Could hydroxyl radicals account for nanoparticle radiosensitization?

Cécile Sicard-Roselli

Laboratoire de Chimie Physique
CNRS UMR 8000, Université Paris-Sud
91405 Orsay, France

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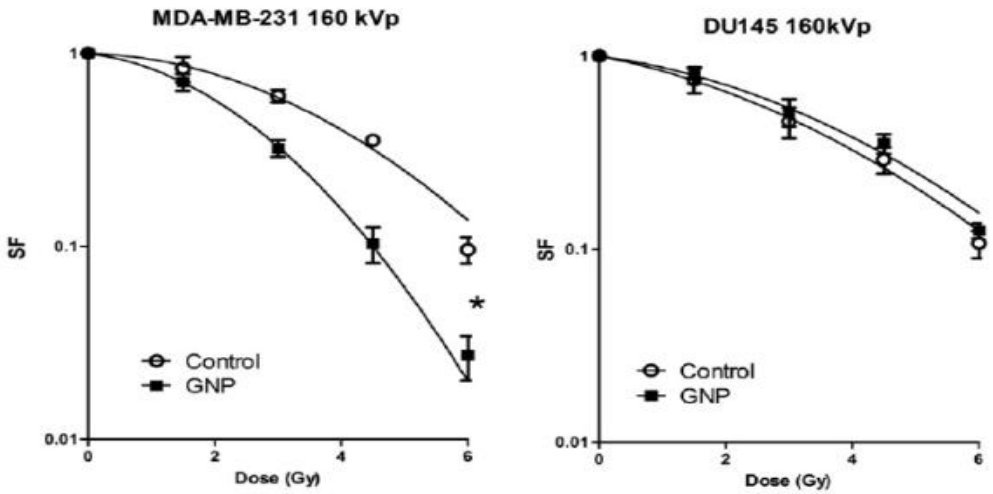
Context

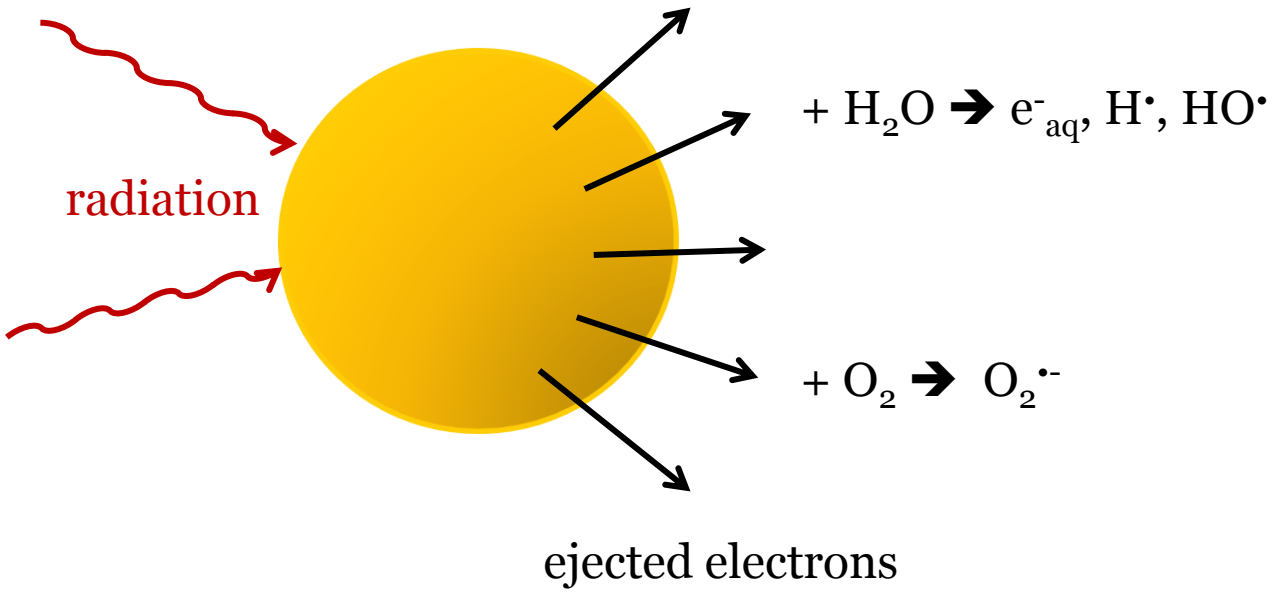
Metallic nanoparticles + ionizing radiation ➔ radiosensitizing effect



Important variability ➔ mechanism?

