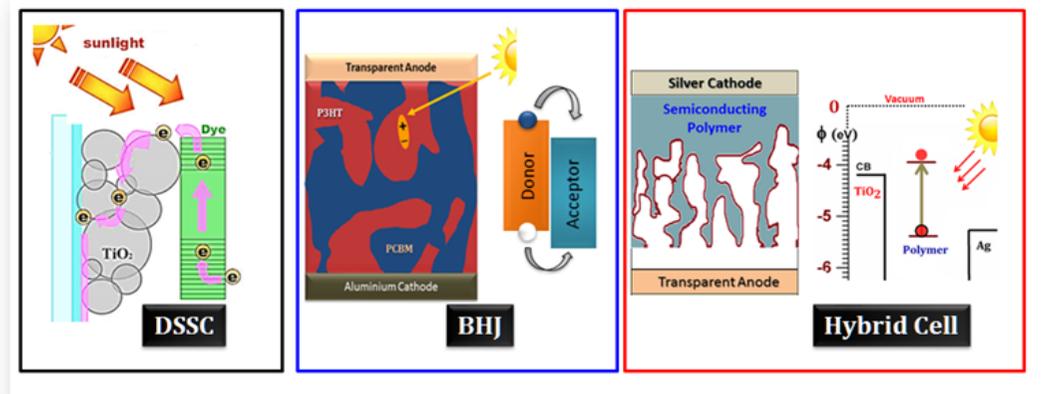
in Japan. To find out more details please visit the group webpage listed on <http://physics.iith.ac.in/>, which also provides links to profiles of individual faculty members.

Specialized elective courses are offered to prepare students for research in Atomic, Molecular and Plasma Physics. Such electives include Lasers and Photonics, Plasma Physics, advanced courses in Atomic and Molecular Physics. Following the course work, the Ph.D program is focused on full-time research. Students will work closely with their supervisors for designing experiments, and

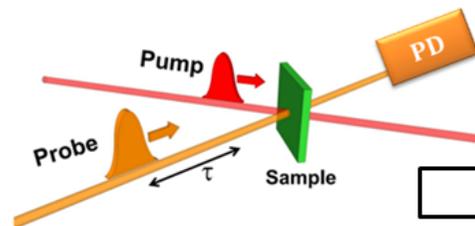
# Optics, Spectroscopy and Laser-Plasma Physics

also interact with other members of the group. Students will also have opportunity to travel abroad for international conferences to present research papers and also to perform experiments at international facilities.

## Donor - Acceptor Interface in Organic solar cells



Crucial mechanism is Exciton dissociation (<100 fs)



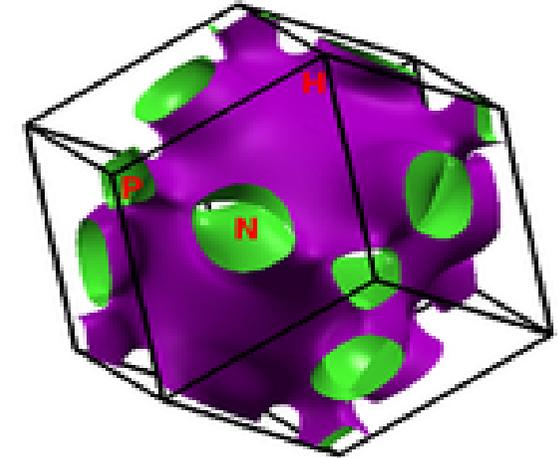
## Femtosecond pump-probe spectroscopy

Photophysics

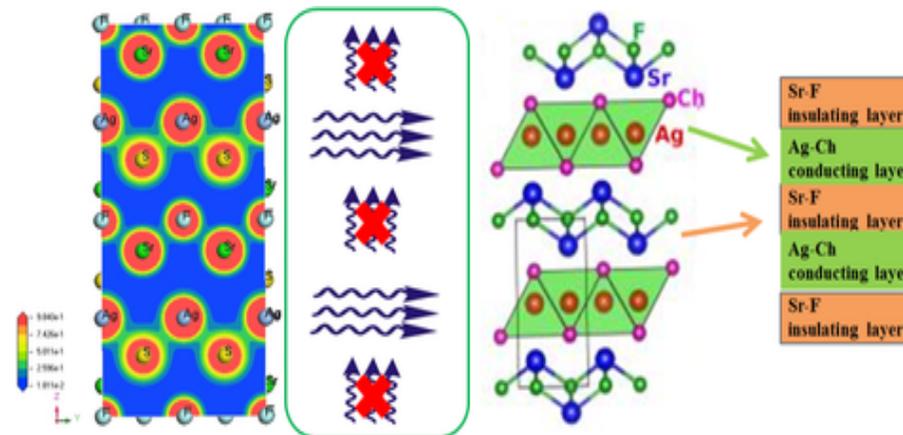
# Computational Condensed Matter Physics

Research in the Computational Condensed Matter Physics group can be divided into two subgroups. The first subgroup focuses on materials, which includes a diverse variety of topics such as basic electronic structure, phase transitions, magnetism, superconductivity, optical properties, transport properties. The second subgroup focuses on the study of complex systems like disordered systems, soft-matter, non-equilibrium statistical mechanics, biophysics, and many more.

This field of research is highly connected to different applications, like graphene, graphene-like materials, bio-mimetic materials, cancer metastasis, which are high in demand now.

