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IUCAA

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Science Day at IUCAA
28 February 2001

On the first Science Day of this millennium, February 28, 2001, the facilities of IUCAA were thrown open to the public, with special added attractions. As always the event drew huge crowds, and participation by students and the public was very enthusiastic and gratifying. Following the pattern set over the last several years, this year too the events comprised of three main activities described below: **Competitions for school students**: Quiz, essay and drawing competitions were organized for high school students. Seventy-five schools sent teams of five students each for entry to the competitions. The star attraction was the quiz, in which a team of three students from each school participated. After the elementary round in the morning, the finals were held in the afternoon. The quiz had questions from different scientific fields with some emphasis on astronomy. In the essay competition, one student from each school was asked to write an essay on one of several exciting topics specified by a panel. The drawing competition too was conducted in a similar manner. It was very interesting to watch students giving free rein to their imagination, drawing while seated here and there on the IUCAA lawns.

Having Fun with Science !

Arvind Gupta, freelance science educator from Delhi, gave a talk to school teachers on his techniques of teaching science to students through very simple, low cost demonstrations. His demonstrations to the teachers and later to students proved to be very popular. Arvind Gupta continued his demonstrations when the public came in large numbers during the afternoon. V. G. Gambhir, Anand Ghaisas, Prakash Navle, Shirish Pathare and B. L. Valvi from the Homi Bhabha Centre for Science Education (HBCSE) in Mumbai trained, on February 27, a large team of 8th standard students from Jnana Prabodhini School to provide scientific demonstrations using equipment brought by the HBSCE. These forty young girls were very confident, accurate and efficient in explaining the experiments to students as well as to other visitors on the open day. The Focault pendulum was explained to visitors with the help of a simple demonstration by Dileep Sathe. An history

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teacher, who substituted in for a science teacher who took ill, commented that she found the lectures, demonstrations, exhibits and the overall programme very understandable. She said that she was glad that she had come, in spite of her initial reluctance to accompany her team of students to a science event.

Programmes for the general public : People were invited to visit the IUCAA premises on the Science Day, between 3 p.m and 7 p.m. The visitors were able to move through the IUCAA campus and become acquainted with the state-of-the-art astronomical work being done. A highlight of this programme was an exhibition on astronomical photographs by David Malin, given to IUCAA by the British Council. The photographs were exhibited along with some additions from IUCAA's own collections. Guided tours of the exhibits were provided to visitors. The research and developmental work going on at IUCAA was presented through two thematic displays, one on the *IUCAA Optical Telescope* and the other on the *Universe on Different Scales*. The displays provided brief exposures to the importance of these areas and pointed out the contributions being made by astronomers at IUCAA. The displays were explained to the public by

Arvind Gupta at his natural best

students and postdocs from IUCAA. Public talks in Hindi and English and a question-answer session in Marathi and English by IUCAA's faculty members were organized in the Chandrasekhar Auditorium.

Looking at the beautiful planet with a ring. This three year old is hardly likely to believe that the planet will have a bad effect on him.

Sky Watch: A major attraction of the Science Day was the night sky observation with small telescopes, all of which were actually built by amateur astronomers using IUCAA facilities. Each observing session was preceded by talks on telescopes and observing techniques. This event was organized by IUCAA members as well as a team of amateur astronomers.

Successful organization of the Science Day events was possible because of the active participation by all members of IUCAA and visiting scientists and students. The organization involved preparing scientific events, talks, displays and demonstrations. But a great deal of planning and administrative and infrastructural support were also necessary to ensure that the thousands of visitors who come to IUCAA on that day were

Mixture of academic and natural surroundings adds to their imagination

The proud winners with their mentors and T. Padmanabhan (IUCAA)

properly received, guided through the premises and exhibits and provided various amenities. The organization and execution of the events was greatly helped by the participation of students and teachers from schools and colleges in the city, as well a number of amateur astronomers from Jyotirvidya Parisanstha, (led by Prakash Tupe), Amateur Astronomer's Club of C-DAC, (led by Ashish Kuvalkar and Hrishikesh Kulkarni) and the Association of Indian Meteor Organization in the city. Several of the events would not have been possible without the help of these groups. Ajit Kembhavi, Arvind Paranjpye and Vinaya Kulkarni provided the overall organization of the Science Day.

Second Level, 1st Workshop on Astronomical Photometry January 17 - 19, 2001

A second level workshop on astronomical photometry was organized in IUCAA for those who participated in the first level and made their own photometers.

The aim was to refresh the knowledge of the participants and to check out if their photometers were working to the satisfaction. Hands on experience on taking observations were also planned during this period.

S. N. Tandon, Ranjan Gupta and Yogesh Wadadekar addressed the participants. Vilas Mistry checked the photometers and carried out repair works when necessary. The participants were also taken to a small town, called Wai, about 100 kilometers south of Pune, for extinction measurement exercise.

The workshop was organized by Ranjan Gupta and Arvind Paranjpye.

