khagol

THE IUCAA BULLETIN

“IUCAA is a new experiment...

...It is essential for IUCAA to inform the university community and others about its various projects and facilities. To this end the IUCAA Bulletin, KHAGOL, is being launched...

Jayant Narlikar
Founder Director, IUCAA
(January 1990)”

100th Issue of KHAGOL

October 2014

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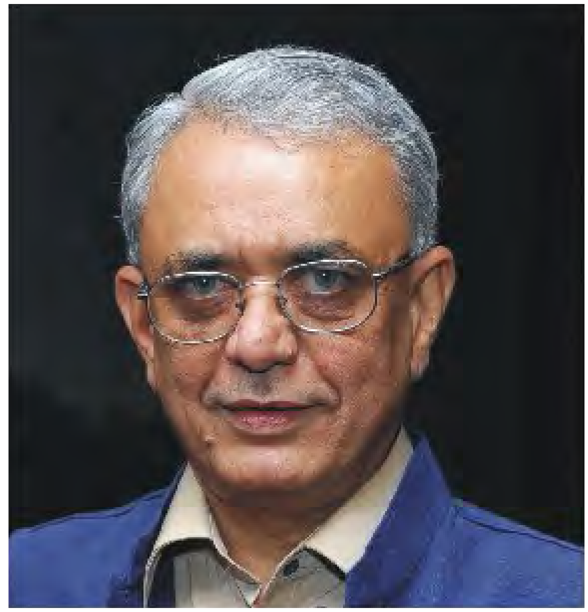
The Khagol clock



Ajit Kembhavi
Director,
IUCCA

The first issue of Khagol was published in January 1990, while this 100th issue is being published in October 2014. Khagol appears once every three months, pretty much on time, but regular readers would have noticed that the 100th issue is a few weeks late. The Editor sincerely apologises for the delay, which is mainly due to the wait for special articles for the issue and the Diwali festival which led to the closure of printing facilities.

We expect that subsequent issues will again appear regularly. We could, therefore, consider Khagol to be a clock ticking once every three months with a cumulative accuracy of about one part in 300, which is not too bad for many purposes. But the Khagol clock goes further than other time keeping devices: every tick of it carries information about important events which occurred in IUCAA over the preceding three month period.

The period covered by early issues of Khagol was, of course, very exciting in many ways. There was a great deal of activity taking place in the shed like structure named after Aditi, who is the mother of Gods. Many of the facilities and projects which later became very important for IUCAA were started here. I believe that the first facility created was an E-mail service set up on a very basic desktop computer, which provided a dial-up connection to NCST, Mumbai. To my knowledge, this was the first E-mail connection in Pune. It resulted in many people who were associated with various institutions, departments and new enterprises coming to Aditi to send and receive E-mail. Several of these people became our friends and later partners in long term highly significant collaborations. The basic E-mail desktop quickly morphed into a sophisticated ERNET node, which for several years provided connectivity to much of Maharashtra outside Mumbai.

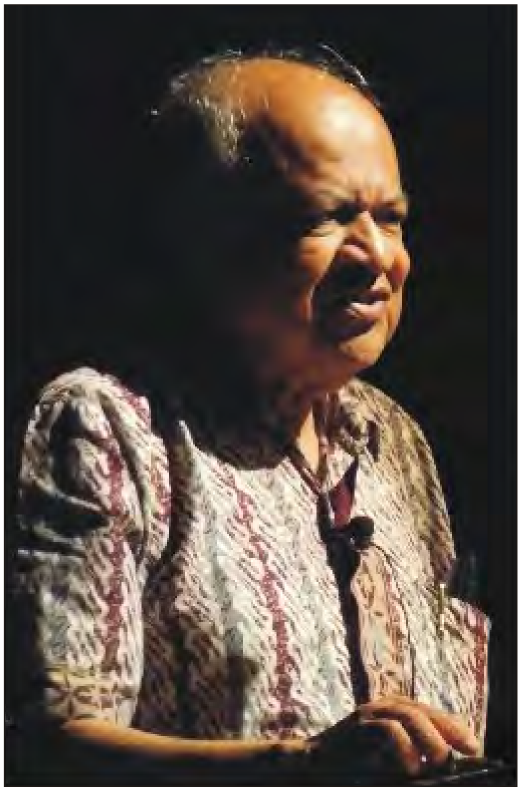
Aditi also housed the first two machines of the IUCAA computer network. These Sun workstations were the most advanced then available and had to be purchased at great cost and with great effort. As soon as the installation was done, I remember saying to Naresh Dadhich that some more machines were needed, which made him choke on tea that he was then drinking. He relaxed only when he realised that these additions would be at modest incremental cost and that is how computer networks grew. Aditi also had the first IUCAA instrumentation laboratory and library, and the idea of a gravitational wave detector for India too was germinated here.

The early issues of Khagol reported many distinguished visitors, including leading relativists, astrophysicists and cosmologists from abroad, like Fred Hoyle, Hermann Bondi, William Fowler, Geoff and Margaret Burbidge, Roger Penrose, Donald Lynden-Bell and Subrahmanyan Chandrasekhar. When I now come across references to these people in books and research papers, it is hard for me to believe that I have seen them all standing or sitting just outside Aditi, where so many interesting conversations took place, sometimes while a cold breeze was blowing, at other times in bright sunshine and occasionally in light showers of rain.

We once met a rather senior team of people from the U.S. National Science Foundation under a tree just outside Aditi. That conversation led to several Indo-US workshops, which were conducted over a few years at IUCAA, and which laid the foundation of many deep collaborations; some of these continue even as the 100th issue of Khagol is being prepared.

While all these important events were covered by Khagol, what remained unpublished in its pages was the close interaction between people, mainly young, from the academic, technical as well as administrative staff of IUCAA, who shared the space in Aditi and worked very hard to set up the institution. The close interaction led to a feeling of camaraderie and warmth which I believe prevails even now, and which has been very important to maintain the harmonious atmosphere in IUCAA amongst all section of its staff. Included in the interaction were our first associates and other visitors from the universities, who soon became an integral part of the structure and whose work has been so important in establishing our reputation. It is sometimes hard to believe how much happened in Aditi.

As the 100th issue of Khagol goes to print, IUCAA is a much bigger place, with iconic buildings, a much expanded academic staff, many students and postdocs, more than 125 visiting associates and fine facilities. There are now many changes taking place. Soon there will be a new building near the Chandrasekhar Auditorium and the era of megaprojects will be beginning, with consequences which are difficult to foretell. But it is hoped that the welcoming, inclusive, collaborative and warm atmosphere will remain with us as we compete, create and achieve more and more. The new construction will leave Aditi intact, to be put to new uses. I am sure that when the 200th issue of Khagol is printed, the photograph of Aditi on the cover will not be of a structure which then will exist only in our memories, but of an old but living shed in which new ideas will continue to be energetically spawned.



Jayant Narlikar
Emeritus Professor,
Founder Director, IUCAA

Quo Vadis cosmology?

For those not familiar with the 1896 classic book Quo Vadis by Henryk Sienkiewicz or with the Hollywood movie of the same name, the latin words mean: Where are you going? In the original story St. Peter asked this question to Jesus whom he encountered, heading towards Rome as he himself was running away from it. The context of the latin words will be clear as you read on.

Cosmology has all along excited human imagination, in which man has tried to make sense of what the cosmos is all about. Barring a few examples like the Nasadeeya Sukta of Rigveda, where the writer expresses a puzzling wonder at the existence of the universe, in most writings the attempt is made to present a fully understood picture of creation. 'Fully understood', of course, means that the author was satisfied that he had got the final answer.

The situation started changing with the dawn of science. The feeling began to gather strength that one cannot get away with thoughts and statements of a factual nature without providing proof. Take the Pythagorean concept of the Earth going round a central fire. The claim that it did not go round the Sun but round this mysterious fire led skeptics to question: Where is this fire… why don't we see it? The Pythagoreans replied by stating that a counter-Earth going along an inner orbit just manages to block our view of the central fire. This may have satisfied the doubting Thomases but not for long. They began to question the existence of the counter Earth. Why don't we see it? They were told that Greece faced the other way when seen from the terrestrial globe. Eventually this defence too was seen to be factually wrong and the idea died a quiet death.

This is a classic example of a wrong theory and we see its manifestations in modern theories of science also. A clear symptom is when the theory requires more parameters to prop it up. Thus, the Greeks needed epicycles to explain planetary orbits, conditioned as they were by the Aristotelian dictum that all natural motion is circular.

Perhaps the scientist most particular about demanding data in support of theory was Isaac Newton. Despite having mathematically worked out the Keplerian orbits, he did not care to publish his solution. He needed the latest information about Moon to substantiate his law of gravitation and he also needed to convince himself that a spherically symmetric object would attract as if its mass were concentrated at its centre. Despite the successes of his law of gravitation, when he was asked to comment on the nature of gravitation, his reply was Non fingo hypothesis: I do not make hypotheses.

Perhaps it was the Newtonian influence that kept astronomy and later astrophysics, on rails so far as evidence in support of astronomical theories were concerned. Take stellar structure for example. The Kelvin-Helmholtz hypothesis for the secret of solar energy had to be abandoned when it ran foul of time scales. For, as per the hypothesis proposed, the gravitational energy reservoir of the Sun would have lasted no

more than twenty million years if it shone at its present luminosity. This was far shorter than the geological timescales which, today place the Earth's age at 4.6 Gyr. Thus, new solar models were needed.
The ionization equation of Meghnad Saha opened the door for data from stellar atmospheres and enabled theoreticians like Eddington to make realistic stellar models. It is to the credit of astrophysics that Eddington's conjecture, inspired by J.J. Perrin that fusion reactions at the centre of the Sun keep it shining, was eventually shown to be right despite the skepticism of nuclear physicists of their own subject.

It was in the same scientific spirit that cosmology took off in the 1930s, after the theoretical models by Friedmann and Lemaitre coupled with the evidence of nebular redshifts found by Hubble and Humason. Further successes were claimed by the standard model of the expanding universe by the work on primordial nucleosynthesis initiated by George Gamow and the prediction by his students Ralph Alpher and Robert Herman of microwave background.

However, from the 1970s onwards, cosmology has undergone a change of approach that should be worrying to anyone who cares for the usual scientific requirement of direct evidence. The successes of the standard model have prompted cosmologists to be adventurous and theorise about epochs closer and closer to the big bang. Ironically, the model itself introduces limitations to this exercise. The existence of the last scattering surface (not directly found but inferred from theoretical extrapolations) tells us that earlier than that epoch direct viewing of the universe is rendered impossible by the scattering of light. When direct observations are not possible, astronomer looks for consistency of what is observed in nearby epochs with what the universe was like in the remote past. Gamow's programme of primordial nucleosynthesis was based on this approach.

