

Is it somebody else's problem to correct errors (or worse) in the scientific literature?

25/01/2023

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Laboratory for Vascular Translational Science

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Je sers la science et c'est ma joie

I serve Science and it's my joy





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Is it somebody else's problem to correct errors (or worse) in the scientific literature? Elisabeth Bik, Guillaume Cabanac & Cyril Labbé



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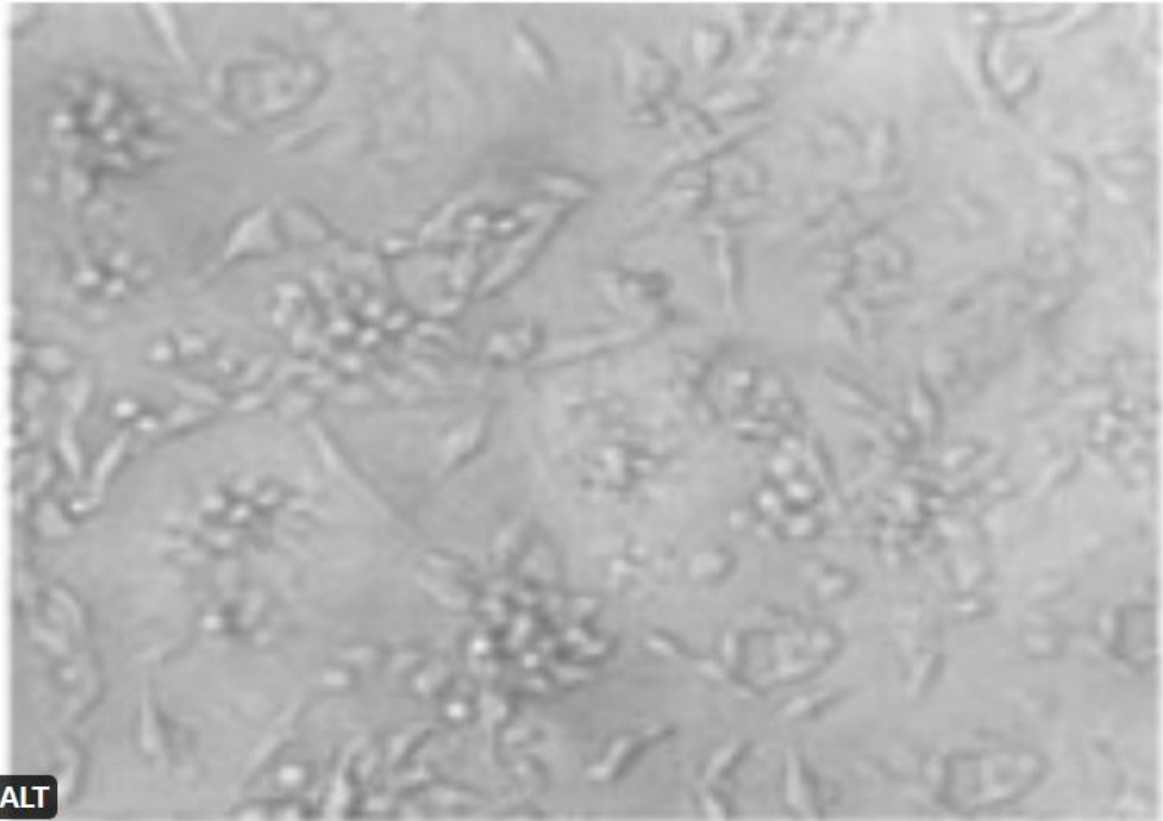
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Elisabeth Bik



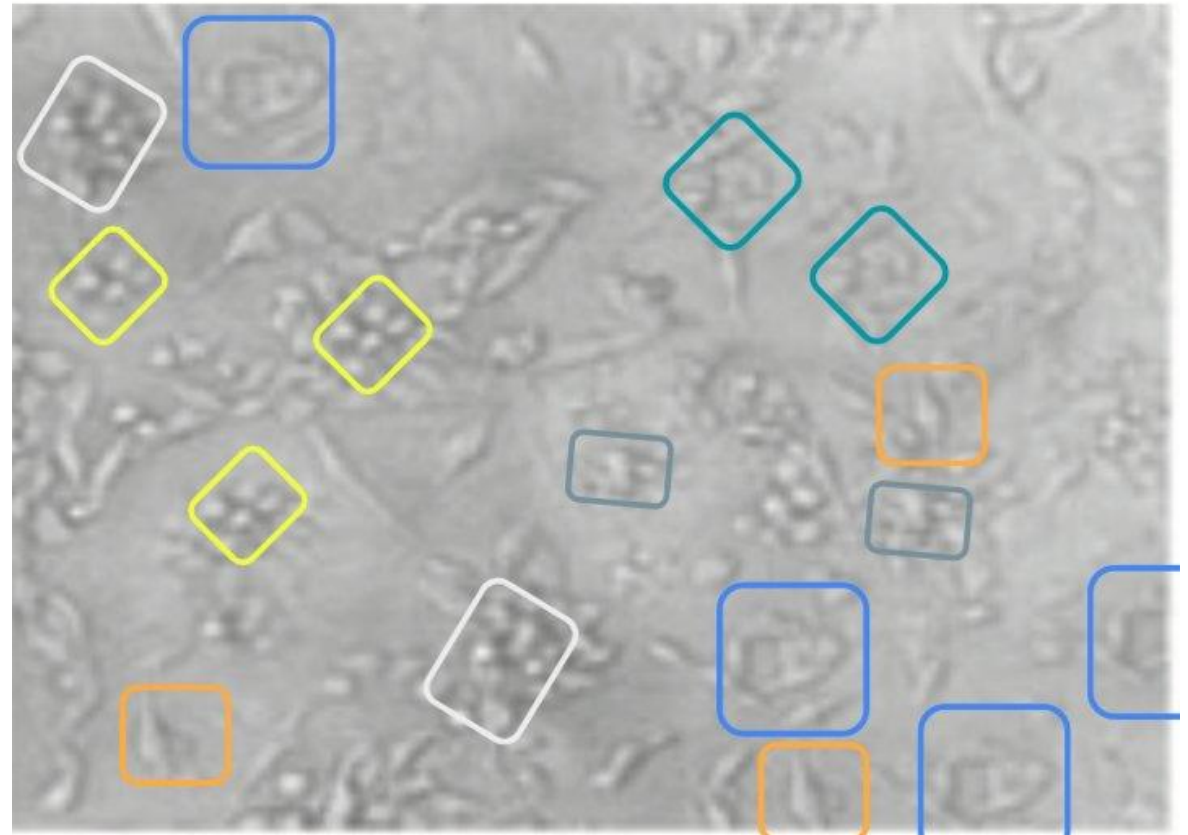
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...

Another beautiful [#ImageForensics](#) challenge for you.
Just one photo, but can you spot the problem(s) here?
Cited 15 times.



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Replying to @raoult_didier

This paper was retracted from IJID.

Can you please explain why it was retracted?

ncbi.nlm.nih.gov/pmc/articles/P...

[Int J Infect Dis](#), 2021 Sep 29 PMCID: PMC8491565
doi: [10.1016/j.ijid.2021.05.065](https://doi.org/10.1016/j.ijid.2021.05.065) [Epub ahead of print]

WITHDRAWN: Early combination therapy with hydroxychloroquine and azithromycin reduces mortality in 10,429 COVID-19 outpatients

[Matthieu Million](#),^{a,b} [Jean-Christophe Lagier](#),^{a,b} [Herve Tissot-Dupont](#),^{a,b} [Isabelle Ravaux](#),^a [Catherine Dhiver](#),^a [Christelle Tomej](#),^a [Nadim Cassir](#),^{a,b} [Léa Delorme](#),^a [Sébastien Cortaredona](#),^{a,c} [Stéphanie Gentile](#),^{d,e} [Elisabeth Jouve](#),^d [Audrey Giraud-Gatineau](#),^{a,c,f} [Herve Chaudet](#),^{a,c,f} [Laurence Camoin-Jau](#),^{a,g} [Philippe Colson](#),^{a,b} [Philippe Gautret](#),^{a,c} [Pierre-Edouard Fournier](#),^{a,c} [Baptiste Maille](#),^{h,i} [Jean-Claude Deharo](#),^{h,i} [Paul Habert](#),^{j,k,l} [Jean-Yves Gaubert](#),^{j,k,l} [Alexis Jacquier](#),^{l,m} [Stéphane Honore](#),^{n,o} [Katell Guillon-Lorvellec](#),^a [Yolande Obadia](#),^a [Philippe Parola](#),^{a,c} [Philippe Brouqui](#),^{a,b} [Didier Raoult](#),^{a,b,*} and IHU COVID-19 Task Force

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Abstract

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Is it somebody else's problem to correct errors (or worse) in the scientific literature? Guillaume Cabanac & Cyril Labbé



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Guillaume Cabanac

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Guillaume Cabanac: Deception sleuth

This computer scientist helped to uncover a new kind of fabricated paper.

