JAGADISH CHANDRA BHATTACHARYYA

(01 September 1920 – 04 June 2012)

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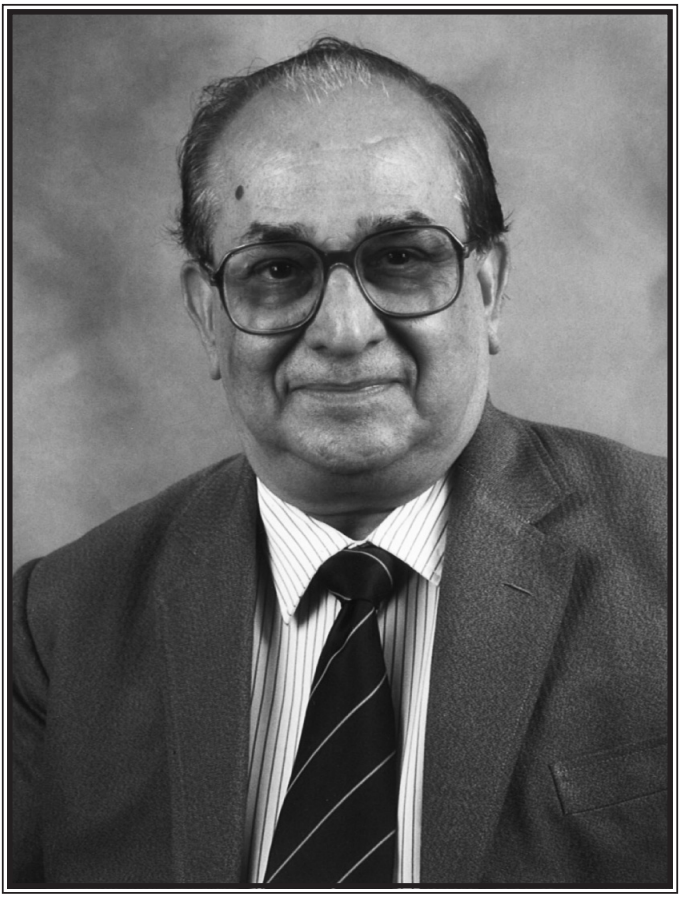

JAGADISH CHANDRA BHATTACHARYYA

(1930–2012)

Elected Fellow 1981

BIRTH AND CHILDHOOD

JAGADISH CHANDRA BHATTACHARYYA was born in a family of scholars and educators in Calcutta, Bengal (now Kolkata, West Bengal). His date of birth according to the official records based on school leaving certificate is 1 September 1930. He remembered that he was born in the Indian lunar month of Jyestha on a Tuesday which does not agree with the above date. Following his own calculations, he believed that the actual date of his birth was 21 May 1929.

His grandfather Mahamahopadhyaya Pramath Nath Tark Bhushan was an erudite scholar of Indology and Vedantic phiosophy. He taught in Sanskrit College, Calcutta and Banaras Hindu University, and authored many books. His son Phatik Chandra Vidyabhushan (Bhattacharyya) was also a teacher in Sanskrit Collegiate School, Calcutta. Jagadish Chandra was born to him and mother Mrinalini Bhattacharyya among three older sisters and three younger brothers. His paternal uncle, Batuk Nath Bhattacharyya was a Professor of English at Ripon College (present Surendranath College) and authored several books in English and Bengali. His first cousin GN Bhattacharyya rose to the position of Director General, Railway Design and Development Organization, Lucknow, and another cousin BP Bhattacharyya became Principal, Sanskrit College, Calcutta. Professor PK Bhattacharyya, FNA, was a distant cousin.

Phatik Chandra had an unrealized ambition of becoming a scientist, and taught science at college in addition to Sanskrit. He named his son after Sir Jagadish Chandra Bose, taught him to recognize constellations and conducted simple experiments at home such as dispersing the sunlight. Being an educationist family, the house was full of books and young Jagadish began to read them avidly. There was tough demand on academic excellence and he felt miserable at the thought of missing the top place in the class in school. His grandfather was a towering figure in the society, whenever he visited home on leave from Banaras Hindu University, there were many famous visitors to his house which included Sir Sarvapalli Radhakrishnan (later President of India), Prof. SN Das Gupta (Principal, Sanskrit College, Calcutta), Mahamahopadhyay Pandit Chinnaswamy Sastry, author Anurupa Devi, Chapalakanta Bhattacharyya (Editor, Ananda Bazar Patrika), Sunitikumar Chatterjee (National Professor), Ramaprasad Mukherjee (son of Sir Asutosh).

