

Maximilian Engel

Korteweg-de Vries Institute, Faculty of Science
University of Amsterdam
m.r.engel@uva.nl

Column New Impulse

A dynamicist in Amsterdam

In this column, researchers who have been recently appointed to one of the Dutch mathematics institutes, introduce themselves.

As a researcher in the mathematical theory of dynamical systems, I am well aware that everything is always in motion. The latest motion in my biography has brought me to Amsterdam; a very dynamical city, indeed, coined by water and cycling traffic. The dynamics lie also in the cultural, economic and academic activity driven by people from all over the world. A perfect place for a cosmopolitan dynamicist. But how exactly has the flow of life carried me to this beautiful and extraordinary location?

My name is Maximilian Engel. I have been an assistant professor for Dynamical Systems and Probability at the University of Amsterdam (UvA) for slightly more than a year, freshly tenured and about to start a new research group on Random Dynamical Systems thanks to my NWO Vidi grant. Here, I am developing a “A Rigorous Framework for Transient Random Dynamics”, together with a team that will be formed in the upcoming months. We will continue lines of research I have conducted as a junior research group leader at FU Berlin on “Random and Multiscale Dynamical Systems”, where I am still holding a partial position until the end of the year to supervise my remaining team members there.

My research on Dynamical Systems concerns mathematical models of time-dependent processes in nature and society, from the motion of planets to the activity of neurons and voting behaviour in democracies. The models describing such phenomena are typically incomplete and contain random parts due to uncertainty about environmental influences. In my Vidi project, in particular, I study the random occurrence of changes between different states and their predictability: I investigate how a system can appear to be in an ordered, predictable state

for a certain period of time (e.g., warm weather for several weeks), but then change into a fluctuating chaotic regime (e.g., rapid changes in temperature and precipitation). The theory of Dynamical Systems and Chaos has a great tradition in the Netherlands, due to people like Balthasar van der Pol or Floris Takens, such that there has been a high probability of me ending up here. But let me tell you the history of that drift towards Dutch dynamics from the start.

Growing up in Bavaria (Augsburg and Munich), i.e. in the South of Germany, I enjoyed a classical education with a focus on Latin and Ancient Greek. I appreciated aspects of school maths



and physics at an early age with some successful participation in the Math Olympiad, but was also always drawn to the old languages, including their mythological stories and philosophy. The key common denominator between those languages and mathematics was definitely the clear and logical structure: translating a Latin or Greek text has always had the character of solving a logical riddle which I relished with great enthusiasm. Logical riddles also fostered my interest beyond school maths and I ended up devouring the beautiful riddle books by the American logician Raymond Smullyan, embedding logical problems into the realm of Lewis Carroll's (also a mathematician) "Alice in Wonderland".

Being passionate about narration, logic and also having become a very political young adult, I started to study philosophy and economics at the Munich School of Philosophy and LMU Munich. Even though enjoying both subjects, I soon felt that I was missing something to understand whatever holds together the world at its core. In philosophy, I enjoyed logic and natural philosophy the most, striving to learn more about the fundamentals of quantum mechanics, statistical physics and the theory of relativity. In economics, I wanted to get a hold of the mathematical basics that were applied to study economical models and data. Hence, driven by a yearning for deep thinking and understanding, I decided to study mathematics in addition to the other subjects: the ultimate trigger for a new love story. Besides my interest in logic and the fundamentals of mathematics, I soon developed a strong enthusiasm for analysis, differential equations and probability theory, also driven by its connections to physics. During my studies in Munich, I also evolved as a Jazz musician, mainly at the double bass with some additional background on the piano and the violoncello, confirming the popular stereotype: math and music go very well together. In summary, for me, math has always been connected to different aspects, be it the natural sciences, politics and the social sciences, music or philosophy. But mostly, it has been incredible fun doing it.

Based on these experiences and willing to explore other parts of the (academic) world, I decided to pursue a PhD at Imperial College in London, where I obtained the opportunity to work on Random Dynamical Systems, under the supervision of Jeroen Lamb (alma mater: UvA) and Martin Rasmussen. My thesis was about the interplay of stochastic forces to create synchronization or chaos and transitions between them. My key idea was to localize the random effects by appropriate conditioning to certain domains of interest, leading to the new notion of conditioned random dynamics. My PhD time in London was characterized by discovering the world of mathematical research but, also more generally, the great power of intercultural learning and understanding. London is the world in one city and opens the door to many new insights.

For my first postdoctoral appointment, I went back to Munich, working on fast-slow systems with Christian Kuehn at TU Munich. He had created an excellent new research group there, with many fantastic postdocs that I am still in touch with (three of them also went to the Netherlands for permanent positions). Christian and I transferred geometric techniques for systems with multiple time scales (like neuronal activity, climate models, etc.) to discrete and infinite-dimensional cases, and also explored random phenomena like isochronicity in stochastic oscillators. Based on these new skills and experiences, I was ready to start my own junior research group at FU Berlin, where I have been supervising 3 PhD students and 3 postdocs in the last almost 5 years. The research group has been embedded into the Cluster of Excellence MATH+ in Berlin, where I extended my research activities into application areas as, for example, chemical reaction networks, interacting agent systems, atmospheric dynamics or artificial neural networks. However, the funding for the position and the group is running out by the end of the year and I had wanted to find a clear long-term perspective; this led to my new position at the University of Amsterdam. Here, also supported by the Vidi grant, I can continue conducting my foundational as well as my more applied research being surrounded by the vibrant Dutch mathematical community and building up on the rich tradition of Dynamical Systems in the Netherlands.

So far, my experiences are extremely positive. The colleagues are very open, friendly and helpful and the whole academic system is very modern and energetic. I am enjoying the lecturing, giving the Topology Bachelor course the second year in a row at UvA and lecturing the MasterMath course Measure Theoretic Probability together with Ronald Meester (VU Amsterdam). The students are slightly more demanding than in Germany and tend to have a slightly smaller frustration tolerance concerning difficult topics and exercises. However, this has the positive aspect of more direct communication and feedback and a stronger focus on keeping everybody on board. In general, working in the Dutch university system is a very good mixture between my UK and my German experiences. There is the well-managed bureaucracy, the pragmatism and the openness akin to the UK, paired with the rigour and challenge of the German mathematical education.

All in all, I have been encountering an inviting scientific and academic culture, together with a fantastic city (apart from the infamous housing prices). Amsterdam has clearly the best ratio of cultural offers to geographic size that I have seen so far. A great place for a dynamicist, a great place for a cosmopolitan European.

Research page: <https://sites.google.com/view/maximilian-engel/home>