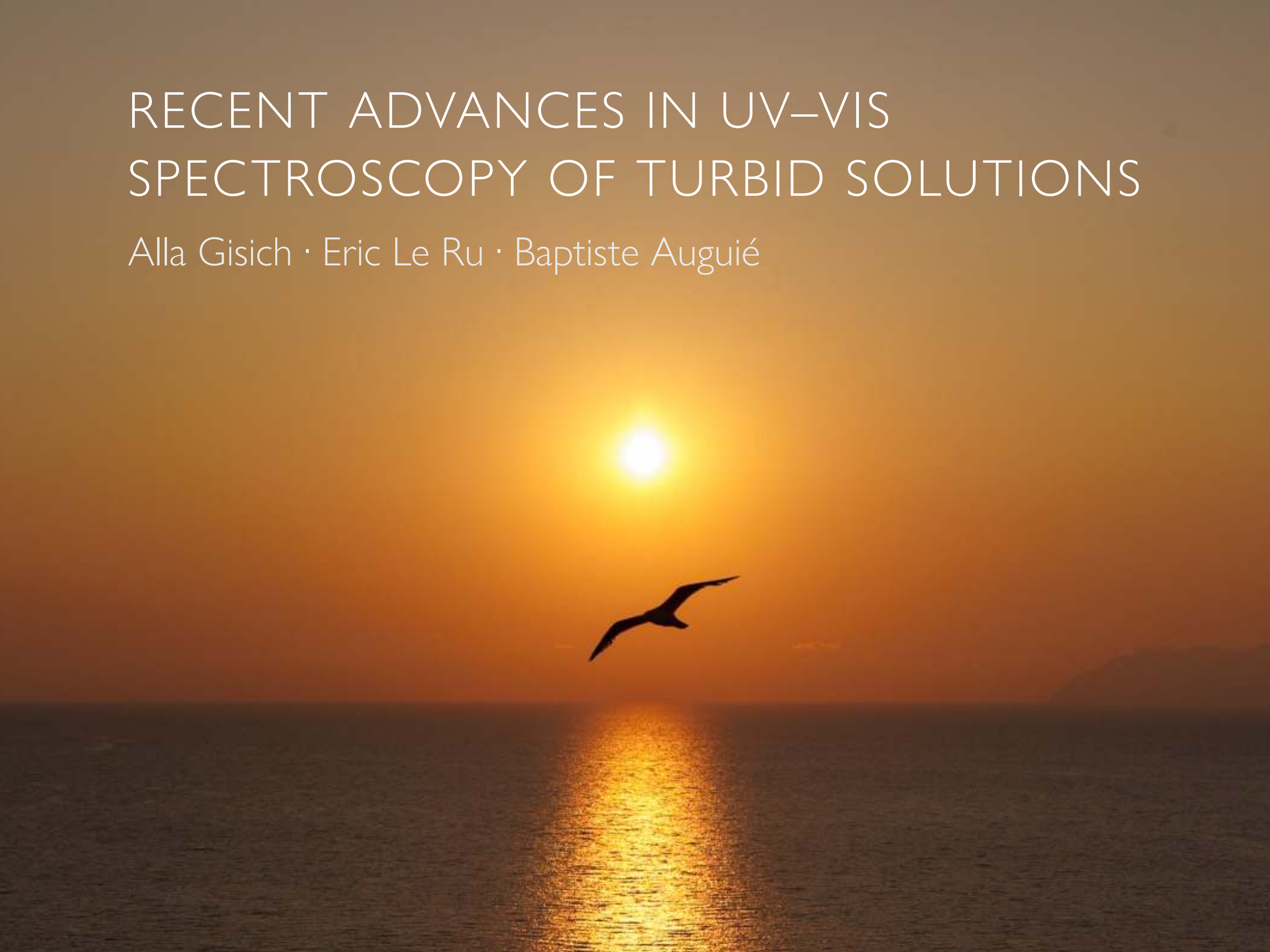
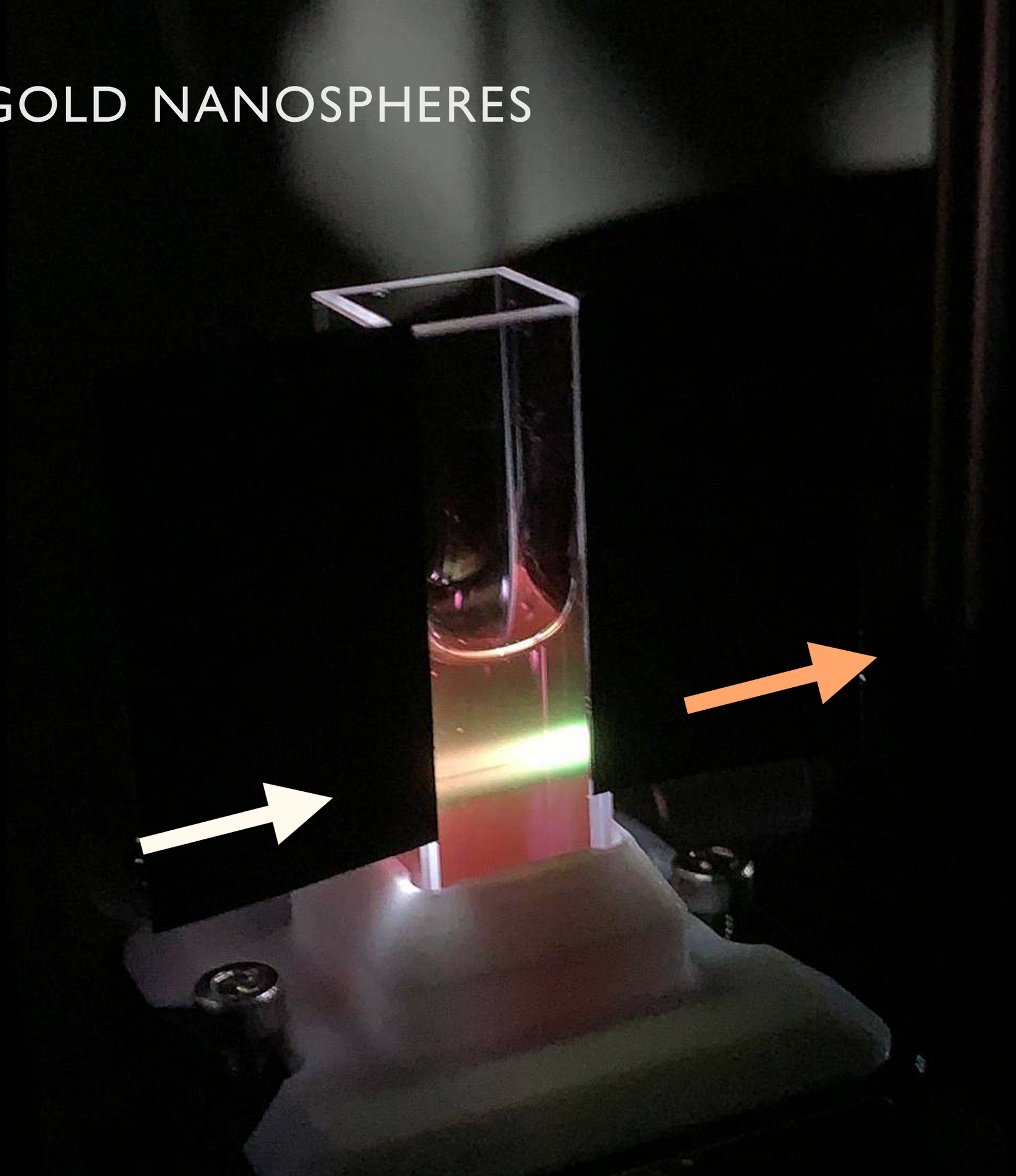
RECENT ADVANCES IN UV–VIS SPECTROSCOPY OF TURBID SOLUTIONS

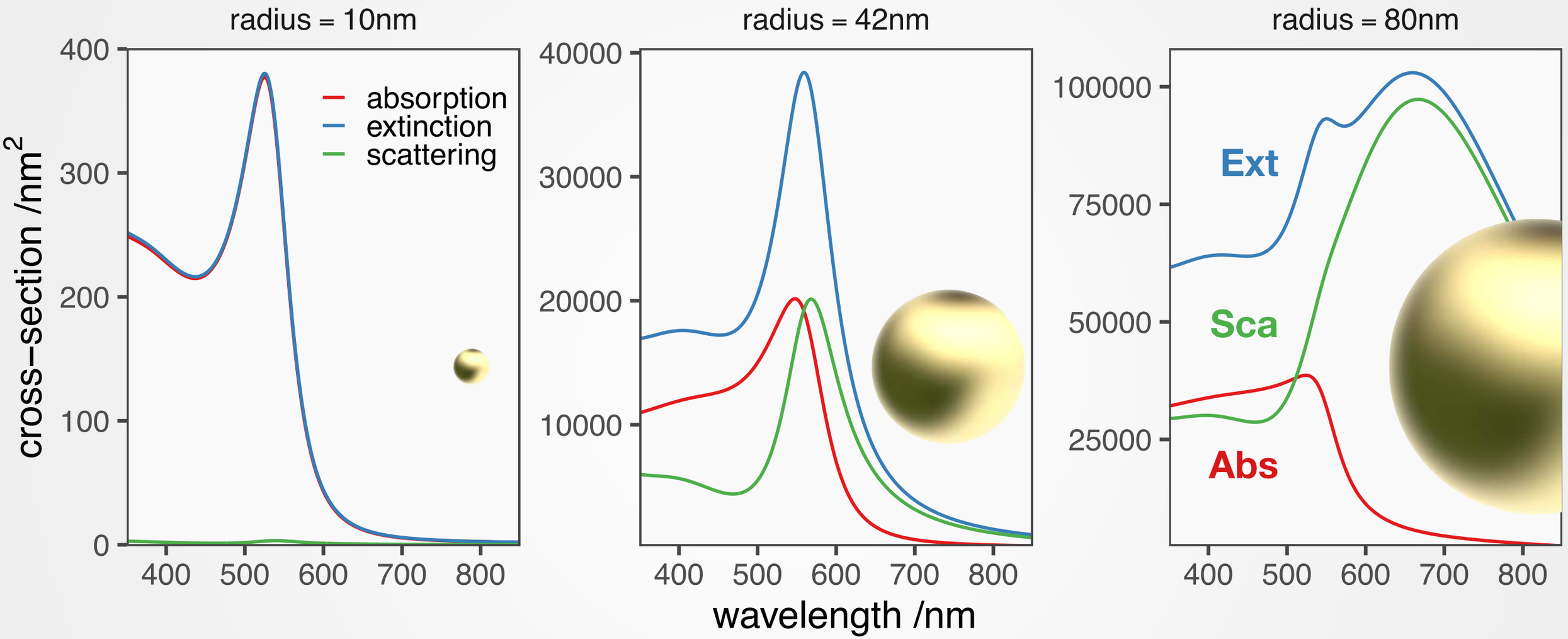
Alla Gisich · Eric Le Ru · Baptiste Auguié



60nm GOLD NANOSPHERES



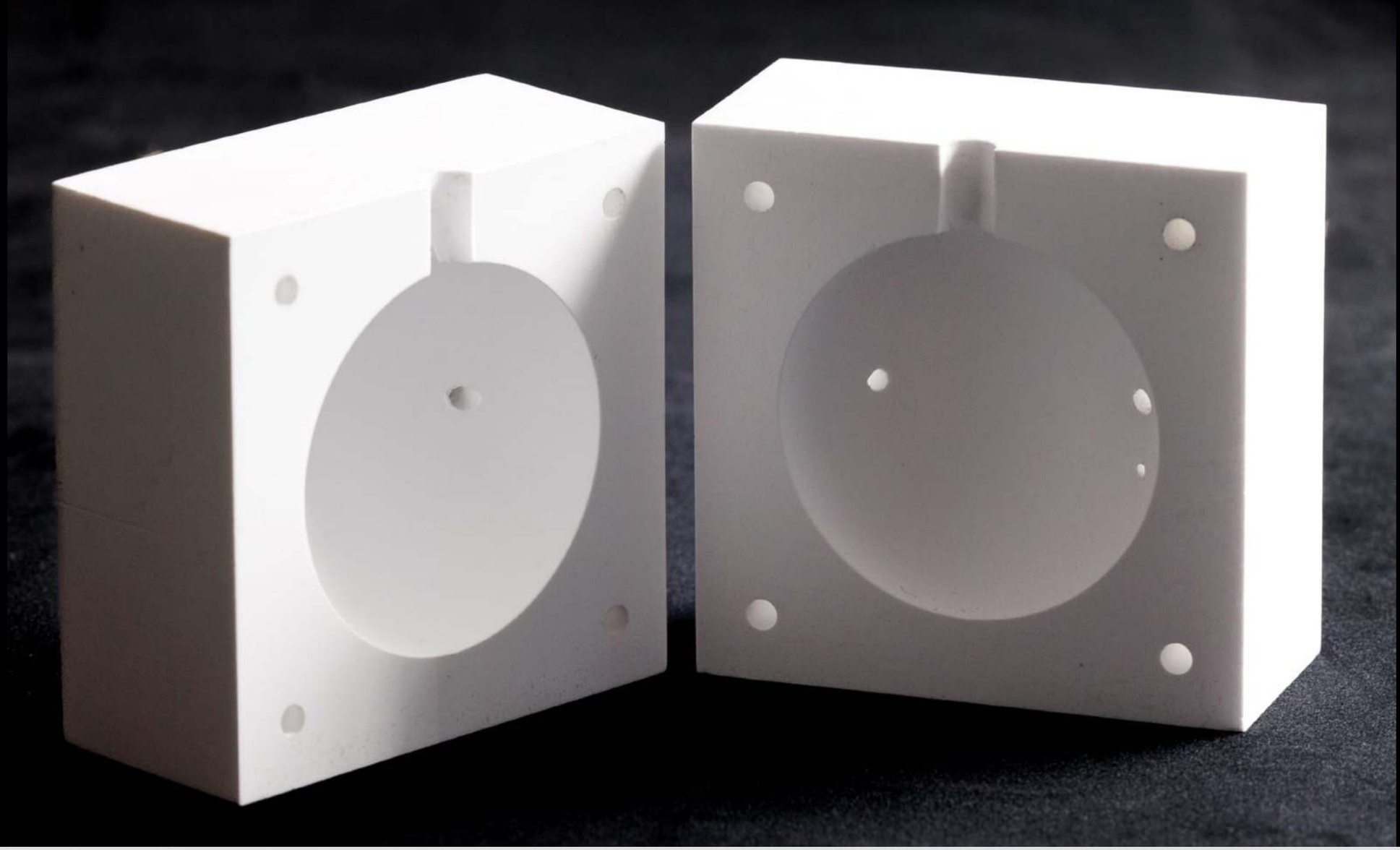
DIFFERENT INFORMATION IN EXT = ABS + SCA

