Ming Hsieh Department of Electrical Engineering

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Intersubband Optical Properties of GaAs/InGaAs Nanopore Superlattices

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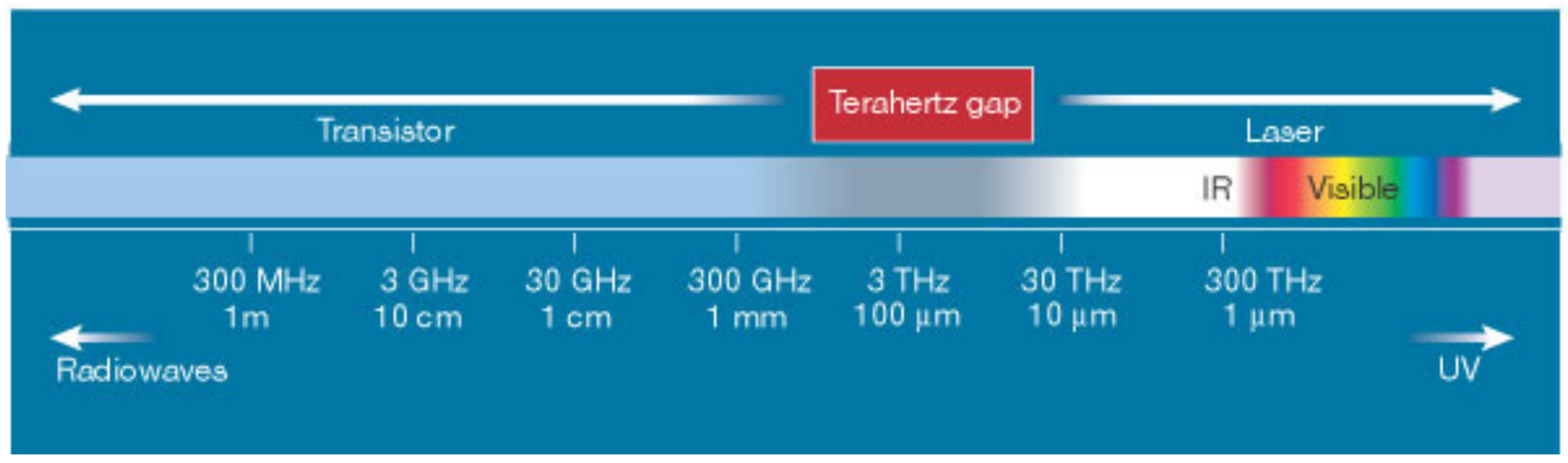
Motivation: The Terahertz Gap

