Physics Education in the Age of A.I.: Challenges, Opportunities, and Careers

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Physics and Astronomy

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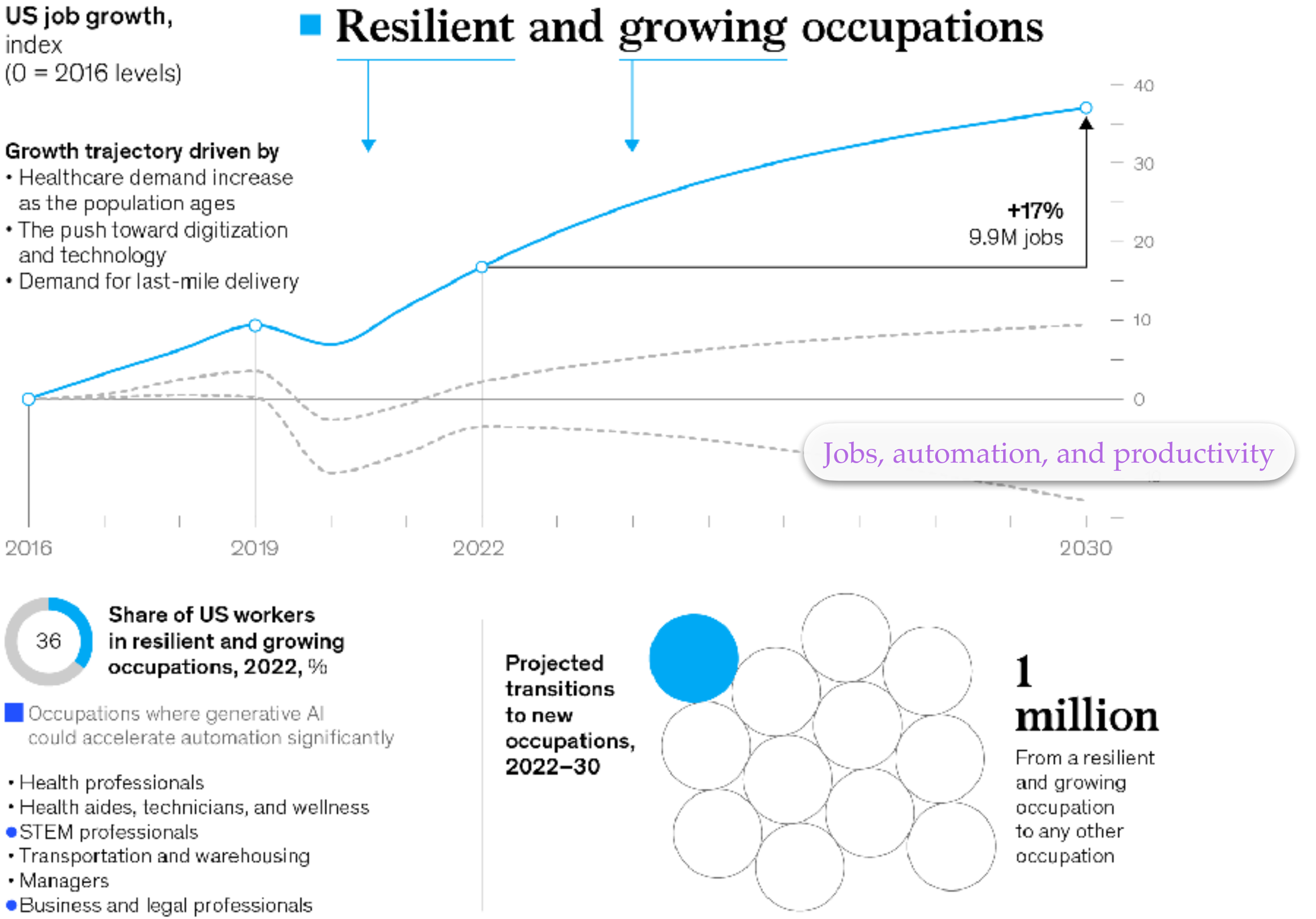
Generative AI Boosts STEM Professions



Physics Education

Your physics education prepares you in a unique way to take on virtually any job.

It is your responsibility to *be aware of career opportunities* and the necessary steps.

You learn to

- *Identify and solve problems* in an analytical, qualitative, and quantitative manner
- Articulate, present, and write scientifically to different audiences

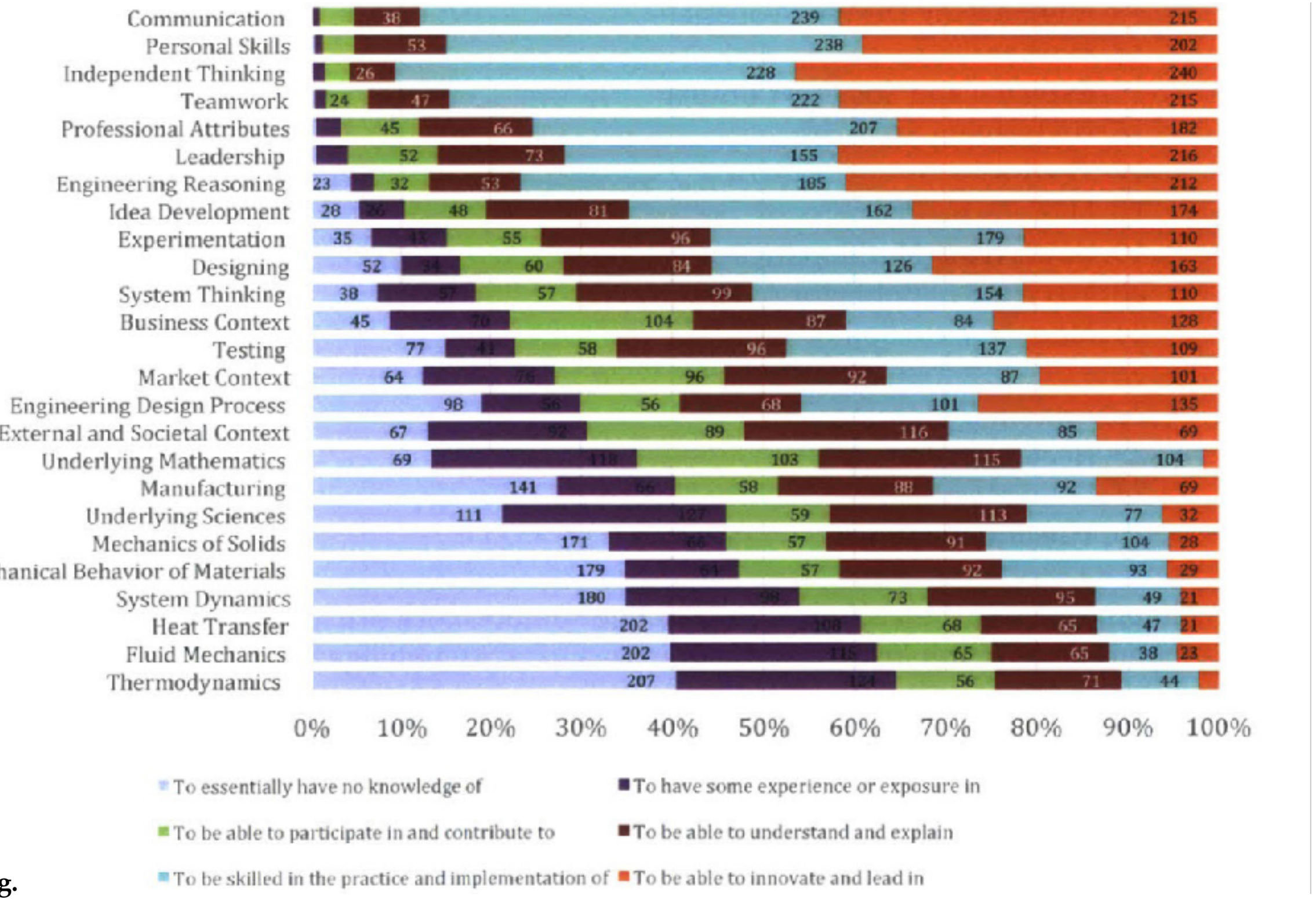
You demonstrate

Creativity Independence Productivity Perseverance

At the end of your Ph.D. and before writing your dissertation and defending, *you*—not your supervisor—*will be the expert*

