

Application	Date Submitted:	
	Cycle: 2026	
	If renewal, current grant:	
	Resubmission?	Prior App:
TITLE OF PROJECT		
APPLICANT NAME	HIGHEST DEGREE(S)	
POSITION TITLE:	APPLICATION CURRENT INSTITUTION ADDRESS (Street, city, state, postal code, country)	
ACADEMIC RANK:		
DIVISION:		
DEPARTMENT:		
E-MAIL ADDRESS:		
Tel:	Fax:	
PROGRAM ELIGIBILITY INFORMATION: (Responses to selected fields displayed below. For some grant programs this section may be blank.)		
	PhD Start Date:	Country of PhD:
	PhD Conferral Date:	Date Tentative?
	Title & Field of PhD:	
DATES OF PROPOSED PROJECT (MM/DD/YYYY) From Through		Secondary Host Institution
HOST INSTITUTION Name Address Tel: EIN DUNS		Have you lived or worked in the Host Country previously? Have you worked at the Host Institution previously? Arrival or Intended Arrival Date at Host Institution If yes to any of the previous questions, give description:

Applicant:

Application Contacts

Role				Role			
Name				Name			
Institution				Institution			
Title				Title			
Division				Division			
Dept				Dept			
Address				Address			
Tel:		Fax:		Tel:		Fax:	
E-mail				E-mail			
Role				Role			
Name				Name			
Institution				Institution			
Title				Title			
Division				Division			
Dept				Dept			
Address				Address			
Tel:		Fax:		Tel:		Fax:	
E-mail				E-mail			
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Title				Title			
Division				Division			
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Address				Address			
Tel:		Fax:		Tel:		Fax:	
E-mail				E-mail			

Proposal To:	HFSP - Postdoctoral Fellowship: Long-Term Fellowship
Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Title Page

Before going further please **read the application guidelines for the Long-Term Fellowships**, which include an overview of the scope and eligibility requirements for this program.

The guidelines can be found under 'Support Links' in the left menu bar.

Deadline to initiate a Letter of Intent: 1pm U.S. Eastern Time on May 7, 2025.

The initiation is completed once the title page has been saved, and a 7-digit LOI ID (1XXXXXX) appears under "Proposal Identifiers", at the bottom of the left menu bar.

Deadline to submit a Letter of Intent: 1pm U.S. Eastern Time on May 15, 2025.

Technical Support hours for ProposalCentral are 8:30am to 5pm U.S. Eastern Time Monday-Friday. You can contact ProposalCentral at pcsupport@altum.com or by calling toll-free 1-800-875-2562 (U.S. and Canada) or 1-703-964-5840 (international direct dial).

We recommend that, from time to time, you go to Section 11 (Validate) and click the "Validate" button to generate a list of any missing required information or files, and again as a final check before submitting your Letter of Intent.

*** Title of Proposal** Inferring cerebellar computations with probabilistic machine learning

If authors use generative AI and AI-assisted technologies in the writing process, these technologies should only be used to improve readability and language of the application, not for creating content. Authors are requested to disclose their use of AI and AI-assisted technologies in the application. HFSP reserves the right to check the use of AI tools with appropriate software and to take the outcome into consideration in the evaluation of applications.

*** Did you use AI, or AI-assisted technologies, in the writing process?** No

Please help us optimize our information sources by telling us where you first read or heard about the current call for HFSP Fellowship applications.

*** Feedback** Other

If Other: My host supervisor

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Applicant

The person who creates the Letter of Intent is automatically registered as the Applicant. Any contact information that you have entered in your ProposalCentral Professional Profile is populated in the fields below. To update or complete this information, click 'Edit Professional Profile'.

The email address shown below will be used for all correspondence and notifications related to your application. It should thus remain valid during the entire review process and the entire funding period, if the application is successful. **Should this email expire in the coming months, please replace it with an email address that will remain valid.**

Note that you do **not** need to complete your ProposalCentral Professional Profile entirely, only the areas marked with a red *

Applicant Petkovic, Janko - University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn)

* ORCID iD:  <https://orcid.org/0009-0009-7455-9484>

* ORCID Authorization: Petkovic, Janko has authorized **Human Frontier Science Program** to add awards to ORCID profile.

