Department of Physics, FLORIDA ATLANTIC UNIVERSITY

Supplemental Application for Admission to the Graduate Program of Physics

STUDENT INFORMATION

Last Name (Complete Family or Surname) (No Initials)	First Name (Given Name)	Middle Name	Suffix (Jr., III, etc.)
Arora	Atul	Singh	

Date of Birth (mm/dd/yyyy): 20/11/1991

Gender: Male ☑ Female ☐

If your transcripts, test scores, etc. might arrive under any name(s) other than those listed above, enter them here

Former Last Name and First Name (1):

Former Last Name and First Name (2):

Country/Citizenship: India

Birthplace: City, State, Country: New Delhi, Delhi, India

CURRENT ADDRESS

The current address will be used to contact you regarding your application

Street Address, Apartment, City, County, State, Country, Zip Code/Int'l Postal Code: 4317/3 Ansari Road, Darya Ganj, New Delhi, Delhi, India 110002

Email Address (Valid email address is necessary throughout the admissions process.)	Daytime Phone Number	Cell Number
toAtulArora@gmail.com		+918699413350

PERMANENT ADDRESS

Is your current address the same as your permanent address? If yes, you do not have to fill out this section

Street Address, Apartment, City, County, State, Country, Zip Code/Int'l Postal Code: 4317/3 Ansari Road, Darya Ganj, New Delhi, Delhi, India 110002

Daytime Phone Number:

TEST SCORES

GRE	Verbal Score	Verbal %Below	Quant. Score	Quant. %Below	Analyt. Score	Analyt. %Below	Subj. (Phys) Score	Subj. (Phys) %Below	Date (mm/yy)
	157	74	161	80	4	56			

TOEFL	Score	Date (mm/yy)
	117	20/91

ENROLLMENT INFORMATION

Term in which you seek admission: ☐ Spring ☐ Summer ☑ Fall Year: 2016

Check the degree for which you are applying: ☑ Doctorate ☐ Masters ☐ Masters in Medical Phys.

Indicate your intended program, major or specialization/track of study (See the Graduate Program Summary sheet):

Physics, Quantum Gravity (Non-string) and Quantum Cosmology.

Is this a change in Major? Yes ☐ No ☑

INSTITUTIONS PREVIOUSLY ATTENDED

List in chronological order, starting with the most recent, every post-secondary institution (including dual enrollment) you will have attended prior to entering this University. Include FAU if you attended previously. You must provide official transcripts from each institution listed. (See instructions)

College	Location	Dates Attended From	Dates Attended To	Degree Earned	Degree Date
Indian Institute of Science Education & Research, Mohali, India | Aug 2011 - May 2016 | Degree will be awarded in May 2016					

Florida Atlantic University encourages applications from qualified applicants regardless of age, sex, handicap, or cultural, racial, religious, or ethnic group.

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH MOHALI
(Established by Ministry of Human Resource Development, Govt. of India)
Sector 81, Knowledge City, SAS Nagar, 140306, Punjab, India

Five year BS-MS Dual Degree Programme
Interim Grade Card

Name of the student : **Atul Singh Arora**
Registration No. : **MS11003**
Year & Month of Completion : (*Programme not complete*)
Cumulative Performance Index (CPI) : **9.4**

