# [FRIA-B1 2016] FORMULAIRE DE DEMANDE / PROPOSAL APPLICATION FORM

FRIA 1e BOURSE [FRIA-B1 2016]

## 1. REFERENCE OF THE APPLICATION

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| 1.1 REFERENCE OF THE APPLICATION | |
|---|---|
| **Reference of the call** | Appel/Call FRIA 2016 |
| | FRIA 1e BOURSE [FRIA-B1] |
| | **Research grant aiming at writing a doctoral thesis in 3 or 4 years** |
| **Application number** | 29379721 |
| **Applicant's first name** | Atul Singh |
| **Applicant's last name** | Arora |
| **Host institution** | U.L.B. |
| **Type of grant for which you are applying** | 1e bourse - 1e année / 1st grant - 1st year |
| **1.2 SUPERVISION OF THE RESEARCH PROGRAMME** | |
| **Promoter's first name** | Jérémie |
| **Promoter's last name** | Roland |
| **Host institution** | U.L.B. |
| | |
| **Graduate school** | Technology and Engineering Sciences |
| **Specialisation (e.g.: Zoology, Biochemistry ...)** | Quantum Information |
| | |
| **Co-promotion**<br>**Scientific collaboration without co-graduation during doctoral studies within a single university but with the specific expertise of 2 official thesis promoters.** | |
| **As provided for in Article 2 of the Rules and Regulations , are you planning to prepare your PhD. with a co-promoter attached to one of the institutions listed in Appendix 1 of the Rules and Regulations ?** | No |
| | |
| **Joint-doctorate**<br>**Scientific collaboration with co-graduation during full doctoral studies within both universities based on the same research work. This leads to a double degree obtained within both universities involved.** | |
| **Do you plan to prepare your Ph.D. under joint supervision?** | No |

# 2. CURRICULUM VITAE OF THE APPLICANT - ACADEMIC BACKGROUND

| 2.1 EDUCATION: DEGREES OBTAINED | | |
|---|---|---|
| **Diploma 1** | **Diploma level** | Bachelor's degree |
| | **Diploma title** | Bachelor of Science |
| | **Institution** | Indian Institute of Science Education and Research, Mohali |
| | **Graduation date** | 24/05/2016 |
| | **Honours obtained** | 9.4/10 (BS-MS combined) |
| | | |
| **Diploma 2** | **Diploma level** | Master 180 |
| | **Diploma title** | Master of Science |
| | **Institution** | Indian Institute of Science Education and Research, Mohali |
| | **Graduation date** | 24/05/2016 |
| | **Honours obtained** | 9.4/10 (BS-MS combined) |
| | | |
| **Diploma 3** | **Diploma level** | |
| | **Diploma title** | |
| | **Institution** | |
| | **Graduation date** | |
| | **Honours obtained** | |
| | | |
| **Diploma 4** | **Diploma level** | |
| | **Diploma title** | |
| | **Institution** | |
| | **Graduation date** | |
| | **Honours obtained** | |
| | | |
| **Diploma 5** | **Diploma level** | |
| | **Diploma title** | |
| | **Institution** | |
| | **Graduation date** | |
| | **Honours obtained** | |

## 2.2 EDUCATION: DETAILS PER YEAR OF STUDY (including passed, failed or aborted academic years) - in chronological order.

***Complete the table below ONLY if you completed your entire education training under the Bologna system AND in an institution of the French-speaking Community of Belgium.***

| Academic year: | Degree level: | Year within the degree's level | Course title: | Graduation date: | % | Honours: | Institution: |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

## 2.3 EDUCATION: DETAILS PER YEAR OF STUDY (including passed, failed or aborted academic years) - in chronological order.

