

THE LOW-FREQUENCY RADIO UNIVERSE

COVER ILLUSTRATION:

One of the GMRT antennas

Drawing courtesy of B. Premkumar, National Centre for Radio Astrophysics, TIFR,
Pune

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ASTRONOMICAL SOCIETY OF THE PACIFIC
CONFERENCE SERIES

Volume 407

THE LOW-FREQUENCY RADIO UNIVERSE
An Event Commemorating the Birth Centenary of Dr. Homi J. Bhabha

Proceedings of a conference held at
National Centre for Radio Astrophysics (NCRA), TIFR, Pune, India
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Preface

During the last couple of decades or so there has been a strong resurgence of interest in low-frequency radio astronomy to address many outstanding and challenging problems and issues. These include: mapping the distribution and evolution of neutral and ionised gas with cosmic epoch, and thereby understanding the time dependence of reionisation; probing large-scale structure and galaxy evolution including the star-formation history of the Universe; exploring the origin and evolution of cosmic magnetism; detecting many new and exotic pulsars to test theories of gravity, and possibly detecting gravitational waves via accurate timing of millisecond pulsars; constraining theories of acceleration and propagation of high-energy particles, and finding and understanding transients in our Universe. The Giant Metrewave Radio Telescope has been in operation for close to a decade, early results have been reported from LOFAR, while the next generation of telescopes such as the Long Wavelength Array (LWA), Murchison Wide-field Array (MWA), MeerKAT, Australian SKA Pathfinder (ASKAP) and the Square Kilometer Array (SKA) should provide exciting results and opportunities in this region of the radio spectrum.

It seems an opportune time to take stock of the results obtained so far at low radio frequencies, discuss exciting astrophysical problems as well as a wide range of technical issues such as high dynamic range and wide-field imaging at low frequencies, mitigating the effects of radio frequency interference, high-performance computing needs, and designing new antenna elements, feeds, correlators for the challenges that lie ahead.

With these objectives a conference and workshop titled ‘The Low-Frequency Radio Universe’ was held at the National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research (TIFR) from the 8th to the 12th of December 2008 at Pune, India. For the purpose of this conference, low frequency has been defined to be less than approximately 1400 MHz. This conference also commemorates the birth centenary of Dr Homi J. Bhabha (October 30, 1909 – January 24, 1966), founder of TIFR and India’s atomic energy programme, and who contributed immensely in both the sciences and the arts. Despite the tragic events in Mumbai towards the end of November 2008, the conference was well attended and a large number of papers on a wide variety of topics were presented.

We thank all the members of the LOC and the SOC, and the entire staff of NCRA whose untiring efforts led to the success of the conference. We would like to specifically thank Reena Shrikumar, secretary of the conference, B. Premkumar, NCRA’s photographer who designed many of the posters and publicity material and looked after the auditorium facilities, and Anna Bhat Joshi who helped put the abstract book and the proceedings together. One of us (DJS) thanks CSIRO ATNF for hospitality during the final stages of editing the volume.

The Editors

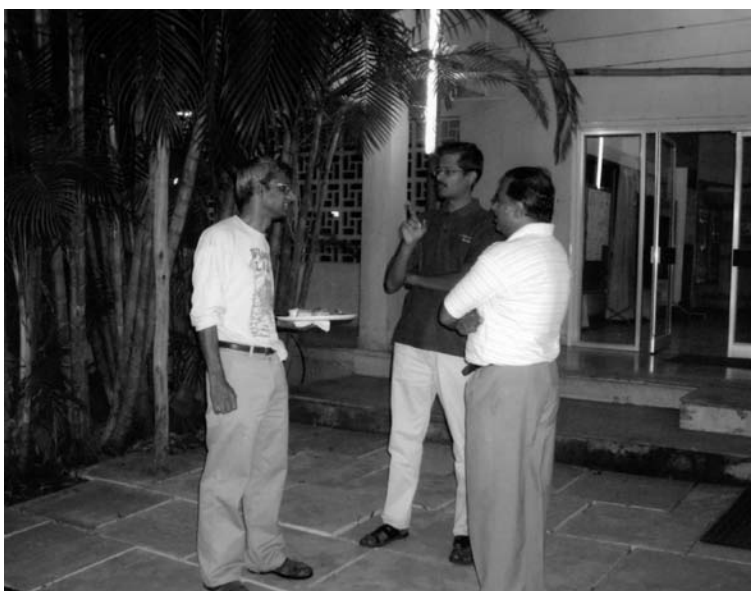
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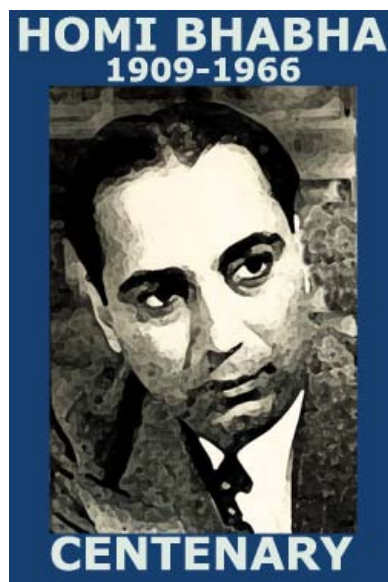
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Jayaram Chengalur, Ananthasubramanian and Swami

