Curriculum Vitae

Name	Ramandeep S. Johal
Citizenship	Indian
Date of Birth	December 6, 1969
Marital Status	Married
Present Position	Lecturer in Physics Post-graduate Department of Physics Lyallpur Khalsa College Jalandhar -144001, India
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EDUCATION

PhD Department of Physics, Panjab University, Chandigarh, India, 1999.
Thesis Title: *Complex-q deformed algebras of quantum groups $SU_q(2)$ and $SU_q(1,1)$ and related studies with applications*
Supervisor: Prof. Dr. Raj K. Gupta.
Examiner I: Prof. Dr. W. Scheid,
Institute for Theoretical Physics, Giessen, Germany.
Examiner II: Prof. Dr. R. Jagannathan,
Institute of Mathematical Sciences, Chennai, India.

MSc Honours School, Department of Physics, Guru Nanak Dev University, Amritsar, India, 1993. **Marks: 66.3%**
Dissertation : *The inverse scattering transform technique*
Advisor: Prof. Dr. Tarsem Singh Gill.

FELLOWSHIPS/AWARDS

1. Post-doctoral fellowship (2002-2003) of the Spanish Ministry of Education, at Department d'Estructura i Constituents de la Materia, Facultat de Fisica, Universitat de Barcelona, Catalunya, Spain
Scientific Hosts: Prof. Dr. Antoni Planes and Dr. Eduard Vives.

2. Alexander von Humboldt post-doctoral fellow (2001-2002) at the Institute for Theoretical Physics, Technical University Dresden, Germany.
   Scientific Hosts: Prof. Dr. Gerhard Soff and Dr. Martin Greiner.

3. Research associate in Department of Science and Technology (DST) project with Prof. Dr. K.N. Pathak at the Physics Department, Panjab University, Chandigarh (2000).

4. Senior Research Fellowship of the Council for Scientific and Industrial Research (CSIR), India (1996).

5. Junior Research Fellowship of the CSIR, India (1994).

6. Junior Research Fellowship of the Graduate Aptitude Test for Engineering 1993 (a national level test), Subject: Physics; **percentile score: 96.25**.

7. Young Scientist Award-1989, from the Centre for Promotion of Science, Guru Nanak Dev University, Amritsar. (*The award, instituted by the Third World Academy of Sciences (TWAS), Italy, is given each year to a candidate in recognition of his/her potential for scientific research.*)

TEACHING EXPERIENCE

1. Lecturer in Physics at Post-graduate Department of Physics, Lyallpur Khalsa College, Jalandhar (2004-); teaching Quantum Mechanics to M.Sc. (part I) class; Statistical Mechanics to M.Sc. (part II).

2. Lecturer in Physics at D.A.V. College, Jalandhar, India, for the session 2000-2001; taught Quantum Mechanics and Quantum Field Theory to M.Sc. (part II), Solid State Physics to B.Sc. (part III).

3. Lecturer in Physics and Materials Science, SUS College of Engineering and Technology, Mohali, India, for the session 1998-1999; taught courses on Physics and Materials Science to the first and second semester students of B.Tech. classes.

4. Short term teaching assistantships at Punjab Engineering College, Chandigarh, (1996); conducted laboratory experiments to first year Engineering students.

5. Teaching assistantship at the Physics department, Panjab University (1997); taught a part of the subsidiary course on Optics to students of B.Sc.(Hons. School) class.

CONFERENCES/VISITS/TALKS

1. Contributed talk at International Conference “News and Expectations in Thermostatistics - Sigma Phi-2005”, Crete, Greece, August 13-18, 2005.
   Title: *Nonadditivity in systems with long range interactions.*

2. Participation in the 9th National discussion meeting on ”Aspects of Quantum Mechanics”, Jan. 3-7, 2005, Varadanahalli, Bangalore.

3. Poster presentation at Statphys-22, Indian Institute of Science, Bangalore, July 4-9, 2004.
   Title: *Statistical mechanics in extended gaussian ensemble.*

4. Participated in International Workshop on ”Mathematics and Physics of Complex and Nonlinear Systems, at Indian Institute of Technology, Kanpur, March 14-26, 2004.

5. Talk at Department ECM, University of Barcelona, June 2002.
   Title: *Generalized entropies and thermodynamic equilibrium.*

6. Poster presentation at the International Conference ”Dynamic Days - 2001”, Max Planck Institute for Physics of Complex Systems (MPIPKS), Dresden.
   Title: *q-deformed algebra and the Tsallis entropy.*

7. Talk given at MPIPKS, Dresden, March 2002.
   Title: *Tsallis statistical mechanics: an approach based on the generalised bit cumulants.*

8. Talk given at the Institute of Theoretical Physics, Technical University, Dresden, Oct. 2001.
   Title: *Quantum dynamics with the unitary phase operator.*

9. Talk given at the School of Physical Sciences, Jawaharlal Nehru University, New Delhi, Feb. 2000, as part of a brief research stay in the **Nonlinear Dynamics group** of Prof. R. Ramaswamy.
   Title: *Applications of the Tsallis statistical mechanics*

10. Participated in the SERC school on **Field Theories in Condensed Matter Physics**, at Harish Chandra Institute, Allahabad, Feb. 2000.