By Diana Kwon

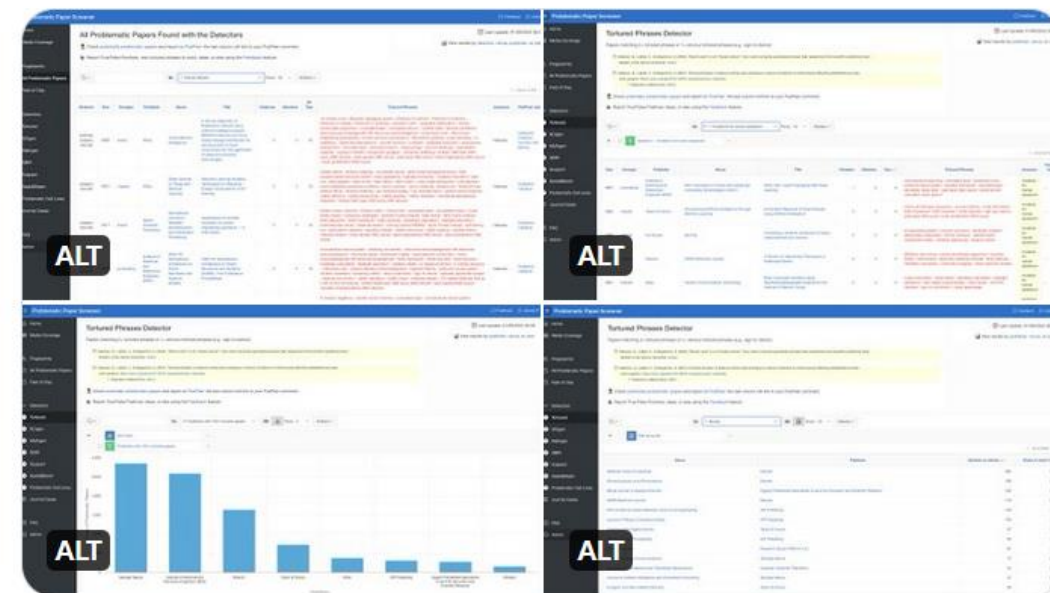
Underground creepy crawly state. Bosom malignancy. Sun oriented force. These might sound like expressions from a work of fiction, but they are actually strange translations, pulled from the scholarly literature, of scientific terms – ant colony, breast cancer and solar energy, respectively. Guillaume Cabanac, a computer scientist at the University of Toulouse, France, spots such bizarre phrases in academic papers

Today... 18,500 problematic articles flagged!



Guillaume Cabanac @gcabanac · 8h

The 'Problematic Paper Screener' flags 11,478 problematic articles with 7 detectors. Cited 84k times 🤯. Your human re-assessment welcome @PubPeer for 6,779 papers with tortured phrases. Let's depollute the scientific literature 🔍 irit.fr/~Guillaume.Cab... twitter.com/gcabanac/statu



COPE and 7 others



7 - Fabrications and applications of polymer-gra sustainability

Tortured Phrases (found)	Established Phrases (expected)
adversely charged	negatively charged
decidedly charged	positively charged
electrostatic fascination	electrostatic attraction
lactic corrosive	lactic acid
medication conveyance	drug delivery
protein articulation	protein expression
surface unpleasantness	surface roughness
twofold abandoned	double-stranded
utilitarian gatherings	functional groups
warm conductivity	heat conductivity

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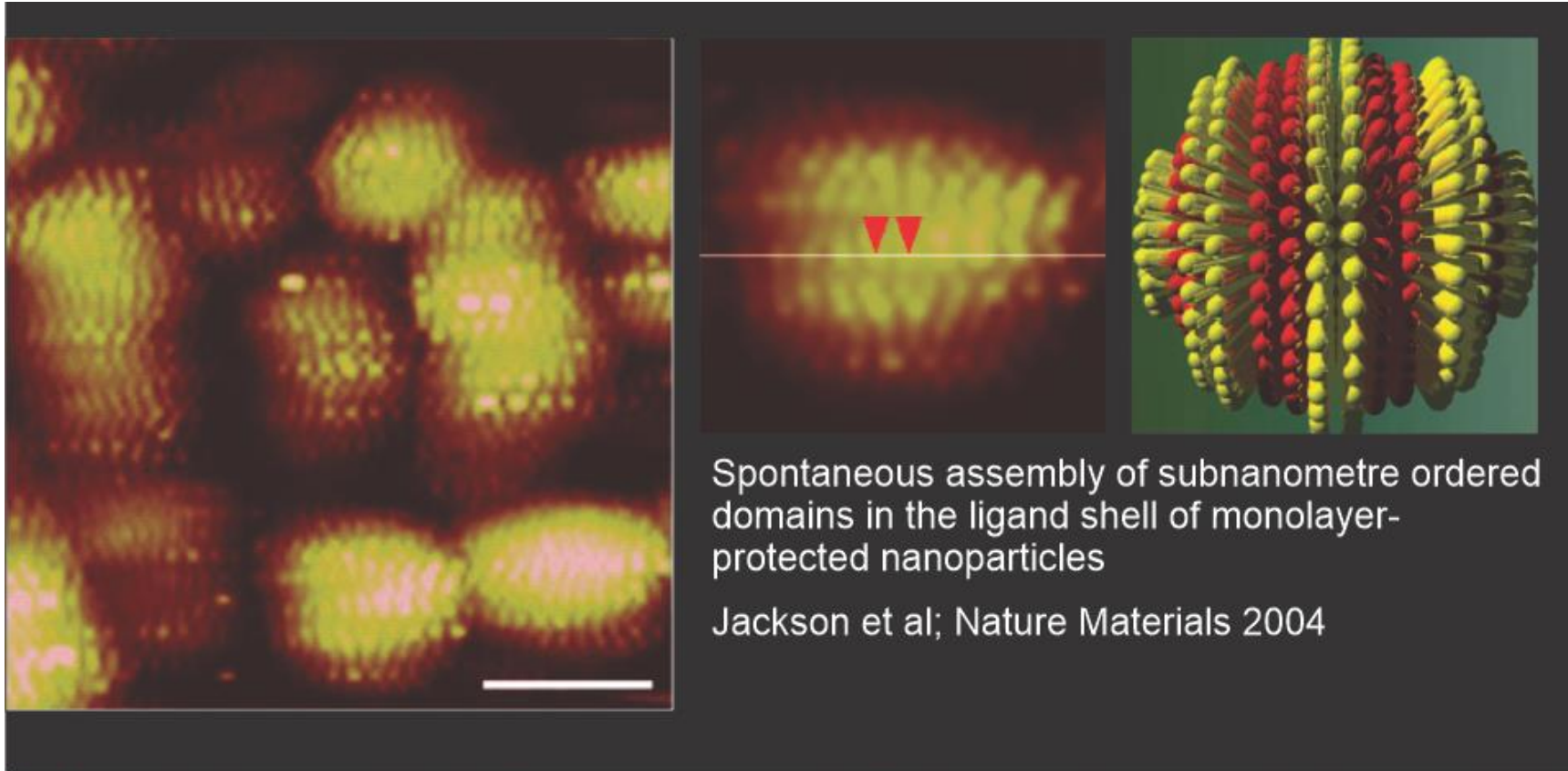
Materials Research Express

TOPICAL REVIEW • OPEN ACCESS

Advances in chitosan biopolymer composite materials: from bioengineering, wastewater treatment to agricultural applications

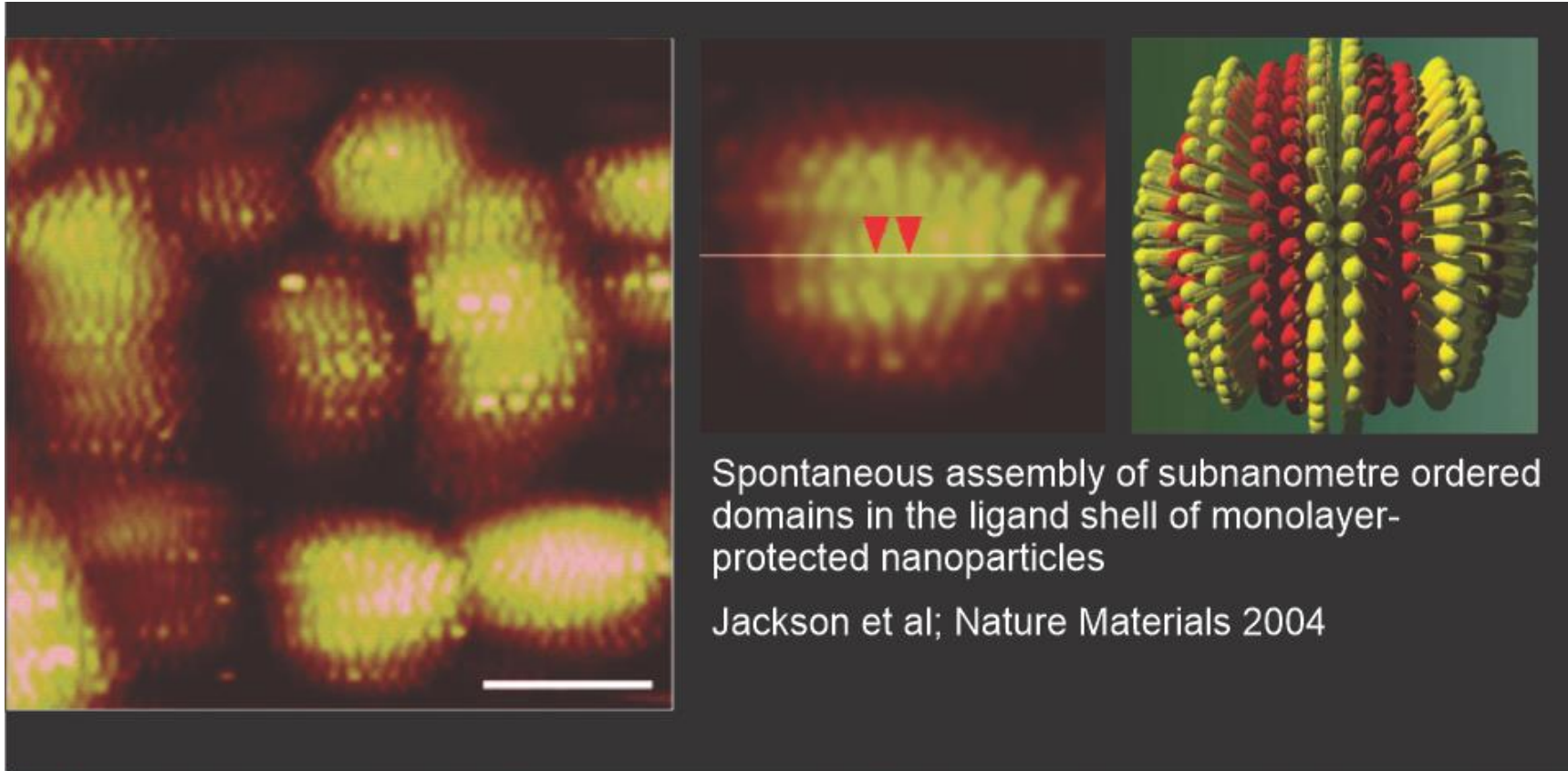
“In any case, there are still difficulties in chitosan in the acidic arrangement in the generous wastewater stream because of the end of the acidic arrangement and the poisonousness and gear misfortune caused by standard acids like HCl or H2SO4 [143].”

