杂化等离子体超构材料腔和 TMDC 薄层中的强耦合和悬链线场增强效应

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光与物质之间的强耦合作为一种基本的量子光学现象，近年来也吸引了研究者们的广泛关注，其不仅具有重要的科学意义，并且对于新型纳米光子器件、高灵敏度传感器、单光子源等新型器件的研发具有重要意义。

澳大利亚堪培拉新南威尔士大学的 Andrey E. Miroshnichenko 教授团队采用具有天线状光场、强电磁场限制能力的可调谐、宽共振范围的金属纳米腔，以及具有高温度稳定性的过渡金属二硫化物 (TMDC) 二维薄层，成功构建了杂化等离子体超构材料腔，并深入探索了光与杂化等离子体超构材料腔之间的相互作用，包括等离子激元-激子强耦合、悬链线场增强效应等。通过改变空腔间隙的大小或厚度，可以对等离子激元的共振能量进行调节，进而与 TMDC 薄层中的激子实现强耦合。随着空腔间隙宽度、厚度的增大，悬链线场增强效应还将逐渐减弱，进而导致不同程度的 Rabi 分裂（室温下 Au-$MoSe_2$ 和 Au-WSe_2 异质结构中的 Rabi 分裂能量介于 77.86 ~ 320 meV 之间）。因此还可以通过调谐悬链线场增强效应来控制等离子激元与激子之间的耦合强度。

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Strong coupling and catenary field enhancement in the hybrid plasmonic metamaterial cavity and TMDC monolayers

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Plasmonic nanocavities are essential in plasmon-exciton strong coupling due to their tunability and ability to restrict electromagnetic fields in a compact volume. However, not all plasmonic nanostructures have the same tunability and field confinement properties.

The research group, led by Prof. Andrey E. Miroshnichenko discussed the successful development of strong plasmon-exciton coupling and catenary field enhancement in a hybrid plasmonic metamaterial cavity containing transition metal dichalcogenide (TMDC) monolayers. Plasmonic metamaterial cavities were chosen for their capacity to restrict electromagnetic fields in an ultrasmall volume and their ease of integration with intricate structures. The plasmon resonance of these cavities spans a wide frequency range, which may be adjusted by changing the size or thickness of the cavity gap. This tuning is consistent with the excitons of the WS_2, WSe_2, and $MoSe_2$ monolayers. TMDC monolayers were chosen for their capacity to facilitate strong light-matter interactions due to their temperature stability, high radiative decay rate, and notable exciton binding energies. By combining these unique properties, a strong coupling regime was realized.

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