

No. 33

A Bulletin of the Inter-University Centre for Astronomy and Astrophysics (An Autonomous Institution of the University Grants Commission)

January 1998

The 9th IUCAA Foundation Day



One of the highlights of the Foundation Day celebrations held on December 29 each year at IUCAA is the Foundation Day lecture delivered by some eminent personality. This year IUCAA was fortunate in having Professor Sir Michael Berry to give this keynote lecture. Michael Berry is currently he Royal Society Research Professor at H.H. Wills Physics Laboratory, Bristol. He has received numerous awards for his outstanding contributions in different areas of physics including Maxwell Medal of IOP 1978, Julius Edgar Lilienfeld prize (AMS) 1990, Naylor prize (AMS) 1992, Science for Art prize 1994, Dirac prize

(ICTP) 1995, Hewlett-Packard Solid State Physics prize 1995 and Kapitza Medal (Russia) 1997.

He is well-known among the physics community for his investigations related to (what is usually called) the Berry's phase, which he modestly refers to as "geometric phase".

In his lecture titled "Geometric phases and the separation of the world", he gave a lively summary of different situations in which geometric phases arise in physics and their consequences. One of the everyday examples of geometric phase is in the ability of a falling cat to contort itself in such a way as to always land on its feet. More esoteric examples involve twisted stacks of crystal plates, halfturns of certain special spin states, the Pauli exclusion principle and Hannay's angle for the World. The last one makes a small contribution to the length of the year, though, separating this contribution from other effects could be - according to Berry - fairly difficult.

When geometric phase reacts back on the environment which creates it, it produces a pseudo-force which Berry calls 'geometric magnetism'. As usual in the physics of pseudoforces, there arise several real effects. During the course of his Foundation Day lecture, Berry demonstrated how a spinning top can stay stably levitated above a magnet because of similar effects. Berry calls this levitation without meditation! He concluded his lecture discussing a set of unsolved problems related to geometric phase.

It was a delightful experience for the IUCAA gathering to hear Sir Michael Berry about the phase that launched a thousand scripts.

Inside...

Announcements . 2-4,9,10
Parsecstones
in Astronomy:21 4
GR 15 Report 5-8
Past events report 9,11

Seminars	10
Colloquia	10
PEP Talks	10
IUCAA Preprints	10

Talks during	
visits abroad	11
Visitors	1-1
Visitors expected	11
Anecdote	12

RESEARCH SCHOLARS 1998

Admission Notice

IUCAA invites applications for its graduate school leading to a Ph.D. degree in Astronomy and Astrophysics. Selection for the academic year 1998-99 will be made on the basis of a written test and interviews to be held in Pune in the first week of July 1998. The academic programme will commence in August 1998.

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Graduate School: Selected students will undergo graduate courses in physics, astronomy and related areas for two semesters. Satisfactory completion of the courses will allow students to register for a Ph.D. programme. The graduate courses will be organised in collaboration with the National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research (TIFR), Pune. The total duration of the Ph.D. programme, including the graduate school, will be 4 years.

Qualification: Students with M.Sc.(physics/applied mathematics/ astronomy/electronics) or Bachelor's or Master's degree in engineering or technology with adequate background in physics and mathematics are eligible to apply. Candidates with an engineering or technology background and interest in experimental physics are also encouraged to apply. Candidates expecting to obtain their degrees by July 1998 may also apply. All selected candidates will be required to clear the UGC-CSIR NET examination within one year of admission to the research programme, if they have not already done so.

Scholarship: Each student will be paid scholarship of Rs. 2,500/- per month for the first two years and Rs.2,800/- per month for the remaining two years. (This amount is likely to be increased.) In addition, there will be a contingency grant of Rs.10,000/- p.a. and other benefits including free accommodation. The continuation in the scholarship is, however, subject to satisfactory performance of the student every year.

Application: Forms can be obtained by writing to the Coordinator, Core Programmes, IUCAA, Post Bag No. 4, Ganeshkhind, Pune 411 007, along with 24 x 11 cm. self addressed stamped (Rs. 2.00) envelope. Completed applications should arrive at IUCAA no later than April 1, 1998. Candidates called for written test and interviews will be paid 1.33 times the rail fare each way by II class (not airconditioned) and a halting allowance for the days of the interview. A common test and interviews may be conducted for admission to IUCAA and NCRA (TIFR).

