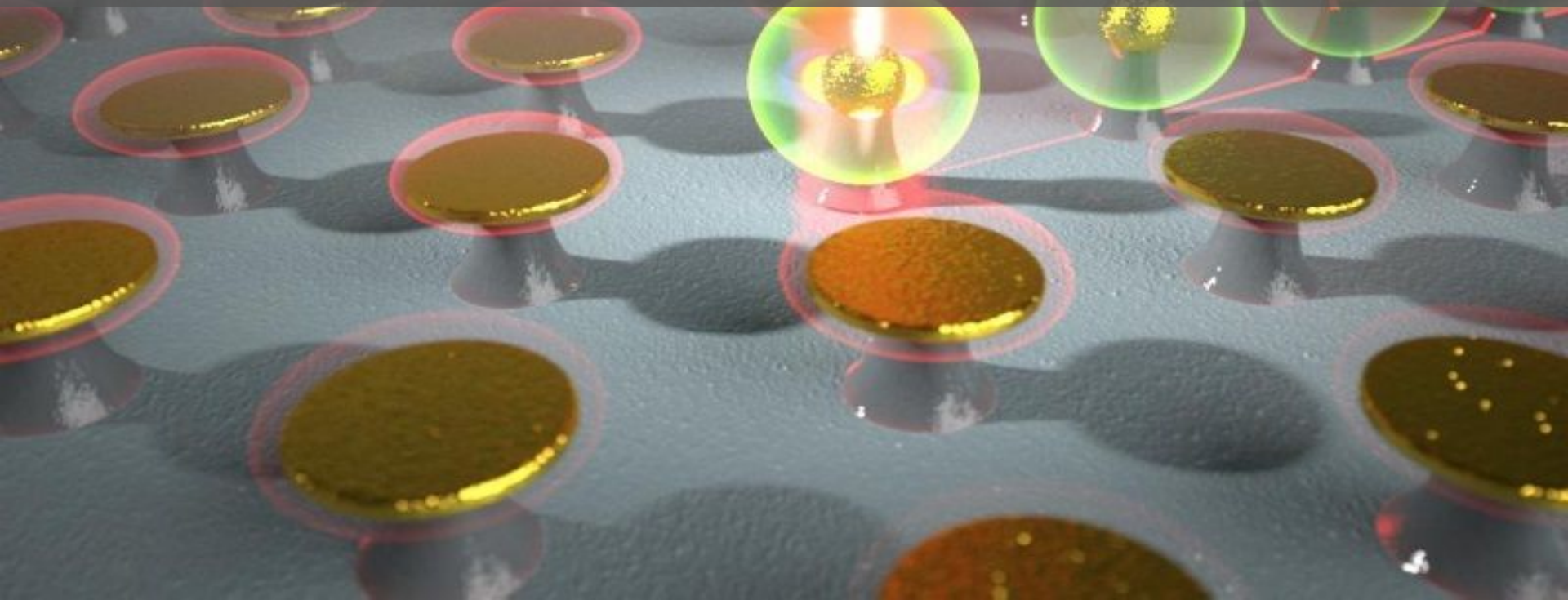
IEM Instituto de Estructura de la Materia

CSIC Consejo Superior de Investigaciones Científicas

Nanofotónica y Metamateriales (Teoría)

José A. Sánchez Gil, Vincenzo Giannini, Diego R. Abujetas



IEM Instituto de Estructura de la Materia

CSIC Consejo Superior de Investigaciones Científicas

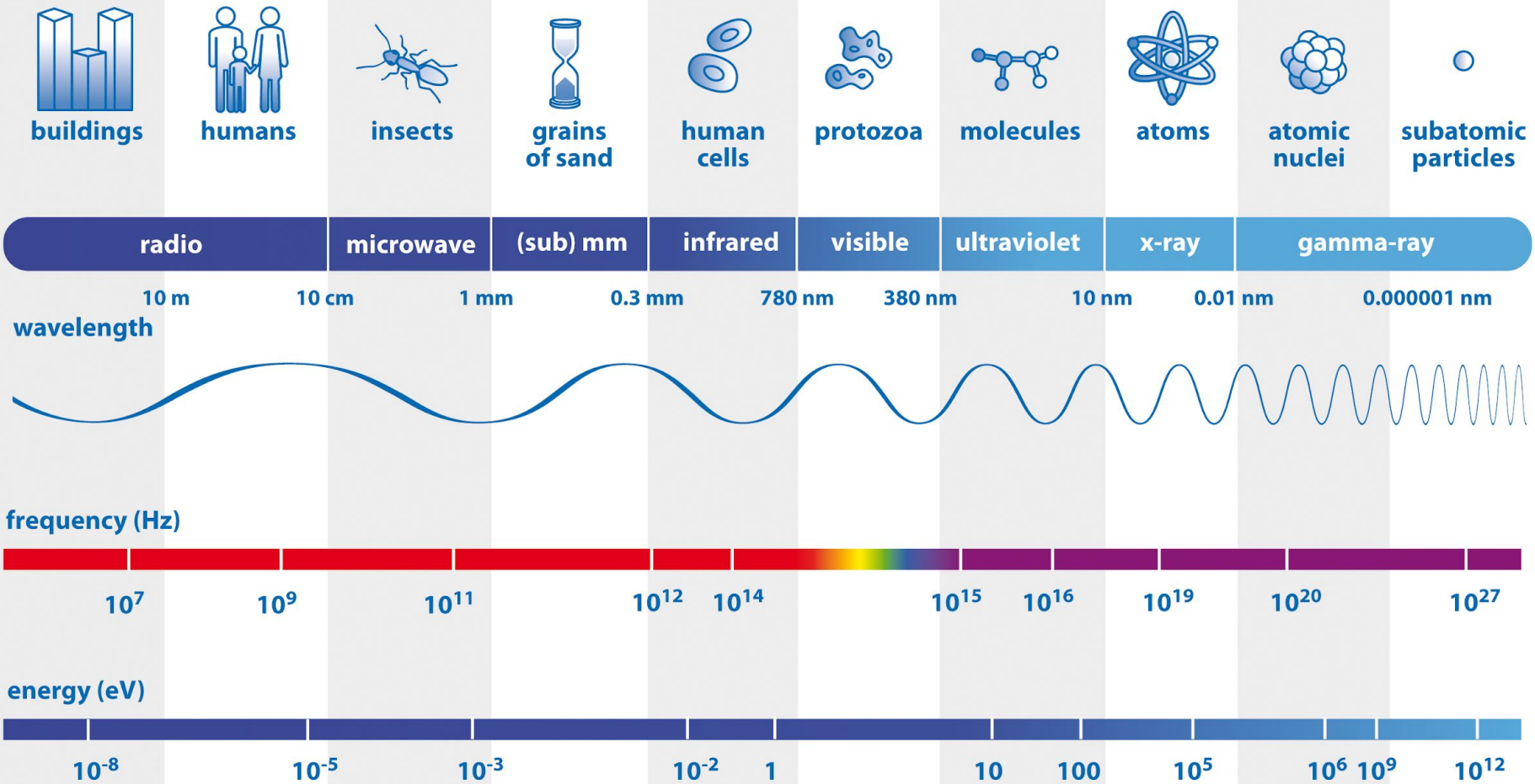
Dpto. Espectroscopía Nuclear, Vibracional y de Medios Desordenados

Espectroscopías de Superficie y Fotónica de Plasmones Superficiales

Jose A. Sánchez Gil
Vincenzo Giannini

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

¿Qué es la nanofotónica?



Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

¿Qué es la nanofotónica?

