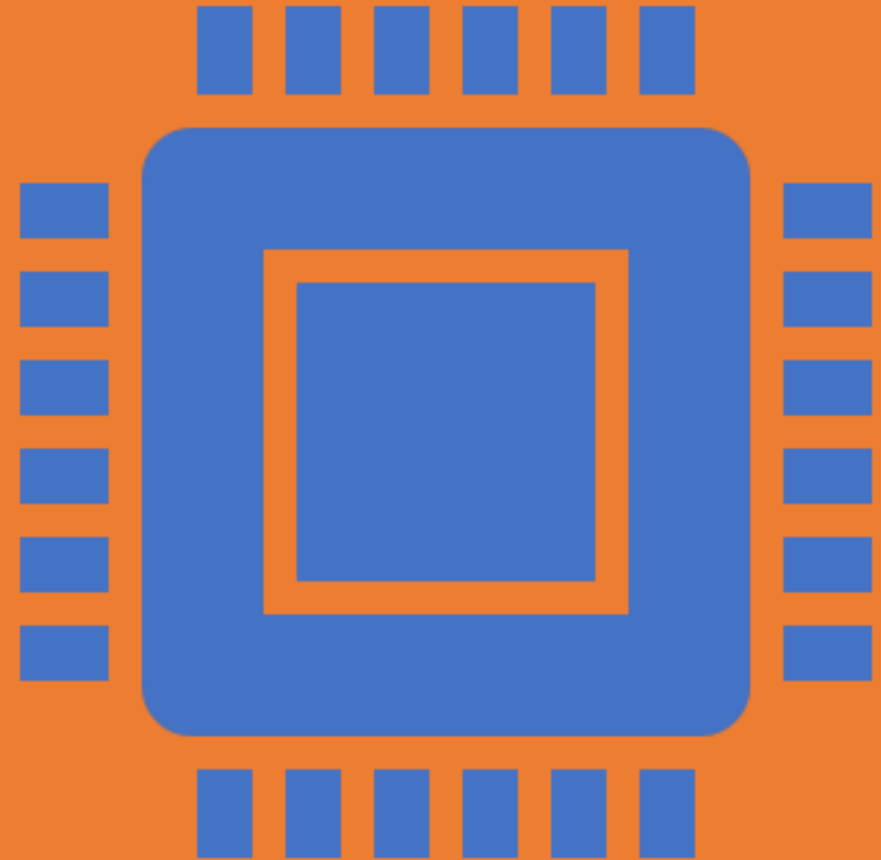


Multidisciplinary integrated research on biological quantum artificial intelligence

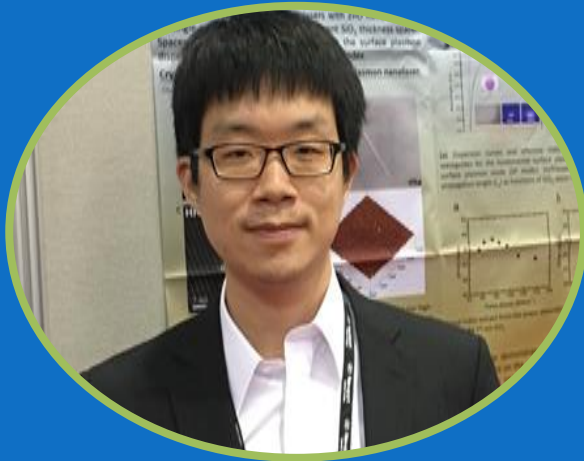
Timothy Chou

Department of Photonics

National Cheng Kung University



BIO



Dr. Timothy Chou

MOST YSG SCHOLAR

Educational qualification

Ph.D. degree: Institute of Lighting and Energy Photonics, National Chiao-Tung University, Tainan, Taiwan (2010~2016).

B.S. degree: Department of Physics, National Cheng-Kung University, Tainan, Taiwan (2006~2010).

Work Experiences

Assistant professor at department of photonics, National Cheng Kung University (2019~present)

Postdoc at The Hebrew University of Jerusalem (2018~2019)

Research Topic: Manipulating quantum fluids in ultra-high-quality microcavities via electrical control

Postdoc at Department of Physics, University of Michigan (2017~2018)

Research Topic: Study on TMDC based Tamm plasmon-polariton microcavity

Postdoc at Department of Photonics, National Chiao Tung University (2016~2017)

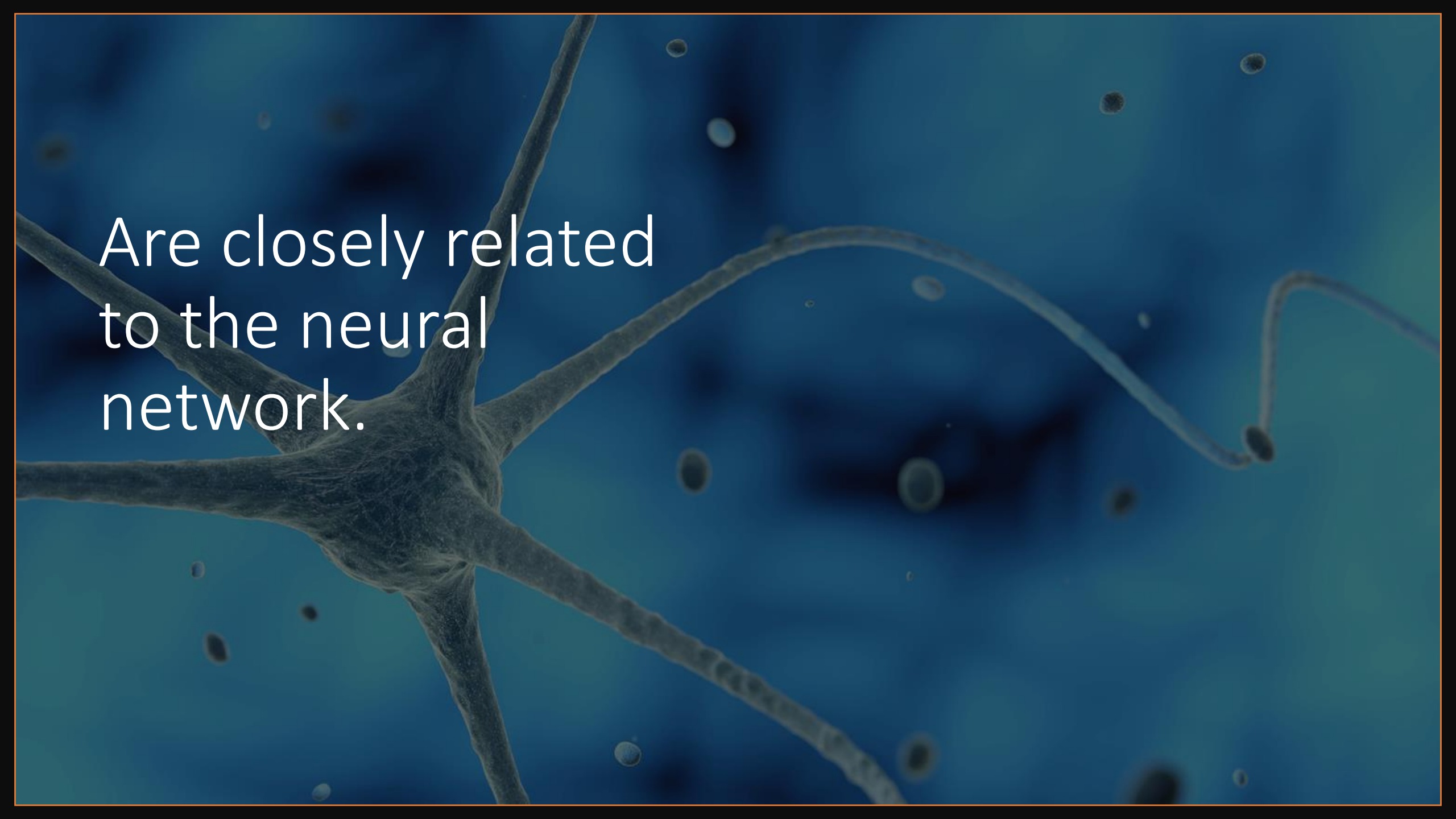
Research Topic: Ultra-compact plasmonic lasers and laser arrays



How we feel

How we thought



A microscopic image of a neuron, showing a central cell body (soma) with several branching processes (dendrites and an axon) extending outwards. The background is a deep blue, and there are several small, dark, circular structures scattered throughout, likely representing other cells or debris in the tissue.