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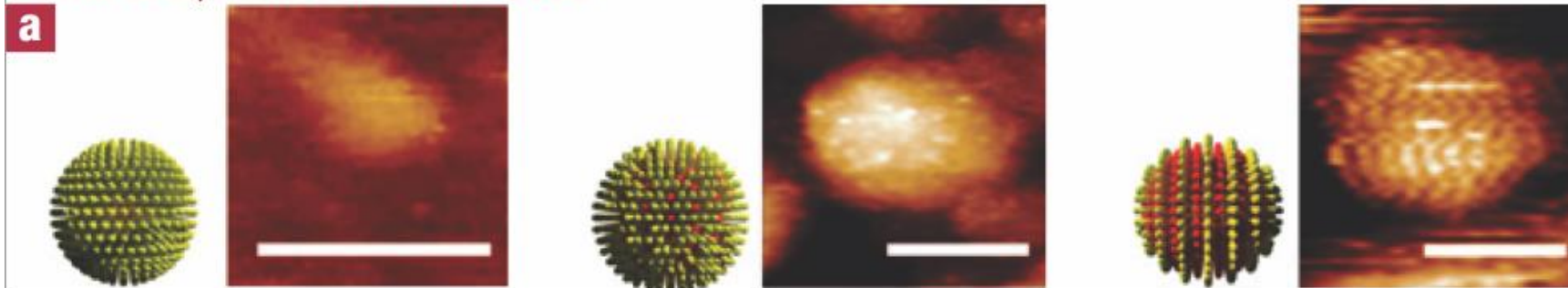
As a post-doc in
2004? Yes

Is it somebody else's problem to correct errors (or worse) in the scientific literature?



Surface-structure-regulated cell-membrane penetration by monolayer-protected nanoparticles

Verma et al; Nature Materials 2008



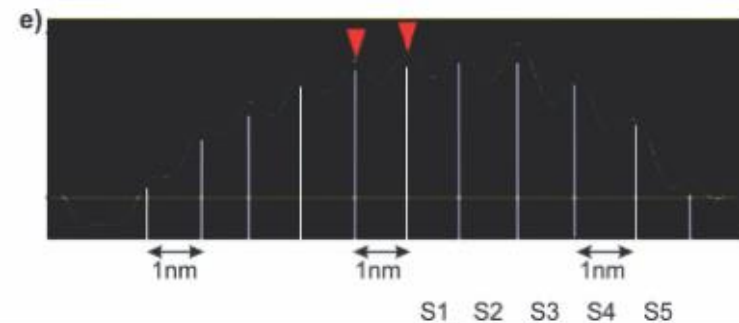
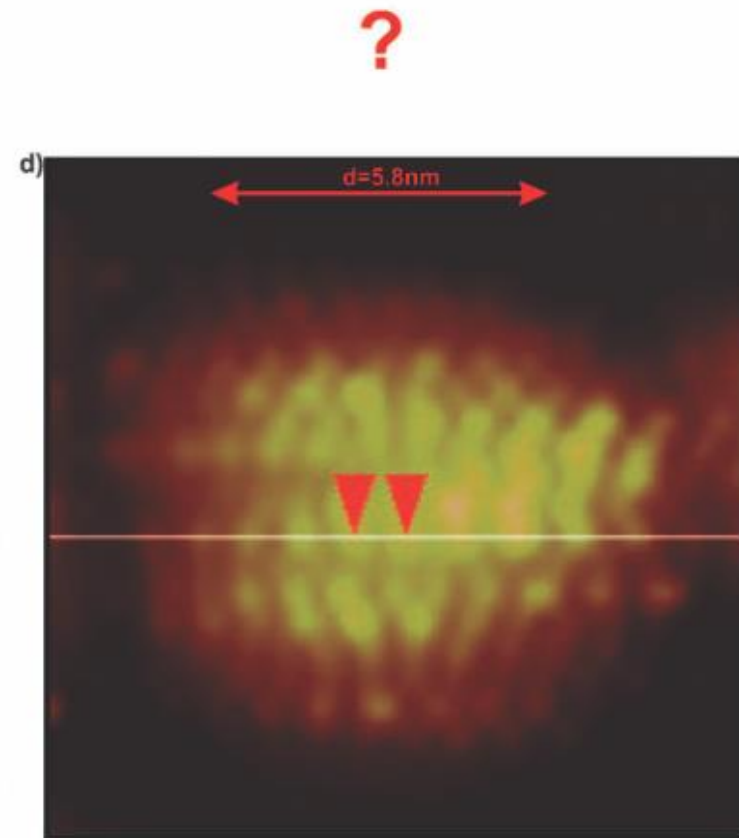
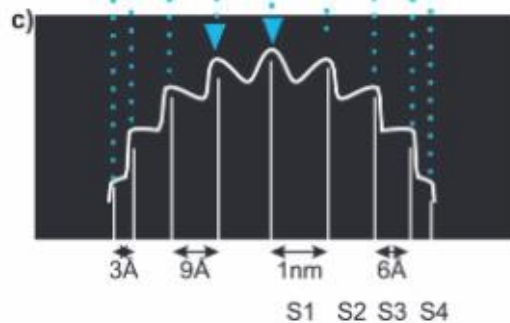
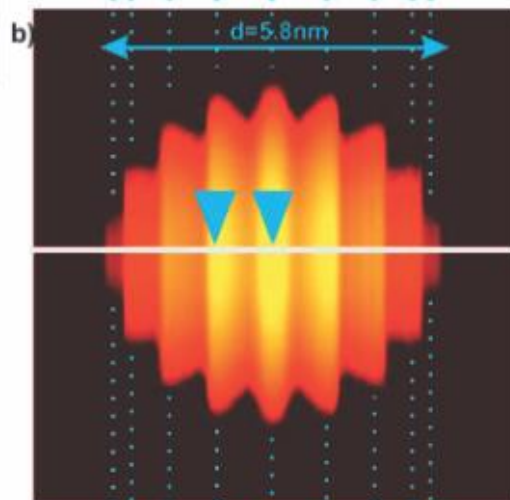
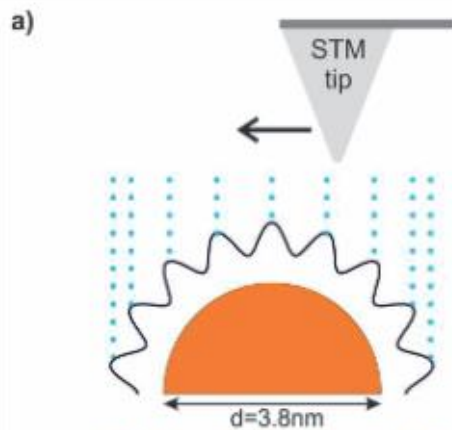
As a young PI
in 2008...

*Stripy
Nanoparticles
Revisited
Submitted
2009*



Stripy Nanoparticles Revisited

Cesbron et al; Small 20??

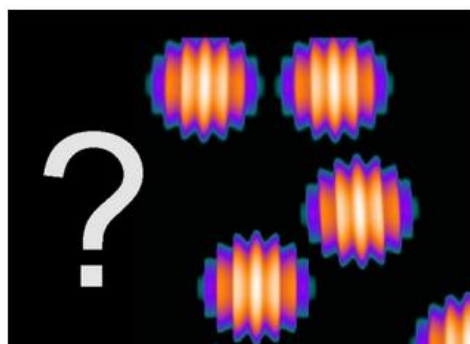


**Stripy
Nanoparticles
Revisited
Published
2012**

A blog:
a good
place to
discuss
scientific
articles
without
having to
wait three
years for
referees
comments
& editors'
decisions...



STRIPY NANOPARTICLES REVISITED




Challenging published results is an onerous but necessary task. Today, our article entitled [Stripy Nanoparticles Revisited](#) has been published in *Small*, three years after its initial submission to this journal (3/12/09) and about three and a half years after the first submission (to Nature Materials, 21/07/09).

As its title indicates, the article challenges the evidence for the existence and properties of “stripy” nanoparticles. The stripy nanoparticle hypothesis was first

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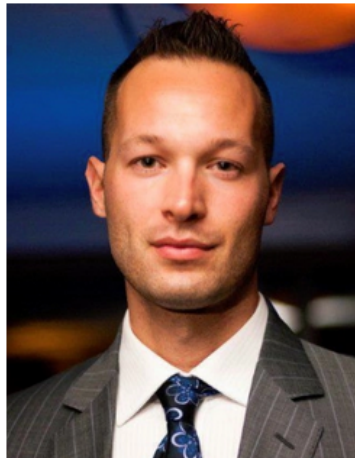
 Raphaël Lévy on [What Proportion of Scientific...](#)

 Raphaël Lévy on [What](#)

Is it somebody else's problem to correct errors (or worse) in the scientific literature?
As a PhD student, Predrag thought it was his job (but he wasn't allowed to).



SEVEN YEARS OF IMAGING ARTIFACTS: WHAT GIVES?



This is a guest post by [Predrag Djuranovic](#), currently a [graduate student](#) at the [MIT Department of Materials Science and Engineering](#).

In 2005, I was a graduate student in Francesco Stellacci's lab at MIT. My project was investigating a potential phase separation in the ligand shells on semiconductor nanoparticles. I explain below how, after months of strenuous STM imaging, I came to the conclusion that the "ripples" and "hexagonal packing", were nothing but common scanning artifacts, called feedback oscillations or "ringing".

