

Curriculum Vitae

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2. **Address:** Professor and Head, Stat-Math Unit,
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3. **Broad Subject Area** Mathematics
4. **Specialization** Operator Theory/Operator Algebras
with special reference to Quantum Probability

6. **Educational Qualifications:**

PhD in Mathematics from Indian Statistical Institute, under the guidance of Prof. K. R. Parthasarathy.

7. **Details of employment:**

- (i) Research fellow at the Indian Statistical Institute, New Delhi for 1988-1993, with fellowship from the National Board for Higher Mathematics, India.
- (ii) Post-doctoral fellow at the University of Pisa, Italy from Jan. 1994 to Sept. 94, with fellowship from INDAM (Italy).
- (iii) Post-doctoral fellow at The Fields Institute, Canada from Sept. 94 to Aug. 96, with fellowship from the Fields Institute.
- (iv) Associate Professor at the Indian Statistical Institute, Bangalore Centre during Oct. 96- April 2000.
- (v) Professor at the Indian Statistical Institute, Bangalore Centre since May 2000.
- (vi) Head, Stat-Math Unit, at the Indian Statistical Institute, Bangalore Center, since April 1, 2010.

8. Professional recognition, awards, fellowships received.

- Awarded the **INSA Medal for Young Scientists** on October 7, 1997 by **Indian National Science Academy, New Delhi**.
- **Associate** of the **Indian Academy of Sciences, Bangalore** from 6 June 1997 to 31 December 2001.
- Received out of turn promotion in May 2000, to become **Professor** in the Stat-Math Unit, Indian Statistical Institute.
- Received the **Swarnajayanthi Fellowship** from the Department of Science and Technology, India.
- Received **B. M. Birla Science Prize** in Mathematics for the year 1998.
- Became a **Fellow** of the Indian Academy of Sciences in 2006.
- Awarded **Shanti Swarup Bhatnagar Prize for Science and Technology (Mathematics)** -2007.
- Became a **Fellow** of the Indian National Science Academy from Jan. 1, 2016.

9. Professional training and research experience:

Ph.D. under the guidance of Prof. K. R. Parthasarathy with thesis title ‘Markov dilations of Nonconservative Quantum Dynamical Semigroups and a Quantum Boundary Theory.’ Field of research work includes Quantum Probability, Operator Algebras, Unbounded Operators etc. Selected for a post-doctoral fellowship by the Fields Institute, Canada for their special year in Operator Algebras. One of the main contributions ‘Cocycles of CCR flows’ has appeared as a Memoirs of the American Mathematical Society. Joint Editor of a monograph of the Fields Institute on Operator Algebras and it has been published by the American Mathematical Society. Joint Author of a Springer Lecture Notes in Mathematics, titled ‘Quantum Independent Increment Processes I: From classical probability to quantum stochastic calculus’.

10. Research projects:

- INSA Young Scientist Research Project ‘ E_0 -Semigroups and dilation theory’ started in July 1998, successfully completed in June 2001. One book, 3 research papers have come out of this project.
- A research paper was possible due to RIP (Research in pairs) program with M. Skeide at Oberwolfach in 1998.
- Principal investigator jointly with W. Freudenberg of a DST-DAAD (Indo-German) joint project ‘Tensor product systems of Hilbert modules’. S. Barreto, S. Dey from India and M. Skeide, V. Liebscher from Germany were other members.

- Participating member along with G. Misra, G. Pisier, P. Biane, and A. Pal in the Indo-French project ‘Non-commutative Markov Processes and Operator spaces,’ completed in March 2004 (K. B. Sinha and S. Attal were principal investigators for this project).
- A member of the Research in Pairs program of Oberwolfach with M. Skeide and V. Liebscher at Oberwolfach in 2007.
- Good progress in Swarnajayanthi Fellowship project entitled ‘Quantum Dynamical Semigroups and Tensor Product Systems’. This project spanned from 2003 to 2008.
- A member of the UK-India Educational Research Initiative (UKIERI) Project on ‘Quantum Probability, Noncommutative Geometry and Quantum Information’, which will run from 2008 to 2011.