Young Jagdish Chandra thus grew up with aspiration for scholarship and excellence, and a yearning to become a scientist.

EDUCATION

Jagadish joined Sanskrit Collegiate School, Calcutta (where his father was teaching), in Class III in January 1937. It would appear that no attempt was made to convert the Indian Tithi of his birth to Christian calendar and an estimated date of birth was assigned to him. He stood first in his class every year, and also bagged annual scholarship based on an extra-curricular Sanskrit examination. Science was a minor subject but the teacher, Panchu Gopal Ghosal who was Assistant Head Master of the School strongly advised him not to deviate from Science. Jagadish, however, chose Additional Mathematics as an optional subject for the Matriculation examination of Calcutta University in 1945.

Bhattacharyya joined the Scottish Church College in July 1945 with a free studentship. Following a good performance in the Intermediate Examination in science, he was admitted to B.Sc. (Honours) course, which he completed in 1949. He stood first in the examination and won the Gangaprasad Gold Medal and Tripundeswar Mitra Gold Medal. He performed very well in practical examination and his practical note book was kept as an example for future students. He finished his M.Sc. in 1951 specializing in Electronics, and obtained third rank at the Calcutta University. Following this, he joined the Institute of Radio Physics and Electronics as Ghosh research scholar. He worked in the area of design and development of electronic instrumentation and helped his supervisor Prof. JS Chatterjee in the development of ultra-high frequency antennas. The laboratory was set up by Professor SK Mitra. Bhattacharyya discontinued this project, having secured a position with the India Meteorological Department. Later, in February 1971, he obtained his D.Phil. from Calcutta University while working at the Kodaikanal Observatory.

EARLY CAREER WITH THE INDIA METEOROLOGICAL DEPARTMENT

Bhattacharyya joined the India Meteorological Department (IMD) as Assistant Meteorologist in January 1953 and was posted in Poona (now Pune). Following successful completion of several departmental tests, he was posted in Delhi, initially for some forecasting work at the Delhi Airport, and later in the Instruments Laboratory. His first paper on instrumentation appeared during this period. He was promoted as Meteorologist Grade II in December 1955 and was posted back to Poona as in-charge of Instruments Workshop.

While Bhattacharyya was busy setting up an electronics laboratory in Poona, Dr. AK Das, director of Kodaikanal Observatory, identified him for the development of ionospheric research and radio astronomy at Kodaikanal. The observatory was set

up in the year 1899 and had made significant contributions to solar astronomy. BN Bhargava had initiated work on ionospheric research and study of radio noise from the Sun. In accordance with the rules of IMD, he would eventually be transferred to some other unit, and hence Das was looking for someone to continue these activities. As a part of preparation, Bhattacharyya was sent for training at Radio Research Station, Slough, UK in October 1957, as a Colombo Plan Scholar.

Bhattacharyya worked at Slough on Ionospheric Studies with WR Piggot and CM Minnis. He spent three weeks at Inverness, Scotland, undertaking high latitude ionospheric absorption studies. He also visited Imperial College, London, University of Bristol, University of Swansee, National Physical Laboratory at Teddington, and Royal Observatory at Herstmonceux. His first brush with astronomy was through the study at Slough on the behavior of ionosphere during a total solar eclipse. His first research paper in Astronomy was on the inference of brightness of solar disk from ionospheric studies during an eclipse, published soon after his return to India.

Upon his return in July 1958, Bhattacharyya was made in-charge of the departmental workshop in Pune where he trained himself in all aspects of instrumentation for meteorology and ionospheric research. He had an opportunity to work with SP Venkiteswaran and Anna Mani during this period. He was promoted as Meteorologist Grade I in 1959. His contributions spanned instrumentation for meteorology, as well as solar and ionospheric research.