When I started to have doubts, I performed simple control experiments, i.e. STM imaging on *bare* conducting substrates (clean substrates without any ligands). I selected two conductive substrates: gold foil (surface roughness comparable to the size of gold nanoparticles) and ITO

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[What's a limit of detection an...](#)

[Down the rabbit hole...](#) on



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« Psychiatrists From Another Dimension (Part 2) Medical Journal Apologizes "For The Distress Caused" By A Paper »

Postpublication "Cyberbullying" and the Professional Self

By Neuroskeptic | January 27, 2014 4:47 pm



An article in *Science* has been getting a lot of attention this week: **Nano-Imaging Feud Sets Online Sites Sizzling**



The 'stripey nanoparticles' debate, which I covered a few weeks ago, is still going on. In 2004, Francesco Stellacci and his colleagues published a paper

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Stellacci 'stripy nanoparticle' dispute heats up

23 JANUARY 2014 | BY PAUL JUMP

Analysis critical of professor's discovery claim is published on arXiv



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8th

ARE FLAWS IN PEER REVIEW SOMEONE ELSE'S PROBLEM?

By Philip Moriarty On April 8, 2013

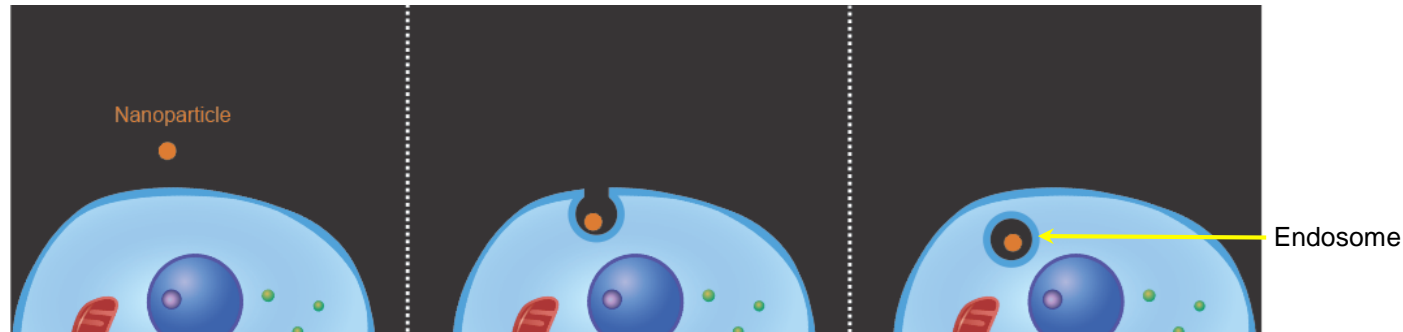


In the stripy controversy, did science “self-correct”?

2011-...

Another scientific controversy

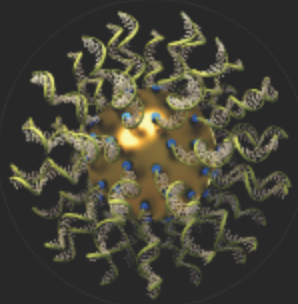
Established knowledge: nanoparticles enter cells but end up in vesicles inside the cell



As Dales has pointed out (3), virus entry by phagocytosis, or during pinocytosis, might simply be a special example of **the general method whereby cells in a wide variety of normal situations take up particulate objects.** But under normal conditions phagocytosis is usually directed to the concentration of assimilated material in membrane-bounded vacuoles or inclusions connected with digestive disposal processes (7, 8), and for infection by ingested virus

In 1963, the mechanism of entry of nanoparticles into cells is already well established knowledge.

1963



SPHERICAL NUCLEIC ACIDS

Oligonucleotide-Modified Gold Nanoparticles for Intracellular Gene Regulation

Nathaniel L. Rosi,* David A. Giljohann,* C. Shad Thaxton, Abigail K. R. Lytton, Min Su Han, Chad A. Mirkin†

We describe the use of gold nanoparticle-oligonucleotide complexes as intracellular regulation agents for the control of protein expression in cells. These oligonucleotide-modified nanoparticles have affinity constants for complementary nucleic acids that are higher than their unmodified oligonucleotide counterparts, are less susceptible to degradation by nuclease activity, exhibit greater than 99% cellular uptake, can introduce oligonucleotides at a higher effective concentration than conventional transfection agents, and are nontoxic to the cells under the conditions studied. By chemically tailoring the density of DNA bound to the surface of gold nanoparticles, we demonstrated a tunable gene knockdown.

Nucleic acid-based methods for controlling gene expression have been developed and sized that this particular type of Au NP

the design of two sets of antisense Au NPs, with the ASODN conjugated to the Au NP surface with either one or four thiol groups (Fig. 1). The

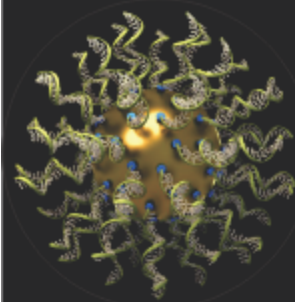
Find

endocytosis

Previous

Next

that higher oligonucleotide packing densities result in a corresponding increase in association constant (15). Taken together, particles A and B offer the opportunity to study the potential of ASNPs in regulating gene expression and, more specifically, the effect of particle binding constants and oligonucleotide loading on the performance of such particles in the context of EGFP expression.



SPHERICAL NUCLEIC ACIDS

Oligonucleotide-Modified Gold

the design of two sets of antisense Au NPs, with the ASODN conjugated to the Au NP surface

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nanoparticles, we demonstrated a tunable gene knockdown.

Nucleic acid-based methods for controlling sized that this particular type of Au NP

stants and oligonucleotide loading on the performance of such particles in the context of EGFP expression.

What happens after the 2006 paper?

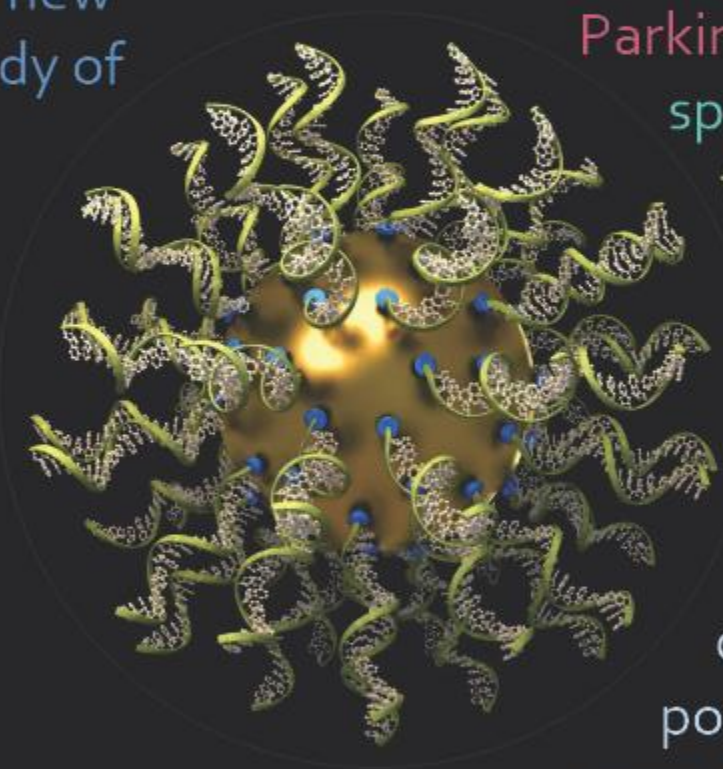
1. Promises. Lots of promises. Big ones.
2. Many more publications *that still fail to answer basic questions about the technology.*
3. IP, Aurasense LCC, Aurasense Therapeutics, Exicure, raising millions of dollars of public and private funds.
4. Commercialisation (SmartFlares) and clinical trials.
5. Prizes. Lots of prizes.

Promises. Lots of promises. Big ones.

"...opens the door for new possibilities in the study of gene function and nanotherapies."

"...can be used as both transfection agents and cellular "nano-flares" for detecting mRNA in living cells."

2006-2009



"...new avenues for tackling glioblastoma, Alzheimer's, and Parkinson's. ... broad-spectrum antibiotics ... traumatic brain injury. ... could positively impact **tens of millions** of people"

"Live cell RNA detection is now possible using inert nanoparticle technology to specifically detect native mRNA"

2013-2015

IP, Aurasense LCC, Aurasense Therapeutics, Exicure, raising millions of dollars of public and private funds.

Particles for detecting intracellular targets

US20100129808A1

United States

Download PDF Find Prior Art Similar

Inventor: Chad A. Mirkin, Dwight Seferos, David A. Glijohann

Current Assignee: Northwestern University

Worldwide applications

2008 · EP CN AU CA WO KR MX JP US 2013 · US

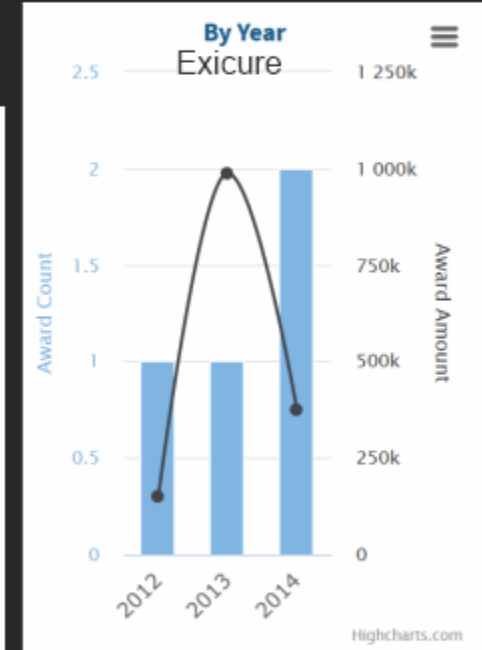
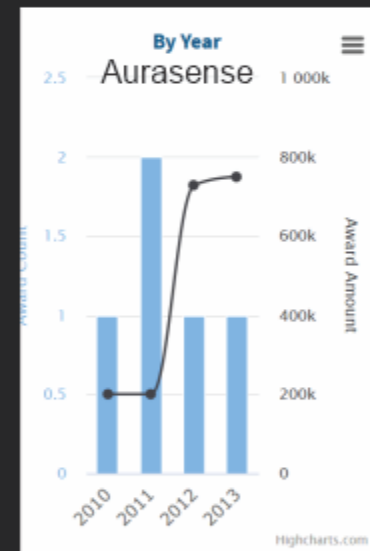
Application US12/526,560 events

2007-02-09 · Priority to US90064807P

2008-02-11 · Application filed by Northwestern University



Department of Defense
Department of Health and Human Services



www.prnewswire.com > news-releases > aurasense-thera...

