2016 COMMONWEALTH SCHOLARSHIP IN THE UNITED KINGDOM-2016

Scholarship Scheme

Name of the Scholarship Scheme :	2016 Commonwealth Scholarship in the United Kingdom-2016
Country for which applying :	United Kingdom
Level of Course : :	Doctoral Degree (up to three years duration)
Subject :	Physics
Registration No :	**ES4\cwsuk\SAKSHAT\2015\1413**

Personal Details

Name of Candidate:-	ATUL SINGH ARORA
Present Address	R710 H7, IISER Mohali, Sector 81, SAS Nagar, Mohali
PIN No:-	140306
State :-	Punjab
Permanent Address	4317/3 Ansari Road, Darya Ganj, New Delhi
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State :-	Delhi
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Email ID :-	toatularora@gmail.com
*Father's Name:-	Assa Singh Arora
Sex:-	MALE
*Marital Status:-	Unmarried
*Nationality:-	Indian
*Date Of Birth:-	20 Nov 1991
Age on 08/10/2015(DD/MM/YYYY):-	Years-23 Months-10 Days-18
*State to which the candidate belongs:-	Delhi

Academic details

***Academic record starting from High School/Higher Secondary**

Name of the University/Board/Institutes	Examination(s) Passed	Degree Obtained	Date of Passing	Division/Class	secured/Maximum marks	Percentage	Major Subject	Uploaded Document
CBSE	High School/Secondary	10th	2008	I	549 / 600	91.50	English, Math, Science, Introductory IT	
CBSE	Higher Secondary	12th	2010	I	400 / 500	80.00	English, Math, Phys, Chem, Comp Sc	
IISER Mohali	Graduation	BS MS	2016	NA	9.3 / 10	93.00	Physics	
IISER Mohali	Post Graduation	BS MS	2016	NA	9.3 / 10	93.00	Physics	

Other Details

Have you cleared IELTS/TOEFL/GMAT? If so, give score

(a) IELTS :-	NA
(b) TOEFL :-	117/120
(c) GMAT :-	NA

Details of professional/practical/training and research experience, if any specifying the period and the number of papers published

Experience :-

Summer 2015, University of Siegen [research project] We proposed a new test of local realism based on correlation measurements of continuum valued functions of positions and momenta, known as modular variables. The Wigner representation of these observables are bounded in phase space, and therefore, the associated inequality holds for any state described by a non-negative Wigner function. This agrees with Bell's remark that positive Wigner functions, serving as a valid probability distribution over local (hidden) phase space coordinates, do not reveal non-locality. We constructed a class of entangled states resulting in a violation of the inequality, and thus truly demonstrate non-locality in phase space. We proposed an experimental setup in which the states can be realized through grating techniques in space-like separated using interferometry. The non-locality is verified from the spatial correlation data that is collected from the screens. I was guided by Prof. Otfried Guehne and worked primarily with Dr. Ali Asadian, who was working as a PostDoc in his group. In: http://arxiv.org/abs/1508.04588. Submitted to: Physical Review A. Summer 2014, IISER Mohali [research project] The objective was to device ways of using a universal quantum computer to perform simulations of quantum phenomena itself, with 'practical' resource requirements. The project involved reading of books and papers, followed by reproducing the results of a paper using a quantum computer simulator, which was written from scratch and an independent discovery of a simple quantum algorithm to simulate mixed states (this result was however already known). I was guided by Prof. Arvind and had helpful discussions with Dr. Sudipta Sarkar and Dr. Abhishek Choudhury. In hindsight, I find that we had come dangerously close to working out a result on simulating quantum tunneling, which was published recently. Winters 2014, IISER Mohali [study project] Studied Mechanics from Landau's first volume (excluding the last chapter) and covered parts of Mathematical Methods from a book on the said topic by Dennery and Krzywicki. I was guided by Prof. Jasjeet Bagla and Prof. Sudeshna Sinha. Monsoon 2013, NCBS [summer school] Participated in a Monsoon School on Physics of Life where we treated selected biological phenomena with physical rigour, headed by Dr. Mukun Thattai Summer 2013, IISER Mohali [experimental project] Worked on setting up

an experiment to study dynamics of a two dimensional magnetic dipole lattice, with Dr. Ravi Mehrotra. Winter 2012, IISER Mohali [study project] Studied Quantum Mechanics from J.J. Sakurai, under the guidance of Prof. Jasjeet Bagla and created a corresponding report. Summer 2012, IISER Mohali [math project] Studied Group Theory and Linear Algebra for understanding Symmetry, under Prof. Kapil Hari Paranjape. A brief introductory understanding of the Knot Theory was also undertaken. LaTeX was learnt during this period, to be able to efficiently communicate via the internet. Summer 2011, IISER Mohali [programming project] Worked on Image Recognition techniques using OpenCV, for Yarn Fault detection under the supervision of Prof. Anirban Guha. This was an extension to an IIT alumni's Masters thesis. The work was done using Visual Studio, C++ and involved understanding of OpenCV and the idea behind various algorithms, to be able to solve the problem at hand. I had worked on various programming/electronics/robotics related projects starting from my schooldays to the first few years at IISER. For details, please see: http://tinyurl.com/ohoqlej or equivalently https://github.com/toAtulArora/IISER_repo/blob/master/SummersMisc2015/CV/CV.pdf

Period :- during summer and winter breaks

No of paper(s) published :- 1 (preprint)

Previous employment with name and address of Employer and period of employment, if any :

Employer Name	Employer Address	Period of Employment

Nature of the present employment with date of appointment, designation and the name and address of the employer :