Homi J. Bhabha



Homi Jehangir Bhabha (1909–66) started his career as a theoretical physicist at Cambridge in the nineteen thirties and distinguished himself by his researches in the then emerging areas of high energy physics and cosmic rays. Later he excelled as a builder of institutions in India devoted to modern science and technology. He founded the Tata Institute of Fundamental Research (TIFR) in 1945 at Bombay, a premier institution devoted to excellence and the pursuit of research in the frontier areas of science. He was the motive force behind the creation of the Atomic Energy Commission (AEC) by the Government of India in 1948 and became its first Chairman. When the Department of Atomic Energy (DAE) of the Government of India was set up in 1954, he was appointed as its Secretary. The AEC and DAE were responsible for establishing a chain of research laboratories, including the Atomic Energy Establishment at Trombay (later renamed Bhabha Atomic Research Centre) and for the commissioning India's nuclear reactors for research and for the generation of power. These activities also led to the growth of electronics technology in the country and, somewhat later, to those related to space technology. Bhabha, more than any other person, was responsible for introducing and nurturing the growth of modern nuclear science and technology in India. His was a multifaceted personality equally at home in the world of arts.

Bhabha was likened to 'a man of renaissance.' He was a man of science and technology. He was a great administrator of science. He was equally at home in the world of arts. Bhabha grew up listening to his father's and his aunt's excellent collection of

recorded western classical music. Later he developed a taste for classical Indian music and dance also. The choice of Vienna as the headquarters of the International Atomic Energy Agency was to a large extent decided by Bhabha's desire to combine attendance at its meetings with an opportunity to attend the fine musical concerts there. He enjoyed sketching and painting and left behind a number of these. As M F Hussain noted, 'Though a scientist by profession, he was an artist by nature ... To a great extent Bombay is what it is today because of Bhabha. In the early fifties he conceived the idea of starting a collection of painting at TIFR... and Bombay witnessed the birth of modern art.' He was also uniquely qualified to edit a special issue of the Indian art magazine *Marg* on the occasion of the five hundredth anniversary of Leonardo da Vinci, the original renaissance man. He designed the buildings of the Tata Institute of Fundamental Research with great care and attention to every minute detail. The glass windows had frames of a special new aluminium alloy to withstand sea breeze corrosion, and this alloy was manufactured for the first time in India at Bhabha's initiative. The buildings are not only functional but also beautiful. As Helmut Bartsch, the architect, noted, 'In this development the architect worked with a client rather than for a client. The client displayed unending interest and encouragement and constantly added intelligent suggestions and advice. The result, it is hoped, is a building which will not only fulfil its function but should afford a great deal of enjoyment. The siting of the Atomic Energy Establishment is such that the island of Elephanta, which contains beautiful seventh century cave temples, is directly visible. The same juxtaposition occurs between Kalpakkam reactor centre and the famed Mahabalipuram temples. He also had a keen sense of landscape and the Tata Institute of Fundamental Research and the Bhabha Atomic Research Centre are surrounded by beautiful trees and gardens.

Excerpts from an article on Homi Bhabha by Virendra Singh in 'The Scientist in Society' published by Thema, Calcutta, 2000. Reproduced with their permission.

Beginnings of Radio Astronomy in TIFR

Excerpt from a lecture titled 'Science and the problems of development' by Homi Bhabha, at a meeting of the International Council of Scientific Unions in 1966.

Another example is provided by the Radioastronomy Group. Four Indian radioastronomers had jointly written identical letters to the Chairman of the University Grants Commission, the Director General of the Council of Scientific and Industrial Research, and to me as the Chairman of the Atomic Energy Commission offering to return to India as a group and establish radioastronomy here, if facilities and support could be given to them. Having ascertained that the members of the group had considerable original work to their credit and were of sufficient maturity to be able to work on their own in India, it was decided to take up radioastronomy at the Institute. Thirtytwo parabolic dishes presented by CSIRO of Australia, which had been lying unpacked for several years at the National Physical Laboratory, were handed over to the Institute through the willing cooperation of Dr. Husain Zaheer and have been installed not far from Bombay for solar radioastronomical work. In this meantime a project has been developed for the large cylindrical radiotelescope for studying quasars and other radio sources and locating them accurately by lunar occultation. The telescope, which will have four to five times the collecting area of Jodrell Bank, will be designed and built entirely by Indian scientists and engineers and is expected to be in operation within two years. A site for it has been selected after a very extended study as the axis of the telescope, which is

1,700 feet long, has to be parallel to the axis of the earth. Work on the site at Ooty has already started. It is proposed to make this radio telescope one of the centres for inter-university work.



Kalyan Radio Telescope



Ooty Radio Telescope

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