[AuraSense Therapeutics Completes \\$13.6 Million Series C ...](#)

17 Jun 2014 - PRNewswire/ - **AuraSense** Therapeutics, a Chicago-based biopharmaceutical company commercializing spherical nucleic acid (SNA™) ...

www.americaninno.com > Chicagoinno >

[AuraSense Raises \\$18 Million Series C - AmericanInno](#)

6 Feb 2015 - Biotech Startup **AuraSense**, Backed by Bill Gates and Google's Eric ... The company has raised more than \$27 million since it launched in 2009 ...

www.fiercebiotech.com > biotech > exicure-bags-cash-a...

[Exicure raises \\$11.2M in cash as psoriasis, I-O assets near ...](#)

6 Nov 2017 - China's Luye Pharma led the \$11.2 million financing with support from ... That work led to the creation of **AuraSense** Therapeutics, which in ...

www.genengnews.com > ... > Gene Therapy >

[Purdue Pharma, Exicure Launch Up-to-\\$790M+ SNA](#)

12 Dec 2016 - Agreement gives **Purdue Pharma** options to develop **Exicure** AST-005, three additional targets for psoriasis and other ...

Biotech

Backed by Bill Gates, low-profile Exicure steps into spotlight with a \$42M R&D gamble

Prizes. Lots of prizes.



Centenary Prize 2015 Winner

Professor Chad Mirkin
Northwestern University

Awarded for his development of spherical nucleic acids and new nanotechnology-based tools in biomedicine and materials science

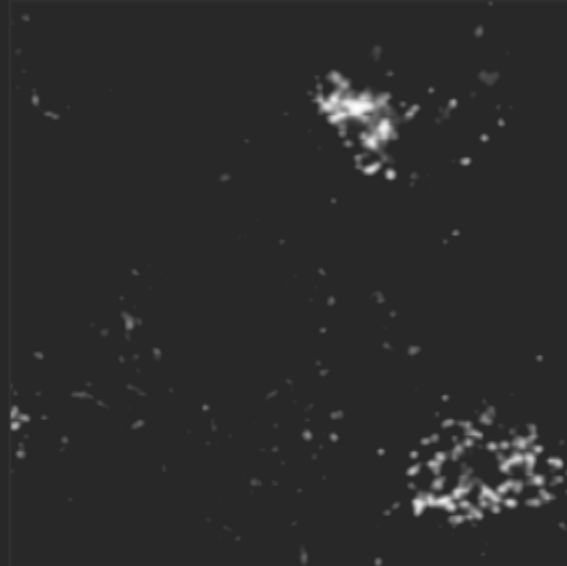
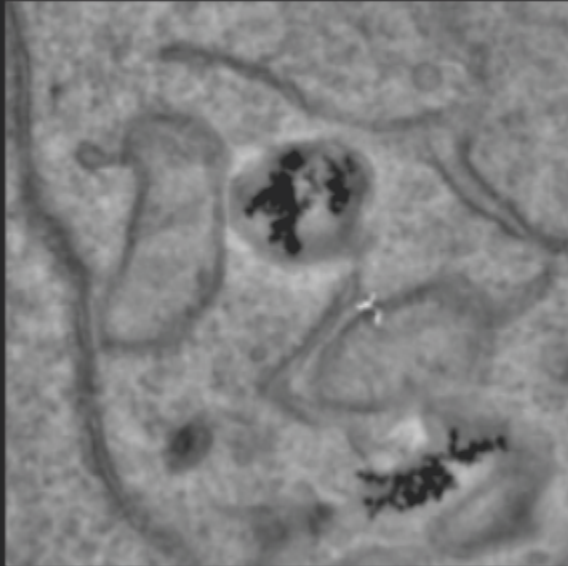


About the Winner

Chad Mirkin is the Director of the International Institute for Nanotechnology and the George B Rathmann Professor of Chemistry, Chemical and Biological Engineering, Biomedical Engineering, Materials Science and Engineering, and Medicine at Northwestern University. He is a chemist and a world-renowned nanoscience expert, who is known for his discovery and development of spherical nucleic acids (SNAs) and SNA-based biodetection and therapeutic schemes, the invention of Dip-Pen Nanolithography and related cantilever-free nanopatterning techniques, On-Wire and Co-Axial Lithography, and contributions to supramolecular chemistry and nanoparticle synthesis. He has authored over 600 manuscripts and over 900 patent applications worldwide (252 issued), and he is the founder of multiple companies, including Nanosphere, AuraSense, and AuraSense Therapeutics.

Mirkin has been recognized with over 100 national and international awards including, the ACS Nano Lectureship Award for the Americas (2014), the Linus Pauling Medal (2013), the Walston Chubb Award for Innovation (2013), the ACS Award for Creative Invention (2012) and the \$500,000 Lemelson-MIT Prize (2009). He is a Member of the President's Council of Advisors on Science & Technology (Obama Administration), and he is the only chemist to be elected to

Spherical nucleic acids do not detect mRNA; case study #1 (Liverpool, UK)



“Our results indicate that SNAs [...] cannot be used to report on mRNA levels in live cells. [...] Once taken up we consistently observe a punctate distribution indicating retention within vesicular compartments. This was confirmed by electron microscopy and photothermal imaging. Furthermore, the controls (the scrambled and constitutively-fluorescent uptake control) showed similar levels of fluorescence.”

2015

Spherical nucleic acids do not detect mRNA; case study #2

(former manager of cell-based assays at EMD Millipore)

Is it somebody else's problem to correct errors (or worse) in the scientific literature?

I spent 8 months doing applications development on Smartflare and found zero evidence that it recognizes the targeted mRNAs. [...] I was hoping that they would take it off the market but they keep going due to the few publications showing positive results.



Luke Armstrong

It wasn't Luke's job.

2015

Spherical nucleic acids do not detect mRNA; case study #4 (Kraków, Poland)

Is it somebody else's problem to correct errors (or worse) in the scientific literature?

We report a total lack of correlation between fluorescence intensities of SmartFlare probes and the levels of corresponding RNAs assessed by RT-qPCR. To ensure strong differences in the levels of analysed RNAs, their expression was modified via: (i) HMOX1-knockdown generated by CRISPR-Cas9 genome editing, (ii) hemin-mediated stimulation of HMOX1- and IL1 β -mediated stimulation of IL6- and PTGS2 transcription, (iii) lentiviral vector-mediated Nrg1 overexpression.



For Maria & Joanna, it was important to do it.

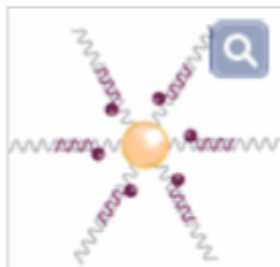
Article | [Open Access](#) | Published: 15 September 2017

SmartFlares fail to reflect their target transcripts levels

Maria Czarnek & Joanna Bereta 

2017

Spherical nucleic acids do not detect mRNA; case study #6



Compare

SF-913 | SOX2; Human, Cyanine5 RNA Detection Probe | SmartFlare

With **SmartFlare™** RNA Detection probes, you can detect RNA in live cells. With an overnight incubation of SOX2; Human, Cyanine5 RNA Detection Probe you can detect the presence of SOX2 within your cells [More >>](#)

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2018



256th American Chemical Society (ACS) National Meeting & Exposition



“In science, we need to share the bad news as well as the good news. In your introduction you mentioned four clinical trials. One of them has reported. It showed no efficacy and Purdue Pharma which was supposed to develop the drug decided not to pursue further. You also said that 1600 forms of NanoFlares were commercially available. This is not true anymore as the distributor has pulled the product because it does not work. Finally, I have a question: what is the percentage of nanoparticles that escape the endosome..”



Home / News & Opinion

RNA Detection Tool Debate Flares Up at ACS Meeting

Researchers have flagged several issues with so-called SmartFlares over the years, and it's still unclear why they don't appear to work under certain circumstances.

Sep 5, 2018
KATARINA ZIMMER



At a recent American Chemical Society Meeting in Boston last month, an ongoing disagreement over a particular tool for detecting and visualizing RNA in living cells, called SmartFlares, reached a fever pitch. At one point, [Chad Mirkin](#), a chemist at Northwestern University who [helped develop](#) the technique, called outspoken critic [Raphael Levy](#), a biochemist at the University of Liverpool, a “scientific terrorist.”

ABOVE: © ISTOCK, ERANICLE

“SNAs will dramatically expand the field of nucleic acid medicines and allow Exicure to develop drugs that impact diseases localized in tissues conventional nucleic acids won't enter, including the skin, eye, lung, ear”



Market Summary > Exicure Inc

1.76 USD

+ Follow

-125.74 (-98.62%) ↓ all time

Sep 1, 11:46 EDT • Disclaimer

1D | 5D | 1M | 6M | YTD | 1Y | 5Y | Max



Open	1.78	Mkt cap	8.73M	52-wk high	43.50
High	1.81	P/E ratio	-	52-wk low	1.49
Low	1.72	Div yield	-		

“on November 9, 2021, the Audit Committee of our Board of Directors was notified of a claim made by a former Company senior researcher regarding alleged improprieties that researcher claims to have committed with respect to our XCUR-FXN preclinical program for the treatment of Friedreich’s ataxia.”

In the spherical nucleic acid controversy, did science “self-correct”?

