

Celebrating the Discovery of Gravitational Waves



Members of LIGO-India team met the Prime Minister prior to his departure to USA, where the LIGO-India MoU was signed.
(L to R) Tarun Souradeep, Dhiraj Bora, R. Chidambaram, Sekhar Basu, Narendra Modi, P. D. Gupta, and Somak Raychaudhury

Marking a historic moment in science, Gravitational Waves were first detected on September 14, 2015 by both of the twin Laser Interferometer Gravitational-wave Observatory (LIGO)

detectors, located in Livingston, Louisiana, and Hanford, Washington, USA. The result was announced to the world on February 11, 2016 by the LIGO Science Collaboration (LSC), which involved a significant contribution from scientists in India. IUCAA hosted a synchronised press event on behalf of the nationwide gravitational wave community on the evening of February 11 that carried on to a second session on the morning of February 12, 2016. Top science journalists and media persons from all over the country attended these events. The major science news, together with the Indian contributions got wide coverage in the Indian news media, internet and television, including prime time TV coverage on the evening of February 11. The celebrations at IUCAA were graced by science luminaries, Anil

Kakodkar, Jayant Narlikar, and chairman of the IUCAA Governing Board, Sreekumar Banerjee. Highlights of the two day celebration were the presence of C. V. Vishveshwara, whose early prediction of the black hole ringdown made in 1971 was validated by this discovery; and an abundantly attended public talk by Sanjeev Dhurandhar, IUCAA, who is also an Indian pioneer in gravitational wave research. A dramatic twist to the proceedings in the evening was revealed by the IUCAA Director, Somak Raychaudhury, when he showed three timely tweets from the Prime Minister of India that hailed the global science discovery, the Indian contributions and hinted at the Union Cabinet approval for LIGO-India in the near future.

The current Indian gravitational wave scientific community has arisen out of

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research programmes carried out over three decades. Notably, at IUCAA, the group led by Sanjeev Dhurandhar, who initiated and did foundational work on developing data-analysis techniques to detect these weak signals buried in the detector noise and led the solo Indian group in the LSC in the initial era of LIGO for a decade. Currently, the pan-Indian participation in the LSC, under

the umbrella of the Indian Initiative in Gravitational-Wave Observations (IndIGO), involves sixty-one scientists from nine institutions, namely: CMI Chennai, ICTS-TIFR Bengaluru, IISER-Kolkata, IISER-Thiruvananthapuram, IIT Gandhinagar, IPR Gandhinagar, IUCAA Pune, RRCAT Indore, and TIFR Mumbai. Most members of these GW science teams nation-wide attended the



celebrations at IUCAA and had an opportunity to interact with the national media. The events were jointly organised and managed by the gravitational wave researchers at IUCAA with great help from the IUCAA science outreach and the administration.



Signing of the LIGO-India MoU in USA on March 31, 2016.

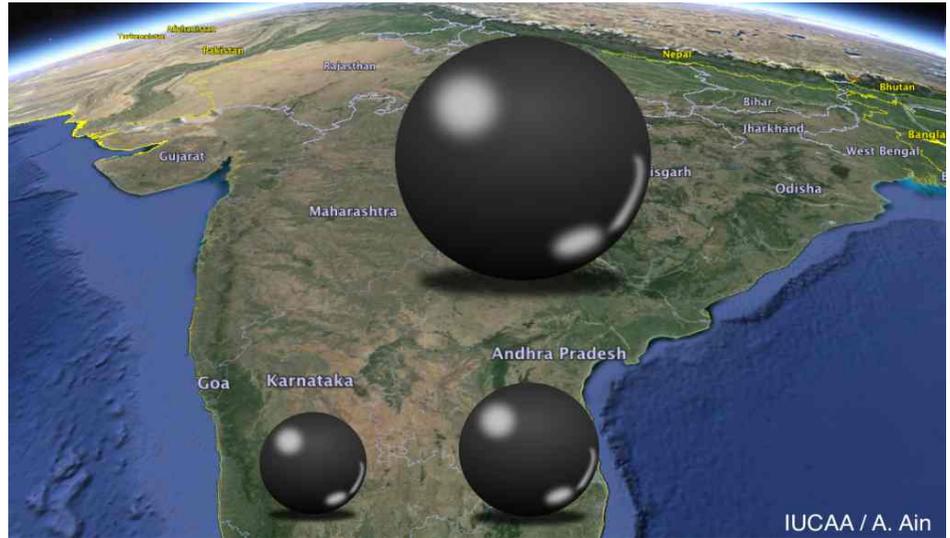


Events Celebrating the Discovery of Gravitational Waves...

The discovery of gravitational waves paves the road to the possibility of observing our universe in gravitational waves if one can locate their source with an additional detectors placed in India, far from the LIGO detectors, forming one or more large triangles. The global science community is unanimous that the key to the future of gravitational wave science, beyond the discovery phase launched with the announcement on February 11, 2016, lies with the LIGO-India observatory.

The Union Cabinet of India has granted 'in principle' approval to the LIGO-India mega science proposal on February 17, 2016. LIGO-India will establish a state-of-the-art gravitational wave Advanced LIGO detector on the Indian soil in collaboration with LIGO Laboratory, led by Caltech and MIT, USA. This was rapidly followed up by signing of an MoU between the National Science Foundation, USA and the Department of Atomic Energy and Department of Science and Technology of India on March 31, 2016 in the USA in the presence of the Prime Minister of India Shri. Narendra Modi. These steps make an emphatic statement of the Indian government's commitment to the rising aspirations of the Indian science to make a far-reaching impact in the global arena of Science and Technology, and to provide opportunity to the country's youth to proudly look forward to careers in international-level science research within the country.

The LIGO-India project will be jointly coordinated and executed by three premier Indian lead institutions: The Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune of the University Grants Commission, with Department of Atomic Energy (DAE) organisations, the Institute for Plasma Research (IPR), Gandhinagar, and the Raja Ramanna Centre for Advanced Technology (RRCAT), Indore. LIGO-India will be jointly funded by the Department of Atomic Energy DAE and the Department of Science and Technology (DST). IUCAA, the key



The observed signal was created by two massive black holes merging together in a galaxy 1.3 billion light years away. The masses of the black holes are 36 and 29 times the mass of the Sun. Black holes are so high in density that these massive black holes are actually even smaller than earth. The two merging black holes and the resulting bigger black holes are shown in approximate scale in the above image.

science stakeholder of LIGO-India will be responsible for the science teams, human resources development, data acquisition and scientific data computation. IUCAA would continue to extend logistic support to the IndIGO consortium of researchers in this field spread over a dozen premier institutions, namely, the IITs at Gandhinagar, Madras (Chennai), and Kanpur; IISERs at Thiruvananthapuram, Kolkata and Pune; Chennai Mathematical Institute; ICTS Center of TIFR, Bengaluru; and the University of Delhi.

