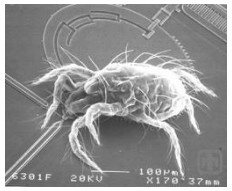
The Scale of Things – Nanometers and More

Things Natural



Dust mite

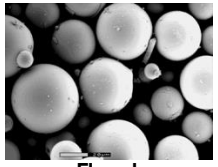
200 μm

Ant

~ 5 mm

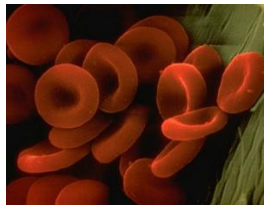
Human hair

~ 60-120 μm wide



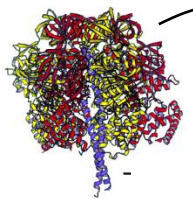
Fly ash

~ 10-20 μm

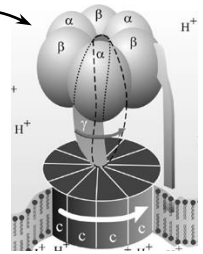


Red blood cells

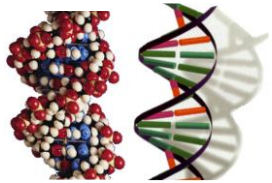
(~7-8 μm)



~10 nm diameter

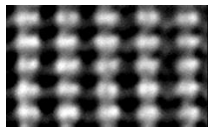


ATP synthase



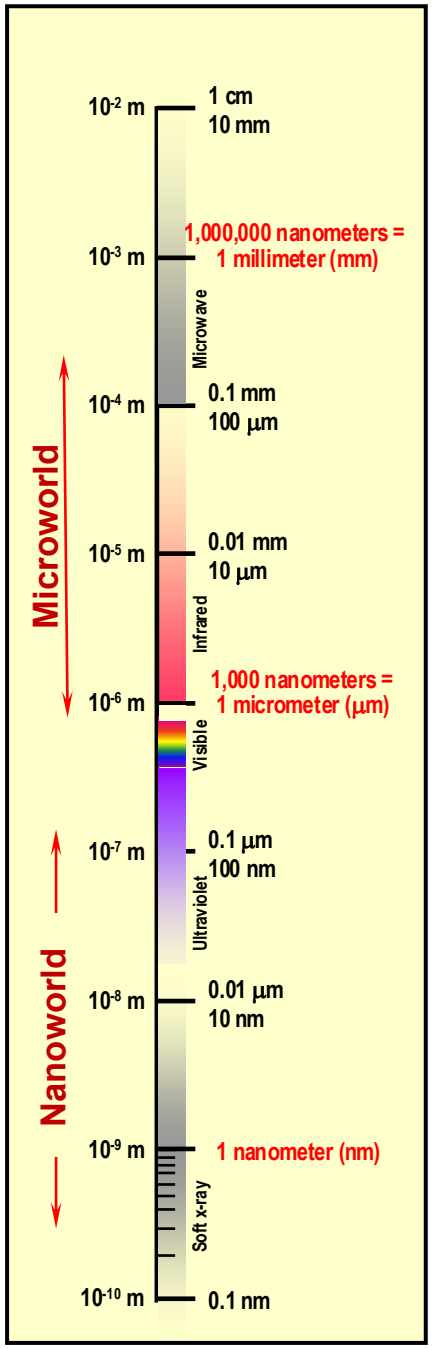
NA

n diameter

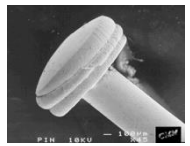


Atoms of silicon

spacing 0.078 nm

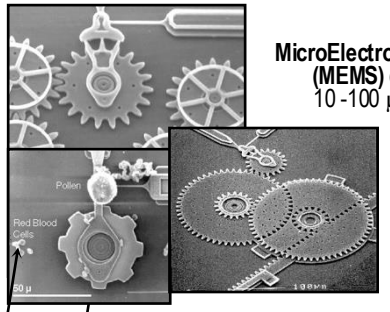


Things Manmade



Head of a pin

1-2 mm

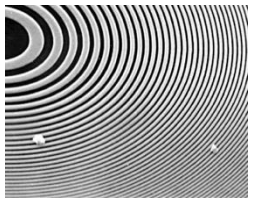


MicroElectroMechanical (MEMS) devices

10 -100 μm wide

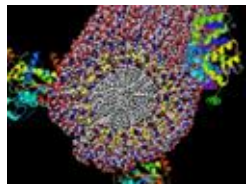
Pollen grain

Red blood cells



Zone plate x-ray "lens"

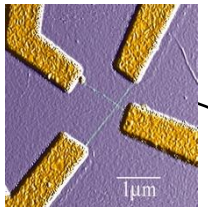
Outer ring spacing ~35 nm



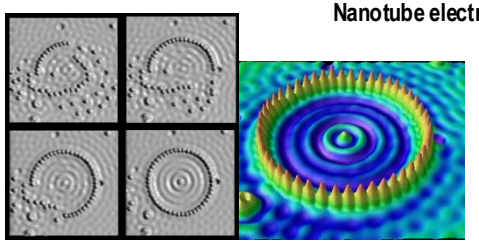
Self-assembled,

Nature-inspired structure

Many 10s of nm



Nanotube electrode



Quantum corral of 48 iron atoms on copper surface positioned one at a time with an STM tip