Name: Prefix _____ * First Janko Middle _____ * Last Petkovic

* Highest Degree(s) M.D.

Other Degree(s) B.S.

Position/Title Doctoral Student

* Current Institution University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn)

* Department Mathematics and Life Sciences

Current Address

* Street Regina-Pacis-Weg 3

* City Bonn State/Province Does Not Apply * Zip/Postal Code 53113 * Country Germany

* E-Mail j.petkovic91@gmail.com

Phone: Work: _____

To register your degrees, please select the “Edit Professional Profile” button above and then navigate to Section 2 (Degrees) on the left menu bar.

Please list ALL your degrees in the appropriate sections. The Pre-doctoral degrees correspond to the Baccalaureate Degrees in the Professional Profile and the Doctoral Degrees correspond to the Post Baccalaureate Degrees.

List your doctoral degree in the "Professional Profile" even if it has not yet been conferred (completed).

* Pre-doctoral degrees (e.g. Bachelor, Master, etc.)	Degree	Other Degree	Institution	Year
	Other	Bachelor's Degree	Università di Bologna	2021
* Doctoral degrees (e.g. PhD, MD, etc.)	Degree	Other Degree	Institution	Year
	Other	Medical Degree	University of Bologna	2016

Provide additional information about your PhD.

* PhD Start Date:	1/1/2022
* PhD Conferral (Completion) Date:	1/8/2025
* Is the Conferral date tentative?	Yes
* Title and Field of PhD	Computational Neuroscience
* PhD Institution Name	Bonn University
* PhD Department	Department of Mathematics and Life Sciences
* PhD Institution City	Bonn
* Country in which PhD was/is	Germany

In the CV section below, **list in chronological order, starting with the most recent activity up to the submission date of the Letter of Intent, ALL:**

- Periods of university education, research experiences, research training or lab rotations included in the degree program;
- Other activities: full/part time positions (inside/outside science), volunteer work, travel and periods when you did not work or study (parental leave, illness, civil or military service, full time care for an immediate family member, unemployment, etc.)

DO NOT INCLUDE conferences attendances or presentations, supervision of students, abstracts of projects, publications, etc.

LEAVE NO GAPS IN YOUR TIMELINE! Entries with overlapping periods are fine.

Please register each item in a separate line and use the following format:

11/2014 to 10/2015: institution, city, country, activity, supervisor.

Please see the CV example by clicking on the information (?) button.

*** CV**

Education and academia:

10/2024 - present

Bonn University | Germany

Doctoral studies

Tchumatchenko Lab for Theoretical and Computational Neuroscience

01/2022 - 9/2024

Mainz University | Germany

Doctoral studies

Tchumatchenko Lab for Theoretical and Computational Neuroscience

09/2017 - 03/2021

Bologna University | Italy

Bachelor's Degree in Physics, cum Laude

02/2017 - 04/2017

Dr. Stefano Zannoni General Practice

Bologna | Italy

Voluntary General Practice internship

02/2017

Bologna University

Medical Abilitation State Exam

11/2016 - 01/2017

Bolzano Hospital (ER, General Surgery); Bologna, Dr. S. Zannoni | Italy

Mandatory Medical Abilitation Internship

09/2010 - 10/2016

Bologna University | Italy

Medical Degree, cum laude

Teaching:

Spring semester 2024, Spring semester 2025

M.Sc. program in Neuroscience, Bonn University | Germany

Computational methods in neuroscience

Medical profession:

09/2020 - 09/2021

AUSL Imola - Bologna province | Italy

COVID-19 primary care physician

06/2017 - 12/2021

AUSL Bologna, AUSL Imola - Bologna province | Italy

On-call general physician

04/2017 - 12/2021

Dr. Stefano Zannoni and Dr. Monica Mascitti general practices, Bologna | Italy

Substitute general physician

In '**Past/Present Fellowships**' please provide: the duration, research topic, location, name of your supervisor and funding agency (EMBO, Marie-Curie, Erasmus, etc.) of all fellowships you have been awarded. Also include any other sources of support such as fellowships or training grants that you hold at the time of submission and which will be activated at the proposed Host Institution.

Please register each item in a separate line.