Second attempt at “correcting science”: the spherical nucleic acid controversy

2006

2013

Commercialization of SNAs (SmartFlares) to detect mRNAs



2014

2015

Publication (by us) of *The spherical nucleic acids mRNA detection paradox*; Confirmation from an ex-application development specialist that the SmartFlares do not work

2016

2017

Publication (by Czarnek and Bereta) of *SmartFlares fail to reflect their target transcripts levels* = information from another group that the SmartF

Catalogue Number	Availability
SF-913	Discontinued

2018

Commercialization stops.

Chad Mirkin calls me *a scientific terrorist* and *a scientific zealot* for asking a question about this at the ACS National meeting in Boston

The questions raised by those controversies are (mostly) not about science

2013

2014

2015

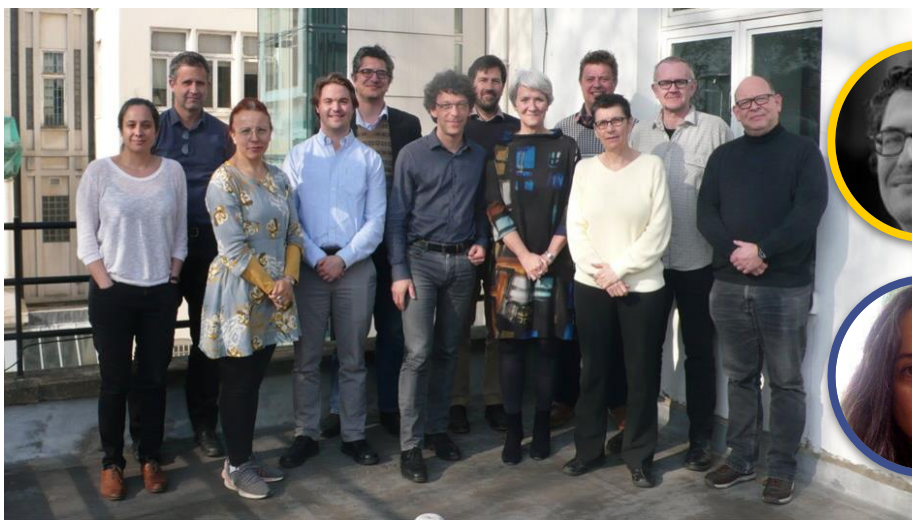


Encounter with Sociologist Marianne Noël at the 2015 ACS National meeting in Boston

2016

2017

2018



April 2019: Seed Meeting of the French Embassy in London - *NanoBubble: scientific controversies in nanoscience in the age of fake news, social media and post-publication peer review*



November 2019: NanoBubbles submitted



SCIENCES



Une affaire d'inconduite scientifique agite un laboratoire de recherche en chimie

Publications trafiquées ou simples erreurs ? Une directrice de recherche d'une unité mixte CNRS-Sorbonne Paris Nord attend le verdict de la procédure disciplinaire. « Le Monde » a enquêté sur cette affaire, qui met aussi à l'épreuve les instances scientifiques.

Par David Larousserie

Publié hier à 15h33 • Lecture 6 min

Context: the discovery

The advert for a lecturer position mentioned in the previous slide was eventually advertised. As I was the contact person for the teaching, a potential candidate asked for a meeting. This person was a research and teaching associate (ATER) in CSPBAT. I accepted to meet her. Before the meeting, I had a quick look at her publications and I found this in the first article I opened:

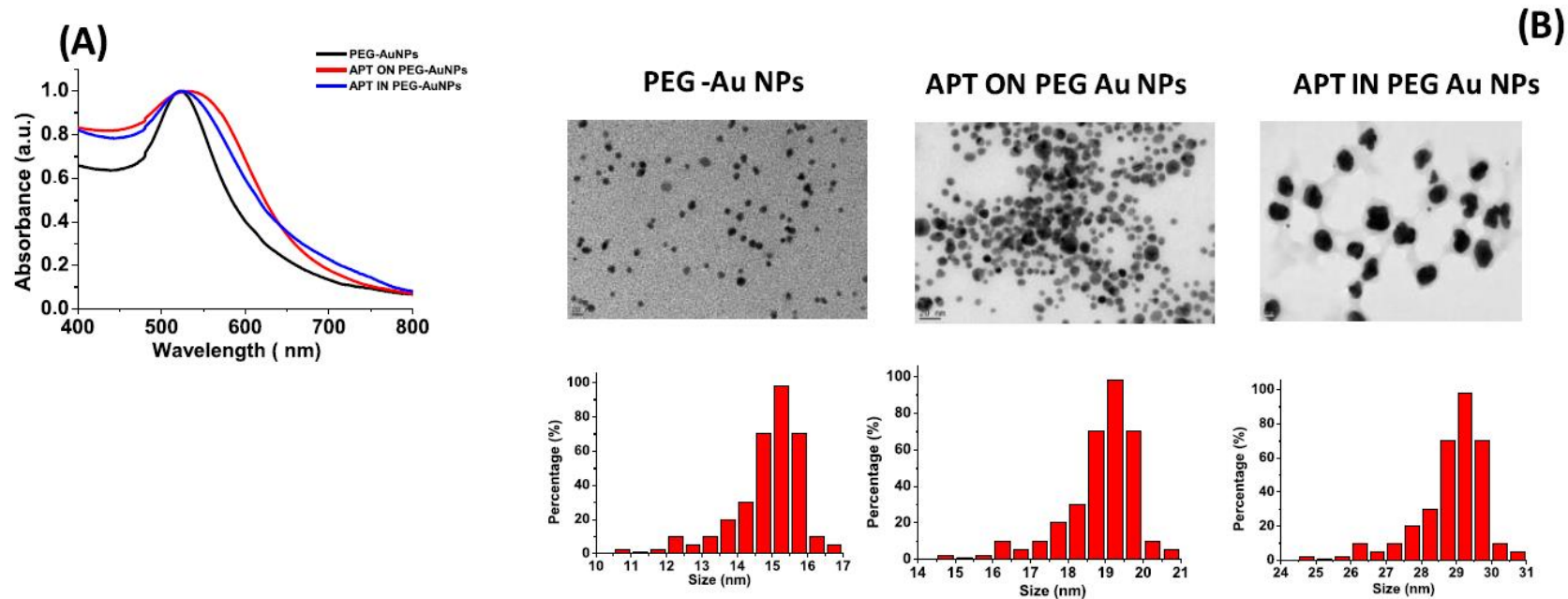
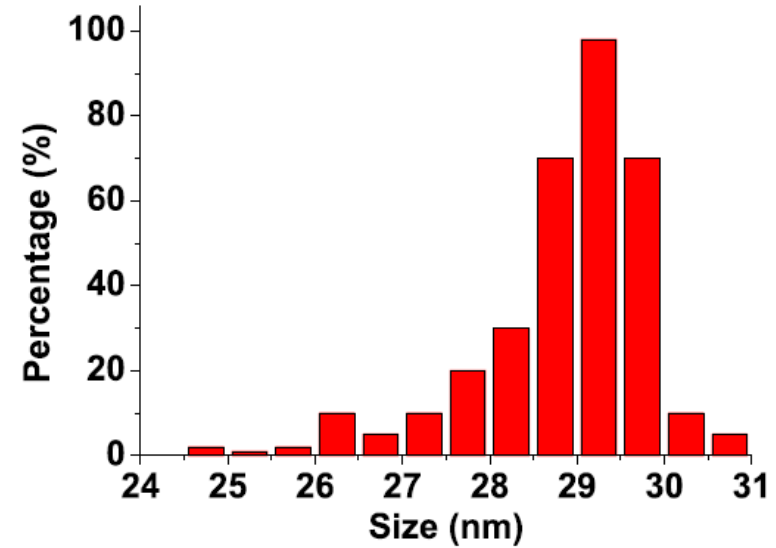
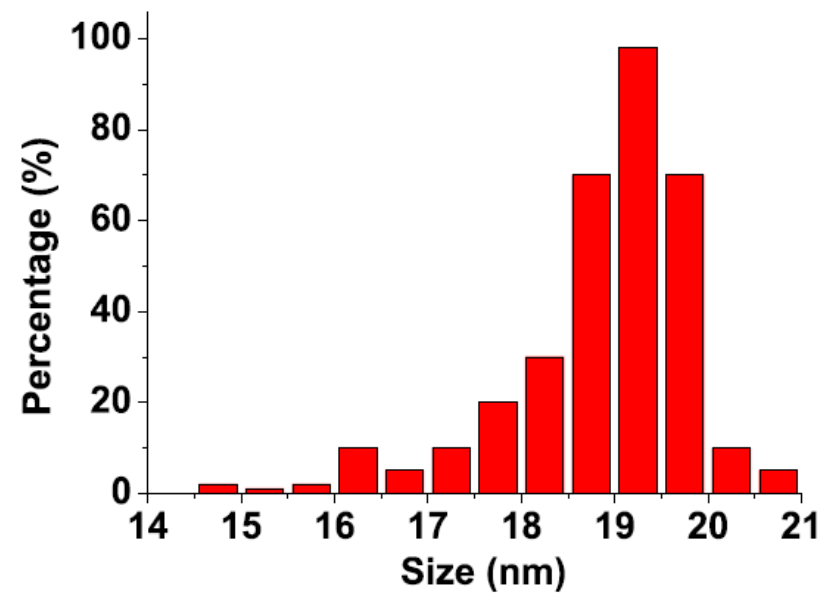
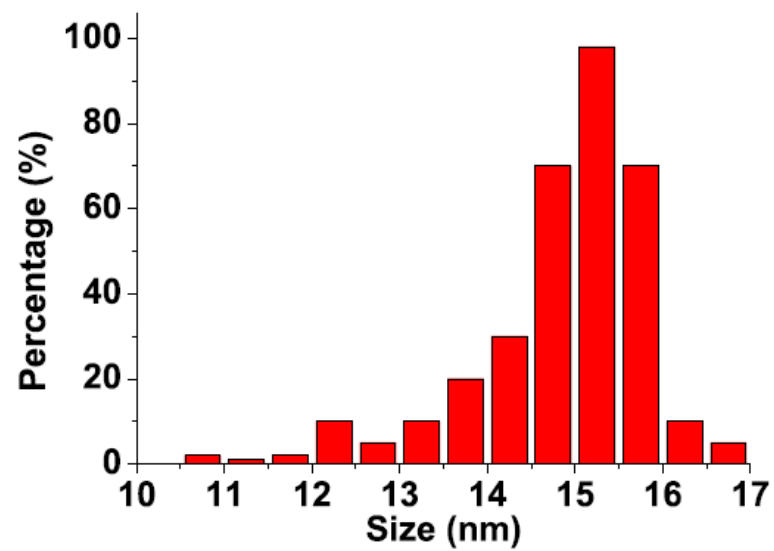
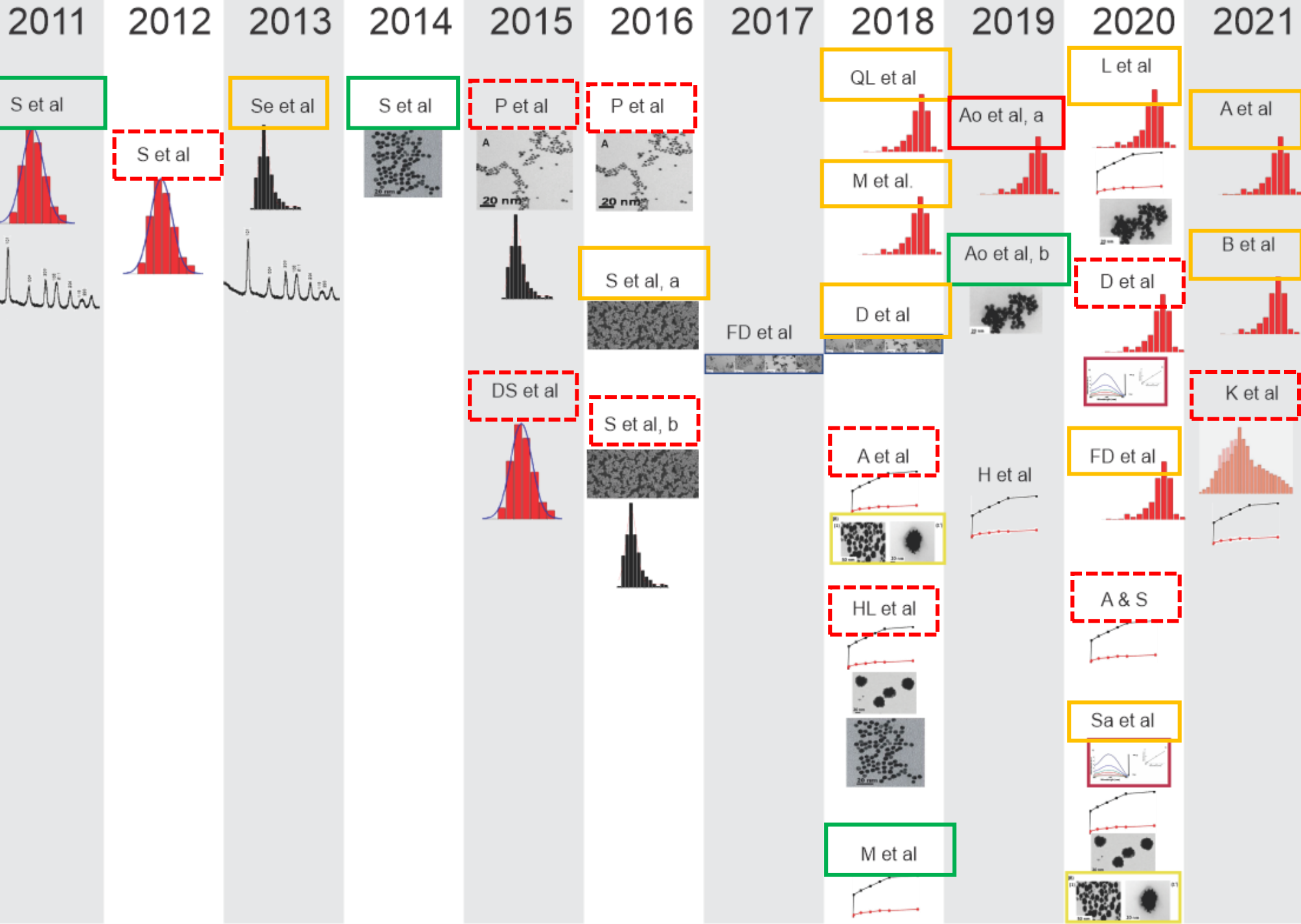


