

RABI BHATTACHARYA

The Department of Mathematics
The University of Arizona
617 N Santa Rita
Tucson, Az 85721.

1. Degrees

Ph.D. (Statistics Dept) University of Chicago, 1967.

2. Positions Held: 1967-72 Assistant Professor, Stat. Dept., Univ. of California, Berkeley.

1972-77 Associate Professor, Mathematics Dept., University of Arizona.

1977-82 Professor, University of Arizona.

1978-79 Visiting Professor, Indian Statistical Institute

1979 (Summer) Distinguished Visiting Professor, Math. and Civil Engineering, University of Mississippi.

1992 Visiting Professor, University of Bielefeld, Germany, June 26-July 28

1994 Visiting Professor, University of Bielefeld, Germany, Feb. 15-April 15

1994 Visiting Professor, University of Gottingen, Germany, April 15-June 15

1996 Visiting Professor, University of Bielefeld, Germany, June 8-July 9

2000 Visiting Scholar, Stanford University, June-September

2000-01 Visiting Scholar, Oregon State University

1982-02 Professor, Indiana University (Dept. of Mathematics)

2002- Professor of Mathematics, University of Arizona

3. Honors and Awards:

1977 Special Invited Paper, Annals of Probability

1978 IMS Fellow

1989 DMV Lecturer (by invitation of the German Mathematical Society)

1994-95 Humboldt Prize (Alexander von Humboldt Forschungspreis)

1996 IMS Special Invited Lecture, IMS Annual Meeting, Chicago (Medalion Lecture)

1999 Special Invited Paper, Annals of Applied Probability

2000 Guggenheim Fellowship

4. Professional Associations:

Fellow of Institute of Mathematical Statistics

American Mathematical Society

5. Research Interests:

1. Markov processes in discrete and continuous time and stochastic differential equations, and their applications to equations of mathematical physics, science, engineering and economics.

2. Analytical theory and refinements of limit theorems

3. Large sample theory of mathematical statistics, including Edgeworth expansions and the bootstrap, and statistics on shape spaces and other manifolds (with applications to engineering, biology and medicine), bioassay.

6. SERVICE:

Editorial Work: 1976-79 Associate Editor, Annals of Probability

1979-81 Associate Editor, Annals of Probability

1984-88 Associate Editor, J. Statistical Planning and Inference

1985 Associate Editor, Econometric Theory

1986-88 Associate Editor, J. Multivariate Analysis

1988 Advisory Board, J. Multivariate Analysis
1989 Journal of Multivariate Analysis, Econometric Theory
1990 Econometric Theory, Journal of Multivariate Analysis
1991 Journal of Multivariate Analysis, Econometric Theory
1992 Econometric Theory, J. of Multivariate Analysis
1993 Econometric Theory
1994 Econometric Theory
1995 Econometric Theory
1996 Econometric Theory
1997 Econometric Theory
1998 Econometric Theory
1999 Econometric Theory
2000-02 Annals of Probability, Associate Editor
2000-2002 J. Statist. Planning and Inference, Coordinating Editor
2002- Statistica Sinica, Associate Editor
2006- Annals of Applied Probability, Associate Editor

Other Professional Service:

1990 Midwestern Probability Symposium (Member, Organizing Committee, 1990).
CBMS Regional Conference Board (Panelist 1990-92). 1993 International Conference on Probability, Bloomington, Indiana (Member, Organizing Committee).
1995 Member of the Organizing Committee of the international conference Mathematical Heritage of Norbert Wiener (Sponsored by the Indian Statistical Institute and the Delhi University).
1997 Chair, Session on Topics in Stochastic Processes Bernoulli Soc./ISI Meeting, Dec.
1998-2001 Elected Member of IMS Council 1998-2001.
2001 Organizer of a session at the IMS Western Regional Meeting Vancouver, June, 2001.
2002 Member, NSF panel and workshop: The Role of Probability in Scientific and Mathematical Research: A Workshop in Current and Emerging Research Opportunities, June, 2002.