11. Arranging conferences, workshops.

- Jointly with Prof. G. Misra, organised a national level workshop on ‘Recent Advances in Operator Theory and Operator Algebras’ at the Indian Statistical Institute (Dec. 21 to Jan. 2 1999), Bangalore.
- Jointly with Prof. K. B. Sinha and Prof. G. Misra, has organised an international conference ‘Quantum Probability and Infinite Dimensional Analysis (QPIDA)’, at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore during December 14 to 18, 1999. Lectures were given by distinguished mathematicians like S. R. S. Varadhan, Luigi Accardi, T. Hida, K. R. Parthasarathy, R. Leandre and others.
- Jointly with Prof. G. Misra, organised a national level workshop ‘ISI workshop on Recent Advances in Operator Theory and Operator Algebras-II’ during Dec. 24, 2001 to Jan. 4, 2002.
- Was an active member of the local organizing committee of the India-AMS meeting held in Bangalore in December 2003.
- Member of the local organizing committee of the international conference on operator theory, quantum probability, and non-commutative geometry held at the Indian Statistical Institute, Kolkata during Dec. 20-23, 2004.
- Along with Prof. G. Misra organized ‘ISI Workshop on Recent Advances in Operator Theory and Operator Algebras-III’ in Bangalore during December 12-22, 2005.
- Member of the Organising Committee of the Workshop on Noncommutative Dynamics and Applications held at the Fields Institute, Toronto during July 16-20, 2007.
- Jointly with M. Skeide organised a special session on ‘**Dilation theory**’ at the 28th Conference on Quantum Probability and Related Topics, held at Guanajuato, Mexico during September 2-8, 2007.

- Along with K. B. Sinha organised a Discussion Meeting on Non-commutative Geometry and Operator Algebras' at Orange County, Coorg during February 25, 2008- March 1 2008.
- Jointly with T. Bhattacharyya and K. B. Sinha, organised the **31st international conference on Quantum Probability and Related Topics** at Bangalore during August 14-17, 2010 as a satellite conference of ICM-2010.
- Jointly with M. Skeide and U. Franz organised a Mini-Workshop on at the Mathematics Institute, Oberwolfach on 'Product systems and independence in Quantum Dynamics' during February 15-21, 2009.
- Jointly with T. Bhattacharyya and J. Sarkar organised 'Recent Advances in Operator Theory and Operator Algebras, Dec. 31, 2012-January 11, 2013, at ISI Bangalore.
- Jointly with J. Sarkar organised 'Recent Advances in Operator Theory and Operator Algebras, Dec. 9-19, 2014, at ISI Bangalore.

12. Scientific Assignments/Academic Visits in India and abroad

- Short course given on completely positive maps at the 13th annual conference of the Ramanujan Mathematical Society, held at the University of Tirunelveli during June 4 to 6, 1998.
- Was a faculty member of the International Mathematical Olympiad training camp held at Mumbai during May 5 to June 4, 1999.
- Visited S. Attal (Fourier Institute, Grenoble) for two months during Oct-Nov. 2002 under the Indo-French Project mentioned above and a paper 'Atomic dilations' came out of it.
- Visited J. Martin Lindsay, University of Nottingham during Dec. 19, 2002-June 30, 2003, under Indian National Academy of Sciences, Royal Society exchange visit program and additional funding from EPSRC, UK.
- On invitation by EMA Universitat, Greifswald, Greifswald, Germany participated and gave a series of lectures in a workshop on 'Dilations, Endomorphism semigroups and their classification by product systems' (June 18-21, 2003) and an international conference on infinite dimensional analysis and quantum probability (June 22-28, 2003).
- On invitation by Ritsumeiken University, Japan gave a short course on Dilations of quantum Markov semigroups, in their *Symposium on Recent developments in E-semigroups and related topics*, during March 8-16, 2005.
- Visited J. Martin Lindsay and S. C. Power in Oct. 2005 with travel funding under the Swarnajayanthi Fellowship project.
- Gave an invited lecture and organised (with M. Skeide) a special session Quantum Probability conferences in Guanajuato, Mexico (2007).

