Probing quantum plasmonics and the ultimate limits of light compression with Van der Waals heterostructures

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Van der Waals materials have emerged as a toolbox for in-situ control of a wide range of collective excitations coupled to light: polaritons2. In this talk, we will show several examples of novel ways of exciting, controlling and detecting polaritons3,4,5,6. Plasmon modes propagating almost as slow as the electron Fermi velocity show a strong quantum non-local response, which can be further exploited to study many-body effects.

We further show that a graphene-insulator-metal heterostructure can overcome the trade-off of optical confinement and loss, and we demonstrate plasmon confinement down to the ultimate limit of the lengthscale of one atom1. Record strong normalized mode volume confinement of the range 109 - 1010 was achieved by far-field excitation of plasmon modes squeezed into an atomically thin h-BN spacer between graphene and metal rods. These ultra-confined plasmonic modes, addressed with far-field light excitation, enables a route to new regimes of ultra-strong light-matter interactions.

References

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Figures