ELECTROMAGNETISMO + MATERIA CONDENSADA

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \cdot \mathbf{D} = \rho$$

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

- Medio contínuo
- Propiedades Macroscópicas
- Ecs. Constitutivas para ***D*** y ***B***

$$\frac{\hbar^2}{2m}\nabla^2\Psi + V\Psi = \frac{i\hbar\partial}{\partial t}\Psi$$

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

METALES EN EL VISIBLE

Teoría de Drude para metales: el modelo de electrones libres

$$\mathbf{D}(\mathbf{r},\omega) = \epsilon(\omega)\mathbf{E}(\mathbf{r},\omega), \epsilon(\omega) = 1 - \frac{\omega_p^2}{\omega(\omega + i\gamma)}$$

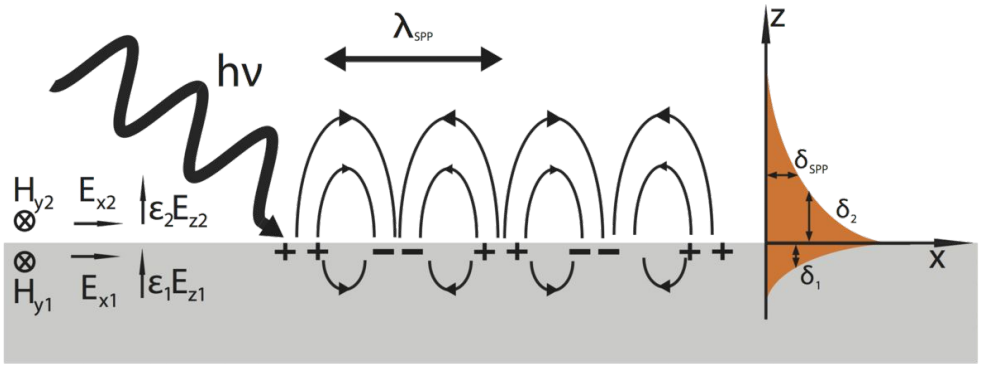
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

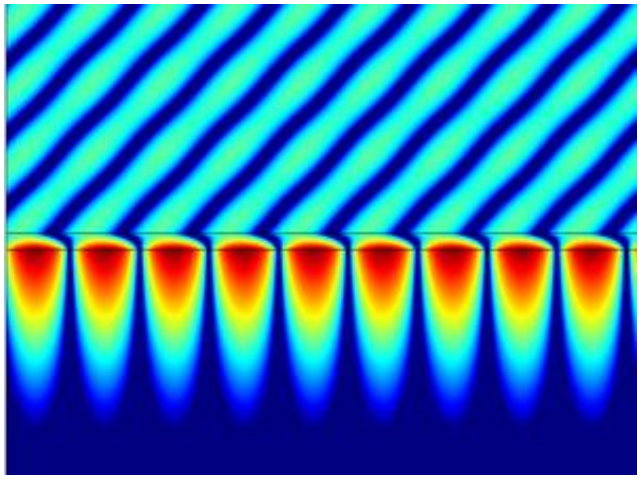
IEM Instituto de Estructura de la Materia

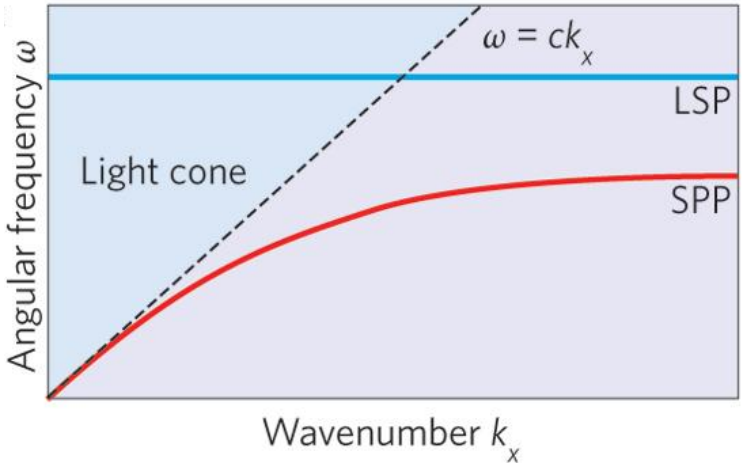
CSIC Consejo Superior de Investigaciones Científicas

PLASMONES SUPERFICIALES

¡SOLUCIONES CONFINADAS EN LA FRONTERA METAL-DIELÉCTRICO!

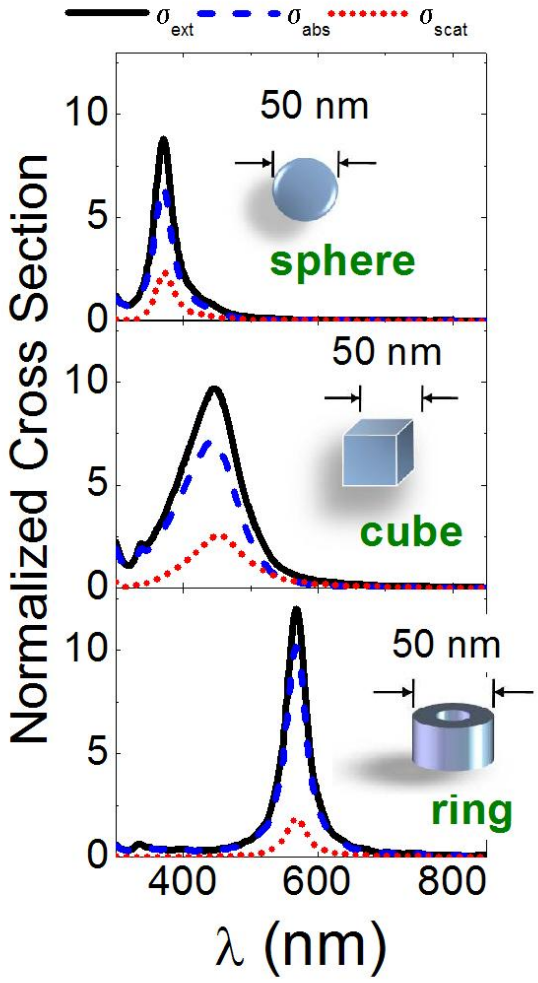


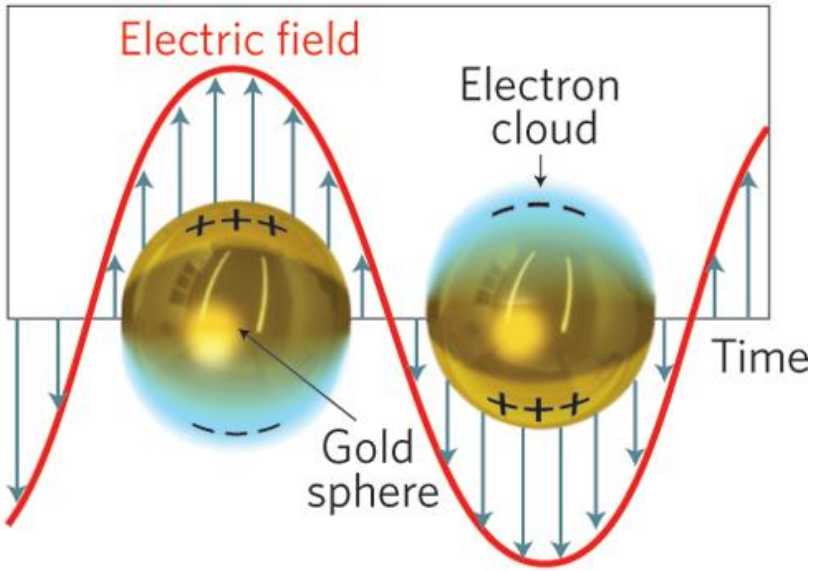




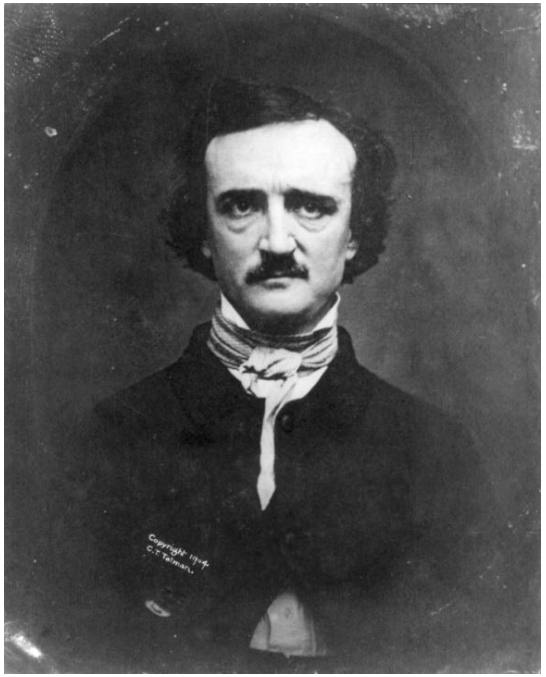
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

