# MODELING THE COLLECTIVE EXCITATIONS IN MAGNETIC MULTILAYER SYSTEMS

**D.Cherin – (Reg No 71110112016)**

## ABSTRACT

Magnetic materials have become controllable on the nanometer scale. Such fine structure exhibit a wide range of fascinating phenomena such as low dimensional magnetism, Giant Magnetoresistance (GMR) etc. Magnetic multilayers with nanometer spacing are among the first metallic quantum structures to become incorporated into electronic devices such as reading heads for hard disks etc. As a result, a class of magnetic/non-magnetic multilayer termed ‘spin valve’ has been introduced into magnetic devices. The study about these nanostructures is a true variant of electronics in which electron spin is used rather than the electron’s charge.

The discovery in the field of spintronics is mainly caused by the interaction of the flowing electrons with the background magnetization inside a ferromagnet. The magnetic multilayer systems, we have taken for investigation is spin valves, MTJs and also cubic spinel ferrite structure. One of the main exciting effects in spintronics is the reciprocal influence of the spin polarized current on the background magnetization. This phenomenon is known as Spin Transfer Torque (STT) which permits the control of the magnetization in spin valve based nano structure. This was predicted by Slonezewski and Berger in the year 1996. The spin valve is a trilayer structure having two ferromagnetic layer (pinned and free layer) separated by a non-magnetic spacer layer. The MTJ is a spin valve with an insulator as spacer layer. The STT can generate magnetic excitations and

magnetizations switching in the free layer of spin valves and MTJs. The ferromagnetic materials, the moment of magnetization and the average are not zero. The underlying interactions in these ferromagnets come from the spin-spin interaction caused by the overlapping of wave functions. Additional interactions, which can influence the magnetic structures include magneto crystalline anisotropy, applied magnetic field, demagnetization field etc. This can be incorporated into the Landau-Lifshitz-Gilbert-Slonezewski (LLGS) equation which is the fundamental equation for magnetization dynamics in magnetic multilayer systems.

The nonlinear equation can be solved for exact solutions (solution) using mathematical techniques such as reductive perturbation method, Holstein-Primakoff method, Stereographic projection method. The soliton exist due to the precise balance between the effects of nonlinearity and dispersion. These solitons have a constant velocity and they maintain their shape even after collision with another soliton. The spin polarized current transferred through a magnetic body can switch its magnetic moment without applying an external magnetic field. We have also analyzed the chaotic dynamics of spin valve by introducing an AC current along with the effect of STT.