Evanescent surface modes can generate propagating modes in metamaterial slab waveguides

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Metamaterial waveguides have captured the interest of many researchers working on passive optical devices because a new kind of surface modes is available which is supported not by the index difference as in conventional waveguides but by the different *signs* of permittivity (ε) or permeability (μ) across the material interfaces. There have been a lot of literatures reporting their potential use in various applications including optical nano-circuits [1, 2], antennas [3], and storage of light [4] to name just a few. In many cases, we use slab structures (composed of more than two interfaces between different media) instead of single-interface waveguides [5-7]. Usually, the slab modes are formed via the interaction or coupling of surface modes *locally propagating* through their respective single interfaces [see Figs. 1(a) and 1(b)]. This raises a question: what will happen if such single interfaces do not support any propagating local surface mode? We will refer to the pair of metamaterials composing such single interfaces as the *cutoff-regime* media. Our study here is regarding on whether the slab adopting cutoff-regime media can have a propagation mode or not.

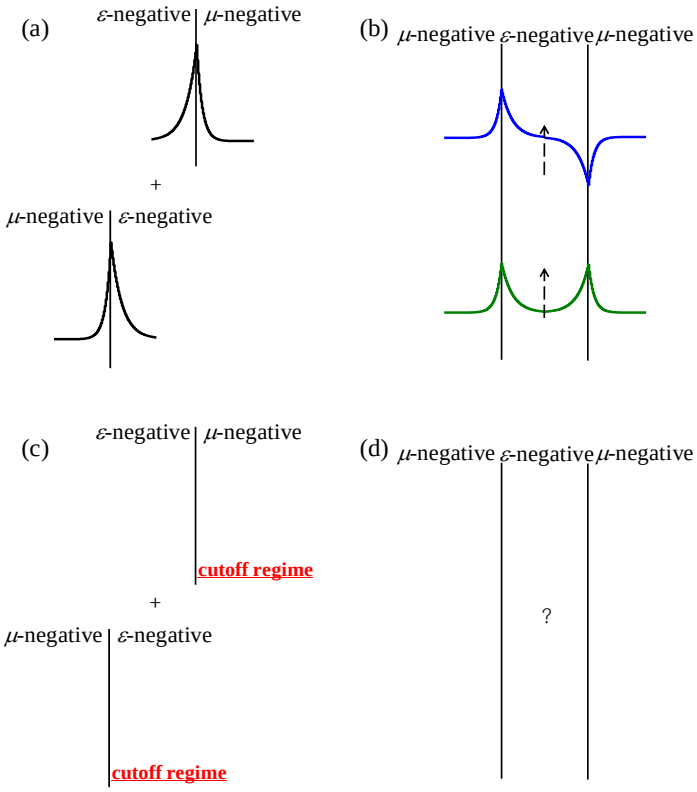

Figure 1. (a), (b) In usual cases, slab modes are generated via the interaction (such as symmetric or anti-symmetric coupling) of surface modes propagating locally through their respective single interfaces. (c), (d) Then, what will happen if the single interfaces do not support such a propagating local surface mode?

In this presentation, we will show that, in the symmetric 3-layer configuration, the strong interaction between two interfaces composed of cutoff-regime media can induce a propagating slab mode. This novel propagating mode has its origin in this strong coupling between *evanescent* local surface modes so that it becomes cut off when the core size (or the distance between two single interfaces) becomes large enough to make the coupling effects negligible.

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