Corral diameter 14 nm

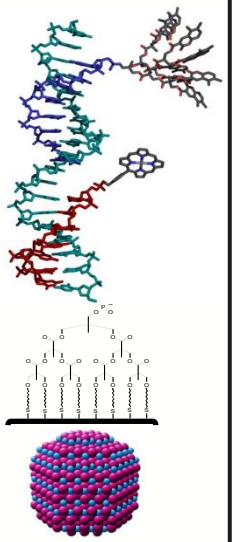
Carbon nanotube

~1.3 nm diameter

Carbon buckyball

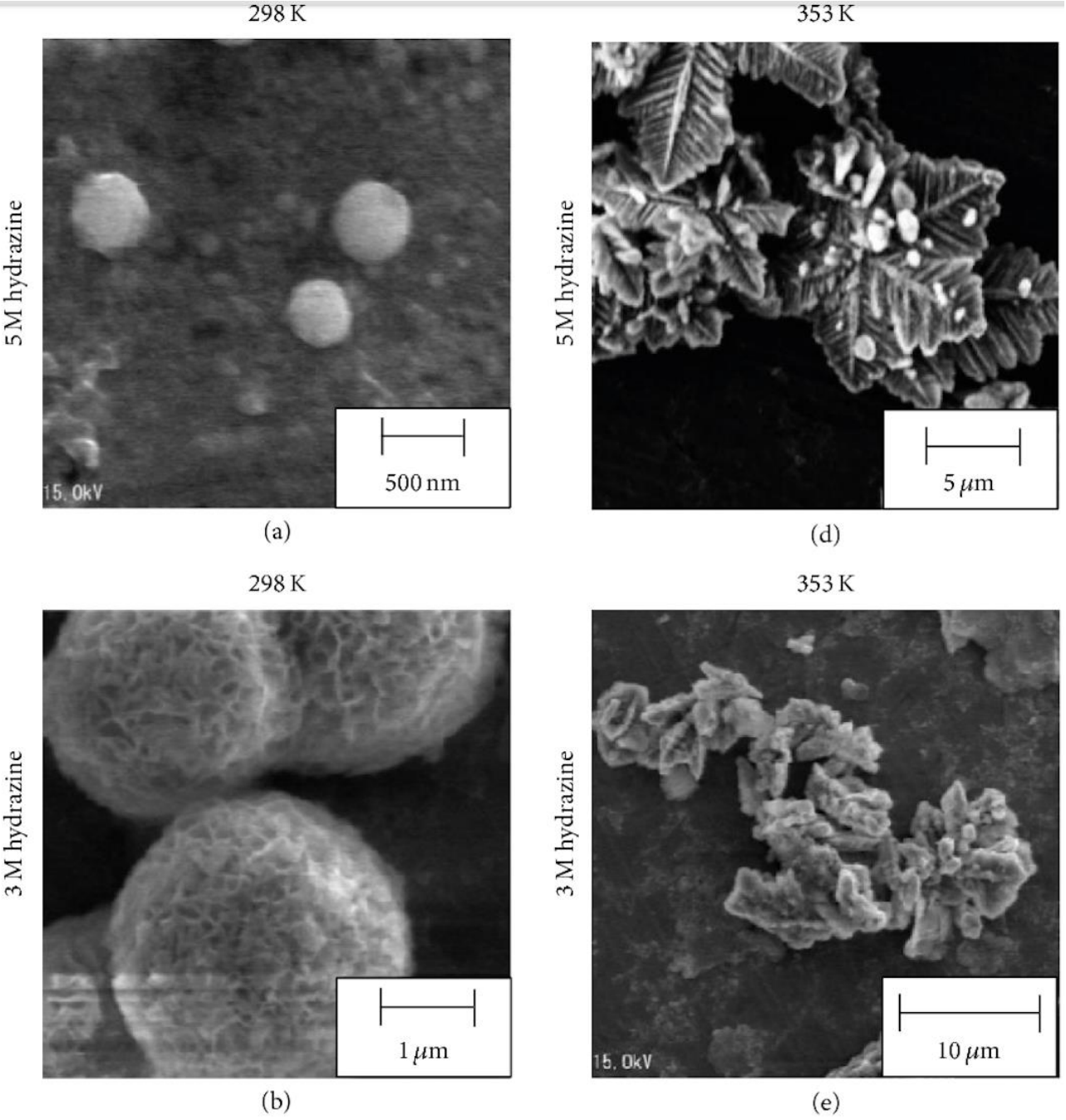
~1 nm diameter

The Challenge



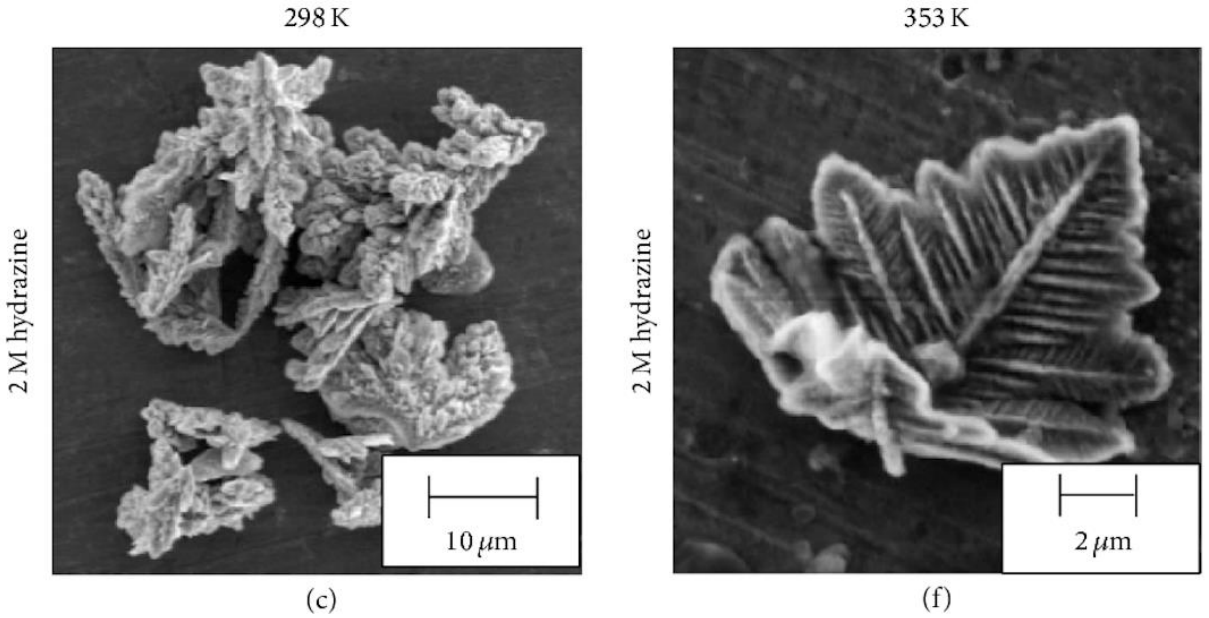
Fabricate and combine nanoscale building blocks to make useful devices, e.g., a photosynthetic reaction center with integral semiconductor storage.

Office of Basic Energy Sciences
Office of Science, U.S. DOE
Version 05-26-06.pmd



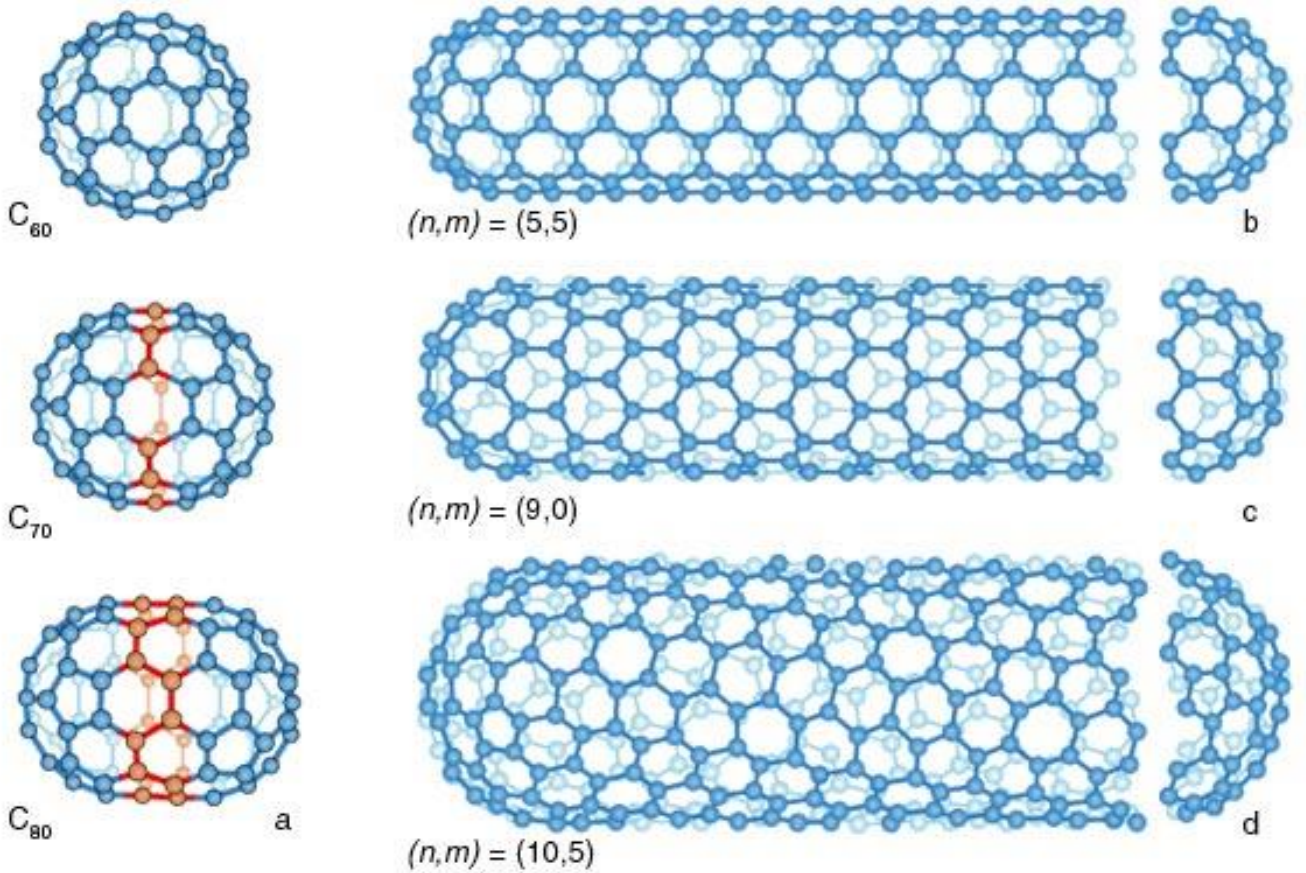
Synthesis and Characterization of Cobalt Nanoparticles Using Hydrazine and Citric Acid S. Salman, T. Usami, M. Okido