Figure 1. (A) Normalized UV-vis absorption of APT ON PEG-AuNPs (red line), APT IN PEG-AuNPs (blue line), and PEG-AuNPs (black line); (B) TEM images and size distribution of PEG-AuNPs (on the left) before and after functionalization of APT by carbodiimide chemistry (APT ON PEG-AuNPs in the middle) and chelation reaction (APT IN PEG-AuNPs on the right). Scale bars: 20 nm.



Slide updated
25/01/2023



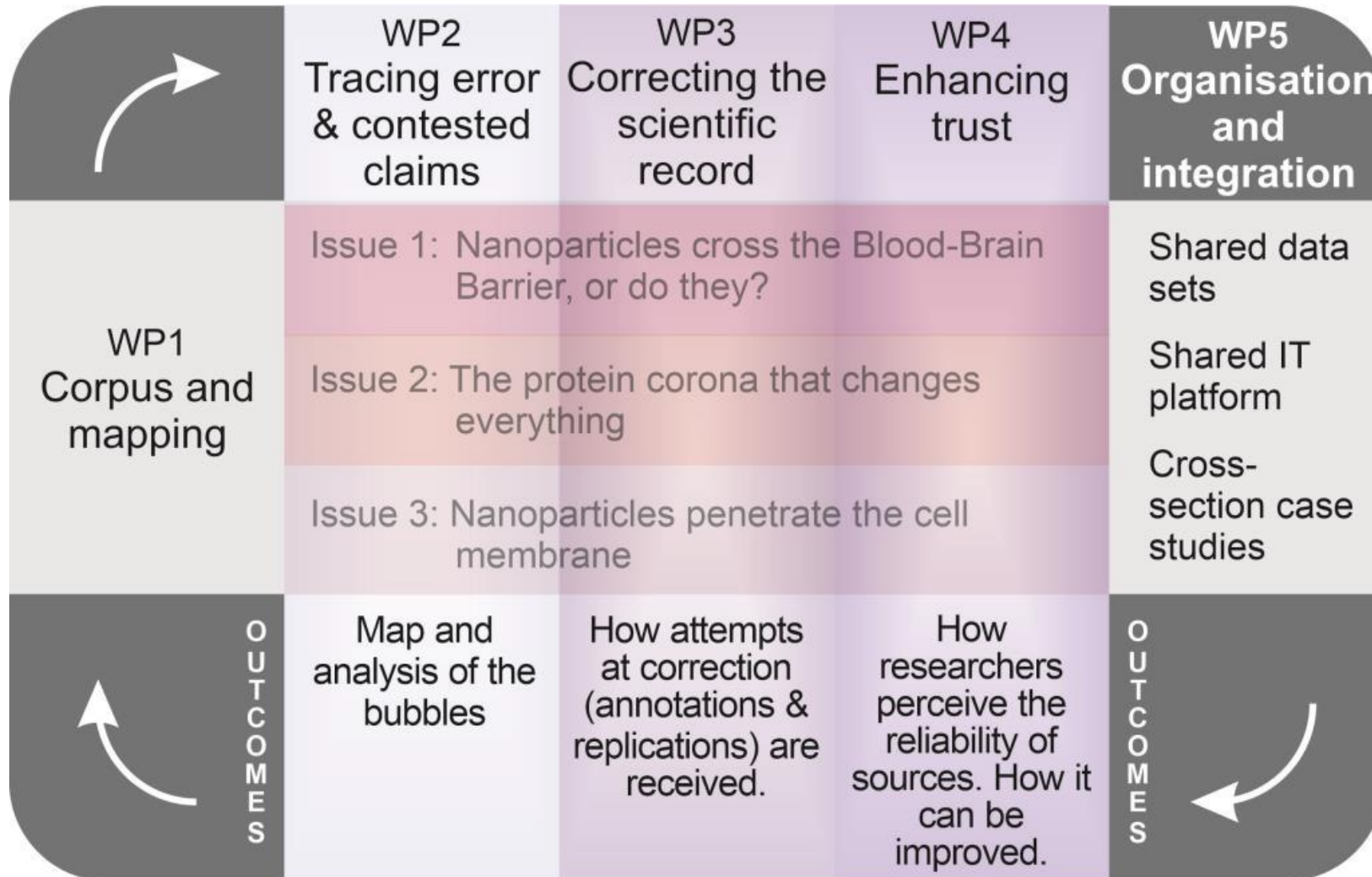
4
No
correction
needed

10
Corrected

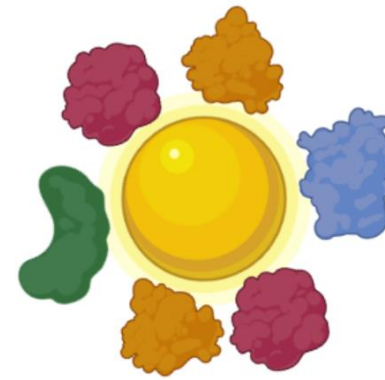
1
Retracted

10
???