- Visited three Italian Universities in September-October 2008 on invitation from Prof. F. Fagnola, Prof. Luigi Accardi and Prof. M. Skeide.
- Gave an invited lecture in the First Indo-Brazil Mathematics meeting Rio de Janeiro (2008),
- Gave an invited lecture in the Quantum Probability Conference, Hammamet, Tunisia (2008).
- Attended India-UK Frontiers of Science meeting, Hyderabad (2008).
- Gave a short course on Instructional Workshop on Spectral Theorem in the Kerala School of Mathematics during June 15-16, 2009. This was the first Workshop of the Kerala School of Math.
- Gave a series of lectures in the Workshop on Functional Analysis and Harmonic Analysis held at the Kerala School of Mathematics during February 1-10, 2010.
- Attended International Congress of Mathematicians of 1998 (Berlin), 2006 (Madrid), 2010 (India).
- Visited Prof. Un Jig Ji of Chungbuk National University, South Korea and gave a series of lectures during October 11 - 22, 2010.
- Gave a full course of four lectures on Product systems and E_0 -semigroups in the School on Product Systems and independence in Quantum Dynamics' and gave a plenary lecture in the follow up Conference, during March 7 - 18, 2011 at Alfried Krupp Wissenschaftskolleg, Greifswald, Germany.
- Gave a series of lectures including a public lecture in Israel on invitation by the Director of the Center for Mathematical Sciences, Technion-Israel Institute of Technology in December 2011.
- Gave an invited talk in the 34th International Conference on Quantum Probability and Related Topics at the Steklov Institute in Moscow, in Sept. 2013.
- Participated in the International Congress of Mathematicians, August 13-21, 2014.
- Gave an invited lecture in the 35th International Conference in Quantum Probability and Related Topics, Chungbuk National University, Korea, August 22-26, 2014.

13. Administrative duties at ISI.

- **in-charge for Students Academic Affairs** at the Bangalore Centre of the Indian Statistical Institute (responsible for smooth running of B.Math. and M. Stat. courses) for two years.
- In-charge of Departmental Seminars for two years.
- Active in several selection committees and syllabus revision committees of the Institute.

- Worked as the Karnataka Regional Coordinator for the Mathematical Olympiad for three years.
- Took charge as **Head of Stat-Math. Unit** on April 1, 2010.
- Convener of the PhD-DSc(Math) Committee of the Indian Statistical Institute, Kolkata since October 2012.

14. Editorial duties and related work.

- **Chief Editor**, Proceedings of the Indian Academy of Sciences-Mathematical Sciences.
- Member, Editorial Board, Journal of Ramanujan Mathematical Society.
- Member, Editorial Board, Annals of Functional Analysis.
- Member, Council of Editors, Resonance, Journal of Science Education, 2000-2014.
- Refereed papers for professional journals like Journal of Linear Algebra and its Applications, Proceedings of Indian Academy of Sciences, Journal of Probability theory and related fields, Journal of infinite dimensional analysis and quantum probability, Mathematische Zeitschrift, Proceedings of the Indian Academy of Sciences, the Journal of Ramanujan Mathematical Society.
- Member of American of Mathematical Society and **reviewer** for **Mathematical Reviews** which publishes reviews of all scholarly publications in Mathematics. Reviewer for several papers every year.

