Neuronal field model analysis from a mathematical point of view

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Stochastic dynamics play a fundamental role in modeling neuronal activity, capturing intrinsic noise and external variability in neural systems. In this talk, we analyze the stochastic neuronal model investigated by Kramer et al. [1] and originally proposed by Steyn-Ross et al. [2], to answer the questions of existence and uniqueness of solutions. We determine conditions and modifications under which the model that consists of stochastic differential and wave equations, is well-posed using methods from stochastic and functional analysis. These results provide insights into the interplay between noise and nonlinear dynamics as well as the applicability in studying phenomena, such as seizure mechanisms and cortical activity.

[1] M. A. Kramer, H. E. Kirsch and A. J. Szeri; Pathological pattern formation and cortical propagation of epileptic seizures, J. R. Soc. Interface (2005)

[2] Moira L. Steyn-Ross, D. A. Steyn-Ross, J. W. Sleigh, and D. T. J. Liley; Theoretical electroencephalogram stationary spectrum for a white-noise-driven cortex: Evidence for a general anesthetic-induced phase transition, Phys. Rev. E , Vol. 60 (1999)