Intracellular Diffusion: From Crowding to Migration

Christine Selhuber-Unkel

Heidelberg University, Institute for Molecular Systems Engineering and Advanced Materials (IMSEAM), Heidelberg, Germany
* selhuber@uni-heidelberg.de

Intracellular motion is an essential mechanism to ensure the function of biological cells. It is not only important for the transport of stored molecules, e.g., lipids and enzymes, but can also be a decisive factor for the development of diseases. This is particularly interesting in investigations of the highly motile pathogenic amoeba *Acanthamoeba castellanii (A. castellanii)*, which has a supercrowded intracellular space. Using high-speed live cell imaging in combination with single-particle tracking analysis, we have shown that the motion of endogenous intracellular particles in the size range from a few hundred nanometers to several micrometers in *A. castellanii* is strongly superdiffusive and influenced by cell locomotion, cytoskeletal elements, and myosin II. We demonstrate that cell locomotion significantly contributes to intracellular particle motion, but is clearly not the only origin of superdiffusivity. By analyzing the contribution of microtubules, actin, and myosin II motors we show that myosin II is a major driving force of intracellular motion in *A. castellanii*. The cytoplasm of *A. castellanii* is supercrowded with intracellular vesicles and granules, such that significant intracellular motion can only be achieved by actively driven motion, while purely thermally driven diffusion is negligible.

References

[1] M. Timmermann, N. Lukat, L. Schneider, IV WC Shields, G. Lopez, C. Selhuber-Unkel: *Migration of microparticle-containing amoebae through constricted environments*. ACS Biomater. Sci. Eng. **6**, 889-897 (2020).

[2] S. Thapa, N. Lukat, C. Selhuber-Unkel, A. G. Cherstvy, R. Metzler: *Transient superdiffusion of polydisperse vacuoles inside highly-motile amoeboid cells*. J. Chem. Phys. **150**, 144901 (2019).

[3] S. Gutekunst, K. Siemsen, S. Huth, A. Möhring, B. Hessler, M. Timmermann, I. Paulowicz, Y. Mishra, L. Siebert, R. Adelung, C. Selhuber-Unkel: *3D Hydrogels Containing Interconnected Microchannels of Subcellular Size for Capturing Human Pathogenic Acanthamoeba Castellanii*. ACS Biomater. Sci. Eng. **5**, 1784-1792 (2019).

[4] J. F. Reverey, J. H. Jeon, H. Bao, M. Leippe, R. Metzler, C. Selhuber-Unkel: *Superdiffusion dominates intracellular particle motion in the supercrowded cytoplasm of pathogenic Acanthamoeba castellanii*. Sci. Rep. **5**, 11690 (2015).