PLASMONES SUPERFICIALES LOCALIZADOS (LOCALIZED SURFACE PLASMON RESONANCES)





Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

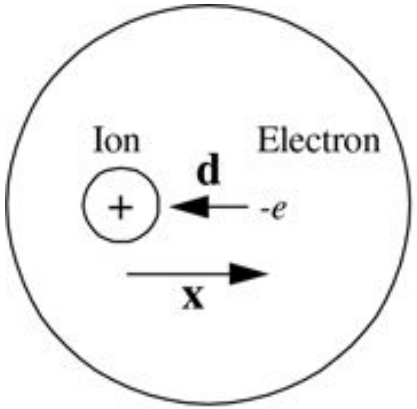


Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

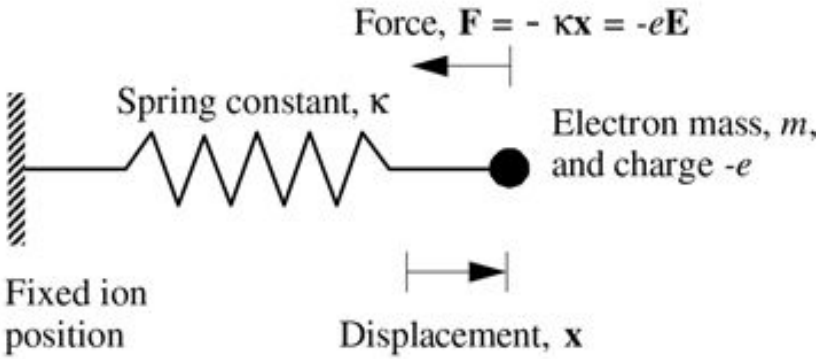
DIELÉCTRICOS EN EL VISIBLE

Modelo de Lorentz: el modelo de osciladores

$$\mathbf{D}(\mathbf{r},\omega) = \epsilon(\omega)\mathbf{E}(\mathbf{r},\omega), \epsilon(\omega) = \epsilon_\infty + \frac{\omega_p^2}{\omega_0^2 - \omega^2 - \imath\gamma\omega}$$



(a)



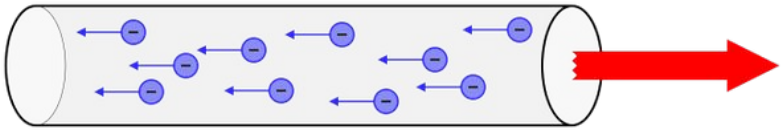
(b)

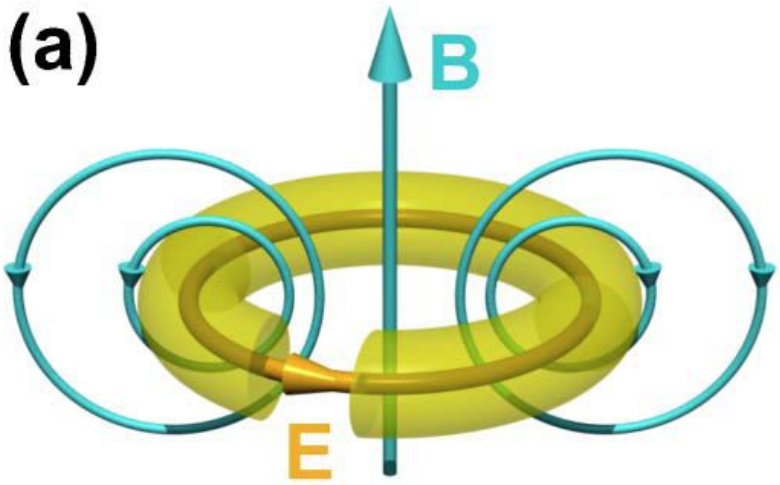
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

