Alexandre Champagne-Ruel

NASA Postdoctoral Program Fellow

Tempe, AZ alexandre.champagne@asu.edu alexandrechampagne.io

Origins of Life • Astrobiology • Complex Systems

ACADEMIC POSITIONS

NASA Postdoctoral Program Fellow **Current**
Arizona State University, Mathis Group *Tempe, AZ*

EDUCATION

Ph.D. Physics **2025**
Université de Montréal *Montréal, QC*
- Thesis: *Spatiality in Prebiotic Evolution: Toward a Physics of the Emergence of Complexity*
- Advisor: Paul Charbonneau

M.Sc. Physics **2020**
Université de Montréal *Montréal, QC*
- Thesis: *From Game Theory to Exobiology: The Emergence of Cooperation as a Critical Phenomenon*
- Advisor: Paul Charbonneau

B.Sc. Physics **2018**
Université de Montréal *Montréal, QC*

B.Sc. Philosophy **2012**
Université de Montréal *Montréal, QC*

PUBLICATIONS & PRESENTATIONS

Manuscripts in preparation

A. **Champagne-Ruel**, "Signals of Life: The Concept of Information in Astrobiology", In prep. 2025.

A. **Champagne-Ruel** and C. Mathis, "Spatial Patterning and Selection: How the Environment Sets the Stage for Complexity", In prep. 2025.

Articles under review

OoLEN, S. Asche, C. Bautista, D. Boulesteix, A. **Champagne-Ruel**, C. Mathis, et al., "What it takes to solve the Origin(s) of Life: An integrated review of techniques", 10.48550/arXiv.2308.11665 (2023), (Submitted to Cell Reports Physical Science).

Published articles

A. **Champagne-Ruel**, S. Zakaib-Bernier, and P. Charbonneau, "Diffusion and pattern formation in spatial games", Physical Review E **110**, 014301 (2024).

A. **Champagne-Ruel** and P. Charbonneau, "A Mutation Threshold for Cooperative Takeover", Life **12**, 254 (2022).

S. Gelin, A. **Champagne-Ruel**, and N. Mousseau, "Enthalpy-entropy compensation of atomic diffusion originates from softening of low frequency phonons", Nature Communications **11**, 3977 (2020).

Invited talks

A. **Champagne-Ruel**, "Physics of Complexity And Agnostic Life Detection", Trottier Institute for Research on Exoplanets (Canada), 2025.

A. **Champagne-Ruel**, "Spatial Patterning and Selection: How the Environment Shapes Molecular Complexity", Max Planck Institute for Terrestrial Microbiology (Germany), 2025.

A. **Champagne-Ruel**, "From Emergent Complexity to Reliable Life Detection", Arizona State University, 2024.

A. **Champagne-Ruel**, "Cooperation and the Origin of Life", Quantum Photonics Clubhouse Podcast, 2022.

A. **Champagne-Ruel**, "Coopération, émergence et transitions: comment la physique statistique peut nous éclairer sur la question des origines", Qu'est-Ce Qu'expliquer Une Origine En Science ? (CIRST, UQAM), 2022.

Oral presentations

A. **Champagne-Ruel** and C. Mathis, "From Emergent Complexity to Reliable Life Detection", BEACON (Iceland), 2025.

A. **Champagne-Ruel**, "Diffusion: an Overlooked Driver of Prebiotic Complexity", AbSciCon (Providence), 2024.

A. **Champagne-Ruel**, "Théorie de l'information et origine de la vie", 90e Congrès de l'ACFAS, 2023.

A. **Champagne-Ruel**, "A Mutation Threshold for Cooperative Takeover", AbSciCon (Atlanta), 2022.

A. **Champagne-Ruel**, "Cooperation: an emergent universal feature at the dawn of life", Interdisciplinary Origin of Life Meeting for Early Career Researchers (Montréal), 2022.