Bhattacharyya's transfer to Kodaikanal came through in July 1964 when MK Vainu Bappu had succeeded AK Das as its director. He was promoted as its Assistant Director in 1966. Vainu Bappu, an accomplished astronomer and builder of observatories, and Bhattacharyya an accomplished instrumentation scientist joined hands immediately, and Bhattacharyya entered into his early career in solar physics. Recognizing the vast experience of Bhattacharyya in instrumentation, Bappu suggested he develop a solar magnetograph as a Ph.D. thesis project. With the Rs 100 limit on procurement of an individual item at the unit of IMD, Bhattacharyya had to innovate, but he did complete a prototype in a year and an improved version the following year and a working instrument in 1967. The five-minute oscillations of Sun were discovered by then, and he used the instrument to study these and other time scales and submitted his thesis on the "Studies of Solar Magnetic and Velocity Fields" to Calcutta University in November 1969. The University awarded him a D.Phil. degree in February 1971.

Bhattacharyya also continued the ionospheric studies initiated by BN Bhargava. In collaboration with the groups at Kodaikanal, he established the effect of solar radiation on ionosphere and used it as an indirect measure of solar activity, continuing with his 1958 paper that compared the 1944 and 1954 eclipses. He also measured the Faraday rotation of satellite signals. In 1970, Bappu and Bhattacharyya conducted a successful solar eclipse expedition to Mexico, breaking a half-century

spell of failures encountered by the observatory in total solar eclipse studies (primarily due to clouds during the events). The funds were just sufficient for the travel of two persons with necessary instruments. The two worked without any assistants and set up a camp at Miahuatlan in Southern Mexico. The valuable data obtained during this eclipse led to the discovery of cooler regions in the lower solar corona. IIA has been regularly observing solar eclipses around the world since then.

ESTABLISHMENT OF THE INDIAN INSTITUTE OF ASTROPHYSICS

Kodaikanal Observatory was a part of India Meteorological Department (IMD) for administrative convenience since the Imperial British Government. In the year 1945, MN Saha Committee which reviewed and planned the future of astronomy in India, recommended modernization of the observatory, and the work was initiated by successive directors. However, the progress was slow due to paucity of funds for new initiatives beyond the routine operations. The activities at Kodaikanal were reviewed in 1967 by Prof. S Bhagavantham Committee for Scientific Reorganization (COSR), which recommended the formation of an autonomous institute for furtherance of astronomy and astrophysics. The Indian Institute of Astrophysics was thus formed, registered as a society at Dindigul district headquarters on 1 April 1971. As is customary, the existing employees of IMD had an option to join the new institute, or continue with the IMD. The institute was set up to promote academic excellence, and the posts were temporary without the benefits associated with a regular government position. As a compromise, the existing IMD employees were offered permanent position as well as pensionary benefits that were not applicable to new employees. Promotions would, however, be based on individual performance. A large number of employees opted to continue with IMD with posting outside Kodaikanal. Bhattacharyya decided to continue working with Bappu to carve out the IIA and also to carve out a scientific career for himself. He had reached the position of Assistant Director of Kodaikanal Observatory at a very young age, and if he had opted for IMD it was certain that he would have reached the position of Director General of IMD well before his superannuation. Instead, he relinquished his position of Assistant Director (which was not provided for in the bye-laws of the new institute) and accepted his appointment as Associate Professor in 1972. Yet, all the continuing employees always referred to him as AD. The newly appointed staff of IIA referred him by his initials, JCB, and this name stuck subsequently.

Bhattacharyya was promoted as a full professor in 1981 and retired as Senior Professor in 1990. These promotions were at a much lower pace compared to what he would have received in IMD, and also what is now customary at IIA and other research institutions in the country; but he never attached importance to such advancements compared to the satisfaction he derived from developing innovative instruments to meet his requirements for frontline scientific research.

It was decided that IIA would perform better in the environment of a city where it can interact with other institutions. Kodaikanal and Kavalur would be operated as its field stations. Proximity to the field station was also a necessary requirement and hence Madras and Bangalore were considered for the choice. Bangalore won when the State Government provided land for the institute in Koramangala, then in the outskirts of Bangalore on the road towards Kavalur and Kodaikanal. Until the site was developed, Raman Research Institute provided space for a temporary office and laboratory which Bhattacharyya headed in 1973 with some existing and some new academic staff. KR Sivaraman, who had worked with him at IMD, Pune, and was transferred to Kodaikanal following him, and Ch. V Sastry who had also joined Kodaikanal Observatory were among the senior staff.

