

# JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH

Bengaluru 560 064

## Curriculum Vitae

<b>Name</b>	N. S. Vidhyadhiraja
<b>Present Designation</b>	Professor and Dean, Fellowships and Extensions
<b>Address</b>	Theoretical Sciences Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bengaluru, India.
<b>Age and Date of Birth</b>	46, 18 <sup>th</sup> September 1973

### 1. Details of academic qualification:

- ❖ Postdoctoral fellow, March 2001 - March 2005, University of Oxford, UK.
- ❖ Ph.D., Physics, Aug 1995 - Feb 2001, [Indian Institute of Science](#), Bengaluru, India.
- ❖ M.Sc., Physics, Aug 1990 - Apr 1995, [Indian Institute of Technology, Kanpur](#), India.

### Membership of Professional bodies:

- ❖ Life Member - Indian Physics Association (Member ID- )
- ❖ American Physical Society (Member ID-61059122)

### 2. Details of Service:

From	To	Institution	Designation
April 2019	Present	JNCASR, Bengaluru	Dean, Fellowships and Extensions
March 2019	Present	JNCASR, Bengaluru	Professor

March 2013	Present	JNCASR, Bengaluru	Associate Professor
March 2007	March 2013	JNCASR, Bengaluru	Faculty Fellow
March 2005	March 2007	JNCASR, Bengaluru	Fellow

### Other positions:

#### ❖ Visiting positions

- Visiting Professor, 10/2013 - 09/2014, Louisiana State University, LA, USA (On sabbatical from JNCASR)
- Visiting Professor, Birck Nanotechnology Centre, 07/2010-09/2010, Purdue University, IN, USA
- Visiting Professor, Physics Department, 05/2008-07/2008, University of Cincinnati, OH, USA.
- Visiting Professor, Nanotechnology and Physical Sciences, 05/2007-07/2007, Motorola India Research, Bangalore, India.

#### ❖ Adjunct positions

- Adjunct Faculty member, Physics Department 10/2013-Present, Louisiana State University, LA, USA
- Adjunct Associate Research Professor, 06/2011-05/2014, Birck Nanotechnology Centre, Purdue University, IN, USA

### 3. Report of the work done:

#### 3.1 Guidance of students for research conferment:

##### (a) Research Scholars who have obtained M.S / Ph.D degree

Name of the student	Title of Thesis	Year	Degree
Wasim Raja Mondal	A Quantum Cluster Approach to Vibrational Spectra and Anderson Localization of Phonons in Disordered Harmonic Lattices	2020	Ph.D
Rukhsan UI Haq	Renormalization group studies of the interplay between Kondo effect, valence fluctuations and topological order	2017	Ph.D
Anirudha Mirmira	A Floquet Hamiltonian approach to driven	2017	M.S

	quantum dot systems		
Nagamalleswara Rao Dasari	Development and application of computational quantum many-body methods for strongly correlated models and materials	2016	Ph.D
Sudeshna Sen	Emergent phenomena in spatially and energetically inhomogeneous strongly correlated model electron systems	2016	Ph.D
Pramod Kumar	Valence fluctuations and disorder effects in strongly correlated electronic systems	2014	Ph.D
Naushad Ahmad Kamar	Disorder and proximity driven phenomena in s-wave superconductors	2013	M.S
Sudeshna Sen	Theoretical Studies of transport at the nanoscale	2011	M.S
Himadri Barman	Diagrammatic perturbation theory based investigations of Mott transition physics	2011	Ph.D
Abhay Kumar Tiwari	Transient and steady state lateral charge transport in polymeric semiconductors	2010	M.S
Debabrata Parihari	Numerical studies of low energy behaviour of a few spin ladders and magnetic field effects in heavy fermions	2008	Ph.D

(b) **Research Scholars who have submitted thesis for Ph.D degree:** None

(c) **Research Scholars who are registered for Ph.D degree:**

- ❖ Anirudha Mirmira
- ❖ Vinayak Mallikarjuna Kulkarni
- ❖ Gurshidali

### **3.2 Guidance of students for project work, if any:**

- ❖ Summer students:
  - 2019 - Sushmita Tripathi (Univ of Hyderabad), Vinod Kumar (St.Stephens), Siddhant Kumar Panda (NISER), Anpuj Nair (IISERK), Amal VS (IISERK), Samarth Prabhu (NITK), Gunjan Sharma (JNCASR)