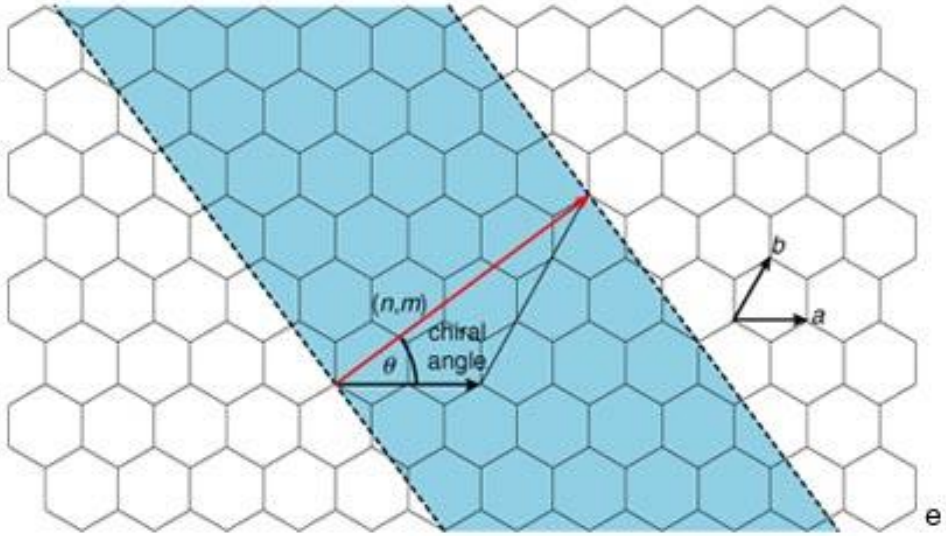
13 March 2014 *J. Nanotechnology*

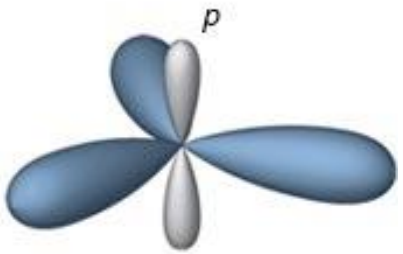


SEM images of cobalt nanoparticles produced at 298 and 353K at various hydrazine concentrations.

