677th ASRC Seminar

Date : 13 : 30 ～ Tuesday, May 16

Location : 103 Meeting Room, ASRC Bldg.

Speaker : Prof. Stewart E. Barnes
(University of Miami)

Title : Spintronics approach to transcranial magnetic stimulation and detection

Abstract: Neuroscience insists the cerebral cortex is the highest level in the nervous system that controls the functions of lower levels. A main focus in this area is examination of the hierarchical circuitry of the brain that exercises the executive control of movement/behaviour in a noninvasive manner. The aim is to stimulate the neurons in this region, a couple of centimetres below the surface of the brain, using the time varying magnetic field generated by ``virtual magnets" lying within a race-track spintronics device placed at the external surface of the head. Neurons are very non-linear devices. When stimulated beyond a threshold level, they enter for a while a ``limit cycle" generating a train of ~1 ms spikes of a characteristic form described by, e.g., the (1984) model of Hindmarsh and Rose based on the seminal (1952) work of Hodgkin and Huxley. The transmission of these spikes along a neutron is more mundane and described by the (circa 1850) cable equation, a type of diffusion equation. It is believed that neurons fire when stipulated beyond an electric field E_c ~ 10 V/m directed along the length of the nerve, i.e., roughly towards to centre of the brain. As do current ``butter-fly" coils the virtual magnet is designed to produce a B ~ 1-2 T time dependent magnetic field but better focussed in time and space. The challenge is to understand the excitation mechanism sufficiently well in order to stimulate neurons with a few millimetre spatial resolution. This is difficult at both the spintronics and neuroscience levels.

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