Job Information

**Organization/Company** Alma Mater Studiorum, University of Bologna  
**Research Field** Mathematics, Physics

**Researcher Profile** First Stage Researcher (R1)  
**Application Deadline** 15th April 2024  
**Type of Contract** Temporary  
**Job Status** Full-time  
**Job funded through the EU Research Framework Programme** MSCA

Marie Curie Grant Agreement Number: 101119552

**Offer Description**

We are excited to advertise 11 3-year positions for **doctoral candidates** to begin in 2024 as part of the Horizon Europe Marie Skłodowska-Curie Action Doctoral Network (MSCA DN) CaLiForNIA “Cartan and differential geometry, Lie theory, quantum groups and noncommutative geometry For novel and Innovative Applications to quantum algorithms and geometric deep learning”. CaLiForNIA is a research training network, which aims to push the frontier of research in these two key topics, Lie Theory and Cartan Geometry in synergy with the complementary investigations in the areas of Quantum Groups and more generally Noncommutative Geometry, including physical applications. The goal of CaLiForNIA is to apply mathematics originating from the above research to the new and strategic fields of quantum computing and geometric deep learning, top priorities in HorizonEurope.

The consortium includes the following recruiting institutions:

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<th>Alma Mater Studiorum - University of Bologna (UniBo)</th>
<th>IT</th>
<th>Beneficiary</th>
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<td>Masaryk University in Brno (MU)</td>
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<td>Institute of Mathematics of the Czech Academy of Sciences (IMCAS)</td>
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<td>University of Valencia (UEVG)</td>
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<td>University of Amsterdam (UvA)</td>
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<td>University of California (CU)</td>
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<td>University of Auckland (UOA)</td>
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Requirements

Candidates must hold a Master’s degree (specific degrees depending on the positions) with excellent academic transcripts.

We are looking for highly motivated, outstanding students with optimal interpersonal and communication skills.

All candidates must prove full proficiency in spoken and written English.

Eligibility criteria

To be eligible for all positions, the applicants must satisfy the following requirements:

- They must not be already in possession of a doctoral degree.
- They must comply with the MSCA mobility rule: not have resided or carried out their main activity (work, studies, etc.) in the country of the recruiting beneficiary for more than 12 months in the three years immediately prior to their recruitment.

Applicants who will complete their Master’s degree by the deadline for enrolment in the doctoral degree programme are also entitled to apply*.

*Local eligibility criteria apply depending on each position and beneficiary institution. Please check the individual position description on the website

Additional Information

Benefits

- A PhD thesis co-supervised by two main supervisors (Supervisor #1 and Supervisor #2) from two different institutions and access to two research environments.
- Further intersectorial and international experience through a two months secondment at partner organisations.
- The opportunity to work in a multidisciplinary team within a world-wide consortium of research institutions and industrial partners.
- An extensive network-wide training program.
- Doctoral Candidate (DC) are funded by the Marie Skłodowska-Curie Actions (MSCA) of the European Union’s “Horizon Europe” research and innovation program under grant agreement No 10119552.
- The MSCA programme offers competitive and attractive working conditions. The successful candidates will receive a salary in accordance with the MSCA regulations for doctoral candidates. Gross salary will consist of a Living Allowance
(= € 3.400/monthly, correction factor to be applied per country) and a monthly Mobility Allowance of €600. An additional monthly family allowance of €660 is applicable depending on family situation (for additional information see the EU MSCA website). Please be aware that these amounts are subject to taxes, the exact salary will be confirmed upon employment.

Additional comments
Starting dates of the projects will be between 01/06/2024 and 30/11/2024.

Where to apply
All the application material should be sent to the following mailbox: 2024callcalifornia@gmail.com.

Contact
For more information see the project’s website https://site.unibo.it/california-msca-se/en
For questions about the application procedure please contact: 2024callcalifornia@gmail.com.

Selection process
The selection procedure will consist of the following steps:

- **Eligibility check**: The Recruitment Committee will check that each application is complete and that applicants fulfill the eligibility criteria described in the previous sections.
- **Remote Evaluation**: Each eligible application will be evaluated independently by the Selection Committee according to the project options expressed by the applicants.
- **Online interviews**: The short-listed candidates will be interviewed by the Selection Committee that will include the recruiting Supervisors plus one/two additional consortium members and/or external members with a balance in terms of gender (not less than one-third), geography and academic/private sector representation. Candidates, positively evaluated, but not initially called for interviews, will be put on a reserve list (for reallocation in case of candidate(s) withdrawal).
- **Notification of the selection outcomes**: Short-listed candidates will be informed about the outcome, and those selected will be put in touch with the corresponding Supervisors and the HR Department of the hosting institution to initiate the hiring procedure. Applicants who have not been successful, but who have received a positive evaluation, will be put on a reserve list to cover possible renunciations and future selections.