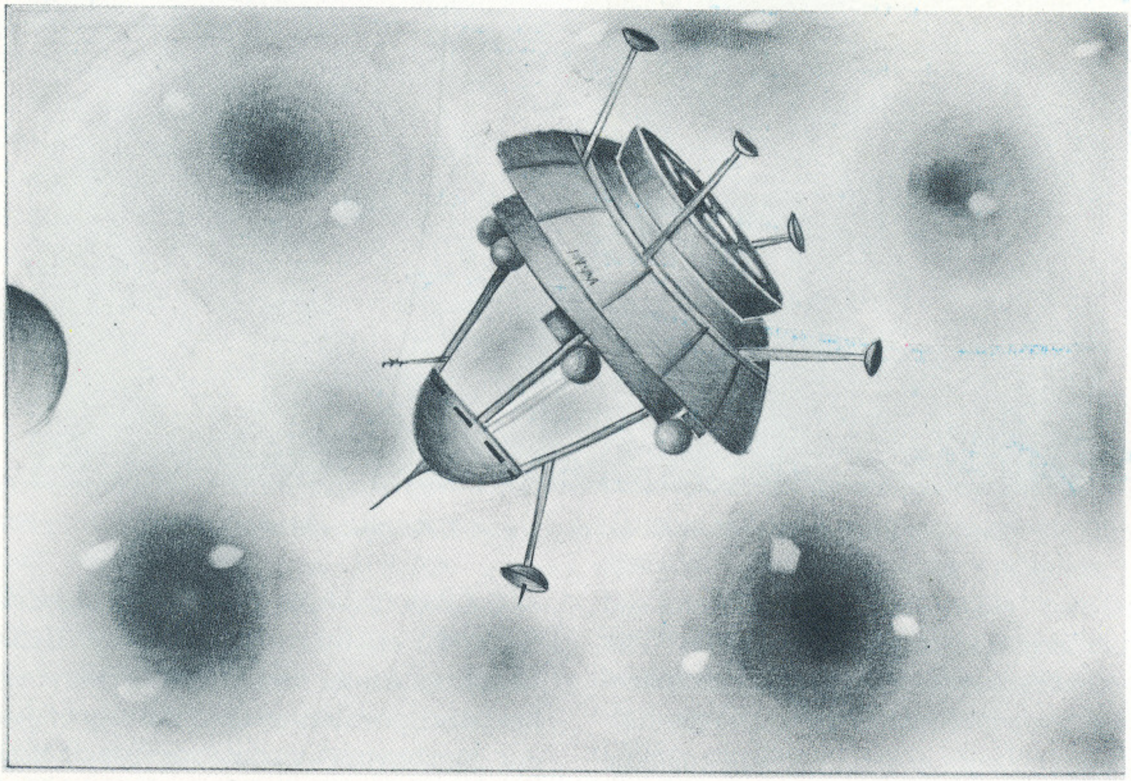
Welcome to . . .

Prasad Subramanian, who has joined as a Post-doctoral Fellow. His research interests are solar physics, black hole astrophysics and plasma astrophysics.