Are closely related
to the neural
network.

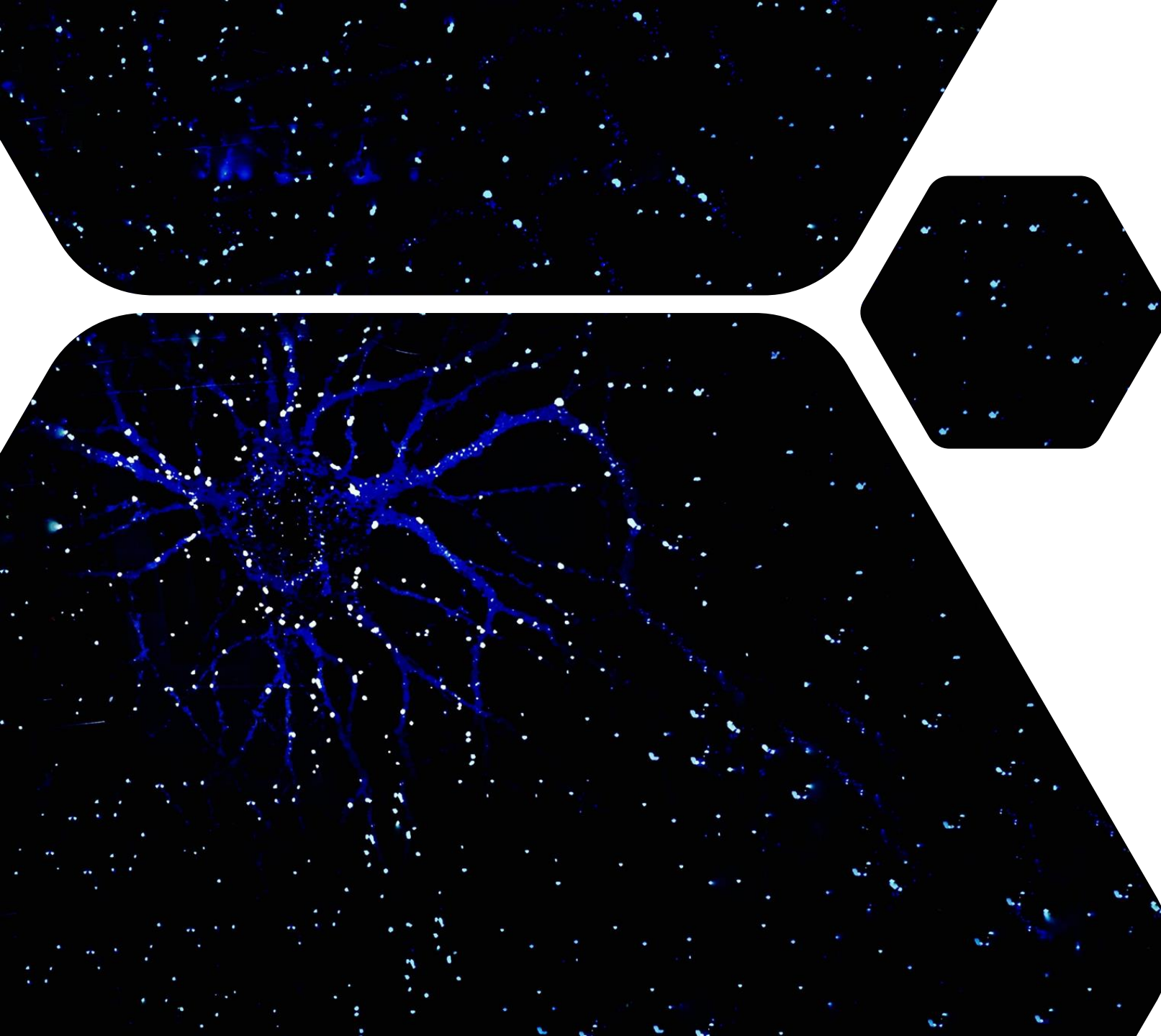
Which inspires...

- Cell therapy
- Neuropharmacology
- Neuroimaging
- A.I. (ANN)
- etc.





However



- In human's (or animals) body, different genes are expressed in migrating neurons at various locations, implying the existence of mixed signals (or information?) along the migratory path. This detail is still *unknown*⁷

Also, what's
inside the black
box of ANN
computation?



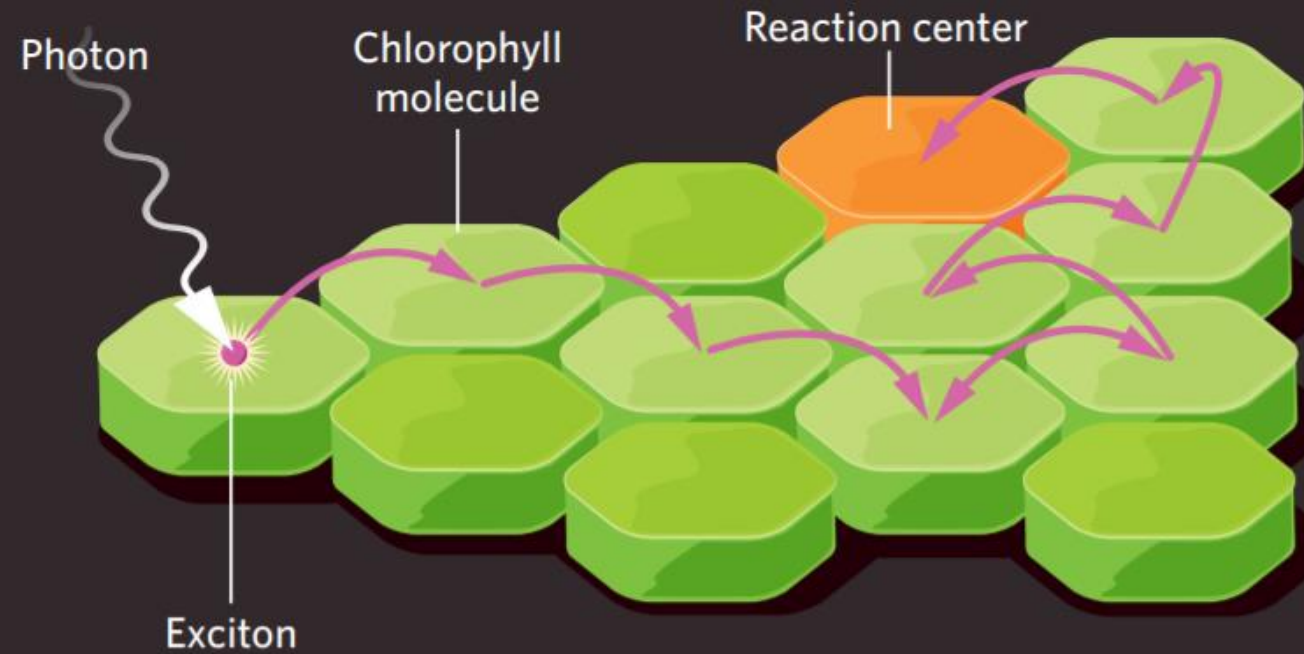
Could we explain by
physics?