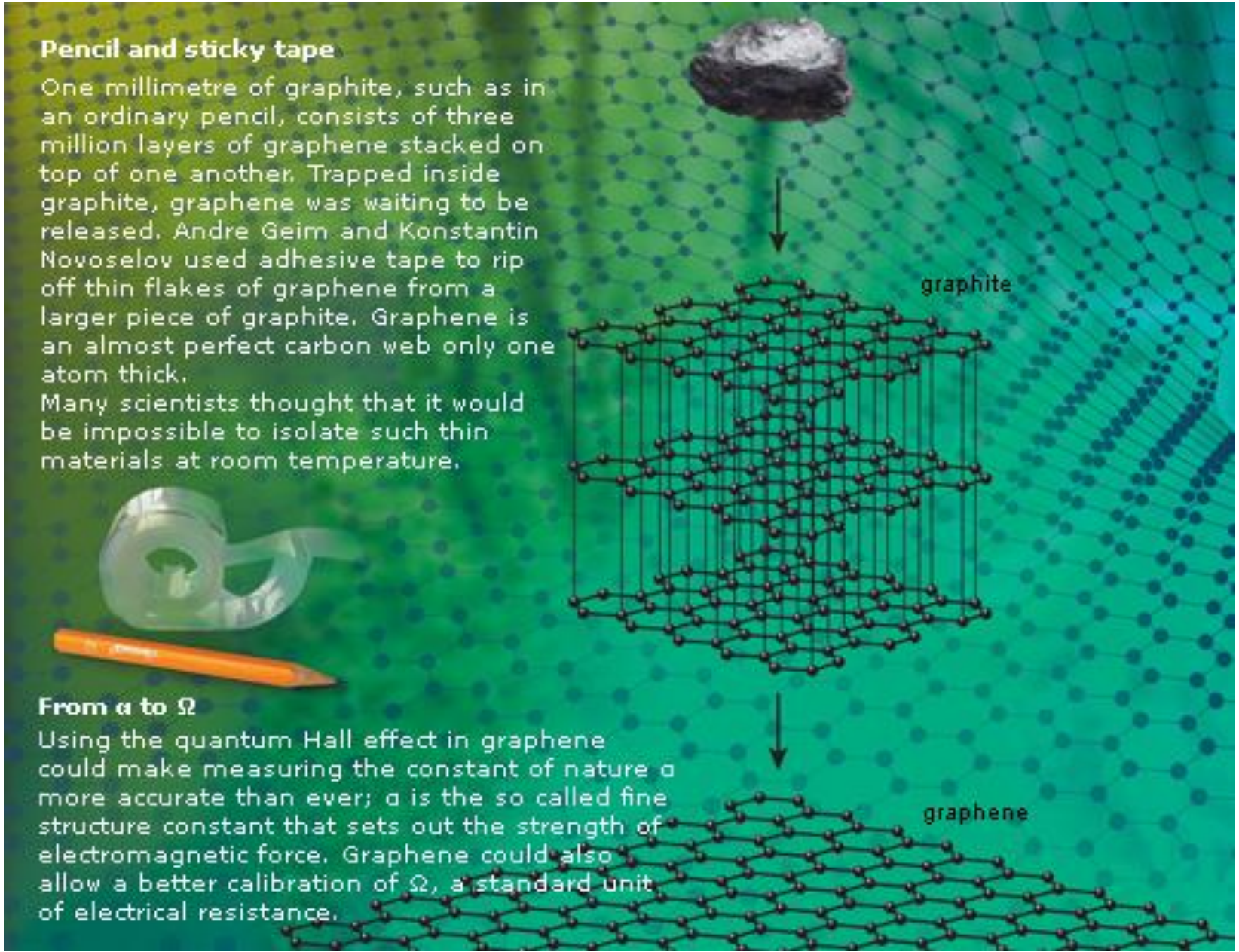
buckyballs and carbon nanotubes



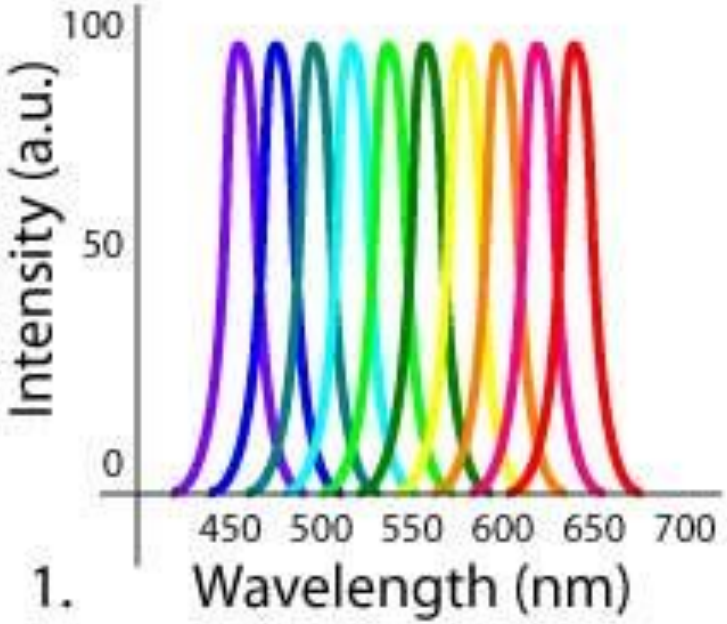


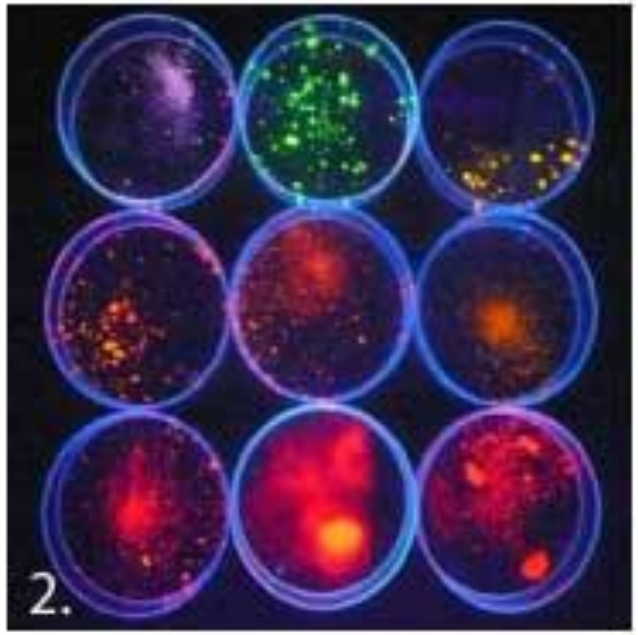


The Nobel Prize in Physics 2010 awarded to Andre Geim and Konstantin Novoselov
"for groundbreaking experiments regarding the two-dimensional material graphene"



Quantum Dots





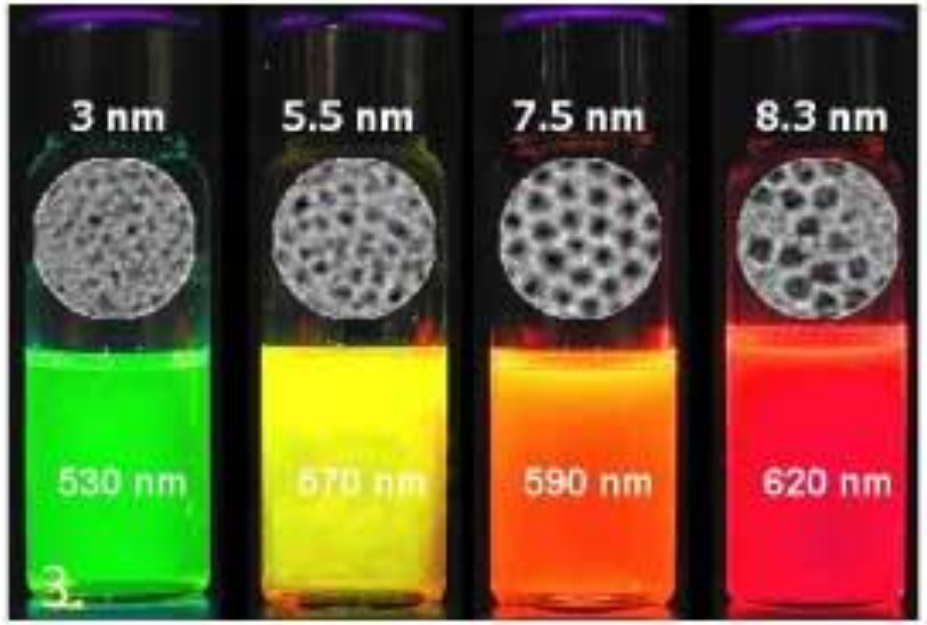


Figure1. Photoluminescence spectra of the quantum dots at wavelength of emission.
Figure2. Ocean's quantum dots in powder form.
Figure3. TEM of Ocean's quantum dots and their corresponding colors at the wavelength of emission.

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Madison, WI 53706

Research Website

Hamers Group

Research Interests

Electrode and Catalyst Development, Energy, Environmental, Functional Materials, Laser/NMR spectroscopy, Mechanism and Theory, Physical Inorganic, Biomaterials, Single-molecule, Surfaces and Interfaces, Nanomaterials and/or Nanotechnology

AFFILIATIONS

Director, Center for Sustainable Nanotechnology

Environmental Impact of Nanomaterials

Nanoscale materials have the potential to significantly advance society by improving the performance of many emerging technologies, reducing energy use, and enhancing the use of scarce resources. The rapidly increasing use of nanomaterials also raises questions about the possible environmental safety and health issues surrounding the potential release of engineered nanoparticles into the environment.

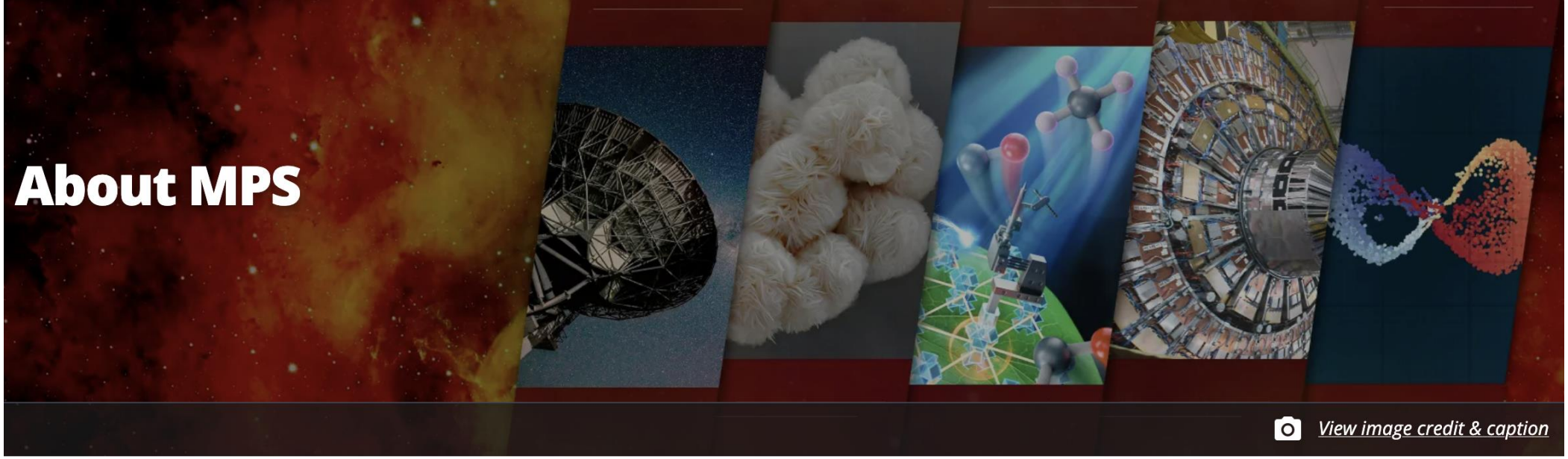
The Center for Sustainable Nanotechnology is a multidisciplinary research effort that links **UW-Madison** with 11 other universities and the **Pacific Northwest National Laboratory**, with Prof. Hamers as the overall Director. The CSN involves approximately 75 graduate students, faculty, and undergraduate students who are focused on developing a molecular-level understanding of how nanomaterials interact with the environment and its associated life forms.