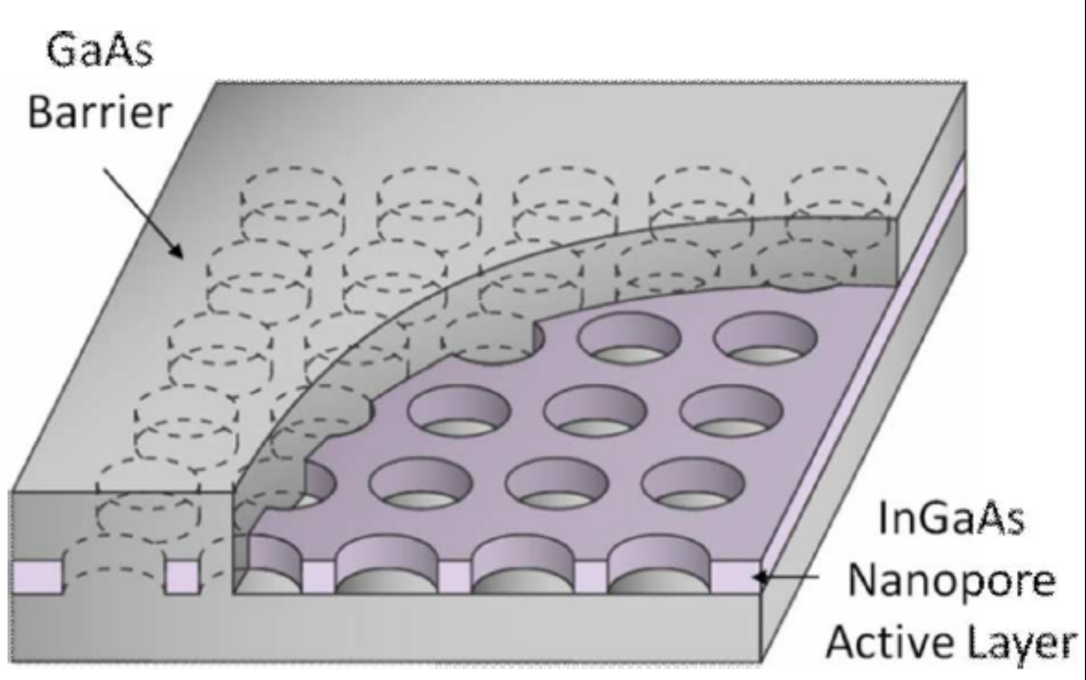


The terahertz gap, from about 300 GHz to 30 THz, exists because the frequencies of current solid-state electronics (e.g. transistors) and photonics (e.g. lasers) do not overlap.

Applications

- Medical Imaging
- Telecommunications
- Chemical Detection
- Spectroscopy
- Astronomy

Model



Schematic diagram of the GaAs/InGaAs nanopore superlattice

Theory

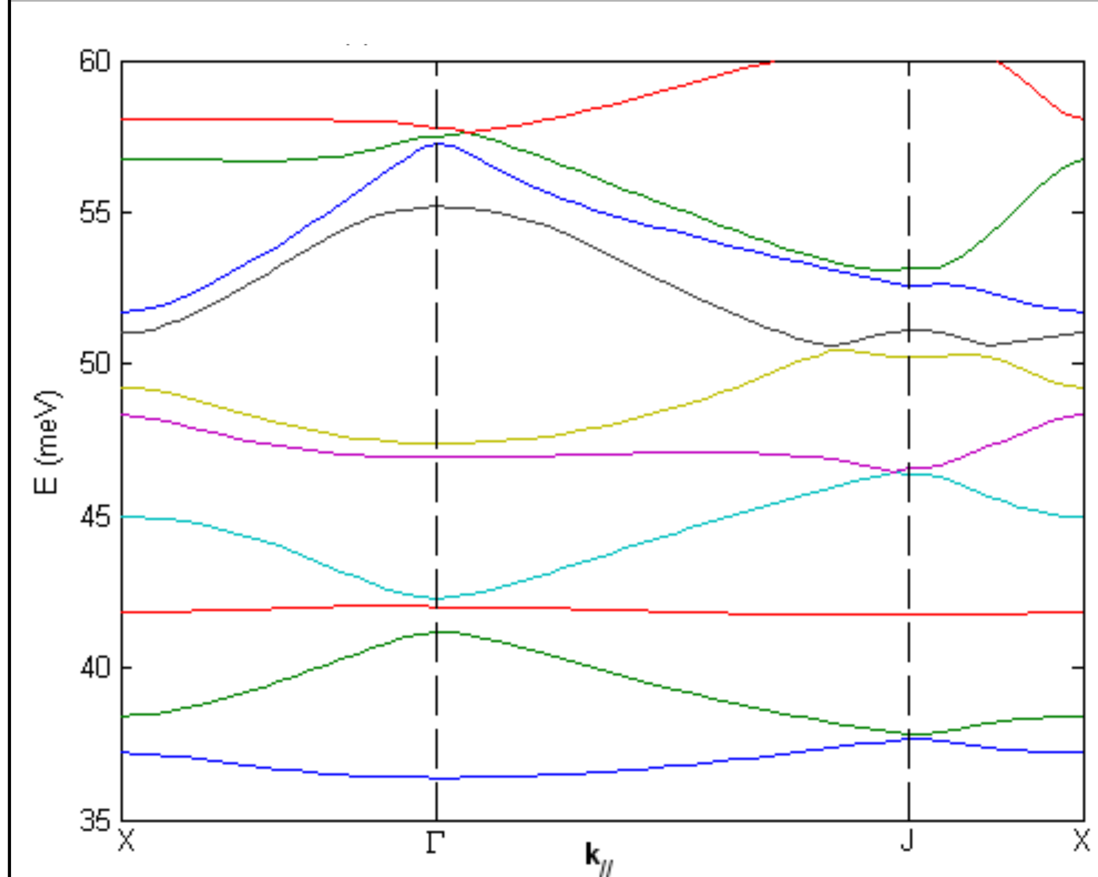
The 3D Schrödinger equation is solved with the finite difference method within the position dependent effective mass and offset potential approximations:

$$-\frac{\hbar^2}{2m_e}\vec{\nabla}\left(\frac{1}{m(\vec{r})}\cdot\vec{\nabla}\psi(\vec{r})\right)+V(\vec{r})\psi(\vec{r})=E\psi(\vec{r})$$