...living matter, while not eluding the **"laws of physics"** as established up to date, is likely to involve "other laws of physics" hitherto unknown, which however, once they have been revealed, will form just as integral a part of science as the former.-**Erwin Schrödinger**^{r6}



Traditional Model

According to the traditional, or “incoherent,” model of this process, the exciton’s route to the reaction center is more or less random. Because energy can be lost during the transfer process, such a path can end up being wasteful.



PHOTOSYNTHESIS

ALL PATHS TRAVELED*²

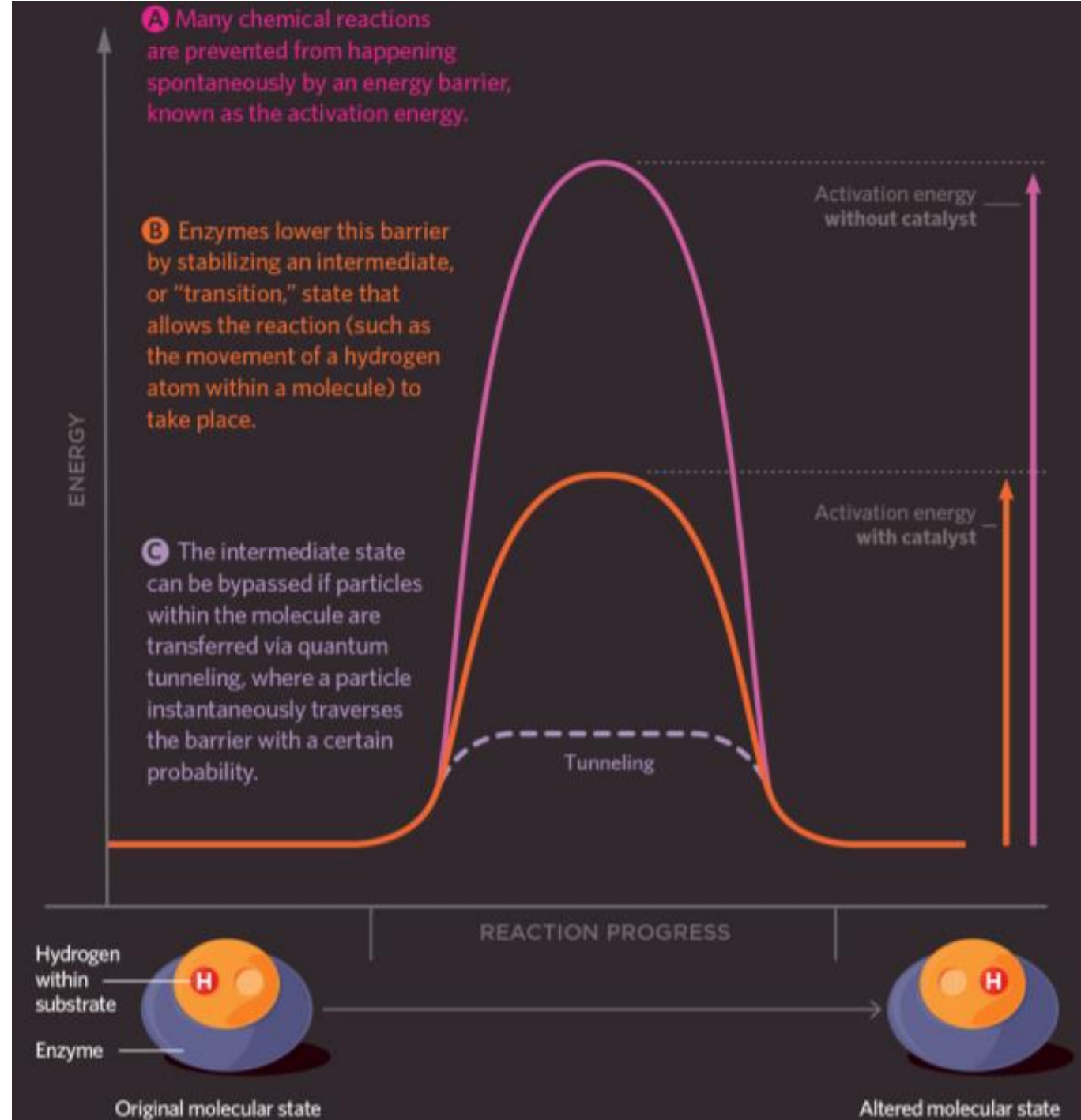
Quantum Model

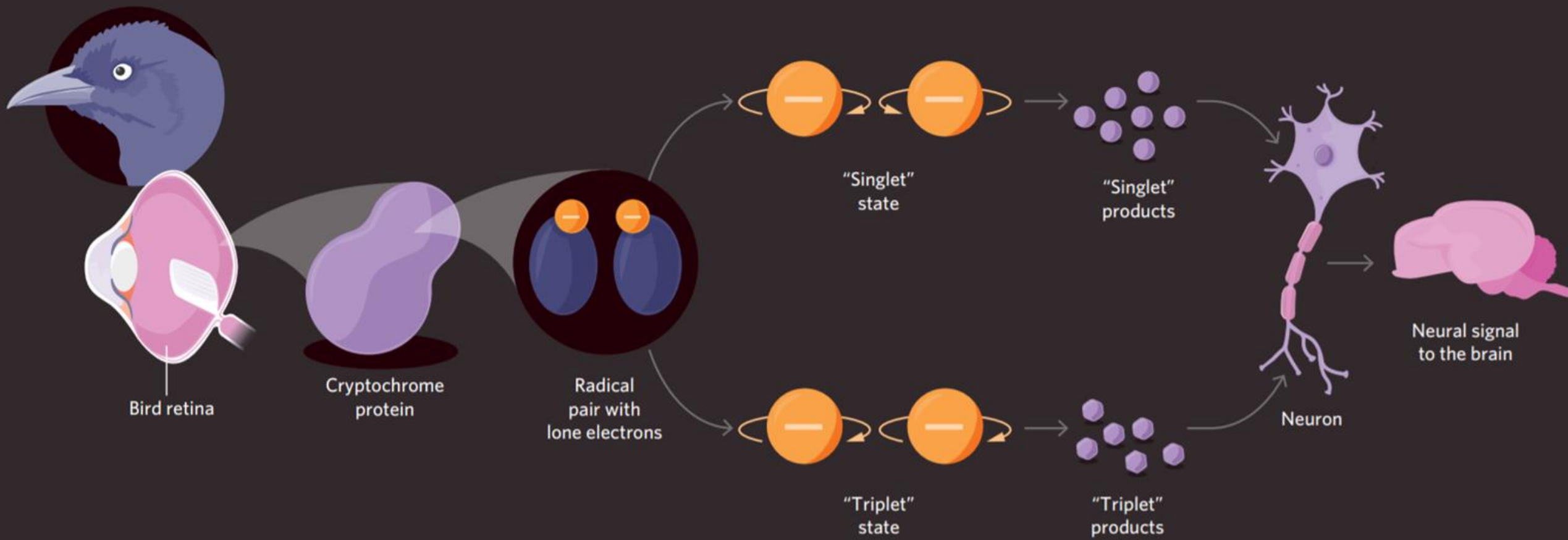
By contrast, if the energy transfer process is “quantum coherent” such that the exciton travels like a wave, it can explore all possible paths simultaneously and only take the most efficient route.



