

JYOTIPRATIM RAY CHAUDHURI

Contacts

Office: 03453-255049, 03453-258434

Fax: , 03453-258434

Department of Physics

Katwa College (Under Burdwan University)

Katwa, Burdwan-713130; W. B.

Emails: jprc_8@yahoo.com

jyotipratim@gmail.com

Curriculum Vitae

Education

Ph. D. (Science)	Jadavpur University, India (IACS, Kolkata-32)
M. Sc. (Physics) (Special Paper: Particle Physics)	Visva Bharati
B. Sc. (Hons. In Physics)	University of Calcutta, India

Other examination qualified

CSIR NET 1991

GATE – 94 (Percentile 97.18)

Ph. D. Thesis

Title: **Studies of Nonequilibrium Stochastic Processes in Some Model Systems.**

Advisor: **Professor Deb Shankar Ray**

Department of Physical Chemistry

Indian Association for the Cultivation of Science (IACS)

Jadavpur, Kolkata 700032, India

Post Doctoral Fellowship

1. Postdoctoral work-with Professor Eli Pollak, Department of Chemical Physics, Weizmann Institute of Science, Israel, during September 2002 to March 2003, as Feinberg Graduate School Fellow
2. Awarded UGC post Doctoral Fellowship during 2009-2010.

Affiliation

Associate Professor (in Physics)
 Department of Physics, Katwa College
 Katwa, Burdwan-713130

Teaching Experience

Sl No	Institute/Organisation	Start Date	End Date	Designation	Type of work
a	Katwa College, Katwa, Burdwan	10/03/2000	09/03/2004	Lecturer	Undergraduate Physics Teaching (Both Hons. and general)
b	-do-	10/03/2004	09/03/2009	Senior Lecturer	-do-
c	-do-	10/03/2009	31/10/2012	Reader	-do-
d	-do-	01/11/2012	Till date	Associate Professor	-do-

News-Highlights

1. Our paper entitled "*Taming the escape dynamics of nonadiabatic time-periodically driven quantum dissipative system within the frame of Wigner formalism*" [*Chemical Physics* 431, 26 (2014) <http://dx.doi.org/10.1016/j.chemphys.2014.01.008>] was among the 10 MOST DOWNLOADED articles in March 2014.
2. Our paper "*Realization of a Brownian engine to study transport phenomena: A semiclassical approach*" [*Physical Review E* 81, 061112 (2010), doi:10.1103/PhysRevE.81.061112] has been cited as a "**RESEARCH HIGHLIGHT**" in *NATURE INDIA* [doi:10.1038/nindia.2010.87; Published online 30 June 2010]

3. We have contributed One Chapter in *“Recent Advances in Spectroscopy: Astrophysical, Theoretical and Experimental Perspective”*, published by Springer (Heidelberg, 2010).

Grants Support

1. CSIR (New Delhi, 2008-2011): Title **“Development and applications of theoretical models to study anisotropic diffusion and transport phenomena in some complex systems”** [01/2257/08/EMR-II dated 01.11.2008] **(Completed)**
2. (1).UGC-Minor Project (Kolkata, 2007-2009): Title of the Project **“Quantum dynamics of dissipative systems.”** **(Completed)**
3. (3) UGC-Minor Project (Kolkata, 2005-2007): Title of the Project **“Philosophical Consequences of Quantum Physics”** **(Completed)**
4. UGC (New Delhi, 2007-2009): Title **“Study of Dissipative Dynamics to Investigate the Transport Problem : Effects of Velocity Dependent Coupling”** [UGC-32-304/2006(SR)] **(Completed)**.

Ph. D. Students

1. **Dr. Satyabrata Bhattacharya** (Degree Awarded 2011, BESUS, Presently IEST Shibpur)
2. **Dr. Pradipta Ghosh** (Degree Awarded 2011, BESUS, Presently IEST Shibpur)
3. **Dr. Anindita Shit** (Degree Awarded 2013, BESUS, Presently IEST Shibpur)
4. **Ms. Poulomi Chatterjee** (Registered, IEST Shibpur)

Other relevant information

1. National Scholarship: For securing Rank 112 in Madhyamik Examination and Second Position in Murshidabad District.
2. National Scholarship for Higher Secondary result.
3. Summer visting Teacher Fellow (2006) of the Indian Academic of Sciences, Bangalore.
4. Fellow of Satyendra Nath Bose National Centre for Basic Sciences, Kolkata.