Projects in Radio Astronomy

An attempt is being made to introduce the Radio Astronomy facilities available at the Giant Metrewave Radio Telescope (GMRT) and the Ooty Radio Telescope (ORT) to interested persons from Indian universities in the form of suitably designed projects. IUCAA invites applications, in plain paper, from academic members of Indian universities to do a project at the National Centre for Radio Astrophysics (NCRA), related to observational aspects of Radio Astronomy. The details of this scheme are as follows -

(1) The scheme is open to the following persons:

(a) Permanent academic staff members of universities.

(b) Post-docs with Ph.D. degree working in the universities.

(c) In exceptional cases, applications from students nearing completion of their Ph.D. may also be considered. The student should include along with their application, a recommendation letter from their guide.

Interested persons should write directly to the Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007, giving their biodata, list of publications and a short write-up (less than 200 words) indicating their specific interest in Radio Astronomy or related areas (if applicable). Previous experience in Observational Astronomy and especially Radio Astronomy should be highlighted in the application.

(2) The last date for receipt of applications by the Coordinator, Core Programmes, IUCAA is March 2, 1998.

(3) Selected persons will be invited to spend about two months at NCRA doing a project in Radio Astronomy. The project could involve working with GMRT or ORT or analysis of data already available from ORT. The detailed nature of the project, etc. will be decided by the NCRA taking into account the background of the applicant. It is envisaged that some of the successful candidates will periodically visit IUCAA and NCRA in future and will continue with their Radio Astronomy interest and involve themselves in greater measure with GMRT-related activities.

IUCAA will pay the travel and subsistance allowances for the selected persons as per the current norms. The accommodation will be arranged either at IUCAA or NCRA or at the Telescope site for the duration of the project.

The selected candidates will be informed by the end of March 1998 and the projects are expected to start around May 1, 1998.

The Counting of Radio Sources

The discovery of Cygnus A and its identification with an extragalactic system led to the resolution of a major controversy and led to another!

By 1950, the radio astronomers at Cambridge, led by Martin Ryle had discovered many radio sources and their general conviction was that they were radio stars in our Galaxy. Tommy Gold, on the other hand believed that they were largely extragalactic. His minority view, however, turned out to be correct with Cygnus A, the typical extragalactic radio source, although on the more powerful side. By mid-1950s a large number of such radio galaxies had been discovered.

In the 1930s, Hubble had attempted to count galaxies to larger and larger distances. His aim was to estimate the volume-distance relationship, on the assumption that the galaxies are uniformly distributed. He expected that this relationship might be different from the Euclidean one of volume proportional to the cube of distance, thereby telling us which cosmological model is closer to reality. Hubble's attempts did not succeed as the number of galaxies to be counted is far too large.

Radio sources are not that common and radio astronomers, both in Cambridge and Australia felt that their counting may demonstrate the effect looked for. Since radio sources did not have measured redshifts, their flux density was measured with the assumption that fainter sources would be farther. Ryle and his group claimed that the slope of the number count versus faintness was much steeper than the Euclidean value, and that these findings discredited the steady state theory. The Australians like B. Mills and J. Bolton, on the other hand, did not find any significant departure from a Euclidean distribution.

In the early sixties, there was a big controversy about the interpretation of source counts with Hoyle claiming that there was no significant deviation from the steady state predictions, given the lack of understanding of the physical properties of these sources; and he and the author gave a counter-example to Ryle's claims.

Today, with a greater understanding of radio sources and with the knowledge of redshifts of the brighter ones, it is clear that the steady state theory is consistent with the counts at the bright end. In general, the original question of which particular geometry is singled out as the most favoured one has been sidetracked in that the counts are seen to be mixed up with the physical properties of the sources and their evolution. Nevertheless, the controversy helped to push radio observations to greater and greater levels of sensitivity.

REGIONAL CENTRES

As a further step in its primary objective of reaching out to universities for promotion of Astronomy & Astrophysics, IUCAA will be setting up a few Regional Centres in different parts of the country. IUCAA will be providing some important journals and books to the Centres. It will also provide travel support to university and college teachers, interested in Astronomy, Astrophysics and related areas, who live in the region around the Centre, to visit the Centre from time to time.