BHATTACHARYYA THE ASTRONOMER

While Bhattacharyya had an ambition for experimental science since childhood, he had never thought of taking up astronomy for his career. His brush with radio astronomy came with the plans of AK Das that he should develop this area at Kodaikanal. While being groomed towards this, he realized the future potential of astronomy in India through his meetings with AP Mitra and Govind Swarup. He learnt about the interest of MN Saha in radio astronomy, and the setting up an optical observatory by Vainu Bappu near Nainital.

Bhattacharyya's work in solar astronomy, and ionospheric as well as radio astronomy is mentioned earlier. UV Gopala Rao, and later Ch. V Sastry took leadership in radio astronomy. KR Sivaraman assumed leadership in solar astronomy over the years. Yet, Bhattacharyya continued to work in the area of solar magnetic fields and activity, especially through further instrumentation, alongwith younger colleagues and a student KS Balasubramaniam. Studies of solar corona during total solar eclipse were successful with his experiments during the 1970 eclipse in Mexico. On 16 February 1980, the path of a total solar eclipse passed through southern India. Bhattacharyya was appointed the National Coordinator for the observations of this eclipse. IIA set up two camps: one at Hosur near Hubli and another at Jawalgere near Raichur where teams from many other institutions from India and abroad also converged. The present writer worked closely with him on identification of the sites and setting up the camps. This provided an opportunity towards a deeper understanding of Bhattacharyya's personal qualities: simplicity, modesty, honesty and integrity, which continue to inspire even today.

In the meantime, Vainu Bappu had begun to rejuvenate stellar astronomy at Kodaikanal, utilizing 8-inch Madras Equatorial built in the 19th century, and the 20-inch Bhavanagar telescope which had laid dormant for nearly half century. Bhattacharyya participated in photoelectric photometry with the 8-inch telescope, and embarked upon a journey that would take him to commission the 93-inch

telescope in just two decades. The impetus he received towards this was through the study of occultations, when a solar system body moves in front of a star. He made a series of discoveries in the solar system with very modest equipment.

Vainu Bappu had initiated capacity building for telescope manufacture by encouraging AP Jayarajan to grind and polish optics at Kodaikanal. A 15-inch telescope was built in the workshops of the Observatory by 1966, and Bappu and Bhattacharyya began to developed dry-ice cooled photometers. The telescope and photometer were shifted to Kavalur, the site identified for a new observatory. The planet Jupiter was to occult a bright star β Scorpii on 13 May 1971; Bhattacharyya decided to observe it from Kavalur in order to study the structure of Jupiter's atmosphere. The conventional chart recorder used in photometry was too slow for such a study. So, Bhattacharyya connected a 4 trace Tektronix oscilloscope with one channel displaying the light curve, and another providing time beeps. The screen was photographed and the light curve analysed from this trace. This innovation led to the discovery of stratification in the Jovian atmosphere published as a single author paper in the journal *Nature*. The need for fast recording of light became apparent with this exercise, and Bhattacharyya went on to developed a pulse counting photometer. He tested this instrument in 1972 on a 24-inch telescope loaned by Lowell Observatory, Arizona, USA, for the observations of Mars during the opposition of 1971.

The 40-inch Zeiss telescope from the then Federal Republic of Germany was installed and commissioned at the Kavalur Observatory during the first half of 1972. Jupiter's satellite Ganymede was to occult a star on 7 June with the observatory in the path of the event. There was international interest, and collaborations were sought by institutions in the USA and UK. Bhattacharyya improved the performance of his cathode ray oscilloscope technique by providing 10-Herz pulses to the oscilloscope. He could thus record the event with 0.1s time resolution. The disappearance and reappearance of the star behind Ganymede was not abrupt as one would expect for a body without atmosphere. The observations implied that Ganymede has an atmosphere with surface pressure greater than a microbar. Combined with additional observations from Lembang, Indonesia, an international collaborative paper was published in the high impact journal *Science*, announcing the discovery of significant atmosphere of Ganymede, and estimating accurate diameter and density of the satellite.