The above approach is justified if we are confident of the physics used for extrapolation. In Gamow's programme this was the case: nuclear physics and thermodynamics were well understood from their laboratory studies. But the same cannot be guaranteed in the modern studies of the very early universe. For, particle physicists have yet to formalize their ideas into a theory of very high energy physics. To see the problem in proper perspective, the present particle accelerators may reach energies of up to ten TeV, whereas issues pertinent to modern cosmology like inflation, horizon problem, flatness problem and monopole problem require us to know the physics at 1016 GeV, some ten orders of magnitude above the experimental limit mentioned above. Yet, the cosmologist does not blink as he formulates theories about the universe at that early stage without direct observation and without established physics.

Take the issue of dark matter. Assuming that there are no MOND-like alternatives, applications of Newtonian gravity tell us that the density of matter (visible as well as dark) in our universe far exceeds the density at which the primordial nucleosynthesis process that produces deuterium can work. In short, the standard model loses a plus point. There is also a conflict with the data on inhomogeneities of the microwave background. If all existing matter were to interact with radiation, the inhomogeneities of the latter would be far too high. To avoid these embarrassments, it is assumed that a large part of the matter is of the kind that does not interact with radiation. It is supposed to be non-baryonic, that is not made of neutrons and protons. So far no such matter has been detected in the physicist's laboratory. Indeed, the amazing degree of belief in non-baryonic matter sans any direct evidence, reminds me of Hans Andersen's story 'The Emperor's New Clothes'.

It may be mentioned that the idea of inflation was proposed to deal with some problems of the standard model. The alternative that the standard model may be wrong was never considered, just as the Pythagoreans introduced the counter Earth without considering that their basic hypothesis may be incorrect. A look at research in cosmology today finds a free for all situation where concepts like branes, phantom fields, non-baryonic dark matter, dark energy, etc. flourish with hardly any compelling evidence. Paradoxically, the cosmological ideas of today are no more scientific than the philosophical speculations of those early civilizations.

So I ask: Quo Vadis cosmology? Unlike St. Peter who followed the lead of Jesus. I do not find the path taken by Cosmology worth following.

S. K. Pandey
Associate, IUCAA
Vice - Chancellor,
Pt. Ravishankar Shukla University,
Raipur

I am associated with IUCAA, since its establishment, as an associate from the first batch, i.e., some time in the year 1990, and when I received an email as well as a phone call from Professor Ajit Kembhavi for a short writeup for Khagol on completion of its 100th issue, literally I started counting the number of years of my association with IUCAA (or you may say counting my days left now!) as well as on what to write for Khagol ! Going down the memory lane, as readers would agree with me, has always a mixed tone- 'Kabhi Khushi Kabhi Gum'. So, as the due date was nearing, I decided to write on the dividends that my association with IUCAA has paid off to me and more so for the young graduates that I got associated with while working with them in the University. But as a person who claims to be working with positive thinking, I would write only on the best part that I have lived through as a part of my association with IUCAA.

My association with IUCAA: Dividends paid off with bonus…

This also reminds me to realize how fortunate I have been throughout my life whether at home in the caring and loving arms of my parents, who let me made free to decide my future course of career or in educational courtyard under the blessing of my teachers at every stage, specially, during my postgraduate studies and beyond. My entry into the Physics Department of Pt. Ravishankar Shukla University in 1973, in a way, has played a decisive role in shaping my career that I enjoy and relish. Here, I would like to pay my heartfelt gratitude and homage to Professors Suresh Chandra and R. K. Thakur, but for them neither was it possible for me to complete my higher studies nor could have made it to TIFR or IUCAA during later years. I find short of words in expressing my gratitude to them; they are no longer in this world, but without them, specially, Professor R. K. Thakur, who introduced me to the exciting world of Astronomy and Astrophysics, which was not even known to me until then as distinct area of teaching and research in Physics, the rest of my academic career would have been a big zero to say the least! My three years (1977-80) of stay in TIFR for my doctoral work at the insistence of Professor Thakur has been the golden years of my career. I was very fortunate to have come in contact with Professor J. V. Narlikar and Professor S. M. Chitre, who took me under their wings while in TIFR, and I owe them a lot for their blessings and guidance which made me what I enjoy today.

I became fond of several researchers in TIFR of those days including H. M. Antia, Ajit Kembhavi, Rajiv Gavai and Swarna Kanti Ghosh, Bhaskar Datta and many more whose friendship I still relish and enjoy, as I learnt several dimensions of life which otherwise would have remained unknown to me! I completed my doctoral work which dealt with some aspects of Convective instabilities in the Solar Atmosphere under the supervision of Professor S. M. Chitre. My close association with H. M. Antia helped me a lot otherwise I could not have completed my thesis work during the three years at TIFR. Afterwards, there was a big professional break, though, until the establishment of IUCAA which became yet another turning point of my life, but footprints which could establish my association with IUCAA has already been carved out while in TIFR. Hence, this distraction, otherwise my colleagues would remain under wrong impressions as far as my transformation from big zero to significant decimal places after zero on self assessment is concerned. The letter which I received from Ajit Kembhavi some time during the academic year 1989-90 to visit IUCAA in a sense was the beginning of a life long but pleasant and ever refreshing journey for me. That was the beginning of my collaboration with Ajit, who then introduced me the wonderful world of Observational Astronomy using CCDs. I still remember the first lesson from Ajit with some books/articles that he asked me to go through. This exciting world of observational astronomy using CCDs well resonated with what my teacher Prof Thakur had advised me to take up, after I completed my doctorate in Physics. It was from Vijay Mohan in UPSO, Nainital that I had my first observing lessons. Ajit gave me a long list of galaxies, mostly spirals, for observations. NGC 2701, a beautiful but very complex spiral galaxy was amongst the first set of objects that we observed at Nainital during Diwali in 1990, and with that began learning image processing steps and CCD data reductions using IRAF which had just been installed on set of SUN workstations in ADITI, the initial housing of IUCAA. Ajit and I used to sit for hours learning every finer detail of CCD data reduction on Sun systems and used to discuss each step mostly at Ajit's residence over the evening tea, ending mostly with dinner; (my grateful thanks to Mrs. Asha Kembhavi for preparing delicious dishes). At some stage, I then convinced Ajit to focus on ellipticals and lenticulars, to begin with, as they had fairly smooth light distribution on optical images, and hence simple to handle and try out image processing steps on them. My research programme in collaboration with Ajit and other research students, has been confined to E/SO galaxies, except that it went through refinement since the early formative years. I was rather reluctant to take up sponsored projects, but Ajit persuaded me do so, and in retrospect, I realized the importance of the projects, as it allowed me to strengthen research facilities in my work place with a set of workstations and CCD data reduction software, and most importantly, I grew confident in supervising research students and could continue the research activities in the Physics Department of the University. Devendra Sahu was my first Ph. D. student, who now works at IIA, Bangalore.

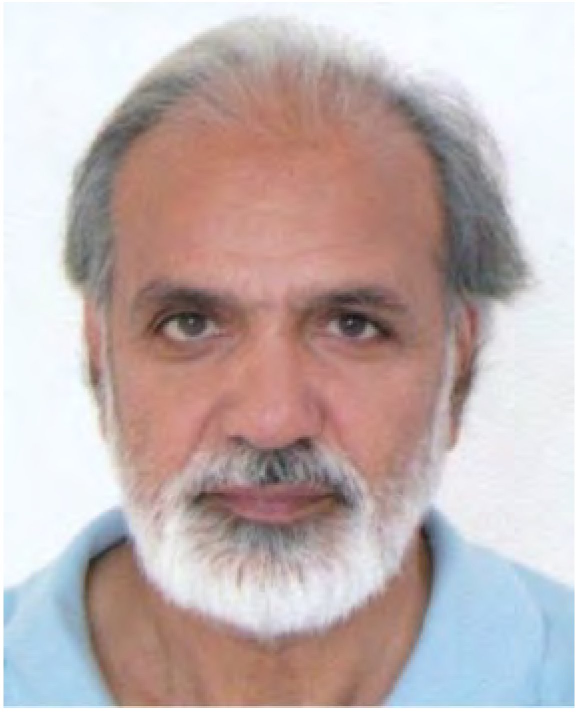
While our collaborative programme in CCD imaging of galaxies continued, there was yet an important development at the University in the form of procurement of 14-inch optical telescope from Celestron with SSP photometer at the instance of Professor Thakur, primarily to start observing programs for post graduate students. At this juncture, Padmakar Parihar appeared with a proposal to make use of the 14-inch Celestron telescope for photometric study of RS CVn type active stars as well. We managed to finally install this in the dome that was already available, thanks to IUCAA, as it had turned me confident in taking up research projects independently. I feel proud now in mentioning that Padmakar Parihar and Sudhanshu Barway completed their doctoral work on Chromospherically Active Stars as a part of sponsored research projects from CSIR based on their data taken with the Celestron telescope of the University as well as the Meade 16-inch telescope that IUCAA had then procured. Experience gained on working with small optical telescopes has been passed on to other Universities/institutions, and still used in the University for training the postgraduate students. For a couple of years during 1996-98, at the advice and recommendation of Professor Narlikar, I served at SRTM University, Nanded as the University wanted to initiate teaching and research in Astronomy. Even though I could not continue there for long, M. K. Patil, a young lecturer then at SRTMU came to the rescue as he joined me as a research scholar, made use of small telescopes that were procured at the SRTMU, and now I feel proud as I see him as a mature researcher in Observational Astronomy and further that he has developed a small research group in the University, which is growing year after year.

My association with IUCAA since 1990, has encouraged and helped me in initiating and strengthening not only my own research interests, but made me confident enough to strengthen my parent department and University in terms of research facilities by way of sponsored research projects from DST/CSIR/ISRO. I was fortunate to have been associated with a dedicated group of students who have, over the years, proved themselves by making use of facilities at IUCAA as well as at the University. With the establishment of IRC at our Uinversity, the bond with IUCAA became stronger than before. This is continuing even after I took up the responsibilities of the University as the Vice-Chancellor since 2009.

The dividends that were credited to me with growing CV, my students and the University for sustaining the culture of Astronomy became possible only because my association with IUCAA. But for IUCAA, all the facts narrated in above paragraphs would have remained only in my dreams.

My association with IUCAA not only paid me dividends, but also the bonus which not many people know. My children too enjoyed the benefit of my association with IUCAA. Eldest daughter, Shefali did her graduation as well as postgraduation from Pune, while youngest daughter, Shivani completed her MCA in Pune, which eventually became her home as Dr. Vijay Mohan's daughter-in-law. My Son, Shishir, had his coaching at Pune for entry into military service, and finally made it to Indian Air Force.