15. PhD Supervision

- Guided Mr Santanu Dey in Multivariable Operator Theory. He was awarded PhD by the Indian Statistical Institute in 2004. Subsequently he was in E-M-A Universitat, Greifswald Germany, in various positions, completed a habilitation thesis there and is currently a faculty member at IIT Mumbai.
- Guided Mr Mithun Mukherjee in the theory of Product Systems. He has submitted his PhD thesis to ISI in 2010. Mr Mukherjee was post-doctoral fellow at the University of Lancaster, UK and Ben Gurion University, Israel. He is currently INSPIRE Faculty Fellow at IISER, Kolkata.
- Guided Mr K. Sumesh for a thesis in the field of Hilbert C^* -modules.
- Currently guiding three PhD students.

List of publications [In chronological order]

(Five most important ones indicated with * are [8], [10], [16], [17], and [22].)

(a) Thesis

- [1]. Markov Dilations of Nonconservative Quantum Dynamical Semigroups and a Quantum Boundary Theory, submitted to Indian Statistical Institute on July 6, 1993.

(b) Published Papers

- [2]. On a characterization of velocity maps in the space of observables, **Pacific Journal of Mathematics**, vol. **152**, No.1 : 1-14 (1992); MR **92K:46099**.
- [3]. A stochastic differential equation with time dependent and unbounded operator coefficients, (with Kalyan B. Sinha). **Journal of Functional Analysis**, Vol. **114**, 12-31 (1993); MR **95a:60080**.
- [4]. Generalized harmonic oscillators in quantum probability, (with K.R. Parthasarathy), **Seminaire de Probabilites XXV** , Springer LNM-1485 : 39-51 (1991); MR **93k:81117**.
- [5]. On greatest common divisor matrices and their applications, **Linear Algebra and Its Applications**, Vol. 158 : 77-99(1991) ; MR **92K:15038**.
- [6]. On some convex sets and their extreme points, (with V.Pati and V. S. Sunder), **Mathematische Annalen**, **296**, 637-648 (1993); MR **94f:46076**.
- [7]. Kolmogorov's existence theorem for Markov processes in C^* algebras (with K. R. Parthasarathy), **Proceedings of Indian Academy of Sciences (Math. Sci.)**, Vol.103, 253-262 (1994), MR **95g:46118**.
- [8].* Markov dilations of nonconservative dynamical semigroups and a quantum boundary theory, (with K. R. Parthasarathy) **Annales de l'Institut Henri Poincare**, Vol. **31**, 601-651 (1995). MR **96i:46079**.
- [9]. Examples of unbounded generators leading to nonconservative minimal semigroups, (with Kalyan B. Sinha), **Quantum Probability and Applications**, Vol. **IX**, 89-103 (1994).
- [10].* An index theory for quantum dynamical semigroups, **Transactions of American Mathematical Society**, Vol. **348** 561-583 (1996); MR **96g:46059**.
- [11]. On quantum extensions of semigroups of Brownian motions on an half-line (with F. Fagnola and K.B. Sinha), **Russian Journal of Mathematical Physics**, (**John Wiley**) **4 (1)**, 13-28 (1996), MR **97j:81177**.