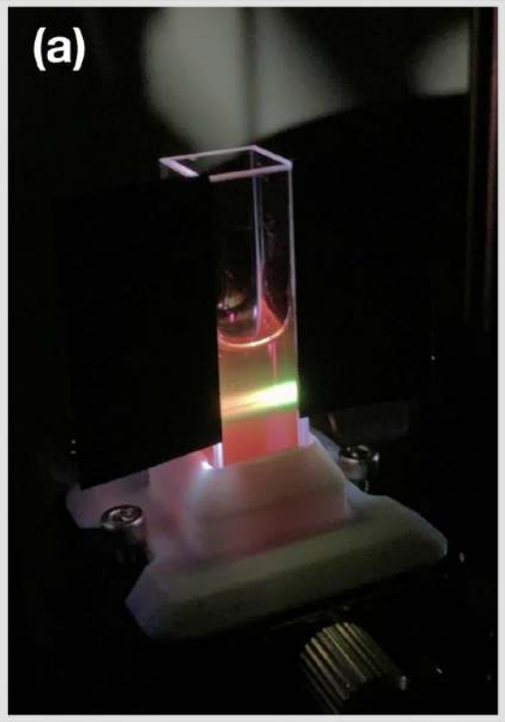


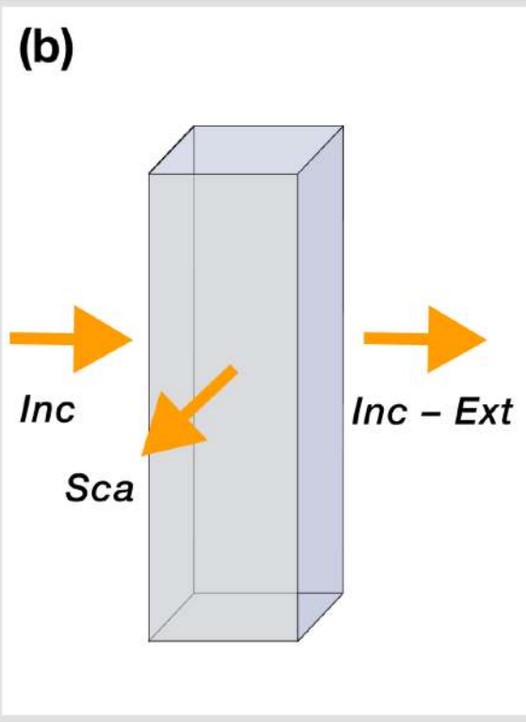
- Testing what we think we know: quantitative comparison
- Surprisingly few works in this area

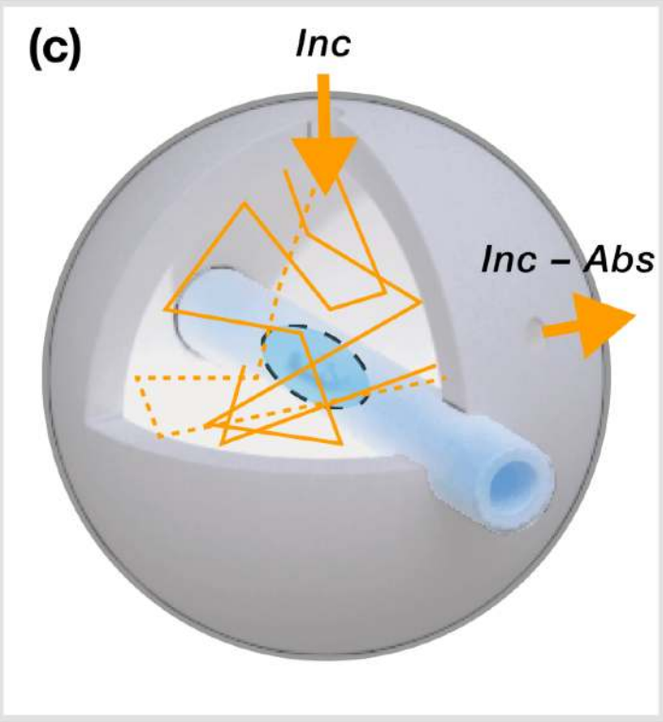
  Collings *et al* J. Phys. Chem. B 103, 1999 • Micali *et al* Anal. Chem. 73, 2001

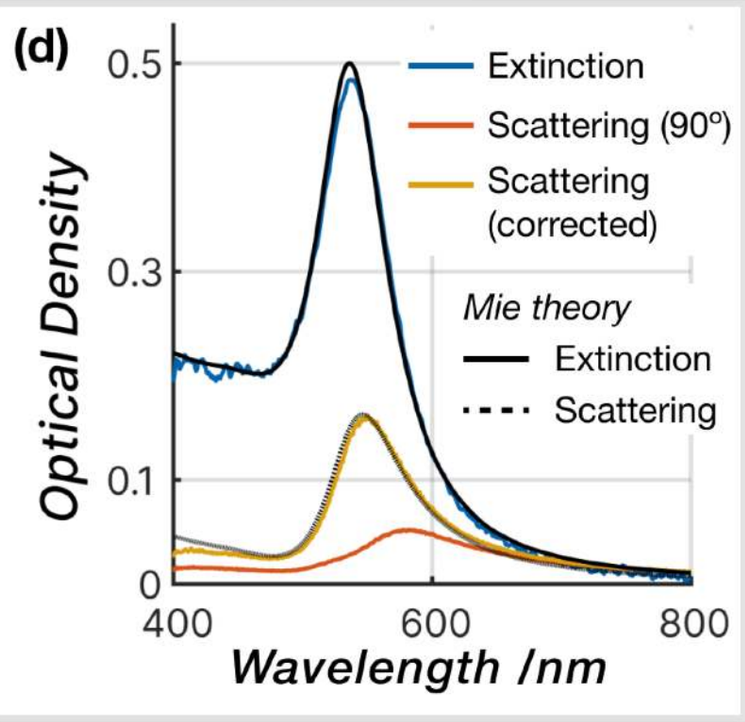
  Bin Ren *et al* Anal. Chem. 87, 2015



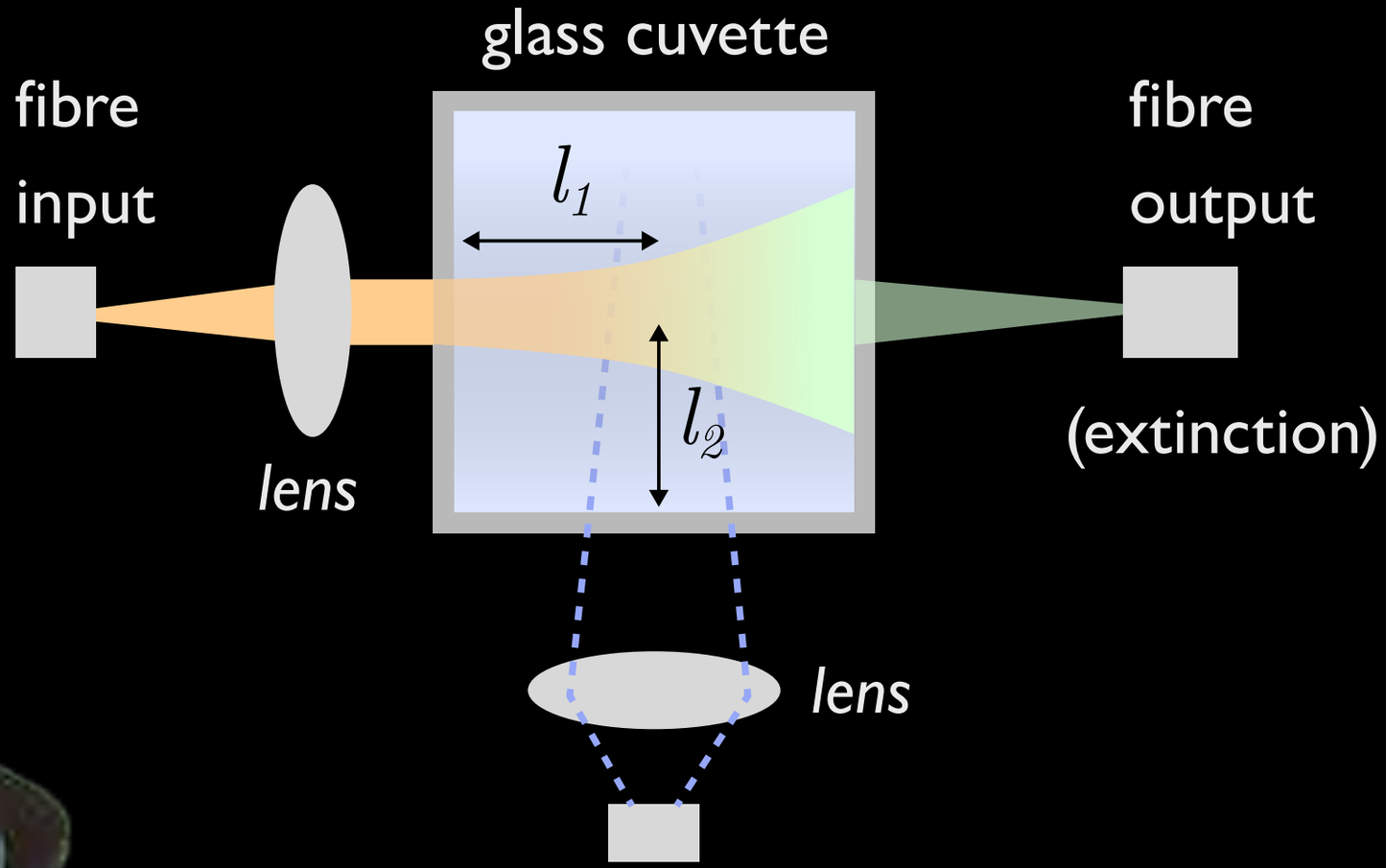

(a)


(b)
Inc
Sca
Inc – Ext

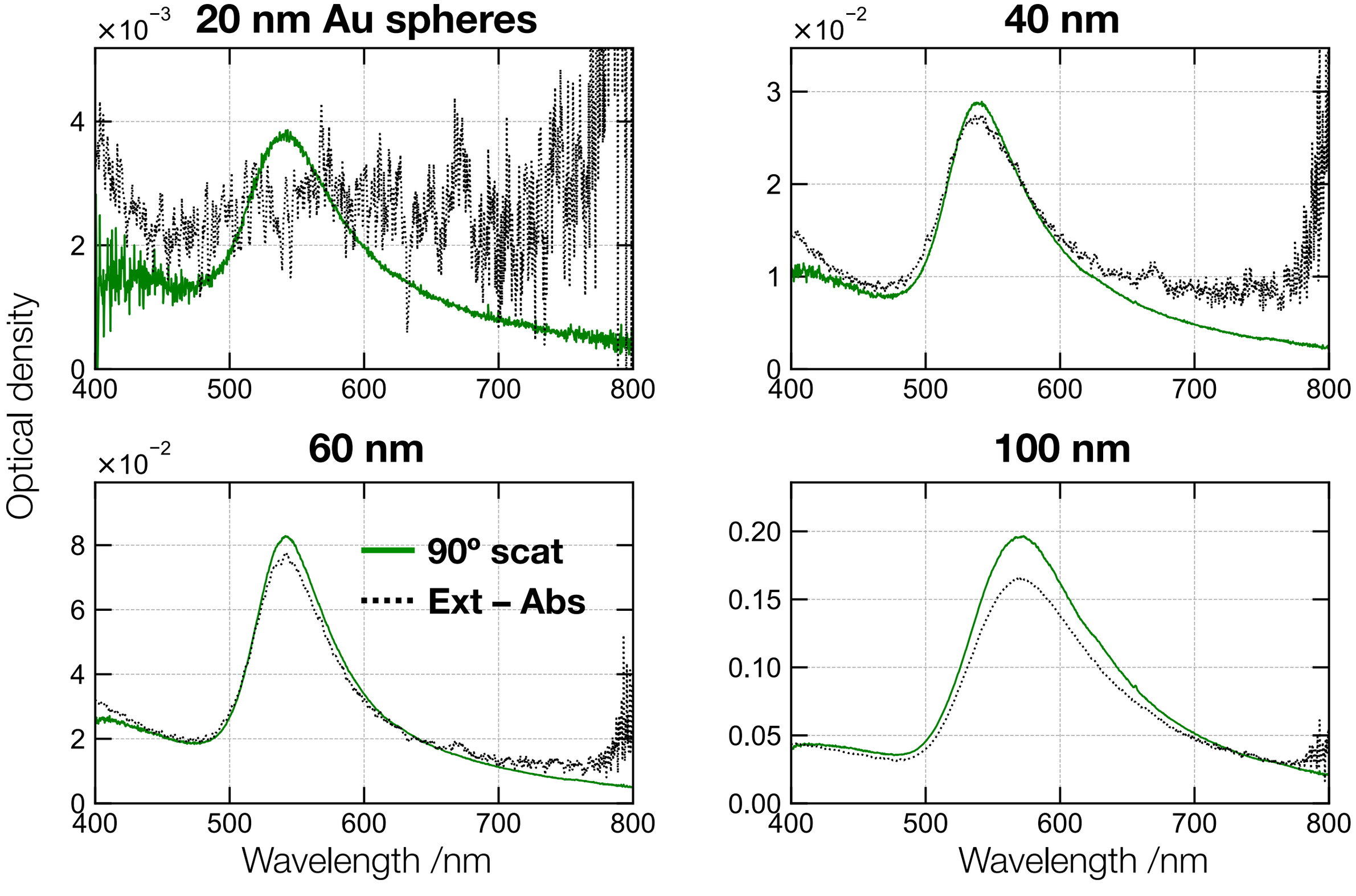

(c)
Inc
Inc – Abs


(d)
0.5
0.3
0.1
0
Optical Density
400
600
800
Wavelength /nm
Extinction
Scattering (90°)
Scattering
(corrected)
Mie theory
Extinction
Scattering