In short, I was fortunate to have been in strong association with IUCAA, which I continue to enjoy with a stronger bonding than ever. I am trying my best in spreading the excitement of Astronomy not only by way of teaching and research, but also by way of reaching out to young students at schools, colleges as well as general public through lecturing, radio/television and sky gazing programmes. This was made possible on the basis of what I learnt from my teachers and friends at every stage of my life. Given the opportunities that I have access to, perhaps I should have done more, but this may be ascribed to inherent limitations I am endowed with!



Naresh Dadhich
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By holding the fingers of principle and concept

Abstract:
It is most remarkable that the Nature accords to some general principles, and the main aim of this discourse is to attempt to understand things by holding their fingers.

1. Introduction

It is said that the most incomprehensible thing about the Nature is that it is comprehensible in terms of simple mathematical equations, and some general principles and concepts. One of the prime occupations of human kind had from time immorial been to knowing and understanding of working of the Universe. With the advent of modern science, there came a profound revelation that it could all be understood by some general laws like Newton's gravitational law, which are described by mathematical equations. What we wish to do in this discourse is to probe some fundamental physical principles and concepts with a view to understand the known in clearer and transparent manner, and to explore and extrapolate new frontiers.

2. Universality and Duality

Let us begin with the very general concept of universality which we simply define as anything that is the same for all and equally shared by all. What are the most primary universal entities we know of? The obvious answer is space and time. If they are both universal, they cannot be independent else we should be able to identify a property that is true for one not for the other. This would break and violate universality. Thus, all universal entities must be related with one another and that relation must also be universal. This is why space and time cannot be independent, and the universal relation binding them together is the universal velocity that has to be the same for all observers. In this way we come to a profound inference by simply holding the finger of a very general concept that there must exist in Nature a universal velocity [1]. And it needs no reference to any physical phenomena. This is how space and time are bound together into spacetime by the universally invariant velocity, say c.

The general principle that emerges is that all universal things must be related to each-other, and ultimately to the most primordial universal entity spacetime.

On the other hand, let's define force free state of space and time, which is characterized by space being homogeneous and isotropic, and time being homogeneous. Since space is homogeneous, we can freely interchange x and y, further time is also homogeneous and hence we should be able to do the same for x and t. But then their dimensions don't match, homogeneity is a general property which must always be respected and hence make the dimensions match. That then again requires the universal velocity so that x and ct can be interchanged. Space and time could be envisioned as dual to each-other, where one is always at rest while the other always flows, and the universal velcoity is what binds them together. Then universal velocity also defines the line of causality demarking the events that could be causally connected and those that cannot be. This state of spacetime which is free of all forces and dynamics, we would term as homogeneous [2].

The next question is what should be the geometry of homogeneous spacetime. Nothing must be imposed or prescribed for universal entity, spacetime, from outside. Since spacetime is homogeneous, so must be its geometry - curvature. It is a spacetime of constant curvature, not necessarily of zero curvature. Minkowski flat spacetime is an imposition from outside, where constant curvature is put to zero. Note that no physical principle or property demands that. A completely dynamics free spacetime is, therefore, of constant (homogeneous) curvature, which is defined by $R_{abcd} = \Lambda(g_{ac}g_{bd} - g_{ad}g_{bc})$. Thus, Λ emerges as a constant of spacetime structure on the same footing as c. It defines a universal invariant length. These two universal constants are the most fundamental as they are the part of spacetime structure, no other constant could claim this degree of fundamentalness. Like c binds space and time into spacetime, Λ curves it so that it can define dynamics of inhomogeneous spacetime. That is what we take up next.

What happens when spacetime is inhomogeneous, it should naturally embody dynamics of some force field? What could that force be which employs spacetime geometry as its playground? Its dynamics should also be determined by spacetime geometry. We know that Riemann curvature satisfies Bianchi identity, $R_{ab[cd;e]} = 0$, which on contraction yields a divergence free Einstein tensor with vanishing divergence; i.e., $G^b_{a;b} = 0$ where $G_{ab} = R_{ab} - (1/2)Rg_{ab}$. We are, thus, naturally led to the equations $G_{ab} = -\kappa T_{ab} - \Lambda g_{ab}, T^b_{a;b} = 0$. This is the equation of motion of force that is the cause of spacetime inhomogeneity and hence its source T_{ab} must also be universal physical property of all that physically exist - energy momentum distribution. Then it becomes the Einstein equation of gravitation and Λ emerges as a constant characterizing the state of spacetime in absence of T_{ab}. It is, therefore, a true constant of spacetime and is on the same footing in the equation as T_{ab} and hence it cannot be put to zero at one's whim and fancy.

Note that we have arrived at Einstein's gravity, GR, without asking for it, while it naturally emerges as the universal force responsible for inhomogeneity of spacetime. In the conventional picture, there is a discontinuity or break in going from zero curvature (flat) for absence of gravity to non-zero curvature in presence of gravity. In contrast, we have a continuity in going from homogeneous curvature in absence of gravity to inhomogeneous curvature in presence of gravity. Spacetime is, therefore, inherently curved, and for absence or presence of gravity, it is only the question whether it is homogeneous or inhomogeneous. This is indeed very pleasing on concept and elegance. Further note that Newton's inverse square law is now not prescribed but dictated by the spacetime geometry. Nothing could be imposed from outside on spacetime. The most wonderful prediction that springs out of this viewpoint is that the Universe must suffer accelerated expansion, which was what was observed in the supernova observations in late 1990s [3]. This is what determines empirically the value and sign of Λ. Note that universality does not fix the sign of Λ, it is the observation that fixes it as positive and and also value.

Had Einstein followed this geometric way to arrive at his equation, not only he would have realized Λ as a true constant of spacetime (rather than the alleged greatest blunder) but would perhaps have made the greatest predictions of all times that the Universe would suffer accelerated expansion some time in future. This would have been most remarkable and we would have all been spared of the monumental confusion that had been carrying on for a century.

Homogeneous and inhomogeneous curvature spacetimes could be envisioned as dual to one another. They respectively describe no force (absence of all forces) and universal force - Einstein gravity. In other words, "no force" and "universal force" are dual to one another. Both are universal, and hence are described by geometry of spacetime. Thus, emerges a general principle:

Geometry is the language of universality, anything universal must be expressible as a geometric statement.

This should be taken as a good guiding principle for further probing and seeing beyond.

3. Λ versus Vacuum Energy

Matter fields produce quantum fluctuations in vacuum and for that, it is possible to write a corresponding stress tensor relative to flat spacetime, which has precisely the same form, λg_{ab}. That is how comes the great mismatch of 10^{120} orders when Λ is slated against the Planck length. The question is how should vacuum energy gravitate, should it through a stress tensor or more subtly like gravitational self interaction - gravitational field energy? Both are secondary source of gravity as they are both created by matter, and have no independent existence of their own. Thus, it is a matter of principle that they must gravitate similarly.

Gravitational field energy gravitates not by a stress tensor but instead by curving space. In GR, that is why Newton's inverse square law remains intact but now space is not flat but curved which accounts for gravitational interaction of gravitational field energy [4]. GR has to account for two new phenomena, one of light feeling gravity and the other of gravitational self interaction. Since light's velocity cannot change, it cannot experience acceleration exerted by $-\nabla\Phi$. The only way it can feel gravity is that gravity curves space[1]. So light demands space to be curved, which is what is precisely done by gravitational field energy - self interaction. The two new aspects beautifully take care of each-other leaving Newtonian gravity intact. It is the most remarkable and enlightening feature of Einstein's gravity.

Vacuum energy is on the same footing as gravitational field energy and hence it must also gravitate not by a stress tensor but by enlargement of spacetime framework. Unfortunately that we would not know until we have quantum theory of gravity. Without that it is hard to guess how should the framework be enlarged? One of the possible extrapolations could be that vacuum energy gravitates via higher dimension [5]. As gravitational field energy left Newton's law intact, vacuum energy should leave GR intact in the usual 4-dimensional spacetime. This is a very attractive and enticing idea, which is in good conceptual resonance and in line with how gravitational field energy gravitates? However, all this should naturally emerge as and when we have quantum theory of gravity until then it would all be tentative probing. What seems to emerge is that quantum gravity should involve gravitational aspects of vacuum energy and perhaps also higher dimension in an essential and integral way.

Once Λ is free of the Planck length, it can have any value what is empirically determined by expansion of the Universe [3], and what the number 10^{120} tells us is that the Universe measures as much in units of the Planck area [2]!

4. Looking Beyond

We know matter bends and it ought to have micro-structure for that. Since gravity bends space, space should also have micro-structure. Without a micro-structure, how could it bend or how could anything freely propagate in it? You may wonder that I am reinventing Aether which was disproved by the historic Michelson-Morley experiment. This myth has attained faith like solidity which needs to be debunked. What the experiment proved was that one cannot measure motion relative to Aether. That is, it cannot serve as a reference frame simply because it is present everywhere. But this does not mean that something, for example vacuum, which is present everywhere cannot have a structure. Well, we do have to ascribe some structure to vacuum for it to suffer quantum fluctuations. Purely from these simple common sense considerations, it stands to reason that space must have micro-structure. What are the micro-units, building blocks that make space as continuum? Loop quantum gravity has been struggling to address and fathom this fundamental question for a long time but has still long way to go [6]. Deep down we are struck with the fundamental duality between discrete and continuum, which is of course the natural arena for quantum theory of spacetime - gravity.

When we say our Universe is expanding, what is it that expands? Universe is by definition all inclusive and hence it cannot expand into something as there exists nothing beyond. The text book explanation is that it is coordinate grid that expands which is really begging the question. Spacetime or the Universe is a physical entity embodied with physical properties. Expansion of the Universe should, therefore, mean creation of new spacetime as it expands! Perhaps quantum theory of spacetime may as well shed some light on this.

We began with probing universality, which led to binding of space and time into spacetime and further it incorporated universal force - gravity into its fold through the curvature of spacetime. Is there anything else universal that needs to be folded in? The fundamental quantum principle - uncertainty principle is universal as it applies to everything.

[1]The entire GR literature uses the phrase bending of light which is as profoundly wrong as saying Sun goes around the Earth. *Light cannot bend, what bends is space* and we measure bending of space by light as a probe.

Following our general guiding principle of all universal things must be related, it must also be related to the fundamental universal entity spacetime, and it should also be geometrized. This is what we have not been able to do so far, and that is why, I believe, quantum theory is incomplete. All these questions, quantum theory of spacetime and gravity, synthesis of uncertainty principle with spacetime as well as gravitational incorporation of vacuum energy perhaps via higher dimension are interwoven and related. A new comprehensive theory would have to encompass all these and would also expound some new conceptual and physical canvas. In breaking new ground, what seems to be critically missing is that we have not yet been able to formulate a guiding principle like the Equivalence Principle for direction and illumination.