11. Talk given at the Physics Department, Indian Institute of Technology, Kanpur, Aug. 1999.
    Title: *q-calculus and the nonextensive statistical physics.*

12. Participated in the **International Workshop on Special Functions and Differential Equations** - Institute of Mathematical Sciences, Chennai, 13-24 Jan. 1997.

13. Poster presentation at the International Nuclear Physics Symposium, INPS-1995, at the Bhabha Atomic Research Centre, Trombey.
    Title: $SU_q(2)$ *algebra and the rotational spectra in superdeformed nuclei* .

14. Invited talk given at the 2nd DAE Workshop on Nuclear Structure Physics, Roorkee, India, Feb. 1995.
    Title: *Quantum group* $SU_q(2)$ *and the complex-q deformed harmonic oscillator.*

15. Participated in the Summer School-1992 at Raman Research Institute, Bangalore.
    Review Study: *Fractional statistics.*
    Advisor: Prof. Joseph Samuel.

RESEARCH INTERESTS

My broad current research interests are

1. Statistical physics
2. Long-range interacting systems
3. Dynamical systems
4. Fundamentals of Quantum Theory and Quantum Information

OTHER INTERESTS/HOBBIES

- Writing about science; about 20 articles and book reviews published in The Tribune, a daily from Chandigarh.
- (Still) photography

REFEREE FOR:

- Physica A
- Physical Review E

Summary of research contributions:

1. Statistical physics

A part of my work is concerned with the definition of entropy and the consequences of its generalization. Generalised entropies or information measures appear to be useful for giving an effective description of complex properties of finite systems or when there is incomplete information about the system. A major question is whether one can extend thermodynamic formalism using generalized entropic functionals. In recent years, a particular generalization of the Gibbs-Boltzmann entropy has attracted much attention. The so called nonextensive statistical mechanics is based on a non-logarithmic entropy, dependent on a real parameter q. I could gave a unified view of the connection between Tsallis entropy, multifractals and q-deformation theory (Phys. Rev. E **58** (1998) 4147; Phys. Lett. A **253** (1999) 47).

The standard thermodynamic framework for multifractals is based on Boltzmann-Gibbs formalism. We have developed a new formalism for multifractals based on Tsallis statistics. Particularly, it has been shown that in the thermodynamic limit or as the partition size vanishes, the extensive limit ($q \to 1$) is obtained. (Physica A **282** (2000) 525, with R. Rai).

The statistics of the bit number is a useful tool to characterise complex probability distributions. We have generalized the notion of bit moments and bit cumulants within a nonadditive framework. A formal basis has been given to these quantities based on the generators of the discrete calculus. This gives a different insight into the relation between Tsallis and Renyi entropies (Physica A **294** (2001) 436, with R. Rai; Phys. Lett. A **294** (2002) 292).

I have discussed the transformation of the thermodynamic formalism based on the nonadditve entropy to the one based on the additive entropy, using the zeroth law of thermodynamics (preprint cond-mat/0207268). This work has been extended and the relation between an additive entropy and a general composable entropy, has also been discussed (Phys. Lett. A **318** (2003) 48).

Recently, we have developed a statistical mechanical framework to treat systems in diathermal contact with a finite heat reservoir (Phys. Rev. E **68** (2003) 56113). Generalised thermodynamic relations have been derived and the effects of finite bath properties have been studied on prototype physical models such as a few-spins system in constant external magnetic field. Possiblity of first-order phase transitions have been pointed out in finite systems and the generalized distributions have been compared with q-exponential distributions.

2. Quantum theory

Phase angle and a component of the angular momentum form a pair of conjugate variables. When the angular momentum eigenvalues are unbounded, one can use a continuous real valued phase variable. By analogy with classical mechanics, the continuous time derivative of the phase change is expected to give a quantity such as angular velocity. But for a finite dimensional space of the angular momentum, the phase operator acquires discrete eigenvalues. Thus the notion of angular velocity becomes nontrivial in a finite dimensional space. I have established the correct notion for the angular velocity in this case, by carefully invoking the notion of quantum-classical correspondence (Phys. Lett. A **263** (1999) 62).

In 1950, Wigner published an interesting problem: Do the commutation relations between operators determine the equations of motion ? Actually, there is an ambiguity concerning the choice of commutation relations for different operators which obey the same equations of motion. The problem has been discussed for the harmonic oscillator in infinite dimensional space and also for the angular momentum algebra. For the case of a magnetic dipole spinning in an external magnetic field, it has been argued that the usual angular momentum operators as well as certain classes of deformed angular momentum operators satisfying other commutation relations, all obey the same equations of motion. However, for the finite dimensional representations of the angular momentum operators, there is a simple explanation for this ambiguity. Then the equations of motion are not determined by the angular momentum operators but by the unitary phase operator, which remains invariant under continuous deformations of the angular momentum operators (Phys. Lett. A **292** (2002) 238).

