# New pathways to control single emitter radiation in novel electric and magnetic antenna platforms

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Nano-antennas, commonly used in research, are mostly designed for controlling the radiation from electric dipolar emitters by exciting elementary dipolar modes in plasmonic nanostructures [1]. Recently however, two new notions have emerged, bearing a potential for novel paradigms in the design of nanophotonics devices: excitation of dark modes in plasmonic linear antennas by a radiating dipolar emitter [2,3] and tunable magnetic resonances of dielectric submicron spheres [4,5]. We report on our findings regarding these new antenna designs and propose pathways to achieve a versatile control of their performance and efficiency.

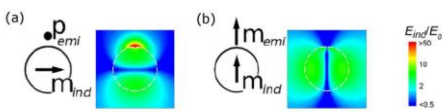


**Figure 1:** Near-field intensity of the electric field induced by (a) an electric dipolar ($p_{emi}$) and (b) a magnetic dipolar ($m_{emi}$) emitters in the proximity of a silicon spherical nanoparticle ($m_{ind}$).

Modification of the decay rates of a single dipolar electric emitter can be achieved by positioning it in the vicinity of a metallic linear nanoantenna in which higher-order plasmonic excitations are induced. We show that it is possible to effectively tune the enhancement or suppression of both the radiative and non-radiative decay processes by controlling the position and orientation of the dipole with respect to the antenna.

Furthermore, we consider the decay of an electric or magnetic dipolar emitter positioned in the vicinity of a spherical submicron dielectric particle. As we show, silicon nanospheres, with strong magnetic dipolar resonances in the near infrared, provide a canonical example of dielectric antennas that can be used to selectively enhance the magnetic dipolar emission. Near the magnetic resonance, we find a strong enhancement of the decay rate of magnetic emitters which resembles the enhancement of electric dipole emission near a resonant plasmonic particle.

Our results show new important phenomena that emerge from the system comprising canonic nano-optical elements, such as linear plasmonic antennas, dipolar emitters and dielectric nanospheres. The magnetic response from high-refractive index materials can stand as a building block of novel metamaterials and infrared communication platforms.

## References

[1] R. Esteban, T. V. Teperik, and J. J. Greffet, Physical Review Letters 104 (2010) 026802.
[2] M. K. Schmidt, S. Mackowski, and J. Aizpurua, Optics Letters 37 (2012) 1017.
[3] M. Liu, T.-W. Lee, S. K. Gray, P. Guyot-Sionnest, and M. Pelton, Physical Review Letters 102 (2009) 107401.
[4] A. García-Etxarri, R. Gómez-Medina, L. S. Froufe-Pérez, C. López, L. Chantada, F. Scheffold, J. Aizpurua, M. Nieto-Vesperinas, and J. J. Sáenz, Optics Express 19 (2011) 4815.
[5] M. K. Schmidt, R. Esteban, J. J. Sáenz, I. Suárez-Lacalle, S. Mackowski, and J. Aizpurua, Optics Express 20 (2012) 13636.