**Good Vibrations: Plasmon-Exciton Coupling in Gold/Molybdenum Disulfide Hybrid Systems**

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**Introduction**

Plasmons
- Coupling of photons to free electrons within metals
- Plasmon resonances defined by nanoparticle geometry
- Nanoscale regions of intense electric fields
- Generates coherent oscillations of the electron cloud.

Molybdenum Disulfide
- Mechanically exfoliated from molybdenite
- Three atom thick crystalline structure
- Highly translucent
- Optically excitable
- Strong exciton binding energy (0.5 eV)

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**Objective**

Explore exciton-plasmon hybrid system coupling in 2-dimensional materials.
- Determine enhancement of intrinsic optical properties of MoS\(_2\).
- Attempt to produce exotic bound exciton-plasmon states.

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**Results: Enhanced Photoluminescence**

- Photoluminescence Comparison
  - Both A and B exciton peaks are enhanced in presence of gold nanorods.

**Results: Exciton Energy Shift**

- Photoluminescence Comparison
  - Exciton peaks blue shift in presence of gold nanorods.

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**Conclusions**

- Enhancement of PL at least indicates weak plasmon-exciton coupling (Purcell effect).
  - Here the plasmon effectively acts as an antenna for photons.
- Energy shift in PL implies a stronger degree of coupling.
  - The blue shifted peak could be the high energy Rabi splitting peak, an indicator of strong coupling.
  - The HSQ spacer layer ensures that blue shift is not due to direct electron transfer.
  - The suspected coupling mechanism is coherent dipole-dipole coupling.

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**Future Work**

- Vary HSQ thickness to determine distance dependence of plasmon-exciton coupling.
- Extinction microscopy to see Rabi splitting or Fano resonances further supporting strong binding.
- Explore the extent of non-resonant vs on-resonant coupling between MoS\(_2\) and plasmons.

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**Methods**

- Mechanically exfoliated MoS\(_2\) flake onto silicon and glass substrates
- Applied HSQ spacer layer onto flake to reduce potential hot electron transfer
- Patterned nanorods using e-beam lithography
- Deposited gold using thermal evaporation
- Measured photoluminescence spectra

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**References**