The host institution where the Centre is located would be expected to provide office space, computing facility, e-mail connectivity and accommodation to the visitors. Each Centre will have a coordinator from the host institution, who will provide academic leadership as well as manage the Regional Centre. **Detailed information about the Regional Centres as well as the mode of application are being circulated separately. These can also be obtained by writing to the Coordinator, Core Programmes, IUCAA.**

15th Meeting of the International Society on General Relativity and Gravitation (GR 15)



GR15, the fifteenth Meeting of The International Society on General Relativity and Gravitation (ISGRG), was hosted, for the first time in the Asia-Pacific region, during December 16-21, 1997 by IUCAA. The triennial meeting united about five hundred active minds (from more than thirty countries) in celebration and pursuit of Einstein's theory and its ramifications in a broad spectrum of related avenues of research.

The Conference began on the 16th morning with brief introductory remarks by Jayant Narlikar, Naresh Dadhich and Ted Newman. Jurgen Ehlers presented the Basilis Xanthopoulous Award to Matt Choptuik for his pioneering work on novel phenomena in scalar field collapse, which has opened up a new area of research in GR over the last five years.

The morning sessions had seventeen plenary lectures by renowned experts on topics which could be broadly classified as - (i) Classical Gravity, (ii) Quantum Gravity, (iii) Black holes, (iv) Cosmology, (v) Gravitational waves, (vi) Experimental aspects of GR, (vii) Related topics. The afternoons had six workshops running in parallel on four days, which dealt with more specialised presentations on each of the above fields.

Classical gravity was covered from the analytic and numerical viewpoints by Helmut Friedrich and Ed Seidel. While Friedrich presented recent developments in geometric asymptotics and the Einstein equations, Seidel showed us how numerical explorations can reveal the as yet unknown secrets of general relativity through an appropriate definition and analysis of the initial value problem. In another lecture, Carlos Kozameh focussed on a new formulation of GR in terms of null surfaces, a topic which has attracted some attention over the last few years.

On the other front, lectures on quantum gravity by Gary Gibbons and Carlo Rovelli set out to explore the various approaches to the subject. One of the major contenders of QG-string theory - was represented in an overview lecture by Gibbons. Rovelli dealt with the several different approaches to QG, briefly summarizing their successes and failures and made an attempt towards emphasizing what the future line of research should be. The curious, opposite facts that loop quantum gravity has been successful entirely in the non-perturbative regime, whereas string theory has largely been so in the perturbative domain (modulo recent progress in nonperturbative string theory) was emphasized in his presentation.

Black hole physics had three speakers - Ramesh Narayan, Jorge Pullin and Matt Choptuik. These three talks presented a fairly unique combination of new results. Narayan dealt with the possible astrophysical evidence of such objects through the analysis of observational data - a fact which is of great current interest in recent times. Pullin focussed on black hole collisions from the analytic (perturbation theory) point of view (with an eye on improving upon numerical techniques) and Choptuik presented exciting evidence of new phenomena (such as universality, discrete self similarity, which have parallels in condensed matter systems) first observed in numerical work on massless scalar field collapse and later found in other collapse scenarios as well.

In cosmology, we had Kumar Chitre and Vladimir Lukash summarizing gravitational lensing, CMBR and structure formation. Malcolm Longair, on the other hand, gave a stimulating overview of both theoretical



Matt Choptuik receiving the Basilis Xanthopoulous Award and observational cosmology, including results from the Hubble Space Telescope observations.

A large international community on gravity wave (re)search has indeed developed over the last few years. Progress on this topic was reported by Eanna Flanagan, Norna Robertson and Massimo Cerdonio. While Flannagan covered astrophysical sources, Cerdonio dealt with resonant bar detectors. Robertson summarized the future of the upcoming interferometric detectors in various parts of the globe and emphasized the importance of building a collective effort as a concluding remark.

The last talk of the conference, by Neil Ashby, focussed on the Global Positioning System and its importance



and applications in the context of testing special and general relativity.

Apart from lectures devoted exclusively to GRG, there were a couple of talks, which incidentally had no direct connection to the main theme of the Conference. These were - Michael Berry's plenary talk on caustics and singularities in the context of optics and Anton Zeilinger's interesting discussion on quantum teleportation from the experimentalist's point of view. Both the speakers, however, demonstrated quite seriously, how the topics they dealt with could actually be of deep relevance in future in the context of gravity as well.

The afternoon sessions had a fair number of extended presentations by renowned experts - Roger Penrose and George Sparling (on twistors), Hermann Nicolai (on D = 11 supergravity), Gautam Mandal (on strings and semiclassical properties of black holes), Alexei Starobinsky (on cosmological models with a decaying cosmological constant), A.K. Raychaudhuri (on singularity free models) - to name a few.