- To get the job of your choice, you need several meaningful first-author papers and talks
- Duration and university do not matter (as much as you think)
- Discipline and topic do not matter

Expected Proficiency

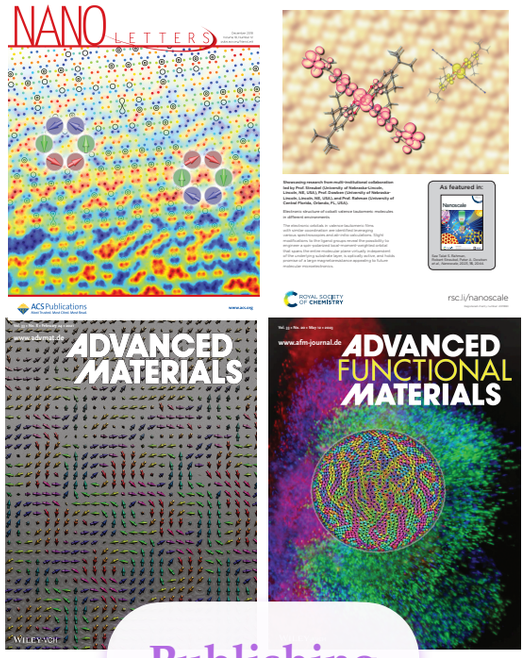


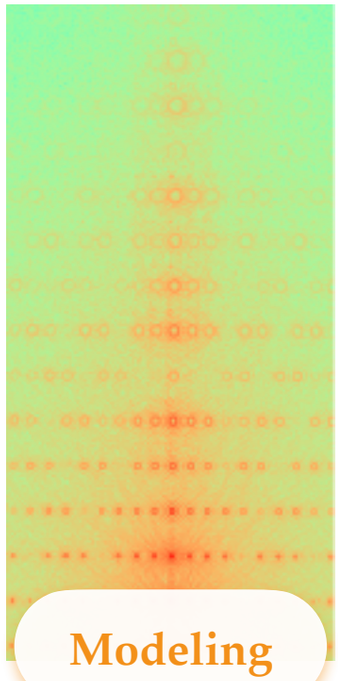
Survey:
MIT Eng.

Motivation and Aspiration

- Why do you want a Physics degree?
- Determines priorities, assigned tasks, and skills needed independent of topic

- Draw from *your own accomplishments* as undergraduate or graduate researcher





Possible Career Paths

Plan during undergraduate, graduate, and postdoctoral level of your career

Consider personal interests and funding landscape in the U.S.

Traditional

- Research scientist and technician at national labs and government agencies
- Faculty and research professor

Limited number of open positions and a lot of work

- Industry research and development

Alternate

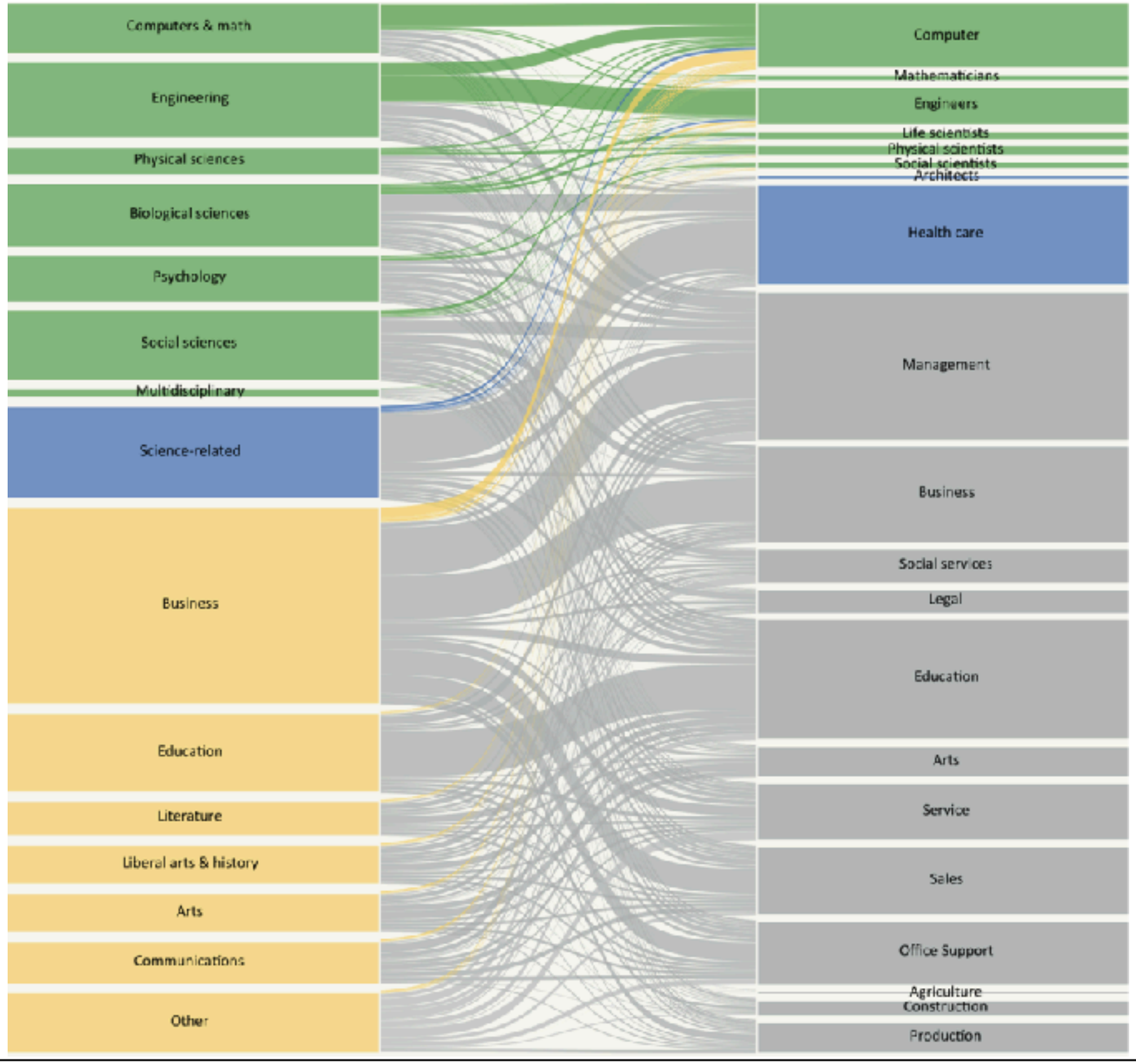
- Software engineer and developer
- Consultant in private or non-profit companies or for government
- Clerk and attorney
- Editor and program manager
- Management

- *Identify and solve problems* in an analytical, qualitative, and quantitative manner
- Articulate, present, and write scientifically to different audiences

Creativity **Independence** **Productivity** **Perseverance**

Entails project, time, and people management skills.

From College to Jobs: Pathways in STEM



FYI: Science Policy News

FYI HOME | ARTICLES | BUDGET TRACKER | BILL TRACKER | AGENCIES | ABOUT FYI

FYI Bulletin

Stay informed with our deep-dive updates.

2 to 4 emails per week

FYI This Week

Start your week with a preview of what's ahead and a recap of recent news.

Weekly - Mondays

FYI Monthly Digest

Catch up on everything FYI published in the previous month.