Bhattacharyya continued to improve the time resolution of photometry in order to apply the technique to study lunar occulations. Moon has no atmosphere, and its limb acts as a knife edge between the star and the telescope. The Fresnel diffraction pattern recorded with millisecond accuracy can provide information at a very high angular resolution. The technique can be used to measure the angular diameter of a star, probe the intensity distribution over its visible hemisphere, and could resolve

binary stars that are too close to each other and lost in the blur due to earth's atmosphere. Accurate timing of lunar occultation would also provide information on the shape of the lunar limb at the point of occultation with an unprecedented accuracy. Bhattacharyya developed the high time resolution observational technique fully, using his customary innovation, employing audio cassettes for analog recording and digitizing the data subsequently. Following the demonstration of the instrument in December 1975, he lost out to developed countries where solid state devices and large scale integration were already moving at a very high speed. Bhattacharyya may not have found the idea of importing subassemblies and integrating the instrument a sufficient challenge. The responsibilities of the institute also began to weigh heavily upon him during his later years and he had to concentrate all his energies towards successful completion of the indigenous 2.3 m telescope. However, Bhattacharyya continued working in the area of high time resolution photometry, in collaboration with other teams in India who were developing high time resolution photometers, in order to study the fast variations of emission from compact stars. Working with P Santhanam during the 1980s he also demonstrated a system with sub-millisecond recording capability that could be used to observe the light pulses from the Crab pulsar.

The occultation of a star by Uranus on 10 March 1977 provided another opportunity for investigation of solar system objects. The 1-m telescope at Kavalur was the largest available on the predicted path of the occultation. A team from Arizona sought collaboration to observe with this telescope using its own photometer. However, the collaboration was called off when refined predictions showed that Kavalur will not be on the path. Bappu and Bhattacharyya decided to observe it with the indigenous equipment anyway. The event being a slow one, a conventional photometer with chart recorder output provided sufficient time resolution for the observations. During observations, Bhattacharyya noticed a sharp drop in light before the onset of the occultation by the planet, as if due to an unknown satellite. An American team observed the event from a smaller telescope in an aircraft flying along another part of the path of occultation. This team also observed a similar dip. Since the dips occurred at different position angles about Uranus, and chances of the two teams discovering two independent satellites was negligible, both the teams began to look at the possibility that Uranus also has a ring system similar to Saturn. The first announcement of the ring system came from the American team which initially called it a 'satellite belt' and eventually identified five different ring systems. The discovery that the system is similar to Saturn's ring system, came with the study of finer details of the diffuse parts and several thin rings apparent in the data from Kavalur. Bhattacharyya and Bappu published the discovery of additional thin rings in a paper published in *Nature.*

The proposal of such a detailed ring system met with some skepticism internationally. It was then found that a group from U.P. State Observatory, Nainital

had also observed this event with a similar 1-m telescope. The data from these two telescopes, 1500 km apart, provided the best set of observations available for this event. Bhattacharyya led a team comprising of scientists from IIA as well as UPSO in the analysis of the combined data and proposed a more detailed extended ring system of Uranus. There was difficulty in publishing these results in a specific journal for a long time, due to a hostile referee. Later, Z Kopal read the manuscript while visiting IIA, and promptly published it in the international journal *The Moon and the Planets*, edited by him. The additional thin rings were also observed by a team from California during another occultation in April 1978 observed from Cerro Tololo with a 2.5-m telescope. The broad and diffuse features were noticed through direct imaging by the Voyager II spacecraft in 1986. Sadly, both the teams claimed credit for discoveries, and did not refer to the published work from India. Bhattacharyya and his student R Vasundhara, and also the team from Nainital observed a further occultation by Uranus in April 1981 and confirmed several features observed earlier. Continuing such studies further Vasundhara and Bhattacharyya detected possible particulate matter in the magnetosphere of Saturn in 1986, which also received little response from the international community.

Bhattacharyya encouraged and inspired R Rajamohan to search for asteroids through a project named "Kalki". Several asteroids were discovered in 1988-89, and some of them bear names of Ramanujan, Bhattacharyya and Gokumenon. Under his encouragement, SK Saha completed a speckle interferometer, and R Srinivasan led the CCD development project to fruition. Srinivasan strongly participated in the commissioning of the 2.3 m telescope, took charge of the electronics laboratory set up by Bhattacharyya, and led the instrumentation team for nearly two decades after Bhattacharyya's retirement.