- 2018 - Mainak Das (*Ramakrishna Mission Residential College, Narendrapur*), Lakshmi P.N (*Indian Institute of Science Education and Research, Trivandrum*); Sachin Bharadwaj (*RV college of Engg, Bengaluru*)
- 2017 - Revathy Subbavally M (*Bishop Moore College, Mavelikara, Kerala University*); Sachin Bharadwaj (*RV college of Engg, Bengaluru*)
- 2016 - Shivam Kumar (*Integrated Science Education and Research Centre (ISERC), Visva Bharati, Santiniketan*), Rajath Krishna R (*St. Xaviers, Mumbai*)
- 2015 - Ayush Kumar (*IIT, Roorkee*), Rajat Kumar Panda (*NISER, Bhubaneswar*)
- 2010 - Shrihari Tagat (*Mysore University*), B. Radhakrishna (*Mysore University*)
- 2009, 2010 M. S. R. Kumar, (*Mysore University*)
- 2006, 2007 - Janu Verma (*Delhi University*)

❖ **Project students:**

- July 2019 - Present : Sujan KK (*NITK*)
- Nov 2018 - June 2019: Amarnath Chakraborty (*Univ of Hyderabad, Now at Univ of Missouri*)
- May 2017 - June 2018: Anirban Sharma (*Indian Institute of Science Education and Research, Pune*)
- July 2017 - Present: Sachin Bharadwaj (*RV college of Engg, Bengaluru*)
- Jan 2011 - Jan 2012: Deb Sankar De (*School of Physical Sciences, Jawaharlal Nehru University, New Delhi*)
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**3.3 Publications:**

- ❖ Total number of research papers published: 48
- ❖ Research papers published in the last 5 years: 24
- ❖ Research papers under review: 2

**3.4 Teaching:**

- ❖ Courses at JNCASR, Bangalore: (2007-Present)
  - Advanced Solid State Physics
    - January-April 2020
  - Physics of Materials
    - August - December 2019
  - Advanced solid state physics
    - August - December 2018
    - January-April 2017
  - Solid state physics
    - January-April 2016
    - January-April 2015
  - Quantum Mechanics

- August - December 2012
  - August - December 2011
- Advanced Condensed Matter Physics - Quantum Many Body Theory
  - January-April 2011
- Statistical Mechanics
  - January-April 2010
- Electromagnetism (Jointly with Dr.Rajesh Ganapathy)
  - January-April 2010
- Mathematical methods
  - August - December 2008
- Computational Methods
  - August - December 2007
- ❖ Guest lecturer at Mysore University (2008, 2009): Thermal Physics
- ❖ Guest lecturer at Mysore University (2010) : Statistical Mechanics and Kinetic theory

## 4. Other contributions

### 4.1 Scientific Roles

- ❖ SERB Expert committee member for MATRICS scheme
- ❖ Conducted evaluation for consideration of promotion: SINP Kolkata (July 2019)
- ❖ PhD Thesis examiner (IISc, JNU, HRI, IITK)
- ❖ Special invitee to the selection committee for interviewing the shortlisted candidates for the DST National and Overseas Postdoctoral Fellowships (2018)
- ❖ Referee for proposals submitted to Indo-French Centre for the Promotion of Advanced Research (CEFIPRA), New Delhi (2018)
- ❖ Science and engineering research board (SERB) referee for high risk high reward and distinguished investigator award (2018)
- ❖ SERB selection committee member for national postdoctoral fellowships (2017)
- ❖ SERB expert committee member for early career research award projects (2017)
- ❖ Ph.D thesis committee member for Mr.Samuel Kellar, a Ph.D student at Louisiana state university (2017-Present)
- ❖ Committee member for evaluation of proposals for vision group of science and technology of Karnataka government (2016, 2017)
- ❖ Referee for Physical Review Letters, Physical Review B and Physical Review E
- ❖ Member of a committee for selection of kishore vigyan protsahan yojana scholars (2018, 2019)
- ❖ Member of a committee for selection of Gifted children under the NIAS-Maiya Prodigy Fellowship program
- ❖ Member of a committee for selection of teachers to be appointed within kendriya vidyalaya sangathan (July 2016, May 2017, Mar 2018)

## **4.2 Administrative roles at JNCASR**

- ❖ Dean, Fellowships and Extensions, JNCASR (April 2019 - Present)
- ❖ Chairman, Housekeeping and Horticulture & Gardening Tender Committee
- ❖ Joint Entrance Screening Test (JEST) co-ordinator for JNCASR (2008-Present)
- ❖ Library Committee member (2009-Present)
- ❖ Integrated Ph.D. course coordinator and TSU course coordinator (2017-April 2019)
- ❖ Dining hall committee member (2018)
- ❖ Convener, Physical Sciences for the JNCASR Summer Research Fellowship Programme for the years 2016 and 2017.
- ❖ Transport committee member (2013-15)
- ❖ Theoretical Sciences Unit: Student Seminar Series Convener, 2007-2013
- ❖ Member of question paper committee for national entrance exam for Integrated PhD program (Materials Science), 2008-Present