Monthly - Once per month

https://ww2.aip.org/fyi

Send the above selected newsletters straight to my inbox!

Your Email Address

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By signing up you agree to allow AIP to send you email newsletters. You further agree to our privacy policy and terms of service.

Policy Fellowships in Congress and White House

Everything is about money (entirely political decision—lobbying)

Science policy == budget policy

- Data, statistics, and science welcome for decision making process *as long as they serve agenda*
- Most reports will never be read or used
- Information and data from personal connections in D.C. or Library of Congress

Congressional staffer

- U.S. Senate or House of Representatives
- Assigned to committee or elected official
- Writing reports, response, and speeches (timeline: *hours to weeks*)
- Taking phone calls
- Data analysis

Similar to paper submission, revision, rebuttal

Press staffer

- White House press secretary
- Press briefings
- Write speeches for (V)POTUS
- Find issues in news, analyze statements, and draft response (timeline: *minutes to few hours*)

U.S. citizenship required to work as STPF fellow.

White House Office of Science and Technology Policy (OSTP)

Science communication and coordination on behalf of POTUS

- Provides advice to POTUS and executive branch
- Works with federal departments and agencies and with Congress to create visions, strategies, policies, and programs for science and technology
- Engages with industry, academia, philanthropists, civil society, and governments

Procedure

Policy transcends disciplines

- OSTP organizes and facilitates <-> agencies write and edit reports
- Request for information -> receive data -> analyze and set goals -> draft report -> obtain comments from public discussion (workshops) -> revise report

Open Access

National Quantum Initiative

National Nanotechnology Initiative

CHIPS and Science Act

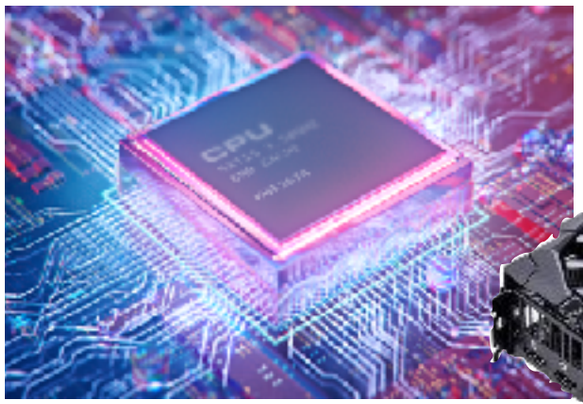
Judicial Branch: Clerking

U.S. Court of Appeals for the Federal Circuit

- Any appeal of *intellectual property lawsuits* in the U.S. are handled in D.C.
- 98% of civil litigations resolved without trial (2-10 years of litigation till trial)
- Trial roughly one year

- Clerks, i.e., assistants to Judge (no science background), are Ph.D. with science and technology education
- Review literature of precedent, patents, journals, and news
- Analyze data and draft *layman recommendation* to Judge
- Take notes during trial and litigations
- Audience: jury of uneducated individuals

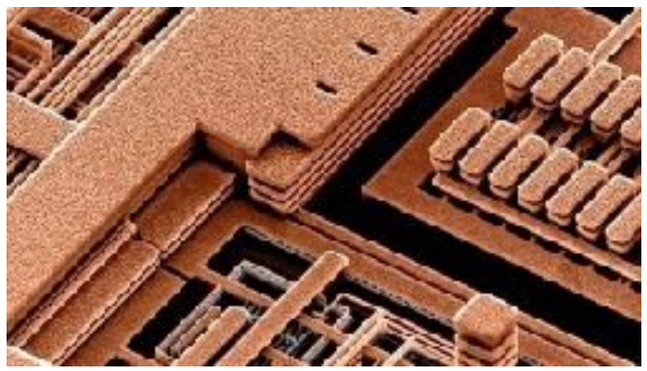
Microelectronics

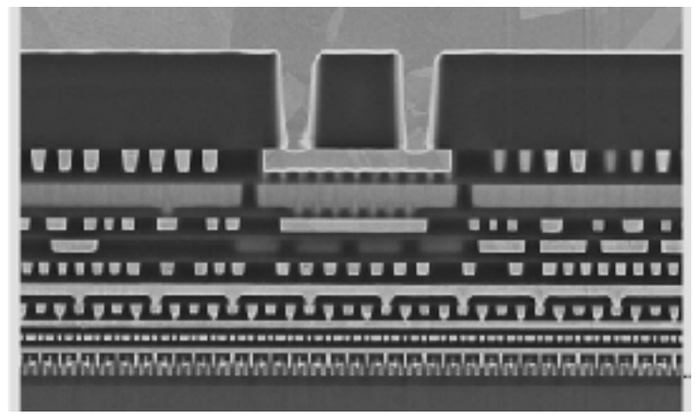


CPU [1]

GPU [2]

SEM of CPU [3]



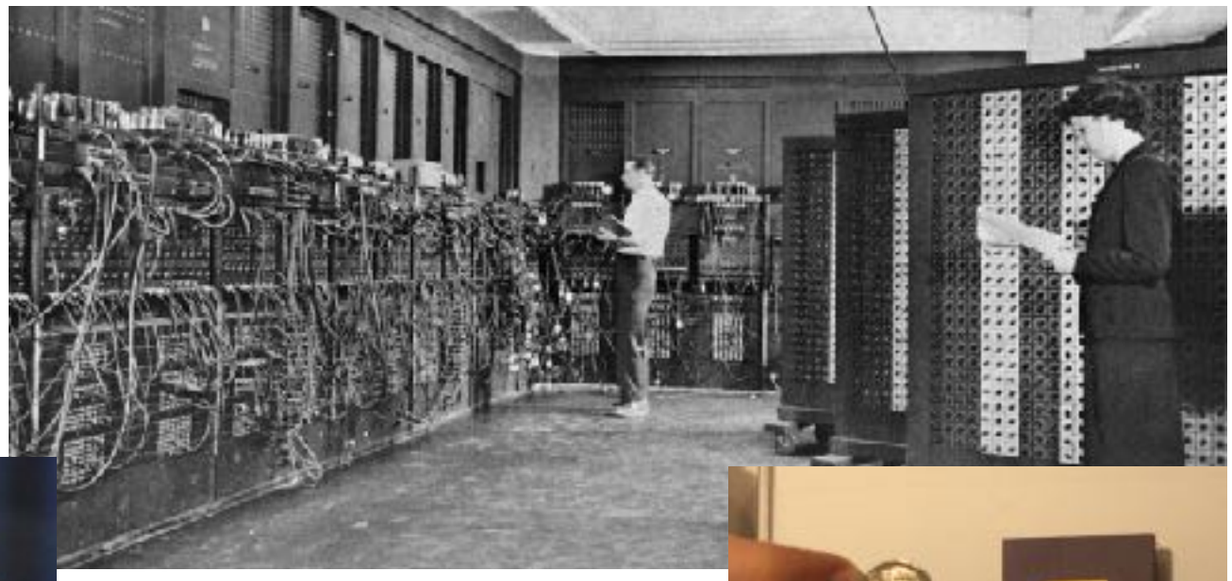


SEM cross-section [4]

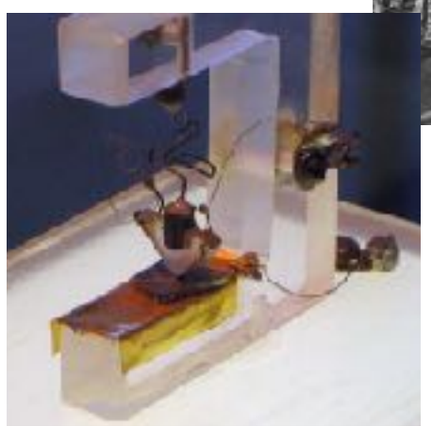
10 nm scale

[1] https://blog.gamebench.net/measuring-cpu-usage-in-mobile-devices
[2] https://www.hellotech.com/blog/whats-a-gpu-what-gpu-do-you-have
[3] IBM Research
[4] MSSCORPS CO., LTD. Hsinchu, Taiwan
[5] https://www.britannica.com/technology/electronics/The-semiconductor-revolution
[6] https://en.wikipedia.org/wiki/ENIAC