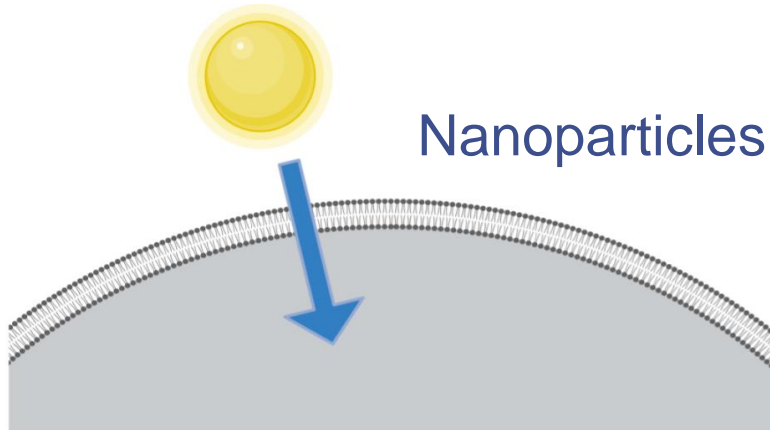
ERC Synergy project NanoBubbles : *How, when and why does science fail to correct itself?*



3 bubbles

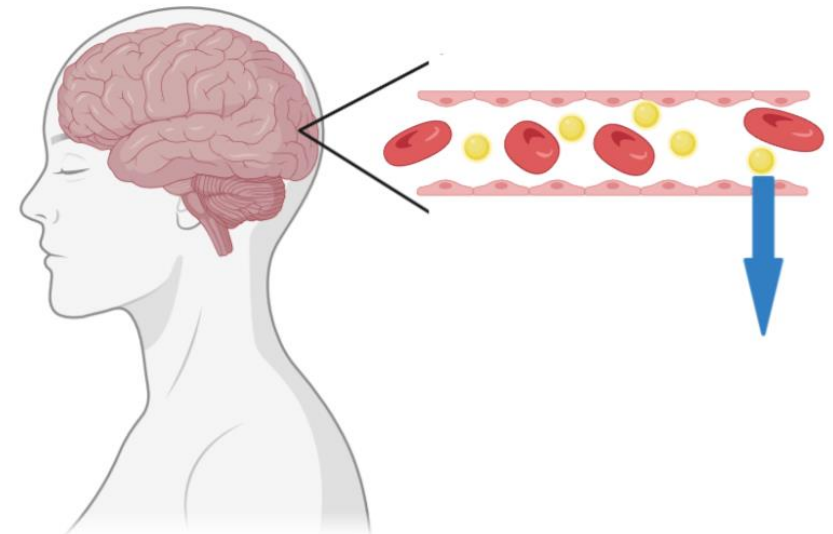


The protein corona that changes everything



Nanoparticles penetrate the cell membrane

Nanoparticles cross the Blood-Brain Barrier, or do they?



Multidisciplinary perspectives on errors and correction of science

Science and Technology Studies

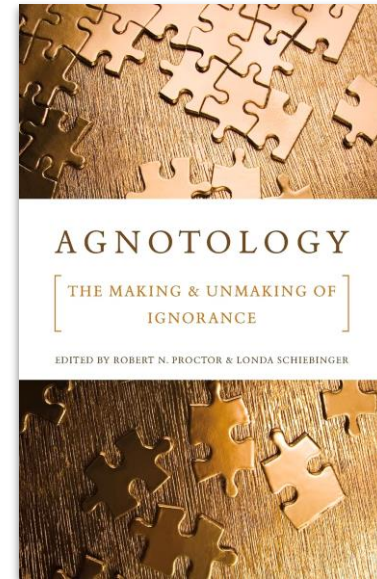
- Tacit knowledge
 - laboratories & conferences
 - ethnographic studies
- Explicit knowledge
 - journals & textbooks
 - historical, literary & quantitative/digital methods

Sociology of error

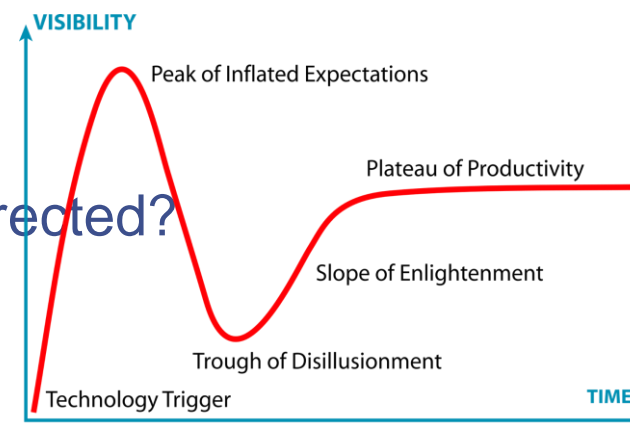
- science as a social and human activity
- redirecting the focus from individual misconduct or sloppiness to collective processes

Sociology of promises or expectations

- when expectations become performative
- how promises and hypes end, or are adjusted and corrected?

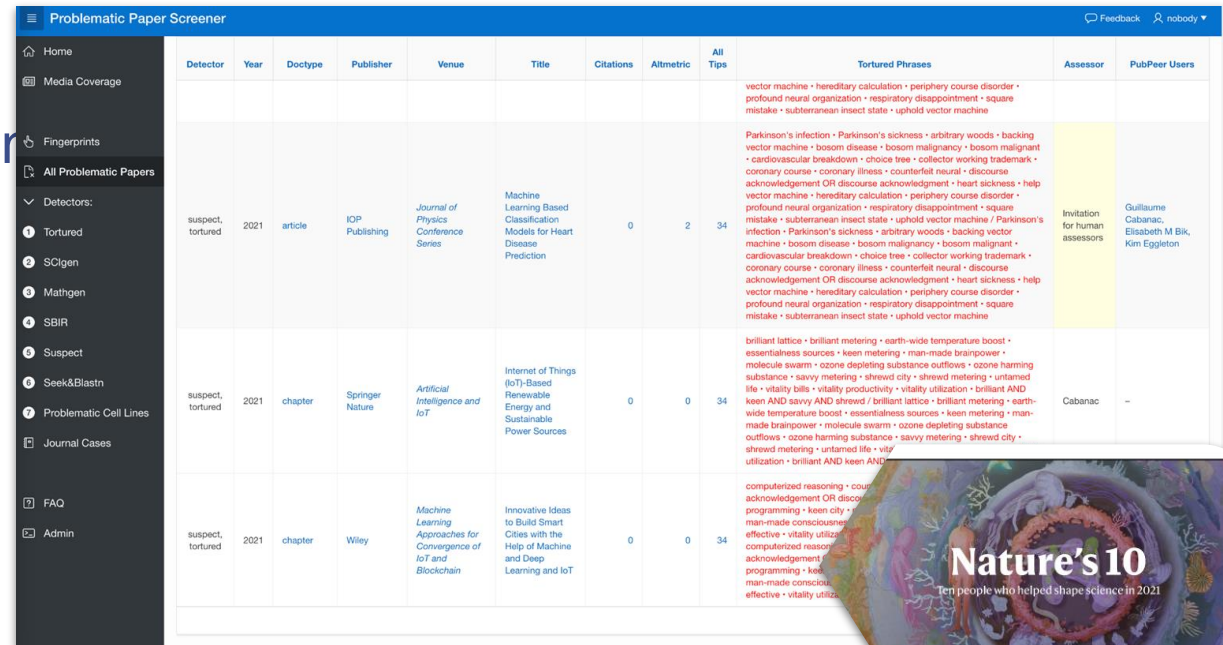


Proctor & Schiebinger.
Agnotology: The Making and
Unmaking of Ignorance.
Stanford University Press,
2008



Digital methods: scientometrics and text analysis

- large corpora
- automatic screening of scientific publications
 - to detect unreliable or odd results
- tortured phrases (colossal information/big data, counterfeit consciousness/artificial intelligence)
- automatically generated papers
- incorrect use of nucleotide sequence reagents
- to track claims and counter-claims
- to study citations
- critical citations to detect disagreement
- how claims circulate



Detector	Year	Doctype	Publisher	Venue	Title	Citations	Altmetric	All Tips	Tortured Phrases	Assessor	PubPeer Users
suspect, tortured	2021	article	IOP Publishing	Journal of Physics Conference Series	Machine Learning Based Classification Models for Heart Disease Prediction	0	2	34	vector machine • hereditary calculation • periphery course disorder • profound neural organization • respiratory disappointment • square mistake • subterranean insect state • uphold vector machine	Invitation for human assessors	Guillaume Cabanac, Elisabeth M Bik, Kim Eggleton
suspect, tortured	2021	chapter	Springer Nature	Artificial Intelligence and IoT	Internet of Things (IoT)-Based Renewable Energy and Sustainable Power Sources	0	0	34	brilliant lattice • brilliant metering • earth-wide temperature boost • essentialness sources • keen metering • man-made brainpower • molecule swarm • ozone depleting substance outflows • ozone harming substance • savvy metering • shrewd city • shrewd metering • untamed life • vitality bills • vitality productivity • vitality utilization • brilliant AND keen AND savvy AND shrewd / brilliant lattice • brilliant metering • earth-wide temperature boost • essentialness sources • keen metering • man-made brainpower • molecule swarm • ozone depleting substance outflows • ozone harming substance • savvy metering • shrewd city • shrewd metering • untamed life • vitality utilization • brilliant AND keen AND	Cabanac	-
suspect, tortured	2021	chapter	Wiley	Machine Learning Approaches for Convergence of IoT and Blockchain	Innovative Ideas to Build Smart Cities with the Help of Machine and Deep Learning and IoT	0	0	34	computerized reasoning • counter-acknowledgement OR discourse acknowledgment • keen city • man-made consciousness • effective • vitality utilization • computerized reasoning • counter-acknowledgement OR discourse acknowledgment • keen city • man-made consciousness • effective • vitality utilization		



Problematic Paper Screener

<https://www.irit.fr/~Guillaume.Cabanac/problematic-paper-screener/>

Ethical aims require ethical reflection

Aim: ensure good, rigorous science through effective methods of correction

Requires: rigorous and transparent ethical approaches and procedures



Image: Qwedgeonline 'Tight Rope' [URL](#)

No over-stretched claims!

THIS IS US

Node color =
PI official attachment

Edge =
shared research topic

Post-publication peer review
Correction practices
Claims and hype
Conferences
Replication ...



PubPeer



European Research Council
Established by the European Commission



This presentation is part of the project **NanoBubbles: how, when and why does science fail to correct itself?** that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme.

Grant agreement number ID: 951393

Thanks!

<https://nanobubbles.hypotheses.org>

[@ Nano Bubbles](#)