- [12]. On minimality of Evans-Hudson flows (with F. Fagnola), **Bull. dell'Unione Mat. Ital., Serie VII**, Vol. **IX-A-3p.** (1997) 671-683, MR **98i:81124**.
- [13]. Product systems of one dimensional Evans-Hudson flows, **Quantum Probability Communications**, Vol. **X** (1998)187-194. MR **2001h:81127**.
- [14]. A generalised intertwining lifting theorem, **the Fields Institute Communications Volume: 20 Operator Algebras and their Applications, Vol. II**, Ed. P. Fillmore, J. Mingo, (1998) 1-10, MR **99j:47010**.
- [15]. Minimal dilations of quantum dynamical semigroups to semigroups of endomorphisms of C^* -algebras, **J. Ramanujan Math. Soc.** **14**, No. 2 (1999) 109-124. MR **2000m:46132**.
- [16].* Cocycles of CCR flows, **Mem. Amer. Math. Soc.**, **149**, no. 709 (2001). MR **2002e:46083**.
- [17].* Tensor product systems of Hilbert modules and dilations of completely positive semigroups (with M. Skeide), **Infin. Dimens. Anal. Quantum Probab. Relat. Top.**, Vol. **3**, Number 4, 519-575(2000). MR **2001m:46149**.
- [18]. Minimal isometric dilations of operator cocycles, **Integral Equations and Operator Theory**, **42**(2002)125-141. MR **1870435 (2002m:47051)**.
- [19]. A model theory for q -commuting contractive tuples, (with T. Bhattacharyya), **J. Operator Theory** Vol. **47**(2002), no. 1, 97-116. MR **1905815 (2003c:47018)**.
- [20]. Atomic dilations, Advances in quantum dynamics (South Hadley, MA, 2002), 99-107, **Contemp. Math.**, Vol. **335**, Amer. Math. Soc., Providence, RI, 2003. MR **2026012 (2005b:46150)**.
- [21]. Standard noncommuting and commuting dilations of commuting tuples. (with Tirthankar Bhattacharyya and Santanu Dey), **Trans. Amer. Math. Soc.** Vol. **356**(2004), no. 4, 1551-1568. MR **2034318 (2005b:47011)**.
- [22]*. Type I product systems of Hilbert modules, (with S. Barreto, V. Liebscher and M. Skeide), **J. Funct. Anal.** Vol. **212** (2004), no. 1, 121-181. MR **2065240 (2005d:46147)**.
- [23]. Regular quantum stochastic cocycles have exponential product systems (with J. Martin Lindsay), in *Quantum Probability and Infinite Dimensional Analysis*, Ed. M. Schurmann and U. Franz, QP-PQ, Vol. XVIII, World Scientific (2004) 126-140. MR **2211885 (2007h:81128)**.
- [24]. On product systems arising from sum systems (with R. Srinivasan), **Infinite Dimensional Analysis, Quantum Probability and Related Topics**, Vol. **8**, no. 1 (2005) 1-31. MR **2126876 (2006e:46075)**.

- [25]. A completely entangled subspace of maximal dimension, **International Journal of Quantum Information**, Vol. 4, No. 2 (2006) 325-330.
- [26]. Minimal Cuntz-Krieger dilations and representations of Cuntz-Krieger algebras, (with Santanu Dey and J. Zacharias), **Proceedings of the Indian Academy of Sciences, Mathematical Sciences**, Vol. 116 (2006), No. 2, 193-220. MR **2226131 (2007h:46066)**.
- [27]. Integrators of matrices, (with Mithun Mukherjee), Integrators of matrices. **Journal of Linear Algebra and its Applications**, Vol. 426 (2007), no. 1, 71–82. MR **2344560**.
- [28]. A Problem of Powers and the Product of Spatial Product Systems, (with Volkmar Liebscher and Michael Skeide), Proceedings of the 28th Quantum Probability Conference, Sep 2-8, 2007, held in Guanajuato, Quantum probability and related topics, 93106, QPPQ: Quantum Probab. White Noise Anal., 23, World Sci. Publ., Hackensack, NJ, (2008). MR2590656 (2011c:46142).
- [29]. Maximal Commutative Subalgebras Invariant for CP-Maps: (Counter-)Examples, (with Franco Fagnola and Michael Skeide) **Infinite Dimensional Analysis, Quantum Probability and Related Topics (IDAQP)** Vol. 11, No. 4 pp. 523-539. (2008). **arXiv:0804.1864** , MR **2483795** (2009m:46100).
- [30]. Inclusion systems and amalgamated products of product systems (with Mithun Mukherjee), **Infinite Dimensional Analysis Quantum Probability and Related Topics (IDAQP)** Vol. 13, No. 1, 126, (2010) MR**2646788 (2011f:46087)**.
- [31]. Subsystems of Fock Need Not Be Fock: Spatial CP-Semigroups, (with Volkmar Liebscher and Michael Skeide), **Proc. Amer. Math. Soc.** 138 no. 7, 2443–2456, (2010). **arXiv:0804.2169** MR **2607874**.
- [32]. Stinespring’s theorem for maps on Hilbert C*-modules (with G. Ramesh and K. Sumesh), **J. Operator Theory** 68:1(2012), 173178. MR2966040
- [33]. The spatial product of Arveson systems is intrinsic. (with Volkmar Liebscher, Mithun Mukherjee, Michael Skeide) **J. Funct. Anal.** 260, no. 2, 566573 (2011),MR **2737413** (2011k:46090).
- [34]. Linear maps respecting unitary conjugation, **Banach J. of Math. Anal.** Vol. 5, No. 2, 1-5 (2011). MR2780863 (2012d:47111)
- [35]. Roots of states, **Communications on Stochastic Analysis** Vol. 6, No. 1 (2012) 85-93.
- [36] Bures distance for completely positive maps (with Sumesh K.) *Infin. Dimens. Anal. Quantum Probab. Relat. Top.* 16 (2013), no. 4, 135001, 22pp MR3192708.

