

# Nanoparticles in Water

## What's Coming Down the Pipe?

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# Nanotechnology 101

**I have no idea what you're talking about...**



**...so here's a bunny with a pancake on its head.**

# Nanotechnology 101

- Engineered nanoparticles (i.e., anthropogenic)
- One axis  $\leq 100$  nm
- An enabler
- Quantum mechanics
- Novel properties (hang on, we'll get there)

# Where is it?

- Sunscreens
- Clothing
- Sports equipment
- Medical
- Agriculture
- 1,600+ nano-enabled products
- Increasingly everywhere

The bad news...



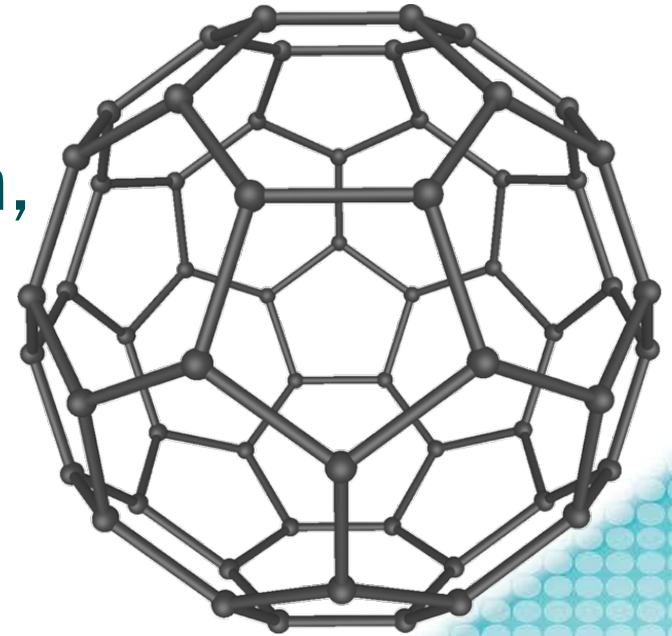
**OH, THE HUGE MANATEE!**

# (Mis)behavior

- Persistent in surface waters
- Pass through controls
- Not removed (mostly) by treatment systems
- Kill or inactivate beneficial bacteria
- Harmful effects on living organisms
- Unexpected interactions in nature

# How much?

- Hundreds of thousands of tons/year manufactured
- Releases during production, use, and disposal
- Pathways into water



# The search

- Mostly unregulated
- Could your laboratory detect in water:
  - Nanoscale silver?
  - Nanoscale titanium dioxide?
  - Carbon nanotubes or buckyballs?
- Different techniques for different characteristics
- Are you looking for it?
- Should you be?
- Is a new method needed?



# Techniques

Technique	Nano-object Parameters											
	Concentration	Size	Size Distribution	Surface Charge	Surface Area	Shape	Agglomeration	Crystallinity	Chemical Properties	Mechanical Properties	Thermal Properties	Electrical Properties
Atomic Force Microscopy		✓	✓		✓	✓	✓			✓		
Brunauer-Emmett-Teller					✓							
Condensation Particle Counter	✓				✓							
Differential Electric Mobility Analyzing System	✓	✓	✓									
Differential Scanning Calorimetry											✓	
Dynamic Light Scattering	✓	✓	✓									
Electron Back-Scatter Diffraction								✓				
Electron Energy Loss Spectroscopy									✓			
Fluorescence Spectroscopy	✓	✓					✓		✓			
Fourier Transform Infrared Spectroscopy/Imaging									✓			
Induced Grating Method		✓	✓				✓					
Inductively Coupled Plasma – Mass Spectrometry and Single Particle ICP-MS	✓	✓	✓				✓		✓			

Now, the good news



# Now, the good news

- Groundwater remediation
- Kill or inactivate bacteria (sound familiar?)
- Imaging enhancement
- Filter technology
- Efficient fertilizer delivery
- Field devices
- Decreased sample size and prep time

# Questions? (and thanks!)



# References

- *Are nanoparticles a threat to our drinking water?*  
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<http://ehp.niehs.nih.gov/1306574/>
- *Silver Release from Silver Nanoparticles in Natural Waters*  
<http://pubs.acs.org/doi/abs/10.1021/es304023p>
- *The Project on Emerging Nanotechnologies: Consumer Product Inventory* <http://www.nanotechproject.org/cpi/>
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- *Nanotechnology and Engineered Nanoparticles: A Primer*  
[http://shop.perkinelmer.com/Content/Manuals/GDE\\_NanotechnologyPrimer.pdf](http://shop.perkinelmer.com/Content/Manuals/GDE_NanotechnologyPrimer.pdf)
- Forthcoming nanotechnology white paper from ELSC