Here I have raised some questions of principle and concept with a purpose to draw onto them for some enlightening insight and new revealation, and hope that it serves as a gentle provocation. This should be a fitting salute to Einstein and his theory at the turn of its century.

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Gravity: 100 years later

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The year 2015 is being celebrated as the centenary year of Einstein's development of General Relativity and thus, is an appropriate occasion for us to review our understanding of gravity. The fact that every attempt to combine the principles of quantum mechanics and general relativity has failed to yield fruit - usually after much hype and excitement in the initial stages of development of different models - suggests that perhaps there could be some basic flaw in our understanding of the real nature of gravity.

Research during the last one decade or so strongly suggests that this could indeed be the case. Gravity is possibly an emergent phenomenon, like e.g., elasticity or fluid mechanics with the field equations of gravity having the same status as, say, the equations governing elastic vibration. Applying the principles of quantum theory to elastic vibrations will at best lead to the concept of phonons but not to the quantum structure of matter. Similarly, a quantum treatment of gravitational field equations may not lead to the quantum structure of spacetime. Instead, one should look for the true microscopic degrees of freedom ("atoms of spacetime") and deal with them directly in the complete theory.

Unfortunately, we are today as ignorant of the nature of atoms of spacetime, as physicists were at the time of Boltzmann, about the atomic structure of matter. But, in spite of this, Boltzmann could correctly infer the existence of atoms from the fact that matter exhibits thermal phenomenon. In order to allow the thermal energy to be stored in the micro-structure, Boltzmann introduced the powerful principle: "If you can heat it, it must have micro-structure" .

This principle, as it turns out, is applicable to spacetime itself! One key result which arises when we combine quantum theory with general relativity is that spacetimes can be hot, just as normal matter can be hot. Observers in a spacetime who perceive a horizon will attribute to that spacetime a temperature and entropy. Blackhole is the most well-known example of this phenomenon, but it is by no means the only one. An accelerated observer in any spacetime will attribute a temperature to the spacetime. This is a purely quantum phenomenon and arises from the fact that the vacuum state of a freely falling observer will appear to be a thermal state for the accelerated observer. This fact allows us to attribute a non-zero temperature (and entropy) to the spacetime. This, in turn, suggests that one could make progress in understanding the structure of gravity by using a thermodynamic approach and applying the Boltzmann principle to the spacetime itself.
Such an approach yields rich dividends and throws light on

several structural aspects of GR which otherwise remain mere algebraic accidents. Let me describe a few of them [1, 2].

(i) To begin with such an approach allows one to actually count the atoms of spacetime even though we have no clue as to what they are! This is similar to the fact that one could introduce and work with the Avogadro number in the early days of atomic theory without really knowing what it counts. Interestingly enough, the number of atoms of spacetime scales with the area of a boundary for a region of space rather than with the volume of that region.

(ii) One can now associate two kinds of degrees of freedom with a given region of space. There will be certain number of bulk degrees of freedom contributed by normal gravitating matter residing in the volume. There will also be certain number of degrees of freedom contributed by the atoms of spacetime living in the boundary. Incredibly enough, in any static spacetime these two numbers are strictly equal! This is an elementary notion of gravitational holography, which follows directly from the gravitational field equations.

(iii) When these two numbers are not equal, the spacetime metric will be time-dependent and, in fact, this difference between the bulk and surface degrees of freedom (`holographic discrepancy') will drive the time evolution of the spacetime metric. The gravitational field equation, in the most general case, can then be written in a strikingly thermodynamic language describing how that the difference in these degrees of freedom drives the heating or cooling of the spacetime.

(iv) Just as in thermodynamics, in the case of gravity as well, one can obtain the field equations from a thermodynamic extremum principle. This is, in fact, the most direct link between thermodynamics and the description of spacetime.

What is still more surprising is that these results transcend Einstein's GR and is applicable to much wider class of theories called Lanczos-Lovelock models. This shows that these results caricature some deep principle about spacetime rather than just about Einstein's theory of gravity [3].

These ideas also provide a totally new way of attacking the cosmological constant problem [4]. The emergent gravity paradigm shows that there exists a conserved number (related to microscopic degrees of freedom) for our Universe, which links the numerical value of the cosmological constant to two other parameters of cosmology, which can be determined from high energy physics. Emergent gravity paradigm suggests that this conserved number should have the value 4. Using this, one can actually compute the numerical value of the cosmological constant, and it turns out to be exactly what is determined from the observations!

So, may be, we need yet another paradigm shift about the nature of gravity, possibly as revolutionary as the one suggested by Einstein hundred years back. This might pave the way for bringing together the principles of quantum theory and gravity in a manner very different from what has been envisaged so far and, in the process, might solve what could possibly be the most important problem in theoretical physics -- namely the value of the cosmological constant.

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The origin of cosmic magnetism

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The universe is magnetized. We all know of the earth's dipolar magnetic field, which allows us to navigate using the compass. What is not well known is that the field will resistively decay in about 10,000 years unless constantly maintained. Moreover, the north and south poles reverse irregularly every 100,000 years or so. Our Sun is also magnetized, with its poles reversing very regularly, every 11 years. On larger scales, magnetic fields of order a micro Gauss and coherent on scales of a few to ten kilo parsecs are detected in disk galaxies and even in the intra cluster medium (ICM) between galaxies in galaxy clusters. The origin and maintenance of such cosmic magnetism is an issue of fundamental importance.

A popular paradigm involves the generation of a seed magnetic field followed by turbulent dynamo amplification of the seed. Dynamos convert kinetic energy of motions to magnetic energy. Recall that a bicycle dynamo works by electromagnetic induction, where motion of a conducting coil in a magnetic field generates an emf and currents, which then lights a bulb. A similar principle works in astrophysical systems as well. The fluid in the earth's core, star, galaxy or the ICM is conducting. Motions of this conducing fluid in the presence of a seed magnetic field, generates an emf due to induction. This in turn generates a current in such a way that the original magnetic field is maintained or amplified. An important question is whether velocity fields exist in astrophysical systems, which can systematically lead to such field amplification?

One such possibility is turbulence, which is ubiquitous in all systems from stars to galaxy clusters. Turbulence arises due to instabilities like convection in stars, or is driven by other forces, like supernovae in galaxies, and cluster mergers in the context of the ICM. The presence of turbulence in a highly conducting fluid generically leads to dynamo action.

Note that in a highly conducting fluid, magnetic field lines are almost frozen into the fluid. And in any turbulent flow, fluid parcels random walk away from each other and so magnetic field lines get extended. Such random stretching is associated with compressions in the perpendicular directions, to conserve volume in nearly incompressible flows, and more field lines then go through a given area, amplifying the field, until resistivity comes into play. This fluctuation dynamo grows fields on the fast turbulent eddy turn over time scale and can magnetize any turbulent plasma. It perhaps provides the sole means for cluster magnetization. The resulting field is, however, highly intermittent, and active research is on to understand whether the degree of field coherence is sufficient to explain observations of the ICM.

A remarkable change in the turbulent dynamo action occurs if the turbulence is helical or cyclonic, that is the velocity field has screw like motions with predominantly one sign for the handedness of the screw. In any rotating and stratified medium, turbulence naturally becomes helical, like the generation of cyclones in the earths atmosphere. In the presence of helicity, magnetic fields coherent on scales larger than the scale of the motions can develop. Suppose one starts with an initial large scale field in the toroidal direction in a star or a disk galaxy. Helical turbulent motions of the gas draws out the toroidal field into a loop and twists it to look like a twisted Omega. Such a twisted loop is connected to a current, which has a component parallel to the original toroidal field. If the motions have a non-zero net helicity, this parallel component of the current adds up coherently.

A toroidal current then results from the toroidal field. Hence, poloidal fields can be generated from toroidal ones. Of course, microscopic diffusion is essential to make permanent changes in the field. The toroidal component of the field itself can be further enhanced by the shearing and stretching of the radial component of the poloidal field, by the differential rotation of the star or galaxy. This closes the toroidal-poloidal cycle and leads to exponential growth of the large-scale (or mean) field, whose coherence scale can be much larger than the scale of the turbulence. Such a mean-field turbulent helical dynamo is thought to be the underlying mechanism for the generation of coherent fields in planets, stars and disk galaxies.

Such a picture of large-scale dynamo action faces several potential problems. Firstly, while the mean field dynamo operates to generate the large-scale field, the fluctuation dynamo is producing small-scale fields typically at a much faster rate. When the small scale field grows to be comparable with the turbulent kinetic energy, we expect Lorentz forces to come into play and saturate the field growth. Can then the mean field dynamo continue to operate to grow fields?

Further, in a highly conducting fluid, magnetic helicity, which measures the linkages between field lines is nearly conserved. When helical motions twist say a toroidal flux tube, an oppositely signed internal twist develops on smaller scale, to conserve magnetic helicity. The Lorentz force associated with this small-scale twist goes to oppose the twisting effect of helical motions and quench the dynamo. Solving both these problems is at the forefront of current research on turbulent dynamo theory.

Another interesting possibility is that magnetic fields are a relic from the early Universe, arising perhaps during inflation or some other phase transition. Indeed, tentative evidence from gamma-ray observations of blazars, that even the intergalactic medium in voids are magnetized which favour such mechanisms. During inflation, the universe is undergoing rapid expansion, and vacuum fluctuations of the electromagnetic field can be naturally transformed to classical fluctuations. Coherent magnetic fields result, but are dramatically diluted by the same expansion, unless parameters are tweaked. Electroweak or QCD phase transition can lead to appreciable field strengths, but with very small coherence scales limited by the Hubble radius. An inverse cascade of magnetic fields to larger scales is then required. Overall it appears that the origin of cosmic magnetism is still quite an open problem and provides an interesting challenge for young minds to work on.

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Mangalyaan keeps the Indian tradition!

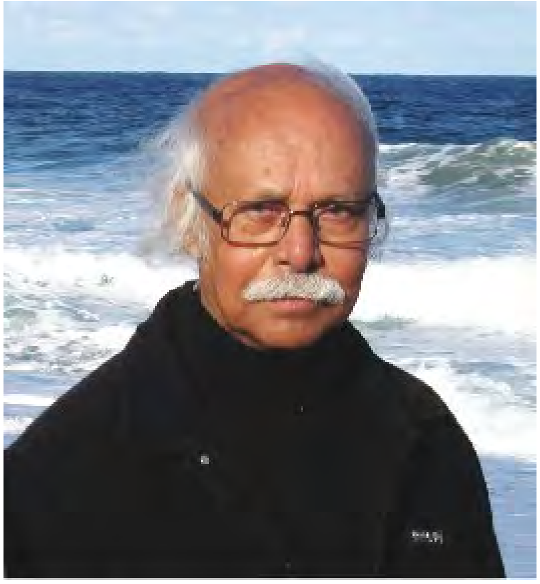
It was a pleasant surprise for me when Professor Ajit Kembhavi asked me to appear through the pages of the 100th issue of Khagol.