Code	Title of the Course	Cr	Gd
	Semester I		
BIO101	Cellular basis of life	3	A
BIO111	Biology Lab I	1	B
CHM101	Chemistry of elements & chemical transformations	3	D
CHM111	Chemistry Lab I	1	B
HSS101	Language Skills	2	B
IDC101	Introduction to computers	2	A
MTH101	Symmetry	3	A
PHY101	Mechanics	3	A
PHY111	Physics Laboratory I	1	B
	Semester III		
BIO201	Genetics & Evolution	3	A
BIO211	Biology Laboratory III	1	A
CHM201	Spectroscopic & other physical methods	3	B
CHM211	Chemistry Laboratory III	1	A
IDC201	Astronomy & Astrophysics	2	B
IDC211	Workshop Training	1	A
MTH201	Curves & Surfaces	3	A
PHY201	Waves & Optics	3	C
PHY211	Physics Laboratory III	1	A
	Semester V		
HSS632	Philosophy of Rationality	4	A
IDC351	Seminar (attending)	1	A
PHY301	Classical Mechanics	4	A
PHY302	Quantum Mechanics	4	A
PHY303	Electrodynamics	4	A
PHY311	Adv Optics & Spectroscopy Lab	4	A
	Semester VII		
IDC451	Seminar	1	A
PHY401	Nuclear & Particle Physics	4	A
PHY402	Solid State Physics	4	B
PHY411	Nuclear Physics Lab	4	A
PHY638	Physics of Fluids	4	B
PHY656	Quantum Principles & Quantum Optics	4	A
PHY658	Radiative effects & REnormalization Group in Relativistic Quantum Field Theory	4	A
	Semester IX		
HSS633	Ethics	4	A
PRJ501	Thesis Research	16	A

Code	Title of the Course	Cr	Gd
	Semester II		
BIO102	Gene expression & development	3	B
BIO112	Biology Lab II	1	B
CHM102	Atoms molecules & symmetry	3	B
CHM112	Chemistry Lab II	1	B
HSS102	History of science	2	B
IDC102	Hands-on electronics	2	A
MTH102	Analysis in one variable	3	B
PHY102	Electromagnetism	3	A
PHY112	Physics Laboratory II	1	A
	Semester IV		
BIO202	Behaviour & ecology	3	B
BIO212	Biology Lab IV	1	A
CHM202	Energetics & Dynamics of Chemical Reactions	3	A
CHM212	Chemistry Lab IV	1	A
HSS202	Philosophy of Science	2	A
IDC206	Quantum physics for scientists	2	A
MTH202	Probability & Statistics	3	A
PHY202	Thermodynamics & Statistical Physics	3	A
PHY212	Modern Physics Lab	1	A
	Semester VI		
IDC352	Seminar (attending)	1	A
PHY304	Statistical Mechanics	4	A
PHY305	Atomic & Molecular Physics	4	A
PHY312	Advanced Electronics & Instrumentation Lab	4	B
PHY631	Quantum Computation & Quantum Information	4	A
PHY646	Field Theory	4	A
	Semester VIII		
IDC402	Nonlinear dynamics, chaos & complex systems	4	A
IDC452	Seminar (delivering)	1	B
PHY412	Condensed matter physics lab	4	A
PHY422	Computational methods in physics	4	A
PHY659	Gauge Theories, the standard model & beyond	4	B
PHY661	Selected topics in classical & quantum mechanics	4	A

Date of Issue: **December 28, 2015**

Rajesh Parangpe
(Acting)Dean Academics

Meaning of Grades: A=Excellent, B=Good, C=Average, D=Pass, F=Fail.
Points for Grades: A=10, B=8, C=6, D=4, F=0
CPI is the credit weighted average of points earned.

Cr: Credits; Gd: Grade

$$\text{CPI}=\frac{\text{Total of(Credits}\times\text{Points)}}{\text{Total Credits}}$$

DEAN (Academics)
Indian Institute Of Science Education & Research (IISER) Mohali

Examinee Score Report

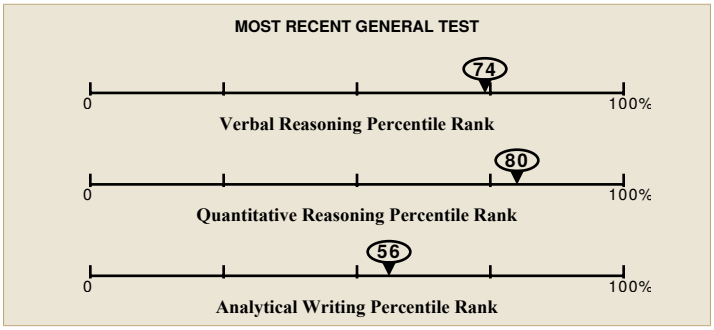
Arora, AtulSingh

Note: This report is not valid for transmission of scores to an institution.