Enzyme Catalysis

A Tunnel Through the Barrier^{*2}





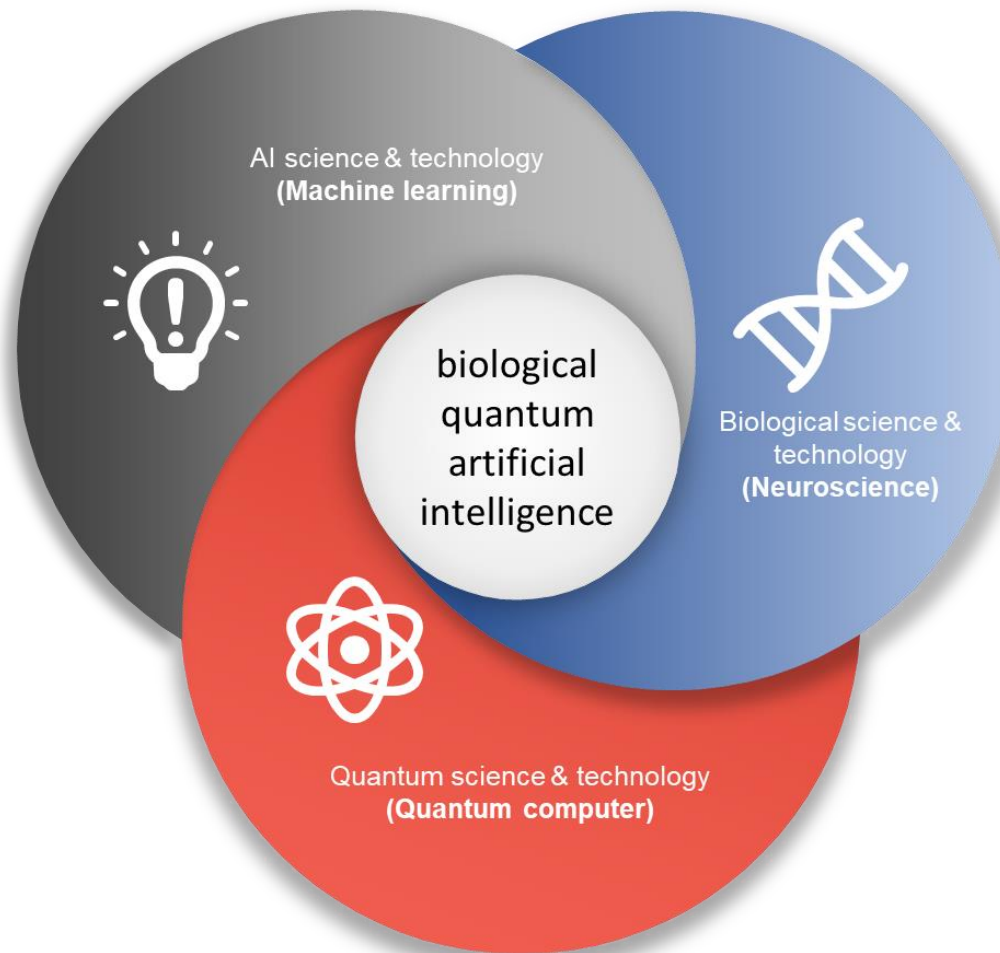
MAGNETORECEPTION

- SPINNING SENSORS *2



What else can we
PLAY?