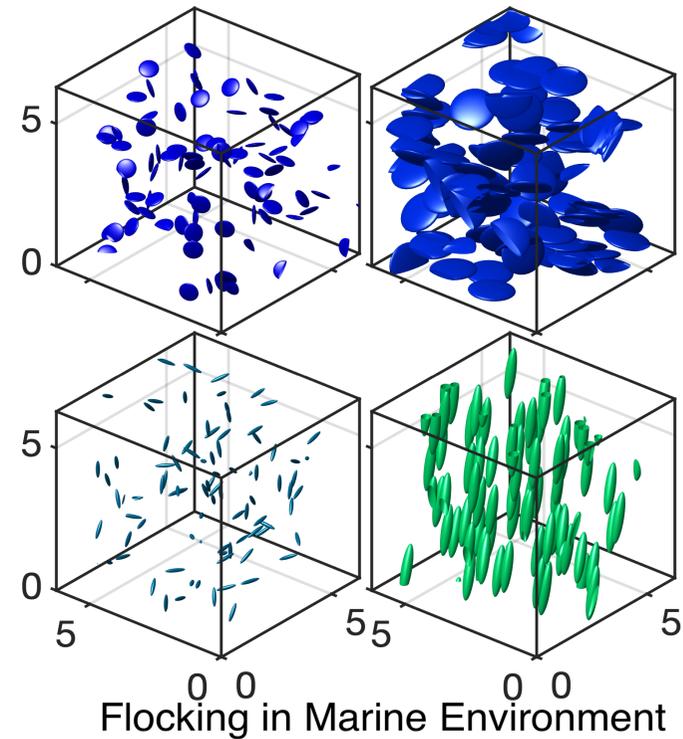


Fermi Surface of  $LaRu_4P_{12}$



Charge flow in a layered structure of  $SrAgChF$

# Computational Condensed Matter Physics



In addition, one can find a huge range of applications such as detector systems, energy storage, superconducting materials etc.

Our group at IITH is actively involved in exploring various material properties using first-principle calculations to design high potential materials for different applications. For more details visit <http://physics.iith.ac.in/index.html>. We welcome applications from students who are strongly motivated to work with us on innovative problems in Condensed Matter Physics.

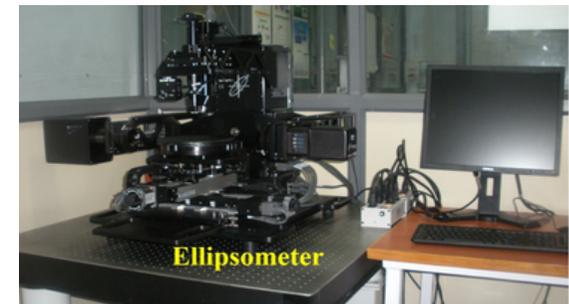
# Experimental Condensed Matter Physics

Understanding the fundamental physical concepts behind various materials, in particular, technological devices such as spin-electronics, semiconductor devices and nanoelectronics have been of great interest in recent past due to their strong potential for practical applications. On top of that today's technology demands smaller, faster and reliable devices. It is a challenge to understand the ultrafast time scale ( $10^{-9}$  s to  $10^{-18}$  s) prevalent in these nanoscale systems brought about by processes involving fundamental interactions between electron, spin, phonon and their corresponding correlation length and time scales.

The experimental condensed matter physics group at IITH conducts vibrant research in frontier areas of physics such as spintronics, magnonics, magnetic materials, advanced functional materials and microelectromechanical systems (MEMS). We thus offer a diverse range of cutting-edge topics for students to work on. Research laboratories are equipped with state of the art experimental facilities, thereby providing direct hands-on experience. Faculty members in this group have strong national and international collaborations, which provide many opportunities for students to visit and interact during the course of their research. Students can select a research field based on their interests and subject to the availability of vacancies with respective faculty members.

Courses for PhD scholars are designed in such a way that the students can attain very good understanding about their research field. The Physics department aims at strengthening the core physics course along with specialized elective courses.

Some of the elective courses aimed at Ph.D students interested in working in our group, include experimental techniques, advanced functional



materials, application of magnetic materials, microfabrication techniques, semiconductor device physics, spintronics and many more.



# Eligibility and Application Procedure

## Eligibility and Application Procedure

Currently, Ph.D program at IITH takes in students either through the regular route or a special route for sponsored candidates. The eligibility criterion for the applicants to the Ph.D program is laid out in the following:

### For Regular Ph.D. Candidates:

M.Sc. (Physics/Applied Physics/Electronics) or an equivalent degree in engineering(M.E./M. Tech. or M.Sc.(Engg) etc.) with a valid Physics GATE score/UGC-JRF/CSIR-JRF/DST-INSPIRE Fellowship.

OR

B.E./B. Tech. or equivalent engineering degree with a valid Physics GATE score.

### For Sponsored Candidates:

Candidates working in reputed research or industrial organizations may also apply for the **sponsored** Ph.D. program (please contact the head of the department for further details, criteria etc.) A proof of sponsorship from parent organization must be provided at the time of interview. NET qualified candidates are encouraged to apply. The eligibility criteria are similar to those for regular Ph.D candidates. Interested candidates are requested to contact the head of the department

for further details. **Note:** Sponsored candidates are not eligible for stipend.

If you are interested in the activities of a particular research group or a particular faculty member at IITH Physics and you are interested in exploring the possibility of pursuing a Ph.D, **please send an email to the particular faculty**. Applications for the Ph.D program are received twice (normally in March/ April and October/November each year). Please look for PhD advertisement on our website for exact dates. One can also contact the Head of Department of Physics for further information.

**MoE candidates:** please check the departmental website for potential research areas.

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