Last (Family/Surname) Name, First (Given) Name, Middle Initial

Print Date: 12/22/2015

Address:	4317/3 Ansari Road Darya Ganj New Delhi, 110002
Email Address:	toatularora@gmail.com
Phone Number:	8699413350
Date of Birth:	11/20/1991
Social Security Number (last 4 digits):	
Gender:	Male
Intended Graduate Major Code:	0808
Intended Graduate Major:	Physics and Astronomy - Physics
Most Recent Test Date:	10/24/2015
Registration Number:	3992009



All dates are formatted as MM/DD/YYYY.

This score report includes all of your General Test and Subject Test scores earned from July 1, 2008 to the present. Only reported scores are available for display.

General Test Scores

Test Date	Verbal Reasoning*				Quantitative Reasoning*				Analytical Writing	
MM/DD/YYYY	Prior Format		Current Format		Prior Format		Current Format			
	Scaled Score	Estimated Current Score	Scaled Score	% Below	Scaled Score	Estimated Current Score	Scaled Score	% Below	Score	% Below
09/28/2015			157	74			161	80	4.0	56

NS - No Score. Indicates that no questions were answered.
* The GRE Verbal Reasoning and Quantitative Reasoning score scales changed in August 2011. For tests taken August 2011 or later, scores are printed in the "Current Format" columns. For tests taken before August 2011, scores on the prior scales and the corresponding estimated scores on the current scales are printed in the "Prior Format" columns.

Score Recipient(s)

Your score reporting history is shown below. "Pending" indicates your scores are not yet available, or your order has not yet been processed.

Undergraduate Institution

Report Date	Institution (Code)	Department (Code)	Test Type	Test Date

Score Recipient(s)

Report Date	Institution or Fellowship Sponsor (Code)	Department (Code)	Test Type	Test Date
12/09/2015	U MD Coll Park (5814)	Physics (0808)	General Test Subject Test	09/28/2015 10/24/2015
11/21/2015	U CA Los Angeles (4837)	Physics (0808)	Subject Test	10/24/2015
11/21/2015	U Michigan Ann Arbor (1839)	Physics (0808)	Subject Test	10/24/2015
11/21/2015	U Chicago (1832)	Physics (0808)	Subject Test	10/24/2015
11/21/2015	Princeton U (2672)	Physics (0808)	Subject Test	10/24/2015
10/07/2015	U Chicago (1832)	Physics (0808)	General Test	09/28/2015
10/07/2015	U CA Los Angeles (4837)	Physics (0808)	General Test	09/28/2015
10/07/2015	Princeton U (2672)	Physics (0808)	General Test	09/28/2015
10/07/2015	U Michigan Ann Arbor (1839)	Physics (0808)	General Test	09/28/2015

* Undergraduate Institution does not wish to receive scores
** Score recipient not valid/active

QUESTIONS ABOUT THIS GRE EXAMINEE SCORE REPORT

Information to help you interpret your GRE scores is available at www.ets.org/gre/stupubs. If you have any questions concerning this GRE Report of Scores, call ETS at 1-609-771-7679 or 1-866-473-4373 (toll free for test takers in the U.S., U.S. Territories*, and Canada) between 8:00 a.m. and 7:45 p.m. EST or email gre-info@ets.org. For information about interpreting your scores, consult **Interpreting Your GRE Scores**, which is available at www.ets.org/gre/understand.
**Includes American Samoa, Guam, Puerto Rico, and U.S. Virgin Islands*

SCORE REPORTING

Policies pertaining to score reporting and use are periodically reviewed and revised by the GRE Board. The policies and procedures explained in the 2013-14 *GRE Information and Registration Bulletin* are effective only for the time period of August 1, 2013 to June 30, 2014 and supersede previous policies and procedures in previous bulletins. GRE scores are reportable for five(5) years following the testing year (July 1 to June 30) in which you tested. Currently, GRE scores earned after July 1, 2008 are available.

