Cell growth under mechanical pressure and universal non-Fickian diffusion properties in living systems

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Cells act against steric constraints when growing in a spatially limited environment. At the multicellular level, confined cell proliferation results in the emergence of a growth-induced mechanical pressure. Compressive stresses are ubiquitous to any cell population developing in confinement, such as most solid tumors or microbes, and can deeply impact cell physiology.

We observed that the growth of *S. cerevisiae* decreased under mechanical pressure. Using novel genetically encoded nanoparticles (GEMs) to assess the rheological properties of a cell, we show that compressive stress decreases the motion of macromolecules inside the cell. Under compression, reactions such as protein synthesis can become diffusion-limited, globally decreasing the dynamics of biomass production, and elucidating a mechanism in which growth limitation can be attributed to modifications in the rheological properties of cells.

These observations are conserved in bacteria and in mammalian cells. Interestingly, we observe that the diffusion statistics of GEMS in the cytoplasm of these organisms display conserved non-Fickian properties, suggesting that the conserved decrease under confined growth could stem from universal modulation of rheological properties.

At the end of the talk, we will discuss the potential origin of this universality. We will show in particular that one needs to be careful when analyzing the statistics of diffusion and examining only the distribution of diffusion coefficients, as this metric is strongly influenced by the optical width of the imaging system, creating a strong statistical bias. We will propose a model based on the natural polydispersity in size in the cytoplasm to explain the various statistics observed in these different organisms.