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ABSTRACT | Daniel S. C. Damineli

Title

Minimal modeling of biological rhythms: advantages of keeping the representation of circadian oscillators simple

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Abstract

Chronobiology, the study of the endogenous organization of physiological and behavioral timing, has a long tradition in investigating biological rhythms and has constituted a fertile ground whereby modeling approaches can reveal fundamental properties underlying biological phenomena. Detailed ODE models have been extensively used to characterize endogenous pacemakers, also called circadian clocks, especially at the level of gene transcription. In spite of the high biological explicitness, their power to predict rhythmic behavior is severely constrained by the lack of knowledge about the molecular underpinnings and realistic parameter values. In contrast, minimal models lack the explicit representation of the system components focusing, instead, on the main phenomenological aspects of a given process. In this seminar I will exemplify the heuristic value of the latter approach in explaining the organismal responses to multiple and conflicting periodic environmental cues (Zeitgebers). The emergence of eclosion and locomotor rhythms in *Drosophila,* under the simultaneous influence of light and temperature cycles, with varying phase shift between these Zeitgebers, has been attributed to an endogenous timing system comprised of two autonomous oscillators, one entrainable by light/dark and the other by temperature. However, the network of signaling inputs and inter-oscillator coupling pathways remains elusive, in the same fashion as the observation of "forbidden" phase relation between both oscillators, designated "phase-jumps". We show that the phenomenological coupled-oscillator model by Pittendrigh-Pavlidis, as well as the even simpler model of coupled phase oscillators, can account for this phenomenon, as they both exhibit hysteresis in the phase difference between the coupled oscillators in function of the phase shift between the two as Zeitgebers. We will furthermore discuss how these phenomenological findings could be incorporated in future models and experimental designs in studies of conflicting Zeitgebers.