*** Jain et al.** Int. J. Radiation Oncology Biol. Phys., Vol. 79, No. 2, pp. 531–539, **2011**

Interaction GNP – radiation

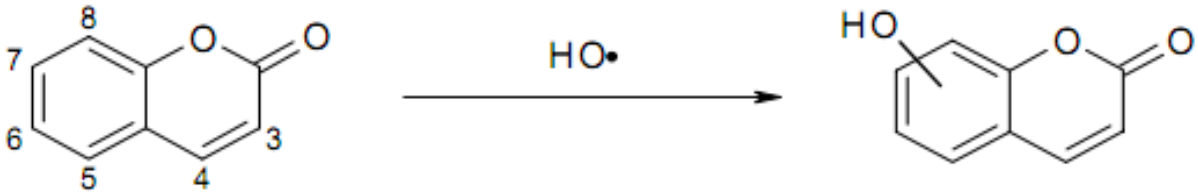


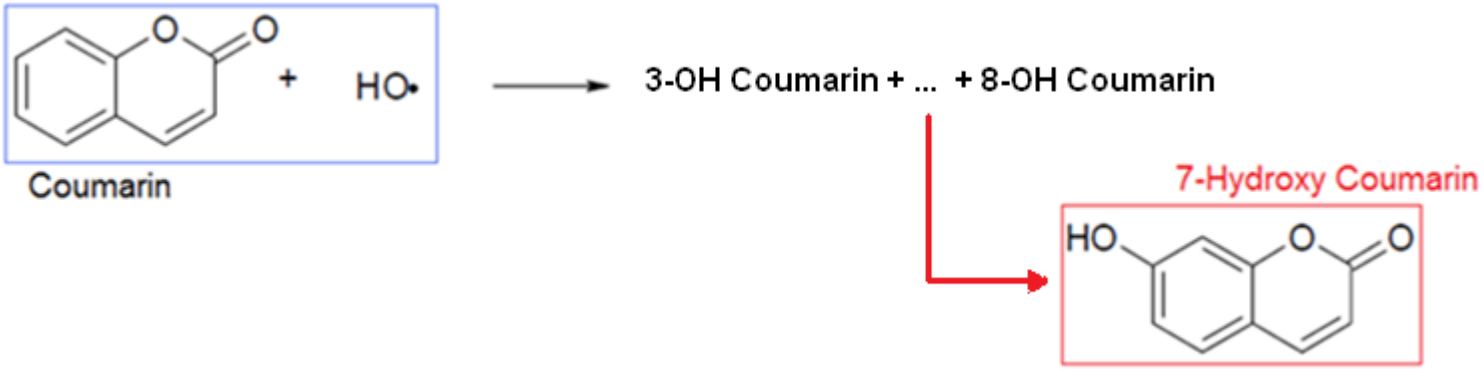
Overproduction of $HO^\bullet$ evidenced ➔ precise quantification