IN THE SHOES OF HIS CAPTAIN

Following the formation of the Indian Institute of Astrophysics in 1971, Vainu Bappu initiated a multipronged development plan. He was already busy developing modern focal plane instrumentation at the 1-m telescope, Kavalur. The Institute was provided land in Koramangala, Bangalore for its headquarters where facility would be created for grinding the primary mirror. He inducted new faculty for all round academic development, in observations as well as theory. While the new campus was getting ready, V Radhakrishnan provided laboratory space in Raman Research Institute, where Bhattacharyya led a faculty and set up an electronics laboratory. The group moved to the Koramangala campus in 1975 when Bappu and several others from Kodaikanal also moved when the first, temporary building was ready. The optics laboratory was built the next year when AP Jayarajan and his team started their operations. Bhattacharyya moved the electronics laboratory which found ample space in the first permanent building that was ready in 1977. Bappu was extremely active in research, as well as in international organizations. He was Vice President of

International Astronomical Union for six years beginning 1967, and was elected President at the XVII General Assembly of the Union at Montreal in 1979. Development of the new institute required discussions with leading scientists and science policy makers in the country, and also with the government for necessary funds. Bappu was constantly traveling when not observing with the telescopes at Kavalur. Thus, Bhattacharyya and a few other senior faculty members had to take significant load of routine operations of the institute in its present campus.

Vainu Bappu had developed the concept of a large telescope in 1968 and began to detail it in 1972. The feasibility report was ready in 1976 and design and fabrication followed. AP Jayarajan took charge of optics, and Bhattacharyya took charge of electronics and controls. Bhattacharyya was also the member of the Project Management Board along with Project Manager SC Tapde and experts from other institutions. Vainu Bappu chaired the Board. The untimely demise of Vainu Bappu on 19 August 1982 placed the full responsibility of the project squarely on the shoulders of Bhattacharyya. In his own words, "*The incident which shook me most during the execution of the project was the totally unexpected passing away of Dr. Bappu; not only did I lose my friend, philosopher and guide, but found myself saddled with the responsibility of seeing through the task of completing this complex project. I felt like a sailor who has lost his captain in the stormy sea.*"

The unfinished task of Vainu Bappu was not just the 2.3m telescope project. The foundations of the institute were yet to be laid firmly, and the IAU General Assembly was planned to be held in India in 1985, the first one in Asia. Bappu was guiding four students for their Ph.D. who felt orphaned as well. Bappu was the founder editor of *Journal of Astrophysics and Astronomy*, Indian Academy of Sciences. He had also initiated a national project of site survey in high altitude, dry site at Leh. Bhattacharyya was the right person who could complete these tasks, and he felt it was his duty towards Bappu. While he was sure he could take charge of execution of all these activities, he feared he lacked the stature of Bappu and may not be able to secure the support he needs in terms of continued funding and help from external expert individuals and groups. The storm he faced was not just the enormity of the tasks, but also the external forces that coveted the position of the director of the now prestigious institute. There were weaker members of the institute who were easily swayed by these forces and began to deflect the feeling of inadequacy they had felt in response to Vainu Bappu's stature, towards Bhattacharyya after Bappu's disappearance from the scene. MGK Menon, who chaired the Governing Council of IIA since its inception, is largely responsible for quelling the disquiet, and ensuring that Bhattacharyya could concentrate fully on the tasks on hand. He appointed Bhattacharyya as acting director soon after Bappu's demise (he was already officiating when Bappu was away with a visiting position in Munich where he passed away), and ensured that he is formally appointed as Director, since he was convinced that the 2.3 m telescope can be completed only with this decision.

VAINU BAPPU TELESCOPE

The Government of India had constituted in 1945 a Committee with Prof. MN Saha in chair to draw up plans for the development of astronomical research and teaching in India at the existing observatories and universities. The main recommendations made by this committee included the establishment of an astronomical observatory with a telescope of large aperture. The largest telescope in the world at this time had an aperture of 100-inch (Mt Wilson, California, USA). Kodaikanal Observatory, under the leadership of AK Das and later MK Vainu Bappu planned to set up such a telescope, but the proposal went through only after the formation of IIA. In the meantime, Bappu had inspired AP Jayarajan of the observatory to develop skills of grinding large optics. A 236 cm (93 inches) mirror blank was available at fairly low cost from Federal Republic of Germany, and was procured in 1974. Fabrication of different components was entrusted to Indian manufacturers. The construction of the telescope building was initiated in 1978. With the large mirror grinding machine fabricated and installed at the Bangalore campus, the work on the primary mirror commenced in 1979. Following the completion of making the Cassegrain hole and grinding to the approximate shape, the figuring work was initiated in 1981. This slow process of continuous tests and corrections was proceeding well on its tracks when Vainu Bappu passed away. Bhattacharyya was appointed chair of the Project Management Board and took full charge of the project.