Our ultimate goal is to enable the development of nano-enabled technologies in a safe and sustainable manner through a "benign by design" approach. The Hamers group's efforts center in the design and synthesis of nanomaterials with technological importance and reduced biological impact, and in the development of novel analytical methods for characterizing nanomaterials in complex materials.

The NSF Center for Sustainable Nanotechnology

A multi-institutional partnership aimed at developing a molecular-level understanding of the fundamental chemical and physical processes that govern the transformations and interactions of nanoparticles in the environment.


Empowering Discoveries and Innovation
to Transform the Future
NSF 75 YEARS OF
DISCOVERY & INNOVATION
NSF



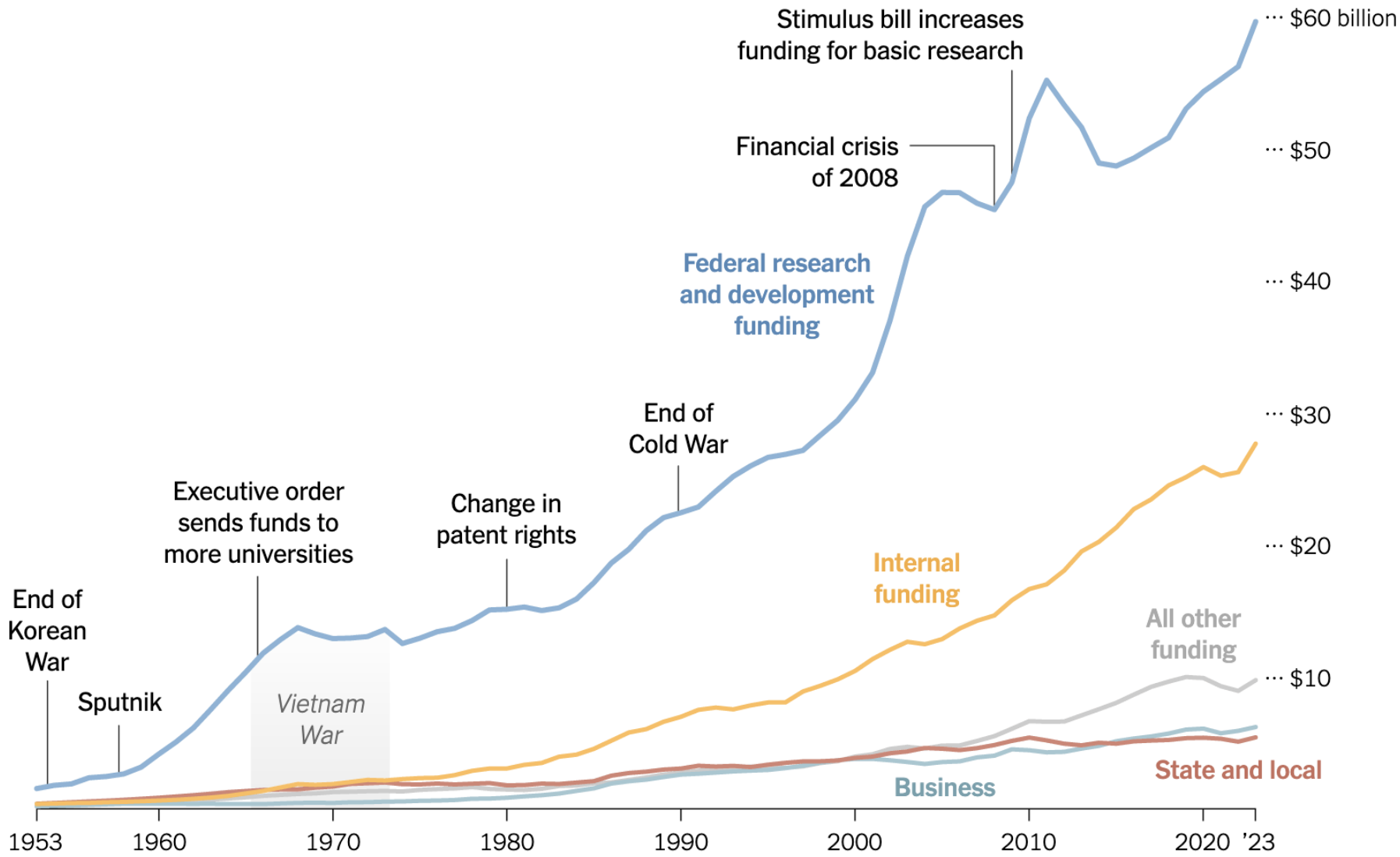
Directorate for Mathematical and Physical Sciences (MPS)

The U.S. National Science Foundation Directorate for Mathematical and Physical Sciences (MPS) enhances our nation's economic growth, security and quality of life by advancing human understanding of the fundamental nature of the universe at all scales. In addition to supporting basic science, world-class research facilities and high-tech infrastructure, MPS also aims to expand and strengthen the science, technology, engineering and mathematics (STEM) workforce by investing in a broad range of training and mentorship opportunities across the U.S.

MPS supports the fundamental science behind countless innovations that have improved our lives: From PET scans that use antimatter to reveal cancerous tumors to life-saving cardiovascular stents made of advanced materials to the atomic clocks behind your phone's GPS-based navigation. MPS harnesses the collective power of the mathematical and physical sciences communities to:

Seventy Years of University Research Funding

American universities spent $60 billion in federal money in 2023, more than 30 times what they spent in 1953, accounting for inflation.