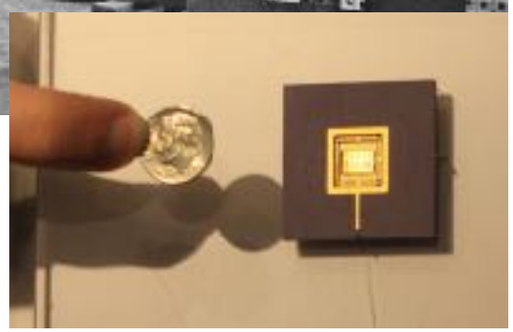
Smart phones, cars, tablets, PCs, TVs, appliances, communication



First computer [6]

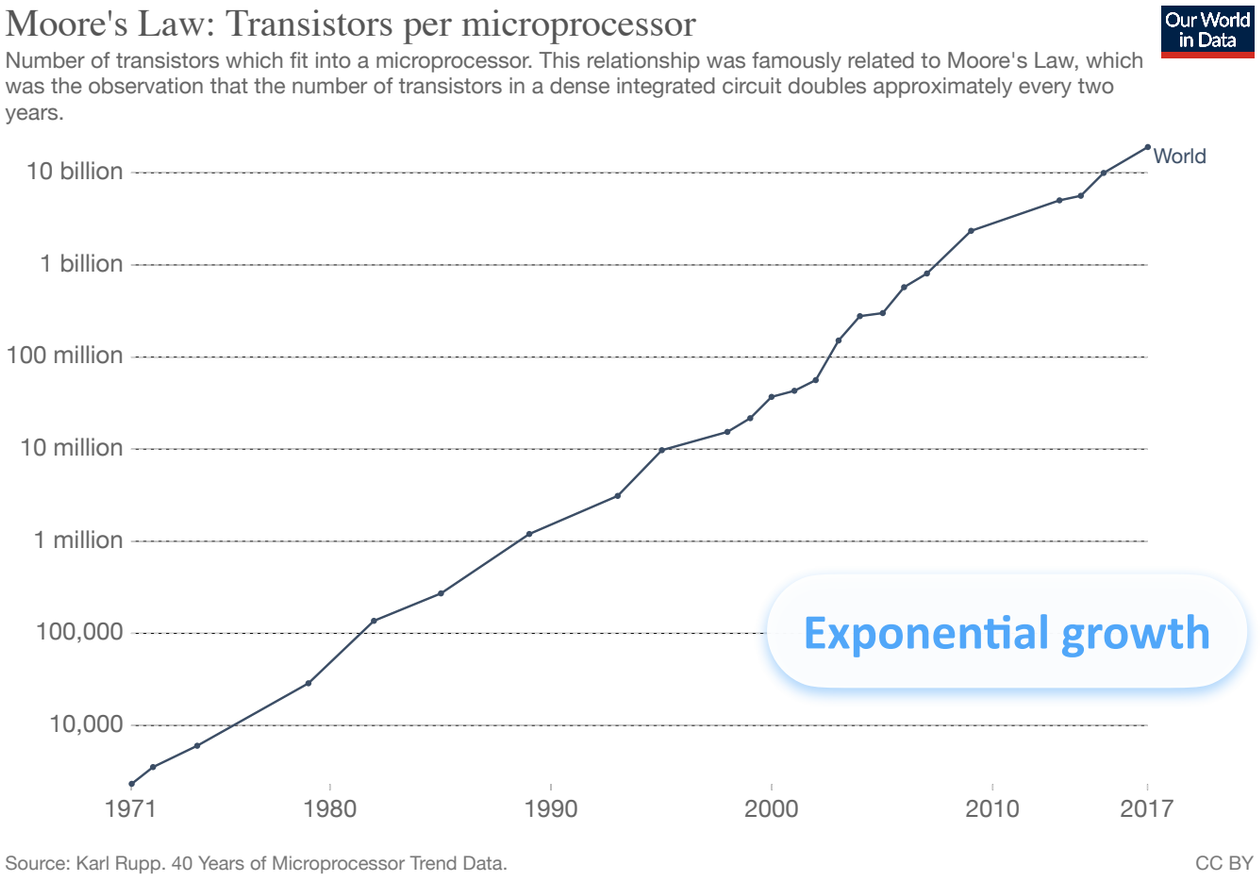


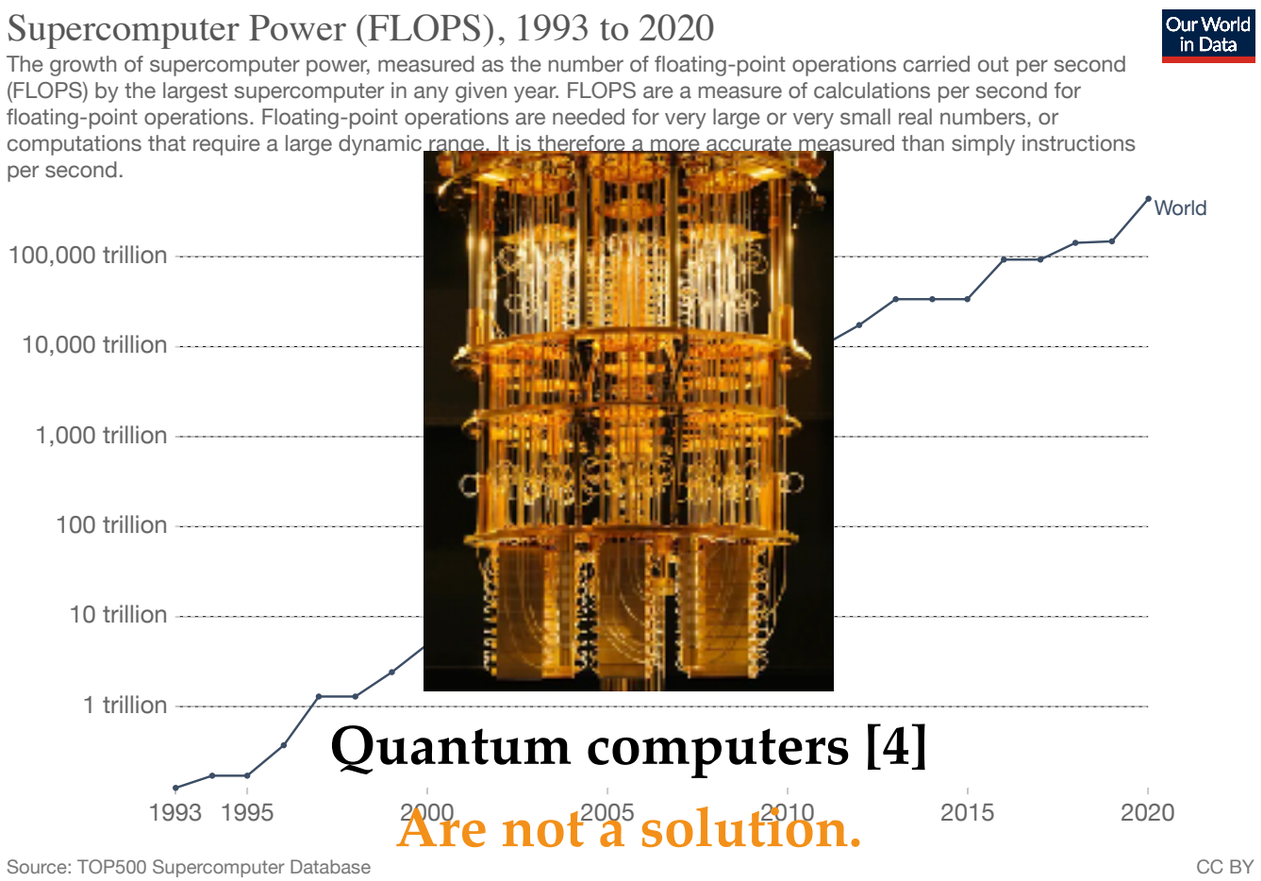
First transistor [5]



1 cm scale

Moore's Law





Quantum computers [4]

Are not a solution.

