Anomalous diffusion and microrheology in cells

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With the use of the "two-fluid model", we discuss anomalous diffusion induced by active protein molecules in viscoelastic media. Active proteins in living cells generate non-thermal fluctuating flows that lead to a substantial increment of the diffusion in the cytoplasm [1]. Using the Green's function of the two-fluid model, we first obtain passive (thermal) two-point correlation functions including the displacement cross-correlation function between the two point particles separated by a finite distance. We then calculate active (non-thermal) one-point and two-point correlation functions due to active force dipoles representing proteins. The time correlation of the force dipole is assumed to decay exponentially with a characteristic time scale. We show that the active component of the displacement cross-correlation function exhibits various crossovers from super-diffusive to sub-diffusive behaviors depending on the characteristic time scales and the particle separation. Our theoretical results are intimately connected to the microrheology technique, and also reproduce the experimental result [2] by adding both passive and active contributions to the mean squared displacement.

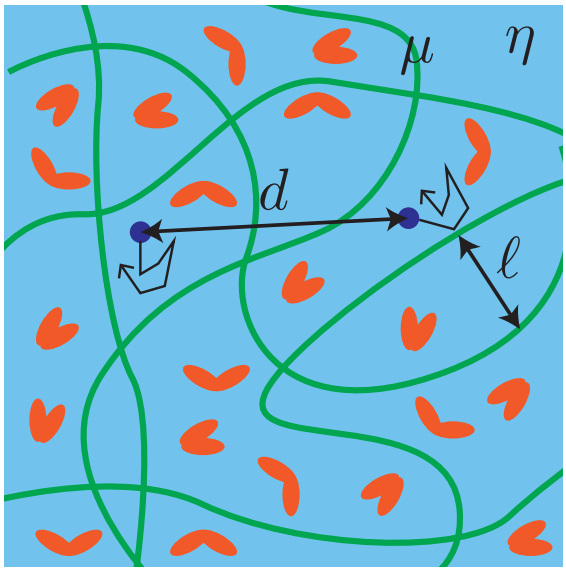

Figure 1: Active proteins in a viscoelastic media

References

[1] A. S. Mikhailov and R. Kapral, *Proc. Nat. Acad. Sci. USA* **112**, E3639 (2015).

[2] M. Guo, A. J. Ehrlicher, M. H. Jensen, M. Renz, J. R. Moore, R. D. Goldman, J. Lippincott-Schwartz, F. C. MacKintosh, and D. A. Weitz, *Cell* **158**, 822 (2014).