IPR will work closely with the LIGO-India project team for the vacuum system and will contribute by way of providing the required technical support and expertise for the specification layout, design adaptation and tendering of the vacuum system. IPR will also contribute to the supervision of LIGO-India project team's work on design and implementation of real time data acquisition and control systems. RRCAT will provide all the required support for key technological expertise for lasers, optics and vacuum by way of design, expert advice,



consultancy and training of human power in vacuum technology and optics/laser technology, etc.

Besides the grand promise of launching a new field of gravitational wave astronomy, LIGO-India will be a premier and frontier science experiment on Indian soil. It will involve laser, optics, vacuum and control system technologies at cutting edge of global capabilities and bring together the best in fundamental science and high end technology available in Indian national research laboratories, IITs, IISERs and Universities. IUCAA welcomes wide participation in this frontier science endeavour from universities and institutions nationwide.

CONGRATULATIONS !!!

DETECTION OF GRAVITATIONAL WAVES AWARDED SPECIAL BREAKTHROUGH PRIZE IN FUNDAMENTAL PHYSICS

For the detection of Gravitational Waves (Published in Physical Review Letters, **116**, 061102, February 11, 2016), opening new horizons in Astronomy and Physics, the special Breakthrough Prize in Fundamental Physics has been awarded. The Breakthrough Prizes in Fundamental Physics are funded by the Milner Global Foundation. The US \$ 3 million award will be shared between two groups of laureates: The three founders of the Laser Interferometer Gravitational-Waves Observatory (LIGO), will each equally share US \$ 1 million, and 1,012 contributors to the experiment will each equally share US \$ 2 million.

The 3 founders of the LIGO are: Ronald W.P. Drever (Caltech), Kip S. Thorne (Caltech), and Rainer Weiss (MIT) USA. Among the 1,012 contributors, 8 are present members of IUCAA, 6 are former members, and among these are 2 visiting associates of IUCAA. Also, there are 2, who were long term project student/post-doctoral fellow in IUCAA. They are:

Present Members

Anirban Ain
Sukanta Bose
Sanjeev Dhurandhar
Sharad Gaonkar
Anuradha Gupta
Sanjit Mitra
Nikhil Mukund
Tarun Souradeep

Former Members

Arunava Mukherjee
Archana Pai
Jayanti Prasad
B.S. Sathyaprakash

Former Members and Visiting Associates

Rajesh K. Nayak
Anand S. Sengupta

Former Project Student/ Post-Doctoral Fellow

Swetha Bhagwat
Soma Mukherjee

The laureates will be recognized at a ceremony in the Fall of 2016, where the annual Breakthrough Prizes in Fundamental Physics (including the special prize) will be presented. The Prime Minister of India, Shri Narendra Modi has congratulated the Indian contributors through Social Media.

The entire team has also been awarded the Gruber Cosmology Prize for 2016. The monetary award of US \$ 0.5 million will go to the three founders, but the entire team of contributors has been recognised in the award.



Anirban Ain



Sukanta Bose



Sanjeev Dhurandhar



Sharad Gaonkar



Anuradha Gupta



Sanjit Mitra



Nikhil Mukund



Tarun Souradeep



Arunava Mukherjee



Archana Pai



Jayanti Prasad



B.S. Sathyaprakash



Rajesh K. Nayak



Anand S. Sengupta



Swetha Bhagwat



Soma Mukherjee



Shri Anil Shirole, Member of Parliament, Pune visited IUCAA on February 21, 2016 to felicitate the scientists engaged in Gravitational Wave research. He also has extended his full support to IUCAA in its endeavour to set up LIGO-India.

School and Workshop on Large Scale Structure: From Galaxies to the Cosmic Web



Understanding the cosmological Large Scale Structure (LSS), both its growth starting from small fluctuations to the evolution of its constituent galaxies and inter-galactic medium, is at the frontier of research in extra-galactic astronomy and cosmology. A number of large international efforts are enabling these studies by providing an unprecedented quantity and quality of data, with low redshift surveys already under way, and Stage IV surveys (e.g., Euclid, LSST) are being planned. The near future will also see the construction and commissioning of high quality instruments, such as the Thirty Metre Telescope and the Square Kilometre Array, which will offer unparalleled advances in observations at, respectively, optical and radio wavelengths.

Painting a holistic picture of the cosmos from these observational efforts requires a deep understanding of the complex interplay of the physics on atomic, astrophysical and cosmological scales that determines the evolution of galaxies on the one hand, and fundamental questions such as the nature of Dark Matter, Dark Energy and tests of General Relativity at the largest



scales, on the other. The school for graduate students, conducted during February 1 - 8, 2016 covered the necessary basics in multiple areas of cosmology and astrophysics, including the following topics:

- * Growth of cosmological LSS and the cosmic web
- * Physics of the evolution of galaxies and the inter-galactic medium
- * Connection between LSS and galaxy evolution
- * Large sky surveys and cosmological probes, and
- * Analytical and semi-numerical methods for studying LSS.

The workshop during February 9 - 12, 2016 following the school brought together a larger number of scientists working in these areas for a more advanced discussion of the latest developments in these as well as complementary topics.

The lectures from the school, as well as the talks from the workshop are being made available online by the IUCAA Library at <http://repository.iucaa.in:8080/jspui/handle/11007/3777>.

The coordinator of the school and workshop was Aseem Paranjape.

KHAGOL - Migration to Electronic Format

Dear Khagol Reader,

Starting from October 2016, Khagol (The quarterly bulletin of IUCAA) will migrate to an electronic format accessible via internet, by substantially reducing the number of printed copies.

Khagol is currently accessible online in PDF format at <http://ojs.iucaa.ernet.in>. However, this location will change to <http://ojs.iucaa.in> once the migration to e-format is completed. In order to provide you with details on accessing e-Khagol, as well as subsequent e-mail alerts, we require your e-mail address. If you wish to receive this information and subsequent alerts, please send an e-mail to publ@iucaa.in from your preferred e-mail account with the subject 'SUBSCRIBE E-KHAGOL'.