Data center [2]

Water cooling [3]

[1] https://ourworldindata.org/technological-progress
[2] https://www.vmware.com/content/dam/digitalmarketing/vmware/en/images/gallery/thumbnails/tn-data-center-servers.jpg
[3] https://arstechnica.com/information-technology/2016/02/microsofts-new-way-for-cooling-its-datacenters-throw-them-in-the-sea/
[4] IBM Research

How to Move Forward?

Structure

- Single-crystals
- Polycrystalline materials
- *Amorphous structures*
- *3D architectures*

Type

- *Metals*
- Insulators
- *Semiconductors*
- Biological systems

Mechanism

- Electric charge
- *Electron spin*
- Voltage
- Spin current
- *Strain*

Device

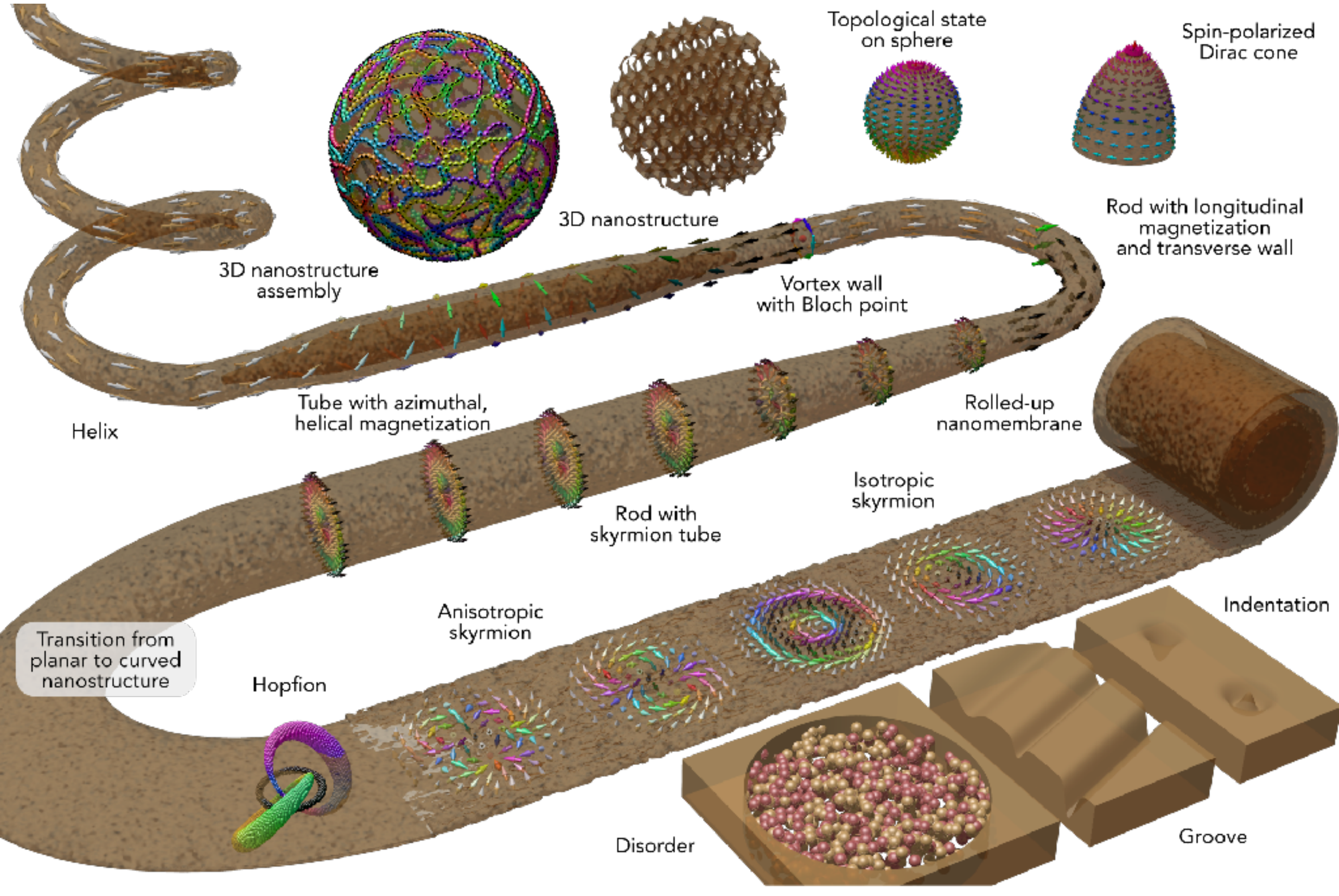
- Single-electron transistors
- *Magnetoelectric materials*
- Molecular electronics
- 3D microelectronics
- *Spin-based microelectronics*

Materials sciences are by nature multidisciplinary and marry experiment with computing.

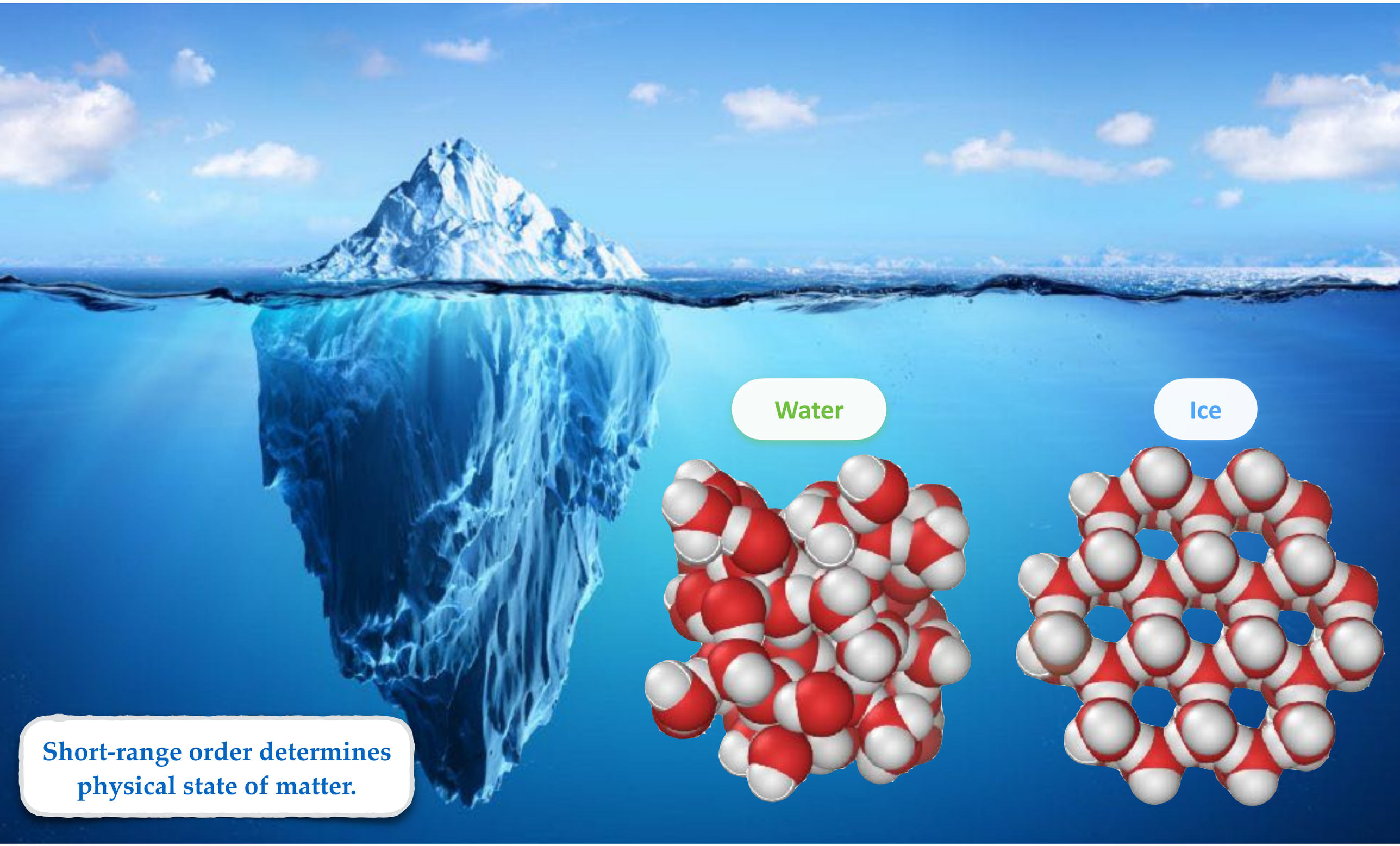
Engineering interfaces and homogeneity/heterogeneity