I will pen down below a conversation between me and a friend who asked me, hearing the news that India had successfully put the Mangalyaan on the Mars' orbit, ***'What are the immediate gains if we know the presence or absence of water on Mars or by taking the images of the surface of the Mars?'***. I gave the following answer, which may not be agreed upon by all; these findings may not have any immediate impact on us but they may throw some light in our attempts to understand the mysteries of the universe in which we live and the other important impacts are the fruits we are going to enjoy today or tomorrow in the fields of communication, producing high quality materials, imaging technology, software development and so on and some of them may find applications even in the medical field, and not only that the Mangalyaan project is first in many respects and it is an indigenous project.

He replied that it is then worthwhile to spend five rupees per Indians. When I added that the ideas of *planetary motion, gurutvakarshan, calculus, trigonometry, etc*. were known to ancient Indian Astronomers and Mathematicians long back before they were (re)discovered by westerners, he bowed his head showing respect to those great people of past and present and asked me another question, `then why can't India excel in other fields too?' to which I said, 'I and you' are responsible and I am forced to wind up this conversation as I am not prepared to listen to any more questions from him.

I conclude this note by adding that IUCAA stands unique in the scientific pursuits among other institutions in India.

Mass extinction: The astronomy connection



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About 90% of all recorded species that ever lived on earth are now extinct. Thus, extinction goes on along with diversity and generation of new species. However, if there is a rapid and widespread decrease in the diversity and abundance of macroscopic live systems, we call it a mass extinction. This happens when a biosphere under long-term stress faces a short term shock. Usually high diversity leads to an enhanced extinction rate, whereas low diversity causes an increase in generation rate. This ecological balancing can amplify a relatively local perturbation to have an extended global effect. A plot of the abundance against time shows about five major peaks and about 20 minor ones. The most catastrophic of these is the Permian-Triassic (P-T) extinction, which killed about 96% of existing species. The most recent one, the Cretaceous-Paleogene (K-T) event which removed 75% of all species and all non-avian dinosaurs. The major extinctions show an approximate periodicity of 26 - 30 million years, although considerable ambiguity remains regarding choice of data.

In 2008, Rodolfo Dirzo and coworkers opined that the earth had already entered the early stage of the sixth major mass extinction phase. Since 1500 AD, the number of big vertebrate animals, like elephants, rhinos, polar bears, etc. decreased significantly, as seen in the case of largest animals in earlier extinction event. Human activities are partly responsible for the onset of extinction.

Considerable work has been done to understand the nature of processes that lead to mass extinctions. While most of these are of terrestrial origin, e.g., large volcanic activities, rise in sea level, sustained global warming or cooling, etc., two possible causes of extra-terrestrial origin have been recognized. The impact of a large asteroid or comet produces dust and particulate aerosol, inhibiting photosynthesis and causing collapse of food chain on land and sea. Paleontologists suggest that an asteroid did hit earth around 66 million years ago. Shankar Chatterjee and co-workers have drawn attention to the large Shiva crater, near Mumbai and suggested a multiple impact scenario. It has been suggested that periodic gravitational disturbances can cause comets from Oort cloud to collide with the earth every 26-30 million years, but the conjecture needs confirmation.

The effect of a close supernova explosion or gamma ray burst (GRB), say within a distance of 10 pc, on earth's ozone layer has also been studied (M. Ruderman and J. Ellis, and D. Schramm). The supernova remnant Geminga, of age 300,000 years and about 130 pc away, the millisecond pulsar PSR J0437-4715 at 150 pc and other close and young remnants present the basic information.

One or more supernova explosions seem probable, given the star death rates, within 10 pc of earth during the last 500 million years. There is already a suggestion that a supernova explosion or GRB is responsible for the End-Ordovician extinction. However, there are too many models and a clear picture is yet to emerge. The new-age astronomers may examine the models making use of accumulated data on Supernovae and Asteroids to unveil the mysteries of mass extinctions.

Khagol @ 100

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Before starting to write this article for the 100th issue of Khagol, I thought, I would have a look at its first issue. Similar to how everything else works in IUCAA, seeing the first issue was very easy. All the issues are readily available on the IUCAA website. A look at the picture on the first page of the first issue brought a flood of memories to mind. It was of Aditi, the place which for me was the first physical perception of IUCAA.

I remember having received a letter from IUCAA, about twenty five years back, informing about its establishment and its objectives and suggesting that I make a visit in the summer. As isolated an astronomer as I was in Utkal University, rather the whole of Orissa, I was on the verge of quitting and migrating to other areas of physics and that letter was a God send. A window of opportunity for continuing research in the area in which I was trained, seemed to be opening. I promptly took up the offer, and Aditi and all its inmates welcomed me warmly.

I remember telling people afterwards that this is the first place where I feel I belong, as it was meant to be for people like me working in a then relatively off the track subject in a remote place in the country, without proper facilities. The rest, as they say, is history. I had been a regular visitor here, and am ending my career as an astronomer right here in IUCAA, which welcomed me to spend my last few productive years as a CSIR emeritus scientist. I have been a witness to every step that IUCAA took, to every new building, to every new faculty and have seen it grow from strength to strength. Without doubt it has established itself as the premier, world class institute in the country for research in Astronomy and Astrophysics. It has been of immense help to astronomers like me, who were on the verge of giving up astronomy, to survive in the field. We got tremendous encouragement and because of IUCAA, academic life for me and numerous other astronomers like me, which would have been stagnant, became vibrant and fruitful.

In all these years, Khagol has been the messenger of IUCAA. It informed us of all that was happening there, all the conferences/workshops/schools that were being organized, planned visits of astronomers, etc. All this helped us plan our own visits. Khagol was always published on time and was always compact, precise, educative, informative and beautifully done. It has undergone a number of changes over the years. The list of visitors has grown exponentially from the paltry 3-4 names to tightly packed names, filling a whole page. The issues have been scientifically informative as well. Early issues carried a series of 30 articles appropriately named "Parsec stones in Astronomy", which were all written by Professor J. V. Narlikar. There was one particularly interesting column on "Resource Summary", which also started early on and also ran over about 30 issues. One came to understand the topics on which IUCAA faculty and postdocs were working. It covered a variety of topics from Cosmology to Virtual Observatory to Scientific Toys of Arvind Gupta. The 16 part column on "Know Thy Trees" made the readers familiar with details of the trees in and around IUCAA. There were other columns such as " Know Thy Clouds", and "Know Thy Birds", which gave glimpses on environment. I wonder which columns are planned for the 100th issue onwards. I am sure whatever they are, they will be as interesting, if not more, for the readers in all corners of the country, who look forward to receiving the latest issue of Khagol.

On this occasion of the 100th issue, I wish Khagol and also IUCAA, a very bright future.

An introductory workshop on relativistic astrophysics

An Introductory Workshop on Relativistic Astrophysics was held during August 21 – 23, 2014 at the Department of Physics, Gauhati University, Guwahati, sponsored by Inter-University Centre for Astronomy and Astrophysics, Pune. There were 50 participants from different parts of the country. The workshop was inaugurated by Mridul Hazarika, the Honourable Vice-Chancellor of Gauhati University, who was also the Chief Guest. Hiralal Duorah, former Vice-Chancellor of Gauhati University and the founder of the Astrophysics group was the Guest of Honour. Karabi Dutta, the Dean of Faculty of Sciences and Anurup Gohain Borua, Head of the Department of Physics had chaired different sessions. Ranjeev Misra, IUCAA; Hiralal Duorah, Gauhati University; Dhrubajyoti Saikia, Cotton College State University; Chandrarekha Mahanta, Cotton College; Sanjeev Kalita, Gauhati University; Ritaban Chatterjee, Presidency University; Amit Pathak, Tezpur University; Madhurjya Prasad Bora, Gauhati University and Santabrata Das, IIT Guwahati were the resource persons.

Topics covered were:
(a) Stellar astrophysics (b) Radiative processes in the Universe (c) X-ray astronomy (d) Dark matter (e) Gamma ray bursts (f) General relativity and cosmology with dark energy (g) Active galactic nuclei (h) Relativistic plasmas in the universe (I) Accretion processes near black holes. Altogether there were 15 lectures.

At the very outset, Sanjeev Kalita, the local coordinator of the workshop delivered the welcome address and expressed the aims and objectives of the workshop. The valedictory function was held at the Lecture Hall of the Physics Department. The participants had shared their experience in the talks and discussions about the latest developments. They also expressed their views on further programmes, hospitality, etc. Sanjeev Kalita conveyed the vote of thanks to IUCAA, local organizing committee members, research scholars of the department for their active cooperation and the office staff for their hard work in making the workshop a success. Ranjeev Misra and Sanjeev Kalita were the coordinators of the workshop.

TMT - WEPOC group meeting

A special meeting of the Thirty Metre Telescope Workforce, Education, Public Outreach and Communications (TMT-WEPOC) group related to Indian outreach was held at IUCAA on July 31, 2014. The special interaction included Gordon Squires and Janesse Brewer, both members of the TMT -WEPOC group, USA, heads of a few Indian planetaria and representatives of research institutes, universities, colleges and amateur astronomy groups, who are actively involved in public outreach. Details of outreach activities at various levels in India were presented and the stakeholders discussed ways of collaboration. They also discussed how they would be able to include TMT outreach in their own fields. Durgesh Tripathi and Samir Dhurde, Indian members of TMT -WEPOC, were the local coordinators of this meeting.

Additions to the IUCAA family

IUCAA extends a warm welcome to the new visiting associates of the Twenty-Fifth Batch joining us for a tenure of three years, beginning from August 2014.

New visiting associates

1. Archana Bora, Gauhati University, Guwahati.
2. Arun Varma Thampan, St. Joseph's College, Bangalore.
3. Dhurjati Prasad Datta, University of North Bengal, Darjeeling.
4. Dibyendu Nandi, IISER, Kolkata.
5. Gargi Shaw, Centre for Excellence in Basic Sciences, Mumbai University.
6. Hameeda Mir, Govt. Sri Pratap College, Srinagar.
7. Irom Ablu Meitei, Pettigrew College, Manipur.
8. K. Sriram, Osmania University, Hyderabad.
9. Rahul Nigam, BITS-Pilani, Hyderabad.
10. Ritaban Chatterjee, Presidency University, Kolkata.
11. Sarmistha Banik, BITS-Pilani, Hyderabad.
12. Saumyadip Samui, Presidency University, Kolkata.
13. Suchetana Chatterjee, Presidency University, Kolkata.
14. Surajit Paul, Savitribai Phule Pune University.
15. Titus K. Mathew, CUSAT, Kochi.
16. Vikram Soni, Jamia Millia Islamia, Delhi.