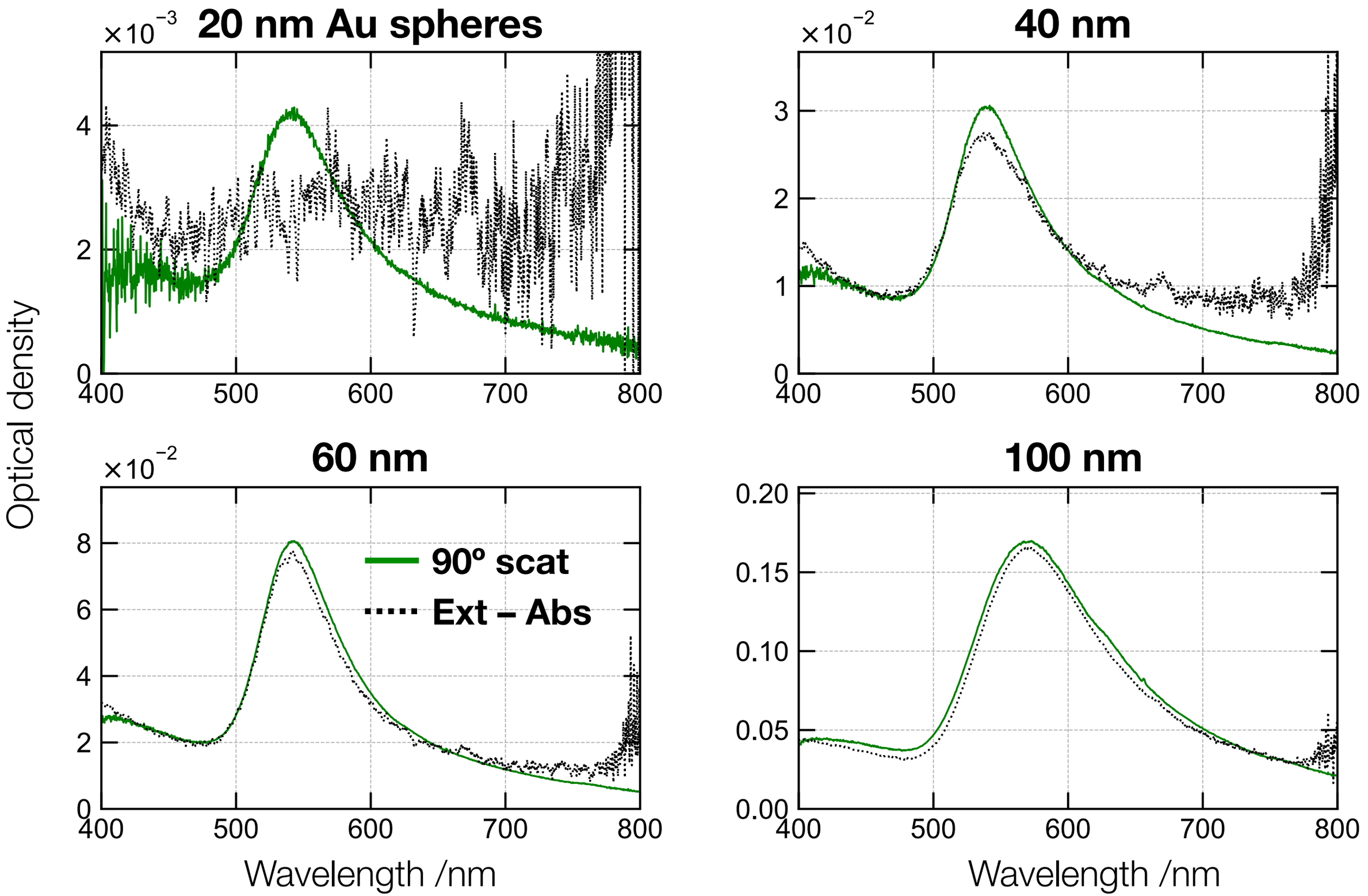
90 DEGREE SETUP



PRELIMINARY RESULTS, NAIVE $I(L) = I_0 \times 10^{-E(L_1+L_2)}$



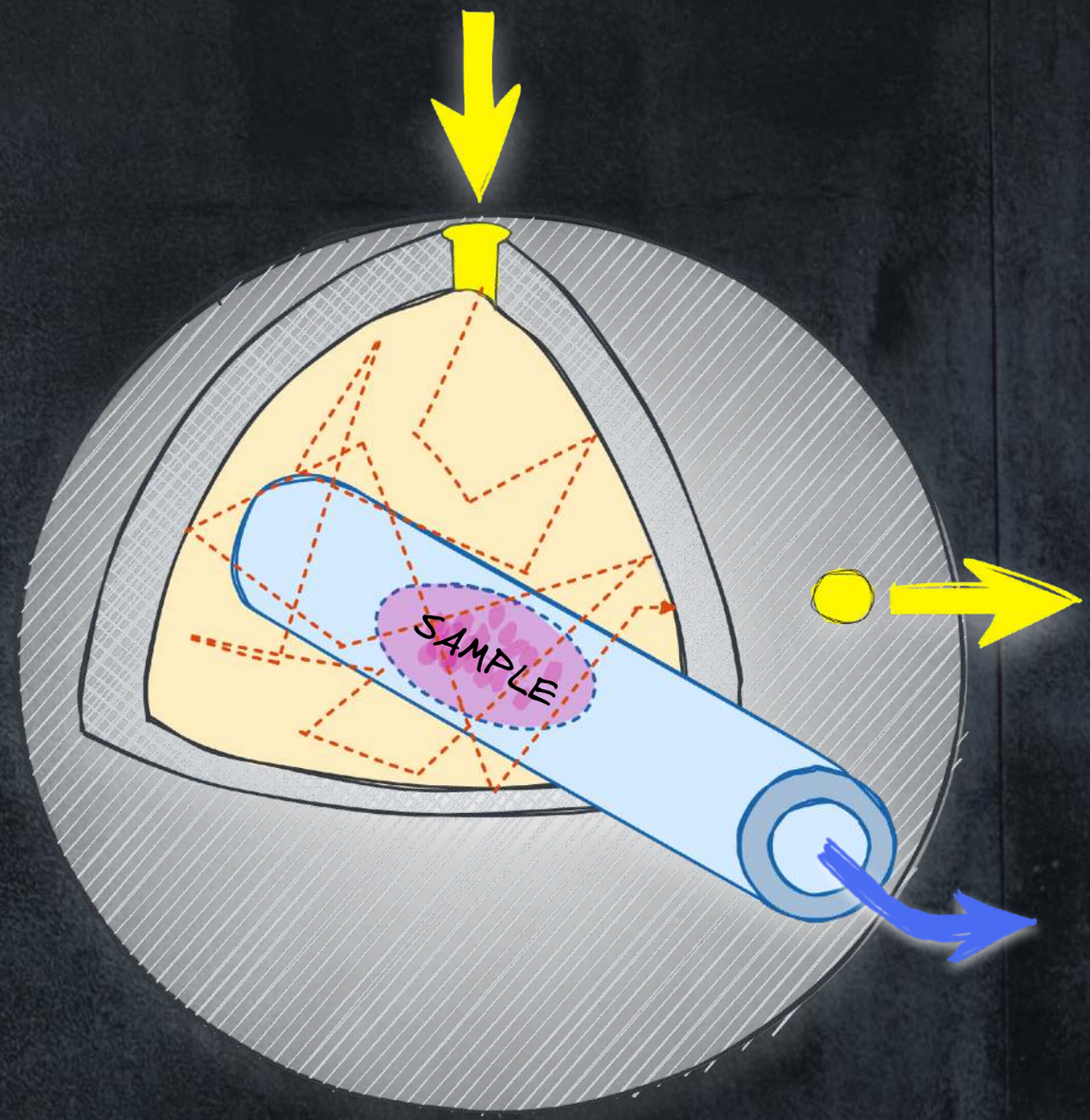
IMPROVED $F_1(S) \times F_2(A)$ CORRECTION



INTEGRATING SPHERE ABSORPTION

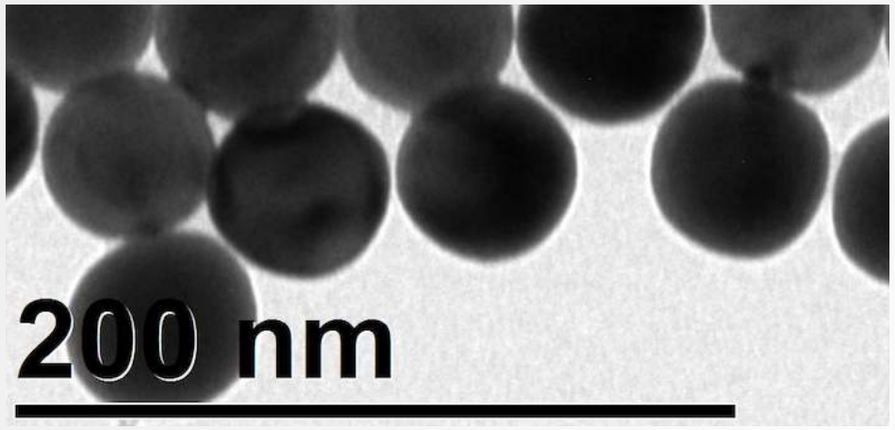
KEY FEATURES

- ✓ Insensitive to scattering
- ✓ Path length increase
- ✓ Orientation averaging
- ✓ Spatial averaging
- ✓ Non-imaging optics



ROBUST & SENSITIVE MEASUREMENTS

RATIO EXTINCTION/ABSORPTION → EPSILON

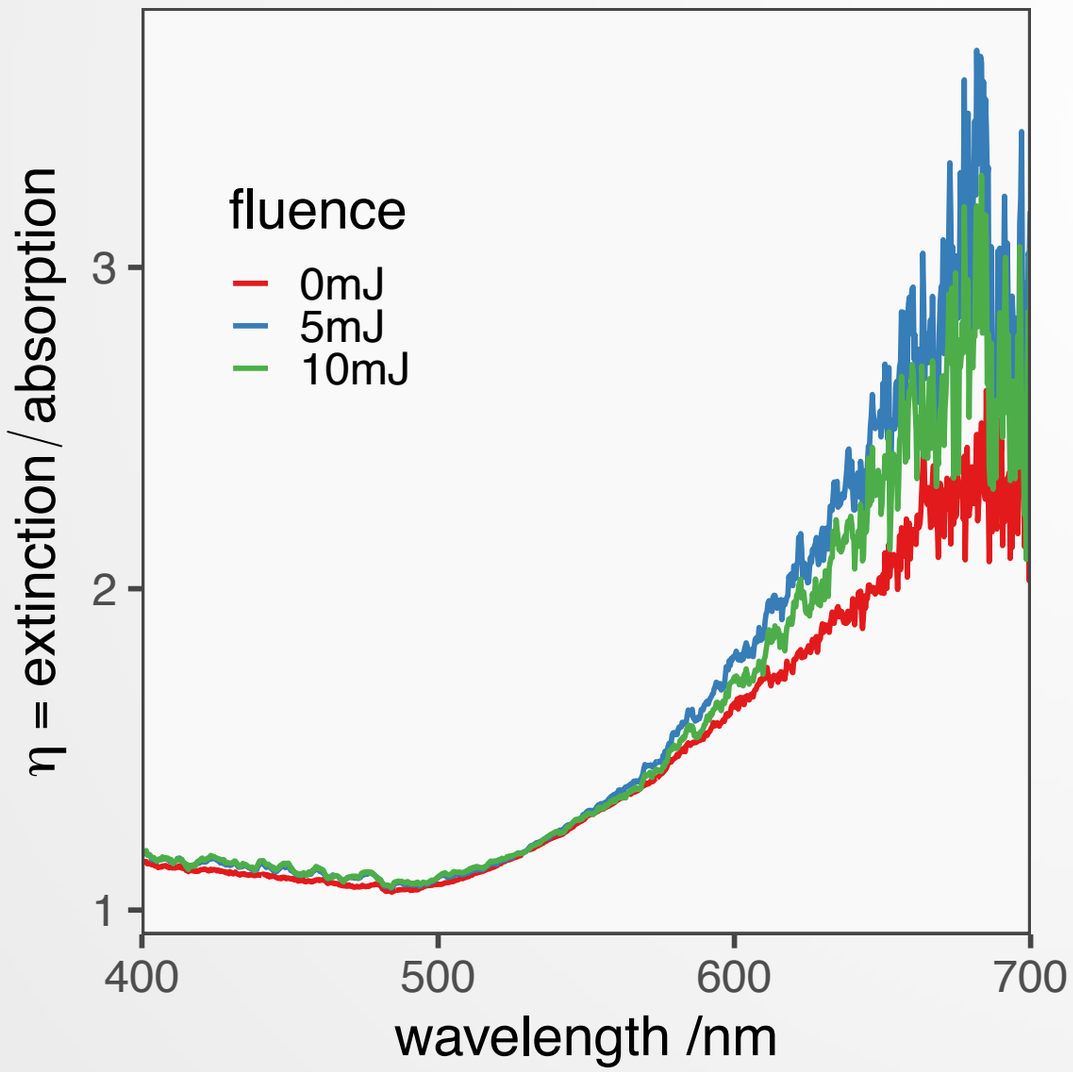


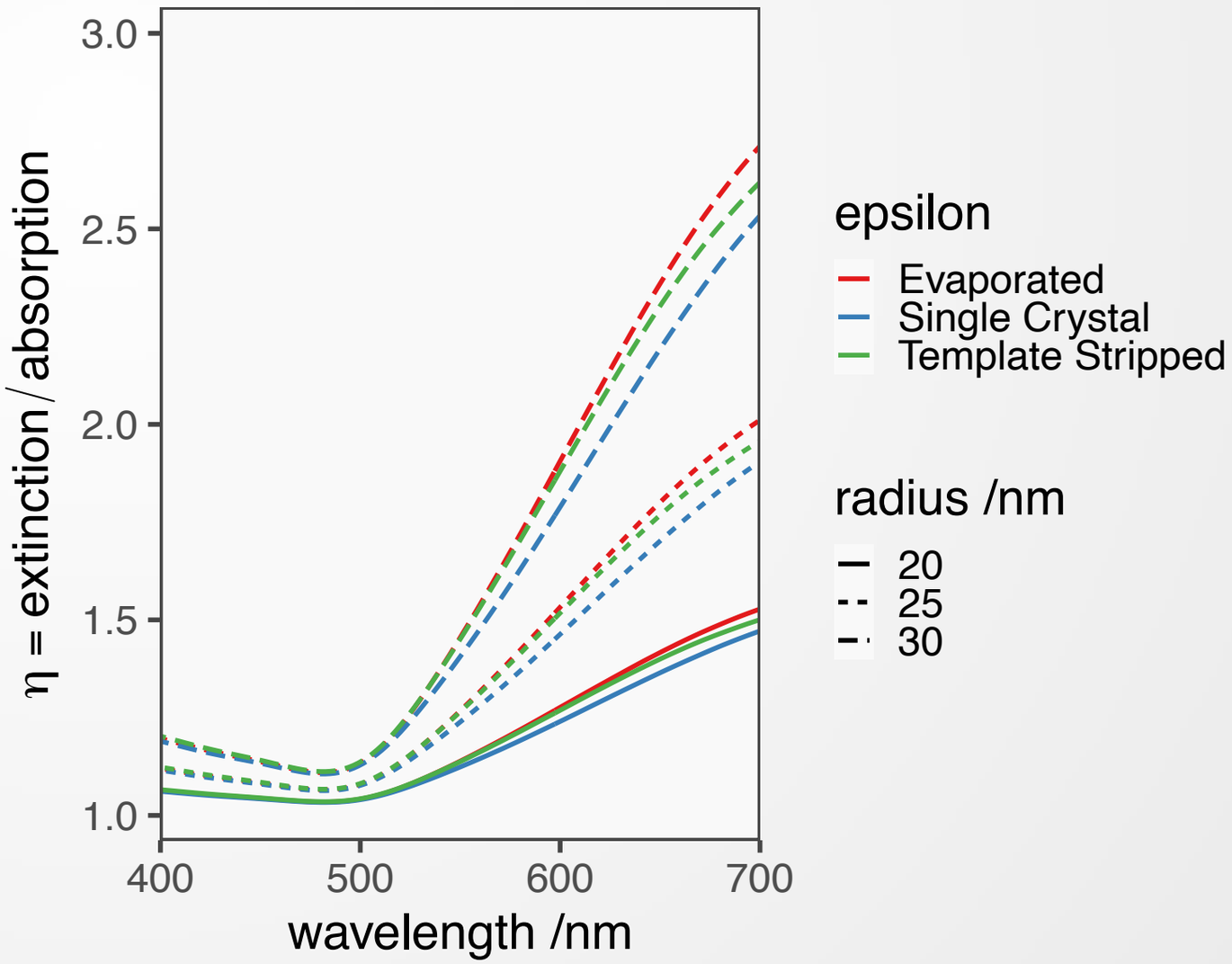
Simulations with thin film-measured dielectric functions