Ongoing efforts in academia (UNL), national laboratories and industry.

3D Nano Magnetism



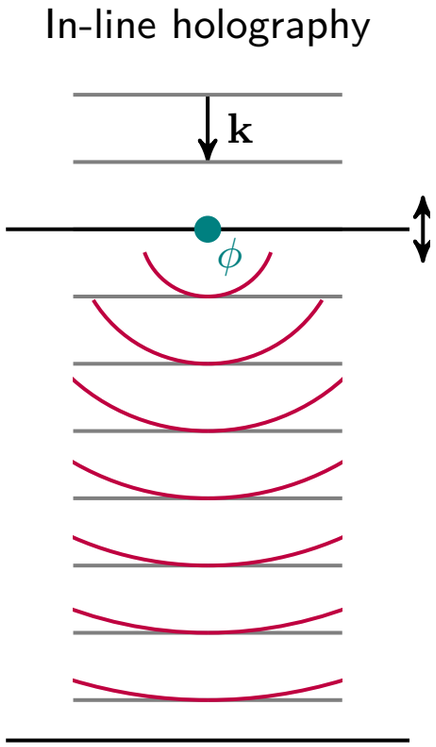
Order of H_2O Molecules

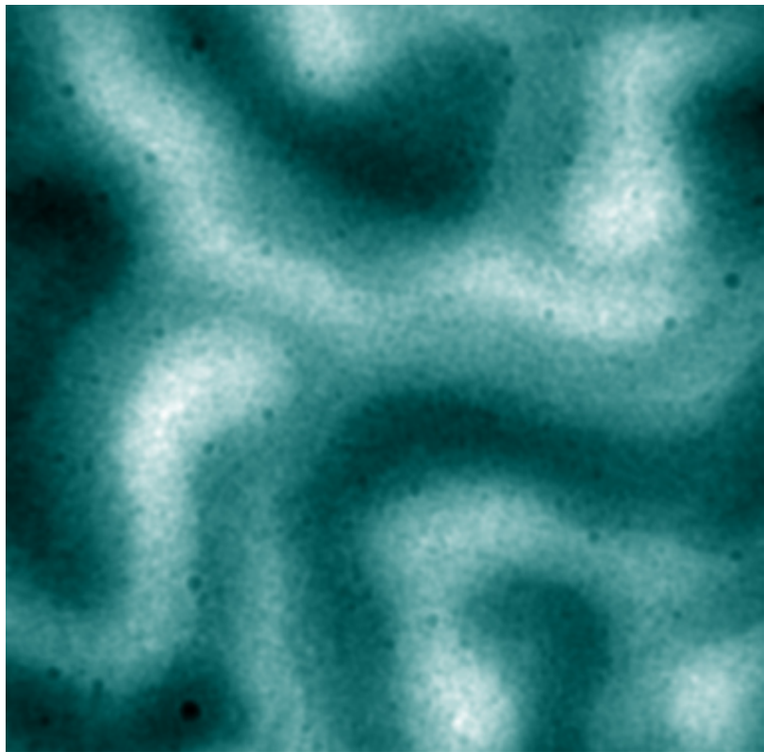


[1] https://andonix.com/uncovering-the-iceberg-of-ignorance/
[2] https://commons.wikimedia.org/wiki/File:Liquid-water-and-ice.png

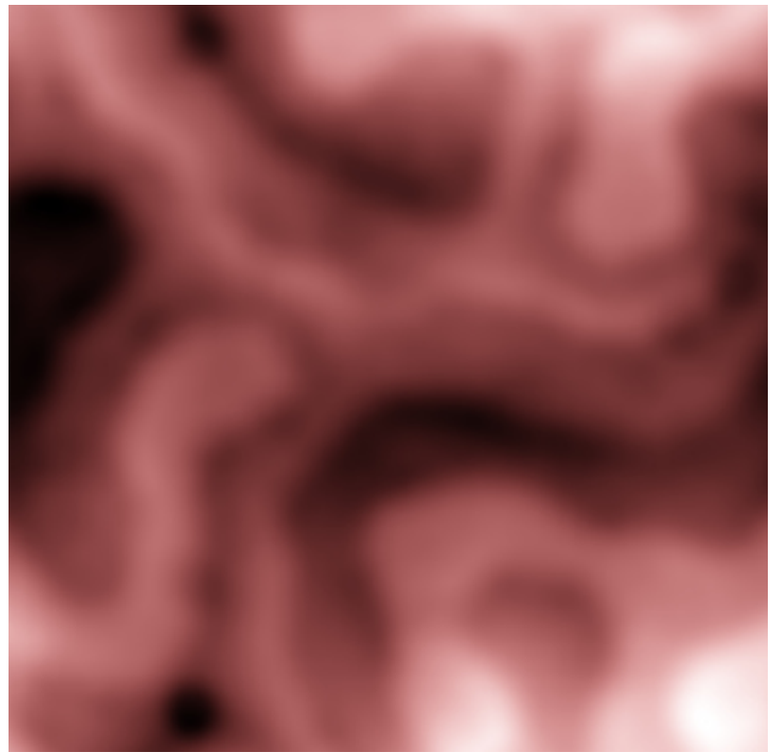
In-line Electron Holography

Correlation between structural defects and magnetization, e.g., domain walls, topological states, thermal spin fluctuations.





Gerchberg-Saxton
(Iterative, slow)



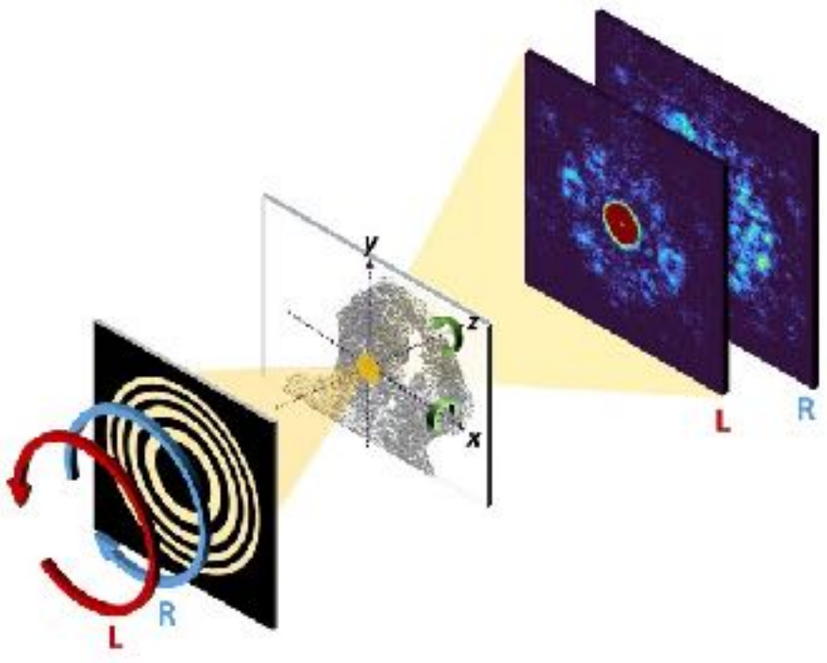
Transport-of-intensity
(Non-iterative, instantly)

Electron phase reconstructed
from 22 focal planes.