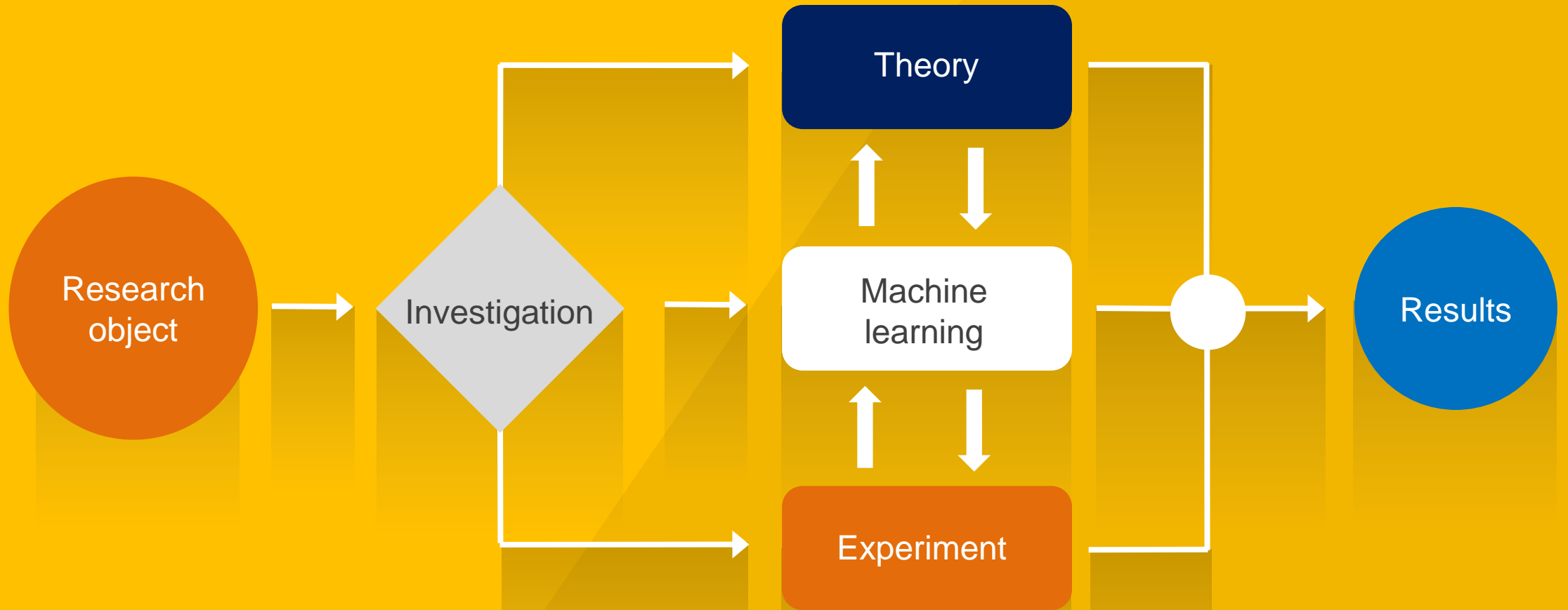
Interdisciplinary Research Forum

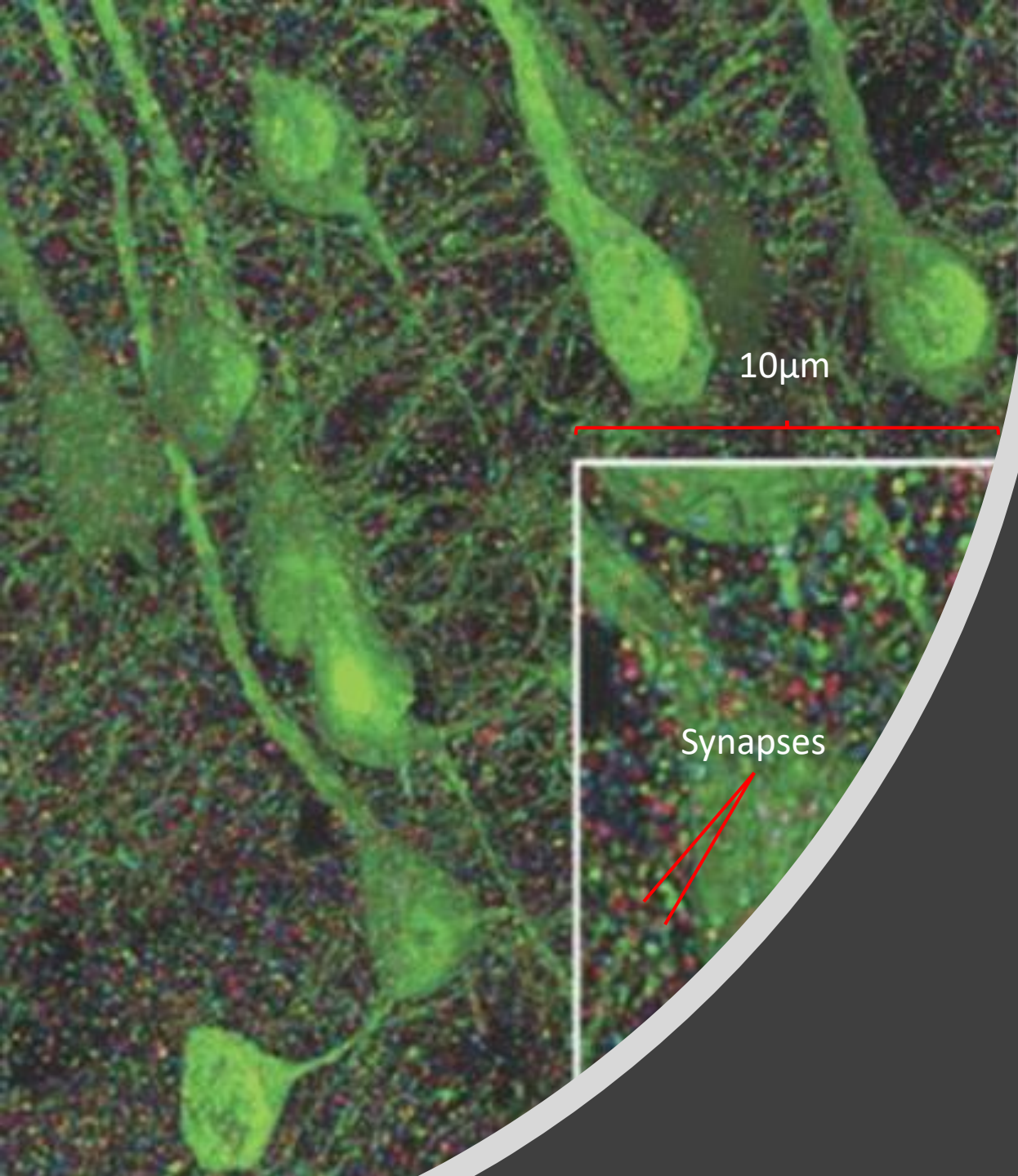


<https://collegeofscience.bookmark.com/>



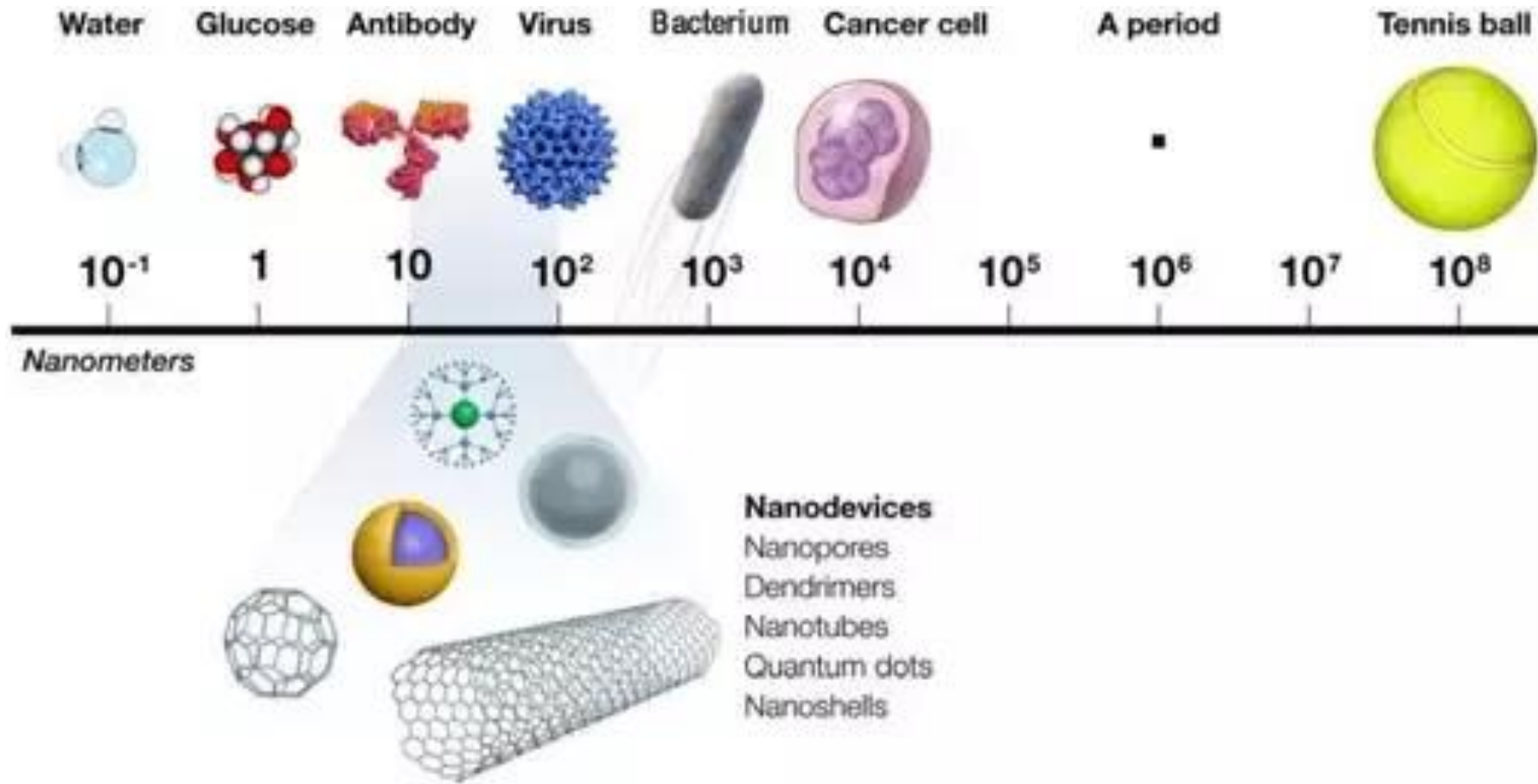
Bionic quantum-neural network: How we work?





Synapses are very small($\sim 1 \mu\text{m}^3$)*³. This narrow gap of extracellular space is approximately 20-40 nanometers (nm) wide.*⁴

Small enough to investigate by quantum physics!



Large enough to be manipulate by nano-tech!