A. **Champagne-Ruel**, "Mutation favors the emergence of cooperation", Life and Space Poland, 2021.

A. **Champagne-Ruel**, "La criticalité dans un système évolutif artificiel", Centre de Recherche En Astrophysique Du Québec (CRAQ) - Rencontre Annuelle, 2019.

Posters

A. **Champagne-Ruel**, C. P. Kempes, and C. Mathis, "Mapping molecular complexity for agnostic life detection", NASA Postdoctoral Program Virtual Symposium, 2025.

A. **Champagne-Ruel**, A. Demers-Bergeron, and P. Charbonneau, "L'émergence de la coopération via l'évolution de réseaux informationnels", 90e Congrès de l'ACFAS, 2023.

A. **Champagne-Ruel**, S. Zakaib-Bernier, and P. Charbonneau, "Diffusion, structures spatiales et origine de la vie", 90e Congrès de l'ACFAS, 2023.

S. Asche, A. **Champagne-Ruel**, S. F. Jordan, M. Preiner, A. d. N. Vieira, J. C. Xavier, et al., "OoLEN - The Origin of Life Early-career Network: Building the community needed to solve the problem", AbSciCon Atlanta, 2022.

A. **Champagne-Ruel**, "A Mutation Threshold for Cooperative Takeover", Gordon Research Conference: Environments for the Origins of Life and Habitability (Oxnard), 2022.

A. **Champagne-Ruel**, "A Mutation Threshold for Cooperative Takeover", Gordon Research Seminar: Challenging Paradigms in Prebiotic Chemistry (Oxnard), 2022.

A. **Champagne-Ruel** and P. Charbonneau, "Les mutations favorisent la coopération en contexte évolutif", Centenaire, Département de Physique, Université de Montréal, 2021.

A. **Champagne-Ruel** and P. Charbonneau, "Mutation favors the emergence of cooperative behavior", Molecular Origins of Life Munich, 2021.

A. **Champagne-Ruel** and P. Charbonneau, "Mutations promote cooperation in an evolutionary setting", XIXth ISSOL Conference, 2021.

A. **Champagne-Ruel** and P. Charbonneau, “Self-organized criticality : a prelude to avalanche models of solar flares”, Space Climate 7 Symposium, 2019.

Press Coverage

É. Beaudoin-Paul, “Entrevue avec Alexandre Champagne-Ruel, récipiendaire de la prestigieuse bourse en astro-biologie de la NASA”, Quartier Libre (2025).

A. Riopel, “Comment reconnaître la vie sur d’autres planètes”, Le Devoir (2023).

GRANTS & AWARDS

NASA Postdoctoral Fellowship ***Project: Mapping Molecular Complexity for Agnostic Life Detection***	146,496 USD	**2025**
Mobility Scholarship (FAÉCUM)	500 CAD	**2025**
Mobility Scholarship (UdeM)	1,500 CAD	**2025**
Google Cloud Research Grant	1,000 USD	**2024**
J. Armand Bombardier Scholarship	10,000 CAD	**2024**
Globalink Research Award (Mitacs Canada)	6,000 CAD	**2024**
Mobility Scholarship (UdeM)	2,000 CAD	**2024**
Mobility Scholarship (CRAQ)	3,000 CAD	**2024**
Google Cloud Research Grant	1,000 USD	**2024**
J. Armand Bombardier Scholarship	10,000 CAD	**2023**
Excellence Award (UdeM)	5,000 CAD	**2023**
Google Cloud Research Grant	1,000 USD	**2022**
J. Armand Bombardier Scholarship	10,000 CAD	**2022**
Doctoral Scholarship (FRQNT)	70,000 CAD	**2022**
Best Poster Award (UdeM)	250 CAD	**2021**
Student Initiative Project (UdeM)	2,000 CAD	**2021**
Scholarship for Transition to PhD (UdeM)	2,500 CAD	**2020**
Excellence Award (UdeM)	1,000 CAD	**2020**
Excellence Award (UdeM)	10,000 CAD	**2018**
John Low Brebner Scholarship (RQMP)	2,500 CAD	**2017**
Excellence Scholarship (UQAM)	4,000 CAD	**2014**
Student Initiative Project (UdeM)	1,000 CAD	**2011**