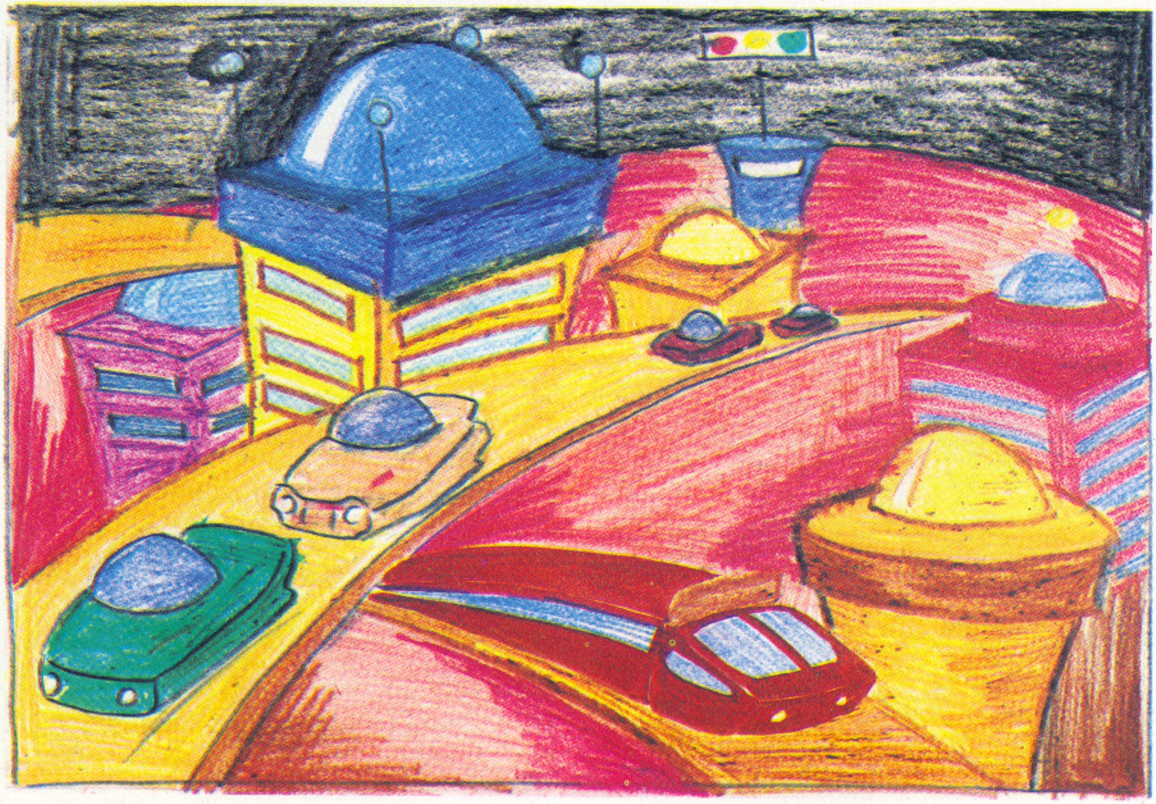
. . . Farewell to

Dipanjan Mitra, who has joined the Max-Planck Institut fur Radioastronomie, Bonn, Germany.

Boud Roukema, who has joined the DARC, Observatoire de Paris - Meudon, France.



Reaching the Stars : Space Flight - First Prize



Life on Mars in 100 years - Second Prize

Cosmic Microwave Background Anisotropy

Introduction

Over the last decade, cosmological observations have attained a level of precision which allow for very detailed comparison with theoretical predictions. The recent observations of anisotropy in the cosmic microwave background (CMB) is a prime example of such intense interplay between theory and observation [1-5]. This article focuses on the angular power spectrum of CMB temperature anisotropy where the current battle line of CMB phenomenology lies.

Origin of CMB

At the heart of the hot Big Bang model (HBBM) of the universe is the primordial origin of the extra galactic microwave background radiation (MBR) in the early hot phase of the universe – a relic of the Big Bang. The serendipitous discovery of MBR [6] provided a big boost to HBBM. The prediction of a Planckian CMB dates from the early nucleosynthesis calculations of Gamow and collaborators. In HBBM, the universe expands adiabatically conserving the photon entropy per comoving volume so that temperature falls as inverse of the expansion factor. The observed MBR accounts for almost all the entropy. Working backwards in time, adiabatic expansion implies a smaller and hotter universe. At redshifts above $z_* \sim 10^7$, the double Compton scattering and free-free emission in the hot plasma ensures that any energy dumped into the universe is rapidly thermalized into a equilibrium Planckian distribution.

Up to the accuracy of the measurements and over the wavelengths explored, the MBR seems to governed by a Planckian black body distribution. The COBE-FIRAS data [7] show that the energy spectrum of MBR photons is accurately described by a Planckian distribution at a temperature, $T_0 = 2.725 \pm 0.002$K. The Planckian distribution of the CMB is set up prior to z_*. Any energy input into the radiation bath in the universe after z_* causes a distortion from the Planckian form. The maximum 1-sigma deviation of the MBR spectrum from a Planckian is constrained to be $\lesssim 0.01\%$ of the peak brightness constraining any energy input, $\delta E_{CMB} < 0.00025\, E_{CMB}$.

By $z_{rec} \approx 1100$, the universe was cool enough for protons and electron in the plasma to "recombine" and the form neutral hydrogen. In the absence of free electrons to scatter them, the observed CMB photons essentially have free streamed to us since the epoch of recombination.

Anisotropy of the CMB

The primordial nature of the microwave background makes CMB observations an extremely valuable cosmological probe. The CMB comprises of the photons in the universe freely propagating to us from $z_{rec} \approx 1100$, carrying a well preserved, easy to decipher, record of the epoch of recombination and evolution of the universe since then. The tiny spatial inhomogeneity which seeded the formation of the large scale structure in the universe is expected to give rise to anisotropy in the CMB temperature on the sky. These anisotropies encode an immense wealth of information on the model of cosmology and formation of the observed large scale structure.

The original CMB discovery paper [6] constrained the level of CMB anisotropy below 10%. This was soon improved to 10^{-3} by the late sixties. By late seventies, balloon experiments from Princeton and Berkeley had discovered and firmly established the dipole anisotropy. Dipole anisotropy $\Delta T_1(\hat{\mathbf{n}}) = T_0(\mathbf{v}\cdot\hat{\mathbf{n}})/c$ in a direction $\hat{\mathbf{n}}$ is attributed to doppler shift of CMB photons due to the velocity $\mathbf{v}$ of earth w.r.t. CMB. Current estimate of dipole anisotropy is 3.372 ± 0.007mK corresponding to $|\mathbf{v}| \sim 370\,$km/s, primarily, the local value of the large scale flow of matter w.r.t. the Hubble flow. The upper limits improved all through the 1980's and ruled out baryon dominated universe with adiabatic initial perturbations that predicted CMB anisotropy at the level of 10^{-4}. However, by early 1980's dark matter dominated universe became popular and presented a revised target at 10^{-5}.

The COBE-DMR opened up a fresh avenue of cosmology in 1992 announcing detection of anisotropy at the expected level of $\sim 30\mu$K on large angular scales ($\ell < 30$) in the CMB flux. This breakthrough was closely followed by a number of detections by other experiments; notably, FIRS and SP91 had strong hints of detection even before COBE. By early 1999, about 19 experiments had detections with tentative evidence for the first acoustic peak around the degree scale [1]. Recently, results from experiments like TOCO, Boomerang (BOOM) and

MAXIMA-I have firmly established the first acoustic peak at the level of 85μK around $\ell \approx 200$ [8]. The thrust now is on estimation of cosmological parameters from the anisotropy data.