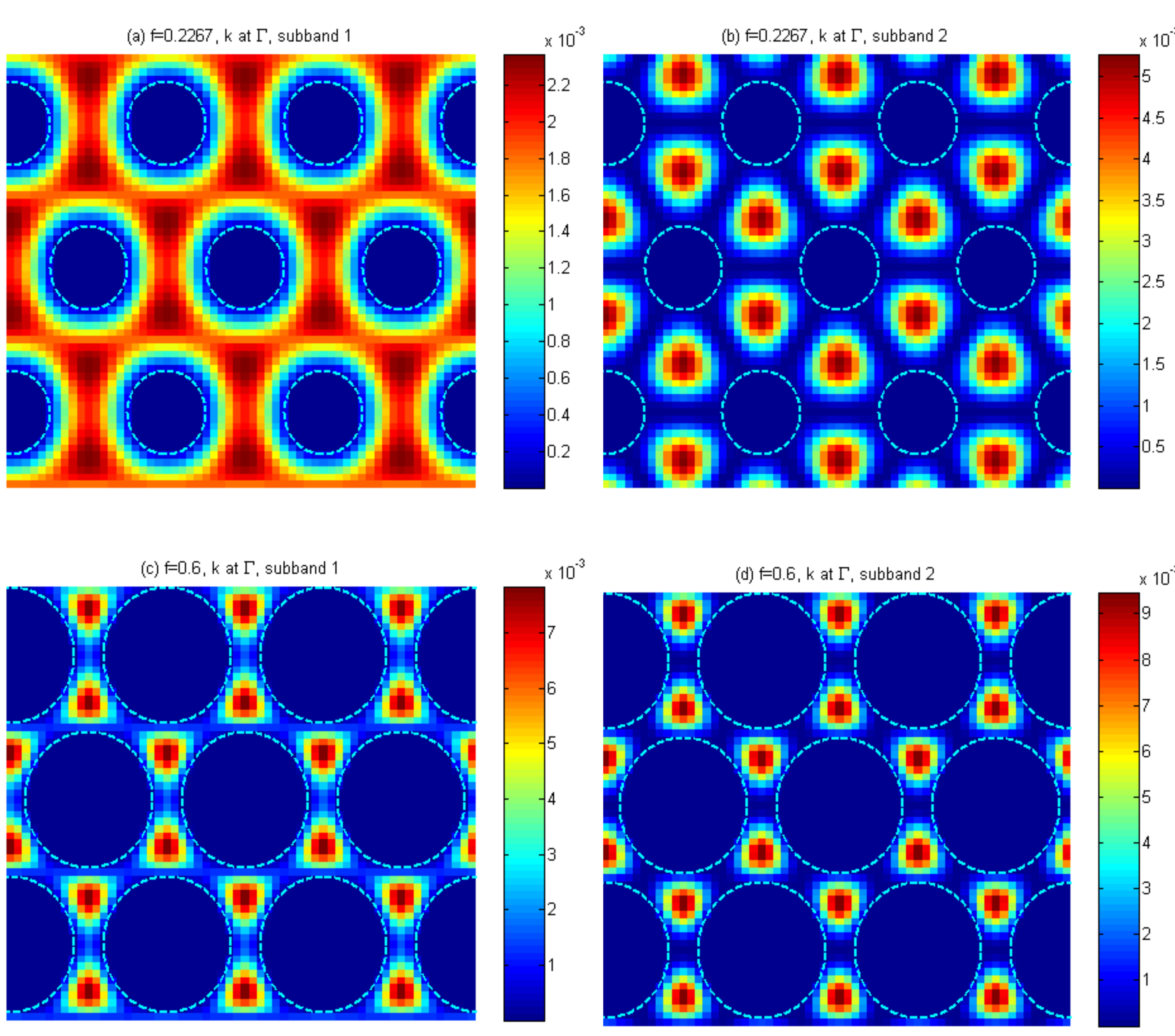
The absorption coefficient due to intersubband transitions is given by:

$$\alpha=\left(\frac{2\pi\omega}{n\varepsilon_0 cV}\right)\sum_{n,m}\left|\langle m|\vec{E}_0\cdot\vec{r}|n\rangle\right|^2(f_n-f_m)\frac{\Gamma/2\pi}{(\Delta E-\hbar\omega)^2+(\Gamma/2)^2}$$