If you prefer to continue to receive printed copies instead of (or in addition to) e-mail alerts, please inform us accordingly by return postal mail or, preferably, by sending an e-mail to publ@iucaa.in with the subject 'KHAGOL PRINT VERSION'.

Kindly note that if we DO NOT hear from you by August 10, 2016, you will NOT RECEIVE printed Khagol copies starting October 2016.

Looking forward to your response and continued readership.

Editor, Khagol

School on Best Practices in Astro-statistics



The School was held at IUCAA during January 27- 30, 2016. It was attended by 25 participants (23 research students from all over the country and 2 teachers). Five resource persons conducted the school with lectures in the mornings and hands-on sessions in the afternoons. The main course was conducted by Coryn Bailer Jones (MPIA, Heidelberg, Germany) who covered the topic of Bayesian methods: Parameter estimation, model comparison, Monte-Carlo methods, etc. The tutorials were primarily based on 'R' codes, which were introduced by U.C. Joshi of PRL, Ahmedabad. Shashi Kanbur from Oswego University, USA



talked on statistical approaches to testing for linearity in regression problems in astrophysics with particular application to extra-galactic distance scale. Jeremie Lasue from University of Toulouse, France talked on multivariate data analysis applied to space missions: Classifying and quantifying ChemCam LIBS data. Ajit Kembhavi of IUCAA, Pune, covered χ^2 distribution and its application to error analysis. On 28th afternoon, H. P . Singh, University of Delhi, New Delhi gave a tutorial on

Astro-statistics with VO tools.

A public outreach talk by Coryn Bailer Jones on 'How do astronomical phenomena affect the earth?' was organized on 29th evening as a part of this school, which was well attended by about 150 persons.

The school was partially funded by IUSSTF, New Delhi. Co-ordinators of this school were Ranjan Gupta (IUCAA) and H. P. Singh (University of Delhi).

Workshop on Electromagnetic Scattering as a Tool in Astronomy and Astrophysics

This workshop was held at the Department of Physics, Maharaja Krishnakumarsinghi Bhavnagar University, Gujarat, during January 4 - 5, 2016, and was attended by 51 participants, consisting of students, research scholars, post-doctoral fellows, and faculty members. This workshop was supported by IUCAA. S.P. Bhatnagar from M.K. Bhavnagar University welcomed the participants, and followed by an introduction of the theme by Ranjan Gupta of IUCAA. The keynote address by J.N. Desai, Physical Research Laboratory (PRL), Ahmedabad was very informative, and he introduced the subject with a historical background and took the audience to the wonderful world of scattering phenomena in nature. N.M. Ashok of PRL, introduced the participants to the novae, and explained how light scattering is used for their study. His



talk set the note for dust production to destruction, and its importance in Astronomy and Astrophysics. Recent activities in the studies of symbiotic novae was lucidly presented by Vishal Joshi of IUCAA. Post lunch, V. Venkata Raman of PRL, talked about techniques of IR based studies in proto-planetary nebulae. U.C. Joshi of PRL, gave an insight into cometary research through

polarimetric studies. Participating research scholars presented their work through posters.

The second day of the workshop began with an indepth introduction of interstellar dust by D.B. Vaidya (Ex-faculty) of Gujarat College, Ahmedabad. He talked about the recent simulation results and their relationships with experimental data.

Ranjan Gupta exposed the participants to various techniques and tools of light scattering, which are used for understanding the astrophysical phenomena. This was followed by R.V. Mehta of M.K. Bhavnagar University presenting an overview of laboratory studies on the localization of light, carried out at the university using ferro-fluid as scatterer

of light. Sharad Sheth of Bhavans College, Ahmedabad, talked on the zonal variability in Mars' atmosphere, studied through data collected by various space probes. The last lecture was by Rupjyoti Gogoi of Tezpur University and an associate of IUCAA, on her work on dust in specific galaxies.

A visit to Bhavnagar Observatory was

arranged, where participants were introduced to the 14" telescope, which was built at IUCAA. A demonstration of ferro-fluid and magneto rheological fluid was also arranged. In the concluding session, Kumar Bhatt of PRL gave a summary and a feedback on the workshop. S.P. Bhatnagar and Ranjan Gupta were the coordinators.

Meeting of International Astronomical Consortium for High Energy Calibration



The 11th Annual Meeting of the International Astronomical Consortium for High Energy Calibration (IACHEC) was held at IUCAA during February 29 - March 3, 2016. The meeting was attended by 60 participants, including 25 from abroad. All major international high energy (X-ray and shorter wavelengths) missions were represented at the meeting. The participation from India was wide-ranging, including ISRO and other research institutions engaged in space astronomy research, as well as several universities and colleges. The meeting discussed in detail the method and results of all aspects of calibration of the instruments aboard these missions, and the cross comparison of calibration results among these missions. Future joint multi-mission calibration programmes were planned. Extensive discussions were conducted regarding India's ASTROSAT mission launched in September 2015.

The programme of the meeting included plenary sessions and parallel discussion sessions of multiple working groups. The working groups were organised around a number of important themes such as Contamination, Calibration Uncertainties, Coordinated Observations, CCDs, High



Resolution and different classes of standard calibration sources including White Dwarfs, Isolated Neutron Stars, Galaxy Clusters and Supernova Remnants of Thermal and Non-Thermal variety. Discussions held in the working group sessions were summarised in the closing plenary session. New statistical techniques for achieving concordance in calibration between different missions was discussed at length, and emerging software tools were described.

A special session in the meeting was devoted to the ASTROSAT mission, in which the capabilities and science goals of the mission were highlighted, and the early calibration results were

presented. At the time of the meeting, the ASTROSAT mission was still in its Performance Verification phase and calibrations were ongoing. Several cross calibration observations between ASTROSAT and other space missions had already been arranged through the IACHEC community. Results of some of them were discussed and further course of action was planned.

As a part of this meeting Matteo Guainazzi, Chair of IACHEC, also delivered a public lecture on the Japanese Hitomi mission, which had been launched just two weeks earlier. The coordinator of this meeting was Dipankar Bhattacharya.

National Science Day - 2016

Since so many exciting happenings in Indian astronomy in the recent past, the National Science Day celebrations at IUCAA gave us a chance to present several highlights to the thousands of people who had visited the campus on the February 28, 2016 for an Open Day.

