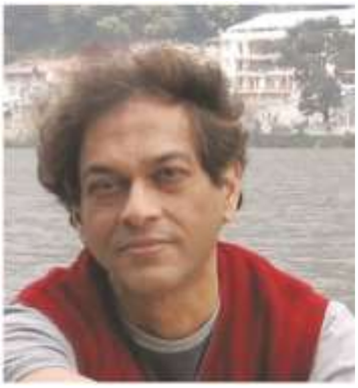
Anjan Kundu (1953–2016)

On 31 December 2016, India lost one of its finest mathematical physicists, Professor Anjan Kundu, who breathed his last during a visit to Bengaluru.

Kundu was born on 24 January 1953 at Kolkata to late Agaman Chandra Kundu and Bhanumoti Kundu. He had his schooling at the renowned Ballygunge Government High School, Kolkata, where he passed his Higher Secondary Examinations in 1970 and got admission to Presidency College (now Presidency University) for Honours Course in Physics. Meanwhile, he got selected for the prestigious Government of India–USSR Government scholarship to pursue higher studies in the Soviet Union. In the same year he was selected for the National Talent Search Scholarship. In 1971, he got enrolled at the Patrice Lumumba People's Friendship University, Moscow for a 5-year integrated Master's course in physics. He got excellent grades in all the semesters and passed the course in 1976 with Excellence (Honours) in physics.

Kundu continued his research at the Patrice Lumumba University under the supervision of Yuri Petrovich Rybakov working on soliton solutions in field models with topological charge and obtained his Ph D degree in 1981. He pursued his postdoctoral research in USSR during 1981–83, at the Joint Institute of Nuclear Research, Dubna. Kundu returned to India in 1983 and joined as a lecturer in physics at the Birla Institute of Technology, Pilani, and later worked for a brief period as a CSIR pool officer at Jadavpur University, Kolkata. In 1986, he joined as a faculty member at the Saha Institute of Nuclear Physics (SINP), Kolkata, where he ultimately became a senior professor in 2009 and superannuated in 2012, but continued on extension till the end.

During his tenure at SINP, Kundu also visited Germany as an Alexander von Humboldt Foundation Fellow during 1993–94 and revisited the country in 1996, 2004 and 2005. He was a Senior Associate at the International Centre for Theoretical Physics, Trieste, Italy during the period 2006–2011. He also served as an external expert for City University of London. He travelled to numerous institutions around the world, including Joint Institute for Nuclear Research, Sapienza University of Rome (Italy), Universities of Bonn, Hannover, Kassel, Dortmund, and Wuppertal (Germany), Freie Universität (Berlin), City University of London, LAPTh – Laboratoire d'Annecy-le-Vieux de Physique Théorique (France), University of North Carolina, Ohio State University and Arizona State University (USA), Australian National University and Prague Technical University, for short academic visits or to attend conferences and workshops. He established collaboration with many scientific institutions around the world, including Joint Institute for Nuclear Research, University of Bonn, University of Hannover, City University of London, etc.



Kundu specialized in the theory of integrable nonlinear dynamical systems, especially on soliton possessing nonlinear systems represented by systems of nonlinear ordinary and partial differential equations and their quantum versions. With the kind of training he had in theoretical and mathematical physics all through his career, Kundu was looking for unifying mathematical structures and their physical implications underlying different nonlinear systems, and with special reference to magnetic, optical, hydrodynamic and particle physics systems. He was fascinated by the intricate mathematical structures, the soliton solutions, conserved quantities, Poisson bracket structures and their quantum behaviour. During his Ph D and postdoctoral work, Kundu deduced a topological toroidal solution of large radius for the Faddeev model with large Hopf index, which is now well recognized. He also deduced exact solutions of non-spherically symmetric exact skyrmions in two dimensions and obtained saturating Bogomolny bound which can explain certain magnetic pattern experiments.

Over the years, Kundu developed a mastery over the inverse scattering theory (both classical and quantum) underlying completely integrable soliton systems. Various types of nonlinear Schrödinger equations and Heisenberg spin chains known in the literature were thought to be independent with independent solutions. It was Kundu who characteristically pointed out that these equations are all interrelated through a gauge unifying scheme, thereby bringing clarity to the situation. This idea led to his identification of several new systems, which are now called Kundu, Kundu–Eckhaus, and Radhakrishnan–Kundu–Lakshmanan equations in the literature. A similar challenge for the need to unify quantum integrable models was met by Kundu and his co-workers by an ancestor model scheme, which is based on a new quantum algebra discovered by him. Applying this scheme Kundu found new integrable quantum models like (i) quantum relativistic Toda chain, (ii) derivative quantum nonlinear Schrödinger field theoretical model, and (iii) a new lattice quantum nonlinear Schrödinger equation, besides the existing ones. Analysis of these systems brought clarity to the structure of quantum integrable models. A longstanding challenge of formulating non-ultralocal class of quantum integrable models was solved by Kundu by proposing a new braided Yang-Baxter equation. Further, he also proposed the pioneering delta and derivative delta function anion gas models and solved them for the first time using Bethe ansatz method. Further, along with his co-workers, Kundu constructed a novel *PT*-invariant Calogero model and showed that the system yields a completely real spectrum.

