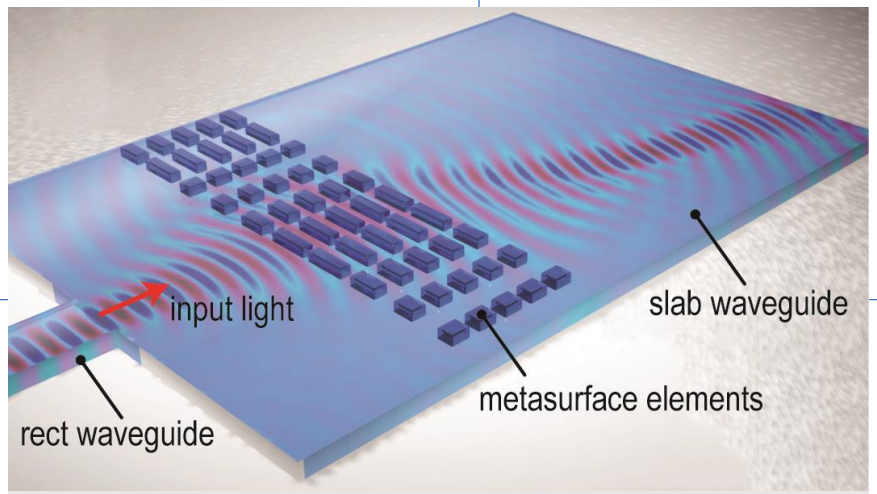
Ultra-Compact On-Chip Integrated Spectrometers based on Metasurfaces

Xingjie Ni (PI)
Charles H. Fetter Assistant Professor
Pennsylvania State University

Research Objectives

- **Goal:** To create an integrated photonic spectrometer with high resolution, high sensitivity, and a small footprint (Start TRL: 1; End TRL: 2)
- **Key innovation:** Integration of the subwavelength metasurface elements and the integrated waveguides to achieve wavelength-dependent light localization
- **Compare to SOA:** Small footprint, lightweight, and fully integrated, while maintaining high sensitivity and resolution



The proposed ultra-compact integrated photonic spectrometer. The guided wave is focused into a wavelength-dependent spot after passing through the region with metasurface elements.

Approach

Use metasurface elements for **direct** phase control of guided waves

- Design an **asymmetric** metasurface to achieve easy light accessibility
- Optimize distribution of metasurface elements to achieve localization of light with **strong dependence** on wavelength in a waveguide
- Collaborate with **IP-IMI** for fully integrated PIC fabrication and on-chip system-level testing

Potential Impact

Enables compact, versatile, energy-efficient spectroscopy (align with **SWaP2**)

- Enables portable systems for chemical and biological sensing, material characterization, and analysis of astronomical objects
- Increases lab-on-chip functionality and reduce the weight and size of the system
- Enables **wearable** devices with spectroscopy capability