**Low-Dimensional Hybrid Halide Compounds:**
**A New Frontier for Material Discovery**

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Three-dimensional hybrid halide perovskites have garnered immense attention due to their exceptional optoelectronic properties, including remarkable quantum efficiencies. These properties stem primarily from their optimal bandgaps for solar spectrum harvesting, low exciton binding energies, and cost-effective synthesis. However, the stability challenges associated with these materials under real-world conditions have spurred extensive exploration of lower-dimensional analogues. While often exhibiting enhanced stability, these lower-dimensional systems generally possess significantly higher bandgaps and exciton binding energies, negating the most crucial advantages of their 3-D analogues. Nevertheless, the vast array of organic moieties available for incorporation into these low-dimensional structures presents a boundless opportunity to uncover novel materials with unique properties.

This presentation will showcase two exemplary studies from our research. First, we will delve into our investigations that culminated in synthesising a highly moisture-stable two-dimensional hybrid lead halide material characterized by an exceptionally low band gap and exciton binding energy within this compound class [1]. We will elucidate the underlying factors contributing to these remarkable properties and identify the critical parameters governing their determination.

Second, we will explore a class of systems where the organic component is chiral and address the fundamental question of whether this chirality can be transferred to the inorganic component, thereby influencing the low-energy electronic structure and optical properties. In this case, we will demonstrate how a blurring of dimensionality boundaries in the low-dimensional regime facilitates enhanced chirality transfer from the organic to the inorganic constituents of the hybrid material [2,3].

References

[1] Debasmita Pariari et al., J. Am. Chem. Soc. 145, 15896 (2023).

[2] Ranjan Das et al., ACS Mater. Lett. 5, 1556 (2023).

[3] Ranjan Das et al., Chem. Mater. 36, 1891 (2024).