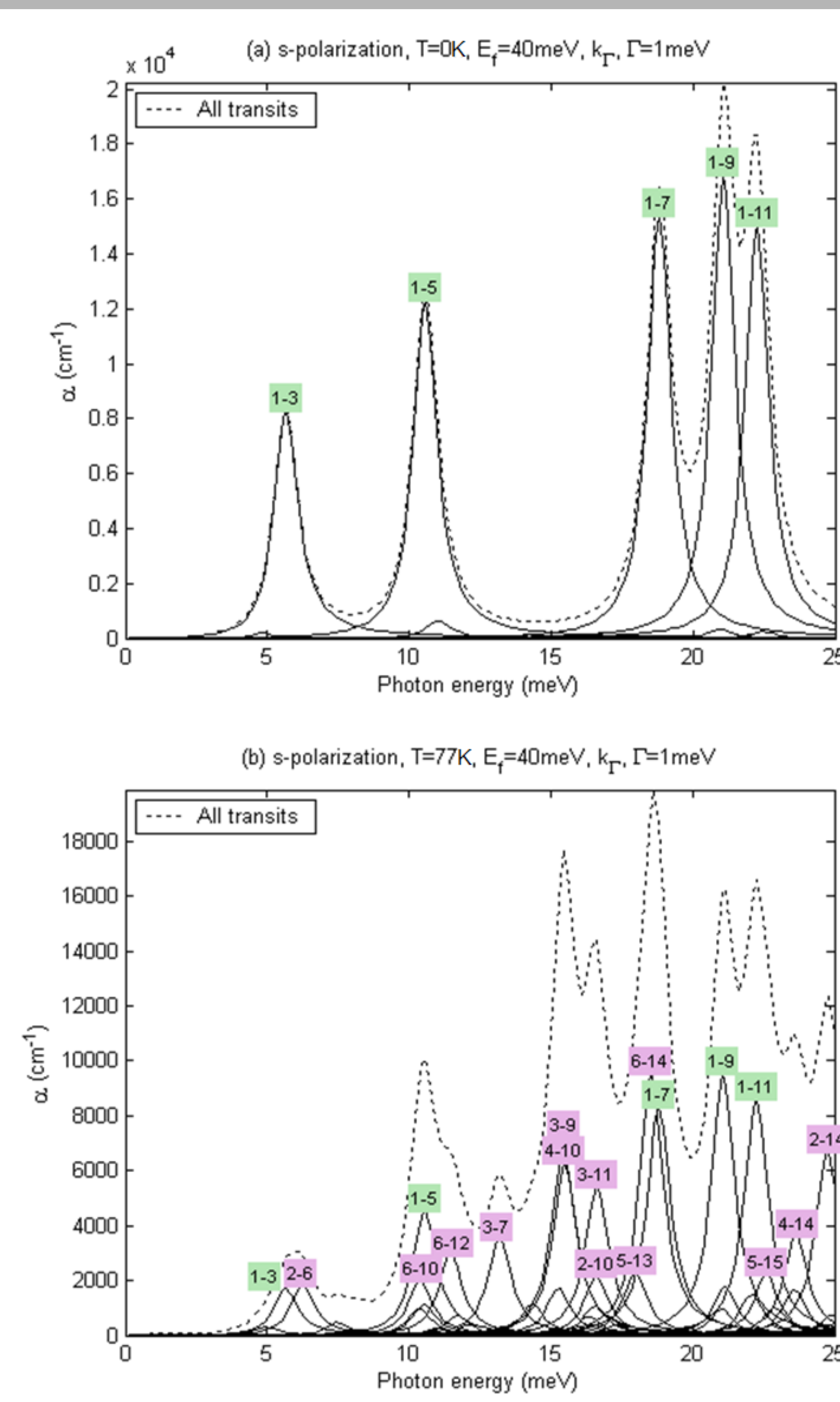
Band Structure



Wave Functions



Optical Absorption



References:

[1] C. Sirtori, "Bridge for the terahertz gap," Nature **417**, 132-133 (2002).

[2] V. C. Elarde, and J. J. Coleman, "A novel ordered nanopore array diode laser," IEEE Photon. Technol. Lett. **20**, 240-242 (2008).

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