1. **Research Title:** On-chip Synchronized Lasers

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Optics, Physics, Electro-Optics, Electrical Engineering/MSc or PhD

4. **Objectives:** Develop physical models for phase-locked microlaser arrays. Extend concepts of slow light and topology from passive chains and two-dimensional arrays to arrays with III-V semiconductor gain, monolithic or heterogeneously integrated on silicon photonics. Design concept photonic integrated devices, and program, characterize them.

5. **Description:** This topic leverages recent advances in non-Hermitian optics and photonics to synchronize multiple lasers on chip. Phase synchronization leads to increased power, narrow emission lines and superior characteristics of low volume integrated lasers. This is achieved by designing the couplings, including phases between optical resonators – from one dimensional chain to periodic chains or two dimensional arrays. The couplings range from nearest neighbor to long distance, e.g., across the array and can be implemented in monolithic structures like indium phosphide or through heterogeneous integration with silicon photonics. Sensors Directorate in AFRL developed in the last five years a device fabrication and testing protocol based on in-house modeling. The first goal of this topic is to identify optimal parameter spaces, starting from lower order approximation models in Matlab, then refining the models with specialized optical software like Ansys Lumerical, and using this information for accurate designs for foundry fabrication. The second goal is to program and characterize the fabricated devices using existing AFRL optical setups, and to provide iterative feedback to modeling and design. This approach will provide a broad understanding of phased-locked microlaser arrays and will underpin minituarized sensors with a large area of applicability.

6. **Research Classification/Restrictions:** Non Classified/Not Restricted

7. **Eligible Research Institutions: All**

8. **Keywords:** Lasers, Integrated Photonics, Design and Characterization

9. **PA Approval #: AFRL-2023-4173**