Recruitment calendar:

- Call opening: 13th February 2024
- Deadline for applications: 15th April 2024
- Remote evaluation: 16th April - 30th April 2024
- Interviews: (selected candidates will receive notice of at least 10 days prior to the interview): 1st May - 30th May 2024
- Notification to candidates: 15th June 2024
- Start date of the fellowship: September/November 2024

**Company/Institute**  
Alma Mater Studiorum University of Bologna  
**Country**  
Italy  
**City**  
Bologna

### How to apply

Candidates are required to submit the following supporting documents through/to

1. The Application form template including personal information; education and research experiences, language and other relevant skills; contact details of at least two scientists for reference; list of up to three positions each candidate is interested in.
2. Curriculum Vitae.
3. A certified/signed copy of a recent transcript of exams taken with relative marks. A certified/signed copy of Master of Science certificate.
4. A motivation letter (maximum 1 page) highlighting relevant research experience, skills and academic achievements and explaining why they are interested in the program and in the selected research projects.
5. Two letters of support provided by academics or research professional. The letters should be sent directly by the letter writers to 2024callcalifornia@gmail.com

**DC1 – Cartan Connections and Representation Theory**

**PhD Enrolment:** Masaryk University – Czech Republic

**Supervisor #1:** Katharina Neusser (MU)

**Supervisor #2:** Ashwin Rod Gover (UOA)

**Objectives:** Investigate various aspects of rigid geometric structures using Cartan connections and methods from representation theory.

**Expected outcomes:** New advances in the theory of Cartan connections and their applications to problems in differential and complex (algebraic) geometry, as well as physics.

**Requirements**

**Research Field:** Mathematics  
**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics.
- General knowledge of Differential Geometry.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences
DC2 – Geometric Control Theory

PhD Enrolment: Masaryk University – Czech Republic

Supervisor #1: Jan Slovak (MU)

Supervisor #2: Andrew Waldron (UC)

Objectives: Find new geometric techniques via Cartan geometry and tractor calculus for the geometric control theory problems, including singularities

Expected outcomes: Extending the alternative method to understand the coupled ODE systems describing the normal extremals, to include singularities.

Requirements

Research Field: Mathematics
Education Level: Master’s degree or equivalent

Specific requirements:
- MSc degree in mathematics or physics.
- General knowledge of Differential Geometry.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences.

DC3 – Contact Geometry with Boundary for Applications

PhD Enrolment: Alma Mater Studiorum – Universita’ di Bologna - Italy

Supervisor #1: Emanuele Latini (UniBO)

Supervisor #2: Andrew Waldron (UC)

Objectives: Generalize, in terms of the curved orbit decomposition program, tractor calculus and the notion of defining densities for the study of conformal manifolds as the asymptotic boundary of a certain Poincare´-Einstein manifolds

Expected outcomes: A better understanding of physical applications (Schroedinger equation), in the context of contact geometry with asymptotic boundary. A theoretical framework for applied problems, e.g. (quantum) information geometry.

Requirements

Research Field: Mathematics, Physics
Education Level: Master’s degree or equivalent

Specific requirements:
- MSc degree in mathematics or physics.
- General knowledge of Differential Geometry and Quantum Mechanics.
- Excellent English language communication skills (written and spoken).
Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC4 – Quantum Flag Manifolds and C*-Algebras**

**PhD Enrolment:** Institute of Mathematics of the Czech Academy of Sciences and Charles University – Czech Republic

**Supervisor #1:** Karen R. Strung (IMCAS)

**Supervisor #2:** Peter Somberg (CU)

**Objectives:** Extend known constructions of graph C*-algebra models for the C*-algebras of quantum homogeneous spaces of Drinfeld–Jimbo quantum groups.

**Expected outcomes:** A new insight in the calculation of explicit K- and KK-theory classes of homogeneous spaces in the C*-algebraic context.

**Requirements**

**Research Field:** Mathematics.

**Education Level:** Master's degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics.
- Some knowledge of Analysis.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC5 – Baum-Connes Conjecture for Quantum Symmetric Spaces**

**PhD Enrolment:** Charles University – Czech Republic

**Supervisor #1:** Réamonn Ó Buachalla (CU)

**Supervisor #2:** Ferdinando Zanchetta (UniBO)

**Objectives:** To produce a BGG style description of the Lusztig anti-holomorphic differential calculus of the A-series quantum flag manifolds. To build on this and produce a quantum Dolbeault-Dirac operator, and investigate its analytic properties in the context of Connes' notion of a spectral triple.