The 17th December morning session commemorated the fiftieth anniversary of the Gravity Research Foundation. Louis Witten, who chaired this session, briefly summarized the history of GRF with amusing remarks, as well as a few slides. The General Body meeting of the ISGRG was also held during the Conference.

The galaxy of distinguished personalities who attended



Speakers at GR 15





Speakers at GR 15

the meeting included, among others, Brandon Carter, David Finkelstein, P.C. Vaidya, Robert Wald, Hans Stephani, Piotr Chrusceil, Richard Isaacson, Bernard Carr, Malcolm MacCallum, Donald Lynden-Bell, Cliff Will, Bruno Bertotti. Roger Penrose delivered a public lecture - `Science and the mind' - in a city auditorium, which was attended by thousands from near and afar.

The Conference participants, of course, had an afternoon's worth of local sight-seeing, a sumptuous banquet and a Odissi dance recital by the reputed

danseuse, Yogini Gandhi. Our very own Vishu (C.V. Vishveshwara) well-known for his brilliant sense of humour, gave an enthralling after-dinner speech at the banquet.

On the whole, the meeting was a great success. The fact that IUCAA had the privilege of having many a great physicist on campus for an extended period of six days or so, actively participating in discussions on diverse topics, would certainly be worth reminiscing in the years to come.





Speakers at GR 15



INTRODUCTORY SUMMER SCHOOL ON ASTRONOMY AND ASTROPHYSICS

The School proposed to be held during May 18 - June 5, 1998 at Pune, is designed to introduce the students of physics, mathematics, electronics engineering and technology to the exciting fields of Astronomy and Astrophysics (A & A). No previous knowledge of A & A is necessary, although familiarity with the basic principles of mathematics and physics will be required.

The school will be funded by the Department of Science and Technology, New Delhi, and hosted by Inter-University Centre for Astronomy and Astrophysics (IUCAA) and National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research, Pune.

We expect to have about 35 students participating in this programme. The programme of the school will consist of lectures, covering fundamentals of A & A as well as recent developments in the field. In addition, participants will take part in individual projects under suitable guidance. The lecturers for the school will be drawn from the leading A & A centres in the country, so that the participants will get an exposure to the work being done in these fields. There is a possibility for a few motivated students, to spend an additional week at IUCAA/NCRA after the school. **Eligibility**: Students completing their 1st year M.Sc. (physics/applied mathematics/ astronomy/electronics) or 3rd year B.E./ B.Tech. in 1998 can apply. Exceptionally bright and motivated students completing their B.Sc.(physics) in 1998 may also apply.

How to apply: In plain paper, in the following format : 1. Name, 2. Sex, 3. Date of birth, 4. Address for communication, 5. Qualifications (standard X onwards) with institution / year / subjects / class / grade / percentage of marks obtained, 6. Short write-up giving motivation for applying for the school, 7. Previous summer schools attended, if any, 8. Names and addresses of two referees (these referees should be teachers/project guides, etc.), and 9. Signature with date.

The applicants should request the above referees to send their confidential assessments/ recommendations under separate envelopes. Applications and referee reports should reach the **Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007**, by March 14, 1998. The selected candidates will be informed by April 15, 1998. They will be provided with travel, board and lodging for the duration of the school.

XIX Meeting of the IAGRG

The XIX Meeting of the Indian Association for General Relativity and Gravitation (IAGRG) was held on December 21, 1997. On this occasion, the fifth Vaidya-Raychaudhuri Endowment Fund Lecture, titled **Accretion powered astronomical sources** was given by Ramnath Cowsik of the Indian Institute of Astrophysics, Bangalore.

Vacation Students' Programme 1998

IUCAA invites applications for the eighth Vacation Students' Programme (VSP). Students selected under the VSP will spend six weeks at IUCAA to work on specific research projects under the supervision of the IUCAA faculty. The programme will conclude with seminar presentations of the projects by the participants, a written test and interview. Those who perform well will be preselected to join IUCAA as research scholars to do Ph.D. after the completion of their degree.

Students who will enter the final year of the M.Sc. (physics/applied mathematics/astronomy/ electronics)/B.Tech./B.E. courses in the academic year 1998-99 are eligible to apply. Applications, in plain paper, giving the academic record of the applicant as well as two letters of recommendations from teachers, mailed directly, should reach the Coordinator, Core Programmes, IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007, by March 1, 1998. The selected candidates will be informed by April 1, 1998 for the programme to be held during June 1 - July 10, 1998.