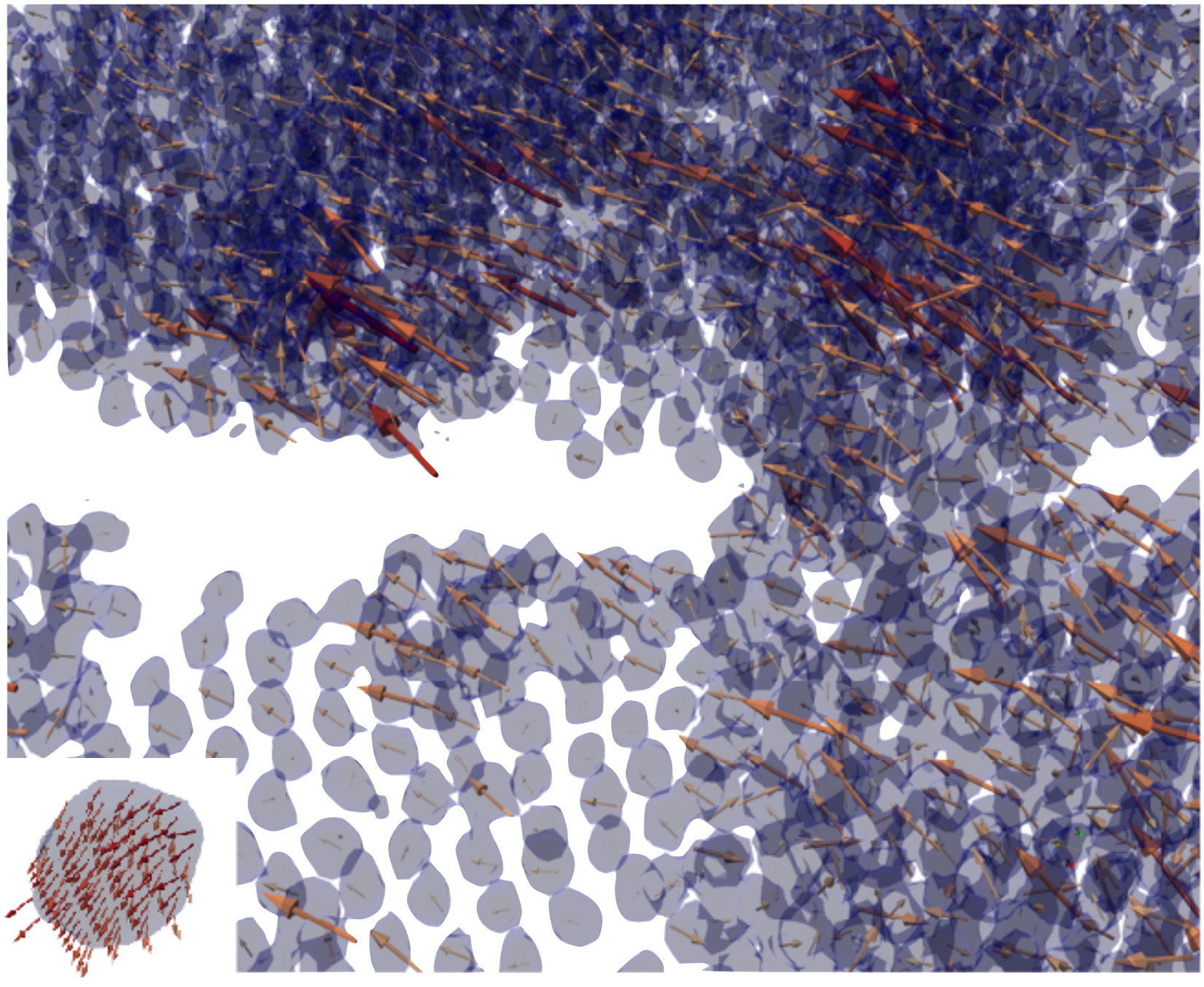
Field-of-view: 1.4 μm

X-ray Vector Field Tomography

Correlation between structural short-range order and magnetization.



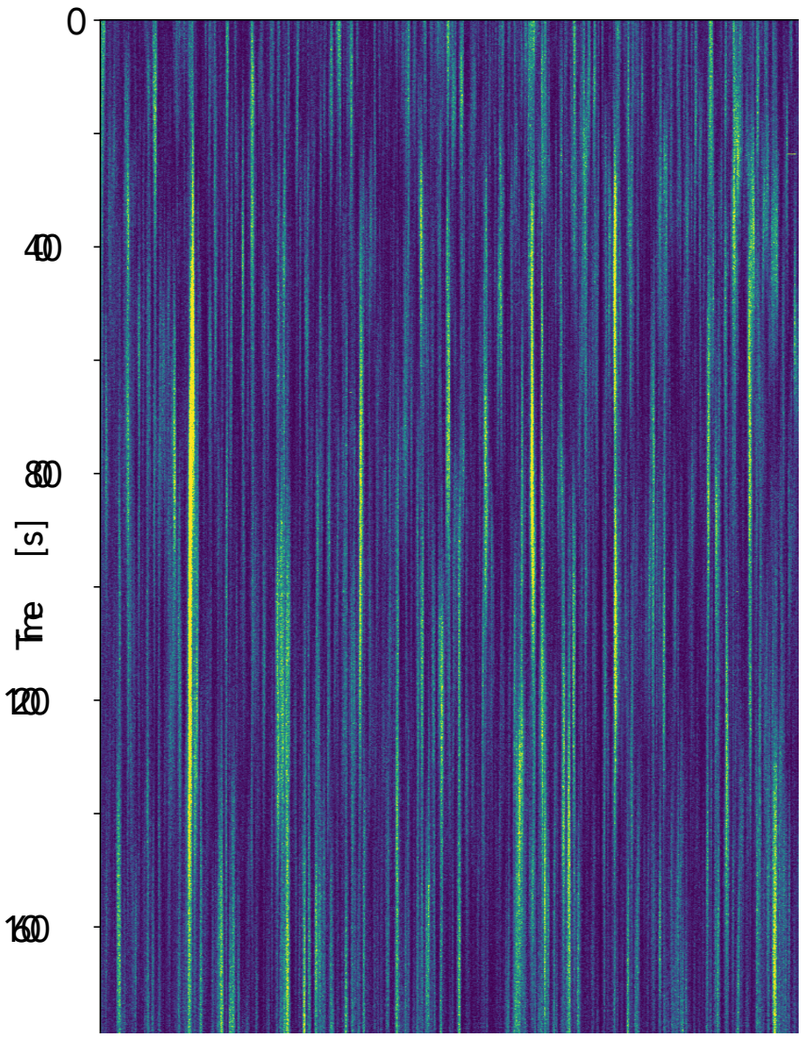
3D magnetization vector field reconstructed from 213,996 diffraction patterns.