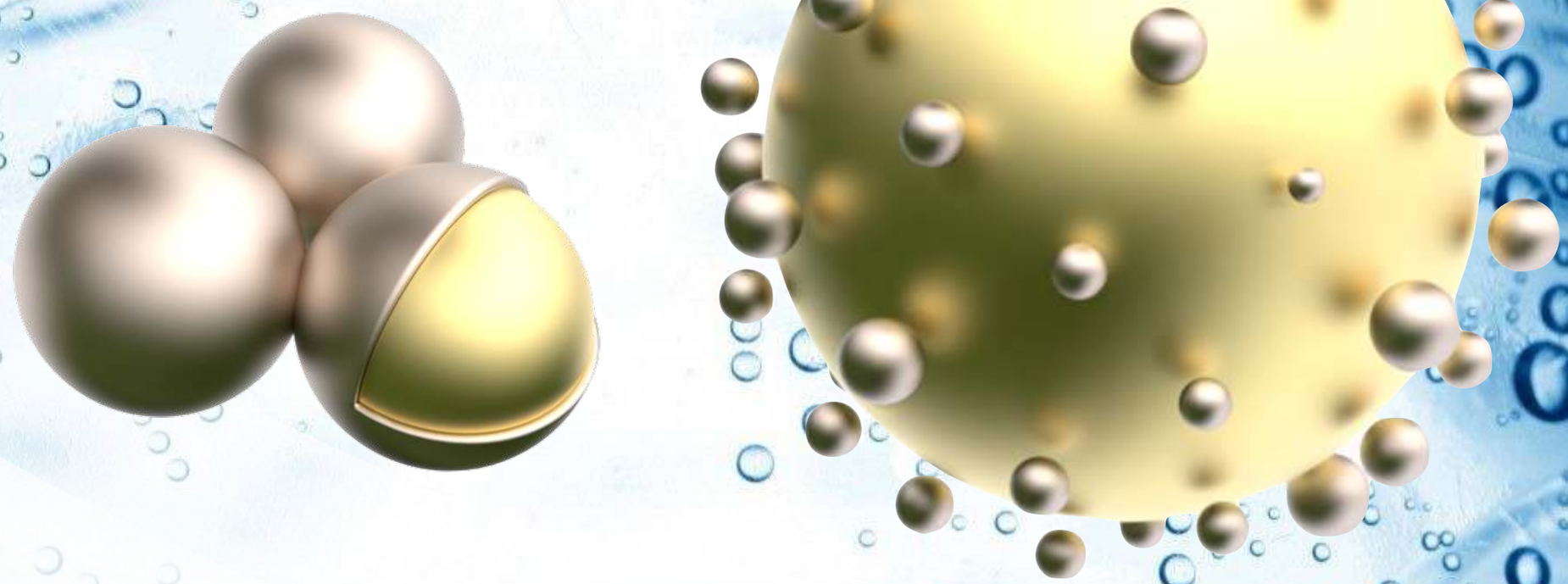
Olmon *et al* Phys. Rev. B 86, 235147 (2012)

Le Ru *et al* ACS Nano 14, 17597−17605 (2020)

Le Ru *et al* Anal. Chem. 91, 14639−14648 (2019)







MEASURING ABSORPTION IN HYBRID CORE-SATELLITE METAL NANOSTRUCTURES

with S. LEE, A. SOUSA-CASTILLO, M. HERRAN, E. CORTÉS (+ COLLABORATORS)

ACS NANO **2023** *17* (3), 3119-3127 • 10.1021/ACSNANO.2C12116
ADV. FUNCT. MATER. **2022**, 32, 2203418 • 10.1002/ADFM.202203418
ACS ENERGY LETTERS **2020** 5 (12), 3881-3890 • 10.1021/ACSENERGYLETT.0C02110

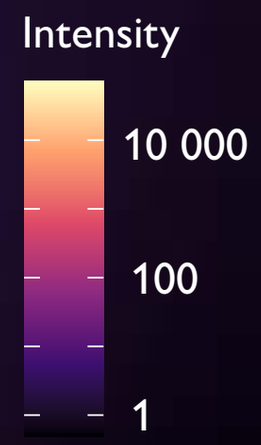
Dmitri Schebarchov

Atefeh Fazel-Najafabadi

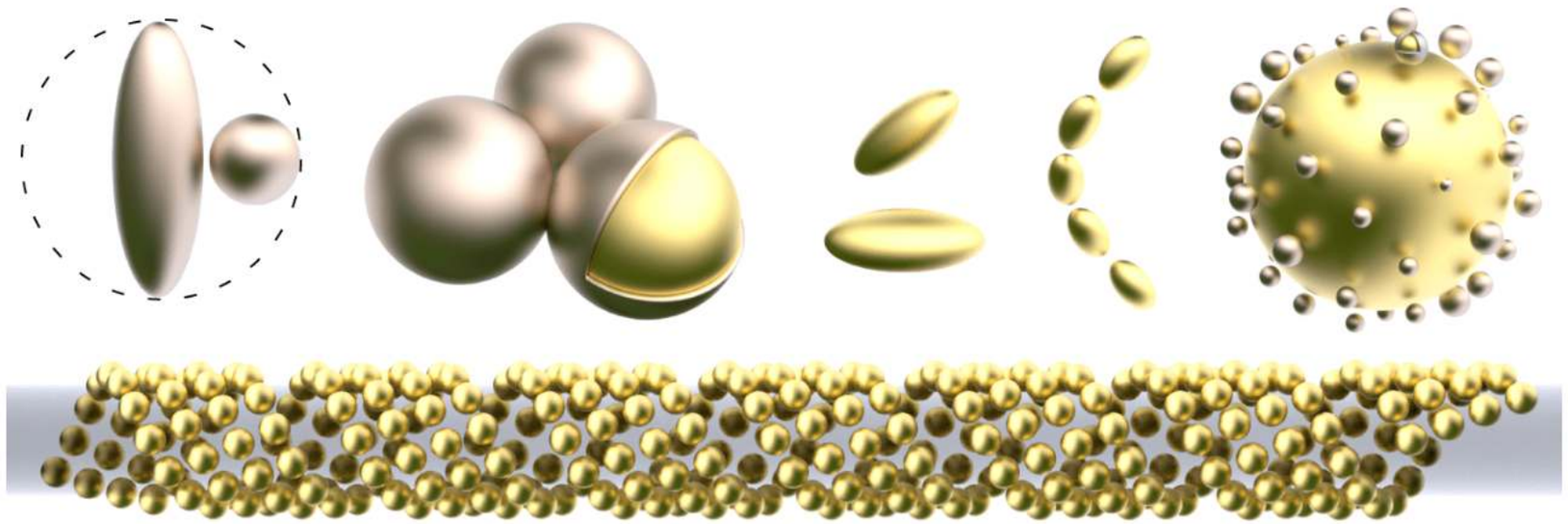
T.E.R.M.S.

(SUPERPOSITION T-MATRIX)

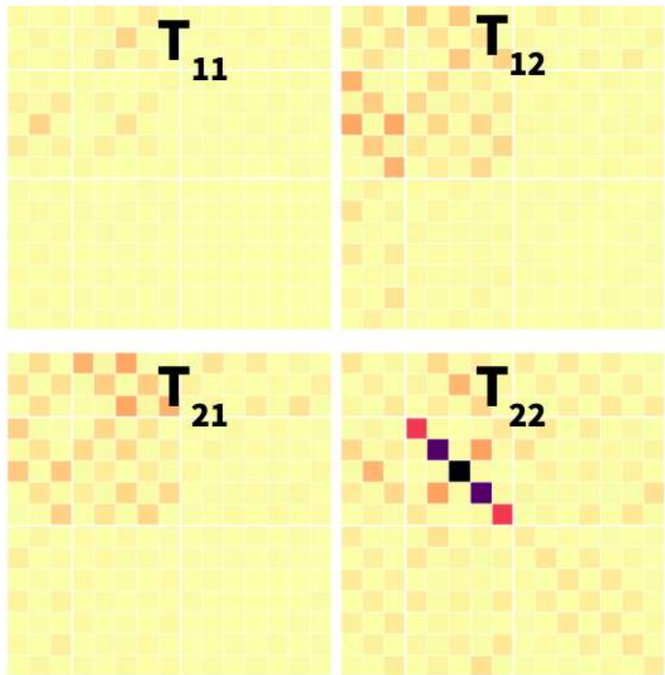
nano-optics.ac.nz/terms



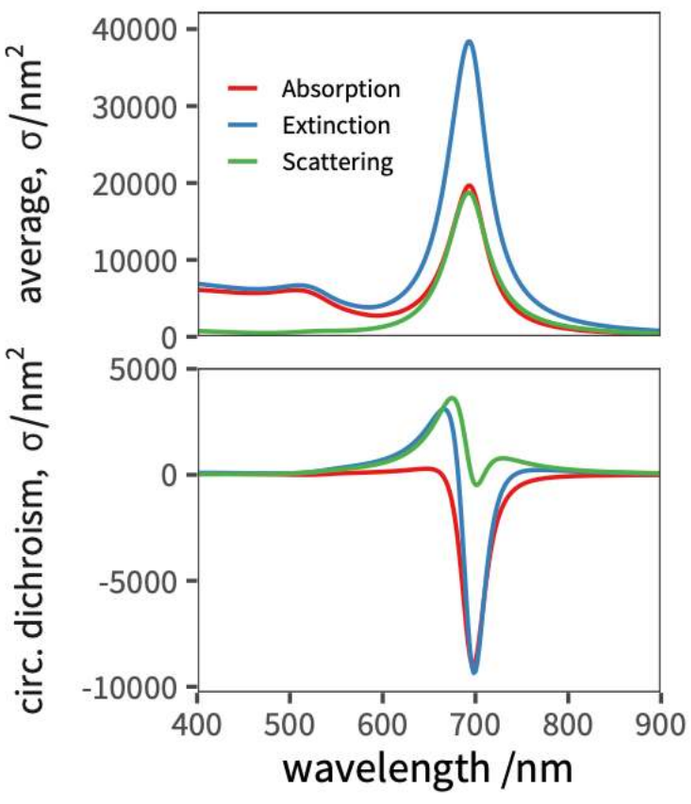
(a)



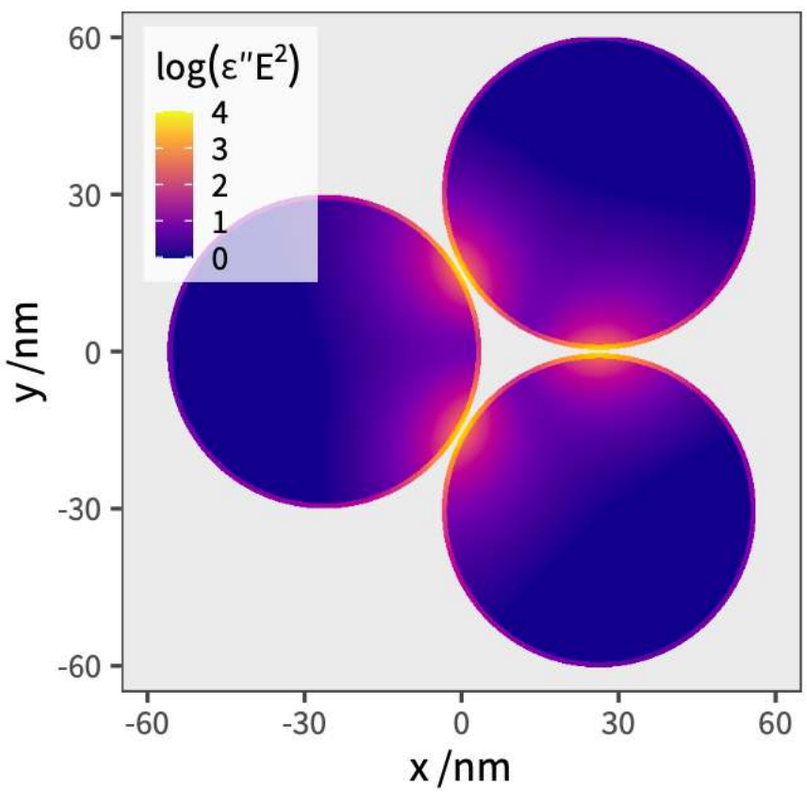
(b)



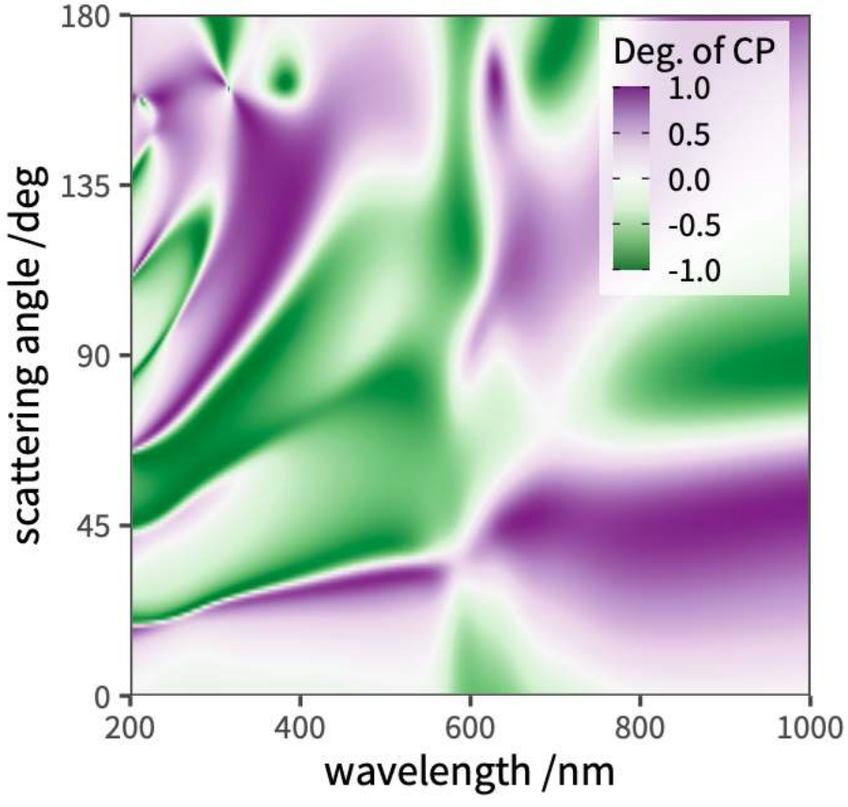
(c)