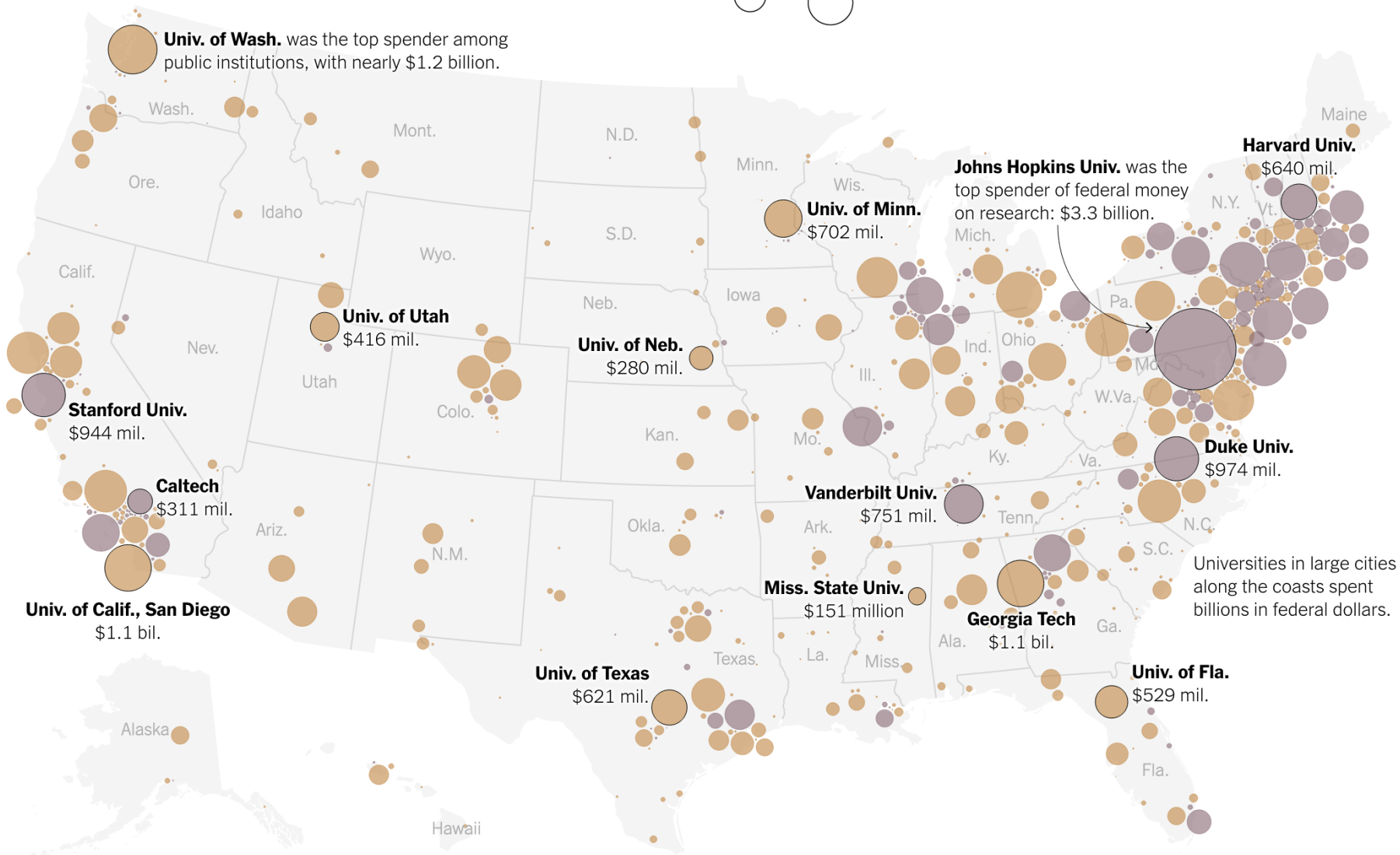


Source: National Center for Science and Engineering Statistics. Fiscal year numbers, adjusted for inflation. Numbers after 2009 include research and development funding for non-scientific fields, which represents a small amount of the total.

Federal funding for research and development in 2023

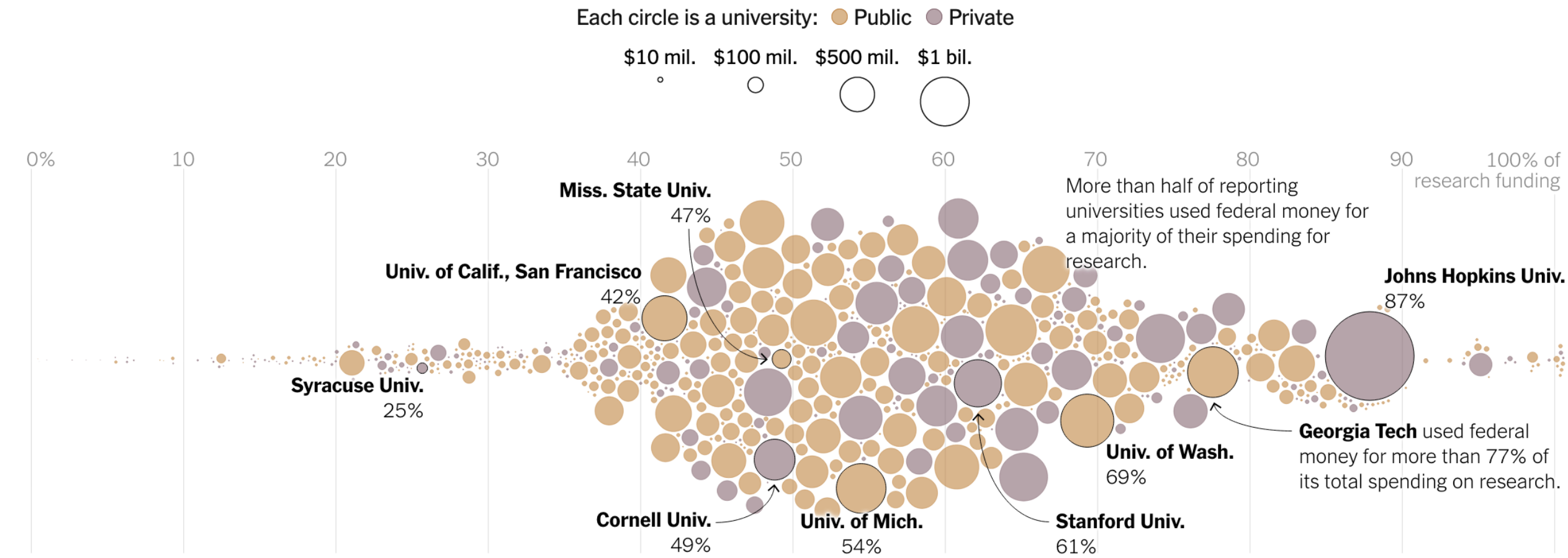
Each circle is a university: Public Private

$10 mil. $100 mil. $500 mil. $1 bil.



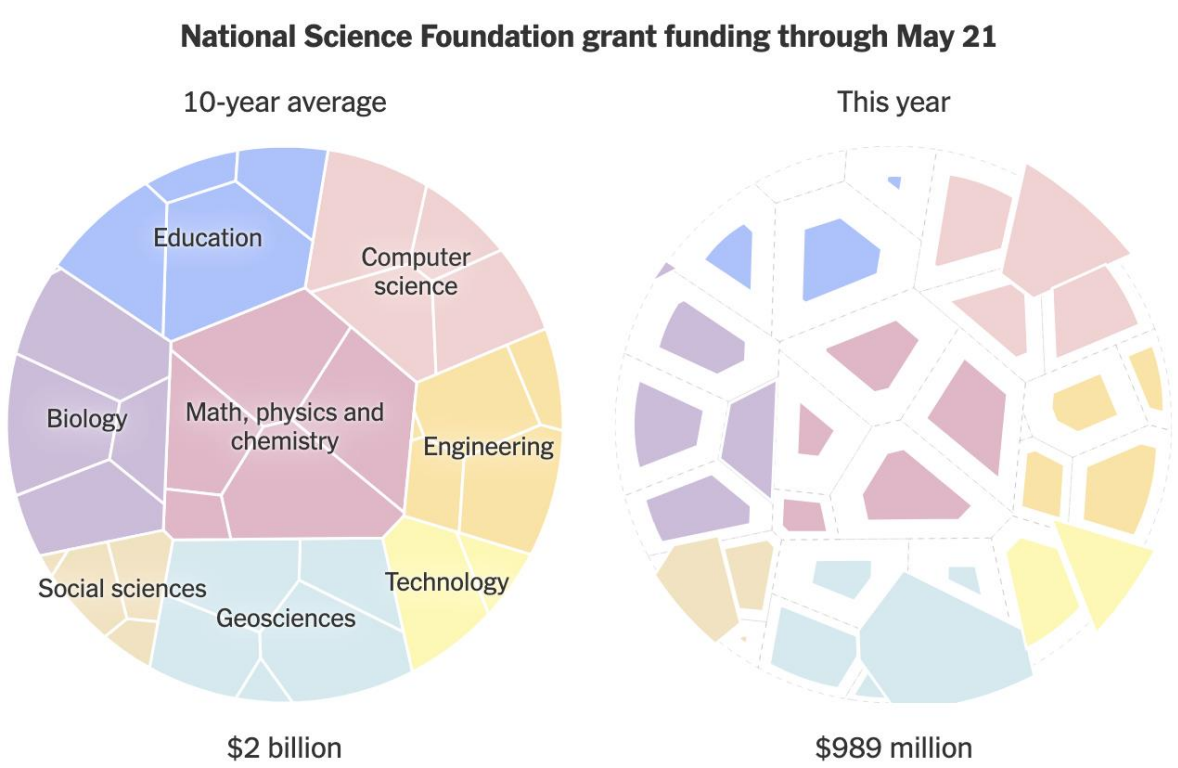
Source: National Center for Science and Engineering Statistics • Note: Numbers are for fiscal year 2023.