2004,2005 Member, NSF CMG panel.
2006 Member, NSF Probability Panel.

7. RESEARCH GUIDANCE: Ten students have completed Ph.D.s.

8. RESEARCH GRANTS: Nearly continuous support came from the NSF (DMS) since 1975. From 1968-1972 research support came from the U.S. Army Research division. In addition, nearly ten years of support came from the NSF division in Environmental Engineering.

9. PUBLICATIONS:

BOOKS:

Research Monographs:

1. Normal Approximation and Asymptotic Expansions, (with R. Ranga Rao) Wiley, New York (1976). Russian Edition (1982). Revised Reprint by Krieger, Florida (1986).
2. Asymptotic Statistics (with M. Denker), Birkhauser, DMV Lecture Series (May, 1990).
3. Random Dynamical Systems: Theory and Applications (with M. Majumdar). Cambridge Univ. Press. (2007)

Graduate Texts:

1. Stochastic Processes with Applications (with E. Waymire), Wiley (1990).
2. A Basic Course in Probability Theory (with E. Waymire). Springer. (2007).
3. Stochastic Processes: Theory and Applications (with E. Waymire). To appear in the Graduate Texts in Mathematics Series, Springer.

ARTICLES:

1968

1. Berry-Esseen bounds for the multidimensional central limit theorem, Bull. Amer. Math. Soc., 74, 285-287.

1970

2. Rates of weak convergence for multidimensional central limit theorems, Theor. Probab. Appl., 15, 68-86.

1971

3. Rates of weak convergence and asymptotic expansions in classical central limit theorems, Ann. Math.Statist., 42, 241-259.

1972

4. Speed of convergence of the n-fold convolution of a probability measure on a compact group, Z. Wahrscheinlichkeitstheorie Ver. Geb., 25, 1-10.
5. Recent results on refinements of the central limit theorem, Proc. Sixth Berkeley Symposium on Math. Stat. and Prob., 2, 453-484.

1973

6. Errors of normal approximation, Proc. International Conf. on Prob. Theory and Math. Statist., Vilnius, U.S.S.R., 117-119.
7. Random exchange economies, J. Econ. Theor, 6, 37-67 (with M. Majumdar).

1975

8. On errors of normal approximation, Ann. Probab., 3, 815-828.

1976

9. On the stochastic foundations of the theory of water flow through unsaturated soil, Water Res. Research, 12, 503-512 (joint with V.K. Gupta and G. Sposito).

1977

10. Refinements of the multidimensional central limit theorem and applications, *Ann. Probab.*, 7, 1-28. (Special invited paper).

1978

11. On the validity of the formal Edgeworth expansion, *Ann. Statist.*, 6, 434-451 (joint with J.K. Ghosh).

12. Criteria for recurrence and existence of invariant measures for multidimensional diffusions, *Ann. Probab.*, 6, 541-553.

1979

13. On a statistical theory of solute transport in porous media, *SIAM J. Appl. Math.*, 34, 485- 498 (joint with V.K. Gupta).

14. Foundational theories of solute transport in porous media: a critical review, *Advances in Water Res.*, 2, 59-68 (joint with V.K. Gupta and G. Sposito).

1980

15. On global stability of some stochastic economic processes: A synthesis. *Quantitative Economics and Development* (Ed. by L.R. Klein, M. Nerlove and R.C. Tsiang), 19-43, Academic Press, New York (with M. Majumdar).

1981 16. A molecular approach to the foundations of solute transport in porous media, I. Conservative solutes inhomogeneous, saturated media, *J. Hydrology*, 50, 355-370 (joint with V.K. Gupta and G. Sposito).
17. Asymptotic behavior of several dimensional difusions, *Nonlinear Stochastic Systems in Physics, Chemistry and Biology*, (Ed. by L. Arnold and R. Lefever), Springer-Verlag.

