UCLA Department of Physics & Astronomy

Biological Physics Seminar

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presenting

Coupled Oscillators and Arnold Tongues in Cell Dynamics

Oscillating genetic patterns have been observed in networks related to the transcription factors NFkB, p53 and Hes1 [1]. We identify the central feed-back loops and found oscillations when time delays due to saturated degradation are present. By applying an external periodic signal, it is sometimes possible to lock the internal oscillation to the external signal. For the NF-kB systems in single cells we have observed that the two signals lock when the ration between the two frequencies is close to basic rational numbers [2]. The resulting response of the cell can be mapped out as Arnold tongues. When the tongues start to overlap we observe a chaotic dynamics of the concentration in NF-kB [2]. Oscillations in some genetic systems can be triggered by noise, i.e. a linearly stable system might oscillate due to a noise induced instability. By applying an external oscillating signal to such systems we predict that it is possible to distinguish a noise induced linear system from a system which oscillates via a limit cycle. In the first case Arnold tongues will not appear, while in the second subharmonic mode-locking and Arnold tongues are likely [3].

[1] B. Mengel, A. Hunziker, L. Pedersen, A. Trusina, M.H. Jensen and S. Krishna, "Modeling oscillatory control in NF-kB, p53 and Wnt signaling", Current Opinion in Genetics and Development 20, 656-664 (2010).

[2] M.H. Jensen and S. Krishna, "Inducing phase-locking and chaos in cellular oscillators by modulating the driving stimuli", FEBS Letters 586, 1664-1668 (2012).

[3] N. Mitarai, U. Alon and M.H. Jensen, "Entrainment of linear and non-linear systems under noise", Chaos, 23, 023125 (2013).

Tuesday, January 21, 2014
4:00 P.M.
3-145L Knudsen Hall