It is convenient to express the sky map of CMB temperature anisotropy in direction $\hat{\mathbf{n}}$ as a spherical harmonic expansion : $\Delta T(\hat{\mathbf{n}}) = \sum_{\ell=2}^{\infty}\sum_{m=-\ell}^{\ell} a_{\ell m} Y_{\ell m}(\hat{\mathbf{n}})$. The CMB anisotropy in a gaussian model is completely specified by its angular two point correlation function $C(\hat{\mathbf{n}}, \hat{\mathbf{n}}') \equiv \langle \Delta T(\hat{\mathbf{n}}) \Delta T(\hat{\mathbf{n}}') \rangle$. Most theoretical models predict statistically isotropic fluctuations, $C(\hat{\mathbf{n}}, \hat{\mathbf{n}}') \equiv C(\hat{\mathbf{n}} \cdot \hat{\mathbf{n}}')$. The anisotropy can then be characterized solely in terms an angular spectrum C_ℓ, defined in terms of the ensemble average,

$$ {}_m a_{\ell' m'}{}^* \rangle = C_\ell \delta_{\ell\ell'} \delta_{mm'} \, . \qquad (1)$$

The C_ℓ spectra for wide variety of models share a generic set of features neatly related to basics physics of primary CMB anisotropy. Fig. 1 is a crisp summary of contributions to $C_e ll$ from distinct physical effects. The C_ℓ are sensitive to important cosmological parameters, such as, the relative density of matter, Ω_0; cosmological constant, Ω_Λ; baryon content, Ω_B; Hubble constant, H_0 and deviation from flatness (curvature), Ω_K. Implicit in C_ℓ is the hypothesized nature of random primordial/initial metric perturbations – (Gaussian) statistics , (nearly scale invariant) power spectrum, (largely) adiabatic vs. iso-curvature and (largely) scalar vs. tensor component. The 'default' settings in bracket are motivated by inflation. Estimation of cosmological parameters implicitly depend on the assumed values of the initial conditions, or, explicitly on the scenario of generation of initial perturbations [9].

The SW plateau fixes the amplitude (and to some extent, slope) of the initial power spectrum. The harmonic series of peaks is rich in cosmological information [10]. The location of the first peak in the spectrum is a sensitive function of the curvature of the universe. Recent CMB observations have not only established the existence of the first peak but using the best fit to a parameterized peak also estimate it to be located at $\ell = 208^{\pm 7}$ (BOOM98 + MAXIMA-I) [11], $\ell = 202^{\pm 7}$ (BOOM98), $\ell = 226^{\pm 17}$ (MAXIMA-I) and $\ell = 212^{\pm 7}$ for combination of all data [5]. (Model independent analysis confirms a peak but cannot pinpoint its location so accu-

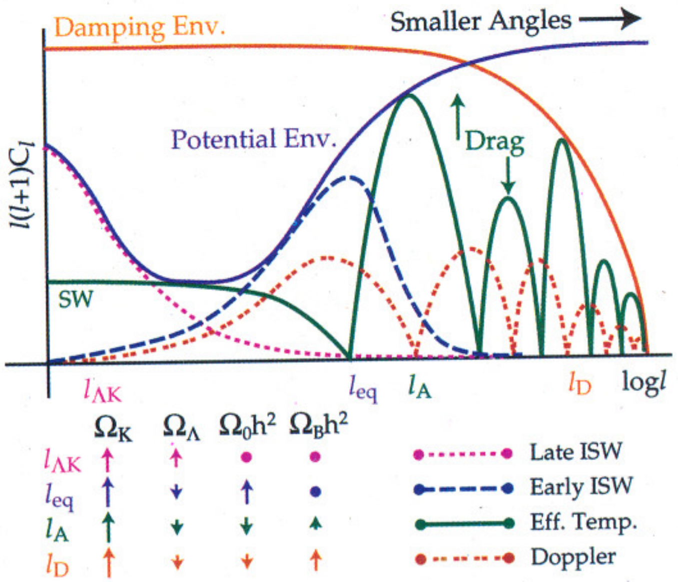


Figure 1: Figure taken from Wayne Hu's home page [1, 3] summarizes the different contributions to the primary CMB anisotropy. Also indicated is the dependence of four length scales that are imprinted on the C_ℓ spectrum on some of the cosmological parameters. The Sachs-Wolfe (SW) plateau at low ℓ is a faithful reproduction of the near scale invariant spectrum of initial metric perturbations. Integrated Sachs-Wolfe (ISW) effect arises from the evolution of metric perturbations along the path of free streaming CMB photons. Late ISW arises on $\ell < \ell_{\Lambda K}$ if the universe has significant curvature or cosmological constant. The early ISW contribution at $\ell \sim \ell_{eq}$ is due to transition from radiation to matter domination. The acoustic and Doppler terms give rise to a harmonic series of oscillatory peaks as a snapshot of the oscillations of a viscous baryon-photon fluid prior to the epoch of recombination. The sound horizon at recombination sets the length scale of the acoustic oscillations. This 'standard ruler' at $z \approx 1100$ then allows an accurate determination of the geometry of the universe from the location of the first peak, ℓ_A via the angle-distance relationship. High baryon density increases viscous drag leading to suppression of even numbered acoustic peaks relative to odd. Power is exponentially damped at large ℓ due to photon diffusion out of matter over-densities (Silk damping) and finite thickness of last scattering surface.

