Blue-emitting perovskites are cutting-edge materials with the potential to transform the way we create blue light for screens, displays, and lighting. Perovskites are special materials known for their ability to efficiently emit light, making them a strong candidate for next-generation technologies. While red and green perovskites are already achieving excellent performance, blue-emitting perovskites are still catching up due to challenges in stability, efficiency, and color purity. This is particularly important because pure, high-quality blue light is essential for accurate color reproduction in displays and for creating white light when combined with red and green.

One of the most promising types of blue-emitting perovskites is called 2D Ruddlesden–Popper (RP) perovskites. These materials have a unique layered structure that not only makes them easy and cost-effective to produce but also gives them excellent properties, like the ability to emit bright blue light at the precise wavelength of ~465 nm needed for top-quality displays. However, there are still hurdles to overcome. The materials can degrade over time, especially under the heat generated by LEDs, and they struggle to maintain their pure blue color and brightness. These issues arise from problems in the material's structure, such as uneven layers and weak interactions between them.

This project focuses on solving these problems by studying and improving a key part of the 2D RP perovskite structure: spacer cations. Spacer cations are molecular "connectors" that help hold the perovskite layers together and influence their overall stability and performance. By designing and studying the insights of the spacer cations, the project aims to strengthen the bonds between the layers, improve heat resistance, and enhance the material's ability to emit bright, stable blue light. This involves studying how these molecular components interact within the material, particularly through forces called van der Waals interactions, which play a big role in how the layers stack and behave.

To achieve these goals, advanced scientific tools like X-ray diffraction, spectroscopic analysis, and electron microscopy will be used to analyze the material's structure in detail. By understanding how spacer cations affect the material's stability and light-emitting properties, this project aims to create blue-emitting perovskites that are not only more efficient and long-lasting but also capable of producing the precise color and brightness needed for high-quality devices.

Ultimately, this work could lead to significant breakthroughs in blue LED technology, enabling brighter, more colorful, and more energy-efficient displays and lighting. These advancements will bring us closer to creating practical, durable, and sustainable devices that meet the high standards required for commercial applications.