CONFERENCES & WORKSHOPS

NASA Postdoctoral Program Virtual Symposium *NASA*	**2025** *Virtual*
Assembly Theory for Folded Matter *Santa Fe Institute*	**2025** *Santa Fe, NM*
Biennial European Astrobiology Conference (BEACON) *European Astrobiology Institute*	**2025** *Reykjavik, Iceland*
Information Driven States of Matter *University of Rochester*	**2024** *Rochester, NY*

AbSciCon **2024**
NASA / American Geophysical Union *Providence, RI*
Origine de la vie : de l'astrophysique à la philosophie **2023**
90e Congrès de l'ACFAS *Montréal, Canada*
Interdisciplinary OoL Meeting **2022**
OoLEN *Montréal, Canada*
Qu'est-ce qu'expliquer une origine en science? **2022**
CIRST / UQAM *Montréal, Canada*
AbSciCon **2022**
NASA / American Geophysical Union *Atlanta, GA*
XIXth ISSOL conference **2021**
International Society for the Study of the Origin of Life *Online*
Life and Space Conference **2021**
Polish Astrobiological Society *Online*
Molecular Origins of Life Munich **2021**
CRC 235 Emergence of Life *Online*
Space Climate 7 **2019**
Université de Montréal *Online*
Annual Meeting **2019**
Center for Research in Astrophysics of Québec *Saint-Alexis-des-Monts, Canada*

TEACHING EXPERIENCE

Mentor – Biocomputing Scholars program **2025 – 2026**
Arizona State University *Tempe, AZ*
Undergraduate Internship Supervision **2022**
Université de Montréal *Montréal, QC*
Teaching Assistant – Introduction to Astrobiology **2021 – 2022**
Université de Montréal *Montréal, QC*
Tutoring – Undergraduate Level **2018 – 2022**
Université de Montréal *Montréal, QC*

SERVICE & OUTREACH

Positions

Member of the Executive Board **2022 – Present**
Origin of Life Early-career Network (OoLEN)
Origin of Life Digest (link) **2021 – Present**
Editor

Conference Organization

- **Interdisciplinary Origin of Life Meeting (Japan, 2026)** (Organizing Committee)
- **Frontiers in Astrobiology and Origins of Life Conference (Iceland, 2025)** (Organizing Committee)
- **Origine de la vie : de l'astrophysique à la philosophie (Canada, 2023)** (Lead Organizer)
- **Interdisciplinary Origin of Life Meeting for Early Career Researchers (Canada, 2022)** (Lead Organizer)
- **Space Climate 7 (Canada, 2019)** (Local Organizing Committee)

Session Convener

- **AbSciCon (Madison, 2026)**: *Assembly Theory Across Scales: From Molecules to Planetary Systems*
- **AbSciCon (Madison, 2026)**: *Exploring self-assembly and self-organization: from prebiotic molecules to the emergence of organic complexity and implications towards the future exploration of Ocean Worlds*

Reviewing Activities

- Royal Society Open Science

Memberships

- International Society for Artificial Life
- Center for Research in Astrophysics of Québec
- Canadian Association of Physicists
- Canadian Astronomical Society
- Origin of Life Early-career Network
- International Society for the Study of the Origin of Life
- Complex Systems Society
- Scientific Society for Astrobiology (Founding Member)

SKILLS

Languages: Fluent in Spoken/Written French, English

Programming: Python, C++, Fortran, Julia, R, LaTeX, MatLab, Assembly, Bash, CSS

Modeling: Agent-based, Evolutionary Algorithms, Machine Learning, Network Theory, Game Theory

Operational: Linux, High Performance Computing (HPC), Git, Web Development, Network Security