**Physikalisches Kolloquium** **Physics Colloquium**

**Einladung** **Invitation**

# Monday, 23 November 2026

**Lecture Hall O25/H2, at 16:15**
**Coffee and cookies will be served in front of the lecture hall from 16:00**

## Collective sensing and information processing in living systems


**Dr. Isabella Graf**

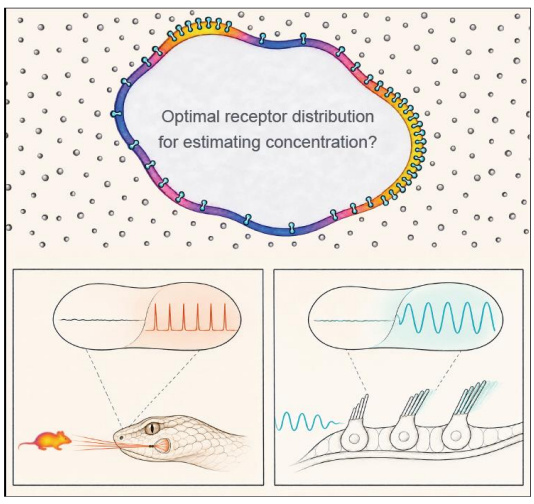
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Living systems need to constantly extract information from and respond to their environment. Since the underlying sensory receptors are molecular and work at body temperature, signals about the environment are oftentimes weak and statistically insignificant at the level of single receptors. Information from many receptors therefore needs to be integrated into a collective response. In this talk, I will discuss our recent efforts elucidating the theoretical principles underlying the physics of collective sensing and information processing. The first part will focus on the sensing of local ligand concentration via surface receptors, a task relevant for as diverse behaviors as bacterial chemotaxis, cell-cell communication, and development. While seminal theoretical studies have demonstrated that the precision of concentration sensing is fundamentally limited by diffusion noise, these studies mainly focused on idealized geometries and uniform receptor distributions. I will argue that both geometry and boundary conditions are crucial for sensing precision and that the optimal receptor distribution minimizing sensing error strongly depends on geometry. The second part of my talk will then focus on how small signals can be robustly amplified into a collective response. Based on several biological sensory systems ranging from mammalian hearing to snake thermosensing, I will argue that proximity to dynamical bifurcations and thermodynamic critical points allows these systems to robustly amplify weak signals even in the presence of extrinsic noise, such as due to a noisy downstream readout process. Together, these results suggest that, by exploiting both spatial organization and the physics of critical dynamics, living systems can turn noisy molecular signals into reliable collective decisions.


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