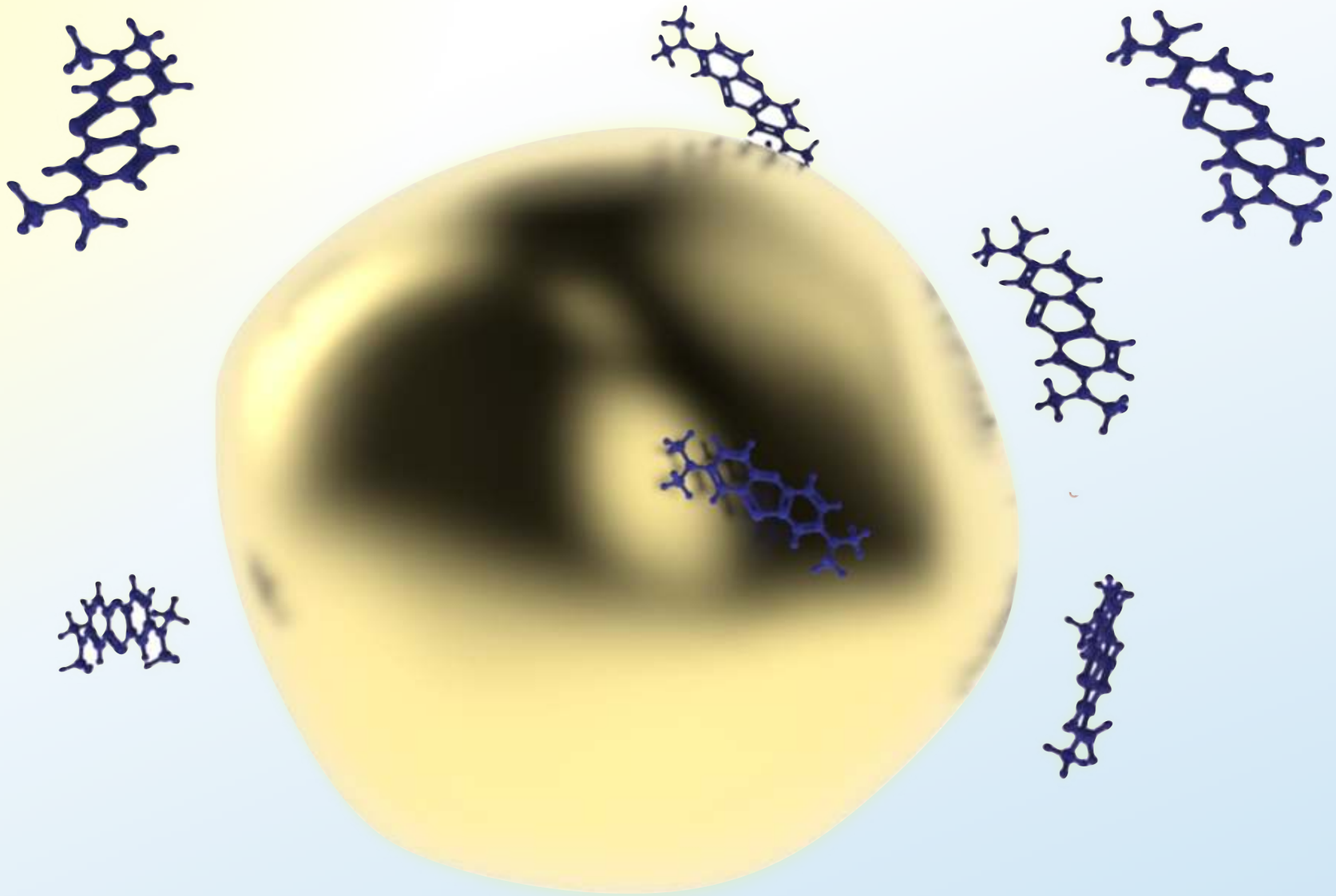
(d)



(e)

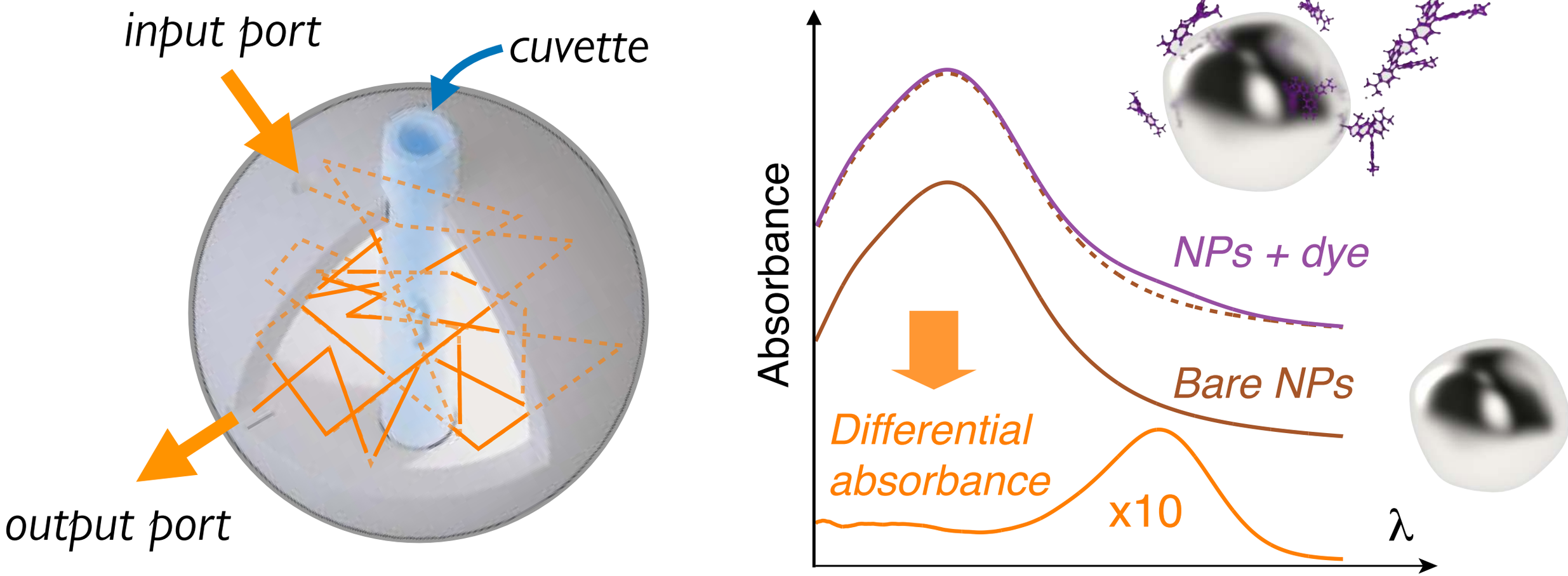


nano-optics.ac.nz/terms

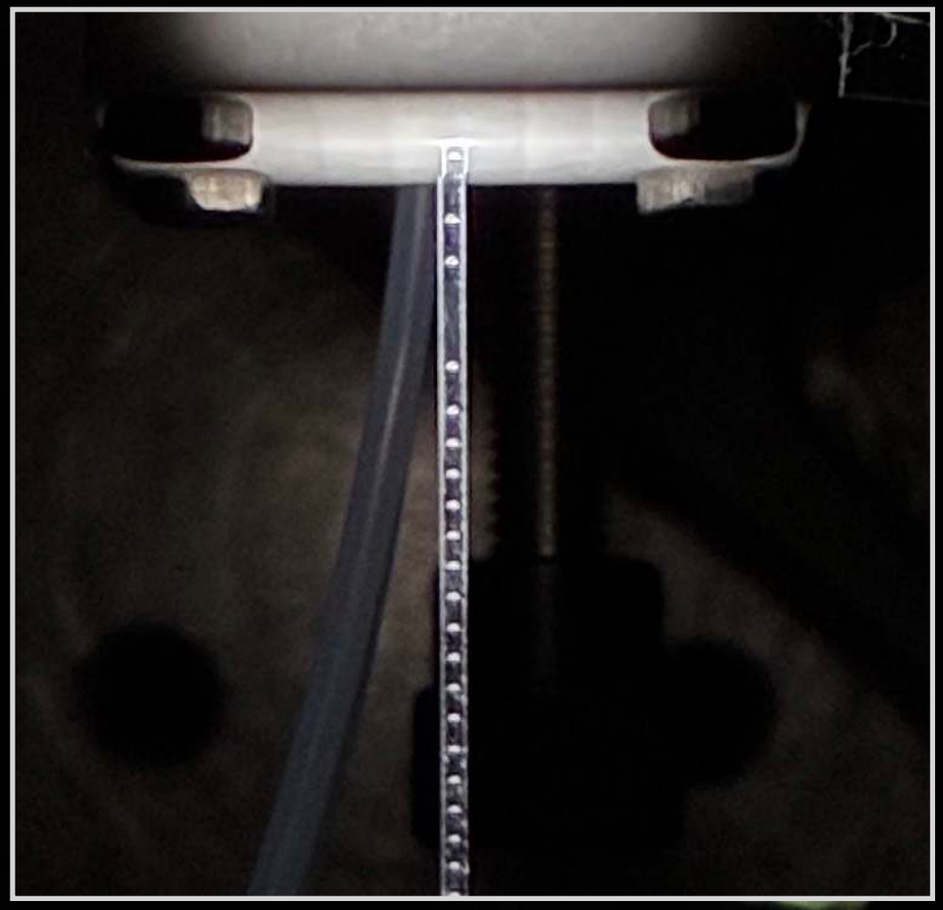


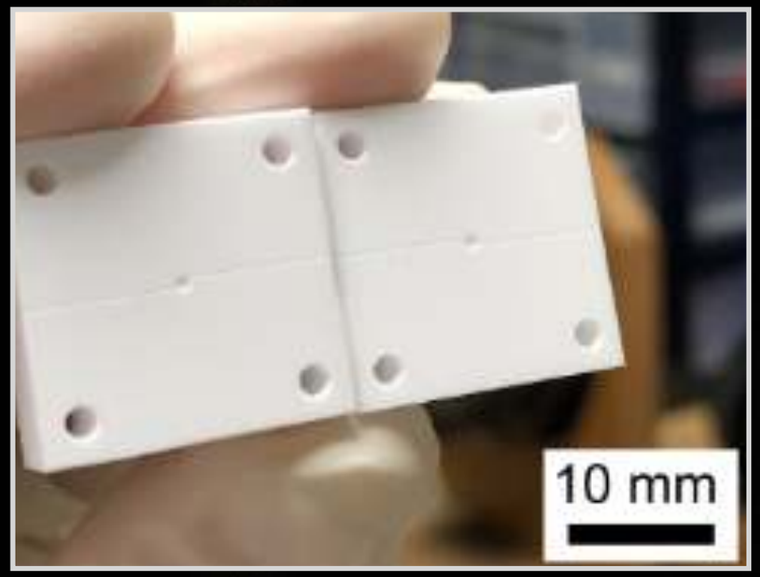
UV–VIS ABSORPTION OF MOLECULES ADSORBED ON A METALLIC NANOPARTICLE

DIFFERENTIAL UV–VIS ABSORBANCE OF DYE–NPs

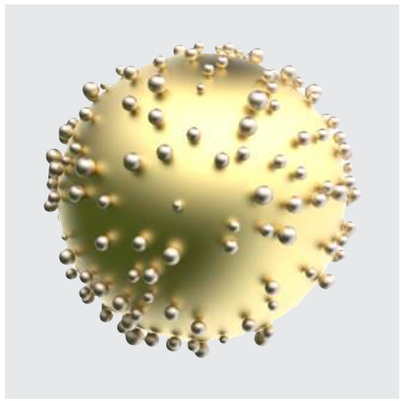


Modified optical absorption of molecules on metallic nanoparticles at sub-monolayer coverage – Nat. Photon. 10, 40–45 (2016)