The main attractions that welcomed visitors were the representative models of the ASTROSAT and LIGO-India (the latter made by the amateur astronomers from the Jyotirvidya Parisanstha). Both the projects have been in the news and were quite a hit. People appreciated the efforts of the teams led by Gulab Dewangan and Sukanta Bose (both from IUCAA), who worked hard on demystifying the complex principles and technology that go into these two projects.

People were also welcomed and guided by the IUCAA staff members, through the various displays, including about 30 spectacular posters, introducing general Astronomy and the related work done at IUCAA. These were put up by the Research Scholars and Post-doctoral Fellows of IUCAA. The general public also got the chance to discover the wonders of the Universe through special demonstrations and talks. A demonstration about Optics and Spectroscopy was put together by the



IUCAA Labs; the members of the Radio Physics Laboratory highlighted the concepts of Radio Astronomy; short talks were given by Prasanta Bera (English), Ruchika Seth, Sonali Sachdeva (Hindi) and Shabbir Sheikh (Marathi) (all from IUCAA).

Special demonstrations were coordinated by Ashok Rupner and Manish Jain (both from IUCAA) kept public rooted in the Chandrasekhar Auditorium during the morning. In the afternoon, there was a live interaction, in which Jayant Narlikar and Somak Raychaudhury, eloquently answered several Astronomy related questions from the public. This was coordinated by Aseem Paranjape and Samir Dhurde. Since, the auditorium was chock-full, Ranjeev Misra (from IUCAA) and Arvind Paranjpye (from Nehru Planetarium, Mumbai) conducted another session in the lecture Hall. Bhaskara 3 at the same time. Following this, there were three special talks on ASTROSAT by Dipankar Bhattacharya (from IUCAA), on Discovery of Gravitational Waves by Sanjeev Dhurandhar (from IUCAA), and an evening lecture on the 2015 Physics Nobel Prize, titled "Burning of the Sun and Turning of the Earth – Probing Nature with Neutrinos" by Amitava Raychaudhuri (from Calcutta University).

In the Science Park area, people could get information about telescope making and get a peek through a solar telescope. These were put up by the Akashmitra group from Pune. The science toys group gave wonderful explanations of various science experiments developed at the

Muktangan Vidyan Shodhika to large crowds. The many science models located in the Science Park were renovated by Maharudra Mate (from IUCAA) and explained by groups led by Sonal Thorve (from IUCAA). Volunteers were trained to showcase the scientific contributions of the four great scientists, whose statues are part of the IUCAA Kund, to explain the principles behind the Foucault pendulum, IUCAA megaprojects, etc. and they did a wonderful job of interacting with the crowd. Some NGOs put up stalls to introduce people to various science books and educational resources. There was the evening sky show wrapping up the celebrations. There were about 1,200 public participating in it and enjoyed watching the sky.

As per tradition, there were events for school students prior to the open day. IUCAA Public Outreach personnel conducted a science quiz along with essay writing, story writing and drawing competitions for the rural students of the Ambegaon Taluka on February 6, 2016. Shabbir Shaikh and Ruchika Seth (both from IUCAA) enthusiastically encouraged students from thirty rural schools, who competed at the venue generously provided by the New English School, Landewadi. A lot of help also came from the IUCAA Girawali Observatory staff Nilesh Pokharkar along with others.

On February 20, 2016, about 450 students from 60 schools in Pune city responded to IUCAA's invitation and participated in another set of inter-school competitions. Students from classes VIII to X took part in the drawing, essay, poetry and science quiz



Public Talks

January 29 -

How do astronomical phenomena affect the Earth? by Coryn Bailer Jones, Max Planck Institute for Astronomy, Heidelberg, Germany.

February 09 -

Testing Einstein's theory by measuring the Universe by Roy Maartens, University of the Western Cape, Cape Town, South Africa.

February 12 -

Einstein's centennial gift: Gravitational waves discovered! by Sanjeev Dhurandhar, IUCAA, Pune.

February 28 -

ASTROSAT by Dipankar Bhattacharya, IUCAA.

Gravitational Waves Discovered! by Sanjeev Dhurandhar, IUCAA.

2015 Physics Nobel Prize, titled "Burning of the Sun and Turning of the Earth - Probing Nature with Neutrinos" by Amitava Raychaudhuri, Calcutta University.

March 02 -

Looking at the invisible heavens with Hitomi by Matteo Guainazzi, Institute of Space and Astronomical Science, Japan.

2nd Saturday Lectures

January 09 -

Studying galaxies in radio light by Yogesh Wadadekar, NCRA, Pune.

February 13 -

Gravitational waves by Sanjit Mitra and Bhooshan Gadre, IUCAA, Pune.

Regular events

During this quarter, the Public Outreach personnel have conducted 25 science toys workshops, 08 basic astronomy workshops, 07 campus visits, 04 taramandal events, and 04 sky watching programmes.

competitions. Bhooshan Gadre (from IUCAA) gave an interactive talk to the teachers, who accompanied the students. After the finals of the quiz competition, all winning students received their prizes from Varun Sahni (from IUCAA), which included the

students from the rural schools, who were specially invited to IUCAA for a visit that day. All the students were enthused and also very happy to have a chance to interact with the IUCAA scientists during these National Science Day celebrations.

IUCAA Preprints

IUCAA preprints released during January - March 2016 can be obtained from the IUCAA library (library@iucaa.in). The preprints can also be freely downloaded from <http://www.iucaa.in/~library/main.html>.

Winners for the Rural Competitions, held on February 6, 2016

Science Quiz:

1st - Sonal Rajaram Kather, Suyesh Mangesh Wagh, and Rutuja Yadav Chaskar, from New English School, Landewadi.

2nd - Pitambar Nareshwar Pande, Ajinkya Rajendra Mohale, and Siddhant Suresh Erande, from New English Medium School, Ghodegaon.

3rd (Joint) - Chetana Nivrutti Gawade, Pragati Lakshman Dongare, and Akshada Baburao Thorat, from Hirkani Vidyalay, Gawadewadi.

3rd (Joint) - Sonali Ghanashyam Bhondave, Omkar Popat Shitole, and Dhiraj Rajendra Sobaji, from Pandit Jawaharlal Nehru Vidyalaya.

Essay Writing:

1st - Sakshi Sitaram Gunjal, from New English School, Landewadi.



2nd - Pragati Prakash Karale, from Hirkani Vidyalay, Gawadewadi.

3rd - Salma Abusallam Shaikh, from Nalanda English Medium School, Manchar.

Drawing:

1st - Shivani Rajesh Irlwad, from New English School, Landewadi.