3. q-deformed algebras and applications

For my Ph.D, I studied generalizations of the q-deformed $SU(2)$ and $SU(1,1)$ algebras for complex values of the deformation parameter q. Under the dynamical symmetry approach, the algebras so obtained were applied for a phenomenological modelling of the vibrational spectra in diatomic molecules (Mod. Phys. Lett. A **11** (1996) 2715, with R.K. Gupta and I. L. Cooper) and the rotational spectra in superdeformed nuclei (J. Phys. G: Nucl. Part. Phys. **25** (1999) L43, with R. K. Gupta). Other applications are (i) casting the definition of nonextensive entropy in q-calculus framework, (ii) using different deformations of the $SU(2)$ algebra to illustrate the Wigner problem in quantum dynamics and (iii) proposing a q-deformed dynamics as a simple model to describe diffraction effects in the critical currents of rectangular Josephson junctions (Mod. Phys. Lett. B **14** (2000) 961).

LIST OF RESEARCH PUBLICATIONS:

Statistical Physics

1. *Composable entropy and deviation from macroscopic equilibrium*,
   R.S. Johal, Phys. Lett. A **332** (2004) 345-349.

2. *Statistical mechanics in the extended gaussian ensemble*,
   R.S. Johal, Antoni Planes and Eduard Vives, Phys. Rev. E **68** (2003) 56113.

3. *Renyi versus Tsallis entropies for systems with q-exponential behaviour: the case of dissipative maps*,
   R.S. Johal and U. Tirnakli, Physica A **331** (2004) 487.

4. *Additive entropy underlying the generalized composable entropy precribed by meta-equilibrium*,
   R.S. Johal, Phys. Lett. A **318** (2003) 48-52.

5. *Generalized bit-moments and cumulants based on discrete derivative*,
   R.S. Johal, Phys. Lett. A **294** (2002) 292-296.

6. *Generalized bit cumulants in nonextensive thermodynamics*,
   R. Rai and **R.S. Johal**, Physica A **294** (2001) 436-445.

7. *Nonextensive thermodynamic formalism for chaotic dynamical systems*,
   R.S. Johal and R. Rai, Physica A **282** (2000) 525-535.

8. *Modified exponential function: connection between nonextensivity and q-deformation*,
   R.S. Johal, Phys. Lett. A. **258** (1999) 15-17.

9. *Tsallis entropy and q-analogue of information*,
   R.S. Johal, Phys. Lett. A **253** (1999) 47-49.

10. *q-calculus and entropy in nonextensive statistical physics*,
    R.S. Johal, Phys. Rev. E **58** (1998) 4147-4151.

Quantum Mechanics

1. *Dynamics with unitary phase operator: implications for Wigner's problem*,
   R.S. Johal, Phys. Lett. A **292** (2002) 238-242.

2. *q-deformed dynamics of Josephson junction*,
   R. S Johal, Mod. Phys. Lett. B **14** (2000) 961-966.

3. *Classical-quantum correspondence and angular velocity in Barnett-Pegg formalism*,
R.S. Johal, Phys. Lett. A **263** (1999) 62-64.

4. *A comment on Planck distribution of complex-q boson gas*,
R.S. Johal and R.K. Gupta - Mod. Phys. Lett. A **13** (1998) 1729-1735.

q-Deformed Algebras and Applications

1. *Quantum group $SU_q(1,1)$ for complex-q deformation*,
R.S. Johal and R.K. Gupta, Mod. Phys. Lett. A **14** (1999) 2211-2214.

2. $SU_q(2)$ *and superdeformed bands in nuclei*,
R.S. Johal and R.K. Gupta, J. Phys. G: Nucl. Part. Phys. **25** (1999) L43-L46.

3. *Squeezed states and 2-parameter quantum groups*,
V. Sahai, **R.S. Johal** and R.K. Gupta, Mod. Phys. Lett. A **13** (1998) 887-891.

4. *On the classical limit of the generalized q-deformed $SU_q(2)$ and $SU_q(1,1)$ algebras*,
R.S. Johal, V. Sahai and R.K. Gupta, Mod. Phys. Lett. A **13** (1998) 91-98.

5. *Two parameter quantum deformation of $U(2) \supset U(1)$ dynamical symmetry and the vibrational spectra of diatomic molecules*,
R.S. Johal and R.K. Gupta, Int. J. Mod. Phys. E **7** (1998) 553-557.

6. $U_q(2) \supset U_q(1)$ *description of vibrational spectra of diatomic molecules*,
R.K. Gupta, **R.S. Johal** and I.L. Cooper, Mod. Phys. Lett. A **11** (1996) 2715-2724.

7. *Quantum group $SU_q(2)$ for complex-q deformation*,
R.S. Johal and R.K. Gupta, Mod. Phys. Lett. A **10** (1995) 2783-2791.

Preprints:

1. *Models of finite bath and generalised thermodynamics*,
   Contribution to Springer series on "Studies in fuzziness and soft computing", under the title: "Perspectives in Chaos, Nonlinearity and Complexity", eds. A. Sengupta and M. Z. Nashed.

2. *Mutual thermal equilibrium in long range interacting systems and generalised entropy*,
   Contribution towards the proceedings of NEXT-2005:Sigma Phi held at Crete, Greece, August 13-18, 2005.