

# Novel Lasers Based on Resonant Dark States

## Scientific Achievement

We designed a surface laser based on stimulated emission into dark photonic bound states with controllable radiation damping and directionality.

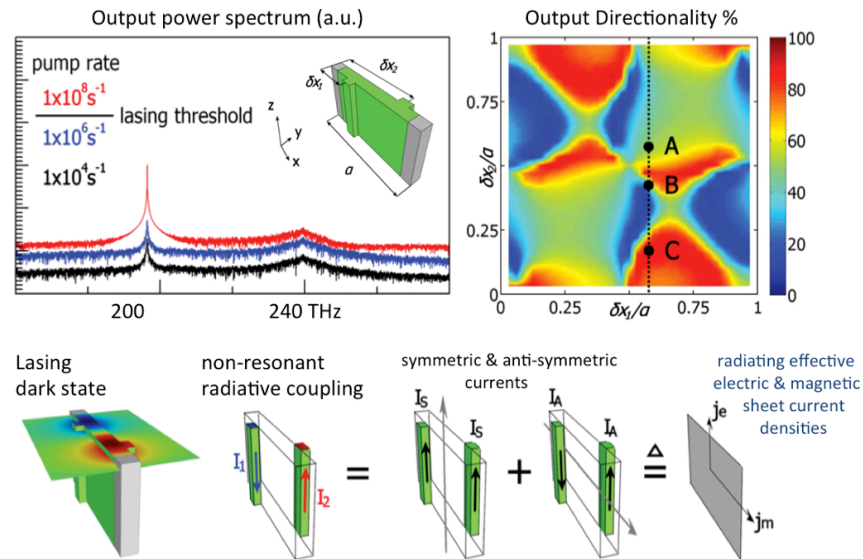
## Significance and Impact

This dark-photonic-state analog of the Spaser allows very small surface-emitting lasers with functionalized beam characteristics.

## Research Details

Separating the lasing state from coupling to the radiated field and implementing it by a resonant dark dielectric bound or surface state allows for novel types of lasers with deeply sub-wavelength thickness. Independent radiative coupling via a metasurface allows explicit control over radiation damping and the emitted beam characteristics and directionality. Together with the low intrinsic loss of the dielectric support of the lasing dark state, this enables low lasing thresholds.

Sotiris Droulias, Aditya Jain, Thomas Koschny, and Costas M. Soukoulis, "Novel Lasers Based on Resonant Dark States," PHYSICAL REVIEW LETTERS 118, 073901 (2017). DOI: 10.1103/PhysRevLett.118.073901.



Simulated optical output and directionality for a lasing dark resonant state in a 60nm thick quantum well (QW) that serves as both the gain medium and support layer for the resonant dark dielectric bound state (top). Schematic principle of operation: Lasing occurs directly into photons in a dark bound state of the thin, high index QW. Metasurface elements decorating the surface then create effective electric and magnetic radiative sheet currents that determine the emitted beam (bottom).