*** M. Misawa & J. Takahashi,** Nanomedicine. **2011** ; 7(5): p. 604-614.

Quantification of HO•

Coumarin oxidation



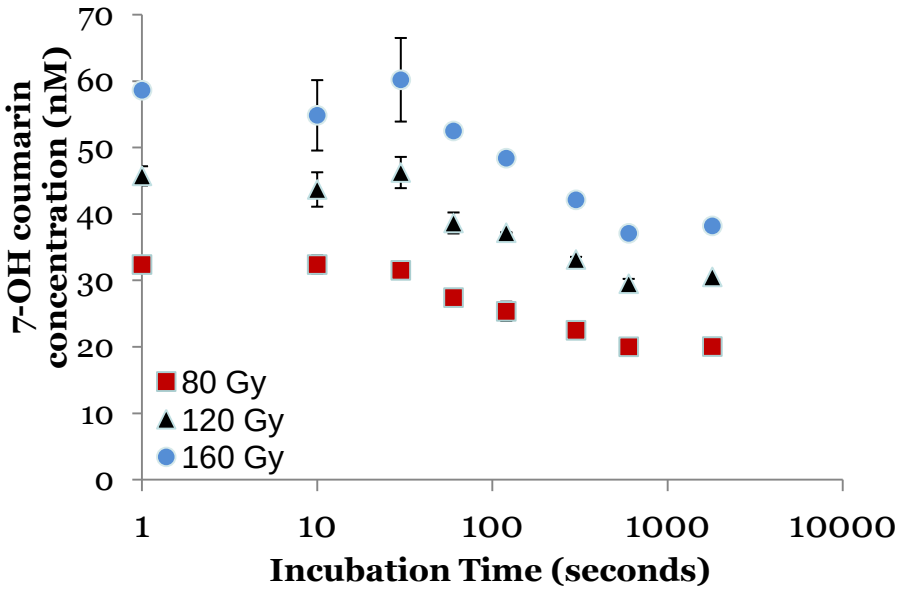


7-hydroxycoumarin as a fluorescent probe for OH radicals ➔ sensitive method

G. Louit & al. Radiation Physics and Chemistry. **2005** ; 72(2-3): p. 119-124.

Fluorescence Signal Decay

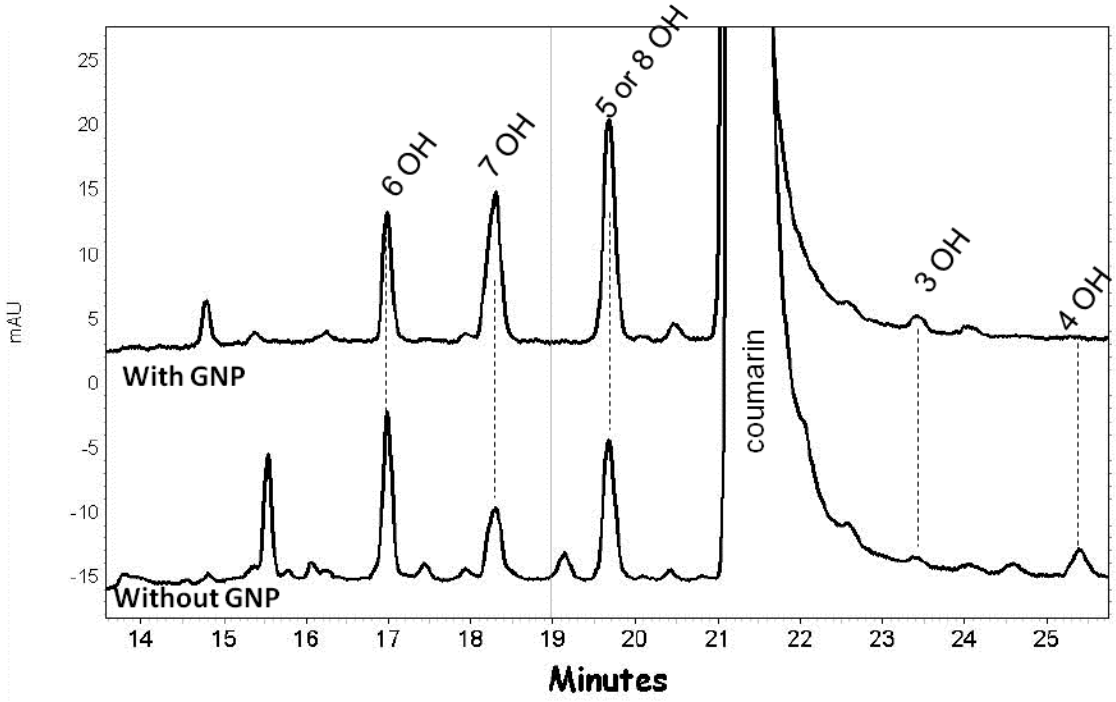
Incubation of oxidized coumarin with nanoparticles



Fluorescence signal decay ➔ Irradiation time < 30 s

Regioselectivity of coumarin hydroxylation

Chromatographic profiles of coumarin oxidation products

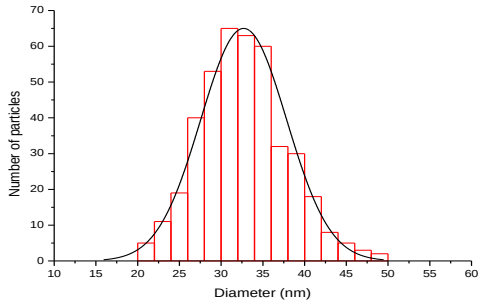


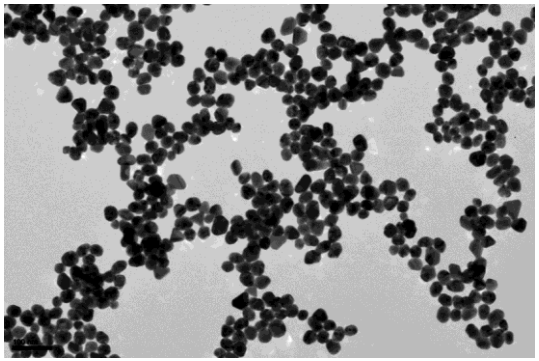
Regioselectivity different in the presence of nanoparticle ➔ no direct comparison with/without NP