## **4.3 External funding**

Principal investigator for SERB funded project (EMR/2017/005398) titled, "*Theoretical investigations of quantum criticality in single impurity and lattice model Hamiltonians*". (~ INR 30,00,000, Approved April 2018)

## **4.4 Awarded Special lectures:**

Short course (4 lectures) at Purdue University, USA (American Physical Society - Indo-US Science and Technology Forum **Professorship award**) on *Dynamical mean field theory and cluster approaches* - Available on nanohub.org ( May 2015)

- ❖ [Lecture 1: Quantum Cluster Approaches for Investigating Strongly Correlated Electronic Systems](#)
- ❖ [Lecture 2: Dynamical Mean Field Theories for Bulk, Layered, Disordered and Nano-systems](#)
- ❖ [Lecture 3: Nonlocal Dynamical Fluctuations Beyond DMFT and the Dynamical Cluster Approximation](#)
- ❖ [Lecture 4: Ongoing Work - A Quantum Cluster Theory for Anderson Localization in Correlated Systems](#)

## **4.5 Invited Talks**

- ❖ “Workshop on 2D Electronic Systems in Magnetic Field”, IISER Kolkata, 14th-15th December 2019
- ❖ “Young investigator meet on quantum condensed matter”, SNBNCBS, Kolkata, 11th-13th December 2019
- ❖ “JNC Research conference on the chemistry of materials”, Trivandrum, Kerala 30th Sep-2nd Oct 2019, Title: *Lattice vibrations in disordered systems: A new theoretical approach.*
- ❖ “Conference on Quantum Condensed Matter (Q-Mat2019) in IISc, Bangalore, 8-10 July 2019, Title: *Disorder in phononic systems: A cluster Green's function approach*
- ❖ “Forum on Quantum Materials”, NISER, Bhubaneshwar, 2-3 May 2019, Title: *Multi-orbital iterated perturbation theory for investigations of strongly correlated electronic materials*
- ❖ Physics Department, NITK, 27th February 2019, Title: *Strong correlations: Adventures in emergence*
- ❖ “Science Day”, NMAM Institute of Technology, Mangalore, 27th February 2019, Title: *Physics as a crucible for inventions and discoveries in technology*
- ❖ “DPS@10”, IISER Kolkata, 23-25 February 2019, Title: *Strong correlations: Existing and emerging directions*
- ❖ “One day Seminar”, Government Science College, Bengaluru, 11th February 2019, Title: *Physics and applications of semiconductor nanostructures*
- ❖ “DST-Purse conference on computational science”, Bangalore University, November 30th 2018, Title: *Computational physics: A few examples.*
- ❖ “Young Investigator Meet On Quantum Condensed Matter Theory”, S.N.Bose National Centre for Basic Sciences, November 20 - 22, 2018, Title: *Emergent non-Fermi liquid behaviour in disordered interacting systems*
- ❖ “In-House Symposium”, JNCASR, November 13-14, 2018, Title: *Stop that sound*
- ❖ School of Advanced Materials, JNCASR retreat at Dandeli, Karnataka , November 9-11, 2018, Title: *Strong correlations: Existing and emerging directions*
- ❖ “Correlation and Disorder in Classical and Quantum Systems”, ICTS, Bangalore, May 29-31 2017, Title: *Continuous Mott transitions in a bilayer Kondo insulator-metal model Hamiltonian*
- ❖ Physics Department, IIT Kanpur, May 19<sup>th</sup> 2017, Title: *Continuous Mott transitions in a bilayer Kondo insulator-metal model Hamiltonian*
- ❖ “Advances in theoretical condensed matter physics”, Poornaprajna Institute of Scientific Research, Bangalore, March 9<sup>th</sup> 2016, Title: *The ubiquitous Kondo effect in strongly correlated electronic systems*