2nd - Pratik Dipak Hule, from Shri Hanuman Vidyalaya, Gangapur.

3rd - Aditi Satish Tavhre, from Janata Vidyamandir, Ghodegaon.





1st Prize - Drawing Competition (Rural)
(Theme: Sun- Earth connection)



2nd Prize - Drawing Competition (Rural)
(Theme: Science for the preservation of Nature)



3rd Prize - Drawing Competition (Rural)
(Theme: Sun- Earth connection)

Winners for the competitions for Pune City students, held on February 20, 2016



Science Quiz:

1st - Aryan Mandar Wadhvekar, Chinmay Jagannath Chavadekar, and Tanmay Vivek Chavan, from Symbiosis Secondary School, Pune.

2nd - Arjun Choudhry, Udit Sharma, and Deepak Sukhadev Shingade, from Army Public School, Khadki.

3rd - Parth Avinash Mane, Pratham Premendra Srivastava, and Aseem Advait Khandekar, from Podar International School, Chinchwad.

Essay: Marathi

3rd - Shubham Ravindra Mahajan, from Jnana Prabodhini Navnagar Vidyalaya, Nigdi.

(No eligible essays for the first and second prizes)

Essay: English

1st -Mrunmayee Nerlikar, from St. Mary's School, Pune.

2nd - Aadit Ajay Laghate, from Bharatiya Vidya Bhavan Paranjpye Vidya Mandir, Pune.

3rd - Mehak Sati, from Army Public School, Pune.

Drawing:

1st - Vaidehi Reddy, from Army Public School, Pune.

2nd - Mrudula Sunil Sawaikar, from

Sevasadan English Medium School, Pune.

3rd - Kyathi Charvi Vallampati, from Global Indian International School, Chinchwad.

Poetry: English

1st (Joint) - Aditi Dindorkar, from St. Mary's School, Pune.

1st (Joint) - Raina Vin, from Delhi Public School, Pune.

3rd (Joint) - Kainaat Bhaskar, from Army Public School, Pune

3rd (Joint) - Pushkar Mohile, from Global Indian International School, Chinchwad.

(No poetry in English was eligible for the second prize)

Poetry: Marathi

1st - Tanmay Narendra Bhide, from Sevasadan English Medium School, Pune.

2nd (Joint) - Shweta Ashutosh Deshpande, from Abhinav Vidyalaya High School, Pune.

2nd (Joint) - Poonam Mohan Thakare, from Vidyapeeth High School, Ganeshkhind, Pune.

(No poetry in Marathi was eligible for the third prize)



1st Prize - Drawing Competition (Urban)
(Theme: Einstein and Gravity)



2nd Prize - Drawing Competition (Urban)
(Theme: Observatories in Orbit)



3rd Prize - Drawing Competition (Urban)
(Theme: Science: Past, Present and Future)

School on Gravitation and Astroparticle Physics

The School on Gravitation and Astroparticle Physics was organized, jointly by the Department of Physics and Astronomical Science, Central University of Himachal Pradesh (CUHP, Dharamshala) and Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, during February 29 - March 12, 2016 at TAB Shahpur. The school began with the formal inauguration by Kuldeep Chand Agnihotri, Hon'ble Vice-Chancellor of CUHP, delivering the inaugural address. About 30 young researchers from different institutes in India and abroad participated in the school.

The first week of the school, mainly focused on advanced theoretical techniques in General Relativity, Gravitational Waves, and Numerical Relativity, during which the speakers were Sanjay Jhingan (Jamia Millia Islamia, New Delhi), Sanjeev Dhurandhar (IUCAA), Amitabh Virmani (Institute of Physics, Bhubaneswar), and Sanjit Mitra (IUCAA). The second week focused on Cosmology and Astroparticle Physics, for which the speakers were Sanjeev Kumar Verma (Delhi University), Subinoy Das (Indian Institute of Astrophysics, Bengaluru), Debasish Majumdar (Saha Institute of Nuclear Physics, Kolkata), and Baba Potukuchi (Jammu University). About



35 lectures were delivered, and there were 3 presentation sessions by the students. All the lectures were videographed and would be uploaded on the university website.

In addition to the regular lectures, 3 public lectures were also organized for the students and teachers of the local schools and colleges. The first public lecture was by Dhurandhar on March 3, who introduced the public to the recent discovery of gravitational waves. This was a wonderful experience to the entire audience, as he was amongst the pioneer scientists, who detected the gravitational waves after almost 100 years of their prediction by Albert Einstein. Second public lecture was by Majumdar on March 11, who took the audience to the wonderful journey of our mysterious universe right from the Big Bang. Third public lecture of the series was delivered by Potukuchi, in which he introduced the audience to the wondrous world of elementary particles and their detection processes.

A very mesmerizing cultural programme was also organized for the participants, in which Satish Thakur, Professor of Music and his students from P.G. College, Dharamshala, thrilled all with their musical performance. There was an excursion on March 6, to



Mcleodganj and nearby places. The enthusiasm of the participants was very encouraging, and all the lectures were very interactive and well appreciated. Overall this school was very successful due to vibrant speakers, energetic participants and diligent efforts of organizers and volunteers. The coordinators of the school were B. C. Chauhan (CUHP), and Tarun Souradeep (IUCAA).



Indo-Korean Workshop on Gravitational Waves

IUCAA hosted an “Indo-Korean Workshop on Gravitational Waves” during January 27-29, 2016. There were 24 participants, out of which six were from Korea and all others from IUCAA and other institutions in India. Sukanta Bose was the coordinator of this workshop.