Samples and irradiation

Nanoparticles

Gold nanoparticles 32.7nm ± 5.2 nm (Turkevitch method)





Irradiations

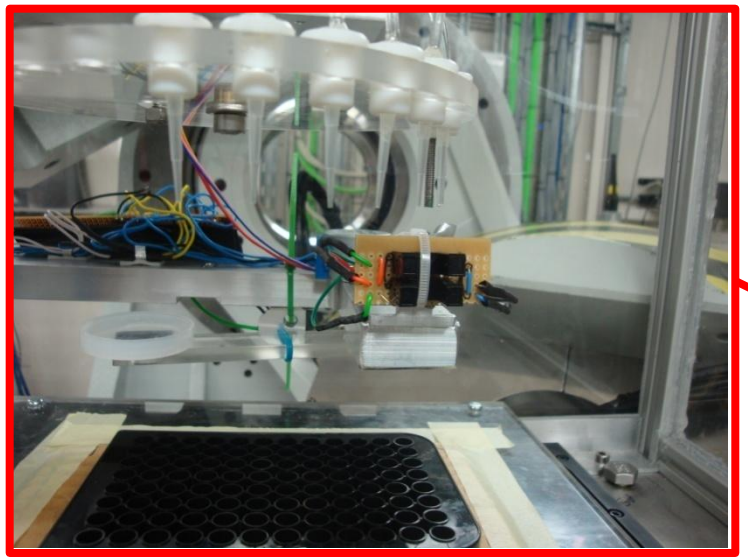
Oxfordshire (UK)