Teaching plan in brief

My primary aim in teaching is to bring onto fore the basic essence of the subject via thorough classroom teaching, using the most orthodox form of classroom lectures – chalk-and-talk. I personally trust this to be the best mode of teaching, especially for the beginners, since it ensures a complete process of learning by providing the student

ample space and time to the listener while the teacher works out the details on the board. In addition, the student also gets a scope to master the art of thinking from the scratch and the way to reach out to the audience. This in turn ensures a better and direct student-teacher interaction, which to some extent gets jeopardized in virtual classrooms, and teaching modes heavily relying on ornamental presentations. Theoretical Physics, by its inherent nature, is a mathematical subject and I trust that it should be understood mathematically at the first place. Mathematical issues, under the hood of a well-structured curriculum, needs to be dealt in a patient manner, allowing the students to have a feel that they are not learning mathematics for the sake of it, instead they have a greater goal to achieve, namely, to unravel the mysteries of nature. In addition, to help the students to have a better understanding, I would like to address the issues pertaining to the chronological evolution of the subject as a whole. My aim will be to inculcate among the students a true interest in the subject and motivate them further to pursue it in a fruitful manner, both academically and socially. I would prefer to address the more classical domains of Physics, like: (1) Mathematical Physics, (2) Classical Mechanics and Dynamical Systems, (3) Statistical Mechanics, and (4) Electrodynamics.

Doctoral research

1. Although in the treatment of classical theory of activated rate processes where the noise is of internal origin, one has a unique Boltzman distribution to characterize the equilibrium state, it is not always easy to describe the corresponding situation due to external stochastic driving by a unique steady state distribution (if the steady state is attainable at all). To address this and related questions, both in classical and quantum domain, we developed a phenomenological and a microscopic model for spectroscopic models and to study the escape rate from a metastable state. We analyzed the classical and quantum dynamics in the various range of dissipation and performed numerical simulation to support our theoretical predictions.
2. While the classical theory of activated rate processes is based on the differential equation for evolution of probability distribution function of a particle executing Brownian motion in a force field, quantum approach is based on path integral formulation which rely on the evolution of quantum partition function of the system interacting with environment. We posed the question whether there is any natural extension of the classical method to the quantum dynamics and demonstrated that Wigner-Leggett-Caldeira equation for Wigner probability phase space function which describes the quantum Brownian motion of the particle in a force field in a high temperature Ohmic limit may be interpreted as

a semi-classical Kramers' equation. This equation has been used to obtain the semi-classical correction to Kramers' rate (a slightly modified form of our equation has later been used by Coffey *et.al.* [W. T. Coffey, Yu. P. Kalmykov, S. V. Titov, and B. P. Mulligan, *J. Phys. A: Math. Theor.* **40**, F91 (2007); *ibid Phys. Chem. Chem. Phys.* **9**, 3361 (2007)] and Garcia-Palacios [Garcia-Palacios and D. Zueco, *J. Phys. A* **37**, 10735 (2009)].

Main Focus of Post-Ph. D. Research Work

1. Developed and applied the quantum theory of Brownian motion in presence of non-linear system-bath coupling, applicable for arbitrary strength of coupling. Such non-linear coupling appears in a variety of contexts as in superconducting tunnelling junctions etc. Its treatment allows calculating escape rate from meta-stable state.
2. Analysis of the interplay of noise and nonlinear dynamics under non-equilibrium conditions. One aspect involves directed motion in presence of non-linear system-bath coupling for ratchet type potential. Another one non-equilibrium transport due to the presence of two or more reservoirs at different temperatures.
3. Tried to understand the underlying mechanisms of molecular motors and to realize and construct new nano-electronic devices.
4. Examination of stochastic dynamics both in classical and quantum regime when the system and/or the bath are externally driven by time dependent force.
5. Investigation of quantum Langevin and Smoluchowski equations in terms of an effective time-independent Hamiltonian in the presence of a rapidly oscillating field by invoking multiple time scale analysis. Applications of our methodology range from the Paul trap to controlling particle bunching and dilution in particle accelerators. This methodology may be relevant for the manipulation of cold atoms and for the suppression of photo-ionization by electromagnetic fields.

