PHYSICAL MATHEMATICS SEMINAR

WHY DOES A WAVEGUIDE GUIDE?
CONFINEMENT OF ELECTROMAGNETIC WAVES,
FROM HOLEY FIBERS TO QUASICRYSTALS

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ABSTRACT:

Much of the design of optical devices centers around the confinement of light, whether in waveguides that shuttle energy from place to place or in microcavities that form optical filters and enhance nonlinear interactions. In the microwave regime, confinement can be achieved by metallic structures, but with dielectric structures for the infrared and optical regimes one is forced to use other mechanisms, such as index-guiding and photonic bandgaps. From an analytical standpoint, there is a deep relationship between index-guiding ("total internal reflection" along a core with a higher refractive index) and classic problems of wave localization from quantum mechanics, in which an arbitrarily weak attractive potential creates a bound state in 1d or 2d, but not in 3d. Analogously, I will present an exact theorem establishing sufficient conditions for dielectric waveguide localization: essentially any increase of the refractive index localizes guided modes for a broad class of microstructured waveguides, including interesting recent designs (such as "holey fibers") involving periodic structures. For aperiodic structures, on the other hand, the problem becomes much more difficult even from a numerical perspective. I describe one interesting class of aperiodic structures known as photonic quasicrystals, and methods to deal with their aperiodicity by lifting Maxwell's equations to higher dimensions in which the problem is periodic.

TUESDAY, APRIL 15, 2008
2:30 PM
Building 4, Room 370

Refreshments at 3:30 PM in Building 2, Room 349
(Applied Math Common Room)

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