- ❖ “Technologies for Extreme Scale Computing”, Centre for computation and technology, Louisiana State University, USA, October 16<sup>th</sup> 2014, Title: *Proximity effects of interactions and disorder in layered electronic systems*
- ❖ ”Indo-US Workshop on Nanomaterials for Energy”, Discovery Park, Purdue University, USA, September 17-18, 2014, Title: *Theoretical investigations of Kondo hole disorder in layered f-electron systems*
- ❖ Physics Department, Purdue University, USA, March 14<sup>th</sup> 2014, Title: *A new approach to Anderson localization*
- ❖ “Contemporary Issues in Condensed Matter Science”, IISc Bangalore, Feb 2012, Title: *Valence fluctuations driven quantum phase transition.*
- ❖ Physics Department, SNBNCBS, Kolkata, Dec 2011, Title: *Valence fluctuations driven quantum phase transition.*
- ❖ “Dynamics of Phase Transformations, JNCASR”, Nov 2011, Title: *Dynamics of local quantum critical valence fluctuations in heavy fermion systems*
- ❖ Physics Department, IIT Guwahati, Oct 2011, Title: *Valence fluctuations driven quantum phase transition*
- ❖ “Karnataka Science and Technology Academy sponsored workshop on condensed matter physics”, Tumkur University, Karnataka, Sep 2011, Title: *Physics of strong correlation*
- ❖ “Indo-US Meeting on New Functional Materials, Manali, India”, June 2011, Title: *Hysteresis and avalanches across the metal-insulator transition in vanadium oxides.*
- ❖ “Workshop on strongly correlated electronic systems”, HRI, Allahabad, Nov 2010, Title: *Heavy Fermions*
- ❖ Physics Department, IIT Kanpur, Nov 2010, Title: *Dynamics and transport in paramagnetic heavy fermion systems*
- ❖ “Sixth JNC Research Conference on Chemistry of Materials”, Kerala, Oct 2010, Title: *Theoretical approaches to understanding strongly correlated electronic systems.*
- ❖ “Nano-Computational Network-2010 Summer School”, Purdue University, USA, July 2010, Title: *Electrical fluctuations at the nanoscale.*
- ❖ Physics Department, Purdue University, July 2010, Title: *Dynamics and transport in heavy fermion systems.*
- ❖ “National Workshop on Electron dynamics in quantum systems”, Digha, Orissa, Feb 2010, Title: *Quantum many body approaches to correlated electron systems.*
- ❖ “Frontiers in Quantum Science”, Institute of Mathematical Sciences, Chennai, Dec 2009, Title: *Issues and Methods in understanding heavy fermion systems*
- ❖ “ICTS Indian Condensed Matter Workshop”, Mahabaleshwar, Pune, Dec 2009, Title: *Interplay of magnetic field and strong correlations in heavy fermion materials*
- ❖ “Annual Faculty Meeting”, JNCASR, Nov 2009, Title: *Interplay of strong correlations and magnetic field in heavy fermion materials*
- ❖ “Symposium on recent trends in quantum condensed matter”, Jawaharlal Nehru University, New Delhi, Mar 2009, Title: *Magnetic field effects in paramagnetic heavy fermion systems*

#### **4.6 Contributed talks at Conferences**

- ❖ International Conference on Theoretical Physics, "Correlations and Coherence at Different Scales", held in Ustron, Poland, September 9-14, 2018, Title: *Phonon localization in binary alloys with diagonal and off-diagonal disorder: A cluster Green's function approach*
- ❖ American Physical Society March Meeting, Feb 2012, Title: *Photocurrent noise in organic bulk-heterojunction solar cells*

#### **4.7 Organizational activities**

- ❖ Planning, and managing of the renovation and construction of the TSU/Complab cluster room, and the TSU Meeting Room
- ❖ Co-Organiser (with Dr.Meher Prakash): JNCASR In-House Symposium - Nov 2015
- ❖ Co-Organiser - International center for theoretical sciences (ICTS) Indian Condensed Matter Workshop, Dec 2011.
- ❖ Organiser - IBM-JNCASR High Performance Computation Workshop, Oct 2011.
- ❖ Organiser: JNCASR In-House Symposium - Nov 2007
- ❖ Co-Organiser - Numerical quantum many body methods in Physics and Chemistry, JNCASR - Sep 2007

#### **4.8 Development projects:**

- ❖ Member of Indo-UK consortium for 'Advancing the efficiency and production potential of Excitonic Solar Cells (APEX)' (Mar 2010- 2013)
- ❖ Resource person for Ministry of Human Resources and Development Advisory Committee on 'Promotion of research in Science and Technology in Universities and other academic, scientific and engineering institutions', 2011-2013

**4.9 Industrial Consultancy:** Visiting professor at the Motorola India Research Labs in the nanosciences group (May-July 2007).