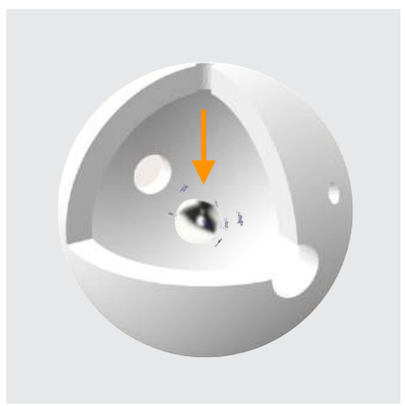



10 mm

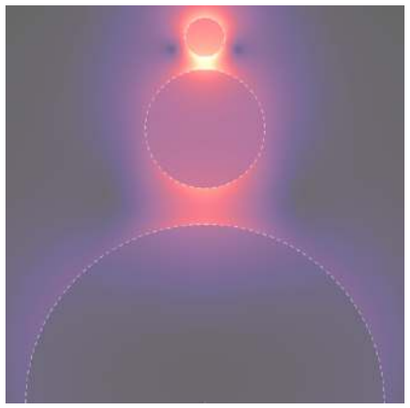
NANO-OPTICS.AC.NZ



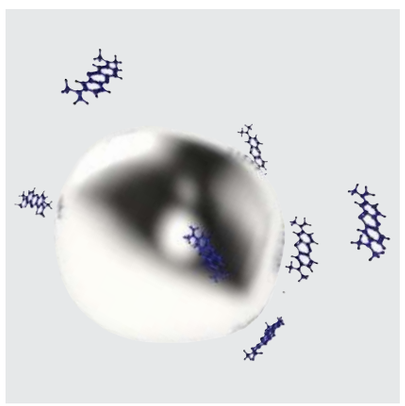
PARTICLE CLUSTERS



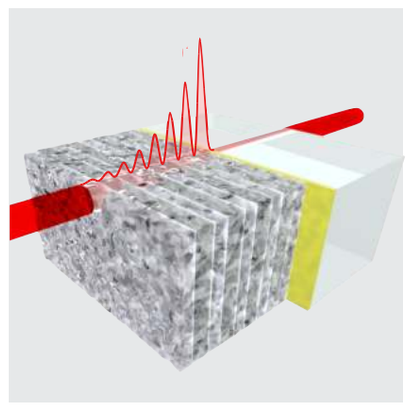
INTEGRATING SPHERES



LIGHT SCATTERING

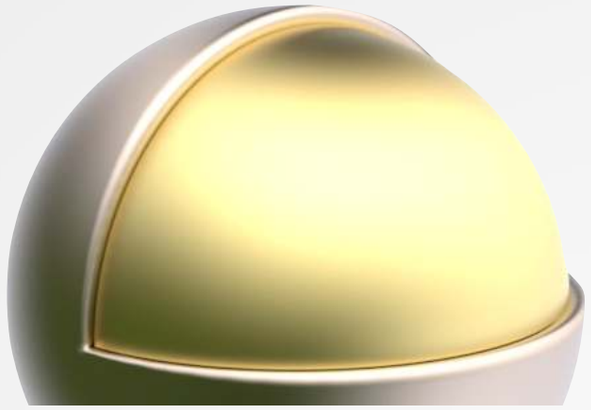


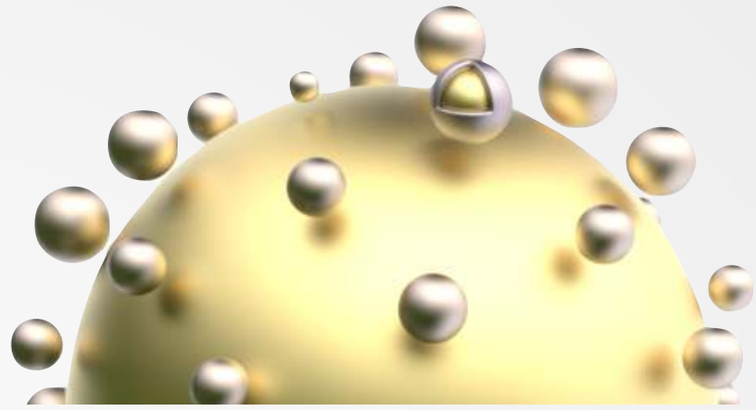
SPECTROSCOPY



PLASMONICS

SUPPORTING SLIDES



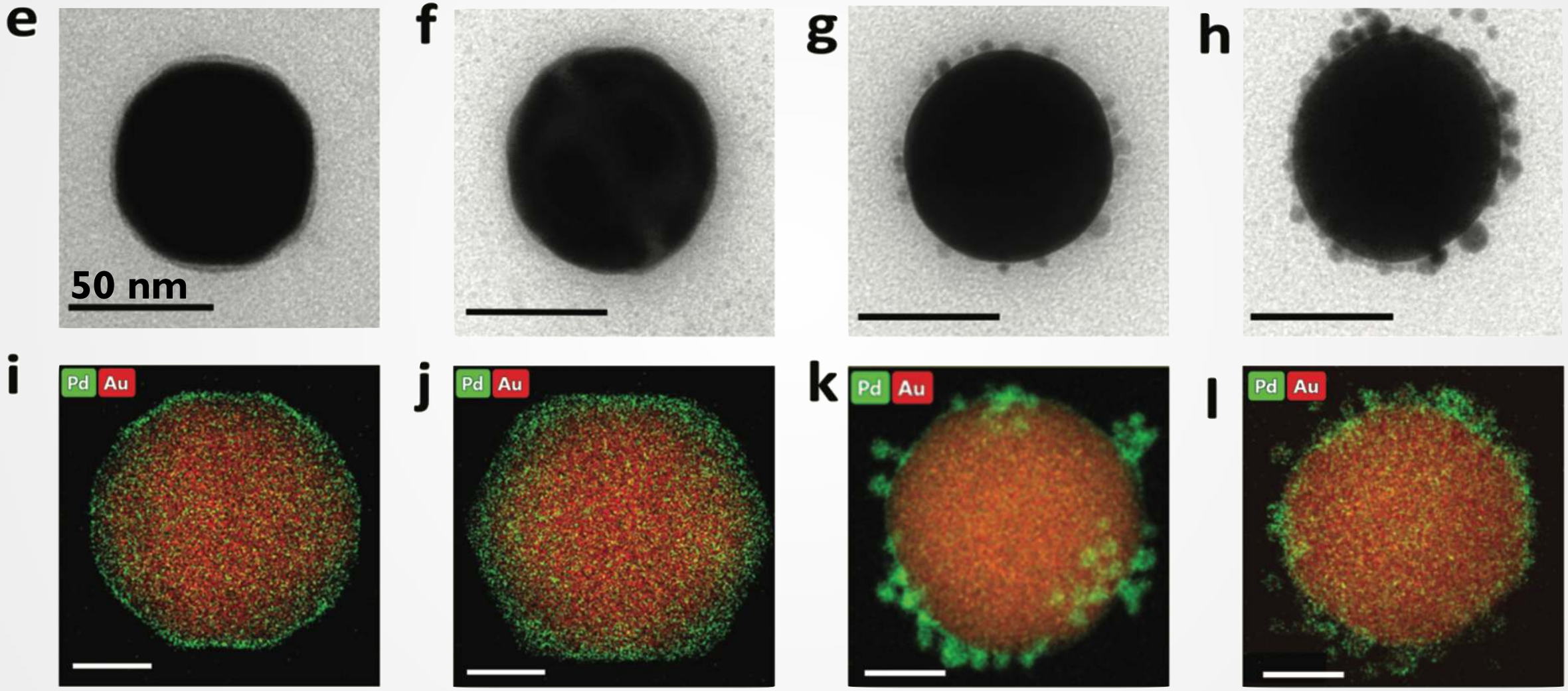


Au@Pd

Au@AuPd

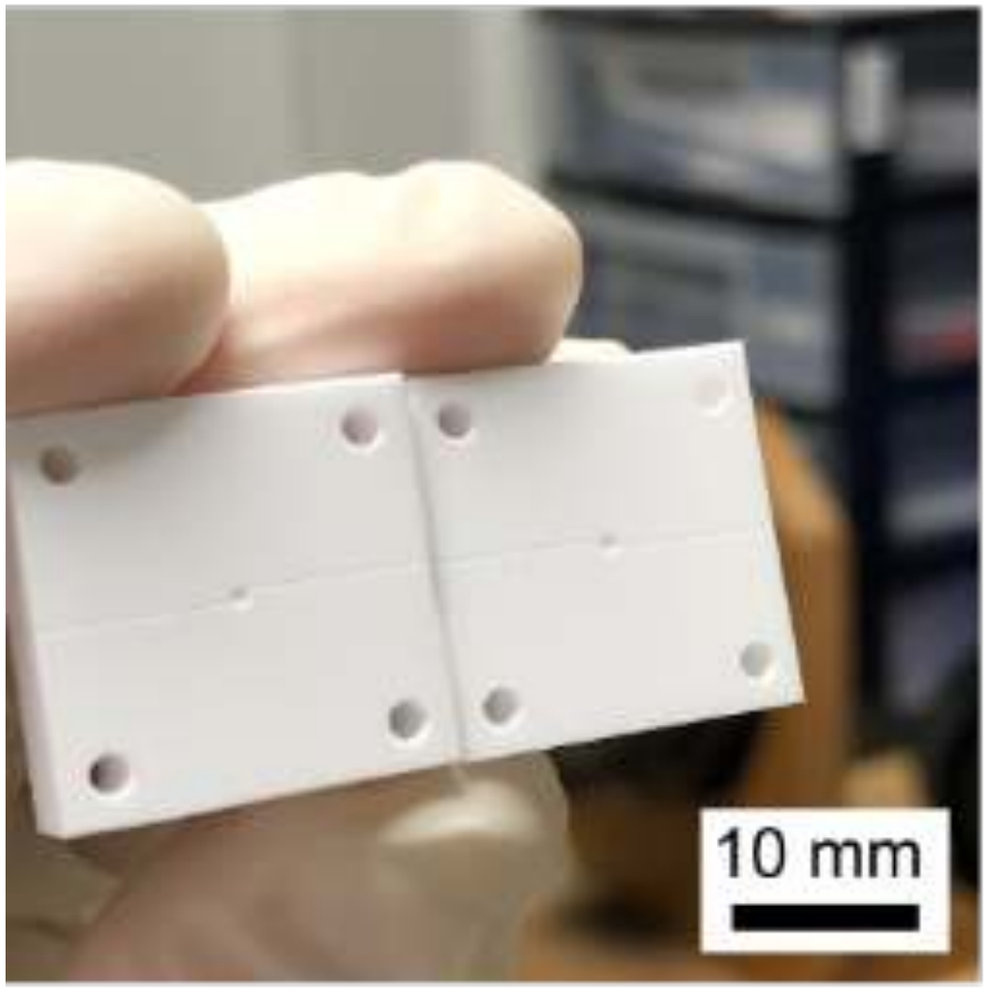
Au–Pd

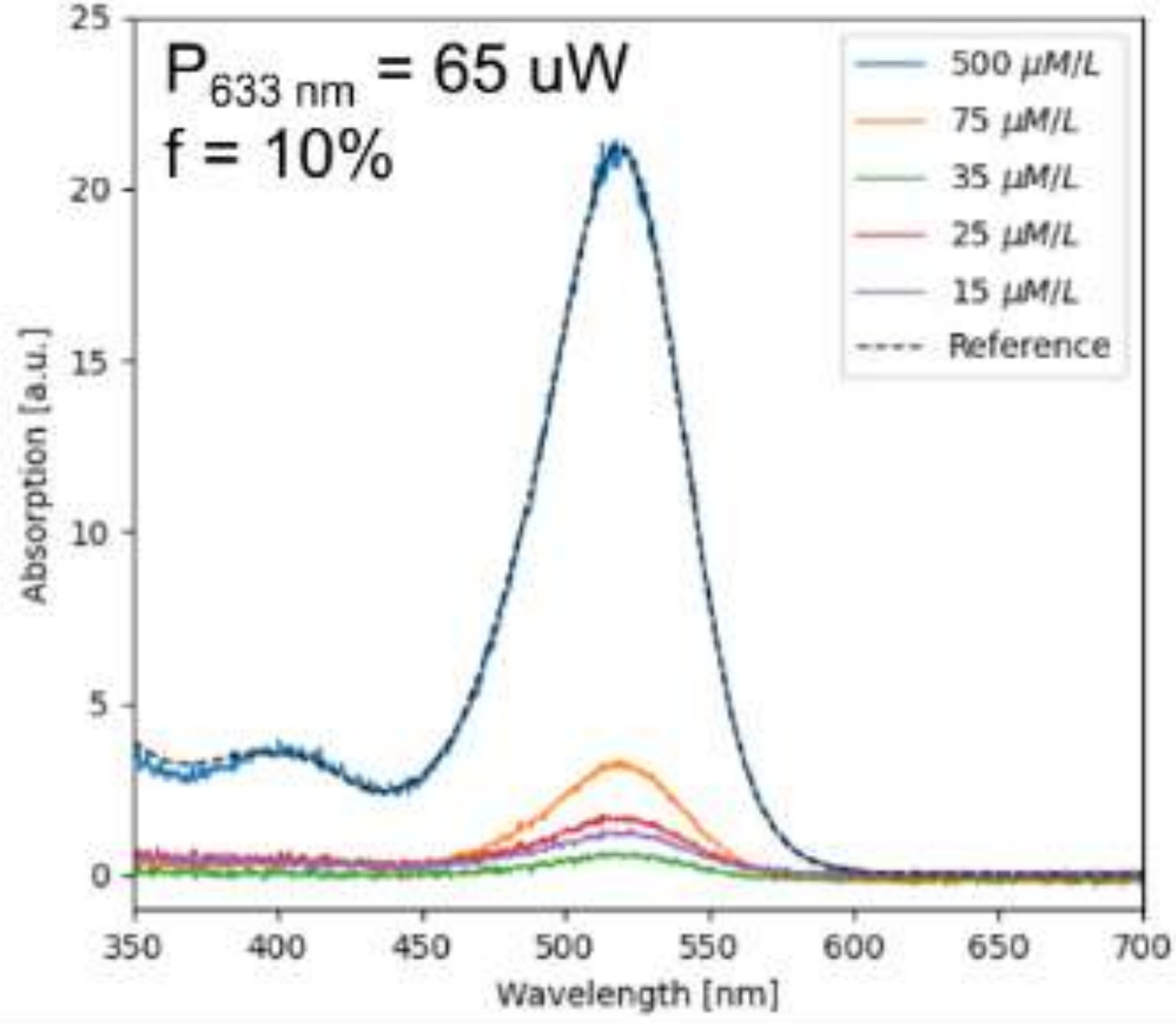
Au–Au@Pd



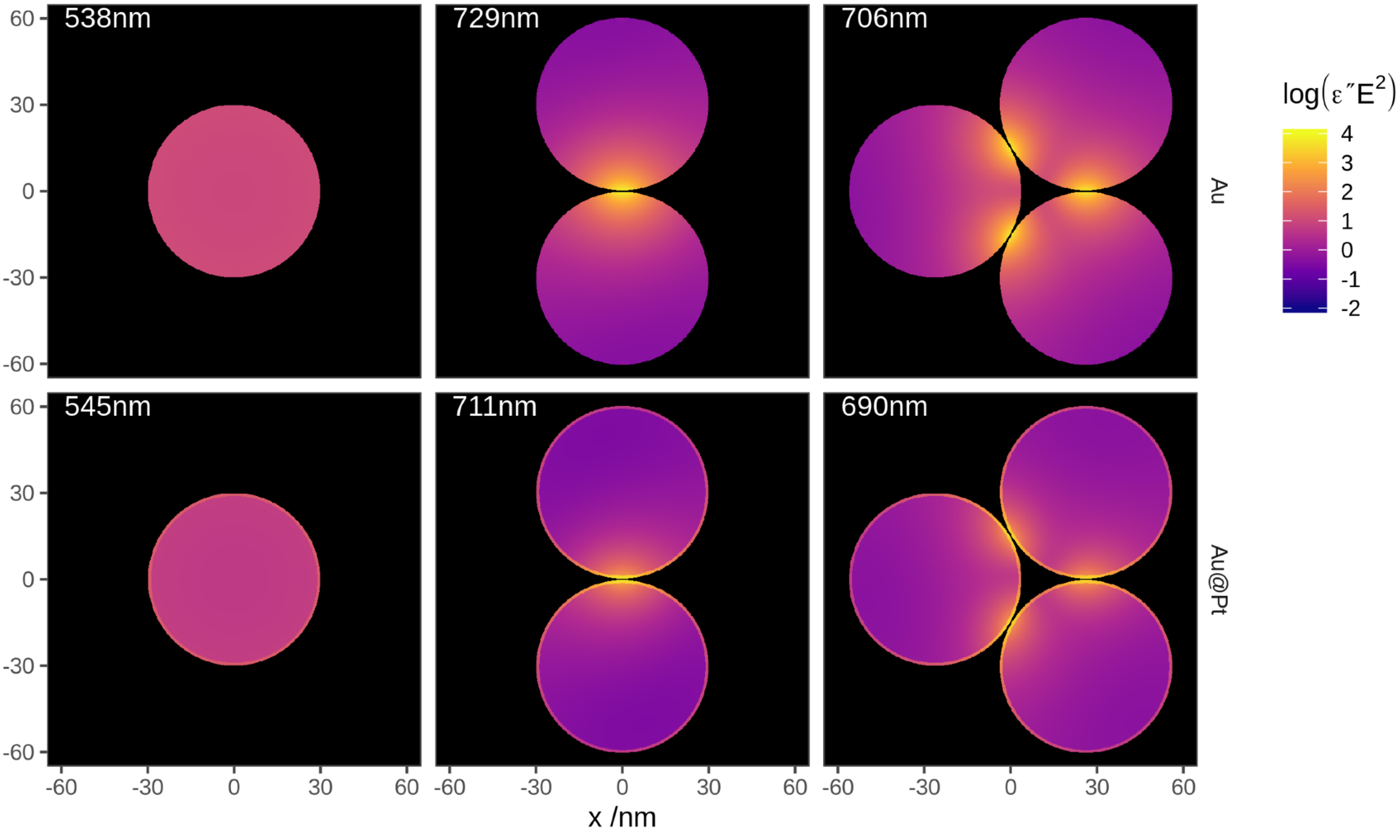
M. Herran, A. Sousa-Castillo, C. Fan, S. Lee, Wei Xie, M. Döblinger, B. Auguié and E. Cortés · *Adv. Func. Mat.* 32, 2203418 (2022)