National School on Gravitational Waves



IUCAA Resource Centre, CUSAT, Kochi, in association with the Department of Physics, M. A. College of Arts and Science, Kochi, organised a National School on Gravitational Waves during December 28, 2015 – January 1, 2016 at M. A. College of Engineering, Kochi. There were 48 participants from all over India. They included faculty members, post-doctoral fellows, research scholars, M.Sc. and B.E./B.Tech. students. The programme consisted of lectures and hands-on sessions. Densley Jose, Principal of M.A. College, presided over the inaugural function, and Sanjeev Dhurandhar (IUCAA) inaugurated the school. The lectures were given by Sanjeev



Dhurandhar (on General Relativity), C. S. Unnikrishnan (TIFR, Mumbai) (on Gravitational Wave Detectors), Patrick Dasgupta (Delhi University) (on Gravitational Waves), Rajesh Nayak (IISER, Kolkata) (on Fourier Transform and Data Analysis), Ninan Sajeeth Philip (St. Thomas College,

Kozhencherry) (on High Power Computing), and Arun K. G. (CMI, Chennai) (on Gravitational Wave Sources). Afternoon sessions were set apart for hands-on sessions, which went up to 6:30 p.m. everyday. The hands-on sessions were handled by Rajesh Nayak, Bhooshan Uday Gadre (Research



Scholar, IUCAA), and Nikhil Mukund Menon, (Research Scholar, IUCAA). Sanjit Mitra (IUCAA) and V. C. Kuriakose (IRC, Kochi) were the coordinators of the school. Joe Jacob

(Newman College, Thodupuzha) and M. D. Benoy (M. A. College, Kothamangalam) were the local organizers of the school. From the feedbacks collected from the

participants, it was understood that they got benefited by attending the school, and they also enjoyed the stay and the food.

Colloquia

- 07.01.2016 Anvar Shukurov on *Prehistoric settlement patterns and stochastic growth equations.*
- 29.01.2016 K. G. Arun on *Testing general relativity using advanced gravitational wave interferometers.*
- 26.02.2016 Robi Banerjee on *Star formation out of the magnetised interstellar medium.*

Seminars

- 06.01.2016 Anvar Shukurov on *Magnetic fields in the multi-phase interstellar medium: Statistical analysis.*
- 13.01.2016 Zeeshan Ahmed on *News from BICEP/Keck array CMB Telescopes.*
- 14.01.2016 Niladri Paul on *Modelling the luminosity-dependence of galaxy clustering using extreme value statistics and the halo model.*
- 21.01.2016 Suvodip Mukherjee on *A new window to measure the imprints of cosmic hemispherical asymmetry from CMB B modes.*
- 03.02.2016 Pratik Dabhade on *Radio giants in the universe.*
- 10.02.2016 Vikram Rana on *Probing hard X-ray nature of ultraluminous X-ray sources and cataclysmic variables with Nustar.*
- 17.02.2016 Sonali Sachdeva on *Survival of pure disc galaxies over the last 8 billion years.*
- 17.02.2016 Kinjalk Lochan on *Black holes: "Not Guilty!" on the charge of destroying information.*
- 18.02.2016 Sami K. Solanki on *Recent advances in studying small-scale solar magnetism and irradiance variability at MPS.*
- 24.02.2016 Nitin Ghatpande on *Insight into lunar and solar eclipses.*
- 25.02.2016 Prasanta Bera on *Perturbation study of magnetic degenerate stars.*
- 25.02.2016 Sumanta Chakraborty on *Gravity and Thermodynamics: The tale of the null catalyst.*
- 02.03.2016 Pavan Kumar Aluri on *Directional dependence of cosmological parameters due to CHA.*
- 09.03.2016 Girish Kulkarni on *Small-scale structure of the IGM and its measurement using quasar pairs.*
- 10.03.2016 Nikhil Mukund on *Subtraction of gravity gradient noise in advanced LIGO and next generation GW detectors.*
- 10.03.2016 Varun Bhalerao on *NUSTAR studies of cyclotron line sources.*
- 16.03.2016 Rajeshwara Dutta on *Cold Hi Gas around low-z galaxies.*
- 16.03.2016 Ravi Joshi on *the Ly α Emission in damped Ly α Absorbers.*
- 23.03.2016 Girjesh Gupta on *Observations of propagation and damping of waves in the solar atmosphere.*
- 23.03.2016 Shabbir Shaikh on *Constraining stochastic gravitational wave background using weak lensing of CMB.*
- 30.03.2016 Sabyasachi Chattopadhyay on *Creating integral field units and more – DOTIFS.*

Visitors (January - March 2016)

Nishant Agarwal, P.C. Agrawal, Fazlay Ahmad, Zeeshan Ahmed, Moumita Aich, Ujjaini Alam, Diego Altamirano, Muhammed Amir, Atma Anand, Aiswarya Andavan, Raul Angulo, S. Annapurni, K.G. Arun, N.M. Ashok, Subramania Athiray, Kalyani Bagri, Coryn Bailer-Jones, Bidisha Bandyopadhyay, Robi Khan Banerjee, S.K. Banerjee, Srikumar Banerjee, Tarun Bangia, Sarmistha Banik, Mustansir Barma, Sudhanshu Barway, Tomaso Belloni, Aru Beri, Priya Bharali, Anupam Bhardwaj, Yash Bhargava, Naseer Iqbal Bhat, Sudipto Bhattacharjee, Sandip K. Bhattacharya, Sukannya Bhattacharya, Sudip Bhattacharyya, Bharat Bhushan, K.G. Biju, Nigel Bishop, Ritabrata Biswas, Dhiraj Bora, David Buckley, Vadim Burwitz, Marcella Carollo, Deepto Chakrabarty, Koushik Chakraborty, Subenoy Chakraborty, Sudip Chakraborty, Luke Chamandy, Vikas Chand, Samstuti Chanda, Sunil Chandra, Suresh Chandra, Subhamoy Chatterjee, Tanmoy Chattopadhyay, Garima Chauhan, Jai Verdhan Chauhan, Pratibha Chauhan, Mark Cheung, Naznin R. Choudhury, Sayantan Choudhury, Rudrani Kar Chowdhury, Haeun Chung, S.D. Connolly, Martin Croce, Amit Das, Mousumi Das, Sanchari Das, Subinoy Das, Sukanta Das, Sushmita Das, Bipash Dasgupta, Himani Dashora, Dhurjati Prasad Datta, Rumi Deb, Sanjib Deb, Tirna Deb, Konrad Dennerl, Vincent Desjacques, Himadri Despatnayak, Jishnu Dey, Mira Dey, Jeremy Drake, Jibitesh Dutta, M. Elango, Savithri Ezhikode, Ophelia Fabre, Nuwanthika Fernando, Santiago Ismael Ferrero, Karl Forster, Alpesh Gajbe, Poshak Gandhi, Sharad Gaonkar, B. Hareesh Gautham, Nitin Ghatpande, Abhirup Ghosh, Archisman Ghosh, Avyarthana Ghosh, Sushant G. Ghosh, Raphael Gobat, Rupjyoti Gogoi, A. Gopakumar, Catherine Grant, Matteo Guainazzi, Pathik Guha, Alok C. Gupta, Prateek Gupta, Sreehari H., Mubashir Hamid, M.K. Haris, Sungwook Hong, Yue Huang, Tanvir Hussain, Asif Iqbal, Md. Sayeedul Islam, Safiqul Islam, Nirmal Iyer, Shabnam Iyyani, Dhairyashil Jagadale, Kushhal Jain, Sheshmal Jain, Sanjay Jhingan, Reju Sam John, James Johnson, Nathan Johnson-Mcdaniel, Arti Joshi, U.C. Joshi, Muhsina K.K., Anil Kakodkar, Nibedita Kalita, Shashi Kanbur, Gungwaon Kang, Vinay Kashyap, Nisha Katyal, Gagandeep Kaur, Jamie Kennea, Ziauddin Khan, Rakesh Khanna, Hansik Kim, Ram Kishor, Saul Kohn, Vinod Krishan, Girish Kulkarni, Sumeet Kulkarni, T.S. Kumar, Richa Kundu, Jeremie Lasue, Peter

