



# PHYSICS COLLOQUIUM: Probing the role of tissue mechanics in the gut-brain axis and neuronal development

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Date:  
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Time:  
10:30 AM – 11:50 AM

Location:  
GRANITE PASS 135

## Abstract:

Your intestines are home to a range of symbiotic bacteria essential to your health. This so-called gut microbiome affects the human brain and neuronal development and may contribute to the pathophysiology of neurodevelopmental disorders. However, it is unclear how risk genes associated with such disorders affect gut physiology in a manner that could impact microbial colonization, and how the mechanical properties of the gut tissue might play a role in gut-brain bidirectional communication. In this talk, I will share data about a particular-gene “*kismet*” and its link to gut-brain axis. *Kismet* is an orthologous gene of chromodomain helicase DNA-binding protein (*CHD*) family members *CHD7* and *CHD8*, which are known risk genes for neurodevelopmental disorders

	GI Transit	Gut Biomechanics	Gut Microbiota	Courtship Behavior
Control				
<i>kismet</i> mutant				

with co-occurring gastrointestinal symptoms in humans. We use *Drosophila melanogaster* with null mutation in *kismet* and find that mutant flies have a significant increase in gastrointestinal transit time, indicating functional homology of *kismet* with *CHD7/CHD8* in vertebrates. We characterize dissected gut tissue using extensional rheology, which revealed significant changes in the mechanics of *kismet* mutant gut elasticity, strain stiffening behavior, and tensile strength. Using 16S rRNA metagenomic sequencing, we also find that *kismet* mutants have a reduced diversity and abundance of gut microbiota at every taxonomic level. To investigate the connection between the gut microbiome and behavior, we deplete gut microbiota in *kismet* mutant and control flies and quantified the flies' courtship behavior, a proxy for neuronal functioning. Depletion of gut microbiota rescues courtship defects of *kismet* mutant flies, indicating a connection between gut microbiota and behavior. In striking contrast, depletion of gut microbiome in the control strain reduces courtship activity, demonstrating that antibiotic treatment can have differential impacts on behavior and may depend on the status of microbial dysbiosis in the gut prior to depletion. We propose that *kismet* influences multiple gastrointestinal phenotypes that contribute to the gut-microbiome-brain axis to influence behavior. We also suggest that gut tissue mechanics should be considered as an element in the gut-brain communication loop, both influenced by and potentially influencing the gut microbiome and neurodevelopment.

## About the Speaker

Mikkel Herholdt Jensen is an associate professor of physics at California State University, Sacramento. He completed his B.S. in physics and mathematics at the University of Southern Denmark in Odense in 2005. After working at the Center for Membrane Physics (MEMPHYS) studying phase transitions and domain coarsening in supported lipid membranes using atomic force microscopy and fluorescence microscopy, he began his PhD work at Boston University in 2006. His doctoral work with Jeffrey Moore focused on investigating the biopolymer actin and the regulation of actin mechanics and dynamics by smooth muscle actin-binding proteins. He graduated with a PhD in physics in 2013, after which he joined David Weitz at Harvard SEAS as a postdoctoral fellow, continuing work on cytoskeletal polymers and cell mechanics using bulk rheology, laser tweezers microrheology, and confocal fluorescence microscopy. He joined the Department of Physics and Astronomy at California State University, Sacramento, in 2015. Mikkel's current research interests include soft matter rheology, thermodynamic driving forces in biomimetic systems, mechanobiology of biopolymers, cells and tissues, and their relation to health and disease. In addition to his soft matter research interests, Mikkel has been teaching physics for almost two decades, first as a teaching assistant at SDU Odense and since at Boston University. He was most recently recognized with his College's Outstanding Faculty Award for Teaching in 2021 and has also undertaken NSF-funded research into active learning modalities and their efficacy in improving equity and student success in undergraduate college physics classrooms.

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