Physics of the Electromagnetic Coupling Mechanisms in Physically Different Structures: A Case Study with Planar Antennas, Narrow Slit in a Thick Conducting Screen and Near-field Scanning Optical Microscope

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This tutorial deals with the underlying physics of coupling mechanisms in physically different structures like *small planar antenna*, *narrow slit in a thick conducting screen* and *near field scanning tunneling optical microscope*, with main emphasis centering on the relevancy and similarities among their working principles.

The talk comprises of four parts: In *section I*, an introductory discussion on the inter-relationship among the working principles and coupling mechanisms of these three technologies, is done.

In *section II*, the problems involved in electromagnetic coupling through narrow and wide slits in a parallel-plate waveguide (PPW) to a nearby conducting strip, as simplified models of the two-dimensional problems of aperture-coupled and proximity-coupled microstrip structures, are discussed. The discussion is then specialized to the impedance matching methods and two types of radiative coupling mechanisms *viz*. cavity and parasitic. These coupling mechanisms are also observed in case of flanged PPW coupled to a conducting strip.

In *section III*, attention is focused on the transmission resonance problem through a narrow slit in a thick conducting screen. As the slit width approaches zero, maximum transmission (transmission resonance) occurs at resonant thicknesses of the conducting screen, which approach multiples of half wavelength. Essentially the same phenomenon as this is also observed in the maximum coupling problem of cavity-type in section II. A brief discussion on transmission resonance phenomena is also given in connection with the high transmission phenomena through sub-wavelength gratings.

The concept of FTIR (Frustrated Total Internal Reflection), widely used in NSOM (Near-field Scanning Optical Microscope), is introduced in *section IV*. When the scattering object such as a probe tip or the sample is brought within the evanescent field, the totally internal reflected (TIR) electromagnetic field is perturbed. By detecting the quantities of the perturbed field, imaging is achieved. The role of the scattering object here is analogous to that of a nearby parasitic conductor in section II.

In this context, a comparative discussion between the notions of impedance matching in section II (corresponding to increasing the conductance and canceling the susceptance components with a conducting strip placed nearby) for physically small radiating structures and conversion of evanescent component to propagating one (corresponding to the role of a scattering object in the evanescent field) in the area of NSOM technology, is given.

Finally, it is hoped that this tutorial may help in better understanding of the underlying physics involved in the working principles of the fore-mentioned technologies, as the title indicates.