Work on Beamlines B16 and I15 20keV X-Rays

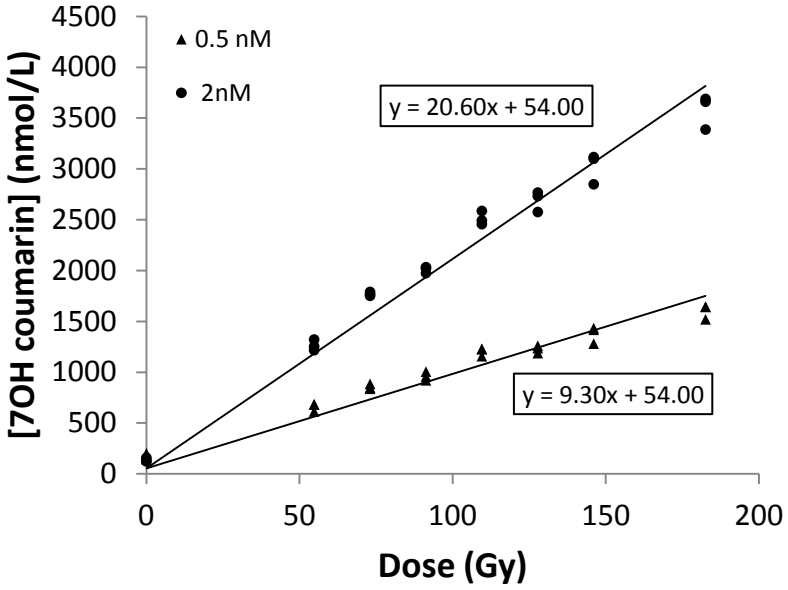
Samples and irradiation

Irradiation system

Drop system ➔ 96-well microplate



Quantification of HO•



Fluorescence signal = 7-OH coumarin concentration as a function of the dose

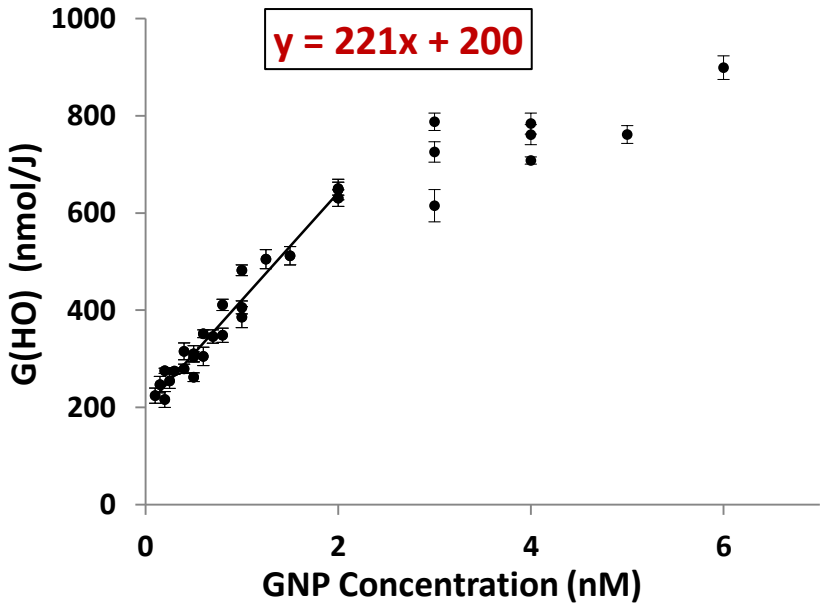
➔ $G_{(7OH\ coumarin)}$

Extrapolation of a yield of 7-OH coumarin for 0 nM of GNP

➔ Quantification of OH radical production in the presence of nanoparticles

G(OH•) = 221[GNP] + 200 nmol/J

[GNP] in nM



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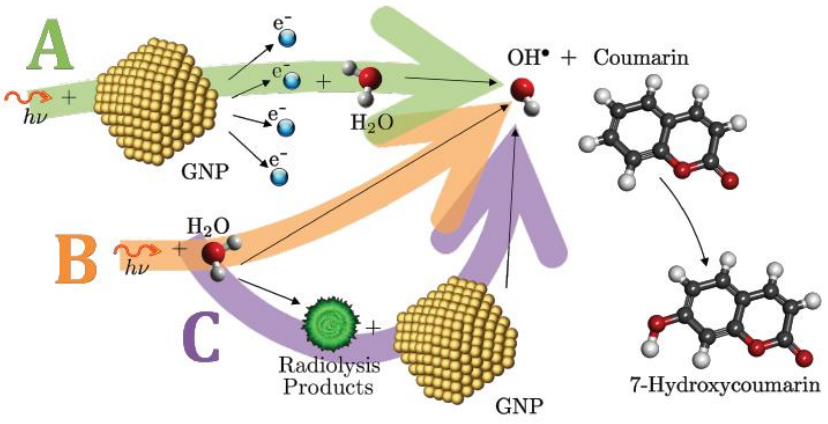
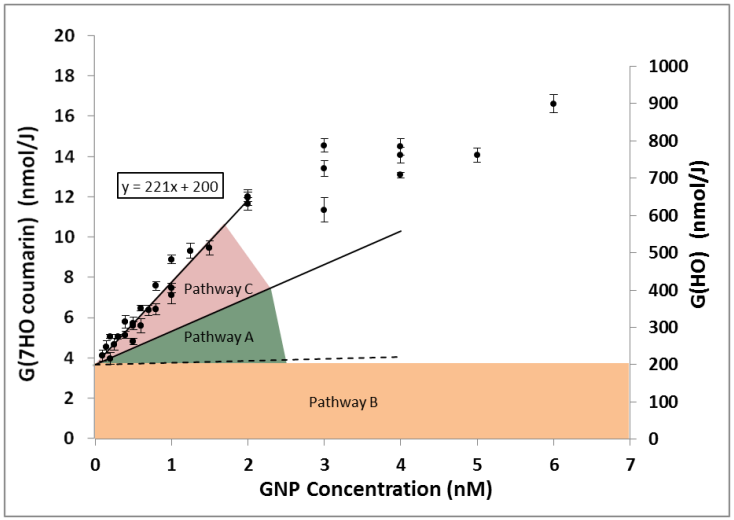
Correlation of HO• production with the « extra » energy absorbed
➔Simulations





Reliable protocole for HO• quantification with any kind of nanoparticles
➔ biological effect?

Impact of the functionalisation and protein corona on the HO• production

Université Paris-Sud, Orsay

Emilie Brun
Stéphanie Droniou
Manon Gilles
Cécile Sicard

Queen's University, Belfast

Fred J. Currell
Colin Kelsey
Harold McQuaid
Chris Polin
Nathan Wardlow

IRAMIS, CEA Saclay

Gérard Baldacchino

Equipe d'accueil des lignes B16, I15 Diamond Light Source, Harwell Research Complex

Plateforme de microscopie électronique IMAGIF (Gif sur Yvette)

Ambassade de France au Royaume-Uni