Proposed CSM Project

The Problem

- Suboptimal material properties are preventing realization of low cost, high performance InAs/InAsSb Type 2 SL based LWIR devices
- Poor vertical transport and short diffusion length limit carrier collection and QE in n - InAs/InAsSb Type 2 SL

The Project

- Bring together the IR community to develop robust validated models that describe transport of minority carriers in both n- and p- InAs/InAsSb Type 2 SL

Payoffs

- Determine whether current material & device limitations are *fundamental* or *technological*
- Enable knowledge-based future device development

Proposed approach

- Use 1D k·p coupled with NEGF to study quantum phenomena in selected local device regions
  - Enhanced representation of the physical processes of a multilayer structure that avoids a priori assumptions of the nature of the transport
- Explore alternative methods to compute the electronic structure: tight-binding and DFT
- Use information obtained from different regions to set up a model for the whole device structure: microscopic particle model or drift diffusion depending on device design goals
- Validate models experimentally
  - Bulk and SL material – bandgap, absorption, mobility
  - Devices (I-V, QE)

Expected Project Outcome

- Understand transport mechanisms (drift, hopping, sequential tunneling, etc.) – to identify which design "knobs" control each process
- Obtain quantified transport and optical parameters (minority carrier mobility, lifetimes, optical absorption)
- Explain experimental (materials and devices) data to understand behavior and limitations
- Propose material optimization to obtain better than current performance

Risks

- k·p has limitations that may impact model fidelity
- NEGF is computationally expensive
- Data doesn't exist or access to data is difficult for model validation