#### **4.10 Outreach contributions:**

- ❖ Lecture at Physics Outreach program of the CNR Rao Hall of Science - "From Basic Physics to Technology" - Nov 2019

- ❖ Carried out Physics experiments at the Jawahar Navodaya Vidyalaya Science Congress at JNCASR- Nov 2019
- ❖ Organized Experiments at the International Year of Periodic Table, IISc- May 2019, Higher Education Academy Dharwad - Sep 2019, Sastra University, Tanjore - Oct 2019
- ❖ Organized the Laxmeshwar, Hubli Outreach program at School Chandan, Hubli, and conducted experiments/demonstrations 2018, 2019.
- ❖ Lectures in physics for students at CNR Rao hall of science, JNCASR (2012-Present)
- ❖ Convener for physics and mathematics part of the student mentor programme at JNCASR (2016-Present)
- ❖ Lecturer at high school teachers training programme, Sagar, Shimoga (Dec 2018)
- ❖ Lecturer at Science Camp, organised by Sagar Science Forum, Shimoga (Oct 2018)
- ❖ Chief guest and lecturer at kendriya vidyalaya sangathan teachers refreshers programme (May 2018)
- ❖ Lecture for physics teachers at higher education academy of Karnataka government, Dharwar (Nov 2017)
- ❖ Lectures and demonstrations at DST-INSPIRE annual camp at JNNCE, Shimoga, Karnataka (2014 - Present)
- ❖ Lecture and demonstrations at CNR Rao Education Foundation sponsored "Science Outreach Program" at Chandana School, Laxmeshwar, Hubli (Jan 2017, Feb 2018)
- ❖ Lecture and demonstrations at "Science Outreach Program", Gangolihaat, Uttarakhand (May 2017)
- ❖ Karnataka Rajya Vijnana Parishat sponsored "The National Year of Mathematics", Gulbarga (Dec 2012)
- ❖ UGC sponsored national seminar, DRM Science College, Davangere, Karnataka (Jan 2012)
- ❖ KSTA sponsored workshop on "Condensed Matter Physics", Tumkur University, (Sep 2011)
- ❖ UGC Seminar on "Frontier areas of condensed matter physics", Dharwad University, Karnataka (Mar 2011)
- ❖ Instructor at high school teachers training programme, IISc Bangalore, Karnataka (Feb 2010)
- ❖ Instructor at Vision group of Science - Refresher course for mathematics teachers, CNR Hall of Science, JNCASR, Bangalore (Sep 2009)
- ❖ Instructor at high school teachers training programme, Bijapur, Karnataka (Dec 2008)
- ❖ Instructor at high school teachers training programme, Haveri, Karnataka (Dec 2007)
- ❖ Sponsored by all the three Indian science academies, "Lecture workshop in Statistical Thermodynamics", Mysore University (Sep 2007)

**5. Any other relevant information (future plan of research activities and any other information)**

**Future plan of Research activities:** We are planning to take forward three existing areas of research, namely

- ❖ (i) First principles studies of strongly correlated materials using a DFT+DMFT approach
- ❖ (ii) Interplay of disorder and interactions in electronic and phononic systems.
- ❖ (iii) Quantum criticality

For the first, we plan to further improve an open-source package that we had developed in-house, namely the multi-orbital iterated perturbation theory (MO-IPT, currently available freely on GitHub), and focus on materials that require a large number of orbitals per unit cell. This project will be led by a student, Gurshidali. The second theme has involved the development of a new formalism called typical medium dynamical cluster approach (in collaboration with three other groups at USA and Germany). Application of this formalism has yielded several surprising results about emergence of non-Fermi liquid behaviour, and on the localization of phonons. Our next focus will be on symmetry broken phases, such as disordered superconductors, as well as on disorder engineering to achieve a desired level of Anderson localization. A senior student, Wasim Raja Mondal, has been working on several issues within this theme, and a new student will be recruited to take this forward. Over the past several years, we have been working on various problems that have encompassed or led to quantum criticality. In fact, recently, we have been awarded an SERB grant for various projects related to quantum criticality, and we intend to continue working in this area.

Two other themes that we have initiated over the last one year are

- ❖ (iii) Time-dependent quantum many body systems,  
and
- ❖ (iv) Non-Hermitian quantum mechanics

One MS thesis has resulted from the first theme, where the student, Anirudh Mirmira has used the Floquet formalism to investigate the steady states of periodically driven quantum dots with and without a connected topological superconductor. He is now continuing on the theme, where his PhD thesis problem is to develop a time-dependent local moment approach to investigate driven impurity systems within the Keldysh formalism, and apply it further to lattice models within the non-equilibrium dynamical mean field theory framework. The second theme is spearheaded by another PhD student, Vinayak. M. Kulkarni, who is delving deep into the analogs of the standard paradigms of usual quantum many body models in the non-Hermitian quantum mechanics. Here, the plan is to explore as many equivalent models as possible, and come up with realistic testable predictions of quantum phase transitions for experiments.