Date of appointment	Designation	Name of employer	Address of employer

Have you been abroad ? if so, give full particulars of the countary and the period. Also, mention the year and month of return to India :

Particulars of the country	Period	Purpose	Duration
University of Siegen, Germany	07 May 2015 - 24 Jul 2015	Research Project (Physics)	**Years-0 Months-2 Days-17**
Danfoss, Sonderborg, Denmark	06 Aug 2009 - 12 Aug 2009	Environment Meet	**Years-0 Months-0 Days-6**

Name and address of three persons who are familiar with your work(Two of them who taught you in an area of study relevant to course and the third may be your employer or a person with whom you have worked professionally)

Name of person	Address
Arvind	arvind@iisermohali.ac.in
Ali Asadian	asadian@physik.uni-siegen.de
Charanjit Singh Aulakh	aulakh@iisermohali.ac.in

Proposed Programme of Study/Research/training specifying details.
(Note :- A research proposal must contains Title, Abstract, Introduction, Methodology, Outcome etc)

Title: Foundations of Quantum Mechanics and Quantum Field Theory Abstract/Proposal: To even talk about the foundations of Quantum Mechanics (QM) is an embarrassing condition for a physical theory. The founders of QM were able to abstract out the practically relevant from the philosophical implications. This forced them to have 'observers' play a pivotal role in the axioms of the theory. More precisely, the theory explicates how the system will evolve if it is not 'observed' and also how it evolves upon being 'observed'. This has been among the main focus of analyzing the foundations of the subject, for the theory fails to tell us precisely what being observed means; this maybe rephrased as that the theory fails to tell which type of evolution to use without any ad-hoc reference to observers. This has been studied in great depth in the past and is still an active area of research; foundations of Quantum Field theories on the other hand is still not as popularly studied. However, even if we are able to arrive at an answer to this question, there are atleast two other rather mysterious aspects at the heart of the theory worth exploring. The first involves what is called a Bell's inequality. This intriguing development proved that nature is not locally real (while some claim reality maybe derived from locality and vice versa). As though this wasn't startling enough, it was shown that despite this 'non-locality', one can't send signals faster than speed of light! Infact, a recent exploration of the constraint of no-signalling has shown that this by itself is too liberal. The quantum theory is more restrictive than simply satisfying no-signalling, which has been captured in what's called "information causality". This shows a very curious relation between apparently distinct concepts and a foundational aspect of a physical theory. Another fascinating direction of research is as follows. Imagine that we were to recast QM into a probability distribution. Now it would seem obvious that if QM is to have some peculiarities, then it must arise from these distributions going negative at some point. Else, it would appear that they represent something we can already imagine in the classical world. Well, it can be shown that this is not entirely true. There can be completely positive distributions that can defy local reality, yes, using the same Bell's inequality. The key here is that the measurement here corresponds to 'very sharp observables'. The nature of these observables isn't very well understood. This is of fundamental interest because the sharpness decides the degree of classicality; this in turn relates to understanding where we define the boundary between the quantum and classical, between the system and the observer. Of course, there are various other directions one can take to explore the different fundamental aspects of QM which exist and others that might arise as we progress, however I hope I have been able to convey the excitement and relevance of the intended research project.

The detail may be given on the following points :-

i) The work presently engaged in :- Bohmian mechanics is an observer independent theory of Quantum Physics. This is particularly interesting for various reasons. Other than the usual reasons, such as how the measurement problem is solved for discrete degrees of freedom (spins say), the following I wish to explore in context of Quantum Mechanics itself. Results about contextuality show that there can't be any determinism (at least in the discrete case). It is worthwhile exploring how this can be handled in a deterministic theory, viz. Bohmian mechanics, where spins are treated as, not properties of particles, but those of wavefunctions. I am also curious about how recent results extending contextuality to continuous variables work for Bohmian mechanics and wonder if one can distinguish between the two theories. The theme here is an exploration of how spins and position are fundamentally different since in QM they are essentially treated the same way. I am exploring these aspects for my master's thesis.

ii) Preferred institutions in UK (Three) :- Prof. Vlatko Vedral, University of Oxford Prof. Almut Beige, University of Leeds Prof. Chris Dewdney, University of Portsmouth

iii) What factors led you to choose to above institutions :- The researcher and his/her work.

iv) Future plans/proposals after the study/research/training and its prospectus :- I intend to do a Post Doc after my PhD. I haven't decided on any specifics beyond that at this stage. I am however convinced that I will return to my home country after I complete my guided research.

v) What are the benefits to your home country :- Understanding the laws of nature, especially their fundamental aspects, helps us gain clarity over how to harness it for the benefit of humanity. The field of Quantum Cryptography and Computation, which are applications of Quantum Physics, will benefit largely from a clarification of foundations of the subject. These techniques are key to success of any nation for their development will revolutionize computers in ways which are unimaginable with current technology, for example Quantum Computers can theoretically break the currently used encryption protocols in bank transactions etc.

Have you been received any offer letter for joining research/admission.(if yes you must attach supporting documets) :Yes
Uploaded Document : uploaded document

Have you been received any academic awards/credential such as Gold Medal, National Awards etc. :Yes
Name of award : KVPY, Academic Excellence
Uploaded Document : uploaded document

DECLARATION

I cerfify that foregoing information is correct and complete to the best of my knowledge and nothing has been concealed/distorted. I understand that if at any time I am found to have concealed/distorted any material information, my selection shall be liable to summary termination without notice and compensation.

(Signature of the Candidate)

Date :- 13 Oct 2015