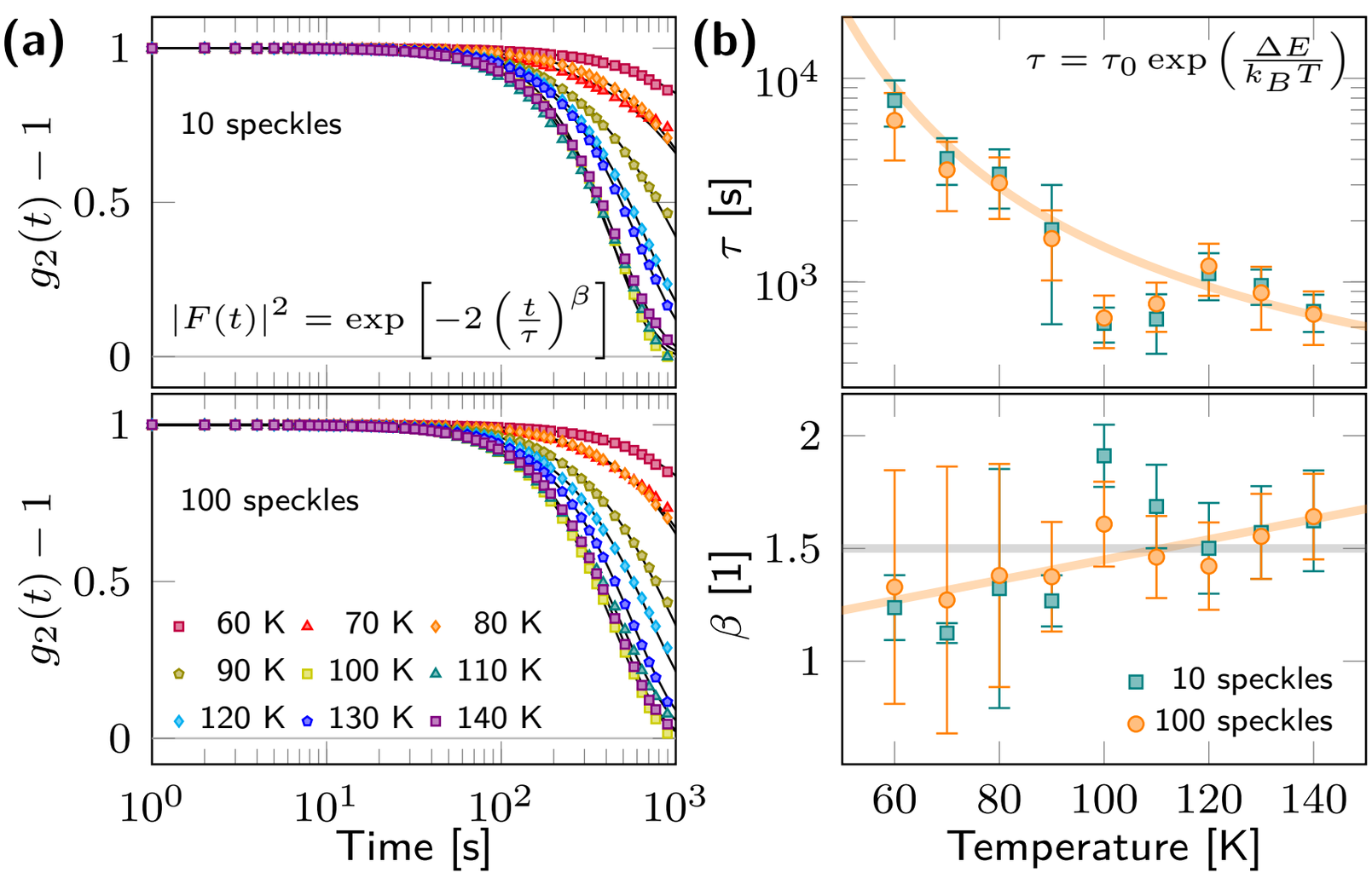
Assemblies of superparamagnetic Fe_3O_4 nanoparticles (22 nm)

X-ray Photon Correlation Spectroscopy

Classification of magnetic phase transitions using coherent resonant scattering, i.e., thermal fluctuations of periodic spin textures.



Waterfall plot



First Steps

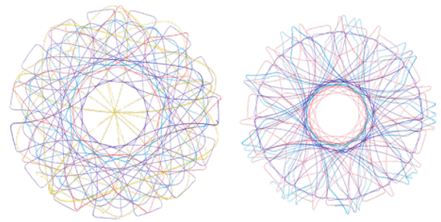
Explore the Beauty of Physics Through Art!

Come join current undergraduate physics students at UNL to learn how physics can be utilized in creating art. You will gain knowledge of the basic physical principles, complete hands-on art projects, and learn how to model what is seen through the use of mathematics. Each week, we offer an inside perspective on why you should choose physics and its relevance today.

Saturdays in February 2:00-4:00 P.M.

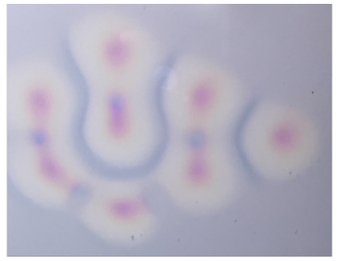
University of Nebraska-Lincoln - Jorgensen Hall -
855 N 16th St, Lincoln, NE 68508
Who: High School Juniors and Seniors
Cost: **FREE** for all students

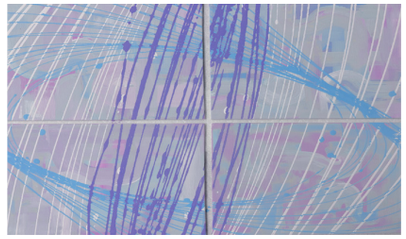
February 1, 2025
February 8, 2025
February 15, 2025
February 22, 2025

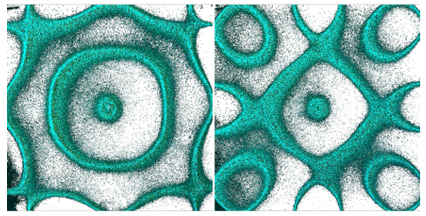


Past Topics:

GEOMETRICAL ART
PENDULUM MOTION
NATURE OF WAVES
MAGNETIC ART







Fill out this Google form to sign up!

For more information or to sign up!
streubel.unl.edu/STARTSMART.html

This series is offered as part of the **START SMART** program, which is supported by **the National Science Foundation** under grant no. 2203933 and the **UNL CAS Research Impact and Engagement Grant**: START SMART.

2025 START SMART

Saturdays in February 2:00-4:00 P.M.

Location: University of Nebraska-Lincoln - Jorgensen Hall - 855 N 16th St, Lincoln, NE 68508

Who: high school juniors and seniors

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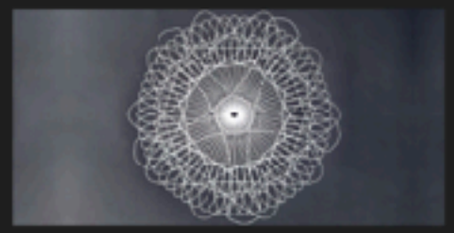


February 1, 2025: *Geometrical Art*

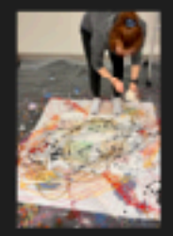
Spirographs: hands-on application and modeling

Guided tour of physics building

February 8, 2025: *Pendulum Motion*

Pendula: hands-on application and modeling

Q&A: Why to choose a physics education?



February 15, 2025: *Nature of Waves*

Interference and resonance: hands-on application and modeling

Q&A: What to do with a physics degree?

February 22, 2025: *Magnetic Art*

Ferrofluids: hands-on application and fundamentals

Q&A: Why to choose UNL Physics?

Get the 2025 flyer