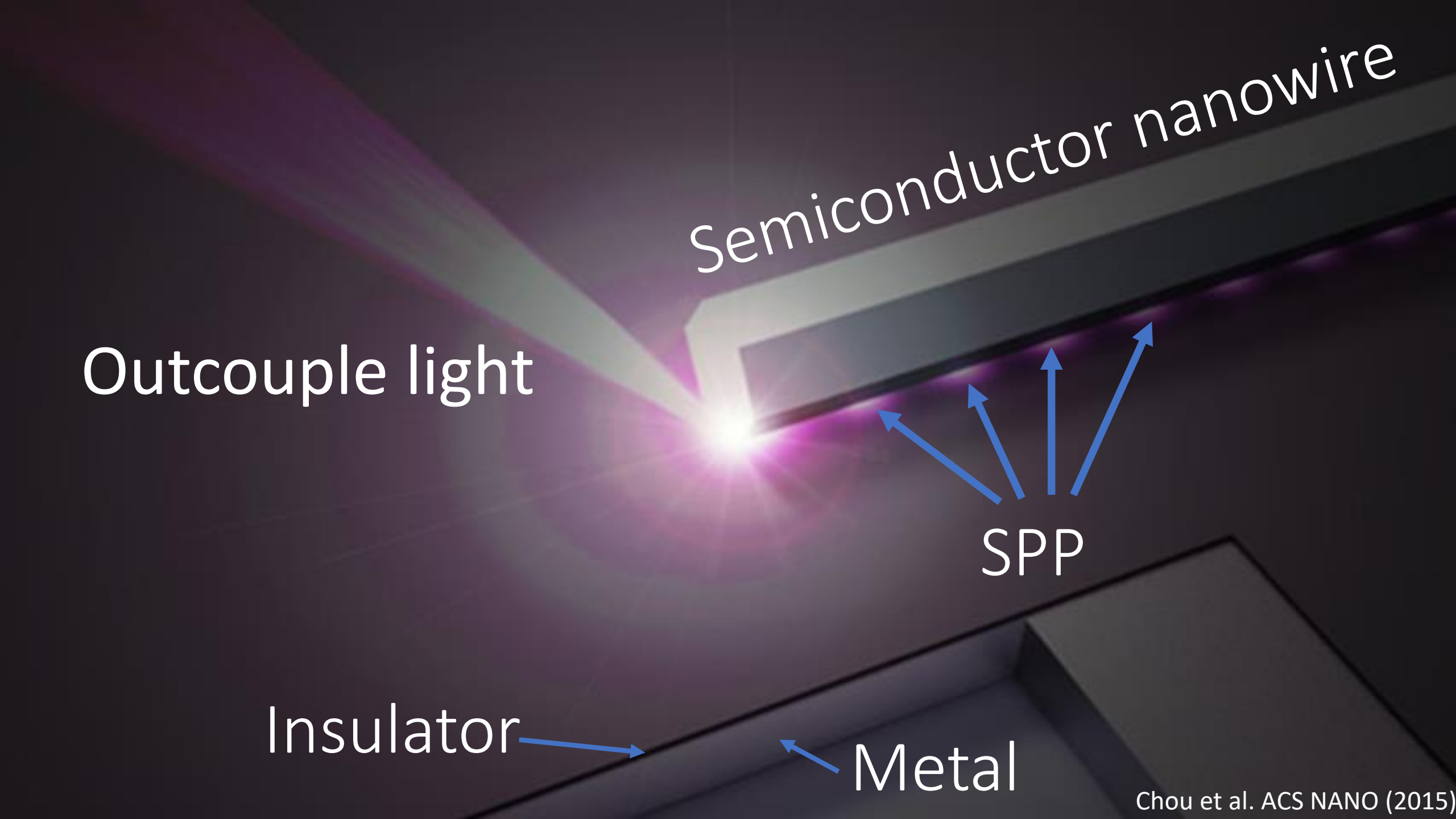
Semiconductor nanowire

Outcouple light

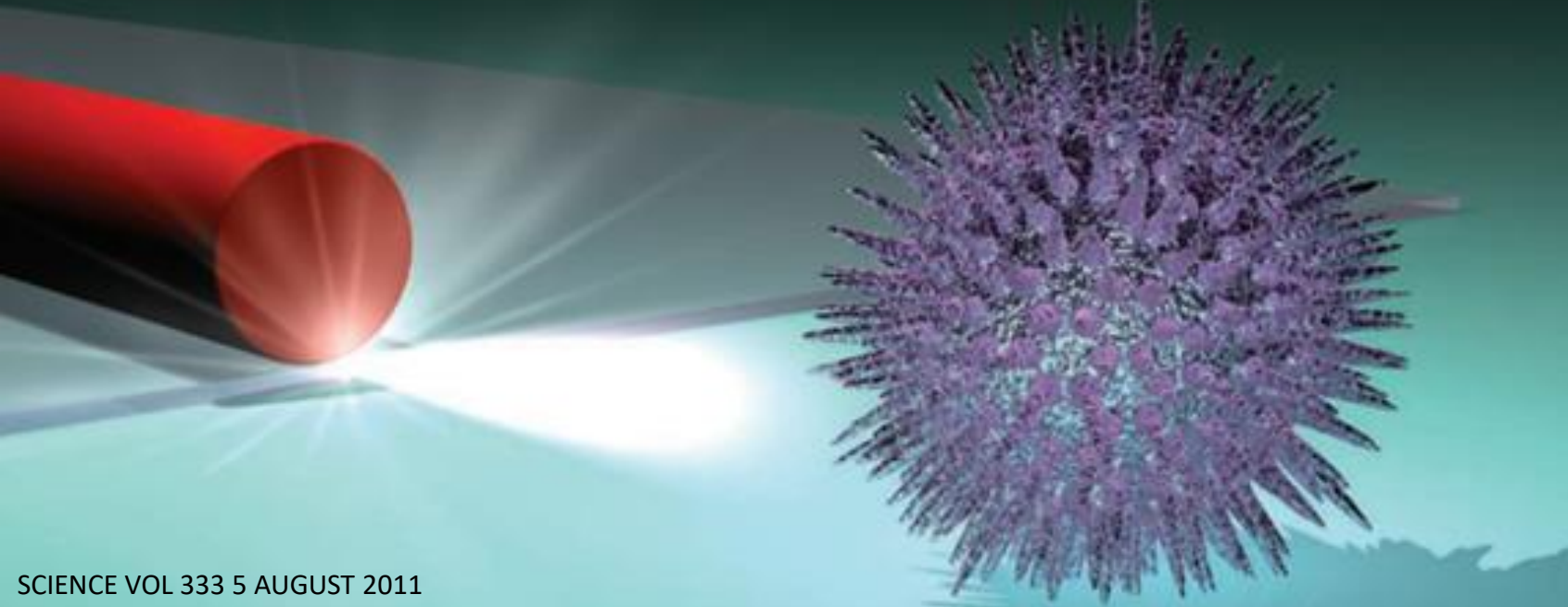
SPP

Insulator

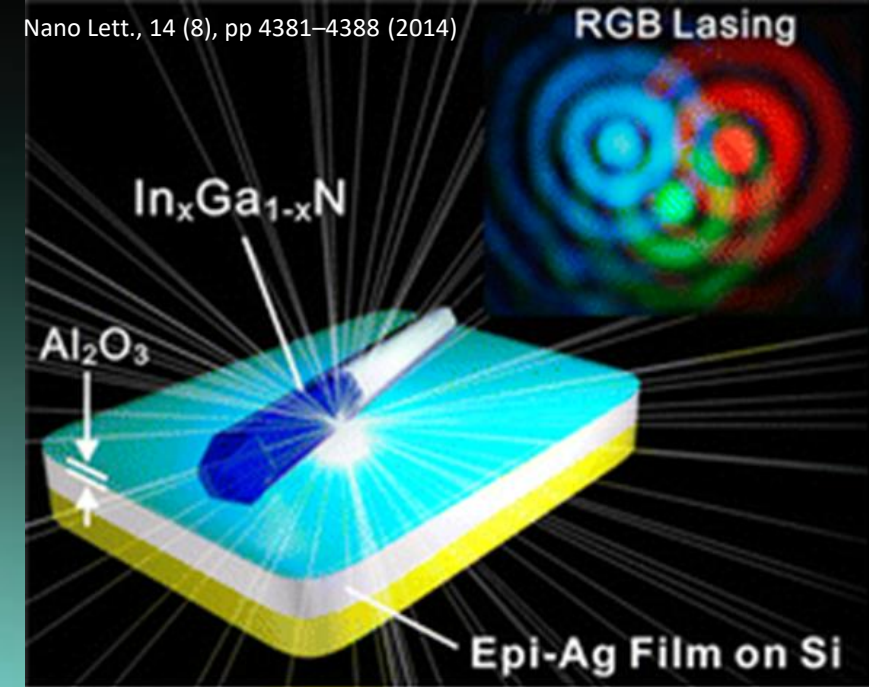
Metal



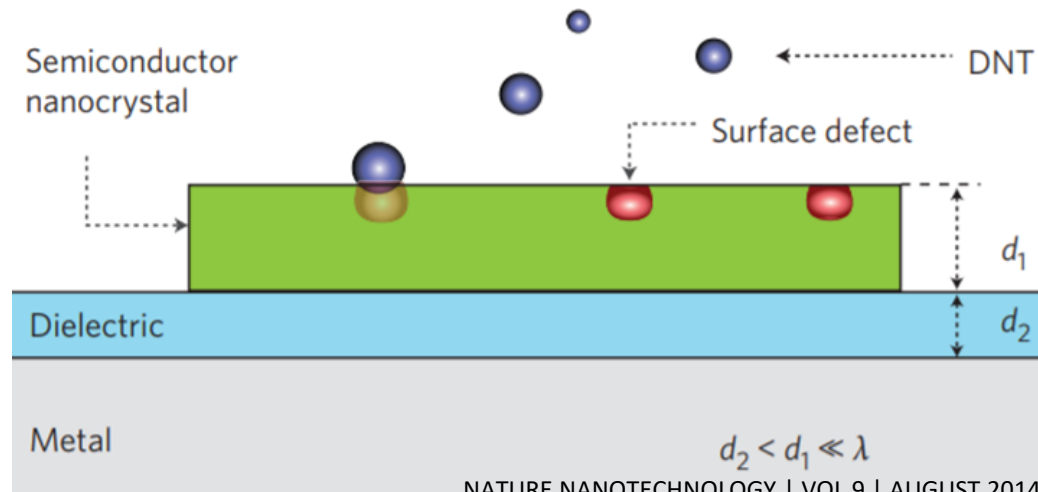