PERCENTILE RANK (% BELOW)

The percentile ranks in this report indicate the percentage of examinees who scored below your score. Note that these percentile ranks may be different from those that applied when the scores were originally reported to you if the scores were earned prior to July 2013. This reflects annual updating of these data to permit admissions officers to compare scores, whenever earned, with those for a recent reference group.

RETAKING A GRE TEST

You can take the GRE revised General Test once every 21 days, and up to five times within any continuous rolling 12-month period. This applies even if you canceled your scores on a test taken previously. You may take the paper-based GRE revised General Test and GRE Subject Tests as often as they are offered.
Note: This policy will be enforced even if a violation is not immediately identified (e.g., inconsistent registration information) and test scores have been reported. In such cases, the invalid scores will be canceled and score recipients will be notified of the cancelation. Test fees will be forfeited.

TOEFL iBT® Test Taker Score Report

Name: Arora, Atul Singh
Last (Family/Surname) Name, First (Given) Name Middle Name

Email: toatularora@gmail.com

Gender: M

Registration Number: 0000 0000 2577 0147

Date of Birth: 20 Nov 1991

Test Date: 26 Sep 2015 **Sponsor Code:**

Arora, Atul Singh
4317/3 Ansari Road
Darya Ganj
New Delhi, Delhi 110002
India

Country of Birth: India
Native Language: HINDI
Test Center: STN12483B - Shiksha Overseas
Test Center Country: India

Inst. Code	Dept. Code
2672	76
1839	76
1832	76
4837	76

TOEFL iBT Scaled Scores

Reading	28
Listening	30
Speaking	29
Writing	30
Total Score	**117**

51

Security Identification

ID Type: Passport **ID No.:** xxxxxxxxxxxxxxxxxxxx2446 **Issuing Country:** India

Reading Skills	Level	Your Performance
Reading	High	Test takers who receive a score at the **HIGH** level, as you did, typically understand academic texts in English that require a wide range of reading abilities regardless of the difficulty of the texts. Test takers who score at the **HIGH** level, typically • have a very good command of academic vocabulary and grammatical structure; • can understand and connect information, make appropriate inferences, and synthesize ideas, even when the text is conceptually dense and the language is complex; • can recognize the expository organization of a text and the role that specific information serves within the larger text, even when the text is conceptually dense; and • can abstract major ideas from a text, even when the text is conceptually dense and contains complex language.

Listening Skills	Level	Your Performance
Listening	High	Test takers who receive a score at the **HIGH level**, as you did, typically understand conversations and lectures in English that present a wide range of listening demands. These demands can include difficult vocabulary (uncommon terms, or colloquial or figurative language), complex grammatical structures, abstract or complex ideas, and/or making sense of unexpected or seemingly contradictory information. When listening to lectures and conversations like these, test takers at the **HIGH** level typically can • understand main ideas and important details, whether they are stated or implied; • distinguish more important ideas from less important ones; • understand how information is being used (for example, to provide evidence for a claim or describe a step in a complex process); • recognize how pieces of information are connected (for example, in a cause-and-effect relationship); • understand many different ways that speakers use language for purposes other than to give information (for example, to emphasize a point, express agreement or disagreement, or convey intentions indirectly); and • synthesize information, even when it is not presented in sequence, and make correct inferences on the basis of that information.