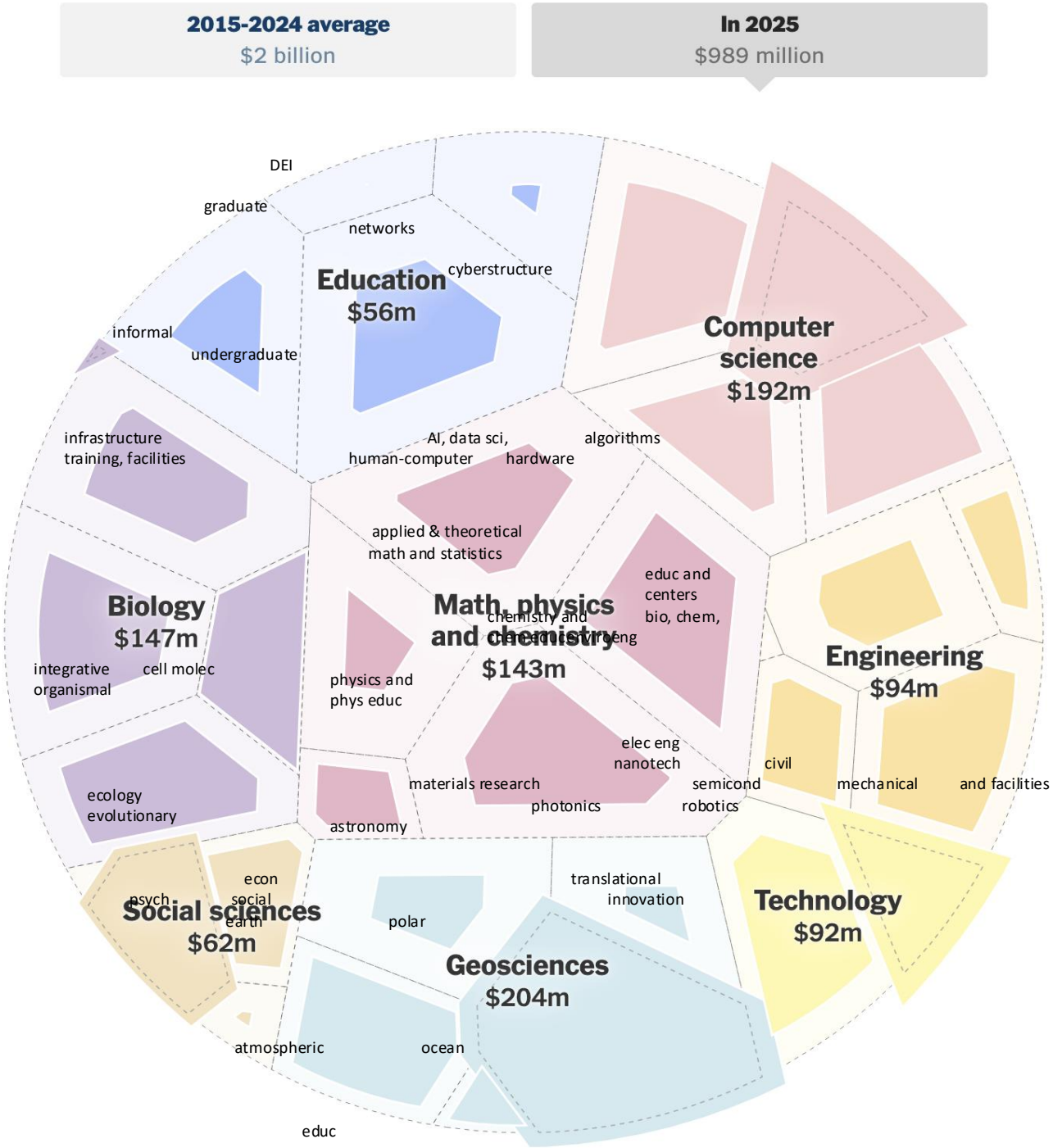
Federal funding as share of total spending for research, by university



Source: National Center for Science and Engineering Statistics • Note: Numbers are for fiscal year 2023.

May 22, 2025
cuts to NSF budget
The New York Times





The New York Times Feb. 7, 2025

Grants from the National Institutes of Health come with additional money for overhead. A planned $4 billion cut would leave colleges with large budget gaps.

The nation's universities and academic medical centers were reeling on Saturday from a directive by the Trump administration to slash funding for medical research, a decision that doctors and scientists said would have a devastating effect on studies aimed at finding treatments for diseases such as cancer, diabetes and heart disease.

The change is aimed at reducing the amount of tax dollars that universities spend on overhead costs. The National Institutes of Health, which announced the move Friday evening, said $9 billion of $35 billion — or about 26 percent — of grant dollars distributed last year had gone to overhead. The new policy, which takes effect on Monday, will cap "indirect funds" for costs like buildings, utilities and support staff at 15 percent and is aimed at saving $4 billion.

Feb. 10, 2025 Judge Temporarily Blocks Trump Cuts to Medical Research Funding

A coalition of 22 attorneys general sued the federal government, claiming that the $4 billion in cuts would "grind to a halt" studies on cancer, heart disease and other conditions.

What is overhead?

Queen’s Special U.S. Doctoral Recruitment Initiative

Queen’s University is a globally engaged, research-intensive institution dedicated to attracting and supporting exceptional PhD students who will significantly advance our research mission.

In response to recent funding cuts in the United States, Queen’s has launched the Special U.S. Doctoral Recruitment Initiative. This initiative provides support for 20 doctoral students whose offers from top U.S. schools have been rescinded or who are reconsidering their acceptance to a U.S. school for the 2025/26 academic year.

As one of Canada’s top universities, Queen’s provides a vibrant and innovative community for graduate scholarship, offering the ideal environment for doctoral students to pursue research and drive new discoveries. **Learn more about the Queen’s experience** and explore **Queen’s available programs**.