***Complete the table below for any situation not mentioned in the previous point.***

| Academic year: | Degree level: | Year within the degree's level: | Course title: | Graduation date: | % | Honours: | Institution: | Country: |
|---|---|---|---|---|---|---|---|---|
| 2015-2016 | Master of Science | 3ème année | Physics Major | | | 10/10 | IISER Mohali | India |
| 2014-2015 | Master of Science | 2ème année | Physics Major | | | 9.4/10 | IISER Mohali | India |
| 2013-2014 | Master of Science | 1ère année | Physics Major | | | 9.8/10 | IISER Mohali | India |
| 2012-2013 | Bachelor of Science | 2ème année | Basic Sciences | | | 9.3/10 | | |
| 2011-2012 | Bachelor of Science | 1ère année | Basic Sciences | | | 8.5/10 | | |

## 2.4 MASTER THESIS OR EQUIVALENT

| | |
|---|---|
| **Title of the master thesis or equivalent** | Contextuality in a Deterministic Quantum Theory |
| **Promoter / Director** | Prof Arvind |
| **Honours (or %) obtained** | A |
| **Please upload your master thesis in PDF format** | ThesisBlankFix.pdf (Document attached to the application) |

## 2.5 ACADEMIC MARKS & RANKING

**Within the days after the validation of your form, the F.R.S.-FNRS will send you a message explaining the procedure regarding the sending of the « ranking » document. NOTICE: this document shall NOT be sent by e-mail NOR shall it be downloaded in your application form on Semaphore..**

**The document shall be filled in since the ranking is an element taken into account for the evaluation.**

# 3. CURRICULUM VITAE OF THE APPLICANT - OTHER INFORMATION

## 3.1 SCIENTIFIC AWARDS AND HONOURS

| Name of the award or honours | Institution/Company name | Awarding year |
|---|---|---|
| Junior Research Fellowship (JRF-NET) | CSIR-UGC, India | 2,016 |
| Certificate of Merit for best academic performance (even semester) | IISER Mohali | 2,015 |
| DAAD WISE fellowship for internship in Germany | DAAD, Germany | 2,015 |
| Certificate of Merit for best academic performance (odd semester) | IISER Mohali | 2,014 |
| KVPY fellowship for pre-PhD studies | DST, India | 2,011 |

## 3.2 PUBLICATIONS

| |
|---|
| **Do you have any publications?** |
| Yes/Oui |
| publications_FRIA_atul.pdf (Document attached to the application) |

## 3.3 FULL TEXT VERSION OF YOUR PUBLICATIONS

| |
|---|
| **If you have publications, you can add the full text version of maximum 2 of them (master thesis excluded), which will be made available to the members of the jury.** |
| 1607.03498v1.pdf (Document attached to the application) |
| PhysRevA.92.062107.pdf (Document attached to the application) |

## 3.4 PROFESSIONAL BACKGROUND
**Previous and current work experiences**

| From | To | Institution/Company name | City | Country | Position | Full-time position | Part-time position, % |
|---|---|---|---|---|---|---|---|
| 01/05/2012 | 01/07/2012 | IISER Mohali | Mohali | India | Summer Intern | Yes/Oui | |
| 01/05/2014 | 01/07/2014 | IISER Mohali | Mohali | India | Summer Intern | Yes/Oui | |

## 3.5 PREVIOUS RESEARCH STAYS (mobility)
**Previous research stays (more than 30 days) outside your main host institution.**

| From | To | Institution/Company name | City | Country | Position |
|---|---|---|---|---|---|
| 01/05/2013 | 01/07/2013 | National Physical Laboratory | New Delhi | India | Summer Intern |
| 01/05/2015 | 01/07/2015 | University of Siegen | Siegen | Germany | Summer Intern |

## 3.6 PERIODS OF INACTIVITY

| | |
|---|---|
| **Over the last 5 years, have you been professionally inactive for more than 2 months?** | No/Non |