RESONANCIAS MAGNÉTICAS

Metales

CORRIENTE DE ELECTRONES

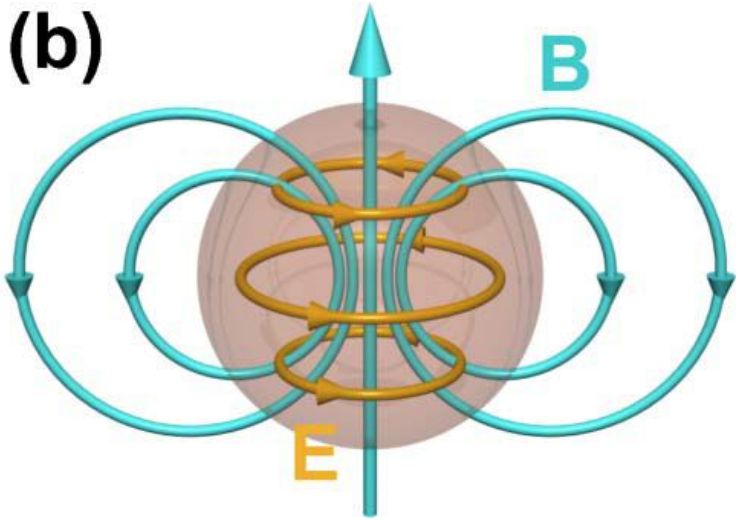




Dieléctricos

CIRCULACIÓN VECTOR DESPLAZAMIENTO

$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$

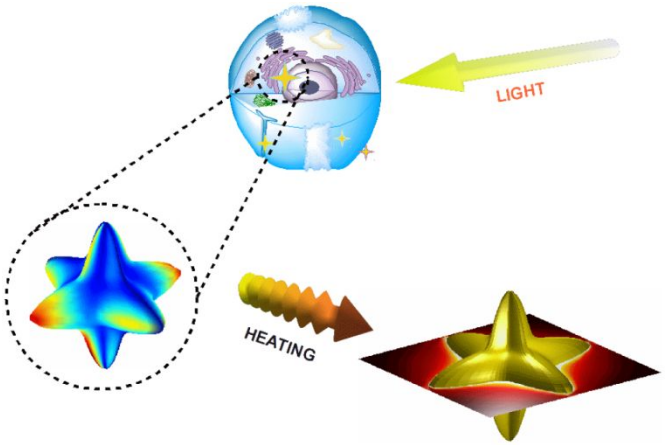


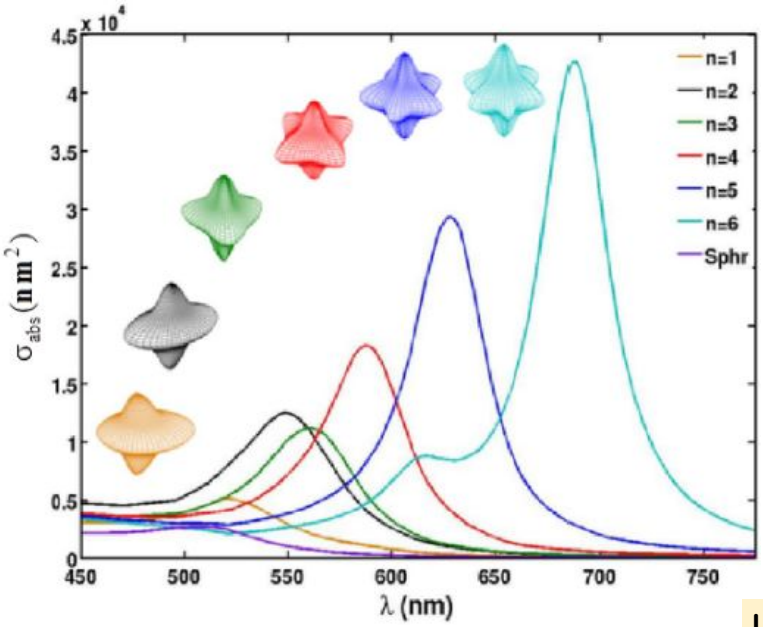
Intereses en Nanofotónica

- Plasmones Superficiales Localizados
- Metamateriales y refracción negativa
- Luz Magnética
- Nanohilos semiconductores
- Aislantes topológicos fotónicos
- Plasmónica en Grafeno
- Plasmónica Cuántica

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

Rodríguez-Oliveros & Sánchez-Gil, *Opt. Express* (2012)



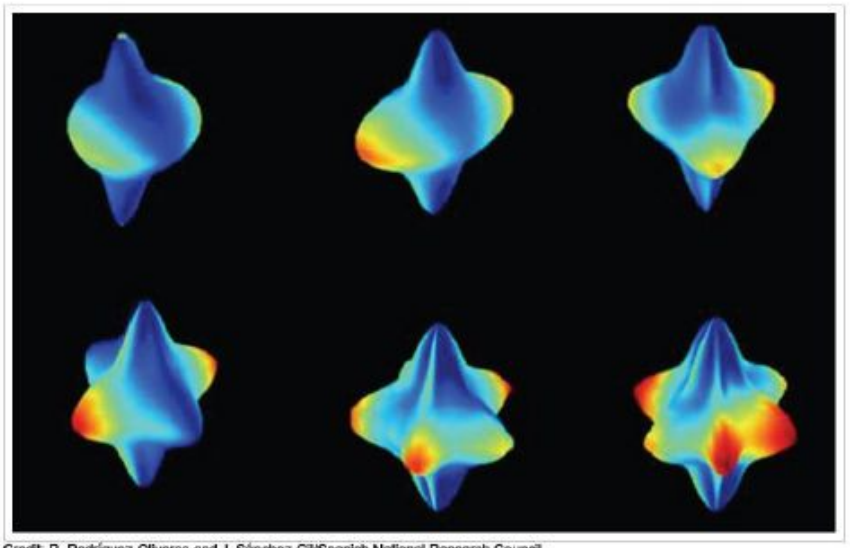


Science NOW UP TO THE MINUTE NEWS FROM SCIENCE

*Science*Shot: Gold Nanostars for Attacking Cancer

by Kate McAlpine on 6 January 2012, 1:40 PM | 1 Comments

Email Print | 0 More PREVIOUS ARTICLE NEXT ARTICLE



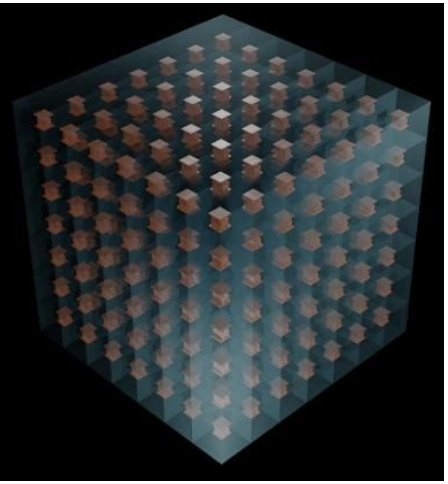
Credit: R. Rodríguez-Oliveros and J. Sánchez-Gil/Spanish National Research Council

Gold stars, so tiny that it would take a thousand of them to span the diameter of a human hair, could be effective tumor-fighters. Previous studies have shown that minuscule particles of metal or other materials, directed to a tumor and then manipulated by lasers or magnetic fields, can kill off malignant cells by heating them up. Now, researchers suggest that golden particles could burn hotter if fashioned into stars. Gold is already an excellent radiator because electrons on its surface efficiently capture light, but when that surface is spiky, the energized electrons collect at the points, producing higher temperatures, as illustrated above. In a paper published this week in *Optics Express*, the team reported that an eight-pointed star could generate temperatures more than ten times higher than a spherical particle. Moreover, it absorbs lower-energy light, and this would make the treatment easier on healthy cells caught in the beam. A 20-pointed star might be even better, but the scientists haven't done those calculations yet.

ScienceNOW. ISSN 1947-8052

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

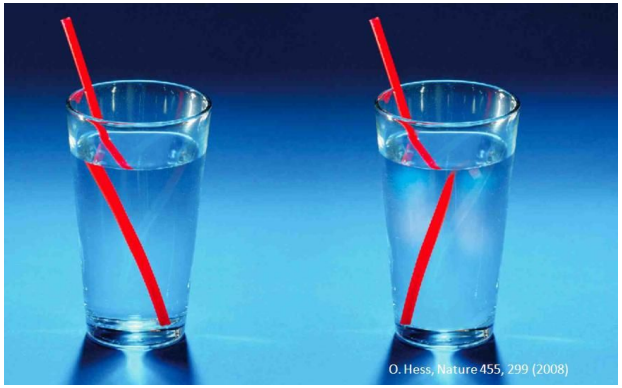
¿Qué son los metamateriales?

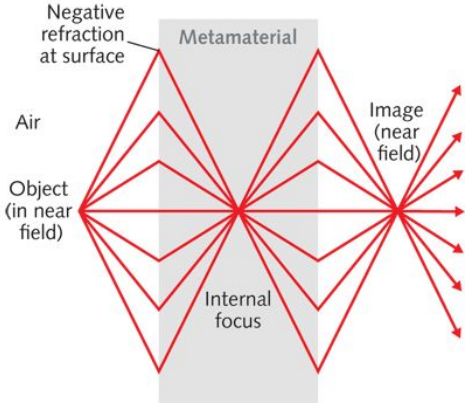


ϵ_m, μ_m

$L << \lambda$

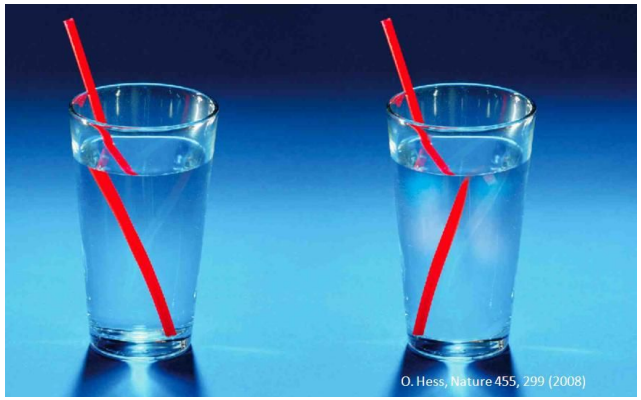
$$\langle \boldsymbol{D}(\boldsymbol{r}) \rangle = \epsilon_0 \epsilon_{eff}(\omega) \langle \boldsymbol{E}(\boldsymbol{r}) \rangle,$$
$$\langle \boldsymbol{B}(\boldsymbol{r}) \rangle = \mu_0 \mu_{eff}(\omega) \langle \boldsymbol{H}(\boldsymbol{r}) \rangle$$