1982

18. Recurrence and ergodicity of diffusions, (with S. Ramasubramanian) *J. Mult. Analysis*, 12, 95-122.

19. On classical limit theorems for diffusions, *Sankhya* 44, Ser. A, 47-71.

20. On the functional central limit theorem and the law of the iterated logarithm for Markov processes, *Zeit. Wahr. Ver. Geb.* 60, 185-201.

1983

21. The Hurst effect under trend, (with V.K. Gupta and E. Waymire) *J. App. Prob.* 20, 649-662.

22. A new derivation of the Taylor-Aris theory of solute dispersion in a capillary, (with V.K. Gupta) *Water Res. Research*, 19(4), 945-951.

23. A theoretical explanation of solute dispersion in saturated porous media at the Darcy scale, *Water Res. Research*, 19(4), 938-944 (joint with V.K. Gupta).

24. On the order of magnitude of cumulants of von Mises functionals and related statistics, *Ann. Prob.*, 11(2), 346-354 (joint with M.L. Puri).

25. Fokker Planck equations, *Encyclopedia of Statistical Sciences*, Vol. 3 (ed. by S. Kotz and R. Johnson) Wiley, New York, (joint with C.M. Newman).

1984

26. Stochastic models in mathematical economics: A review, *Statistics: Applications and New Directions*, Proc. ISI Golden Jubilee Int. Conf. (ed. by J.K. Ghosh and G. Kalianpur), 55-99 (joint with M. Majumdar).

27. On the Taylor-Aris theory of solute transport in a capillary, *SIAM J. Appl. Math.* 44(1) (joint with V.K.Gupta).

1985

28. Some recent results on Cramer-Edgeworth expansions with applications, *Multivariate Analysis VI: Proceedings of the Sixth International Symposium on Multivariate Analysis*, (P.R. Krishnaiah, ed.), 57-75.

29. Asymptotic expansions and applications, Proc. Fourth Vilnius Conf. on Prob. and Math. Stat., Vilnius, USSR.

30. A central limit theorem for diffusions with periodic coefficients, *Ann. Probab.* 13, 385-396.

1986

31. Solute dispersion in multidimensional periodic porous media, *Water Res. Research*, 22(2), 156-164 (joint with V.K. Gupta).

1987 32. Some aspects of Edgeworth expansions in statistics and probability, *New Perspectives in Theoretical and Applied Statistics* (ed. by M. Puri, J. Villaplana and W. Wertz), Wiley, New York, 157-170.

1988 33. Central limit theorems for diffusions with almost periodic coeicients, *Sankhya* 50, 9-25 (joint with S.Ramasubramanian).

34. Asymptotics of a class of Markov processes which are not in general irreducible, *Ann. Probab.* 16, 1333-1347 (with O. Lee).

35. On moment conditions for valid formal Edgeworth expansions, *J. Mult. Analysis* 27, 68-79 (with J.K.Ghosh).

36. Ergodicity and the central limit theorem for a class of Markov Processes, *J. Mult. Analysis* 27, 80-90 (with O. Lee).

37. Convolution effect in the determination of compositional profiles and diffusion coefficients by microprobe step scans, *American Mineralogist*, 73, 901-909 (with J. Ganguly and S. Chakraborty).

1989

38. Asymptotics of solute dispersion in periodic porous media, *SIAM J. Appl. Math.*, 49, 86-98 (with V.K. Gupta and H.F. Walker).

39. Second order and Lpcomparisons between the bootstrap and empirical Edgeworth expansion methodologies, *Ann. Statist.*, 17, 160-169 (with M. Qumsiyeh).

40. Controlled semi-Markov models-the discounted case, *J. Stat. Plan. Inf.*, 21, 365-381 (with M.Majumdar).

41. Controlled semi-Markov models under long-run average rewards, *J. Stat. Plan. Inf.* 22, 223-242 (with M. Majumdar).

1990

42. Applications of central limit theorems to solute dispersion in saturated porous media: from kinetic to field scales (with V.K. Gupta), in *Dynamics of Fluids in Hierarchical Porous Media* (Ed. by J. Cushman),

Academic Press, 61-96.