Leach, Hyung Won Lee, Xiaobo Li, Simon Lilly, Yin-Zhe Ma, Roy Maartens, Ashish Mahabal, Subhabrata Majumdar, Manzoor A. Malik, Siddharth Malu, Julien Malzac, Abhijit Mandal, Soma Mandal, Bari Maqbool, Craig Markwardt, Herman L. Marshall, Titus Mathew, Ian Mchardy, Ashish Mhaske, Eric Miller, Anurag Mishra, Chandrakant Mishra, Aditya Sow Mondal, Krishnanjan Mondal, Anupreeta More, Surhud More, Ankan Mukherjee, Arunava Mukherjee, Mithun N.P.S., Sharvari Nadkarni-Ghosh, Sachindra Naik, K. Rajagopalan Nair, Anuj Nandi, Shyama Narendranath, Biman Nath, Rajesh Kumble Nayak, Abdul Jaleel PP, Nikhil Padmanabhan, Archana Pai, Vihan Pandey, Mahadev Pandge, P.N. Pandita, Dishant Pandya, Ajith Parameswaran, Manu Paranjape, Anish Parwage, Atharva Patil, B.C. Paul, Biswajit Paul, Devraj Pawar, Aurelie Penin, Khun Sang Phukon, Paul Plucinsky, Anirudh Pradhan, Harsh Prajapati, Ved Prakash, Pratyush Pranav, Mussadiq Qureshi, Manuel Rabold, Sendhil Raja, R. Ramachandran, M.C. Ramadevi, Vikram Rana, Solohery M. Randriamampandry, A.R. Rao, B.S. Ratanpal, B.T. Ravishankar, Saibal Ray, Amitava Raychaudhuri, Biplab Raychaudhuri, Namrata Roy, Sunder B. Sahayanathan, Priyanka Sahu, Tarun Deep Saini, Mohd. Saleem, Anuradha Samajdar, Prasant Kumar Samantray, Shishir Sankhyayan, Abir Sarkar, Anjan Sarkar, Kartick Sarkar, S. Seetha, Steven Sembay, Shoma Sen, Anand Sengupta, Shiv Sethi, Vishant Shah, Mohd. Shahalam, Kaushal Sharma, Rahul Sharma, Tanvi Sharma, Meenal Shirmali, Dheeraj Shukla, Anvar Shukurov, Sunil H. S. Simha, Srikanth Panini Singam, H.P. Singh, K.P. Singh, Neha Singh, Prithvi Raj Singh, Priyanka Singh, Rakesh Kumar Singh, Suprit Singh, Sushma Singh, Mark Sirota, Sami Solanki, Surendranath Nadh Somala, Liming Song, Vikram Soni, P. Sreekumar, Abhigyan Srivastav, Arun Srivastava, Malu Sudhaj, Avinash Surendran, Roberto Sussman, Firoza Sutaria, V.O. Thomas, Nidhi Tiwari, Alexei Toporensky, Pranjal Trivedi, Antonino Troja, Paniveni Udayashankar, C.S. Unnikrishnan, Anisul Ain Usmani, Santosh Vadawale, Aparna Venkataramanasastri, T.V. Venkateswaran, Matteo Viel, G. Vijayakumar, Francisco Villaeusca-Navarro, C.V. Vishveshwara, R.G. Vishwakarma, Yogesh Wadadekar, Xufei Wang, Naveel Wani, Sachin Wanve, John T. Whelan, Bobing Wu, Shaolin Xiong, Bal Krishna Yadav, J.S. Yadav, and Shuang-Nan Zhang.

Visitors (Expected)

April 2016 : Rana Adhikari, CALTECH, USA; Atharv Chaba, Aryabhat Foundation, Indore; Raghavendra Chaubey, Banaras Hindu University, Varanasi; Denver D'Souza, Aryabhat Foundation, Indore; Rama Govindarajan, TIFR, Centre for Interdisciplinary Sciences, Hyderabad; Anshu Gupta, Centre for Excellence in Basic Sciences, Mumbai; K. Indulekha, Mahatma Gandhi University, Kottayam; Joe Jacob, Newman College, Kerala; Charles Jose, St. Berchman's College, Kerala; Pankaj Joshi, TIFR, Mumbai; G. S. Khadekar, Rashtrasant Tukadoji Maharaj Nagpur University; Pranshu Kurel, Aryabhat Foundation, Indore; Haritha M. R., Providence Women's College, Kerala; Arun Mangalam, Indian Institute of Astrophysics, Bengaluru; Supratik Pal, Indian Statistical Institute, Kolkata; P. N. Pandita, Indian Institute of Science, Bengaluru; Abhishek Parida, Jamia Millia Islamia, Delhi; S. Patnaik, Jawaharlal Nehru University, Delhi; Sanjay Puri, Jawaharlal Nehru University, Delhi; Sunder Sahayanathan, Bhabha Atomic Research Centre, Mumbai; Shiv Sethi, Raman Research Institute, Bangalore; H. Sharma, Jawaharlal Nehru University, Delhi; Prashant Sukumar, BITS Pilani, Hyderabad; Rupali Talole, Rashtrasant Tukadoji Maharaj Nagpur University; Kartik Tiwari, Aryabhat Foundation, Indore; and D. B. Vaidya, Ex-Gujarat College, Ahmedabad.