# 4. INFORMATION ABOUT Ph.D. ORGANISATION

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## 4.1 Ph.D. ORGANISATION

**Article 11 of the Rules and Regulations: "The 1st Grant scheme starts as from the 1st of October. The starting date can be postponed with the agreement of the Secretary-Rapporteur of the FRIA". Attention: previous months between 1st October and the starting date of the grant shall not extend the duration of the grant, under any circumstances**

| | |
|---|---|
| **If you wish your grant to begin beyond 1st October 2016, please indicate the date foreseen.** | |
| **If you wish your grant to begin beyond 1st October 2016, please justify the reason. (e.g. ongoing contract or grant until xxx).** | |

## 4.2 SCIENTIFIC SENIORITY

| | |
|---|---|
| **Number of years dedicated to research after obtaining the second-cycle diploma** | 0 |

## 4.3 HAVE YOU ALREADY STARTED TO WORK ON YOUR Ph.D. THESIS, ON THIS SPECIFIC TOPIC?

**If yes, fill in the table below**

| From | To | Full-time? | If part time, indicate the percentage | Did you obtain a grant/compensation ? | Funding source (if applicable) |
|---|---|---|---|---|---|
| | | | | | |

## 4.4 ADDITIONAL COURSES RELEVANT FOR THE PREPARATION OF YOUR Ph.D.

| Course title | Institution | Number of ECTS | Included in a Ph.D. programme? |
|---|---|---|---|
| | | | |

## 4.5 PLANNED RESEARCH STAYS (mobility)

**Research stays of more than 30 days that you plan to do outside your main host institution.**

| From | To | Institution/Company name | City | Country | Position |
|---|---|---|---|---|---|
| | | | | | |

## 4.6 ADDITIONAL SCIENTIFIC ACTIVITIES including relevant activities for the present project (in this case, please specify them clearly)

**Indicate, if applicable, your additional scientific activities (e.g. supervising practical works, taking part in conferences, assisting research…)**

# 5. DESCRIPTION OF THE RESEARCH PROGRAMME

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| 5.1 PROPOSAL: GENERAL INFORMATION | |
|---|---|
| **Main language of the proposal** | English/Anglais |
| **Title of the project** | A continuous variable approach towards Quantum Cryptography and Communication Complexity. |
| | Une approche variable continue vers Quantum Cryptography et Communication Complexité. |
| **Shortened title or acronym of the proposal** | CV Quantum Crypt. & Comm. Complexity |
| **Abstract of the project** | Current information processing models are fundamentally limited in terms of speed, efficiency, security and privacy, as they assume a simplified representation of the world, relying on classical physics. In the past few decades, research in the field of quantum information processing promises to break this barrier by achieving the highest security and efficiency allowed by the laws of physics, which suggests that future large-scale network of computing devices will be able to communicate both efficiently and securely using quantum resources.<br><br>However, the development of algorithms and protocols exploiting such a quantum network to its full capacity is hindered by the inherent difficulty at characterising interactive quantum communication models. This is true not only for quantum communication complexity, where few lower bound techniques are known but also for quantum cryptographic primitives, where for example a fundamental primitive such as unconditionally secure weak coin flipping is known to be possible but pragmatically no explicit protocol is known.<br><br>The main objectives of this proposal are to prove tight bounds for quantum communication complexity and to develop optimal and realistic quantum protocols for the main cryptographic primitives. In order to fulfil those objectives, we propose to develop a new framework based on continuous-time communication protocols, where instead of sending messages back and forth, the players interact through a shared messaging system which can be coupled continuously in time to their local workspace. |
| | Les modèles actuel de traitement de l'information sont fondamentalement limités en terne de vitesse, d'efficacité, de sécurité et de privacité car ils reposent sur une représentation simplifiée du monde, basée sur la physique classique. Depuis quelques décades, la recherche en information quantique promet de casser cette barrière en atteignant la sécurité et l'efficacité maximales permises par les lois de la physique, suggérant un futur réseau à grande échelle d'appareils quantiques communiquant efficacement et de manière sécurisée.<br><br>Néanmoins, le développement d'algorithmes et de protocoles exploitant optimalement un tel réseau est limité par la difficulté de caractériser des modèles interactifs de communication quantique. C'est le cas pour la complexité de communication quantique, où peu de techniques de bornes inférieures sont connues, mais aussi pour les primitives cryptographiques, où l'on sait par exemple qu'une primitive fondamentale comme le tirage à pile ou face faible inconditionnellement sûr est possible, bien qu'aucun protocole explicite ne soit connu.<br><br>Les principaux objectifs de ce projet dont de prouver des bornes optimales pour la complexité de communication quantique et le développement de protocoles optimaux pour diverses primitives cryptographiques. Dans ce but, nous proposons de développer un nouveau formalisme basé sur des protocoles de communication à temps continu, où plutôt que de s'échanger des messages, les joueurs interagissent via un système commun couplé continûment dans le temps avec leurs systèmes locaux. |