1991

43. An extension of the classical method of images for the construction of reflecting diffusions (with E.C. Waymire), Proc. R.C. Bose Symp. on Prob., Math. Stat. and Design of Experiments, 155-164. Wiley (Eastern).

1992

44. Stability in distribution for a class of singular diffusions (with G. Basak). Ann. Probab., 20, 312-321.

45. Central limit theorems for diffusions: recent results, open problems and some applications (with S. Sen). Proc. I.I.M. Conf., Oxford Univ. Press.

46. A class of U-statistics and asymptotic normality of the number of k-clusters (with J.K. Ghosh). J. Multivariate Analysis 43, 300-330.

1993

47. The range of the infinitesimal generator of an ergodic diffusion (with G. Basak), in Statistics and Probability: A Raghu Raj Bahadur Festschrift (J.K. Ghosh. et al, editors), 73- 81. Wiley.

48. Random iterations of two quadratic maps (with B.V. Rao) in Stochastic Processes: A Festschrift for G. Kallianpur (S. Cambanis et al., editors), 13-22. Springer-Verlag.

49. Markov processes: asymptotic stability in distribution, central limit theorems, In: Probability and Statistics (S.K. Basu, B.K. Sinha, editors), Narosa Publishing House, New Delhi, 33-43.

1994

50. Proxy and instrumental variable methods in regression with one regressor missing. J. Mult. Analysis 47, 123-138 (joint with D.K. Bhattacharyya).

1995

51. Ergodicity of first order nonlinear autoregressive models, *J. Theor. Probab.* 8, 207219, (with C. Lee).
52. On geometric ergodicity of nonlinear autoregressive models, *Statistics and Probability Letters*, 311-315 (with C. Lee).
53. Methodology and applications. In: *Advances in Econometrics and Quantitative Economics*, 88-122. (G.S. Maddala and P.C.B. Phillips, eds.), Blackwell, Oxford, U.K. (with M.L. Puri).
54. Time scales for Gaussian approximation and its breakdown under a hierarchy of periodic spatial heterogeneities, *Bernoulli* 1, 81-123 (with F. Goetze).

1996

55. Comparisons of Chisquare, Edgeworth expansions and bootstrap approximations to the distributions of the frequency Chisquare, *Sankhya*, Ser. A 58, 57-68 (with N.H. Chan).
56. Asymptotics of iteration of i.i.d. symmetric stable processes, *Research Developments in Probability and Statistics Madan Puri Festschrift*, (E. Brunner and M. Denker, eds.), 3-10 (with B.V. Rao).

1997

57. A hierarchy of gaussian and non-gaussian asymptotics of a class of Fokker-Planck equations with multiple scales, *Nonlinear Analysis, Theory, Methods and Applications*, 30, No. 1, 257-263, *Proc. 2nd World Congress of Nonlinear Analysis*, Athens, Greece, Elsevier Science Ltd.
58. Central limit theorems for diffusions: recent results, open problems and some applications, *Probability and Its Applications* (M.C. Bhattacharjee and S.K. Basu, eds.), 16-31, Oxford Univ. Press (with S. Sen).
59. Phase changes with time for a class of diffusions with multiple periodic spatial scales, and applications, *Proc. 51st Session of the International Statistical Institute*, Istanbul, Turkey.

1999

60. Convergence to equilibrium of random dynamical systems generated by i.i.d. monotone maps with applications to economics. In: *Asymp-*

otics, Nonparametrics, and Time Series: Festschrift for M.L. Puri (S. Ghosh, Editor), 713-742, Marcel Dekker (New York) (with M. Majumdar).

61. Speed of convergence to equilibrium and normality for diffusions with multiple periodic scales, *Stochastic Processes and Applications*, 80, 55-86 (with M. Denker and A. Goswami).

62. Multiscale diffusion processes with periodic coefficients and an application to solute transport in porous media. (Special Invited Paper), *Annals of Applied Probability*, 9, 951- 1020.