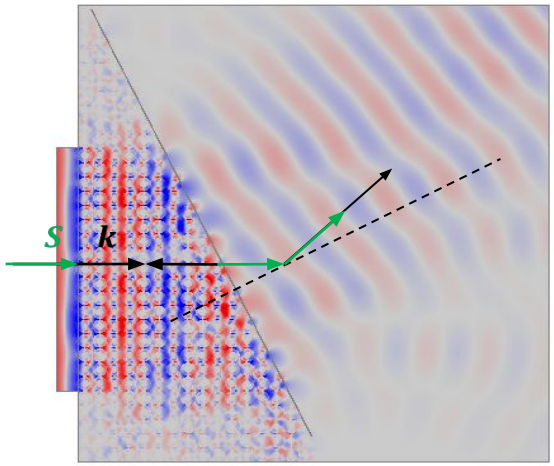


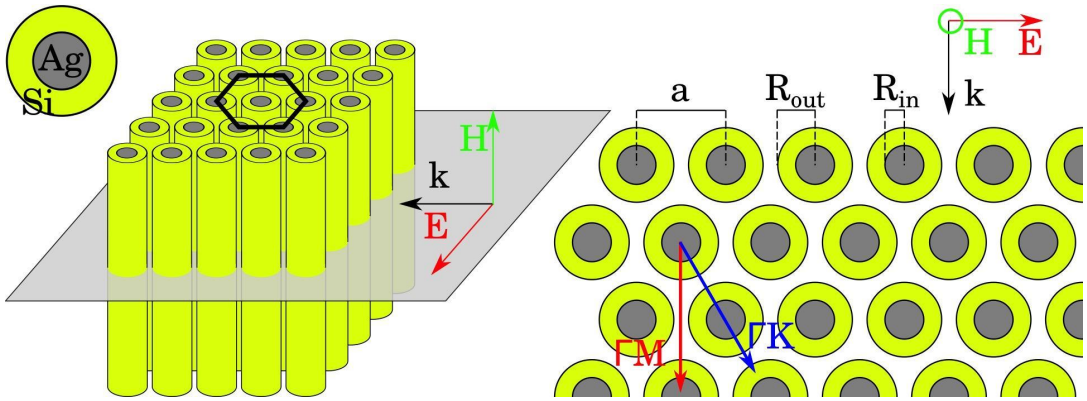


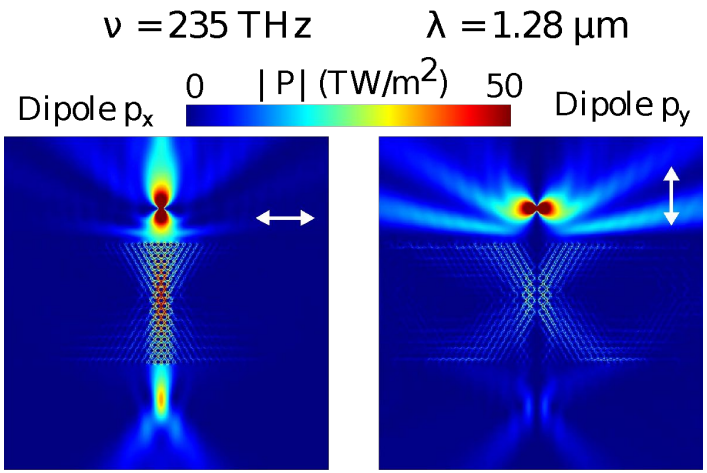
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

Negative Refraction







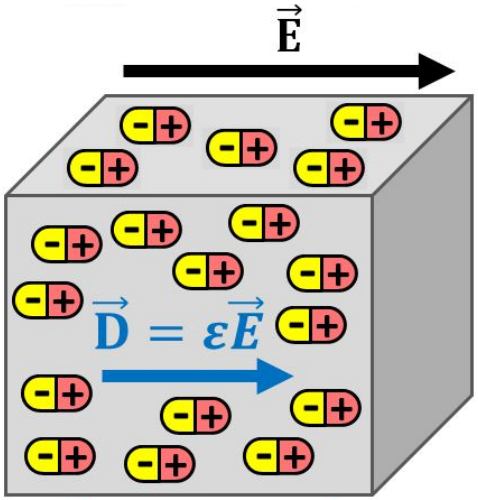


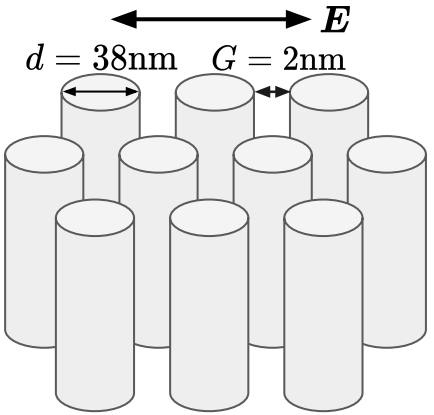
Flat lensing

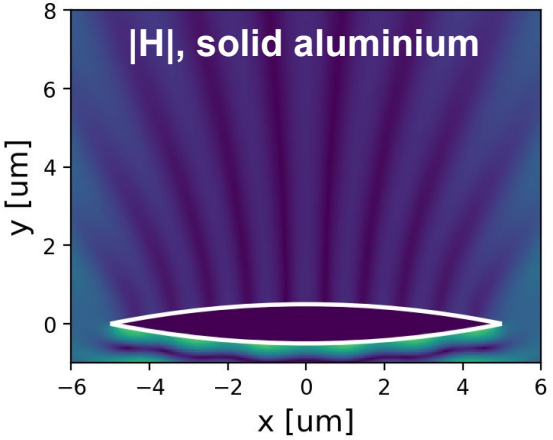
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

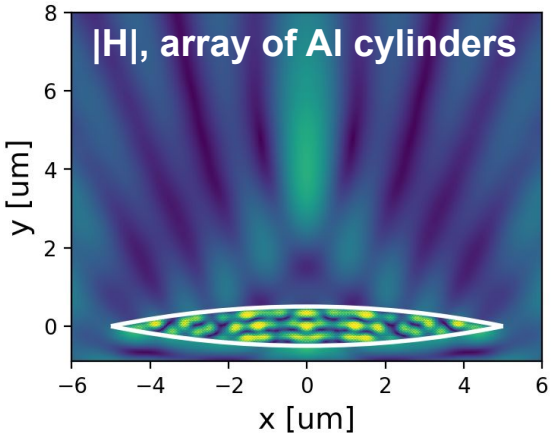
IEM Instituto de Estructura de la Materia

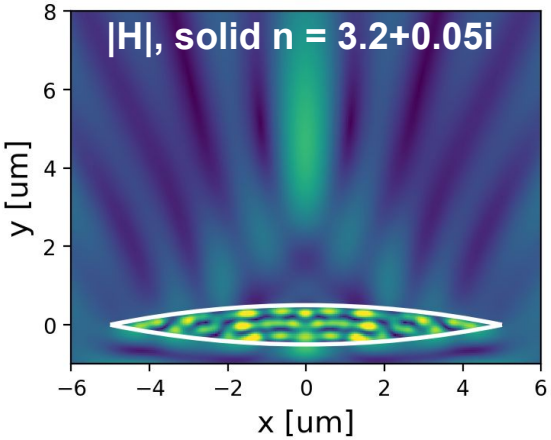
CSIC Consejo Superior de Investigaciones Científicas