rately [4, 17].) These values straddle the geometrically flat ($\Omega_K = 0$) universe cherished by theorists and translate to a preference for the blue shaded wedge in $\Omega_m - \Omega_\Lambda$ parameter plane in Fig.2. Combined with the result $\Omega_\Lambda \neq 0$ indicated by High redshift supernova [18], and/or LSS evidence that $\Omega_m \approx 0.3$, the constraints tighten (Fig.2). Broadly, the current data prefers a flat ($\Omega_K = -0.08^{\pm 0.06}$), cosmological constant ($\Omega_\Lambda = 0.66^{\pm 0.06}$) dominated universe. The suppressed second peak in C_ℓ data prefers a baryon density $\Omega_B h^2 = 0.03^{\pm 0.005}$ much higher than Big bang nucleosynthesis (BBN) esti-

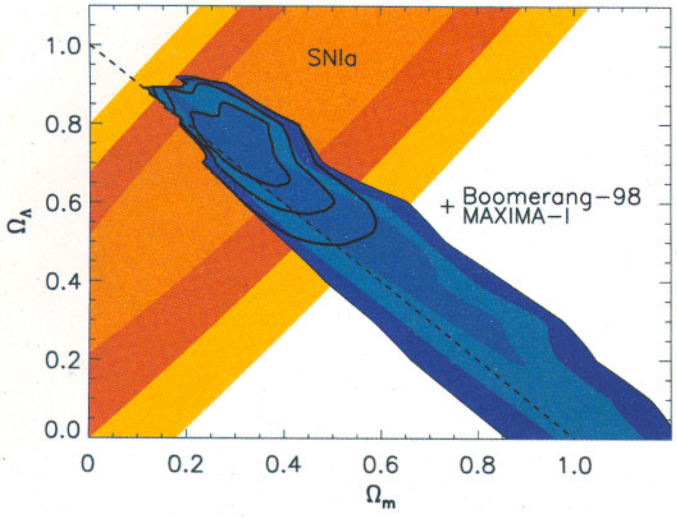


Figure 2: The plot obtained from [11] shows the current constraints from CMB anisotropy and SN1a in the $(\Omega_m, \Omega_\Lambda)$ parameter plane. Shaded contours nearly parallel to the $\Omega_m + \Omega_\Lambda = 1$ line are the one-,two-, three-sigma limits (defined as the equivalent likelihood ratio for a two-dimensional gaussian distribution) of the joint likelihood of the measurements of CMB anisotropy by COBE-DMR, Boomerang1998 and the MAXIMA-I experiments. The contours labelled "SN1a" are similar likelihood contours from high redshift Supernova observations [18]. The heavy set of contours are the combined constraints from the supernova and CMB anisotropy data given by the product of the two probability distributions.

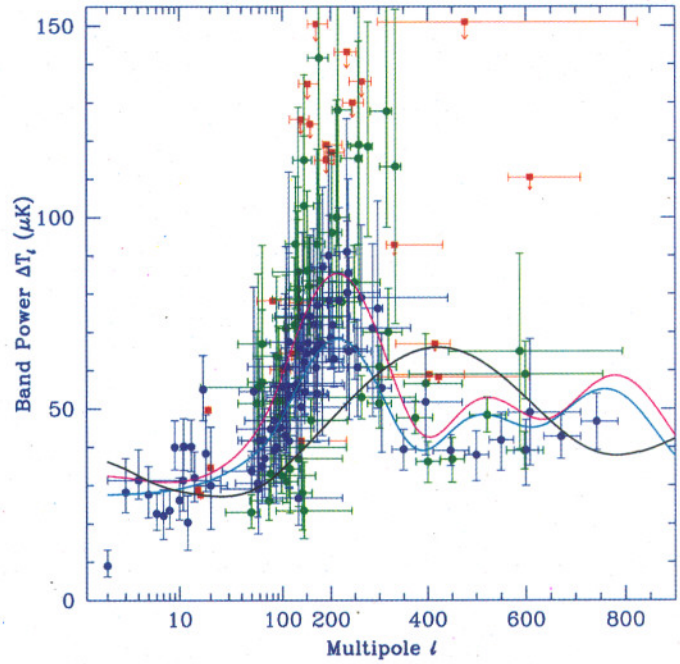


Figure 3: Figure plots the band power estimates of the CMB anisotropy measurements compilation available as a table in [17]. Details of the experiments, window functions, conventions and table of values are available at the KSU website. The detections are plotted a solid circles (loosely, blue points are more significant than green when the data is binned in ℓ space). The red squares denote 2σ upper limits. The location in ℓ corresponds to the peak of the average zero-lag window function horizontal error bar denotes region of ℓ space probed by the window (within $\sqrt{e}$ of peak sensitivity). For detections the 1σ error bar for the band power includes known systematic uncertainties. Where known, beam width and calibration uncertainties have been accounted for and foreground contamination removed. Detections at $\ell > 900$ and upper limits above $\Delta T_\ell = 150\mu$K have been omitted. The curves are the predictions for models with age of universe 12Gyr : (magenta) high baryon density, flat model preferred by BOOM98+MAXIMA-I [11]; (black) $\Omega_\Lambda = 0$ open universe model with same matter density, BBN $\Omega_B h^2$; and, (cyan) flat $\Omega_\Lambda = 0$ BBN Ω_B model. A broad peak in the power spectrum around $\ell \approx 200$ is visually evident. The data seems to be at odds with the open model which predicts a peak at $\ell \approx 400$.