Research Interest and Future Plan

The focus of our research is the investigation of small systems. The properties of objects at the nanoscale are dominated by quantum effects and by thermal fluctuations. They are moreover strongly influenced by the coupling to external environments. The precise understanding of the dynamical effects induced by such a coupling is of central importance in most branches of physics, most prominently quantum optics, solid state physics and nonequilibrium statistical physics. The interaction with the environment

can either *perturb* the evolution of the nanosystem and should therefore be minimized as much as possible - or on the contrary can be used as a powerful tool to *control* its dynamics. Here is a list of major environment-induced effects (classical and/or quantum-mechanical) which belongs to our research area:

- **Diffusion and Fluctuation phenomena**
- **Relaxation and Dissipation processes**
- **Noise-induced transport (Barrier dynamics, Brownian motors, Ratchet effect)**
- **Nano-thermodynamics (Quantum heat engine)**

The study of these various phenomena becomes particularly rich and challenging when system and/or environment are nonlinear or in some sense complex. We would like to develop and implement theoretical tools to treat these different problems, including classical and quantum stochastic theories as well as path integral approach to name a few.

List of School, Seminar, Workshop etc. attended:

1. 46-th Orientation Programme Conducted by UGC Academic Staff College, The University of Burdwan, from 2nd January, 2004 to 29th January, 2004. Obtained Grade A.
2. Visitor Programme, Department of Physics, IIT-Kanpur, during October 10 to November 07, 2005.
3. Workshop- 'PHYSICS 2005', Conducted by Department of Physics, IIT- Kanpur, during 03-06 November, 2005 and delivered a lecture entitled, 'Wigner Distribution : A Semiclassical Approach to Kramers' Problem.
4. All India Refresher Course in 'APPLIED STOCHASTIC PROCESSES', Organized by Indian Academy of Sciences, Bangalore, at Indian Statistical Institute, New Delhi, during 5th December 2005 to 17th December 2005.
5. Four week Refresher Course in Physics, conducted by UGC Academic Staff College, Jawaharlal Nehru University, New Delhi, during January 30 to February 24, 2006. Obtained Grade A.
6. 13th State Science and Technology Congress (28th February-1st March, 2006) and delivered a lecture on 'Semiclassical Approach to Kramers' Problem'.

7. International Workshop on 'Common Trends In Traffic Systems: Physical and Computational Models in Transportation Engineering and Biological Science', held at IIT-Kanpur, during 8th February to 10th February, 2006.
8. Third SERC Scholl on 'Nonlinear Dynamics', Sponsored by Department of Science an Technology, Govt. of India, during 4th December to 23rd December 2006, at IACS, Kolkata.
9. National Seminar on 'Indian Scientific Heritage; Aryabhatta to Harish Chandra', Organized by Ramakrishna Mission Vivekananda University, Belur Math, Howrah, on 23 and 24 February, 2007.
10. 8th Refresher Course in Physics, from 10th March-2007 to 30th March 2007, Conducted by UGC Academic Staff College, The University of Burdwan. Obtained Grade A.
11. National Symposium on Quantum Chemistry, Soft Computing & Optimization (April 04-05, 2008), at IACS, Kolkata.
12. Participated and delivered a contributory talk at the International Conference on 'Recent Advances of Spectroscopy', held at Kodaikanal, during January 28th-31st, 2009, organized by Indian Institute of Astrophysics, Bangalore.
13. Participated and Presented a Poster in the CRSI (Kolkata Chapter) Symposium-viii on 'Advances in Chemical Research', held on August 06, 2010, organized by Department of Chemistry, BESUS.
14. Participated and presented a poster in National seminar on "recent advances in Selected Topics of Chemistry-II", held on March 24-25, 2011, organized by Department of Chemistry, BESUS.