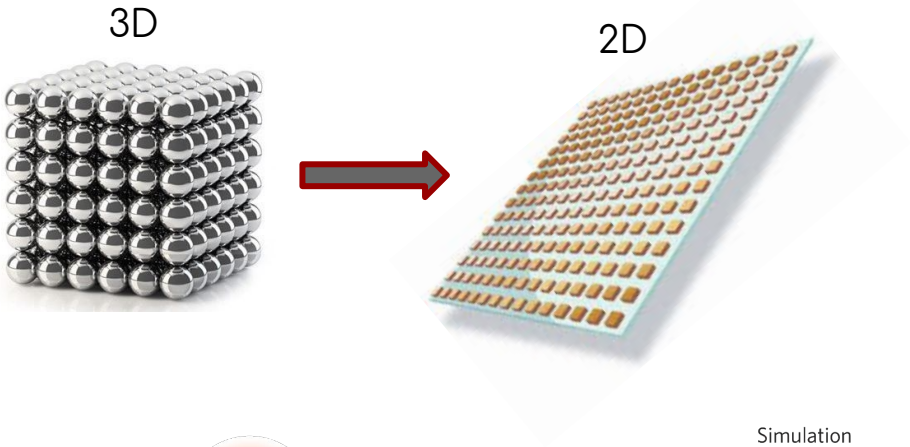


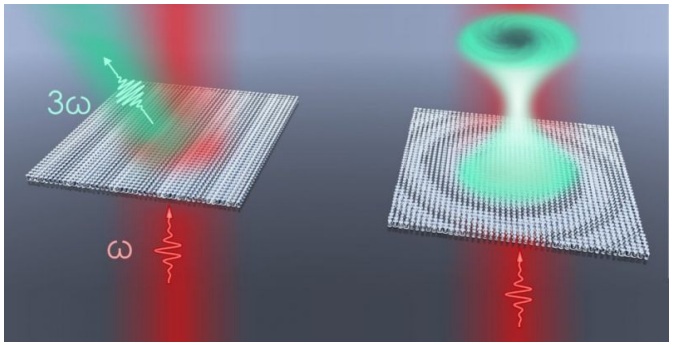


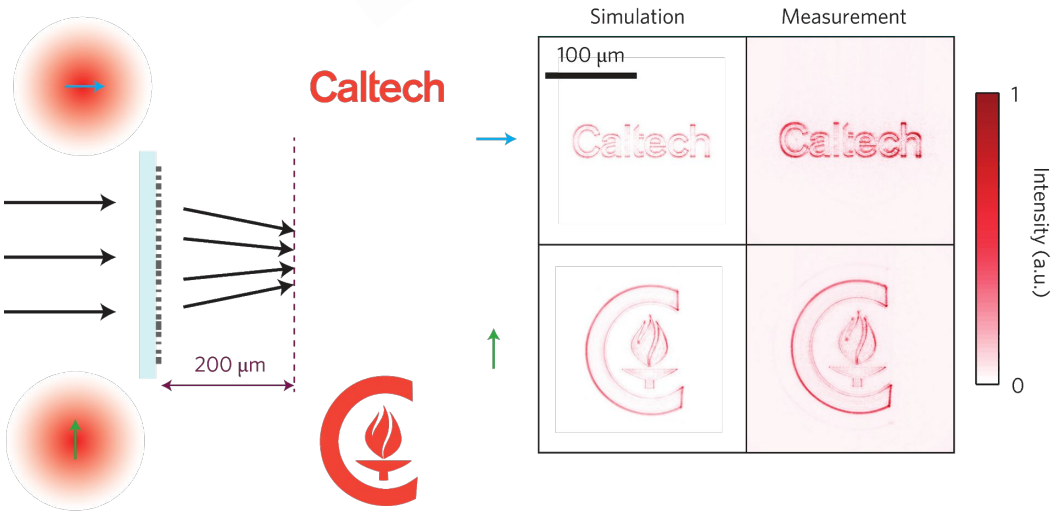
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

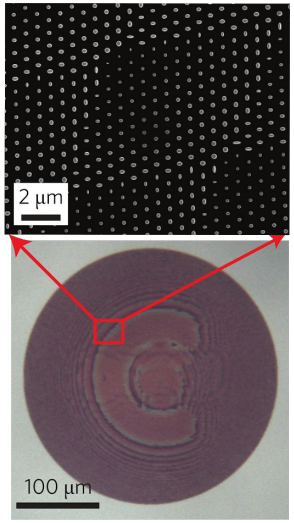
Metasuperficies

CONTROL SOBRE LA INTENSIDAD, FORMA Y FASE DE LA LUZ







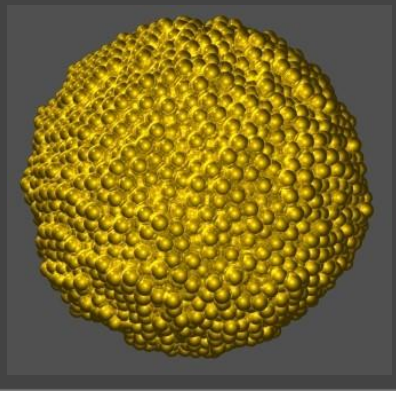


IEM Instituto de Estructura de la Materia

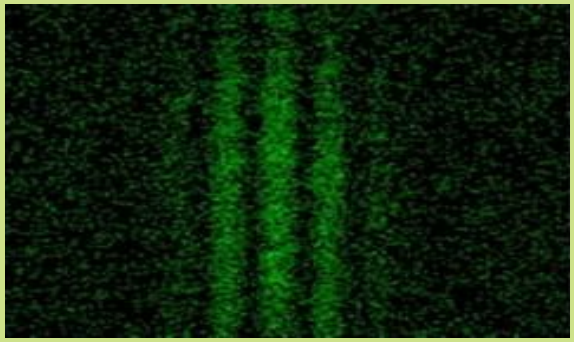
CSIC Consejo Superior de Investigaciones Científicas

PLASMÓNICA CUÁNTICA

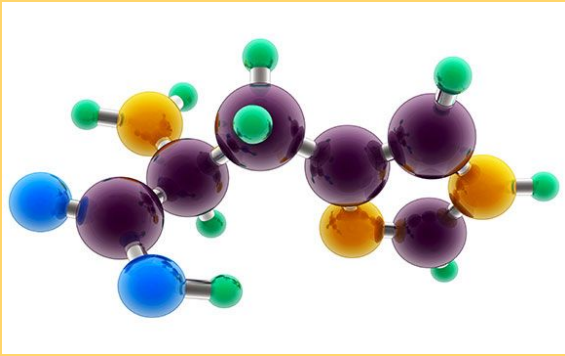
Átomos



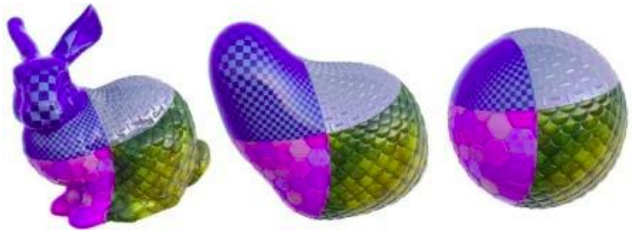
Fotones



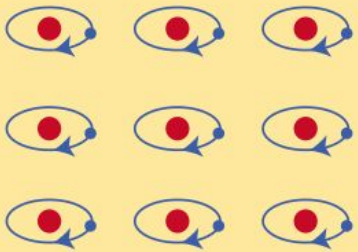
Moléculas



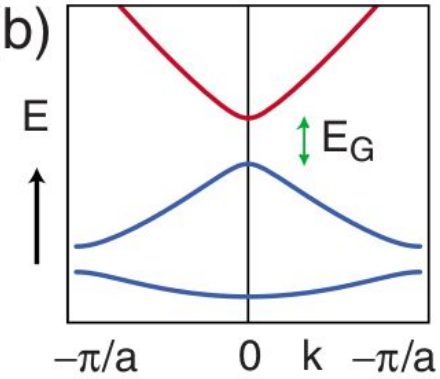
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com