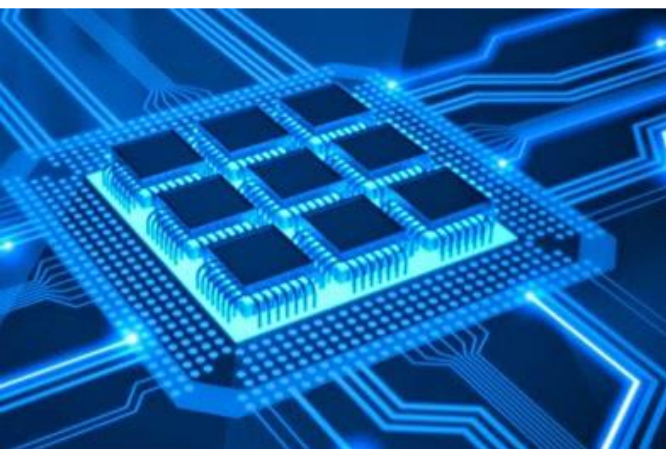
Plasmon nanolaser



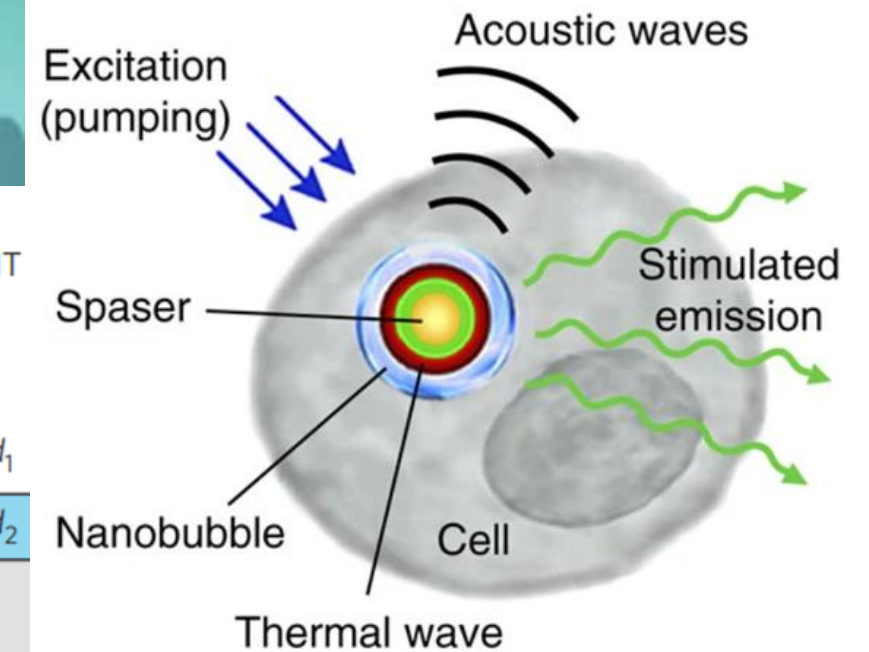
Virus



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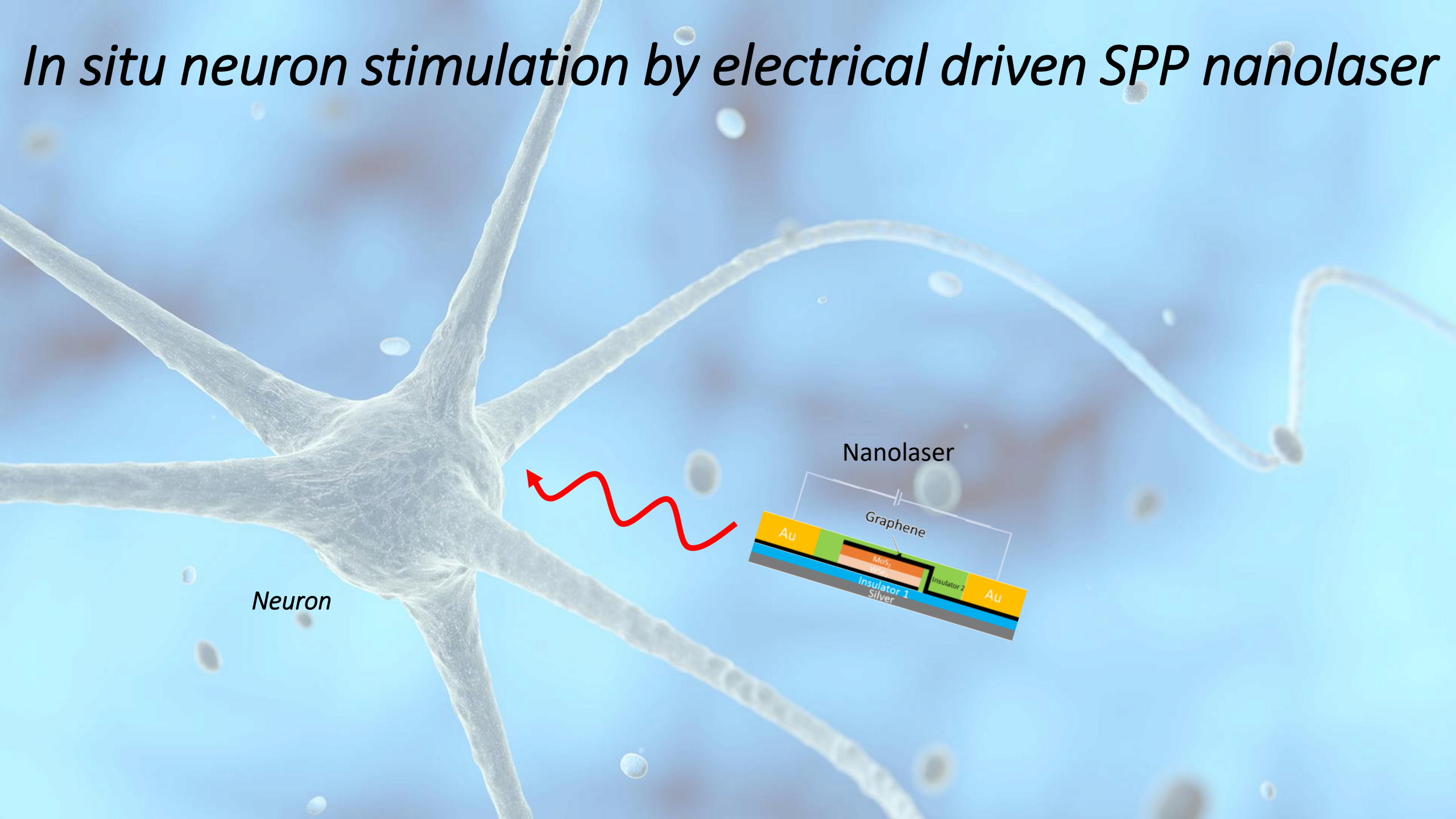