Seminars

3.10.97 Rachel Somerville *on* Galaxy formation at high redshift: Some recent results from semi-analytic models; 3.10.97 Ved Ratna *on* Project ideas for astronomy exhibitions for students of schools and colleges; 7.10.97 Rohini Godbole *on* Structure of photon; 24.10.97 Noella D'Cruz *on* The origin of extreme horizontal branch stars; 3.11.97 Alain Omont *on* Millimetre detection of molecular gas and dust in quasars at redshift larger than 4; 26.11.97 G. Baskaran *on* Quantum Hall systems; and 11.12.97 V. Faraoni *on* Light meets gravity waves.

PEP Talks

17.10.97 Ashish Mahabal *on* The incompleteness theorem; and 12.12.97 Amitabh Bhattacharyya *on* Liquid crystal domains at the water surface.

IUCAA Preprints

Listed below are the IUCAA preprints released during October-December 1997. These can be obtained from the Librarian, IUCAA (**library@iucaa.ernet.in**).

Faraoni, Valerio, Multiple imaging by gravitational waves, IUCAA-51/97; Singh, Harinder P., Gupta, Ranjan and Gulati, Ravi K., Stellar spectral classification based on principle component analysis and artificial neural networks, IUCAA-52/97; Singh, H.P., Roxburgh, Ian W. and Chan, Kwing L., A study of penetration at the bottom of a convective envelope and its scaling with vertical velocity, IUCAA-53/97; Srinivasan, K. Sriramkumar, L. and Padmanabhan, T., The hypothesis of path integral duality II : Corrections to quantum field theoretic results, IUCAA-54/97; Gupta, Abhinav and Padmanabhan, T., Radiation from a charged particle and radiation reaction-revisited, IUCAA-55/97; Misra, Ranjeev, Evidence for advective flow from multi-wavelength observations of Nova Muscae, IUCAA-56/97; Nayeri, Ali, Statistical mechanics of confined binary system : Comparision of three and two dimensions, IUCAA-57/97; Singh, L.P. and Ram, B., Higher dimensional supersymmetric quantum and Dirac equation, IUCAA-58/97; Sahni, Varun, Analysis of large scale structure using percolation, genus and shape statistics, IUCAA-59/97; Dadhich, Naresh, A duality relation: global monopole and texture, IUCAA-60/97; Lohiya, D., Sethi, M., Gahlaut, S. and Batra A., A program for a problem free cosmology within a framework of a rich class of scalar tensor theories, IUCAA-61/97; Lohiya, D. and Sethi, M., A program for a problem free cosmology within a framework of a rich class of scalar tensor theories, IUCAA-62/97; Sarma, M.B.K. and Rao, P.V., V Crateris - Photometric elements, IUCAA-63/97; and Faraoni, V, Testing the bosonic string with cosmology, IUCAA-64/97.

Colloquia

6.10.97 Rohini Godbole *on* Theoretical significance of the 'top' quark discovery; 13.10.97 K.P.Singh *on* Our universe in X-Rays; 27.10.97 R. Nityananda *on* Resonance : When atoms and light meet; 11.11.97 Krishan Lal *on* Real structure of real crystals; 17.11.97 A.D. Gangal *on* Local fractional calculus; 24.11.97 G. Baskaran *on* Novel quantum phases in condensed matter physics; and 26.12.97 V.P. Frolov *on* Plenty of nothing: Black hole entropy in induced gravity.

Talks during Visits Abroad

S.V. Dhurandhar: *Hierarchial research strategies for inspiralling compact binaries*, Gravitational Wave Data Analysis Workshop 2, LAL, Orsay, France, November 13; *The search for gravitational waves*, Basic Sciences Research Institute, Istanbul, Turkey, November 21.

Valerio Faraoni: *Can we detect gravitational waves using their effect as gravitational lenses?*, College de France, Paris, France, November 12.