The manufacturer of the mechanical mount had underestimated the complexity of fabrication. With cost and time overruns, the mount was finally completed in 1984. The building was ready and the installation began immediately. The electronics and controls were developed collaboratively with Bhabha Atomic Research Centre, and the latter team was affected by migrations of original members. By now, Bhattacharyya had recruited and instrumentation scientist R Srinivasan at IIA and he gave him full charge of controls in 1985. Development of auxiliary systems such as automated dome, Cassegrain platform, electrical systems and air-conditioning, vacuum coating plant, VAX 11/780 computer system, etc. converged about this time. The primary mirror was coated and loaded and the first light photograph of Pleiades cluster was taken at the prime focus by Bhattacharyya on 2 November 1985.

On 6 January 1986, late Shri Rajiv Gandhi, the then prime minister of India, visited Kavalur Observatory, and named the newly commissioned telescope as well as the entire observatory after Vainu Bappu. Shri Gandhi and his children enjoyed the celestial sights through India's largest telescope during the same night.

The next task involved equipping the telescope with the state of the art instruments. A wide field corrector system designed and fabricated in the optics laboratories of the institute was installed at the prime focus. A CCD camera was commissioned in 1986. The Cassegrain secondary mounting cage was accidentally

damaged during installation, and required redesigning and fresh fabrication. The Cassegrain optics was installed in 1989 and a Boller & Chivens spectrograph that was decommissioned along with the Image Dissector Scanner at Anglo-Australian Observatory was procured and installed. Meanwhile, the pointing and tracking of the telescope were greatly improved and remote guiding from the control room was implemented. A national time allocation committee was appointed and proposals were sought for observing time with the telescope. The national astronomical community enjoyed access to a large and modern facility during the 1990s.

LAYING FOUNDATIONS OF INDIAN INSTITUTE OF ASTROPHYSICS

Vainu Bappu had created an institution capable of academic excellence, with reasonable funding, library, laboratory space, and freedom in the pursuit of science, during the first decade of its existence. Yet, the institute operated as a large family with Vainu Bappu as the head. It was Bhattacharyya who shaped it fully as an institution. He set about to form structure in terms of groups and facilities, and fostered interactions through periodic academic meetings. He organized monthly scientific meetings where each scientist would describe his work. He conducted these meetings himself, not missing a single one.

Bhattacharyya believed in arriving at decisions through discussions and consensus. Significant decisions were taken at the level of Group Committees, and the 'Faculty' consisting of senior academic members held monthly meetings for major decisions. Interactions between different astronomy interest groups in Bangalore, such as Raman Research Institute, ISRO Satellite Centre, Indian Institute of Science were also strengthened through a Joint Astronomy Programme for Ph.D. students, and through joint summer schools and neighbourhood astronomy meetings. Towards the end of his career, he instituted a separate graduate school at IIA as well in order to provide increased opportunity to students.

Bhattacharyya structured the administrative unit for smooth operation, and provided secretarial support to the academic staff. His experience with IMD, and absolute integrity through which he could view the administrative procedures, while upholding the support required for academic excellence, helped his tasks enormously. He was aware through his own experience that certain amount of minimal comfort in life is necessary if one needs to single-mindedly pursue higher goals, and hence initiated several staff welfare schemes. He introduced a good medical scheme, attended to the problem of housing of employees, streamlined the process of assessment-based promotions, and instituted pension scheme for new employees as well.

Bhattacharyya thus strengthened the foundations of Indian Institute of Astrophysics, and ensured that its smooth course into the future.