mate $\Omega_B h^2 = 0.019^{\pm 0.002}$ [5, 13]. Allowing high Ω_B prefers scale invariant initial spectrum ($n_s = 1.03^{\pm 0.08}$); however, enforcing BBN value prefers a tilt ($n_s = 0.85$ [12]), or, even more radical departures from scale invariance[14].

Fig. 3 shows the current status of flat band power estimates of C_ℓ [17]. The determination of power spectrum C_ℓ is limited by the angular resolution of the beam, the noise of the detector and sky-coverage. Consider an idealized single beam, full-sky experiment with uncorrelated noise per pixel, w. For gaussian and statistically isotropic CMB anisotropy, the expected error is $\delta C_l = \sqrt{2/(2\ell+1)}[\langle C_\ell\rangle + w^{-1}e^{\ell^2\sigma^2}]$ around the expected value $\langle C_\ell\rangle$ [15]. The finite variance at zero noise is the unavoidable cosmic variance arising due to the fact that we can at best measure only one full-sky realization of the CMB anisotropy. The contribution from instrumental noise to δC_ℓ increases rapidly on angular scales smaller than the beam width. Incomplete sky-coverage affects the C_ℓ determination in two ways. First, it increases the variance roughly by inverse of the fraction of sky covered. Second, since spherical harmonics are linearly independent only on the full sphere, the estimate of power spectrum at multipole ℓ is not independent of the C_ℓ's at neighboring multipoles. If the measured CMB anisotropy is not statistically isotropic δC_l gets an additional contribution reflecting the information lost in going from correlation to C_ℓ [16].

In addition to temperature (intensity), there is polarization information (other three Stokes parameters) imprinted on the CMB at last scattering surface. A net pattern is retained from the linear polarization of Thompson scattered CMB photons due to quadrupolar anisotropy of the CMB photon flux around the electrons at z_{rec}. The polarization signals are more than an order of magnitude lower than temperature anisotropy and a detection is still awaited. In recent years CMB polarization has gained acceptance as a promising probe that would complement anisotropy measurements [2, 20]. Since CMB polarization is generated by Thompson scattering, it is a clean probe of last scattering surface. In contrast, CMB temperature anisotropy can be modified by ISW effects even during free streaming. CMB polarization information can be encoded in three power spectra each related to the scalar, vector and tensor components of metric perturbations in a distinct way. CMB polarization is being actively targeted, eg., next Boomerang and MAXIMA balloon flights (MAXIPOL) and upcoming space missions MAP, Planck surveyor.

At present, the only 'all-sky' COBE-DMR map is at low resolution. Higher angular resolution measurements cover only small patches of the sky. Interferometers such as VSA, CBI and DASI will improve on the sensitivity. Ideally, one would like to have an experiment which maps the entire sky at an angular resolution $\sim 10'$. Boomerang and MAXIMA-I have taken the first step. Other long duration Balloon experiments like TopHat, Archeops, Beast are expected in the near future. The two future space missions, MAP (launch April 2001) from NASA and Planck Surveyor (launch 2007) from ESA for high resolution, full sky measurement of the CMB anisotropy and polarization hold a lot of promise.

Within a decade, CMB anisotropy measurements are expected to uncover a wealth of cosmological details. Analysis of upcoming large data sets poses a challenge [19]. Another challenge is to pinpoint the region consistent with available data in an appropriate and well conceived multi dimensional space of cosmological parameters. The measurements till date fit quite comfortably within the broad predictions of structure formation scenarios constructed within HBBM. As numerous CMB enthusiasts grapple with the flood of data, a 'standard model' of cosmology is expected to emerge in the near future.

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Workshop on Astronomical Photometry and Spectroscopy

Participants of the workshop on Astronomical Photometry and Spectroscopy

A five-day workshop on Astronomical Photometry and Spectroscopy was held in the Department of Physics, Bangalore University during January 8 - 12, 2001. Around forty college and university teachers and some research scholars participated in the workshop. While the major sponsor was IUCAA, Bangalore University also provided funds to build up the infrastructural facilities for the workshop.

The workshop was inaugurated by K. Siddappa, the Vice-Chancellor of Bangalore University. Resource persons drawn from IIA, IUCAA, Delhi University and Bangalore University delivered lectures on various theoretical and observational aspects, such as radiation fundamentals, time scales and coordinate systems, stellar photometry, variable stars, interstellar medium, star formation, stellar evolution, spectral classification, spectral widths, solar spectroscopy, spectrophotometry space-based astronomy, etc. Practical sessions in the use of photometers and telescopes were held during three nights. A special lecture on "Particles and the Universe" was delivered by P.I.P. Kalmus, visiting professor from Queen Mary College, London University on 11th January.