List of Publications

(A) Before Ph. D. Degree

1. Quantum theory of dissipation of a harmonic oscillator coupled to a nonequilibrium bath; Wigner-Weisskopf decay and physical spectra, **J. Ray Chaudhuri**, B.DeB,G.Gangopadhyay and D. S. Ray, *J. Phys. B* **31**, 3859 (1998) .

URL: <http://iopscience.iop.org/0953-4075/31/17/011>

2. Theory of nonstationary activated rate processes: Nonexponential kinetics, **J. Ray Chaudhuri**, G. Gangopadhyay and D. S. Ray, *J. Chem. Phys.* **109**, 5565 (1998).
URL: http://jcp.aip.org/resource/1/jcpsa6/v109/i13/p5565_s1?isAuthorized=no
3. Theory of adiabatic fluctuations: third-order noise, S. K. Banik, **J. Ray Chaudhuri** and D. S. Ray, *J. Phys. A* **31**, 7301 (1998).
URL: <http://iopscience.iop.org/0305-4470/31/36/005>
4. Modified Bloch equations in the presence of a nonstationary bath, **J. Ray Chaudhuri**, S. K. Banik, B. Deb and D. S. Ray, *Euro. Phys. J. D* **6**, 415 (1999).
URL: <http://www.springerlink.com/content/ybuequxd60f71j1j/>
5. A simple semiclassical approach to the Kramers' problem, **J. Ray Chaudhuri**, B. C. Bag and D. S. Ray, *J. Chem Phys.* **111**, 10852 (1999).
URL: http://jcp.aip.org/resource/1/jcpsa6/v111/i24/p10852_s1?isAuthorized=no
6. A semiclassical theory of quantum noise in open chaotic systems, B. C. Bag, S. Chaudhuri, **J. Ray Chaudhuri** and D. S. Ray, *Physica D*, **125**, 47 (1999).
URL: <http://www.sciencedirect.com/science/article/pii/S016727899800236X>
7. Adiabatic noise induced escape rate for nonequilibrium open systems, S. K. Banik, **J. Ray Chaudhuri** and D. S. Ray, *Indian J. Chem.* **39A**, 300 (2000). [Invited]
8. The generalized Kramers' theory for nonequilibrium open one-dimensional systems, S. K. Banik, **J. Ray Chaudhuri** and D. S. Ray, *J. Chem. Phys.* **112**, 8330 (2000).
URL: http://jcp.aip.org/resource/1/jcpsa6/v112/i19/p8330_s1?isAuthorized=no
9. Chaos and information entropy production, B. C. Bag, **J. Ray Chaudhuri** and D. S. Ray, *J. Phys. A* **33**, 8331 (2000).
URL: <http://iopscience.iop.org/0305-4470/33/47/301>
10. Analytical and numerical investigation of escape rate for an external noise driven bath, **J. Ray Chaudhuri**, S. K. Banik, B. C. Bag and D. S. Ray, *Phys. Rev. E* **63**, 61111 (2001).
URL: <http://pre.aps.org/abstract/PRE/v63/i6/e061111>

(B) After Ph. D. Degree

11. Escape rate from a metastable state weakly interacting with a heat bath driven by external noise, **J. Ray Chaudhuri**, D. Barik and S. K. Banik, *Phys Rev. E* **73**, 051101 (2006).
URL: <http://pre.aps.org/abstract/PRE/v73/i5/e051101>