Kundu also suggested a novel scheme of nonlinearizing linear equations to integrable systems, thereby deducing important equations like non-holonomic deformations of nonlinear Schrödinger, Korteweg-de Vries and sine-Gordon equations with innovative applications to optical soliton communications and bending of light beam. He proposed a pioneering scheme of exploiting unusual time-Lax operator, yielding new integrable higher dimensional nonlinear Schrödinger equations with application in modelling two-dimensional ocean rogue waves. Further, based on the above ideas, the problem of defect integrable models was solved by Kundu and his colleagues, including defect nonlinear Schrödinger and Toda chain equations. It is in the fitness of things that his last work, accepted for publication on 3 January 2017, documents Kundu's commitment to direct efforts in controlling the hazardous near-shore oceanic waves by implementing his theoretical ideas on leakage-based methods. This is a sequel to his concern to control the devastating consequences of extreme events like the December 2004 Indian Ocean tsunami.

Kundu was recipient of many honours. Apart from the ones mentioned above, he was elected to the Fellowship of the Indian National Science Academy, New Delhi (2014) and Indian Academy of Sciences, Bengaluru (2015). He was a member of the Editorial Board of the *Proceedings of the Royal Society of London, Series A* since 2012. He has trained several outstanding students at SINP and published over 100 papers besides several articles to Proceedings and editing important books. It is remarkable that Kundu could achieve all these despite his life-long affliction with acute myopia and later heroically fighting leukaemia during the final four years of his life.

Kundu was always brimming with novel ideas to expand the horizon of integrable nonlinear systems in multipronged ways. Even under severe physical strain later in his life, he could overcome it by concentrating on his desire to invent new integrable systems, understanding their mathematical structures and applying the results to new physical contexts. These traits have enabled him to develop deep friendship with like-minded scientists both in India and abroad, who all deeply mourn his demise at the pinnacle of his career. Kundu retained his passion for travel to newer places and tasting exotic food, as well as writing science fiction stories and poetry, especially in his mother tongue, Bengali. He remained cheerful all through his life and was endeared by everyone. He is survived by his wife, daughter, and a grandchild.

M. LAKSHMANAN[1,*]
BIKAS K. CHAKRABARTI[2]

[1]*Centre for Nonlinear Dynamics, Bharathidasan University, Tiruchirappalli 620 024, India*
[2]*Saha Institute of Nuclear Physics, Kolkata 700 064, India*
**e-mail: lakshman@cnld.bdu.ac.in*

C. V. Vishveshwara (1938–2017)

C. V. Vishveshwara (Vishu) is associated to most of us with quasi-normal modes or the ringdown of a black hole. The prediction that his simple calculations made was dramatically verified after 46 years with the discovery of gravitational waves by LIGO, which was almost a year before he breathed his last on 16 January 2017 in Bengaluru. It was, therefore, most fortuitous that he could experience the exhilaration and satisfaction of his contribution when the whole world was cheering and applauding. Vishu will be remembered for a long time not only for his seminal contributions to understanding black holes, but also fondly for the word pictures and the Sydney Harris-like cartoons he created to share with his professional colleagues and the lay public the esoteric consequences of Einstein's general theory of relativity. His talks inspired generations of students to a career in science, and through the activities at the Jawaharlal Nehru Planetarium, Bengaluru and the Bangalore Association for Science Education (BASE) the inspiration lives on.

Vishveshwara was born on 6 March 1938 in Bengaluru. He had his schooling there and then went to Mysore University for further studies. He obtained the B Sc (Hons) degree in 1958 and M Sc degree in 1959 from Central College of the then Mysore University. He then went to USA for higher studies. After getting his A.M. from Columbia University, New York, in 1964 Vishu moved to the University of Maryland from where he got his Ph D in 1968. His thesis advisor was C. W. Misner, the 'M' of the directory of the universe, MTW. His thesis subject was 'Stability of Schwarzschild metric'. After stints as a postdoctoral fellow and a visiting faculty member at the Institute of Space Studies (1968–69), New York University (1969–72), Boston University (1972–74), and University of Pittsburgh (1974–76), Vishu returned to Bengaluru in 1976 and joined the Raman Research Institute (RRI). In December 1992, he moved from RRI to the Indian Institute of Astrophysics (IIA), Bengaluru as a senior professor, from where he retired in 2005.

One of the most important and bizarre predictions of general relativity is the existence of black holes – objects from which nothing can come out, including light. It marks a one-way surface which can only be crossed one way but not the other – things can fall in but nothing can come out. A brief historical aside is not out of place to give a flavour of the times when Vishu's important papers were written.

Relativity revolutionized our understanding of space and time by first uniting them into a flat four-dimensional space–time in special relativity, and subsequently for describing gravity making it curved and dynamic in general relativity. Gravity is no longer an external force but synonymous with the geometry of space–time. In 1915, Einstein finally arrived at the correct field equations completing the quest he began in 1907 to obtain general relativity, his relativistic theory of gravitation. Mathematically, the equations were complicated and so he was surprised that within a year Karl Schwarzschild discovered an exact solution of these equations representing a spherically symmetric, asymptotically flat vacuum solution, whose outer region is strictly static. The solution had an unusual feature that a certain component of the metric vanished while another diverged at what was referred to as the Schwarzschild singularity, or better the Schwarzschild surface. Though, in 1939, Oppenheimer and Snyder showed that a person who rides through this surface on an imploding star will feel no infinite gravity or see no breakdown of physics there, these results were not taken seriously due to the mental connotation associated with the word 'singularity' and due to the simple dust model used in the treatment. These objects were referred to as frozen star in the Soviet Union and collapsed star in the West. The realization that this was due to a choice of coordinates or a coordinate singularity was long time coming and conclusively settled in 1958 by Finkelstein (and later in