A booklet containing the abstracts of the lectures was distributed to the participants before the commencement of the workshop. Photocopies of lecture transparencies were also handed over to all the participants for further studies.

Ranjan Gupta was the IUCAA coordinator and B.A. Kagali was the workshop convener at Bangalore University.

Successful observation of Asteroid Occultation

A team of amateur astronomers led by Arvind Paranjpye successfully observed occultation of star HIP 66446 by the minor planet 423 Diotima on March 16, 2001 at 4:12 a.m. IST. Three teams (all mobile) in pair were placed at Londa, Ganeshgudi and Sirsi. Kiran Shah and Mayuresh Prabhune timed the event visually using 8 inch telescope. They timed the duration as 16.2 seconds. They were located south of the central track near Sirsi (Long. -74.844, Lat. 14.633). Arvind Paranjpye and Hrishikesh Kulkarni video recorded the event using a web camera on a PC. They timed the duration as 17.5 seconds and were located at Ganeshgudi (Long. -74.530 Lat. 15.286) which was at north of the central track. The third team of Prakash Nitsure and Tushar Purohit located at Londa (Long. -74.485, Lat. 15.445) was fogged out. The event was also recorded at Vainu

Bappu Observatory, Kavalur.

At the time of writing this note, five stations from France, three from India and one from Italy have reported positive observations to David Dunham, President, International Occultation Timing Association.

The team who carried out successful Asteroid Occultation

Young Astronomers' Meet 2001

Participants of the Young Astronomers' Meet

The seventh Young Astronomers' Meet (YAM) was held in IUCAA during February 7-10, 2001. YAM serves as a unique forum for research students in the country, working in Astronomy, Astrophysics, and related fields, to interact and present their work. YAM activity was initiated in 1992, and the first YAM was held at NCRA. To create facilities for interaction amongst students working in similar fields, and initiation of possible research collaborations are the prime aims behind holding YAM.

This YAM was co-sponsered by DST, IUCAA, and NCRA, and was organised by the research students of IUCAA. The schedule included talk and poster presentations by participants, and special lectures by Ajit Kembhavi on "Observations and Theory: Either, Neither or Both", and by Rajaram Nityananda titled "Lies, Damn Lies, and Statistics". On the last day, a trip to GMRT was arranged, where Govind Swarup introduced the telescope/radio astronomy to the participants.

Following topics were covered in this YAM: Astronomical instrumentation, Astroparticle physics, Cosmology, Compact objects/Accretion phenomena, Galactic and extragalactic astronomy, General relativity and gravitation, High energy astrophysics, Interstellar medium, Solar astronomy and Stellar astronomy.

The meeting was attended by 58 students from various universities and institutes, from across the country. There were a total of 31 talks (25 minutes each). Students from ISRO, Bangalore, have proposed to hold the next YAM.

Update on the IUCAA 2 metre Telescope Project

Mechanical and optical assembly of the telescope has been completed at the factory of Telescope Technologies Ltd., Liverpool, UK. After some further integration of the electrical panels, performance tests would be carried out on the telescope, and if everything goes well, the telescope would be shipped before end of April.The telescope building is nearly ready and the dome is being installed on it. It is expected that large components of the telescope would be installed inside the dome before onset of the monsoon, and further work on installation would continue during the monsoon.The first light instrument, a spectrographic camera of a design based on EFOSC, has been received and integrated with its calibration unit. Preliminary tests have shown that the instrument is working satisfactorily, and further tests are in progress to characterize the instrument.

IUCAA Preprints

Listed below are the IUCAA preprints released during January - March 2001. These can be obtained from the Librarian, IUCAA (library@iucaa.ernet.in)

G.B. Lima Neto, V. Pislar and J. Bagchi, *BeppoSAX observation of the rich cluster of galaxies Abell 85*, IUCAA-1/2001; B.F. Roukema, *How to avoid the ambiguity in applying the Copernican principle for cosmic topology: Take the observational approach*, IUCAA-2/2001; Parampreet Singh and Naresh Dadhich, *Field theories from the relativistic law of motion*, IUCAA-3/2001; T.M. Tauris and S. Konar, *Torque decay in the pulsar $(P, \dot{P})$ diagram: Effects of crustal Ohmic dissipation and alignment*, IUCAA-4/2001; Roy Maartens, Varun Sahni and Tarun Deep Saini, *Anisotropy dissipation in brane-world inflation*, IUCAA-5/2001; R.G. Vishwakarma, *Consequences on variable Λ models from distant Type Ia supernovae and compact radio sources*, IUCAA-6/2001; Silviu Podariu, Tarun Souradeep, J. Richard Gott, III, Bharat Ratra and Michael S.Vogeley, *Binned cosmic microwave background anisotropy power spectra: Peak location*, IUCAA-7/2001; Boudewijn F. Roukema, *How to distinguish a nearly flat universe from a flat universe using the orientation independence of a comoving standard ruler*, IUCAA-8/2001; Boudewijn F. Roukema, *On the comoving distance as an arc-length in four dimensions*, IUCAA-9/2001; Naresh Dadhich, *Subtle is the Gravity*, IUCAA-10/2001; Tapas K. Das and Aveek Sarkar, *Pseudo-Schwarzschild description of transonic spherical accretion onto compact objects*, IUCAA-11/2001; Arun V. Thampan, *Luminosities of disk-accreting non-magnetic neutron stars*, IUCAA-12/2001.