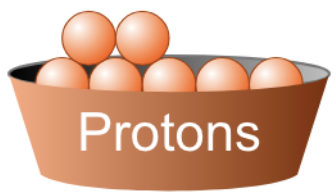
Protons:
Neutrons:
Electrons:

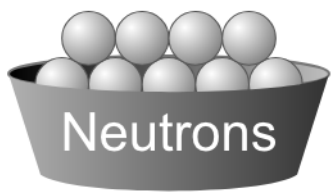
+ Ion

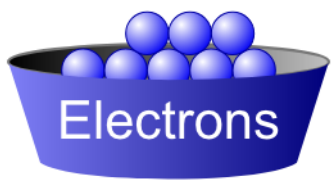
Lithium

Model:

- (•) Orbits
- ( ) Cloud





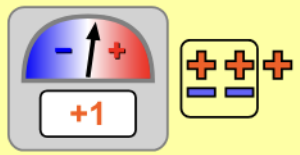


Element

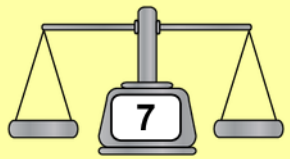
Li

H																	He
Li	Be												B	C	N	O	F	Ne
Na	Mg												Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og	

Net Charge



Mass Number



Show

- [x] Element
- [x] Neutral/Ion
- [ ] Stable/Unstable

THE CHRONICLE
OF HIGHER EDUCATION

'A MIRACLE'

These NIH Grants Were Terminated. Now They're Back.

By Stephanie M. Lee | April 29, 2025

c&en
CHEMICAL & ENGINEERING NEWS

RESEARCH FUNDING

NSF terminates over 1,000 grants in 2 weeks

Chemistry education researchers and others hit by cuts weigh appeals and lawsuits

by ***Krystal Vasquez***

May 2, 2025

White House stalls release of approved US science budgets

Nature NEWS · 27 February 2026

The US Congress rejected sweeping cuts to science agencies.
But the NIH, the NSF and NASA have had their spending slowed.

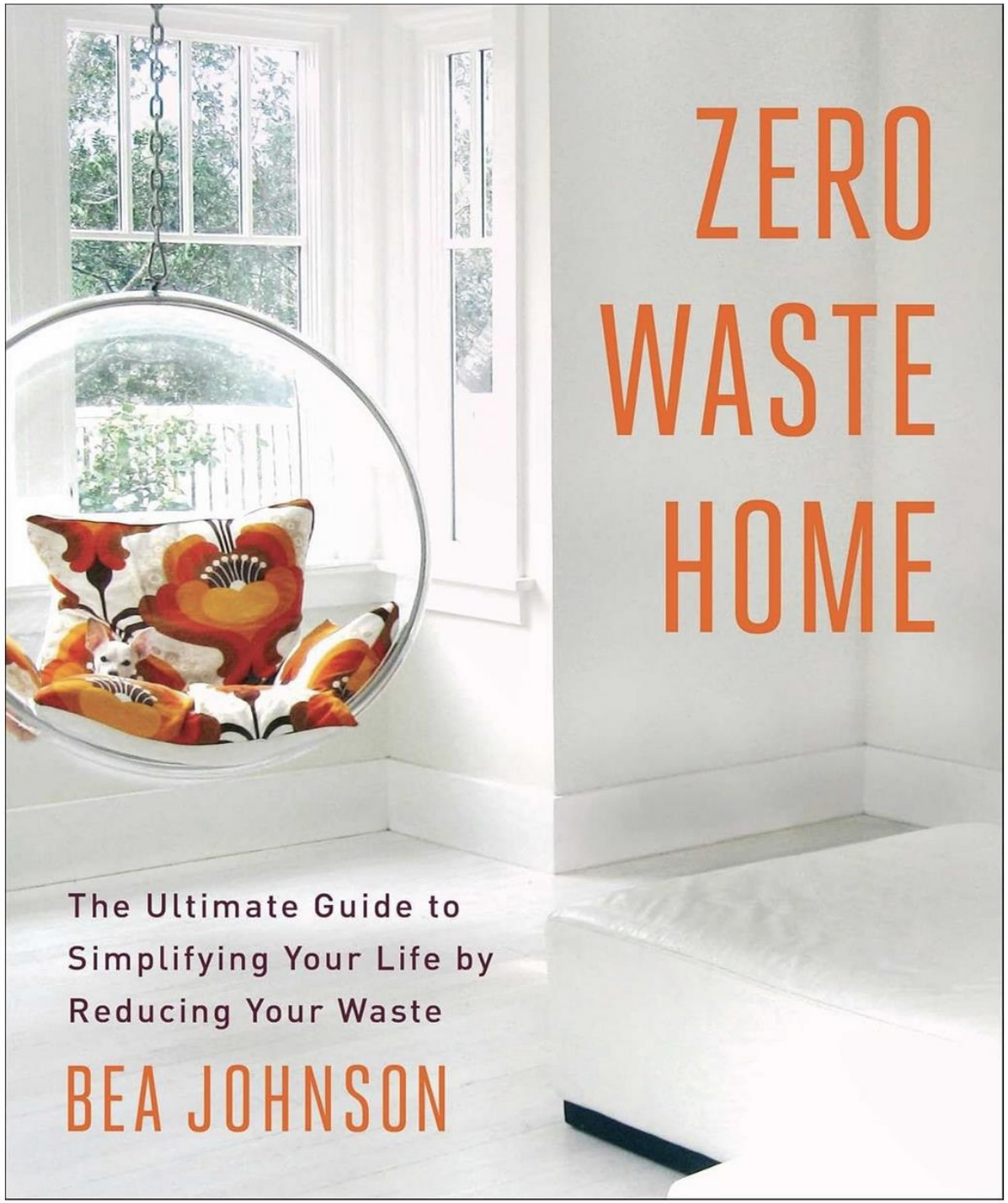
By Max Kozlov, Alexandra Witze & Dan Garisto

Weeks after the US Congress rejected unprecedented cuts to science budgets that the administration of US President Donald Trump had sought for 2026, funding to several agencies that award research grants is still not freely flowing.

April 24 Firing of National Science Board

Garbology Chapter 12
"Put-downs, Pickups and the Power of No"

The chapter describes changes one family of consumers made to benefit the environment. If we all followed their example, what social and economic impacts might result?



BEA JOHNSON'S TEN WAYS TO GET STARTED ON THE LOW-WASTE PATH

1. Bring glass jars, totes, cloth bags and cartons to the grocery store to carry food.
2. Buy in bulk. It eliminates packaging and can be more economical in the long run.
3. Refill clean empty wine bottles at local wine bottling events instead of buying new ones.
4. Use microfiber cloths instead of paper towels.
5. Make your own multipurpose cleaner out of vinegar, water and castile soap.
6. Use handkerchiefs instead of paper tissues.
7. When buying makeup products, choose a company that takes its packaging back and recycles it.
8. Only recycle paper if it's been printed on both sides. Otherwise, use the blank side for making lists or jotting down notes.
9. Use cloth napkins instead of paper napkins. That means cocktail napkins, too.
10. When packing a lunch, wrap sandwiches or other food in a cloth napkin instead of using wax paper, plastic wrap or plastic bags.

THE JUGGERY REFILL SHOP

Shop Now

Home Shop Refill About Contact

Business Closing Sale! Last day to shop is February 21st. 30% OFF EVERYTHING! No code needed! Business Closing Sale! L

A REFILL AND LOW-WASTE STORE

Shop Eco-Friendly and Locally Made Products

Offering Sustainable Options Since 2022

Featured Items

Text us

What's left in Chem 104Q2?

Monday lecture – finish Chapter 13

Tuesday labs – fill out surveys,
presentations on advanced materials / review panel
take home paintings

Wednesday – review for exam 3

Friday – exam 3