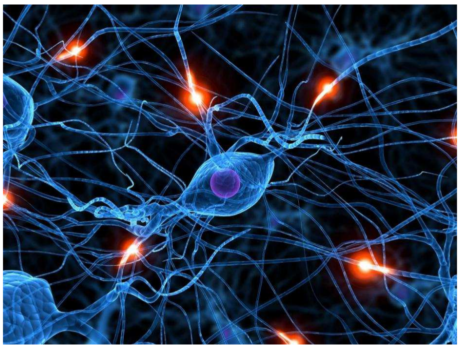
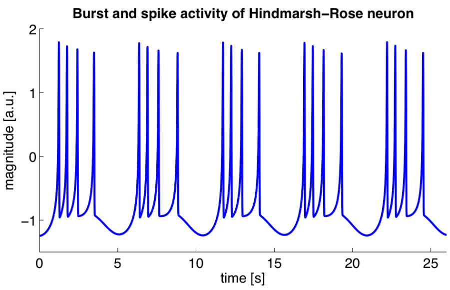
# Is it possible to characterize the neuronal activity by magnetic resonance ?

Their exists two methods to see the neuronal activity in the brain : the functional MRI measures the blood rush in the different brain area by magnetic resonance ; and the EEG measures the electric fields induced by the neuronal currents. fMRI has a good space resolution but its time resolution is small. In contrast, EEG has a good time resolution but a very poor space resolution.
Some researches show that the dynamics of spin systems submitted to noisy signals presents signatures of the nature of the noise (regular, chaotic, markovian, white). The neurons present serveral activity modes, some of them are regular, but other are chaotic. The characterisation of these two kinds of activity by magnetic resonance of spins in neuron cell walls is maybe conceivable. The goal of this project consists to test this hypothesis with numerical simulations.
The system to treat is then a spin ensemble (without mutual interactions) submitted to three interactions : with the MRI external magnetic field, with the electromagnetic noise issuing from the neuronal activity, with the biological medium playing the role of a thermostat (physicians seeming strangely reluctant to cool their patients' heads at $0$ Kelvin). The neuronal activity will be modelised with simple classical dynamical systems (Hindmarsh-Rose and FitzHugh-Nagumo models). The first step will be the coding of an integrator for these equations. The second step will be the simulation and the study of the quantum dynamics of the systems spin+magnetic field+electric noise and spin+magnetic field+thermal noise. After validation of these simulations, the complete system spin+magnetic field+electric noise+thermal noise will be simulated and studied. In order to answer the question in realistic situations, the student must realize a bibliographic work to find the time scales of the problem : spin Larmor precession period, characteristic evolution time of an MRI magnetic field, mean time between two neuronal signal peaks, spin decoherence and relaxation times induced by biological media.






*quantum dynamics, chaotic systems, biophysics, quantum decoherence.*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