Extension of term to the twenty-second batch of visiting associates

1. Anand Sengupta, IIT, Gandhinagar.
2. Asis Kumar Chattopadhyay, University of Calcutta, Kolkata.
3. Bijan Kumar Bagchi, University of Calcuta, Kolkata.
4. Jishnu Dey, Presidency University, Kolkata.
5. Kishor Dnyandeo Patil, B.D. College of Engineering, Wardha.
6. Manzoor Malik, University of Kashmir, Srinagar.
7. Mira Dey, Presidency University, Kolkata.
8. Naseer Iqbal Bhat, University of Kashmir, Srinagar.
9. Ninan Sajeeth Philip, St. Thomas College, Kozhencherri.
10. Pradip Mukherjee, Barasat Govt. College, Kolkata.
11. Rabin Kumar Chhetri, Sikkim Govt. College, Gangtok.
12. Ramesh Chandra, Kumaun University, Nainital.
13. S.K. Pandey, Pt. Ravishankar Shukla University, Raipur.
14. Saibal Ray, Govt. College of Engineering and Ceramic Technology, Kolkata.
15. Sanjay Baburao Sarwe, St. Francis De Sales College, Nagpur.
16. Shantanu Rastogi, D.D.U. Gorakhpur University.
17. Shuvendu Chakraborty, Seacom Engineering College, Howrah.
18. Soma Mandal, Taki Govt. College.
19. Sudipta Das, Visva-Bharati, Santiniketan.
20. Sunandan Gangopadhyay, West Bengal State University, Barasat.
21. Surajit Chattopadhyay, Pailan College of Management and Technology, Kolkata.
22. Suresh Chandra, Lovely Professional University, Phagwara, Punjab.
23. Suresh Kumar, Birla Institute of Technology and Science, Pilani.
24. T. R. Seshadri, University of Delhi.

Workshop on basic astronomy and telescope making

A 2-day hands-on Workshop on Basic Astronomy and Telescope Making for school students was organised jointly by the Kohima Science College (KSC) and IUCAA in Kohima during September 26 - 27, 2014. The participants were from 10 schools from the North-Eastern states of Nagaland and Manipur, with close to 60 students and teachers attending the lectures. Organiser from KSC was Chetan Kacchara, while the external resource persons were Gazi Ameen and Rupjyoti Gogoi, from Tezpur University, and Samir Dhurde and Tushar Purohit, both from IUCAA.

Public talk on “a Universe of wonder”

On July 31, 2014, Gordon Squires, Communications and Education lead, Thirty Metre Telescope gave a public talk on “A Universe of Wonder”. He shared exciting recent discoveries enabled by ground- and space-based telescopes, with some personal stories of how he helped share them with the world. He also described the progress towards astronomy’s next-generation observatory, the Thirty Metre Telescope (TMT).

Public Outreach

“Cosmic history and mysteries”

On August 21, 2014, Thanu Padmanabhan, IUCAA, interacted with the public on “Cosmic History and Mysteries”. He described our current understanding of the universe, emphasizing some recent work, which has the potential to solve the enigma of dark energy. Some deep mysteries about the cosmos were also highlighted, especially regarding its composition.

Ways of “Doing astronomy the hard (ware) way - reflections on travels with instrumentation” by Theodore Williams

On September 19, 2014, Theodore Williams, Director, South African Astronomical Observatory, Cape Town and Professor of Physics and Astronomy, Rutgers University shared his ways of “Doing Astronomy the Hard (ware) Way - Reflections on Travels with Instrumentation”. This public talk was a discussion on some experiences of Theodore Williams, both successful and not, and the attempt to blend Science and Instrumentation, an effort that strongly influences the course of astronomical investigation and discovery.

New arrivals

Aseem Paranjape, who has joined as a Faculty, completed his Ph.D. from TIFR, Mumbai in 2009, followed by post-doctoral stints at ICTP, Trieste and ETH, Zurich, before joining IUCAA in September 2014.

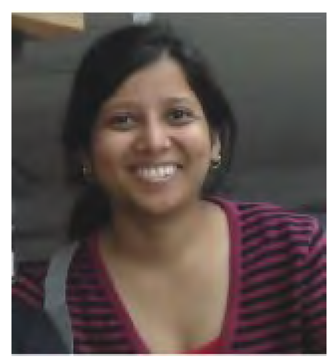
He is interested in a number of topics in cosmology and gravitation, including large scale structure (as traced by dark matter, galaxies and the inter-galactic medium), galaxy clusters, dark energy, primordial non-Gaussianity, general relativity, semi-classical effects near black holes and statistical techniques for cosmology.

He is primarily a theorist and his recent research involves understanding the growth of large scale structure at both low and high redshifts, which is a key aspect of building a complete understanding of the initial conditions and subsequent evolution of the Universe as a whole. Towards this end, he uses analytical tools which he has helped to develop, as well as numerical simulations and mock galaxy catalogues informed by observations.

Isha Pahwa, who has joined as a Post-doctoral Fellow on September 01, 2014. She did her Ph.D. from the University of Delhi, under the joint supervisions of T. R. Seshadri and Debajyoti Choudhury.

Her research is mainly based on the cosmological aspects of extra dimensions. However, she has moved on to the field of large scale structure in the universe. Her primary interests are structure formation in the universe, disk galaxies, and reionization.

Presently, she is working on finding the orientations of galaxies with the cosmic web in smooth particle hydrodynamics simulation, and also how these alignments change with redshift. The origin of angular momentum in galaxies is still an open question. By studying at the change in the alignments with redshift, one may be able to figure out the origin of angular momentum of galaxies.



Anuradha Gupta, who has joined as a Post-doctoral Fellow on September 17, 2014. She did her Ph.D. from Tata Institute of Fundamental Research, Mumbai, under the guidance of Achamveedu Gopakumar. She has studied the dynamics of inspiralling spinning compact binaries containing neutron stars and/or black holes. She has developed an improved gravitational wave phasing prescription to compute inspiral templates that can be relevant for the detection of gravitational waves from such binaries. She also has explored various data-analysis implications of these templates. At present, she has been studying the dynamics of coalescing compact binaries through their merger and ringdown phases. She is trying to construct inspiral-merger-ringdown hybrid waveforms for precessing spinning binaries.

Mayukh Pahari has joined as a Post-doctoral Fellow on August 04, 2014.He has carried out his Ph.D. research work from Tata Institiute of Fundamental Research, Mumbai. His research work mainly concentrates in accretion and radiation mechanism leading to spectral state transitions in black hole as well as neutron star X-ray binaries. In BHXBs, he mainly investigated the co-evaluation of accretion outburst and radio jet, evaluation of spectral and temporal properties at different luminosity and time scale of the outburst, origin of heartbeat oscillations in GRS 1915+105 and IGR J17091-3624 using RXTE, SWIFT, BeppoSAX and Chandra satellite data. In NSXBs, he has investigated the origin of 'Z' track and roll of thermal Comptonization in X-ray outburst evolution. On the basis of his work, he has proposed a modified disk-jet coupling model, valid for both BHXBs and NSXBs.

As a part of his Ph.D. research, he was also involved in astronomical instrumentations, mainly focussing on the characterization of X-ray and Gamma ray detectors like CZT, CdTe and Lanthunum Halide scintillators. He worked as a calibration team member of LAXPC detector on-board ASTROSAT, and currently a member of LAXPC science working group committee. Apart from continuation of his earlier work, he is presently involved in spectral and temporal correlated properties as a probe to investigate the origin of superluminal jet in X-ray binaries, black hole spin measurements using continuum fitting and broad Fe-line method, constraining inner disk radius and reflection component in X-ray binaries using XMM-Newton and NuSTAR data. He is also involved in the calibration of CZTI detector on-board ASTROSAT satellite.

Vishal Joshi, who has joined as a Post-doctoral Fellow on July 10, 2014. He did his Ph.D. from Physical Research Laboratory (PRL), Ahmedabad, Gujarat under the supervision of N. M. Ashok.

During his Ph.D. he has studied the temporal variation of near-infrared light curves of intermediate polar stars, and a magnetic sub-class of cataclysmic variable stars. Later he has studied the near-infrared spectral evolution of several novae and supernovae during his PDF at PRL. He has detected a rare transition from nova spectral class He/N to FeII in early phase of 2011 outburst of recurrent nova T Pyx.

In another symbiotic recurrent nova V745 Sco, he has detected emergence of strong blast wave due to interaction of fast nova eject with wind of red giant secondary star. This nova is one of the only 5 known novae, which has shown gamma ray emissoin duing the outburst. It was proposed that the blast wave was the suitable site of gamma ray generation in the novae. He has also studied the photometric and spectroscopic evolution of the type Ia supernova SN2014J in cigar galaxy, which was one of the closest type Ia supernovae occurred in recent past. Presently, he is working with the instrumentation group in IUCAA.

Ravi Joshi did his Ph.D. from Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, under the supervision of Hum Chand. He has joined IUCAA as a Post-doctoral Fellow.

His Ph.D. research work involved probing the central engine and environments of Active Galactic Nuclei (AGNs). In a frame work of a unified model of AGNs, he has investigated the optical continuum variability nature of various quasar sub-classes, and found the weak-emission line quasars as the potential candidates for elusive radio quite counterpart of blazars. With carefully modeling of emission lines, he has ruled out the weak jet component model in radio-quiet quasars. He has also studied both the associated and intervening absorption lines to probe the quasar outflows.

His present research interest includes the supermassive binary black hole systems, the intergalactic medium and quasar outflows.

India - South Africa flagship meeting

An India-South Africa flagship meeting was organized at IUCAA, on September 19, 2014 to discuss the possible advanced joint collaboration programmes, which can be promoted between the two countries in Observational Astronomy, particularly in the area of Optical and Radio astronomy. Astronomers from South Africa (SA) Sandeep Sirothia, Ted Williams, Francois Kapp and Lindsay Magnus (over Skype), and Yashwant Gupta, Avinash Deshpande, Dipankar Bhattacharya, A. N. Ramaprakash, and Neeraj Gupta made presentations during this meeting on various ongoing plans in Optical and Radio Astronomy. In addition, astronomers from other institutes within India viz. Anil Pandey, H.P. Singh, D.K. Ojha and C. Muthumariappan also participated in these discussions. Nithaya Chetty from SA and Ranjan Gupta were the coordinators for this meeting.