| 5.2 SUBJECT AREA AND JURY |
|---|
| **Applicants are entitled to select:**<br><br>**- Their subject area: applications will be assessed in accordance with the subject area selected. However, the selection of the subject area must be endorsed by the President of the jury, unless the President is from the same university as the applicant. In that case, the Vice-president instead shall accept or refuse the selection. Moreover, applicants must select two descriptor fields at least corresponding to their subject area. If they select only one descriptor field, they must justify their**<br><br>**- The jury related to the subject area mentioned above. In case of conflict of interest and depending of the number of applicants, the FRIA may assign the applicant to another jury.**<br><br>**No change of the subject area will be accepted once the applicant has validated the application form.** |

Informatics and information systems, computer science, scientific computing, intelligent systems
==> PE6 - jury 1

## 5.3 DESCRIPTOR FIELD OF YOUR PROPOSAL

**Please select 2 to 6 descriptor fields defining your research project and place them in order of relevance.**
**IMPORTANT: you have to contact your promoter in order to complete the descriptor fields and unrestricted keywords.**
**For your information, the composition of the juries is available HERE**

| | Relevance | Selected descriptors |
|---|---|---|
| **1st descriptor** | High | ==> PE6_7 Theoretical computer science including quantum information |
| **2nd descriptor** | Medium | ==> PE2_8 Optics and quantum optics |
| **3rd descriptor** | | |
| **4th descriptor** | | |
| **5th descriptor** | | |
| **6th descriptor** | | |

| | |
|---|---|
| **If you chose only one descriptor relevant to your subject area selection, please justify it** | |

**Optional: in case you are conducting a sustainable development-oriented research project, you can select a descriptor listed in the drop down menu below.**

**Unrestricted keywords :**

## 5.4 RESEARCH PROGRAMME PROPOSAL

| | |
|---|---|
| **Please download and complete the template provided and upload it after you have saved it in a PDF format.**<br><br>**The F.R.S.-FNRS insists on strict compliance of the number of pages allowed for documents that shall be enclosed with the application form and stresses again the sovereign consideration of the Jury in case the file would exceed the applicable page limit.** | FRIA_researchProposal.pdf (Document attached to the application) |
| **Does your research involve experiments or samples on human being/material?** | No/Non |
| **Does your research involve animal experiments?** | No/Non |
| **Does your research involve other ethical issues than the ones mentionned above?**<br>**Note that if available forms hereabove are not relevant for those particular ethical issues, please return this document .** | No/Non |

# 6. ACADEMIC REFEREES

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## 6.1 ACADEMIC REFEREES

**In addition to your promoter, please provide the name of two scientific referees (members of the academic staff of a scientific institution - professor, lecturer - CQ, MR or DR of the F.R.S.-FNRS), who are able to give their opinion on your application.The FRIA will contact them (Please check the validity of the E-mail adresses provided).**
**See informations required from referees**
**Note: Your promoter (not to be included below) will also be required to provide a reference letter at the time of the online validation step of your application.**

| First name | Last name | Email |
|---|---|---|
| Arvind | Arvind | arvind@iisermohali.ac.in |
| Otfried | Guehne | otfried.guehne@uni-siegen.de |