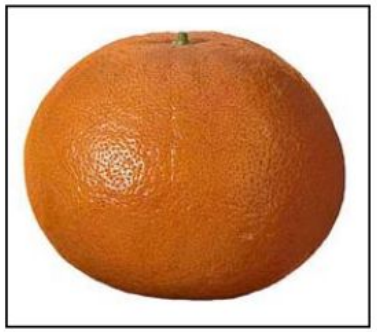
(a) Insulating State



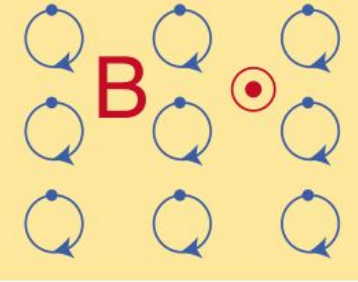
(b)



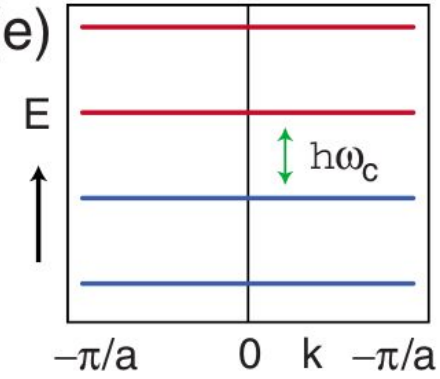
(c)



(d) Quantum Hall State



(e)

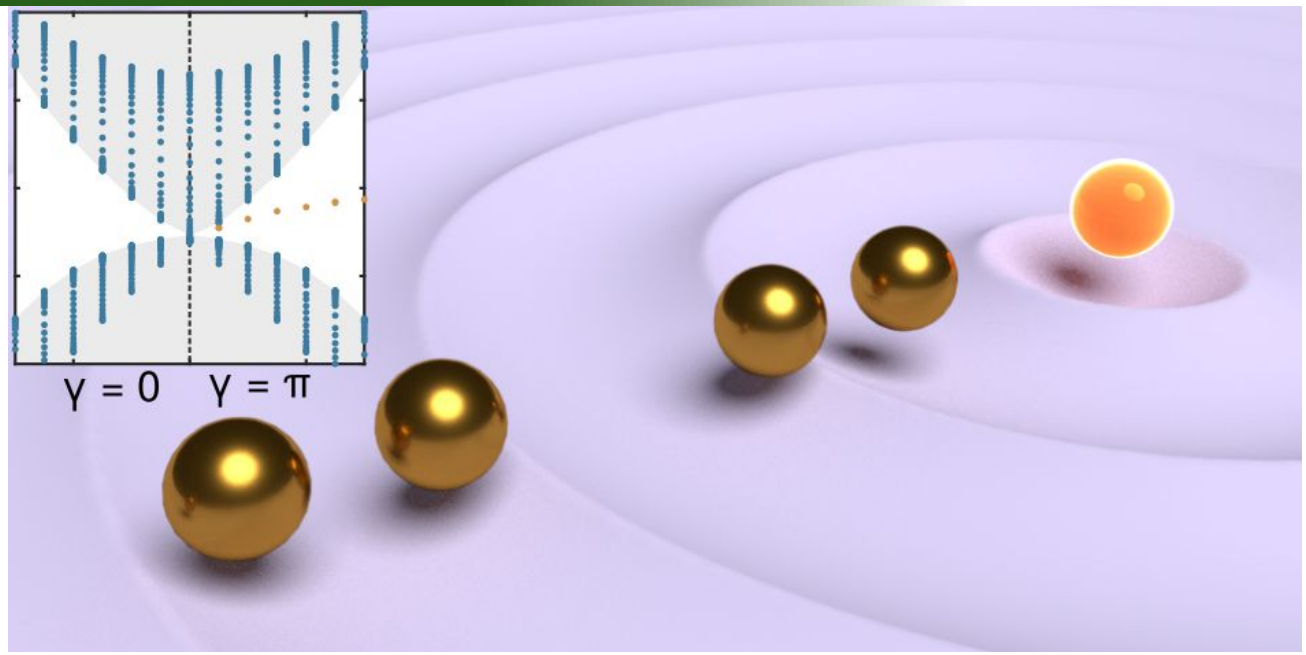


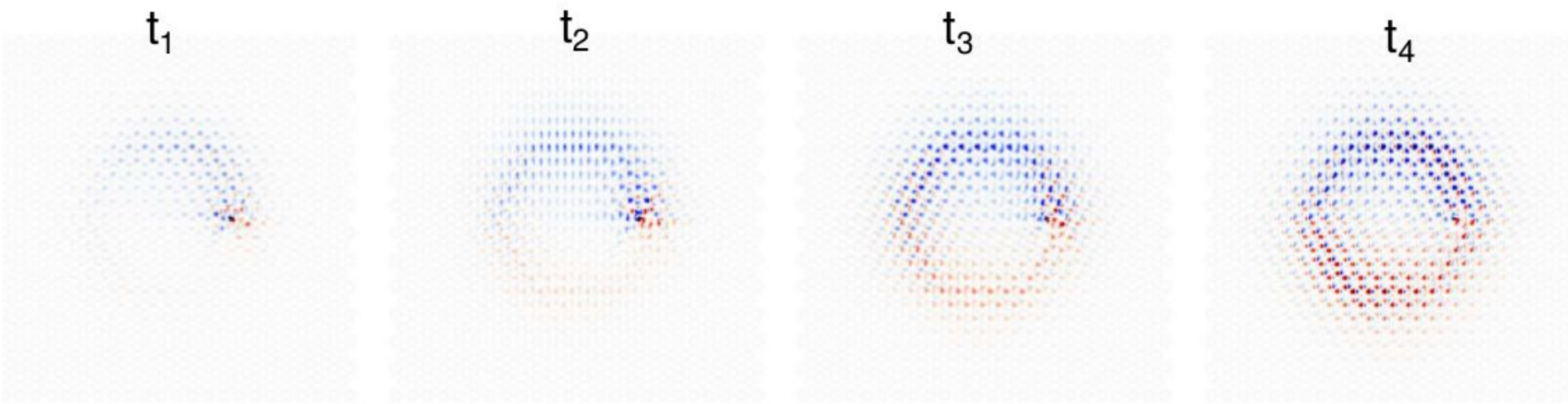
(f)

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

IEM Instituto de Estructura de la Materia

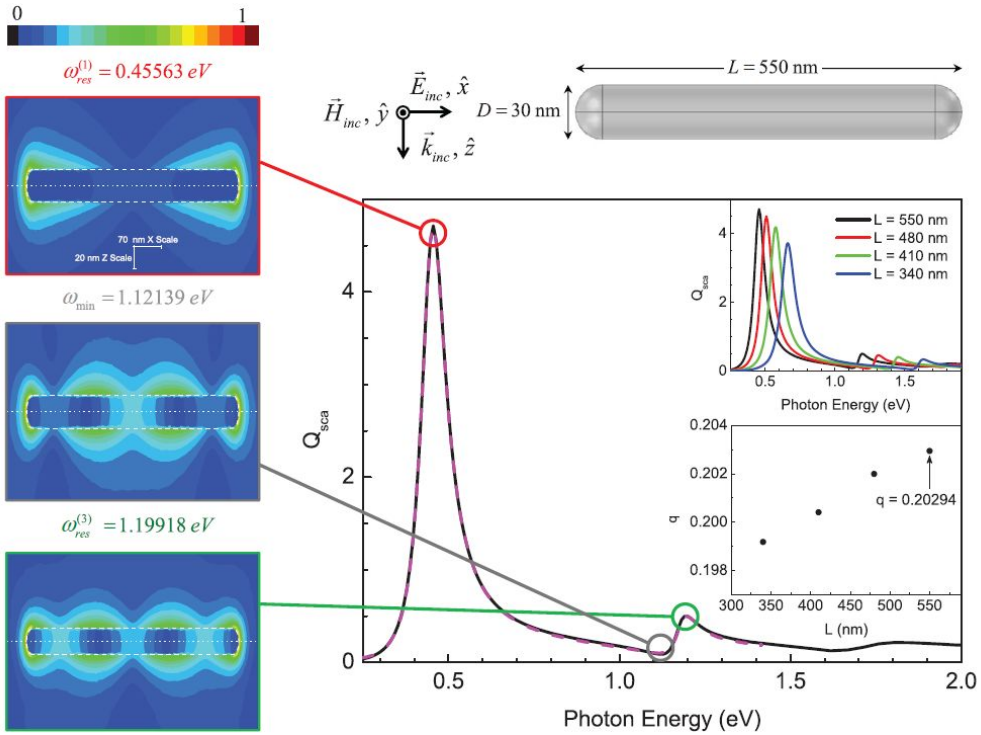
CSIC Consejo Superior de Investigaciones Científicas