Speaking Skills	Level*	Your Performance
Speaking about Familiar Topics	Good	Your responses indicate an ability to communicate your personal experiences and opinions effectively in English. Overall, your speech is clear and fluent. Your use of vocabulary and grammar is effective with only minor errors. Your ideas are generally well developed and expressed coherently.
Speaking about Campus Situation	Good	Your responses indicate an ability to speak effectively in English about reading material and conversations typically encountered by university students. Overall, your responses are clear and coherent, with only occasional errors of pronunciation, grammar, or vocabulary.
Speaking about Academic Course Content	Good	Your responses demonstrate an ability to communicate effectively in English about academic topics typical of first -year university studies. Your speech is mostly clear and fluent. You are able to use appropriate vocabulary and grammar to explain concepts and ideas from reading or lecture material. You are able to talk about key information and relevant details with only minor inaccuracies.
Writing Skills	**Level***	**Your Performance**
Writing based on Reading and Listening	Good	You responded well to the task, relating the lecture to the reading. Weaknesses, if you have any, might have to do with • slight imprecision in your summary of some of the main points and/or • use of English that is occasionally ungrammatical or unclear.
Writing based on Knowledge and Experience	Good	You responded with a well-organized and developed essay. Weaknesses, if you have any, might have to do with • use of English that is occasionally ungrammatical, unclear, or unidiomatic and/or • elaboration of ideas or connection of ideas that could have been stronger.

THIS IS A PDF DOWNLOADED AND PRINTED BY THE TEST TAKER, INTENDED FOR THE TEST TAKER'S PERSONAL RECORDS.

This score report provides four section scores and a total score. An analysis of your strengths and weaknesses in English is included. The level pertaining to each skill should not be generalized beyond the performance on this test. Skill levels and their associated descriptions are not intended for use by institutions as part of their admissions criteria and will not be shared unless you grant permission.

Information About Scores: The following scaled scores are reported for the TOEFL iBT test. A total score is not reported when one or more sections have not been administered. These scores have the following ranges:

Sections	Scaled Scores
Reading	0-30
Listening	0-30
Speaking	0-30
Writing	0-30
Total Score	0-120

Score Legends:

Reading Skills	
Level	**Total Scaled Score Range**
High	22-30
Intermediate	15-21
Low	0-14

Speaking Skills	
Level	**Total Scaled Score Range**
Good	26-30
Fair	18-25
Limited	10-17
Weak	0-9

Listening Skills	
Level	**Total Scaled Score Range**
High	22-30
Intermediate	14-21
Low	0-13

Writing Skills	
Level	**Total Scaled Score Range**
Good	24-30
Fair	17-23
Limited	1-16
Score of Zero	0

Institution Codes: The code numbers shown on page 1 of this report are the ones you selected before you took the test. If any institution code you selected is missing, it was incorrect and the TOEFL® Program was unable to send a score report to that institution.

DEPT.	WHERE THE REPORT WAS SENT
00	Admissions office for undergraduate study or an institution or agency that is not a college or university
01, 04-99	Admissions office for graduate study in a field other than management (business) or law according to the codes selected when you registered
02	Admissions office of a graduate school of management (business)
03	Admissions office of a graduate school of law

Additional information about TOEFL iBT scores can be found on the Test Takers section of the TOEFL website at **www.ets.org/toefl.**

* Skill levels for speaking and writing individual skills are estimates of performance at the *item* level. The total writing and speaking scaled scores and ranges are more accurate. Therefore it is not appropriate to combine the individual skill levels. Doing so may lead to apparent inconsistencies between the diagnostic feedback and reported writing and speaking scores.

IMPORTANT NOTE TO SCORE USERS: This PDF score report was downloaded and printed by the test taker. It is not an Official Score Report sent by ETS directly to an organization designated by the test taker. If you find it necessary to verify the scores on this report, please contact the TOEFL Score Verification Service at +1-800-257-9547 or +1-609-771-7100. Scores more than two years old cannot be reported or validated.

Statement of Purpose

Atul Singh Arora

Fascinated by the idea that the laws of nature are discovered by people, as a child I wanted to become a scientist. Upon growing up, my interest shifted to building simple robots that can help do everyday chores. The construction involved programming, electronics and assembling mechanical parts. Upon learning physics and doing questions from books like Irodov, I became interested in physics again. It was however only after coming to IISER, my second home, that I took seriously the idea of becoming a scientist.