Seminars

25.1.2001 Joanna Rankin on *Pulsar Magnetospheric Emission Mapping: Touching The Physics of Pulsar Emission*; 1.2.2001 Jasjeet Singh Bagla on *Caustics and Singularities in Two Dimensional Gravitational Collapse*; 15.2.2001 Francois R. Bouchet on *Cosmic Microwave Background: Current Status and Perspectives Offered by the Planck Satellite*.

Colloquia

8.1.2001 Guy Consolmagno on *Meteorite Porosity and Asteroid Structure*; 29.1.2001 P.M. Mathews on *The Earth's Variable Rotation and What it Revelas about the Earth*; 19.2.2001 Satish R. Shetye on *Circulation of the North Indian Ocean*; 5.3.2001 Raghavendra Gadagkar on *The Evolution of Cooperation and Altruism in Animals*.

Visitors
(January - March 2001)

S.N. Karbelkar, S. Sethi, A. Toporensky, S. Bhanja, P.S. Joarder, M. Boruah, A. Ganguly, F. Ahmad, N. Iqbal, M.S. Khan, B.B. Walwadkar, G.Consolmagno, S.K. Banerjee, J.S. Bagla, J. Einasto, H. Arp, G. Burbidge, J. Rankin, P.M. Mathews, S. Shetye, M.K. Patil, F. Bouchet, H.K.Jassal, S. Barway, S.K. Sahay, D. Narasimha, D.B. Vaidya, Z. Turakulov, C.D. Ravikumar, N. Philip, H.P. Singh, B.J. Rajadhyax, R. Gadagkar, B. Medhi and S.N. Biswas.

Jitters of the Maiden Seminar

"When I was an undergraduate, I worked with Professor Wheeler as a research assistant, and we had worked out together a new theory about how light worked, how the interaction between atoms in different places worked; and it was at that time an apparently interesting theory. So Professor Wigner, who was in charge of the seminars there, suggested that we give a seminar on it... So this was the first technical talk that I ever gave.

"... Then Professor Wigner came to me and said that he thought the work was important enough that he'd made special invitations to the seminar to Professor Pauli, who was a great professor of physics visiting from Zurich; to Professor von Neumann, the world's greatest mathematician; to Professor Henry Norris Russell, the famous astronomer; and to Professor Albert Einstein, who was living near there. I must have turned absolutely white or something because he said to me, 'Now, don't get nervous about it... First of all, if Professor Russell falls asleep, don't feel bad, because he always falls asleep at lectures. When Professor Pauli nods as you go along, don't feel good, because he always nods, he has palsy,' and so on. That kind of advice calmed me down a bit ...

"So, I remember coming in-you can imagine that first time, it was like going through fire... there were these great men in the audience and it was frightening. And I can still see my own hands... They were shaking. As soon as I got the paper out and started to talk, something happened to me... Which is a wonderful thing. If I'm talking physics, I love the thing, I think only about physics, I don't worry where I am; I don't worry about anything. And everything went very easily. And then at the end when the question time came... Professor Pauli stood up, he was sitting next to Professor Einstein. He said, 'I do not think this theory can be right because of this and this and that and the other thing and so forth, don't you agree, Professor Einstein?' Professor Einstein said, 'No-o-o-o,' and that was the nicest no I ever heard".

[Excerpted from *The Pleasure of Finding Things Out* by R.P. Feynman, Perseus Books]

Visitors Expected

April 2001: D. Lohiya, Delhi University; T. Clochard, IAP; B. Basu, Calcutta; R.S. Kaushal, Delhi University; M.N. Anandram, Bangalore University; B.A. Kagali, Bangalore University; G.P. Singh, Visveswaraya Regional Engineering College; K. George, M.G. University; A.K. Mittal, Allahabad University; M. Sami, Jamia Millia Islamia; Arnab Rai Choudhuri, Indian Institute of Science and K. Shanthi, Mumbai University.

May 2001: P. Barai, IIT, Kharagpur; M. John, St. Thomas College; A.C. Kumbharkhane, Swami Ramanand Teerth Marathwada University; S.N. Hasan, Osmania University; G. Ambika, Maharaja's College; H.P. Singh, Sri Venkateswara College; S. Chaudhuri, Gushkara Mahavidyalaya; P. Khare, Utkal University; D. Chandra, S.G.T.B. Khalsa College and A.K. Goyal, Hansraj College.

June 2001: Subenoy Chakraborty, Jadavpur University; G. Prasad, S.C. College; B.K. Sinha, S.C. College; B.C. Paul, North Bengal University; R. Ramakrishna Reddy, Sri Krishnadevaraya University; Yugindro Singh, Manipur University; Lalan Prasad, M.B. Govt. PG College; T.C. Phukon, Gauhati University; S. Singh, Deshbandhu College.

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