It is expected that a special call for India-SA Flagship projects will be made in due course by the DST of both the countries, which will be beyond the currently on-going joint projects in Astronomy. DST, India had sponsored this meeting.

Workshop on fabrication of night sky photometer for small telescopes

A workshop on fabrication of night sky photometer for small telescopes was organized during September 8 –12, 2014 at IUCAA. This was the fourth one in this series, and 12 selected participants from all over the country took part in this venture, where they fabricated 9 photometer units and were also provided additional flip-mirror units and a data logger for easy observations. The participants were mostly from various universities, colleges and planetaria.

The inaugural talk was given by S. N. Tandon, who had initiated this effort almost 24 years back. Several other talks were given by Arvind Paranjpye, Vijay Mohan, Vilas Mestry, Ranjan Gupta, Samir Dhurde, Varun Bhalerao and Akanksha Devkar, covering related topics of this workshop. Given the good response received for this event, IUCAA plans to have more such workshops in near future along with some improvements in the photometer and accessories like providing illuminated eye-pieces, BVRI filters, etc. Ranjan Gupta was the IUCAA coordinator for this workshop.

The school on recent trends in astrophysics and cosmology

During September 4 - 6, 2014, the school on Recent Trends in Astrophysics and Cosmology, supported by IUCAA, was conducted at Manipal Centre for Natural Sciences (MCNS), Manipal University.
The purpose of this school was to inspire students in nearby regions by providing information on the latest developments in astrophysics and cosmology. Indeed, as far as we could recognize, this school was the first event of this kind in this region. We had selected 41 participants from Manipal University and 11 from institutes outside Manipal University from a large number of applications. Among the participants from Manipal University, around 10 participants were in M.Sc. Physics, and others were M. Tech. and B. Tech. students.

During the school, Ajit Kembhavi (IUCAA) delivered two lectures on Galaxies, and delivered a popular talk on Thirty Metre Telescope to wider audiences. Dipankar Bhattacharya (IUCAA) elaborated on Explosions in the Universe during his three lectures. Ranjeev Misra (IUCAA) gave three lectures on Radiative Processes in Astrophysics. Sanjit Mitra (IUCAA) lectured on Gravitational Waves and Cosmic Microwave Background Radiations. P. Sreekumar (IIA) delivered two lectures on Experimental Astrophysics. The lectures by P. Sreekumar's as well as Kembhavi's popular talk must have been particularly appealing to the participants of engineering background. Debbijoy Bhattacharya (MCNS) lectured on Diffuse Gamma-Ray Emissions and Kazuyuki Furuuchi (MCNS) lectured on Expanding and Inflationary Universe. All the lectures turned out to be very interactive. The discussions with the lecturers also continued during the tea and the lunch times. It was a great opportunity for students not only to learn astrophysics, but also to know possible directions for their career in research and developments in astrophysics.

At the end of the school, from the feedback we found that all the students were extremely happy to have attended the school. Overall, this school provided an excellent platform for all participants, in particular, the students of Manipal University to pursue a career in astrophysics. We were truly thankful to IUCAA and all resource persons for the kind support provided by them, which was crucial for the success of this school. Inspired by the response of the participants and boosted by the kind support provided by IUCAA, we wish to organize more such schools/workshops in Manipal University in future.

Debbijoy Bhattacharya and Kazuyuki Furuuchi were the convener and secretary of the school from MCNS and Ranjeev Misra was the coordinator from IUCAA.

Seminars @ IUCAA

01.07.2014	Suprit Singh on Black holes- Up, close and personal.
01.07.2014	Luke Chamandy on Dynamo action in spiral galaxies.
02.07.2014	Pallavi Bhat on Resilience of helical magnetic fields to turbulent diffusion.
02.07.2014	Santanu Das on Developing one of the most efficient cosmological parameter estimation codes.
03.07.2014	Mohammad Sami on Quintessential inflation or unifying inflation with dark energy.
04.07.2014	Urjit Yajnik on Cosmology and unification.
08.07.2014	Hamsa Padmanabhan on Probing the Universe: Through reionization and later.
10.07.2014	Main Pal on Spectral variability of active galactic nuclei.
10.07.2014	Nagendra Kumar on Energy dependent time delays of kHz oscillation due to thermal Comptonization.
11.07.2014	Manu Paranjape on Negative mass bubbles in de Sitter spacetime.
17.07.2014	Parampreet Singh on Singularity resolution in loop quantum cosmology: An overview.
23.07.2014	Ravi Kumar Kopparapu on Habitable zones and the occurrence of potential habitable planets in extrasolar planetary systems.
30.07.2014	Viral Parekh on Morphological classification and dynamics of X-ray galaxy clusters.
29.09.2014	Himadri D. Bohidar on Self-assembly and gelation in anisotropic colloidal dispersions.

Congratulations to...

Varun Bhalerao on being conferred with the INSPIRE Faculty Award by the Department of Science and Technology (DST) Government of India, New Delhi

Dipankar Bhattacharya on being elected as Fellow, National Academy of Sciences, India.

Farewell to...

Shakti Viraat S. Rathod, who has joined the Osmania University, to continue his Ph.D. in Astrophysics.

Luke Chamandy, who will be taking up a SKA Fellowship at the University of Cape Town.

M. Vivek, who has joined the University of Utah as a Post-doctoral Fellow.

Arunava Mukherjee, who has joined ICTS-TIFR, Mumbai, as a Post-doctoral Visiting Scientist.

Please join us in welcoming ***Suman Bala, Kaustubh Deshpande, Niladri Paul, Debajyoti Sarkar,*** and ***Ruchika Seth,*** who have joined us as Research Scholars.

Visitors expected

Long Term Visitors

P. C. Agrawal; Pushpa Khare.

October 2014

Lars Anderson, Albert Einstein Institute, Germany; **Prasad Arlulkar,** Seoul National University, Seoul; **Kalyani Bagri,** Pt. Ravishankar Shukla University, Raipur; **Ayan Banerjee,** Jadavpur University, Kolkata; **Sumita Banerjee,** Adamas Institute of Tech., West Bengal; **Manoneeta Chakraborty,** TIFR, Mumbai; **Subhamoy Chatterjee,** IIA, Bangalore; **Saumyadip Choudhary,** Assam University, Silchar; **Ramkrishna Das,** S. N. Bose National Centre for Basic Sciences, Kolkata; **Dhanya J. S.,** Institute of Plasma Research, Gujarat; **Tsewang Dorjai,** Indian Astronomical Observatory, Hanle; **Somnath Dutta,** S. N. Bose National Centre for Basic Sciences, Kolkata; **Sharad Gaonkar,** Mumbai; **R. Gannouji,** University Catolica, Chile; **Supriyo Ghosh,** S. N. Bose National Centre for Basic Sciences, Kolkata; **Aruna Govada,** BITS, Goa; **K. P. Harikrishnan,** The Cochin College, Kochi; **Dhiraj Hazra,** APCTP, Pohang, Korea; **Bala Iyer,** RRI, Bangalore; **Kanti Jotania,** M.S. University of Baroda, Vadodara; **Indrani Karar,** Saroj Mohan Institute of Technology, Kolkata; **Soma Mandal,** Taki Govt. College, West Bengal; **Tabasum Masood,** University of Kashmir, Srinagar; **Aditya Sow Mondal,** Visva Bharati, Santiniketan; **Pramod G. Musrif,** AIISMS Institute of Information Tech., Pune; **Rahul Nigam,** Bits-Pilani, Hyderabad; **Dishant Pandya,** P. D. Petroleum University, Gujarat; **Ajith Parameswaran,** ICTS-TIFR, Bangalore; **Ramachandran R.,** Frontline, Delhi; **Frederick Raab,** Caltech, USA; **B. S. Ratanpal,** M. S. University of Baroda, Vadodara; **David Reitze,** Caltech, USA; **Sonali Sachdeva,** University of Delhi; **Abhik Kumar Sanyal,** Jangipur College, Murshidabad; **Kaushik Sarkar,** Jangipur College, Murshidabad; **Subrata Sarker,** Visva Bharati, Santiniketan; **Asoke Kumar Sen,** Assam University, Silchar; **Senovilla Jose,** University of Basque, Spain; **Vishant Shah,** M. S. University of Baroda, Vadodara; **Ranjan Sharma,** P. D. Women's College, West Bengal; **Sathyakumar Sharma,** TMA Planetarium, Manipal; **Gargi Shaw,** Centre for Excellence in Basic Sciences, Mumbai; **Sk. Nayem,** Jangipur College, Murshidabad; **L. Sriramkumar,** IIT, Madras; **Sharanya Sur,** Arizona University, USA; **Reza Tavakol,** Queen Mary University of London, UK; **D. B. Vaidya,** Ex- Gujarat College, Ahmedabad; **Naveel Wani,** University of Kashmir, Srinagar; **Dhanraj Warjurkar,** Seoul National University, Seoul; and **Stanley Whitcomb,** Caltech, USA.

November 2014

G. C. Anupama, IIA, Bangalore; **Tomaso Belloni,** INAF-Observatoire, Italy; **Atreyee Biswas,** West Bengal University of Technology, Kolkata; **Xian Camanho,** Albert Einstein Institute, Golm, Germany; **Brian C. Chaboyer; Subenoy Chakraborty,** Jadavpur University, Kolkata; **Phil Charles; Arup Das,** Assam University, Silchar; **Himadri Sekhar Das,** Assam University, Silchar; **Hari N. D. Das,** Chennai Mathematical Institute; **Sourav Dutta,** Jadavpur University, Kolkata; **Supriyo Ghosh,** S. N. Bose National Centre for Basic Sciences, Kolkata; **Jack Hughes,** The State University of New Jersey, USA; **Reju Sam John,** PEC Pondicherry University; **Sibasish Laha,** Queens University, Belfast; **Nilanjana Mahata,** Jadavpur University, Kolkata; **Helen Mason,** DAMTP, UK; **Joanna Mikotajewska; Supriya Pan,** Jadavpur University, Kolkata; **Surajit Paul,** Savitribai Phule Pune University; **Radhika D.,** ISAC, Bangalore; **Pritesh Ranadive,** Mumbai; **Ashim K. Roy,** ISI, Kolkata; **Parizath Deb Roy,** Assam University, Silchar; **Bijan Saha,** Joint Institute for Nuclear Research, Russia; **Shishir Sankhyayan,** IISER, Pune; **Marek J Sarna; Michael Shara; S.K. Sharma,** Ex - SNBSC, Kolkata; **Nishant Singh,** NORDITA, Sweden; and **Fasih Uzzama,** Jamia Millia Islamia, Delhi.

