SFB 1027 - Seminar

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Mechanical synchronization of beating within and between cardiomyocytes

We present models that predict how mechanical interactions in actively beating heart cells can lead to synchronization of beating both within single cells and between nearby cells. The predictions are compared with experiments [1,2] that measure the substrate rigidity dependence of the structural registry of the sarcomeres and show how this can be mapped onto measurements of the beating strain [1, 2]. This suggests that the correlated beating of heart cells may be limited by the structural registry of the sarcomeres which in turn is regulated by their mechanical environment. Similar structural registry of myosin stacks have recently been observed [3] in stress fibers in fibroblasts and we suggest that this too may be mechanically driven. Recent experiments [4] on synchronization of beating of two nearby cardiomyocytes have shown that a mechanical probe can “pace” a beating cell to within about twice or a quarter of its natural beating frequency. This is indicative of one way by which nearby cardiomyocytes embedded can regulate their mutual beating. We focus [5] on the synchronization of two nearby cardiomyocyte cells or a cell and a mechanical probe and show theoretically that based on their mutual deformations of the substrate (or ECM), two nearby cells can synchronize their phase and frequency in a manner that depends on their mutual orientation; the predictions are compared with the experiments [4] that show a variety of dynamical regimes. Using non-linear dynamics approaches, we predict the persistence time of cells whose beating is either spontaneous or entrained by a mechanical probe and point out the role of biological adaptation in these processes, which have yet to be experimentally explored.

[1] S. Majkut et al., Current Biology, 23, 2323 (2013).
[2] K. Dasbiswas, S. Majkut, D. Discher and S. Safran, Nature Comm., 6, 7085 (2015).
[3] S. Hu, K. Dasbiswas, et al., Nature Cell Biology 19, 133 (2017).
[4] I. Nitsan et al., Nature Physics, 12, 472 (2016).
[5] O. Cohen and S. A. Safran, Soft Matter, 12, 6088 (2016) and to be published.

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Der Gast wird betreut von
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Alle Interessenten sind herzlich eingeladen.

Der Sprecher des SFB
Heiko Rieger

SFB 1027 Physikalische Modellierung von Nicht-Gleichgewichtsprozessen in biologischen Systemen