Workshop on Introductory Astronomy and Astrophysics

A workshop on Introductory Astronomy and Astrophysics was organised by IUCAA at the Raman School of Physics, Pondicherry University, during October 13-14, 1997. There were 65 students (graduates and postgraduates) and 20 college / university teachers attending this workshop. Lectures were given by Varun Sahni, Ranjan Gupta of IUCAA; Biman Nath of Raman Research Institute, Bangalore; and K.S.V.S. Narasimhan from Chennai. The lectures were given on introductory astronomy, cosmology, observational astronomy, stars and galaxies. In addition to these, there was a brief demonstration and discussion on photometer by A. Balasubramanian from the Raman School of Physics, Pondicherry University, who was the local convener of the workshop, explaining the method of calculating the magnitude of a star by measuring the intensities of the sky and the star with a photometer, which was constructed by the speaker at IUCAA. Also, slide shows and video shows were arranged in which interesting aspects of the solar system and galaxies were illustrated. An exhibition of books on A & A, published by the Cambridge University Press was arranged during this workshop.

Visitors

October-December 1997

D.N. Guru, S. Cohan, A. Balasubramanian, P. Nagaraju, S.K. Natarajan, Ved Ratna, George Varghese, M.B.K. Reddy, N.V. Awati, S.S. Prasad, R. Somerville, M.K. Das, H.P. Singh, Y. Nazeer Ahmed, R. Ramakrishna Reddy, S. Ramani, L.P. Singh, S. Banerji, N. Rathnashree, A. Sood, B. Ishwar, A. Pradhan, R. Ramachandran, R. Hablani, B.C. Paul, K.P. Singh, S.N. Karbelkar, Asoke Sen, G. Yellaiah, Z. Ahsan, P.V. Kulkarni, N. D'Cruz, S.P. Bhatnagar, M.K. Patil, P.S. Parihar, R. Nityananda, Ram Sagar, S.D. Sinvhal, S.K. Ghosh,, P. Venkatkrishnan, R. Tikekar, L.K. Patel, H. Patel, D.B. Vaidya, A. Omont, B.A. Kagali, K.N. Joshipura, K.S.V.S. Narasimhan, Krishan Lal, G.P. Pimpale, P.S. Wamane, Indira Bardoloi, M. Barouah, P. Banerjee, G. Baskaran, S. Vaishampayan, P.K. Das, K.P. Ambastha, Asis Mukherjee, N. Vayada, V. Rezania, H. Khosroshahi, K. Nagappan Pillai, N. Ibohal, Judith Perry, K. Jotania, B. Owen, D. Thatte, L.M. Saha, A. Khan, Sushil Kumar, P. Agarwal, R. Sharma, U. Narain, V.H. Kulkarni, R.P. Bambah, M.M. Chaudhri, V.N.R. Pillai, L. Panda, P. Chauhan, S.S. Jha, M. Berry, A. Zdziarski and J. Mikolajewska.

Apart from the above, there were about 450 participants to attend the GR 15 during December 16-21, 1997.

Visitors

Expected

January: S.P.Khare, Meerut College; P. Shah, Meerut College; S. Datta, Delhi University; T.V. Ramakrishnan, Indian Institute of Science; S. Chakraborty, Kalyani University

There would be about 70-80 participants attending the WHEPP-5 workshop during January 12-26, 1998.

The Oldest Profession

Three men, having completed their life span knocked on the gates of heaven. St. Peter, opening the door, shook his head. "Sorry, we are almost full up and can accommodate only one amongst you. I will take the one whose profession is the oldest."

"This surely qualifies me: I am a surgeon" said one of them. "After all, Eve was created from Adam's ribs in the Garden of Eden by surgery. What profession could be before that?"

"Mine", said the second of the three. "I am a landscape artist and I design gardens. The Garden of Eden must have been created out of chaos, by some predecessor of mine."

St. Peter turned to the third one. "What are you?", he asked. "I am a cosmologist", was the reply.

"Come on in! You sure do create chaos in the field", said St. Peter taking the cosmologist in.

Grote Reber, the pioneering radio astronomer of the 1940s, sent us the following cartoon strip, saying that it echos his sentiments towards standard cosmology:





The Resource Summary could not be carried in this issue due to limitation of space. It will continue from the next issue onwards.

- Editor

Khagol (the Celestial Sphere) is the quarterly bulletin of IUCAA. We welcome your responses at the following address:

IUCAA, Post Bag 4, Ganeshkhind, Pune 411 007, India

Phone (0212) 351414

Fax (0212) 350760 e-mail PUBL@iucaa.ernet.in

Telex 0145 7658 GMRT IN

Universal Resource Locator : http://www.iucaa.ernet.in/