

Faculty of Science and Engineering

Profile report: Dynamical Systems (Dynamische Systemen)

- Discipline: Mathematics
- Level: Tenure-track assistant or Associate professor
- Fte: Full time (1.0)

1. Scientific discipline

Dynamical System Theory is a field in mathematics that concerns the study of how systems evolve in time. In many applications it occurs that the time evolution equations which most of the time are given by differential equations or difference equations are too complex to allow for explicit solutions. Dynamical Systems Theory deals with the development of tools and techniques to study the behaviour of such systems even in the absence of explicit solutions. As such it is a broad field with respect to both the range of applications and the spectrum of mathematical tools and approaches.

2. Vacancy

This position is opened by the Board of the Faculty (ref.) and will be embedded in the Bernoulli Institute, basic unit Dynamical Systems, Geometry and Mathematical Physics (DSGMP). The position falls within the framework of 'Career Paths in Science 4' ('Bèta's in Banen 4'). Please see link for [criteria and conditions](#).

3. Selection committee (BAC)

Prof.dr. N.A. Taatgen	Scientific director Bernoulli Institute and Professor of Cognitive Modeling
Dr. H. Waalkens	Associate Professor of Mathematical Physics
Prof.dr. R.W.C.P. Verstappen	Program director Mathematics and Applied Mathematics
Dr. A.M.S. Waters	Assistant professor of Analysis
Prof.dr.ir. N.M. Maurits	Professor of Clinical Neuroengineering
J. Norden	Student member (MSc Mathematics)
Prof.dr. A.J. Homburg	Professor of Dynamical Systems (UvA, external expert)
<i>Advisory members:</i>	
Prof.dr. J. Top	Professor of Arithmetic Geometry and Number Theory, department head Mathematics
Prof.dr. G. Vegter	Professor of Geometry, chair of DSGMP

HR advisor:

L.A. Boomsma

4. Research area

The interest of dynamical systems theory is the behaviour of systems that evolve in time. This first of all concerns the long-term behaviour which comprises stationary, periodic, multi-periodic and chaotic dynamics, but also transient behaviour is of interest. Moreover, bifurcations or transitions between asymptotic states – especially, transitions between regular and chaotic motions – under variation of parameters are of great importance. Of particular importance are methods to detect and understand the dynamics in specific situations, employing numerical and visualization tools and computer algebra. The research also extends to dynamical aspects of stochastic and quantum systems.

One of the motivations as well as an important valorisation of research in Dynamical Systems is the great and continuously increasing demand for nonlinear dynamical models in many other sciences. Here degrees of unpredictability and complexity come into play.

5. Embedding: institute (and base unit)

The Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence (BI) is part of the Faculty of Science and Engineering (FSE). The profile of the institute centers around modeling and computation with a focus on science and technology, keeping a balanced mix of fundamental and applied aspects. The BI comprises five mathematics programmes, six computer science programmes and four artificial intelligence programmes.

The BI has a leading role in the recently established cross-disciplinary research theme on Data Science and Systems Complexity (DSSC) within the FSE. This concerns a research cluster of 60+ researchers in a number of basic disciplines (mathematics, computer science, artificial intelligence, systems & control, engineering, astronomy) and various scientific application domains. The ambition is to understand and solve big data problems by exploiting the joint perspectives from both data science and complexity science.

The new position in Dynamical Systems will be embedded in the research group Dynamical Systems, Geometry and Mathematical Physics. The group DSGMP is involved in the new Groningen Cognitive Systems and Materials Center (CogniGron), and the University of Groningen research themes Data Science and Systems Complexity (DSSC) and Fundamentals of the Universe. This includes collaborations to the Van Swinderen Institute for Particle Physics and Gravity, the Kapteyn Astronomical Institute and the Zernike Institute for Advanced Material. The candidate is expected to contribute to these collaborations.

6. Local and (inter)national position

The group Dynamical System, Geometry and Mathematical Physics (DSGMP) in Groningen is working on the development of mathematical tools using methods from analysis, geometry and measure theory to grasp, study and develop the structures involved.

Traditionally, Groningen has an excellent international reputation in the field of Dynamical Systems. The group has a leading role in the research concerning degrees of unpredictability and complexity of nonlinear models. This includes modern applications involving high-dimensional models with many parameters, the foundations of which in pure mathematics contain many important challenges. The group collaborates with local, national and international experts from adjacent fields like Earth and Life Sciences, Physics, Engineering, Meteorology and Astronomy.

Whereas in Groningen expertise in a wide range of applications (integrable systems, Hamiltonian systems, climate models, biology, theoretical physics, etc.) is still strongly present, the theoretical and fundamental aspects of the subject urgently need to be reinforced. As an example, very recent developments such as the study of emergent behaviours in complex systems have a quickly growing number of applications. Strengthening of our research staff in this area is crucial in order to maintain our reputation.

The BI has a leading role in the cross-disciplinary research theme on Data Science and Systems Complexity (DSSC) within the FSE, and is an important partner in the Groningen Cognitive Systems and Materials Center (CogniGron). Attracting an expert in Dynamical Systems will have a positive impact on our role within DSSC and CogniGron.

The group DSGMP participates in the national NWO-clusters Nonlinear Dynamics of Natural Systems (NDNS+) and Geometry and Quantum Theory (GQT), and is represented in the board of NDNS+. Creation of this new position will strengthen our role in these clusters further, especially within NDNS+.

The profile of this position in Dynamical Systems perfectly fits the “profileringsthema” *Dynamical data* (Dynamische data) in the Sectorplan Mathematics 2019. As also stated in the vision document of the NWO cluster NDNS+ it has been recognized that besides modeling and simulation it is important to emphasize fundamental research in the field of Dynamical Systems Theory. This also fits with the outline of the research activities in Dynamical Systems Theory at the University of Groningen which includes a strong emphasis on differential geometric tools to study e.g. Hamiltonian systems and bifurcation theory. Besides openness for applications and collaborations with researchers in other disciplines we are seeking for a candidate with an internationally recognized expertise in fundamental aspects of Dynamical Systems Theory.

The group is actively involved in the international Dynamical Systems and Mathematical Physics communities, and maintains many contacts with colleagues abroad. The position serves to maintain and further strengthen the expertise in Dynamical Systems Theory at the University of Groningen, on a national level and worldwide.

7. Expected contributions to research

The associate professor is expected to develop an internationally leading research track record in Dynamical Systems, leading to an autonomous research programme within the BI. The research should lead to publications in high impact scientific journals and to contributions to major conferences in the field of expertise. Supervision of PhD students and postdocs is an important part of the research activities. Obtaining substantial external funding for PhD and postdoc projects is crucial. Interaction with other domains that require support from Dynamical Systems (e.g., theoretical physics, systems & control, engineering, cognitive systems) is very important, and involvement in the research themes Data Science and Systems Complexity or Fundamentals of the Universe is very desirable.

8. Expected contributions to teaching

The successful candidate is expected to contribute to the bachelor and master programmes of Mathematics in the Faculty. He/she will contribute both to teaching existing courses, and to the development of new courses and supervise bachelor and master theses.

9. Expected contributions to the organization

The candidate is expected to have an active interest and to provide a positive contribution to the management and organizational tasks of the institute. At the level of the FSE, the candidate will contribute to the organization of the faculty, for example by participating in working groups and committees, in the fields of teaching, research and management. The candidate will participate in relevant national and international organizations.