May 2016: Rizwan Ul-Haq Ansari, Maulana Azad National Urdu University, Hyderabad; Ayan Banerjee, Jadavpur University, Kolkata; Prasad Basu, Cotton College State University, Assam; Ritabrata Biswas, Bankura University, West Bengal; Sujay Kumar Biswas, Ramakrishna Mission Vivekananda Centenary College, Kolkata; Subenoy Chakraborty, Jadavpur University, Kolkata; Surajit Chattopadhyay, Pailan College of Management and Technology, Kolkata; Tirna Deb, Presidency University, Kolkata; Shounak Ghosh, Govt. College of Engineering and Ceramic Technology, Kolkata; Sushant Ghosh, Jamia Millia Islamia, Delhi; Ritesh Ghosh, Visva-Bharati University, Santiniketan; K. P. Harikrishnan, The Cochin College, Kochi; Bhola Ishwar, B.R.A. Bihar University, Muzaffarpur; Dhairyashil Jagadale, Aranyanand Research School and Science Centre, Kolhapur; Kanti Jotania, The M.S. University of Baroda, Vadodara; Suresh Kumar, BITS, Pilani; B. S. Kushwah, Indian School of Mines, Dhanbad; Abhijit Mandal, Jadavpur University, Kolkata; Bivudutta Mishra, BITS-Pilani, Hyderabad Campus; Soumen Mondal, Ramakrishna Mission

Residential College, Kolkata; Rajesh Kumble Nayak, IISER, Kolkata; Jayanta Pati, Hindol College, Dhenkanal; K.D. Patil, B.D. College of Engineering, Wardha; M. K. Patil, Swami Ramanand Teerth Marathwada University, Nanded; Bryan Penprase, YALE-NUS College, USA; Farook Rahaman, Jadavpur University, Kolkata; M. Xavier James Raj, Vikram Sarabhai Space Centre, Thiruvananthapuram; Saumyadip Samui, Presidency University, Kolkata; Swarnim Shashank, Centre for Excellence in Basic Sciences, Mumbai; H. P. Singh, University of Delhi; A. K. Sood, Indian Institute of Science, Bengaluru; A. V. Thampan, St. Joseph's College, Bengaluru; S. K. Tripathi, Indira Gandhi Institute of Technology, Orissa; and Aditya Vijaykumar, BITS, Pilani.

June 2016: Gazi Ahmed, Tezpur University; Priya Bharali, Guwahati University; Parag Bhattacharya, Assam Don Bosco University, Guwahati; Nabajit Chakravarty, Positional Astronomy Centre, Kolkata; Suchetana Chatterjee, Presidency University, Kolkata; Ritaban Chatterjee, Presidency University, Kolkata; Alankar Dutta, Presidency University, Kolkata; Rupjyoti Gogoi, Tezpur University; Pranjupriya Goswami, Jorhat Institute of Science and Technology, Assam; Sarbari Guha, St.Xavier's College, Kolkata; Sourav Halder, Jadavpur University, Kolkata; Priya Hasan, Maulana Azad National Urdu University, Hyderabad; S. N. Hasan, Maulana Azad National Urdu University, Hyderabad; Deepak Jain, Deen Dayal Upadhyaya College, Delhi; Soma Mandal, Taki Government College, West Bengal; Nishant Mittal, HRIT, Ghaziabad; Hemwati Nandan, Gurukula Kangri Vishwavidyalaya, Haridwar; Sanjay Pandey, L.B.S.P.G. College, Gonda; Amit Pathak, Tezpur University; B. C. Paul, North Bengal University, Siliguri; Ananta Charan Pradhan, National Institute of Technology, Orissa; Shantanu Rastogi, D.D.U. Gorakhpur University, Gorakhpur; Subhashish Saha, Ramakrishna Mission Residential College, Kolkata; Prasant Samantray, Indian Institute of Technology, Indore; Joginder Sharma, HRCTGI, Ghaziabad; Gargi Shaw, UM-DAE Centre for Excellence in Basic Sciences, Mumbai; G. P. Singh, VNIT, Nagpur; Parijat Thakur, Guru Ghasidas Central University, Bilaspur; Rashmi Uniyal, Gurukul Kangri Vishwavidyalaya, Haridwar; and Sanil Unnikrishnan, St. Stephen's College, Delhi;

Long Term Visitor

Yogesh Wadadekar, NCRA, Pune.

Farewell to ...

Hamsa Padmanabhan, who has Joined ETH Zurich, Switzerland, as a Post-doctoral Fellow.

Vishal H. Joshi, who has joined Physical Research Laboratory, Ahmedabad, as a Faculty.

Pankaj Kushwaha, who has joined University of Sao Paulo, Brazil, as a Post-doctoral Fellow.

(and welcome to...) **Kaustubh P. Waghmare**, who finished his Ph.D. and joined IUCAA as Data Scientist on the project Big Data Initiatives in Astronomy and Biology.

Hello friends,

Summer is here and you may be enjoying the favourite fruit Mango, but do you know which bird gives call of this season's arrival? It is Koel, a member of Cuckoo family. You may have heard of many Bollywood songs about this bird, for e.g., Koel si teri boli, Koel bolee duniya dolee, etc. Also, many female singers are known as "Gaan Kokila". But, there is a catch here. Actually, female Koel does not sing, and in fact, they have very unpleasant voice kik-kik. It is the male whose song is famous: Koo-Ooo— Koo-Ooo. They are especially vocal throughout the breeding season from March to August.



Crow feeding Koel chick
(Photo Courtesy: Dipak Sawant)

The other interesting fact about this bird is that it is a brood parasite. It does not build any nest. It lays eggs in the nest of other birds like Crows, Mynas, Drongo, Robins, Warblers, Prinia, etc. A male Koel distracts the host bird, and in

the meantime female lays an egg in the nest (sometimes she removes a host egg). Koel chick grows up faster and becomes likely threat to host's chicks.



Female Asian Koel
(Photo Courtesy: Chaitanya Rajarshi)

Asian Koel is large, about 40 cm long, weights about 350 g. The male is black (it may appear like Crow, but with slim body) with red eyes, greenish bill and grey legs. The female is different from male, of brown in colour with white spots. Its tail is striped, and head is streaked.

This least concerned bird is found in South and Southeast Asia, and China. Koel mainly feeds on fruits of trees like, Banyan, Fig, and Peepal, and sometimes on insects, caterpillars, etc. It is a shy bird, mainly lives in dense canopy of trees. You probably may not see this bird very often. Just try to track its call to locate it.



Male Asian Koel (Eudynamys Scolopaceus)
Marathi: Kokila (Photo Courtesy: Umesh Vaghela)

Wish You A Very
Happy Birding

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