**Expected outcomes:** A more formal geometric framework on quantum differential calculus that we extend to the higher orders, where quantum Dolbeault–Dirac operator for the full quantum flag (A type) is replaced by an operator constructed from the quantum BGG sequence of Uq(sln).

**Requirements**

**Research Field:** Mathematics.
**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Differential Geometry.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC6 - Quantum Harmonic Superspace and Unitary Representations**

**PhD Enrolment:** University of Valencia - Spain

**Supervisor #1:** Maria A. Lledo (UVEG)

**Supervisor #2:** Rita Fiorese (UniBO)

**Objectives:** Generalize the Mackey machine to supersymmetry (SUSY).

**Expected outcomes:** Obtain Quantum Minkowski Superspace as homogeneous space together with Poincaré quantum supergroup unitary representations (arbitrary spin representations).

**Requirements**

**Research Field:** Physics.

**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Quantum mechanics and Geometry.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC7 – Quantum Information Geometry**

**PhD Enrolment:** University of Valencia - Spain

**Supervisor #1:** Armando Perez-Canellas (UVEG)

**Supervisor #2:** Elisa Ercolessi (UniBO)

**Objectives:** To investigate Fisher information as a geometric resource in quantum metrology and quantum machine learning.

**Expected outcomes:** To improve the performance of variational algorithms, with application to quantum machine learning and quantum metrology.

**Requirements**

**Research Field:** Mathematics, Physics.
**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Quantum Theory.
- Excellent English language communication skills (written and spoken).
- Available for long visits travels to perform research at consortium partners as well as available for short visits travels to consortium meetings and/or conferences.

**DC8 – Quantum Algorithms**

**PhD Enrolment:** Alma Mater Studiorum – Universita’ di Bologna - Italy

**Supervisor #1:** Elisa Ercolessi (UniBO)

**Supervisor #2:** Armando Perez-Canellas (UVEG)

**Objectives:** Exploit the geometry of quantum states to develop more efficient schemes for hybrid quantum-classical variational algorithms.

**Expected outcomes:** Integration of the quantum circuit and the optimization part in order to take full advantage of the properties of the quantum space where evolution and measurements occur.

**Requirements**

**Research Field:** Physics.

**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Quantum Mechanics and Computer Science.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences.

**DC9 – Geometric Deep Learning**

**PhD Enrolment:** Alma Mater Studiorum – Universita’ di Bologna - Italy

**Supervisor #1:** Rita Fioresi (UniBo)

**Supervisor #2:** Jan Slovak (MU)

**Objectives:** Exploit sheaf theory and information geometry to understand parameter and data spaces in group equivariant graph neural network.

**Expected outcomes:** New emerging algorithms through group equivariance of graphs. New sheaf theoretic approach to graph convolutions. New application to biological data analysis.

**Requirements**
**Research Field:** Mathematics, Physics.
**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Differential Geometry and Computer Science.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC10 – Geometric Deep Learning**

**PhD Enrolment:** University of Amsterdam - Netherlands

**Supervisor #1:** Erik Bekkers (UvA)

**Supervisor #2:** Rita Fiorese (UniBo)

**Objectives:** Understand group equivariant graph neural network.

**Expected outcomes:** New emerging algorithms through group equivariance of graphs. New application to biological data analysis.

**Requirements**

**Research Field:** Mathematics, Physics.
**Education Level:** Master’s degree or equivalent

**Specific requirements:**
- MSc degree in mathematics or physics or related fields.
- General knowledge of Differential Geometry and Computer Science.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

**DC11 – Palatini -- Cartan Formalism**

**PhD Enrolment:** University of Zurich - Switzerland

**Supervisor #1:** Alberto Cattaneo (UZH)

**Supervisor #2:** Emanuele Latini (UniBo)

**Objectives:** Bring BV, BFV formalisms centerstage to develop a new approach to Palatini gravity.

**Expected outcomes:** new differential geometric and representation theory tools for the WP3, WP4.

**Requirements**

**Research Field:** Physics.
**Education Level:** Master’s degree or equivalent
Specific requirements:

- MSc degree in mathematics or physics or related fields.
- General knowledge of Differential Geometry and Physics.
- Excellent English language communication skills (written and spoken).
- Available for long term visits to perform research at consortium partners as well as available for short term visits to consortium meetings and/or conferences

For further information:
https://site.unibo.it/california-msca-se/en
Inquire at:
2024callcalifornia@gmail.com