PLANS FOR A HIGH ALTITUDE OBSERVATORY

John Evershed had set up a solar observing station in Kashmir, considering the advantages of the Himalayan region. Following up on this idea, Vainu Bappu initiated a site survey programme in Leh to look for a high altitude cloud free site for astronomy. A project coordinated by the DST was sanctioned, and A Bhatnagar, then director of solar observatory at Udaipur was appointed the national coordinator. Bhattacharyya ensured strong participation by IIA in the project, and moved the 20-inch Bhavanagar telescope to Leh. This resulted in a series of reports in the Bulletin of Astronomical Society of India during the 1980s. At the end of the project, Bhattacharyya concluded that better sites would be found to the south-east of Leh. He proposed a high altitude 4-m class remotely operated infrared telescope. IIA indeed proceeded to the south-east and installed a downsized 2-m remotely operated optical-infrared telescope at Hanle in the year 2000 which has been operating as the best facility in the country for optical-infrared astronomy. Despite his failing health, Bhattacharyya visited the observatory personally in the year 2001 and viewed the remotely controlled 2-m Himalayan Chandra Telescope with great satisfaction.

PUBLIC OUTREACH

Bhattacharyya was a great teacher as well as science populariser. He taught astronomical techniques at the Joint Astronomy Programme of astronomy institutions of Bangalore. He was an avid reader from his childhood, and had an excellent memory until a few years before his death. He could recount accurately what he had read in literature as well as science, and regale audience with anecdotes. He could explain science in the simplest terms, but found limited opportunities towards science popularization in the formative years of IIA. His first popular article appeared in the Bengali magazine *Desh* in 1977. Following its favourable response, he wrote sporadically while he was busy with the 2.3 m telescope and institute matters. He became more prolific following his retirement and wrote in Bengali as well as English. He also chronicled history of modern astronomy in India, and the history of different aspects of IIA from his own perspective. Some of them which appeared in research journals are listed in the Bibliography. Many more are available in IIA's open access repository. They provide a highly readable source of data for historians of science.

PERSONAL LIFE, PERSONAL QUALITIES AND HONOURS

Bhattacharyya married Indira, daughter of Lt. Gen. Bidyapati Bhattacharyya, Director General, Armed Forced Medical Services, on 1 August 1957 in Calcutta. Their daughter Anuradha Mitra, born in 1960, has been serving as Financial Advisor to different departments and organizations of Government of India. Their son, Sanjoy Bhattacharyya, born in 1965, suffered with a rare ailment following a bright

academic career. This weighed heavily on the heart of Bhattacharyya as also his wife and daughter. However, like the *Stithaprajna* of *Bhagavadgita*, Bhattacharyya went on with his duties towards the IIA and Indian science dispassionately.

Bhattacharyya followed a simple lifestyle and was a friend and well-wisher of everyone. He was fond of music and literature, and had vivid memories of his past experiences. With his sense of humour, he would regale his audience with anecdotes whenever there were opportunities to get together. He often displayed his culinary skills working in the kitchens of Kodaikanal and Kavalur guest houses.

Bhattacharyya was elected the fellow of Indian Academy of Science in 1979 and Indian National Academy of Sciences in 1980. Honours came in plenty following the completion of the 2.3m telescope. He was elected President of Astronomical Society of India in 1986, Fellow of Institution of Electronics & Telecommunication Engineers in 1987, and Fellow of National Academy of Sciences in 1988. He was awarded UGC-Hari Om Ashram Trust Award for Physical Sciences in 1990, Instrument Society of India Award for 1993, and SK Mitra Birth Centenary Award of Indian Science Congress in 2005. He was elected President of Commission 9 of International Astronomical Union on Instrumentation and Techniques in 1992. Nikhil Bharat Banga Sahitya Sammelan felicitated him for his contribution to science popularization in 1993.

Following his retirement in August 1990, Bhattacharyya continued to work at IIA as CSIR Emeritus Professor, and later as Honorary Professor till 1997. He served on the Governing Council of IIA till 2006 during which his visits to IIA reduced. While he had made plans to spend his retired life in Bangalore, his failing health forced him to move to Delhi in the care of his daughter, the ailing son already moved to a home of special care. The vital link with the period of IIA's formation and growth slowly faded and finally disappeared when he passed away in Delhi on 4 June 2012.

EPILOGUE

Jagdish Chandra Bhattacharyya was a great astronomer who built his own instruments, and sustained the legacy of Vainu Bappu towards building astronomical observatories and institutions. While Vainu Bappu is considered father of Indian Institute of Astrophysics, it was the maternal care of Bhattacharyya that helped the Institute grow up to its adulthood. The foundations he laid helped the institute to make greater contributions to facilities at high altitudes, and to step into instrumentation for space astronomy in recent times.

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