December 2014

Jhumpa Bhadra, Heritage Institute of Technology, Kolkata; **Ritabrata Biswas,** Indian Institute of Engg. Science and Technology, Howrah; **Ligeria A. Calcagno,** Universidad Tecnica Federico Santa Maria, Chile; **Koushik Chakraborty,** Govt. Training College, Hooghly; **Suresh Chandra,** Lovely Professional University, Punjab; **Surajit Chattopadhyay,** Pailan College of Mgmt. and Tech., Kolkata; **Goutami Chattopadhyay,** Kolkata; **Claude Catala,** Observatoire de Paris, France; **Rumi Deb,** North Bengal University, Siliguri; **Ujjal Debnath,** Indian Institute of Engg. Science and Technology, Howrah; **Rahul Ghosh,** Bhairab Ganguly College, Kolkata; **Sudan Hansraj,** University of Kwazulu Natal, South Africa; **Donald Lynden Bell,** University of Cambridge, UK; **Soma Mandal,** Taki Govt. College, West Bengal; **C. P. Masroor,** Mahatma Gandhi University, Kerala; **Rahul Nigam,** Bits-Pilani, Hyderabad; **Shivam Pandey,** IIT, Delhi; **B. C. Paul,** North Bengal University, Siliguri; **G. V. Punyakoti,** University of Hyderabad; **Chayan Ranjit,** Seacom Engg. College, Howrah; **Sujata Kundu Ranjit,** Narula Institute of Technology, Kolkata; **Subharthi Ray,** University of Kwazulu Natal, South Africa; **Prabir Rudra,** Pailan College of Mgmt. and Tech., Kolkata; **Subhajit Saha,** Jadavpur University, Kolkata; and **Mohit Sharma,** Jiwaji University, Gwalior.

Visitors (July - September 2014)

Anamika Aggarwal
Gazi Ameen Ahmed
Bobomurat
Ahmedov
Mohd. Shah Alam
Saiyad Sk. Ali
Rakesh Andania
H. M. Antia
G. C. Anupama
K. G. Anusree
Raj Bali
Bidisha Bandyopadhyay
Ayan Banerjee
Arkadip Basak
A. K. Beesham
S. M. Bennett
Priya Bharali
Mohit Bhardwaj
Naseer Iqbal Bhat
Ravinder S. Bhatia
Vishal Bhatt
Sandip K. Bhattacharya
Souradeep Bhattacharya
Celestina Bhengra
Julius Bhengra
K. G. Biju
H. B. Bohidar
Debasish Borah
Janesse Brewer
Mridusmita
Buragohain
Koushik Chakraborty
Nabajit Chakravarty
A. Chandrasekar
Kalyan Brata Chatterjee
A. K. Chattopadhyay
Tanuka Chattopadhyay
B. C. Chauhan
Nithaya Chetty
Partha Chowdhury
Haeun Chung
Mamta Dahiya
Suranjan Das
Bipash Dasgupta
K. S. Dasgupta
Aritra De
S. Dev
P. P. Divakaran
Debiprosad Duari
Vivek Kumar Dubey
Sukanta Dutta
Savithri Ezhikode
Taparati Gangopadhyay
Jayant Ganguli
Sharad Gaonkar
Prerak Garg
Michelle George
Avyarthana Ghosh
Ritesh Ghosh
Rupjyoti Gogoi
Sushmita Gogoi
Alok C. Gupta
Tanul Gupta
R. A. Guria
Mubashir Hamid
Siraj Hasan
Abdolhosein
Hashemizadeh
Basant Hassa
Sheetal Prabhat
Honhoga
Sk. Monowar Hossein
Souvanik Hui
Tanvir Hussain
Asif Iqbal
Safiqul Islam
Nirmal Iyer
Joe Jacob
Dhairyashil Jagadale
D. Jagadeep
Deepak Jain
V. Jithesh
Sanarti Jojowar
Pratik Kadam
Md. Mehedi Kalam
Suman Kerketta
Ravindra Keskar
Imran Khan
Ziauddin Khan
Avas Khugaev
Kishore
Ravi Kumar
Koparappu
Ashwini Kumar
Atmjeet Kumar
Prem Kumar
Saurabh Kumar
Tarun Kumar
Sandhya Kumari
Arpan Kundu
M. L. Kurtadikar
Sujit Kumar Maji
Manzoor A. Malik
Sumit Mamoria
Pranshu Mandal
Jameer Mannur
Bari Maqbool
Sujay Vivek Mate
Karmesh Mehta
Melbin
Jyoti Minjur
Bivudutta Mishra
Nishant Mittal
Siddharth Mohrana
Sargam Mulay
Biswasi Mundu
Dasmi Mundu
Monika Mundu
C. Muthumariappan
Balamdina Nag
K.S.V.S. Narasimhan
Rajesh Nayak
Devendra Ojha
Amitesh Omar
Anil Pandey
Sanjay Pandey
Abhishek Parab
Manu Paranjape
Arvind Paranjpye
Viral Parekh
Abhishek Parida
Pooja Passi
Amit Pathak
Shankar Dayal Pathak
Subodh P. Patil
B. C. Paul
Pramod Pawar
Lalatendu Pradhan
Ashok Prajapati
K. C. Ajith Prasad
Marshal Purti
Farook Rahaman
Sendhil Raja
Karthik Rajeev
Laxman Rankshtre
P. Vivekananda Rao
Smriti Rastogi
Bharti Rawat
Vipin Singh Rawat
Katherine Rawlins
Saibal Ray
Biplab Raychaudhuri
Sonali Sachdeva
Anirban Saha
Sanjay Kumar Sahay
Sunder B.
Sahayanathan
M. Sami
Saumyadip Samui
C. V. Sandeep
Sarita Sanga
Shishir Sankhyayan
T. R. Seshadri
Amit Seta
Phalguni Shah
Md. Arif Shaikh
K. Shanthi
Aishawnnya Sharma
Ashu Sharma
Joginder Sharma
Ram Sharma
Umang Sharma
Gargi Shaw
Sanjar Shaymatov
Yuri Shtanov
B.S. Shylaja
H. P. Singh
K. P. Singh
Nishant Singh
Parampreet Singh
Atreyee Sinha
Sandeep Sirothia
Satish Sonkamble
Gordon Squires
Avinash Surendran
Navita Thakkar
Sanam Thakur
Punita Tigga
Pooja Tolia
S. K. Tripathy
Kirti Trivedi
Pranjal Trivedi
Paniveni
Udayashankar
C. S. Unnikrishnan
Ravindra Upadhyay
A. A. Usmani
Qamar Usmani
Aparna V.
P. Vaishak
S. R. Valluri
Hum Chand Varma
Vasundhara
K. Venkataraman
T. V. Venkateswaran
S. N. Verma
Theodore Williams
Akash Yadav
Urjit Yajnik
A. R. Zungu
Bupinder Zutshi.

IAGRG

RRI

Celebrating the Centenary Year of General Relativity
IAGRG 2015
Raman Research Institute
March 18-20 2015

Keynote Speakers:
Ramesh Narayan (Harvard)
Varun Sahni (IUCAA)

Plenary Speakers:
KG Arun (CMI)
Tarun Souradeep (IUCAA)
Madhavan Varadarajan (RRI)
Samir Mathur (Ohio State)
CS Unnikrishnan (TIFR)

Special Session Speakers:
J. V. Narlikar (IUCAA)
Naresh Dadhich (Jamia Millia)
C. V. Vishveshwara (IIA)

Deadlines:

Abstract Submission: Dec 15th

Early Registration: Jan 15th

Late Registration: Feb 15th

Workshop Chairs:
GR and Relativistic Astrophysics: Archana Pai (IISER-TVM) & Sudip Bhattacharyya (TIFR)
Cosmology: L. Sriramkumar (IITM) & Shiv Sethi (RRI)
Quantum Gravity: Aninda Sinha (IISc) & Amit Ghosh (SINP)

SOC: Sayan Kar (Chair), Sukanta Bose, Pravabati Chingangbam, Golam Hossain, Alok Laddha, Somak Roychoudhury, Tirthankar Roy Choudhury, Sudipta Sarkar

LOC: Sumati Surya (Chair), Debarshini Chakraborty, Pravabati Chingangbam, Banibrata Mukhopadhyay, Tarun Deep Saini, Prateek Sharma.

IUCAA

Know thy birds - 7

Contributed by Chaitanya Rajarshi

LAUGHING DOVE

Hello friends,

How's your bird watching going on? What is the count in your *life list*...Any new *lifer*? What these terms *"life list"," lifer"* means...you will come to know this at the end of the article.

Now, this time, let us get familiar with "Laughing Dove". Its scientific name is *(Spilopelia/ Streptopelia senegalensis).* Other names include little brown dove, Laughing turtle dove, Palm dove or Senegal dove. The bird gets its name from its particular characteristic call, which sounds like human laughter.


(Photo Courtsey: Umesh Vaghela)

Hola (Marathi); Laughing Dove

It is a slim dove with average length of 25 cm, wingspan of about 40 cm and weight about 100 g. You can easily identify this bird with the chessboard pattern on the throat. Its head and breast are pinkish-brown, the wings are blue-grey and the belly is dusty white. The legs are red. Male-female are alike, although the plumage of the female is a little paler.

This Least concerned (IUCN list) bird is resident breeder in Southern Africa, Asia and also found in Australia. You can commonly see it in scrub, dry land and our surroundings.

They breed throughout the year. The nest is platform type made-up of twigs. The bird lays mostly two eggs and the incubation period is about two weeks. Both male female take part in nest building and incubation.

The laughing dove feeds on fruits, grains, seeds and sometimes small insects.

(Photos Courtsey: Chaitanya Rajarshi)

Now, what's a ***"life list" ?*** A life list is the collective record of the bird species that you identify during bird watching and whenever you sight a bird for the first time, it is your ***"lifer"***.

There are many places around Pune for bird watching such as Sinhgad valley, Pashan lake, Kavdi on Solapur Highway. Even if you wander in our Pune university campus, you would see more than 50 birds. So when are you starting? And don't forget to email your bird list to cvr@iucaa.ernet.in

Wish You a Very Happy Birding

KHAGOL

THE IUCAA BULLETIN
October 2014

"The first issue of Khagol was published in January 1990, while this 100th issue is being published in October 2014. Khagol appears once every three months. We could therefore consider Khagol to be a clock ticking once every three months with a cumulative accuracy of about one part in 300, which is not too bad for many purposes. But the Khagol clock goes further than other time keeping devices; every tick of it carries information about important events which occurred in IUCAA over the preceding three month period..."

Ajit Kembhavi
Director, IUCAA
(October 2014)