**Past/Present
Fellowships**

2024-2026

Research topic: linking synaptic protein statistics to plasticity response

Supervisor: Prof. Tatjana Tchumatchenko

Fellowship: Add-on fellowship for interdisciplinary life sciences

Funding agency: Joachim Herz Stiftung

2022-2023

Research topic: biophysical model for synaptic plasticity

Supervisor: Prof. Tatjana Tchumatchenko

Fellowship: Collaborative Research Centre 1080 Fellowship

Agency: Institute for Cell Biology and Neuroscience at Buchmann Institute for Molecular Life Sciences, Goethe University Frankfurt

In '**Additional Comments**' please provide any and all relevant information concerning the evaluation of your research proposal or the eligibility of your application, such as:

- Career interruptions and exceptional circumstances
- 'Exemption to an eligibility rule' that has been previously approved by the HFSP Fellowships Office. Please add the following sentence: 'I was granted an exemption by the Fellowship Office to submit my application' and state (very briefly) the reason for the exemption
- Explanation of publication traditions (authorship policies, venues)
- Information on research articles that are accepted or in press but cannot be registered in Proposal Central, for example if they do not have a DOI (but **DO NOT** list articles which are in preparation, only articles which have been submitted or are still under review)

- Differences in family name (in publications and in the application)
- Explanation of eligibility for applicants with dual nationality who propose to hold the fellowship in one of the countries of which they are a national.

**Additional
Comments**

Proposal To:	HFSP - Postdoctoral Fellowship: Long-Term Fellowship
Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Host Institution

Add/Select the Primary Host

Institution:

VIB institute for Biotechnology, KULeuven, Belgium

*** Department :** Neuroelectronics

Address

Street : 49 Herestraat

City : Leuven

State/Province : Does Not Apply

Zip/Postal Code : 3000

*** Country :** Belgium

Phone : +3249577104

Applicants usually have only one Host Institution (the Primary Host Institution). However, if scientifically required, you may also indicate a Secondary Host Supervisor from the same or a different institution. If so, please add the name and address of the Secondary Host Institution in the text box below. The rules and requirements for all Host Supervisors and Host Institutions are the same.

Please do not register the third year institution/country in this field. At this stage, applicants are not required to provide information about their third year plan.

*** Have you lived or worked in the Host Country previously? :** No

*** Have you worked at the Host Institution(s) previously? :** No

*** Arrival or Intended Arrival Date at Host Institution :** 9/1/2025

Proposal To:	HFSP - Postdoctoral Fellowship: Long-Term Fellowship
Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Host Supervisor(s)

Applicant: Petkovic, Janko | Doctoral Student | University of Bonn (Rheinische Friedrich-Wilhelms-Universität Bonn) | j.petkovic91@gmail.com |

Role	Name	Title	Institution	Email	Phone	Effort	Linked Applications
Primary Host Supervisor	Gonçalves, Pedro	Group Leader	VIB institute for Biotechnology, KULeuven, Belgium	pedro.goncalves@kuleuven.be			

Detailed Information: Pedro Gonçalves

*** Role :** Primary Host Supervisor

Name

*** First :** Pedro

Middle :

*** Last :** Gonçalves

*** E-Mail :** pedro.goncalves@kuleuven.be

Degree(s) : Ph.D.

*** Position/Title :** Group Leader

Institution : VIB institute for Biotechnology, KULeuven, Belgium

Division :

*** Department :** Neuroinformatics

Address

Street :

City :

State/Province : Does Not Apply

*** Country :** Belgium

Zip/Postal Code :

Phone

Work :

*** Please describe if you have already worked, published, or collaborated with the Host Supervisor. If you have not worked with the Host Supervisor, please simply state "no". :**

no

*** Is the Host Supervisor aware of and do they approve of this application? :**

Yes

ORCID iD :

Proposal To:	HFSP - Postdoctoral Fellowship: Long-Term Fellowship
Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Information on Previous Research

Please provide the title, abstract, and keywords of your PhD research.

It is not possible to include graphics or figures.