12. Dynamics of a metastable state nonlinearly coupled to a heat bath driven by external noise, **J. Ray Chaudhuri**, D. Barik and S. K. Banik, *Phys Rev E*. **74**, 061119 (2006).
URL: <http://pre.aps.org/abstract/PRE/v74/i6/e061119>
13. Generalization of the escape rate from a metastable state driven by external cross-correlated noise processes **J. Ray Chaudhuri**, S. Chattopadhyay and S. K. Banik, *Phys. Rev. E*. **76**, 021125 (2007).
URL: <http://pre.aps.org/abstract/PRE/v76/i2/e021125>
14. Simple model for transport phenomena: Microscopic construction of Maxwell Demon like engine **J. Ray Chaudhuri**, S. Chattopadhyay and S. K. Banik, *J. Chem. Phys.* **127**, 224508 (2007).
URL:
http://jcp.aip.org/resource/1/jcpsa6/v127/i22/p224508_s1?isAuthorized=no
15. Directed motion generated by heat bath nonlinearly driven by external noise, **J. Ray Chaudhuri**, D. Barik and S. K. Banik, *J. Phys. A: Math. Theor.* **40**, 14715 (2007).
URL: <http://iopscience.iop.org/1751-8121/40/49/007>
16. Nonequilibrium fluctuation induced escape from a metastable state, **J. Ray Chaudhuri**, D. Barik and S. K. Banik, *Eur. Phys. J. B*. **55**, 333 (2007).
URL: <http://www.springerlink.com/content/53n600xgr1774814/>
17. The quantum rate of escape from a metastable state non-linearly coupled to a heat bath driven by external colored noise , P. Ghosh and **J. Ray Chaudhuri**, *J. Stat. Mech.: Theory and Experiment* doi:10.1088/1742-5468/2008/02/P02014.
URL: <http://iopscience.iop.org/1742-5468/2008/02/P02014>
18. State-dependent diffusion in a periodic potential for a nonequilibrium open system, **J. R. Chaudhuri** and D. Barik, *Eur. Phys. J. B* **63**, 117 (2008).
URL: <http://www.springerlink.com/content/x1013m20t6h35316/>
19. Multiplicative cross-correlated noise induced escape rate from a metastable state, **J. Ray Chaudhuri**, S. Chattopadhyay and S. K. Banik, *J. Chem. Phys.* **128**, 154513 (2008).
URL: http://jcp.aip.org/resource/1/jcpsa6/v128/i15/p154513_s1?isAuthorized=no
20. Time dependent current in a nonstationary environment: A microscopic approach, S. Bhattacharya, S. K. Banik, S. Chattopadhyay and **J. Ray Chaudhuri**, *J. Math. Phys.* **49**, 063302 (2008).
URL: http://jmp.aip.org/resource/1/jmapaq/v49/i6/p063302_s1?isAuthorized=no

21. Directed motion in a periodic potential of a quantum system coupled to a heat bath driven by a colored noise, S. Bhattacharya, P. Chaudhuri, S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Rev. E* **78**, 021123 (2008).
URL: <http://pre.aps.org/abstract/PRE/v78/i2/e021123>
22. Self consistent microscopic theory of frictional ratchet in a nonequilibrium environment, **J. Ray Chaudhuri** and D. Barik, *Indian J. Phys.* **82**, 1577 (2008).
23. Phase induced current in presence of non-equilibrium bath: A quantum approach, S. Bhattacharya, P. Chaudhuri, S. Chattopadhyay and **J. Ray Chaudhuri**, *J. Chem. Phys.* **129**, 124708 (2008).
URL: http://jcp.aip.org/resource/1/jcpsa6/v129/i12/p124708_s1?isAuthorized=no
24. Effect of correlated noises on directed motion, P. Chaudhuri, B. Mukherjee, S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Chem. Chem. Phys.* **10**, 6097 (2008).
URL: <http://pubs.rsc.org/en/content/articlepdf/2008/CP/B808703B>
25. Transport and bistable kinetics of a Brownian particle in a nonequilibrium environment, **J. Ray Chaudhuri**, S. K. Banik, S. Chattopadhyay and P. Chaudhuri, *J. Math. Phys.* **49**, 113303 (2008).
URL: http://jmp.aip.org/resource/1/jmapaq/v49/i11/p113303_s1?isAuthorized=no
26. Harmonic Oscillator in Presence of Non-equilibrium Environment **J. Ray Chaudhuri**, P. Chaudhuri and S. Chattopadhyay *J. Chem. Phys.* **130**, 234109 (2009).
URL: http://jcp.aip.org/resource/1/jcpsa6/v130/i23/p234109_s1?isAuthorized=no
27. Investigation of noise- induced escape rate: A quantum mechanical approach, S. Bhattacharya, S. Chattopadhyay and **J. Ray Chaudhuri**, *J. Stat. Phys.* **136**, 733 (2009).
URL: <http://www.springerlink.com/content/h051800688328762/>
28. Microscopic realization of Kubo Oscillator, **J. Ray Chaudhuri** and S. Chattopadhyay *Chem. Phys. Lett.*, **480**, 140 (2009).
URL: <http://www.sciencedirect.com/science/article/pii/S0009261409010495>
29. Quantum transport in a periodic symmetric potential of a driven quantum system, S. Bhattacharya, P. Chaudhuri, S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Rev. E* **80**, 041127 (2009).
URL: <http://pre.aps.org/abstract/PRE/v80/i4/e041127>
30. Kubo Oscillator and its Application to Stochastic Resonance: a Microscopic Realization" in "Recent Advances in Spectroscopy: Astrophysical, Theoretical and Experimental Perspective", **J. Ray Chaudhuri** and S. Chattopadhyay (Springer, 2010).
URL: <http://www.springerlink.com/content/r5000605m23620pr/>