63. On a theorem of Dubins and Freedman. *J. Theoretical Probab.* 12, 1165-1185. (with M. Majumdar).

2000

64. Estimating the probability mass of unobserved support in random sampling. *J. Statist Plan and Inf.*, 91-106 (with A. Almudevar and C.C. Sastri).

65. Random iteration of i.i.d. quadratic maps. In: *Stochastics in Finite and Infinite Dimensions: In Honor of G. Kallianpur* (T. Hida, R.L. Karandikar, H. Kunita, B.S. Rajput, S. Watanabe and J. Xiang, eds.), Birkhauser, 49-58 (with K.B. Athreya).

66. Stochastic equivalence of convex ordered distributions and applications. *Probability in Engineering and Informational Science*, vol. 14, 33-48 (with M.C. Bhattacharjee).

67. A class of random continued fractions with singular equilibria. In: *Perspectives in Statistical Sciences* (A.K. Basu, J.K. Ghosh, P.K. Sen and B.K. Sinha, eds.), Oxford University Press, 75-86 (with A. Goswami).

2001

68. On characterizing the probability of survival in a large competitive economy. *Review of Economic Design*, 6, 133-153 (with M. Majumdar).

69. On a class of stable random dynamical systems: Theory and applications. *J. Economic Theory*, 96, 208-229 (with M. Majumdar).

70. A note on the distribution of integrals of geometric Brownian mo-

tion. Stat. and Probab. Letters, 55, 187-192 (with E. Thomann and E.C. Waymire).

71. Iterated random maps and some classes of Markov processes. In: Handbook of Statistics, Vol. 19, (D.N. Shanbhag and C.R. Rao, eds.), Elsevier Science. 145-170 (with E.C. Waymire).

2002

72. Markov processes and their applications. In Handbook of Stochastic Analysis and Applications (D. Kannan and V. Lakshmikantham, eds.). Marcel Dekker. 1-46.

73. An approach to the existence of unique invariant probabilities for Markov processes. In Limit Theorems in Probability and Statistics I (I. Berkes, E. Csaki, M. Csorgo, eds.) Budapest. 181-200. (with E. C. Waymire).

74. Phase changes with time for a class of autonomous multiscale diffusions. Sankhya, Ser. A. 64 741-762. (Special Issue in memory of D. Basu).

2003

75. Large sample theory of intrinsic and extrinsic sample means on manifolds-I. Ann. Statist. 31 1-29. (with V. Patrangenaru).

76. Majorizing Kernels and stochastic cascades with applications to incompressible Navier-Stokes equations. Trans. Amer. Math. Soc. 355 5003-5040. (with L. Chen, S. Dobson, R.B. Guenther, C. Orum, M. Oslander, E. Thomann and E.C. Waymire).

2004

77. Random dynamical systems: a review. Econ. Theory. 23 13-38. (with M. Majumdar).

78. Stability in distribution of randomly perturbed quadratic maps as Markov processes. Ann. Appl. Probab. 14 1802-1809 (with M. Majumdar).

2005

79. Large sample theory of intrinsic and extrinsic sample means on manifolds-II. *Ann. Statist.* 1225-1259 (with V. Patrangenaru).
80. Semi-Markov Cascade Representations of Local Solutions to 3-D Incompressible Navier-Stokes equations (with L.Chen, S.Dobson, R.Guenther, C.Orum, M.Ossiander, E. Thomann, E.Waymire).(2005) In *Probability and Partial Differential Equations in Modern Applied Mathematics*, IMA vol.140 Springer, 27-40
81. Phase changes with time and multiscale homogenizations of a class anomalous diffusions (2005). In *Probability and partial differential equations in Modern Applied Mathematics*. IMA Vol. 140. Springer, 11-26

2006

82. Consistency and asymptotic normality of the estimated effective doses in bioassay. *J. Statist. Plan. Inf.* 643-658 (with M. Kong).