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

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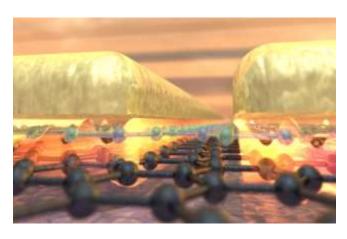
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Van der Waals materials have emerged as a toolbox for in-situ control of a wide range of collective excitations coupled to light: polaritons2. In this talk, we will show several examples of novel ways of exciting, controlling and detecting polaritons3,4,5,6. 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-insulatormetal 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 ultraconfined plasmonic modes, addressed with far-field light excitation, enables a route to new regimes of ultra-strong light-matter interactions.

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- [3] Tuning quantum non-local e?ects in graphene plasmonics. Lundeberg et al., Science (2017)
- [4] Electrical 2pi phase control of infrared light in a 350-nm footprint using graphene plasmons. A. Woessner et al., Nature Photonics 11, 421-424 (2017)
- [5] Near-field photocurrent nanoscopy on bare and encapsulated graphene. A. Woessner et al., Nature Communications (2016)
- [6] Thermoelectric detection and imaging of propagating graphene plasmons. Lundeberg et al., Nature Materials (2016)
- [7] Ultra-confined acoustic THz graphene plasmons revealed by photocurrent nanoscopy. Alonso-Gonzalez et al., Nature Nanotechnology (2016)

Figures



References

[1] Probing the Ultimate Plasmon Confinement Limits with a Van der Waals heterostructures. Alcarez et al., Science (2018)