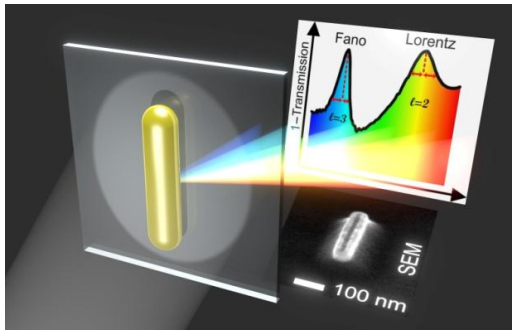


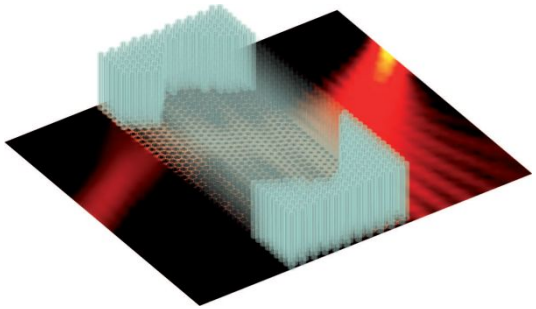


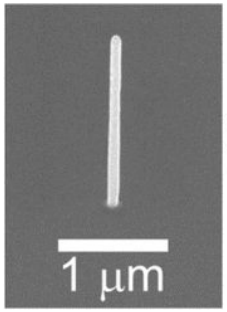
Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

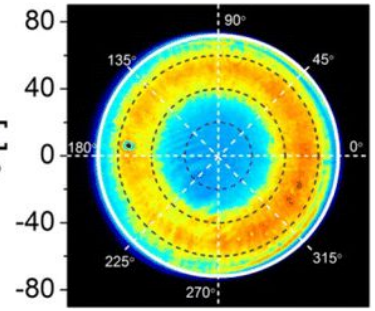
DE LO TEÓRICO... ...A LO APLICADO











Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

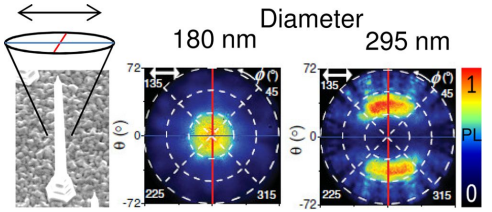
IEM Instituto de Estructura de la Materia

CSIC Consejo Superior de Investigaciones Científicas

NANO LETTERS Letter pubs.acs.org/NanoLett

Directional and Polarized Emission from Nanowire Arrays

Dick van Dam,*[,†] Diego R. Abujetas,[‡] Ramón Paniagua-Domínguez,[‡] José A. Sánchez-Gil,[‡] Erik P. A. M. Bakkers,[†,§] Jos E. M. Haverkort,[†] and Jaime Gómez Rivas*[,†,∥]



NANO LETTERS Letter pubs.acs.org/NanoLett

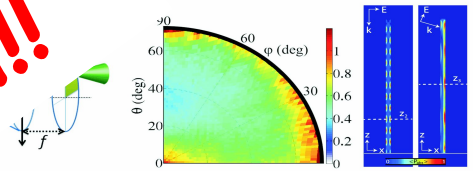
Nanowire Antenna Absorption Probed with Time-Reversed Fourie Microscopy

Grzegorz Grzela,[†] Ramón Paniagua-Domínguez,[‡] Tommy Barten,[†] Dick van Dam,[§] José A. Sár and Jaime Gómez Rivas*[,†,§]

[†]FOM Institute for Atomic and Molecular Physics (AMOLF), c/o Philips Research, High-Tech Campus 4, 5656 Netherlands

[‡]Instituto de Estructura de la Materia (IEM-CSIC), Consejo Superior de Investigaciones Científicas, Ser Spain

[§]COBRA Research Institute, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindh



Help wanted!!

SCIENTIFIC REPORTS

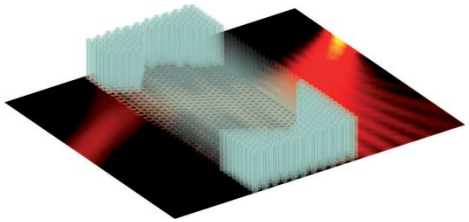
OPEN

Ultra low-loss, is… negative-index m… …d on hybrid metal-semic… …nowires

R. Paniagua-Domínguez, D. R. Abujetas & J. A. Sánch.

Instituto de Estructura de la Materia, Consejo Superior de Investigacione… …ntíficas, Serrano 121, 28006 Madrid, Spain.

SUBJECT AREAS:
METAMATERIALS
NANOWIRES
SUB-WAVELENGTH OPTICS
NANOPHOTONICS AND PLASMONICS



NANO LETTERS Letter pubs.acs.org/NanoLett

Mode Parity-Controlled Fano- and Lorentz-like Line Shapes Arising in Plasmonic Nanorods

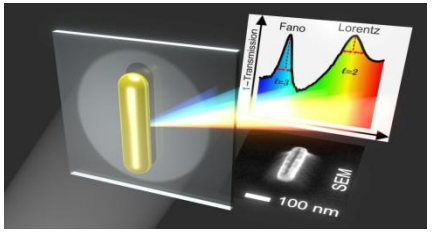
Niels Verellen,*[,†,‡] Fernando López-Tejeira,[§] Ramón Paniagua-Domínguez,[∥] Dries Vercruysse,[‡,†] Denitza Denkova,[†] Liesbet Lagae,[‡,†] Pol Van Dorpe,[‡,†] Victor V. Moshchalkov,[†] and José A. Sánchez-Gil[∥]

[†]INPAC and Department of Physics and Astronomy, KU Leuven, Celestijnenlaan 200 D, B-3001 Leuven, Belgium

[‡]IMEC, Kapeldreef 75, B-3001 Leuven, Belgium

[§]Departamento de Física de la Materia Condensada, Escuela de Ingeniería y Arquitectura, Universidad de Zaragoza, María de Luna 3, E-50018 Zaragoza, Spain

[∥]Instituto de Estructura de la Materia (IEM-CSIC), Consejo Superior de Investigaciones Científicas, Serrano 121, E-28006 Madrid, Spain



Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

Help wanted!!

- Aislantes topológicos fotónicos
  - Contrato Pre-Doc (proyecto EXPLORA)

- Metasuperficies & Plasmónica Cuántica
  - Becas MSCA (Marie Curie)
  - Beca FPI

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com

IEM Instituto de Estructura de la Materia

CSIC Consejo Superior de Investigaciones Científicas

José

Vincenzo

Info: José A. Sánchez Gil ⇒ j.sanchez@csic.es
Vincenzo Giannini ⇒ v.giannini@csic.es ⇒ GianniniLab.com