

# PHYSICAL MATHEMATICS SEMINAR

## Synthetic cell-cell adhesion and logic for programming multicellular interface patterns

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### ABSTRACT:

Multicellular systems, from bacterial biofilms to human organs, form spatial patterns and interfaces to achieve complex functionality, promising applications like programmable biomaterials, artificial tissues, and metabolic consortia. Our ability to rationally engineer such active matter is still limited. My lab recently developed the first synthetic and optogenetic approaches to control cell-cell and cell-surface adhesion for bacterial self-assembly and patterning ('Biofilm Lithography'). I will discuss the biophysical characterization of these tools and their applications to investigate cooperative antibiotic responses in biofilms. I will then demonstrate a synthetic cell-cell adhesion logic to experimentally program and mathematically model complex two-dimensional interface patterns. These interfaces are generated through a swarming adhesion mechanism that enables precise control over interface geometry as well as adhesion-mediated analogs of developmental organizers and morphogen fields. Utilizing tiling and four-color mapping concepts, I present algorithms for creating versatile target patterns. Remarkably, a minimal set of four adhesins suffices to program arbitrary tessellation patterns, implying a low critical threshold for the engineering and evolution of complex multicellular systems.

### SHORT BIO:

Ingmar H. Riedel-Kruse is an Associate Professor at the University of Arizona in the Departments of Molecular and Cellular Biology, Applied Mathematics (by courtesy) and Biomedical Engineering (by courtesy). His research seeks to make it easier to engineer and program multicellular biological systems, circuits and devices in order to foster the human condition. He runs an interdisciplinary lab integrating diverse areas like synthetic biology, biophysics, human-computer interaction design, and embedded cyber-physical systems. He received his Diploma in theoretical solid-state physics at the Technical University Dresden, did his PhD in experimental biophysics at the Max Planck Institute of Molecular Cell Biology and Genetics, followed by a postdoc at the California Institute of Technology. He was then an Assistant Professor for Bioengineering and Biophysics at Stanford University before joining the University of Arizona.

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**TUESDAY, NOVEMBER 2, 2021**  
**2:30 PM – 3:30 PM**  
**Building 2, Room 449**

### MIT Covid policies must be adhered to:

- [remember to keep your mask on while inside buildings](#)
- [eating food is not allowed within lecture rooms](#)