* Title of PhD Research

Protein dynamics underlying multi-spine plasticity

* Abstract of PhD Research

Synaptic plasticity is a complex biological phenomenon, driven by thousands of molecular factors. Despite a substantial corpus of theoretical work, a unifying model able to reconcile the diverse, at times contradictory, experimental plasticity observations is still missing. We approach this problem starting with the design of a multi-spine plasticity model, strictly deriving its equations from the biochemical processes underpinning synaptic change. To allow mathematical tractability, and in accordance with the literature, we consider the two main dynamical processes driving plasticity at the minute-to-hour timescale, i.e. protein phosphorylation and protein diffusion. We show that the deriving high-dimensional system of coupled partial and ordinary differential equations can be solved in closed form by recurring to quasi-steady-state approximation, and robustly fit to experimental data using newly developed optimization techniques. Ultimately, we are able to show, with the aid of the optimized model, how the many and diverse features of synaptic plasticity observed throughout the literature can be recovered with a single diffusion-reactive mechanism. This framework allows us also to disentangle the average properties of the synaptic plasticity response (e.g., the mexican-hat like potentiation profile) from their stochastic counterparts, emerging from the log-normal-like synaptic protein statistics. In particular, we show these statistics are able to account for the widely observed inverse relationship between a spine's initial size and its tendency to undergo potentiation.

* Keywords of PhD Research

Synaptic plasticity, biophysical modeling, model optimization, model selection, stochastic process

Only fill out the fields below if you are currently working, or previously worked, in a postdoctoral position on a project different from your current HFSP Fellowship application. If applicable, please provide the project title, abstract, and keywords of the other postdoctoral position. It is not possible to include graphics or figures.

Do not add information on the research project proposed in this current application in these fields.

Project title of other Postdoctoral Position (if applicable)

Abstract of other Postdoctoral Position (if applicable)

Keywords of other Postdoctoral Position (if applicable)

Proposal To:	HFSP - Postdoctoral Fellowship: Long-Term Fellowship
Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Proposed Research Plan

Below, provide a summary of the scientific content of the proposed project (3000 characters maximum, including spaces and punctuation). It should consist of text only, with no special characters or formatting. It is not possible to include graphics or figures in this field.

Please read the application guidelines and click the information button (?) for more details.

*

Growing evidence is suggesting that vertebrate adaptability relies on the cerebellum's capacity to channel information well beyond its traditionally known motor pathways. In particular, researchers in the field have discovered novel projections to sub-cortical and reward related regions (Washburn et al. 2024; Ohmae and Medina 2015; Washburn et al. 2024; Wagner et al. 2017), observing that the cerebellum is involved in a plethora of tasks not directly related to movement tuning (Strick, Dum, and Fiez 2009; Overwalle et al. 2014). Despite this improvement in phenomenological understanding, the grounding theoretical principles driving cerebellar computations are still strongly debated.

To address this question, several computational models have been proposed, dissecting specific functional aspects and leveraging different mathematical frameworks (Schepper et al. 2021; D'Angelo et al. 2016; Diedrichsen et al. 2019). We plan to build on top of this work and propose a unified theoretical framework of cerebellar computation by integrating model selection and inference theory with experimental validation and neuromorphic applications.

We will start by studying the equivalence of the proposed models with respect to their emerging behaviour, framing the question as a model degeneracy (or robustness) problem (Calaim et al. 2022; Gonçalves et al. 2019). To tackle this problem, we will start by characterizing the models' parameter space using simulation-based inference (Lueckmann et al. 2017), leveraging the latest toolkit developments achieved in our group (Tejero-Cantero et al. 2020; Deistler et al. 2024). Coupling this approach with summary statistic design and dimensionality reduction techniques (Pellegrino et al. 2024; Cenedese et al. 2022) we will characterize these parameter spaces in terms of their computational features, lowdimensional dynamics, and other optimality metrics such as energy efficiency (Jedlicka et al. 2022). With the aid of variational inference techniques (Bishop 2006; Luo 2022), we will search for common latent factors that underpin these emerging features across different models, ultimately separating a healthy neuronal circuit from a pathological one.

Building on these insights, we will develop a new computational model, and test the predictions of our theoretical framework on existing human and animal cerebellar datasets (Kumar et al. 2022; Mayoral-Palarz et al. 2022). Moreover, in strict collaboration with experts in the field (Ribar and Sepulchre 2020), we will investigate how the newly discovered factors can be applied to neuromorphic networks to achieve a superior degree of robustness in motor control tasks.

