**Scientific Achievement**

We developed a characterization method to correlate the optical properties of atomic-defect-based quantum emitters with their atomic and crystallographic structure.

**Significance and Impact**

Next-generation quantum and energy technologies will require bright, controllable emitter characteristics and placement. Our research provides a foundation for creating such emitters based on atomic “defects-by-design”.

**Research Details**

- we combine photoluminescence (PL), cathodoluminescence (CL) and nano-beam electron diffraction.
- across 40 emitters, we identify 4 unique emitter classes: type 1 (only CL active, 650nm); type 2 (identical CL and PL, 625nm); type 3 (shifted CL-PL, 700nm); and type 4 (580nm).
- Complexes of \( C_B V_N, N_B V_N, O_{2B} V_N \), as well as \( V_N \) with interstitials, are the likely candidates.

Work was performed at Stanford University and Harvard

---

Atomic-scale optical characterization of materials, such as quantum emitters in hexagonal boron nitride, is enabled with light-coupled transmission electron microscopy (TEM). Our work revealed 4 distinct classes of color centers with distinct emission wavelengths, charge states, and local strain.