Initially we're taught all the basic sciences plus pure math. I developed a taste for abstract mathematics during that time. My first subject for exploration was group theory and symmetry. I also looked at knot theory at the time and was surprised to learn its relation to quantum computation and elementary physics. I learnt eventually that while mathematics was fascinating in its own right, I missed physics, the connection to reality. That *my equations describe nature*, I realised was rather important for me.

I spent the following summer constructing an experiment whose objective was to study the dynamics of spins on a lattice. Having enough experience with robotics, this project wasn't all that challenging in terms of novelty and learning, even though it took a lot of effort. By the end of it, I was convinced that while constructing physics experiments, there's not too much focus on physics itself. I learnt that I really *wish to explore theoretical physics* in my future projects.

By this time, I had chosen physics as my major. Physics had never ceased to surprise me, but with solid state physics, fluid mechanics, quantum computation, quantum field theory (QFT) and gauge theories, the standard model & beyond, the excitement pinnacled.

In my major years, I spent the first summer exploring the simulation of quantum physics on a quantum computer. This was fascinating for I had independently discovered a small simulation protocol, that extended the pure state simulation to that of a mixed state. That for me, was the first novel construction of its type. However towards the end of it, I felt that I wasn't doing physics. I wanted to work on *finding new laws of nature*.

In the next summer, I was awarded the DAAD-WISE scholarship to work in Germany. While applying, I was confused between quantum gravity and quantum optics & foundations. I chose the latter for I felt it is experimentally more accessible, that our results could at least be verified within our lifetime. I was able to make some progress and construct a new extension of the Bell test[1]. In addition to this, I learnt about Bohmian Mechanics (BM) which is a deterministic theory that describes the same phenomena that Quantum Mechanics does. While I was not disappointed with my progress and had learnt about exciting research directions such as the No-Signalling principle/PR-box and information causality, I somehow *missed the richness of the remaining physics*.

For my master's thesis, I decided to explore BM, a theory in which observers play no fundamental role. This I felt might eventually make interpretation of 'quantum spacetime' more meaningful as a concept. For the thesis though, I'm focusing on a more specific problem, viz. seeing how BM could be consistent with contextuality; more precisely, I want to see how a theory deterministic in position & momentum (q,p) can be consistent with a quantum mechanics' test that says (q,p) must be contextual, if at all they're deterministic. This would show the relation between non-locality and contextuality in the continuous variable regime, which isn't yet properly understood and is of considerable interest. The larger goal is to see how spin like discrete degrees of freedom are fundamentally different from (q,p). Perhaps this would suggest an appropriate understanding of it's extension to QFTs and quantum gravity (QG).

I haven't had any formal courses in QG and therefore perhaps naively so, I'm more inclined towards the loop quantum gravity (LQG) approach, as opposed to string theory. I have gleaned that the dynamics of LQG is the current active area of research with hamiltonian formulations and the spin foam alternative being among the studied approaches. I don't suppose I can formulate a research problem at the moment for my lack of knowledge about the area, however I hope that my past work supports my application to a PhD in this exciting field. The known applications to cosmology could perhaps be a starting point. Interestingly, recently BM was applied to cosmology as a test to distinguish it from QM.

Florida Atlantic University (FAU) has a vibrant group, consisting of various erudite researchers, such as Dr. Muxin Han, Dr. Jonathan Engle and Dr. Warner A. Miller, of the Spacetime Physics Group, which focuses on advancing our understanding of Quantum Gravity. With mavericks working in important and diverse fields, both within and outside QG, I believe, FAU will be an ideal place.

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[1] A. S. Arora, A. Asadian. *Proposal for a macroscopic test of local realism with phase-space measurements.* Phys. Rev. A **92**, 062107.