In summary, by bridging advanced parameter inference, model selection and experimental data analysis, this project will unveil the foundational principles underlying cerebellar computations. This will ultimately pave the way to novel diagnostic approaches and resilient, brain-inspired computational motor controllers.

Select up to five 'Disciplines' from the list below that are applicable to the proposed project. Click (+) to add them to the 'Selected Disciplines' column, on the right.

* Disciplines (choose up to 5)

Selected Disciplines

biology_theoretical

computational biology

computer science

neuroscience

neuroscience_computational

Select up to five 'Keywords' from the list below that are applicable to the proposed project. Click (+) to add them to the 'Selected Keywords' column, on the right.

* Keywords (choose up to 5)

Selected Keywords

artificial intelligence

brain modeling

motor control

neural computation

Parkinson's disease

*** Please provide information on the unique skillset(s) and expertise you will bring to the Host Laboratory, based on your unique scientific background and training (approx. 2-3 sentences).**

In my professional experience as a medical doctor I have gained substantial knowledge about the clinical side of research and, more importantly, developed the interpersonal and practical skills to gauge the clinical applicability of a line of research. During my PhD I had extensive exposure to model design and optimization, building on top of the knowledge I acquired during my Physics B.Sc. in several directions (e.g., dynamical system's theory, PDE theory, probability theory).

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Proposal By:	Petkovic, Janko - 1516656
Institution:	VIB institute for Biotechnology, KULeuven, Belgium

Publications

1. *Petkovic J; Fioresi R, **(C)Spontaneous Emergence of Robustness to Light Variation in CNNs With a Precortically Inspired Module.**, *Neural computation*, 36, , 1832-1853, 2024 Aug 01.
2. #Rita Fioresi; #A. Marraffa; #J. Petkovic, **(C)A new perspective on border completion in visual cortex as bicycle rear wheel geodesics paths via sub Riemannian Hamiltonian formalism**, *Differential Geometry and its Applications*, -, , -, 2024 Jun.
3. #Maximilian Eggl; #Thomas E. Chater; #Janko Petkovic; Yukiko Goda; Tatjana Tchumatchenko, **(B)Linking spontaneous and stimulated spine dynamics**, *Communications Biology*, 6, , -, 2023 Sep 11.

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Additional Information on Publications (Mandatory)

Current Additional Information on Publications Attachment

Type	Description	File Type	File Size	Date
Additional Information on Publications		.pdf	82444	5/14/2025 11:49:22 AM

ADDITIONAL INFORMATION ON PUBLICATIONS

Please provide additional information on **ALL** of your **publications** and **preprints** which are **published, in press, or have been accepted**. DO NOT list articles which are in preparation, submitted, nor 'accepted, pending revision'. Do not list conference abstracts.

Total number of original research papers (including middle authorship):

Number of original research papers in which applicant is lead author (first or co-first):

Within the relevant categories (A, B, C, or D), list the publications in chronological order (starting with the most recent). Please add lines if necessary.

#	Title of the publication	Year of publication	Published in an international peer reviewed journal?	Name of Journal	First or joint first author? Use * for lead author and # for joint first author	Type of contribution (e.g., performed the key experiments, designed the study, provided reagents etc.)
(A) Applicant's co-publications with proposed host supervisor(s)						
1.			Select...			
2.			Select...			
(B) Original research paper(s) from the applicant's PhD thesis						
1.	Linking spontaneous and stimulated spine dynamics	2023	Yes	Communications Biology	#	Dataset analysis, model development, manuscript preparation
2.			Select...			
(C) Other peer-reviewed research papers of the applicant, including peer-reviewed book chapters						
1.	A new perspective on border completion in visual cortex as bicycle rear wheel geodesics paths via sub Riemannian Hamiltonian	2024	Yes	Differential Geometry and its Application	#	Study design, mathematical derivation, manuscript preparation

	formalism					
2.	Spontaneous Emergence of Robustness to Light Variation in CNNs With a Precortically Inspired Module.	2024	Yes	Neural computation	*	Study design, mathematical derivation, model training and evaluation, manuscript preparation
(D) Applicant's Review articles						
1.			Select...			
2.			Select...			