0.9 mm sphere

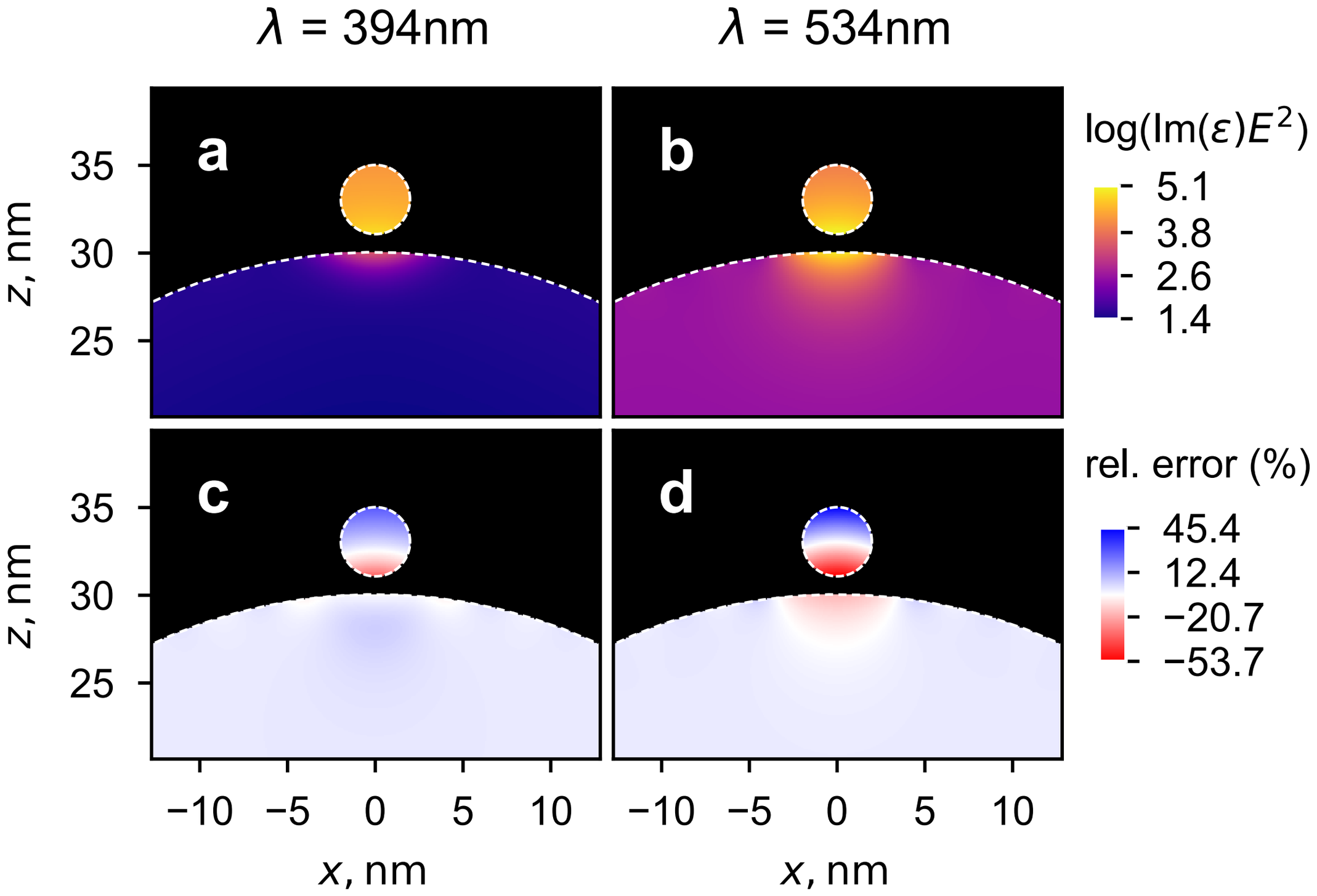

10 mm


$P_{633\ nm}$ = 65 uW
f = 10%
500 µM/L
75 µM/L
35 µM/L
25 µM/L
15 µM/L
Reference
Absorption [a.u.]
Wavelength [nm]
0
5
10
15
20
25
350
400
450
500
550
600
650
700

LOCAL ABSORPTION IN AU@PD NANO-TRIMERS

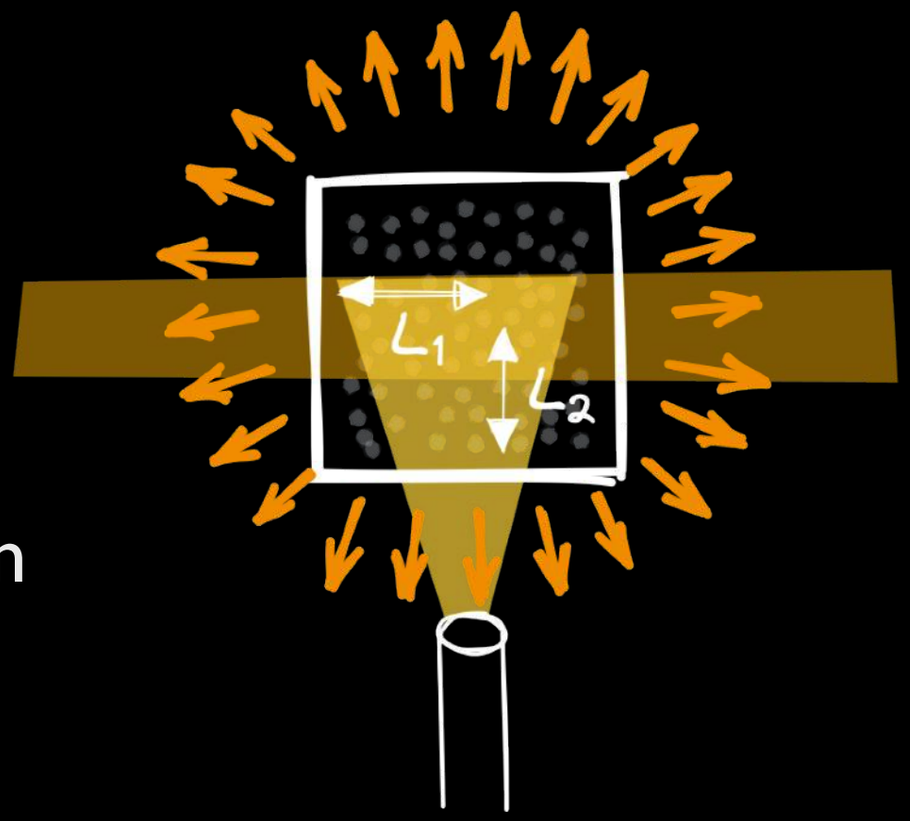


DIPOLE APPROXIMATION VS EXACT RESULTS



CORRECTIONS TO THE SCATTERING SIGNAL

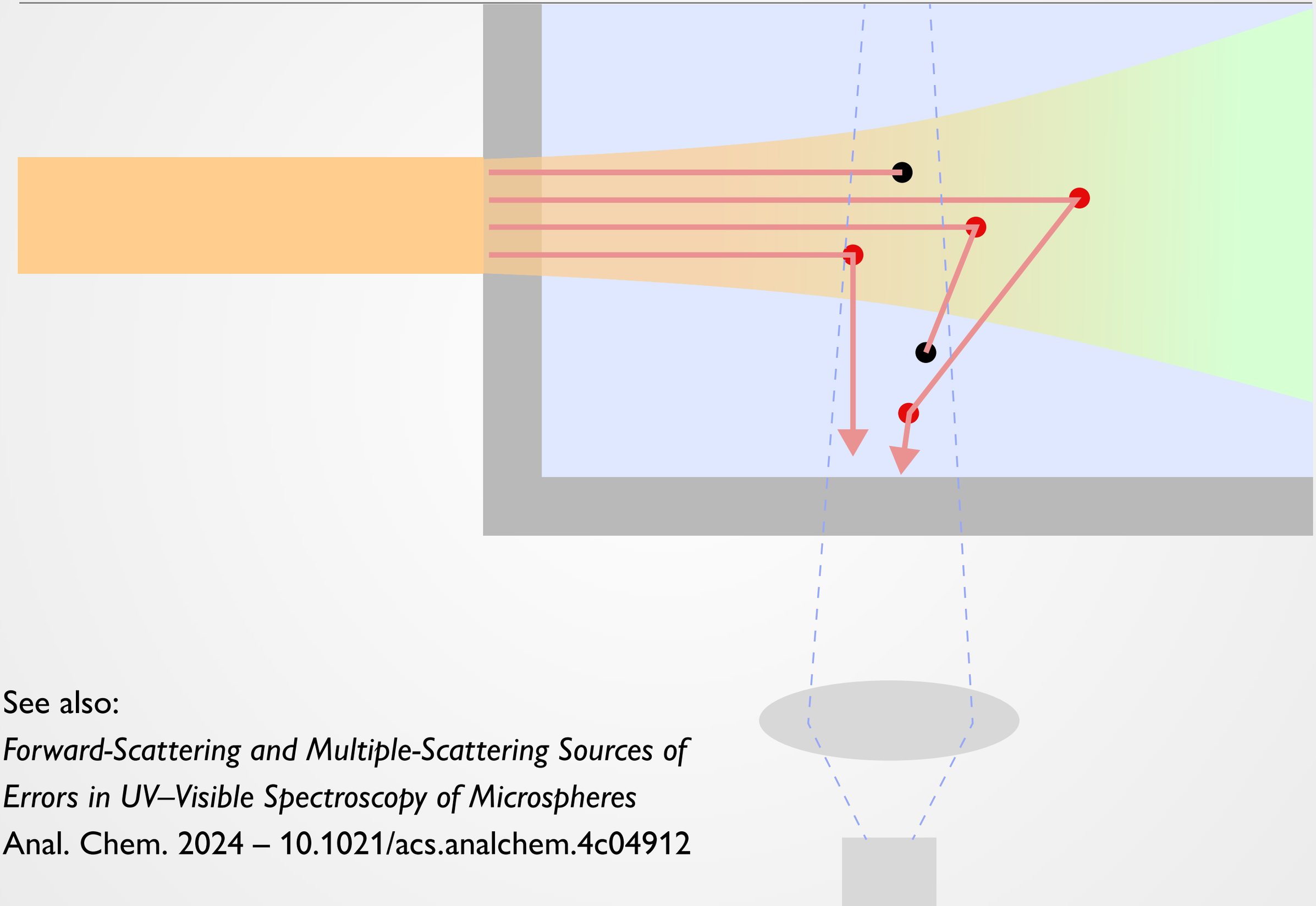
- we only collect a finite solid angle Ω
- **incident light** modified by extinction
- **scattered light** modified by extinction



"Naive" model:

- geometrical scaling factor *K (calibration with standard UV–vis)*
- small (Rayleigh) scatterers – constant scattering profile
- Beer-Lambert type correction $I(L) = I_0 \times 10^{-E(L_1+L_2)}$

SCHEMATIC VIEW OF THE COMPLICATIONS

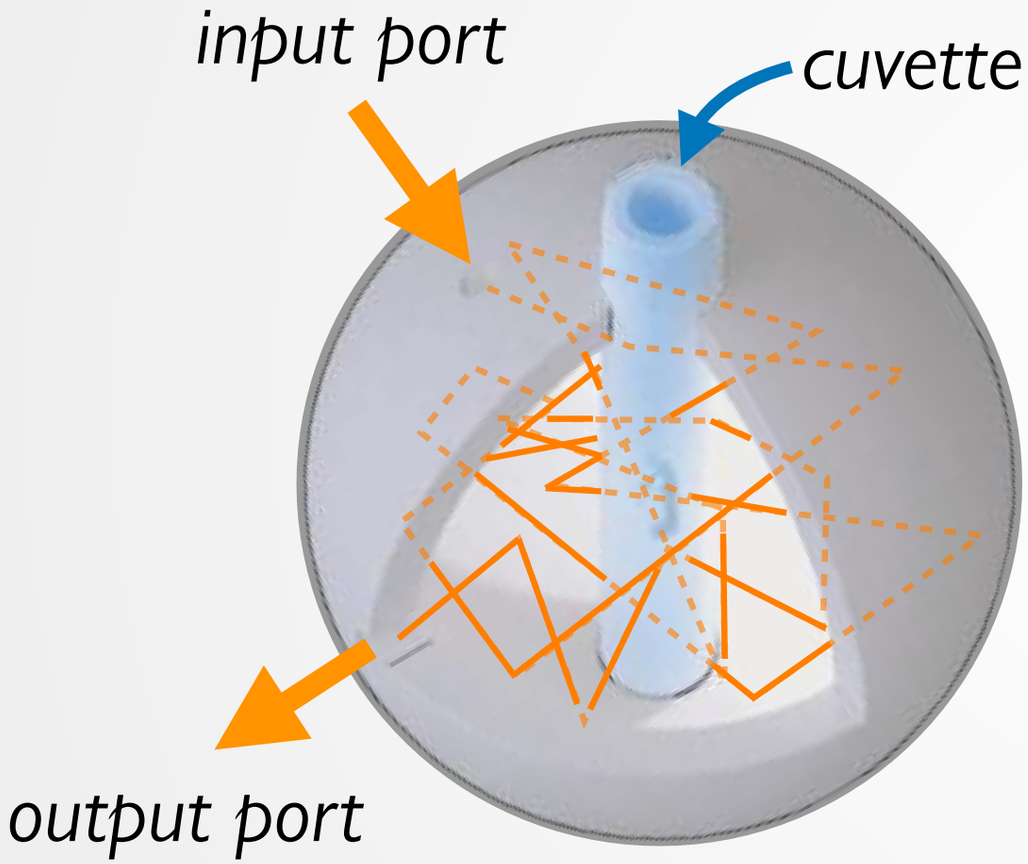


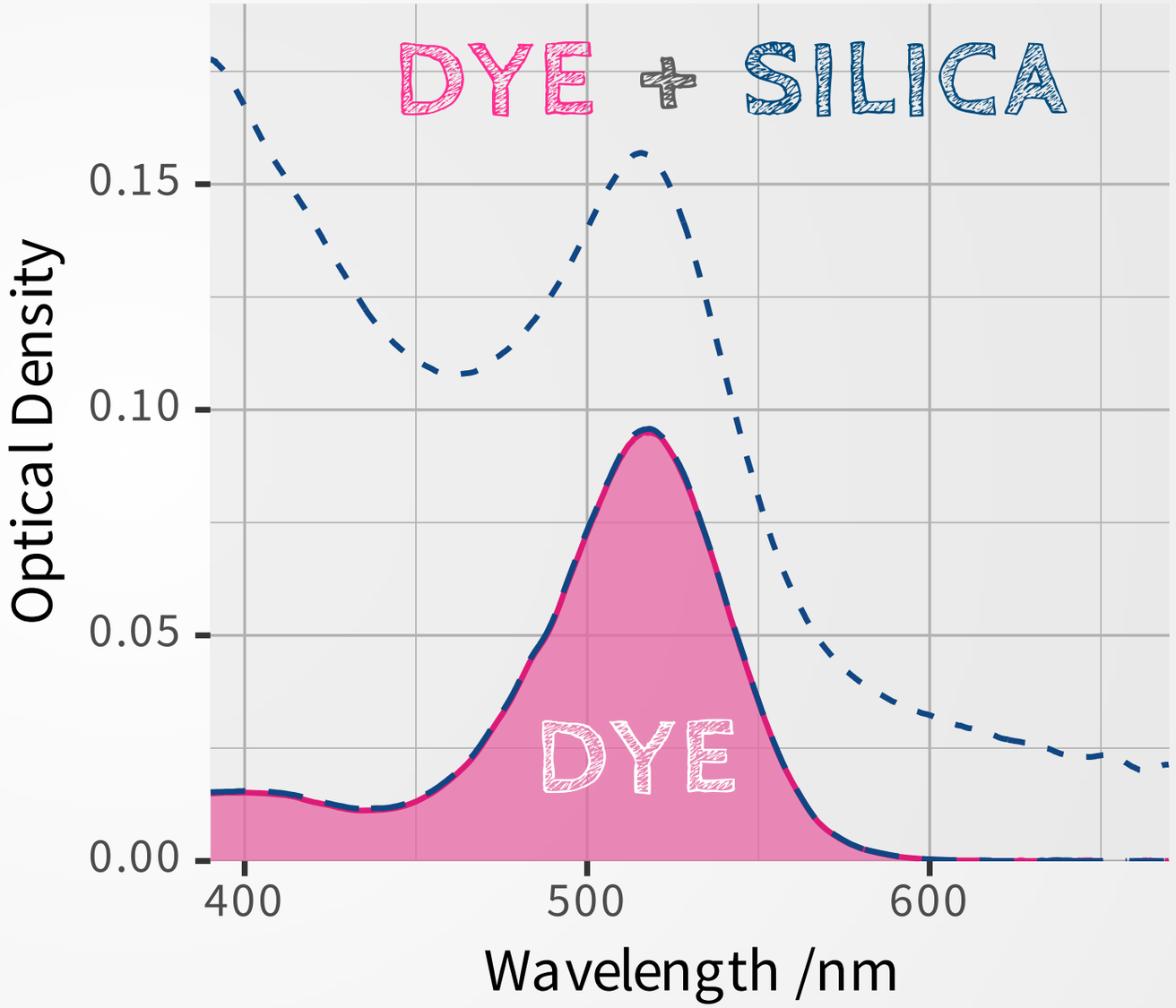
See also:

