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Oscillations and synchronization in human circulatory system

Human cardiovascular system exhibits interesting dynamics, which is expressed in beat-by-beat changes of such variables as heart rate (interbeat interval) and blood pressure. As the system is complex, the origin of this dynamics is complex as well. Part of the dynamics is of neural or electrophysiological nature, depending on the functional state of the heart muscle, which is an example of an active medium, subject to neural control. Another part of the dynamics is related with the vascular response to the hemodynamic heart action. This response depends on vascular resistance and on elastic properties of the vascular wall. The resulting blood pressure and chemical properties (pH) are constantly monitored by specific receptors that initiate neural reflexes, which applies neural control to specific variables. There are many independent mechanisms that may be activated in order to respond to certain fluctuations. Moreover, the characteristic times of different control loops may differ by order of magnitude.

Another source of complex oscillations, crucially important for homeostasis is the respiratory system. All the systems are interrelated in a complex way and give rise to the complex cardiovascular dynamics. One of interesting phenomena that arises in such a system is the cardiorespiratory synchronization and the related phenomenon of the interdependence between short-term dynamics of blood pressure, heart rate and breathing. Both problems will be addressed in the talk.