# 7. REFEREES FROM INDUSTRIAL OR AGRONOMIC WORLD

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## 7.1 JUSTIFICATION FOR THE PROSPECTS OF INDUSTRIAL OR AGRONOMIC APPLICATIONS

**Article 2 of the FRIA Rules and Regulations:**
**FRIA grants are strictly restricted to graduates with an academic education who aim to develop their research career in the industry or agriculture. For this purpose, they shall pursue their studies leading to a Ph.D. in a university of the French-speaking Community of Belgium under the supervision of a promoter permanently appointed or on probation (equivalent to a permanent appointment) in that host institution at the time of the validation deadline fixed for the academic authorities (rectors) and a co-promoter (if any) from one of the institutions listed in Appendix 1 .**

| | |
|---|---|
| **Does your doctoral work have short-term or long-term of industrial or agronomic applications prospects?** | Long term |
| **- Description and justification of the prospects**<br>**- If there are no prospects, please indicate "Not applicable"** | Current information processing models are fundamentally limited in terms of speed, efficiency, security and privacy, as they assume a simplified representation of the world, relying on classical physics. In the past few decades, research in the field of quantum information processing promises to break this barrier by achieving the highest security and efficiency allowed by the laws of physics, which suggests that future large-scale network of computing devices will be able to communicate both efficiently and securely using quantum resources.<br><br>Quantum key distribution, for instance, has now even been demonstrated with continuous variables (a second generation task) by QuIC theory group at ULB in collaboration with the Institut d'Optique d'Orsay. Development of quantum technologies is at its pinnacle with the latest being the launch of the first quantum satellite by China. While there are various technical and theoretical challenges still to be addressed, it is reasonable to conclude that in the long term the results obtained from this project will contribute to the commercialising the use of quantum resources. |

## 7.2 REFEREES FROM INDUSTRIAL OR AGRONOMIC SPHERE

**ATTENTION : : in case of short-term prospects, please indicate the name of two referees from the industrial or agronomic sphere that you have contacted (Belgian companies with some exceptions).**

**Important:he FRIA will contact them and they will be required to provide this document by 30thSeptember at the latest.**

| First name | Last name | Institution/Company name | Email |
|---|---|---|---|
| | | | |
| | | | |

# 8. FINAL SECTION

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## 8.1 APPENDICES

**Administrative appendices**

PhD-acceptance-letter-arora.PDF (Document attached to the application)

BS_MS_degree.pdf (Document attached to the application)

marksheet.pdf (Document attached to the application)

**IMPORTANT:**
**Any modification or correction of the proposal will not be accepted after the closing date of the call (validation deadline fixed for the applicants)!**

## 8.2 LANGUAGE IN WHICH THE PROJECT WILL BE DEFENDED

| | |
|---|---|
| **In which language do you wish to defend your project?**<br><br>**Note that in case you are interviewed, you may decide to take your oral examination in French or in English, regardless of the language used to fill in the application form.** | English / Anglais |

## 8.3 AFFIDAVIT

☐ I declare that I have read the Rules and Regulations of the fellowship for which I am applying. I hereby confirm that the information provided in the proposal is correct and complete. I hereby accept that any omission or false statement on my part, even if unintended, may lead to the cancellation of my application.

I note that the names (applicant, possible promoter and host institution) and the data provided in my application file (title, abstract and descriptors) will be made publicly available if the funding is granted, particularly on the website of the F.R.S.-FNRS.

I note that the comprehensive description of my proposal will only be available for evaluation purposes of my application within the framework of the "FRIA"call of the F.R.S.-FNRS.

**You will be informed of the date of your oral examination in early October.**
**You are required to take the examination at the F.R.S.-FNRS, 5 rue d'Egmont, 1000 Brussels. Note that there is no possibility for any applicant to attend this interview on Skype or via any other means.**
**Juries meetings will take place from 10th October 2016 to 14th November 2016. The composition of the juries will be updated on the website during the second week of October.**