Forward-Scattering and Multiple-Scattering Sources of Errors in UV–Visible Spectroscopy of Microspheres

Anal. Chem. 2024 – 10.1021/acs.analchem.4c04912

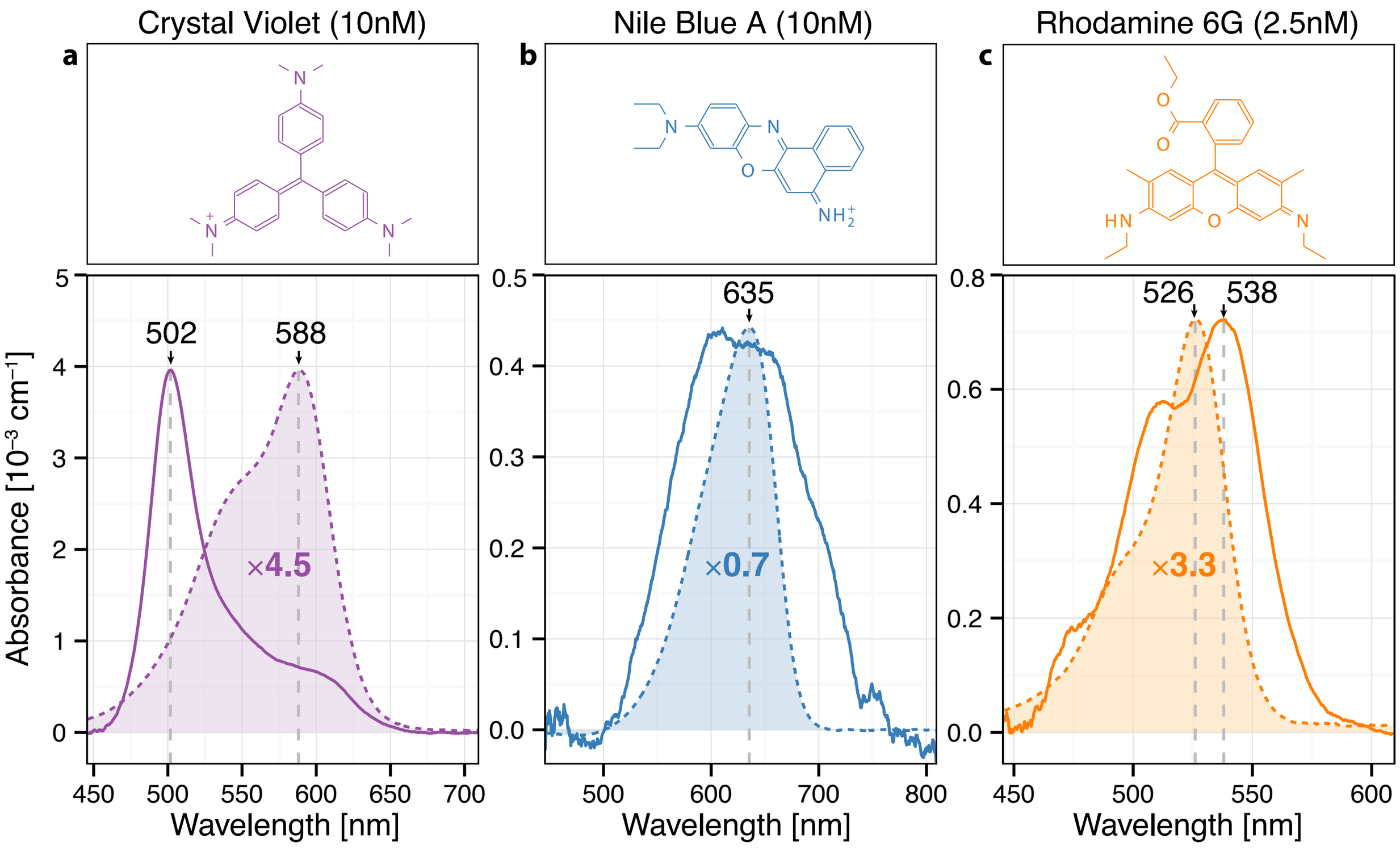
INTEGRATING SPHERE ABSORPTION



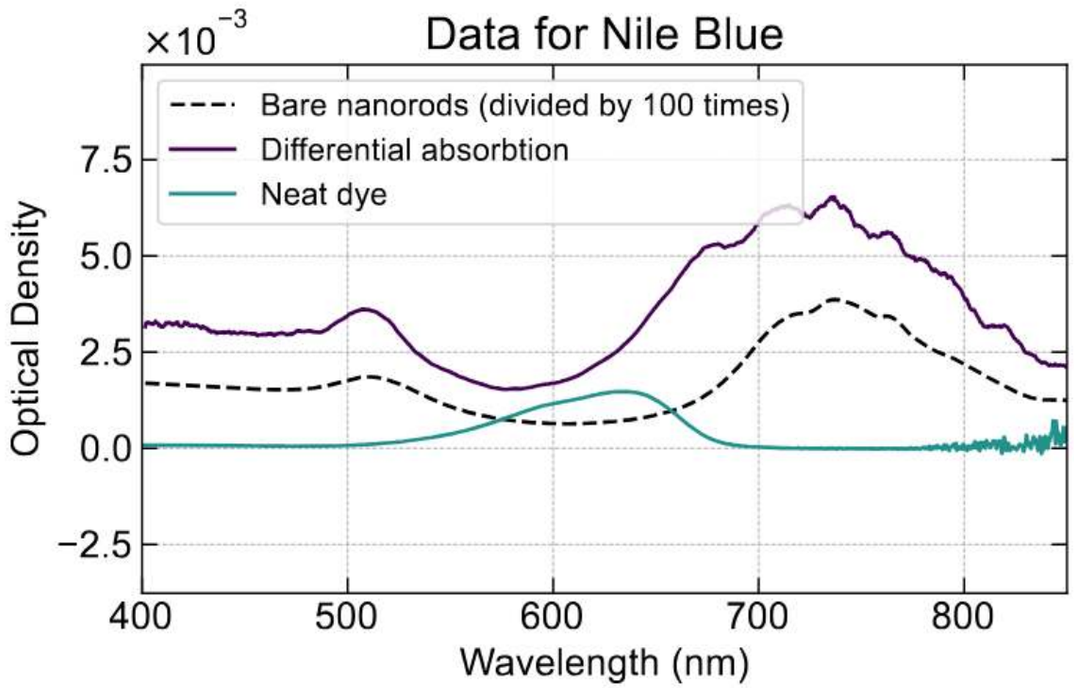


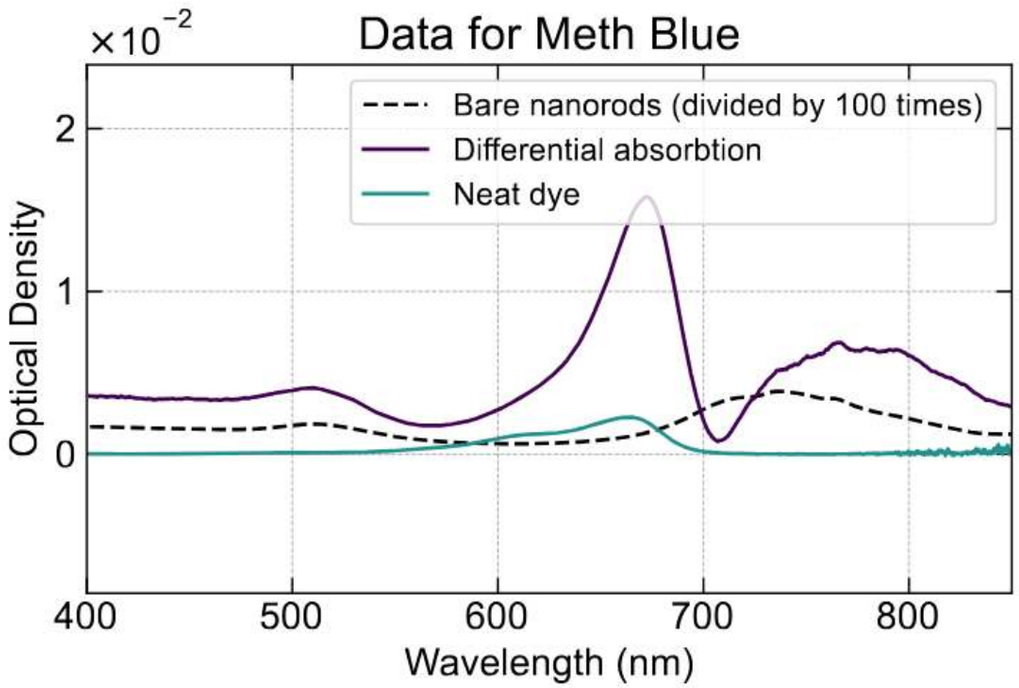
Modified optical absorption of molecules on metallic nanoparticles at sub-monolayer coverage – Nat. Photon. 10, 40–45 (2016)

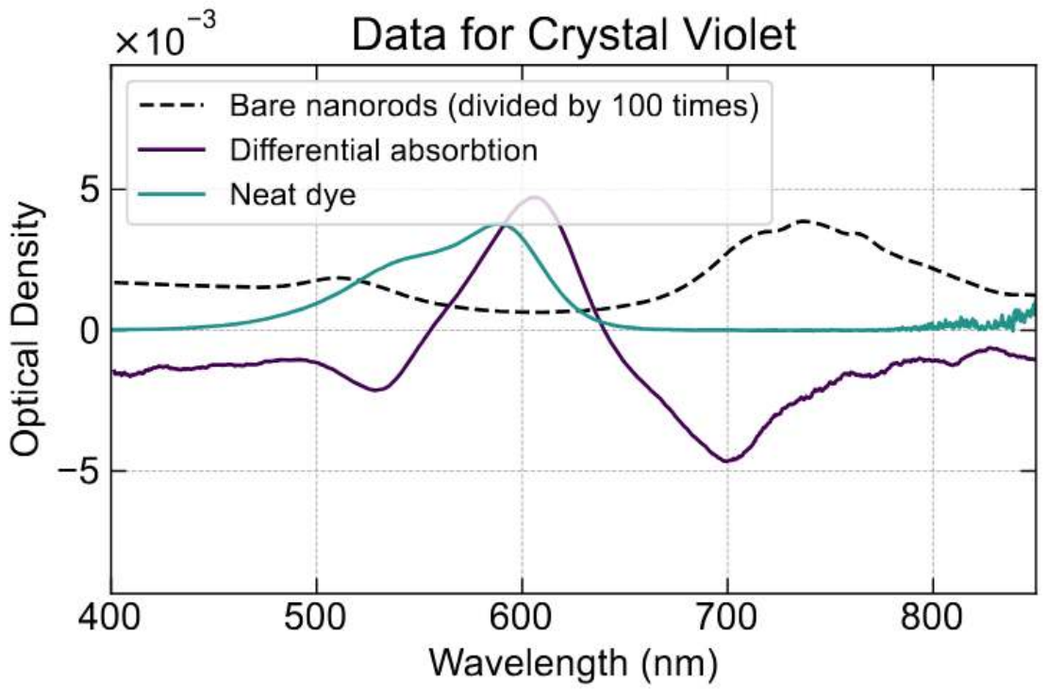
DIFFERENT MOLECULES

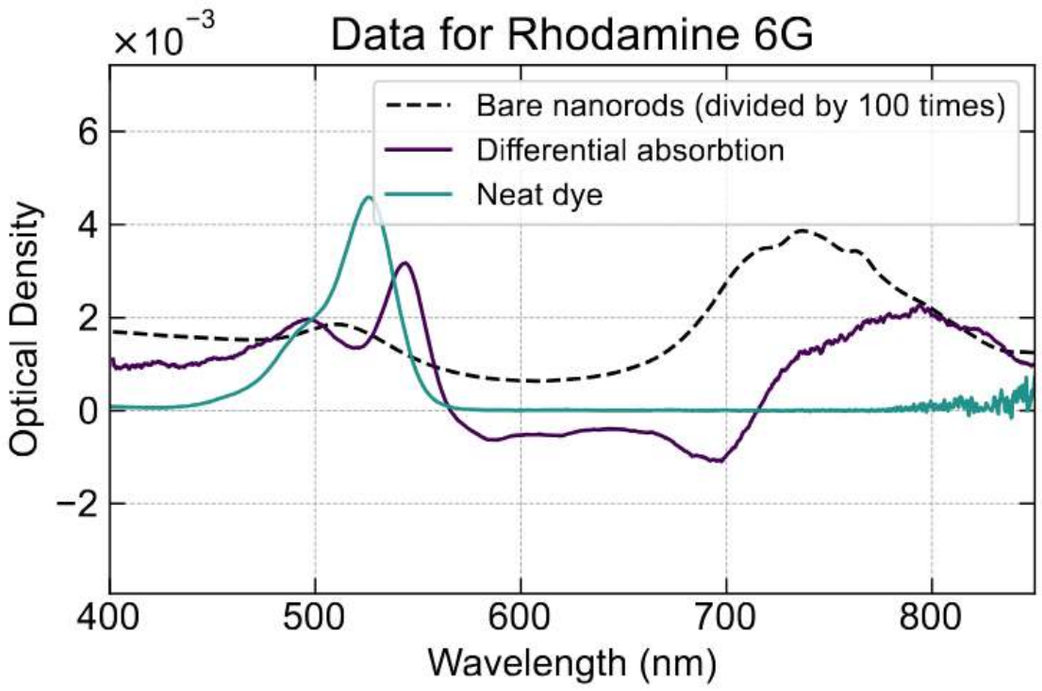


NANORODS + DYE: DIFFERENT COUPLING REGIMES









AU NANORODS – TUNABLE RESONANCES