31. Stochastic resonance in a microscopically realized quantum linear system, P. Ghosh., S. Chattopadhyay and **J. Ray Chaudhuri**, *J. Phys. Chem. B.* 114, 1368 (2010).
URL: <http://pubs.acs.org/doi/abs/10.1021/jp909858c>
32. Generalized Einstein relation in tilted periodic potential: A Quantum mechanical approach, A. Shit, S. Chattopadhyay, S. K. Banik, **J. Ray Chaudhuri**, *J. Phys. Chem. B.* 114, 7854 (2010).
URL: <http://pubs.acs.org/doi/abs/10.1021/jp912069k>
33. Escape of a driven particle from a metastable state: A semiclassical approach, P. Ghosh. A. Shit, S. Chattopadhyay and **J. Ray Chaudhuri**, *J. Chem. Phys.* 132, 244506 (2010).
URL: http://jcp.aip.org/resource/1/jcpsa6/v132/i24/p244506_s1?isAuthorized=no
34. Realization of a Brownian engine to study transport phenomena: A semiclassical approach, P. Ghosh., A. Shit, S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Rev. E* 81, 061112 (2010).
URL: <http://pre.aps.org/abstract/PRE/v81/i6/e061112>
35. Microscopic realization of cross-correlated noise processes, A. Shit, S. Chattopadhyay and **J. Ray Chaudhuri**, *Chaos* 20, 023130 (2010).
URL: http://chaos.aip.org/resource/1/chaoeh/v20/i2/p023130_s1?isAuthorized=no
36. External noise driven bath and the generalized semiclassical Kramers theory, P. Ghosh., A. Shit, S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Rev. E* 82, 041113 (2010).
URL: <http://pre.aps.org/abstract/PRE/v82/i4/e041113>
37. A microscopic model for noise induced transport: Heat bath nonlinearly driven by external white noise, P. Ghosh., A. Shit, S. Chattopadhyay and **J. Ray Chaudhuri**, *Chaos* 21, 013117 (2011).
URL: http://chaos.aip.org/resource/1/chaoeh/v21/i1/p013117_s1?isAuthorized=no
38. Development of a quantum mechanical approach to compute mobility and diffusion coefficient of Brownian particle in a nonequilibrium environment, A. Shit, P. Ghosh., S. Chattopadhyay and **J. Ray Chaudhuri**, *Phys. Rev. E.* 83, 031125, (2011).
URL: <http://pre.aps.org/abstract/PRE/v83/i3/e031125>
39. A semi-classical approach to study multiplicative noise induced rate processes from a metastable state, A. Shit, S. Bhattacharya, S. Chattopadhyay and **J. Ray Chaudhuri**, *Physica A* 390, 2880 (2011).
URL: <http://www.sciencedirect.com/science/article/pii/S0378437111002433>