- [37] The Schur-Horn theorem for operators with finite spectrum, with Mohan Ravichandran, Proc. Amer. Math. Soc. 142 (2014), no. 10, 34413453. MR3238420.
- [38] Nilpotent completely positive maps (with Nirupama Mallick). Positivity 18 (2014), no. 3, 567577. MR3249920.
- [39] On submajorization and eigenvalue inequalities,(with Arup Chattopadhyaya and Kosuru, G. Sankara Raju Kosuru), Linear Multilinear Algebra 63 (2015), no. 11, 22452253, (2014) MR3401940.
- [40] Pure semigroups of isometries on Hilbert C^* Modules, (with M. Skeide), J. Funct. Anal. 269 (2015), no. 5, 15391562. MR3369946.

(c) Books

- [41]. Lectures on Operator Theory, (Editor jointly with G. Elliott and P. Fillmore), Fields Institute for Research in Mathematical Sciences Monograph Series, Vol. **13**, Amer. Math. Soc. 323pp. (1999). MR **2001j:46077**.
- [42]. Quantum Independent Increment Processes I: From classical probability to quantum stochastic calculus. (with David Applebaum, Johan Kustermans, J. Martin Lindsay), Springer Lecture Notes in Mathematics, 1865 (Ed. M. Schurmann and U. Franz), Springer-Verlag, Berlin, (2005). MR**2132092 (2005j:81087)**.
- [43]. Mini-Workshop: Product Systems and Independence in Quantum Dynamics. Abstracts from the mini-workshop held February 15-21, 2009. Organized by B. V. Rajarama Bhat, Uwe Franz and Michael Skeide. Oberwolfach Reports. Vol. 6, no. 1. Oberwolfach Rep. 6 (2009), no. 1, 493547, MR **2604064**. [Report of a Workshop on recent developments in the field].

(d) Expository articles

- [44]. Continuous tensor product systems of Arveson and Powers' Index Theory for E_0 -semigroups, Centro Vito Volterra (Preprint series No. 177), Universita Degli Studi di Roma "Tor Vergata", June 1994.
- [45]. Dilations of quantum Markov semigroups, in *Symposium on Recent developments in E -semigroups and related topics*, Ritsumeikan University, Japan (2005).
- [46]. Operators as Random Variables, in Proceedings of the UGC sponsored national seminar on spectral theory of operators and wavelet analysis, NSS College, Ottapalam, 45-51 (2006).
- [47]. Wigner's Semicircle Law and Free Independence, **Resonance, J. of Science Education**, Vol. 14, No 10, 970-977 (Oct. 2009).

- [48]. Invariants, **Resonance, J. of Science Education**, Vol. 15, No. 7 595-603 (July 2010).