40. A semiclassical approach to explore the bistable kinetics of a Brownian particle in a nonequilibrium environment, P. Ghosh., A. Shit, S. Chattopadhyay and J. Ray Chaudhuri, *J. Stat. Mech.* P02026 (2011) doi:10.1088/1742-5468/2011/02/P02026.
URL:<http://iopscience.iop.org/1742-5468/2011/02/P02026;jsessionid=D13E6E99FDB0B6507BF8FB28465B88A9.c1>
41. Towards an understanding of escape rate and state dependent diffusion for a quantum dissipative system, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Chem. Phys.* **386**, 56 (2011).
URL: <http://www.sciencedirect.com/science/article/pii/S0301010411002400>
42. Effective quantum Brownian dynamics in presence of a rapidly oscillating space-dependent time-periodic field, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Phys. Rev. E (Rapid Communication)* **83**, 060101(R) (2011).
URL: <http://pre.aps.org/abstract/PRE/v83/i6/e060101>
43. Phase induced transport of a quantum Brownian particle in a periodic potential in the presence of an external noise, S. Bhattacharya, S. Chattopadhyay, P. Chaudhuri, and J. Ray Chaudhuri, *J. Math. Phys.* **42**, 073302 (2011).
URL: http://jmp.aip.org/resource/1/jmapaq/v52/i7/p073302_s1?isAuthorized=no
44. Enhancement of transport properties of a Brownian particle due to quantum effects: Smoluchowski limit, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Chem. Phys.* **397**, 48 (2012).
URL: <http://www.sciencedirect.com/science/article/pii/S0301010411005593>
45. Quantum escape in the presence of a time-periodic oscillating force, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Europhys Letters* **97**, 40006 (2012) .
URL: <http://iopscience.iop.org/0295-5075/97/4/40006>
46. Time-independent description of rapidly driven systems in the presence of friction: Multiple scale perturbation approach, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Chaos* **22**, 013131 (2012).
URL: http://chaos.aip.org/resource/1/chaoeh/v22/i1/p013131_s1?isAuthorized=no
47. Escape rate for a quantum particle moving in time periodic rapidly oscillating potential: A time independent approach, A. Shit, S. Chattopadhyay, and J. Ray Chaudhuri, *Phys. Rev. E.* **85**, 051102 (2012).
URL: <http://pre.aps.org/abstract/PRE/v85/i5/e051102>
48. Enhancement of current commensurate with mutual noise-noise correlation in a symmetric periodic substrate: The benefits of noise and nonlinearity, P. Ghosh, S. Chattopadhyay, and J. Ray Chaudhuri, *Chem. Phys.* **402**, 48 (2012).
URL: <http://www.sciencedirect.com/science/article/pii/S0301010412001516?v=s5>

49. Controlling activated processes of nonadiabatically, periodically driven dynamical systems: A multiple scale perturbation approach, A. Shit, Chattopadhyay, S. and **J. Ray Chaudhuri**, (2012) *J. Chem. Phys* **136**, 234506 (2012).
URL: http://jcp.aip.org/resource/1/jcpsa6/v136/i23/p234506_s1
50. Kramers' turnover in class of thermodynamically open systems: Effect of interplay of nonlinearity and noises, A. Shit, S. Chattopadhyay, and **J. Ray Chaudhuri**, (2012) *Chem. Phys. Lett.* **543**, 173 (2012).
URL: <http://www.sciencedirect.com/science/article/pii/S0009261412007105>
51. Kapitza-Landau time window for a periodically driven system with friction: A system-bath Hamiltonian approach, A. Shit, S. Chattopadhyay, and **J. Ray Chaudhuri**, *Eur. Phys. J. B* **86**, 23 (2013).
URL: <http://epjb.epj.org/articles/epjb/abs/2013/01/b120852/b120852.html>
52. Quantum stochastic dynamics in presence of a time-periodic rapidly oscillating potential: Nonadiabatic escape rate, A. Shit, S. Chattopadhyay, and **J. Ray Chaudhuri**, *J. Phys. Chem. A* **117**, 8576 (2013). *Invited Article in Special Issue: "Structure and Dynamics: ESDMC-2013"*.
URL: <http://pubs.acs.org/doi/pdf/10.1021/jp402565y>
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