NATURE NANOTECHNOLOGY | VOL 9 | AUGUST 2014



Nature Communications volume 8, Article number: 15528 (2017)

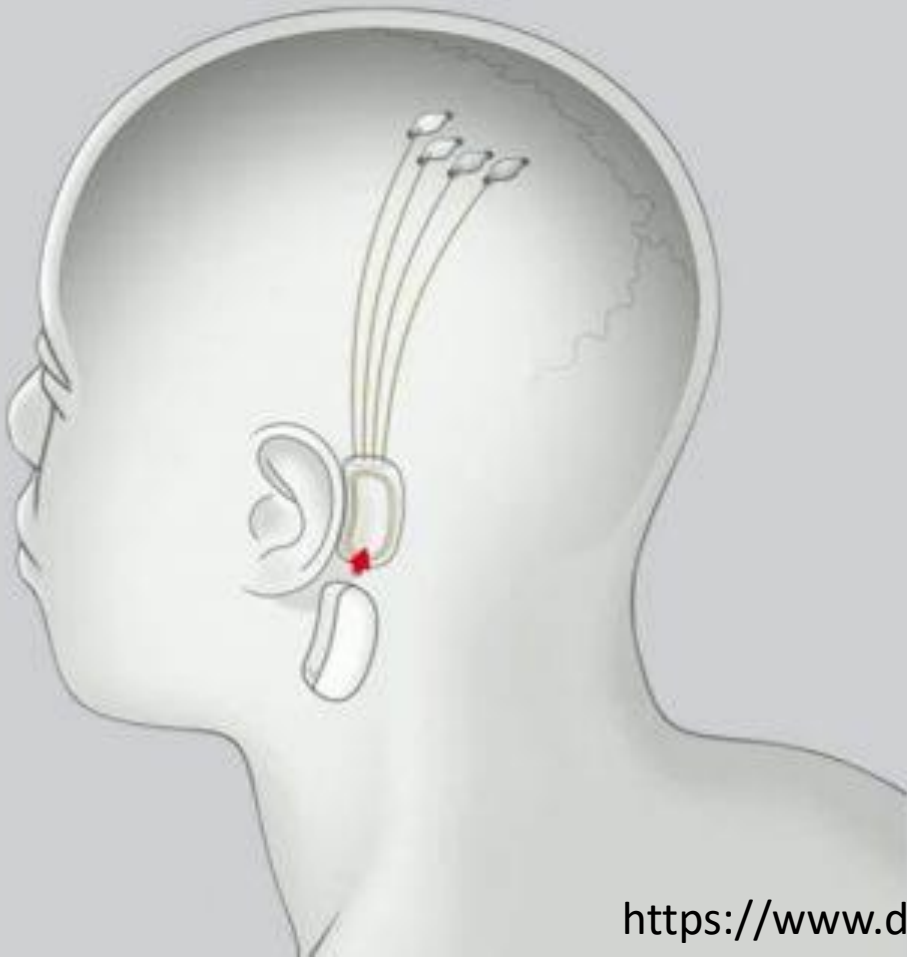
In situ neuron stimulation by electrical driven SPP nanolaser



NEURALINK ARCHITECTURE



Last Summer



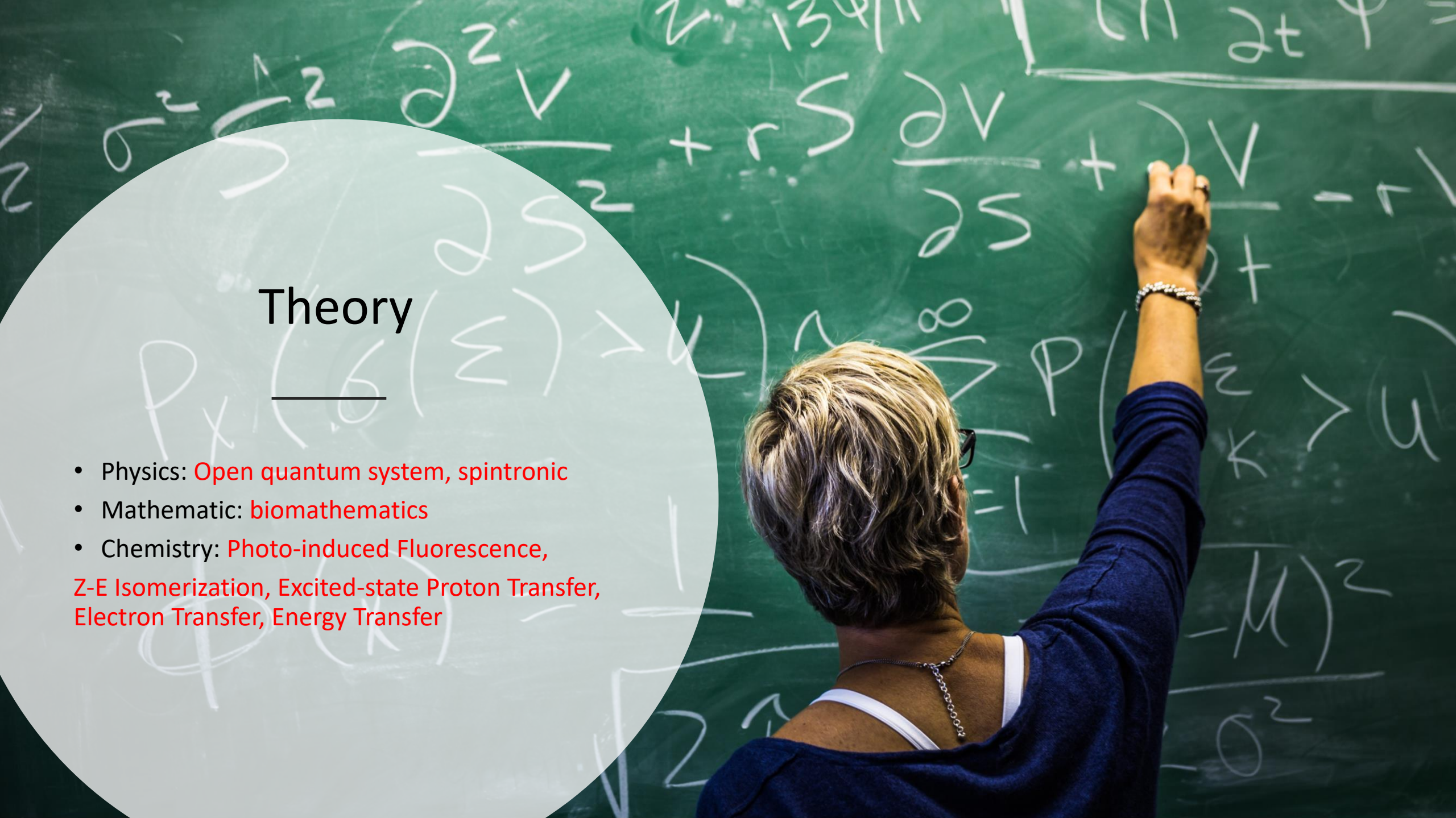
Today



Research object

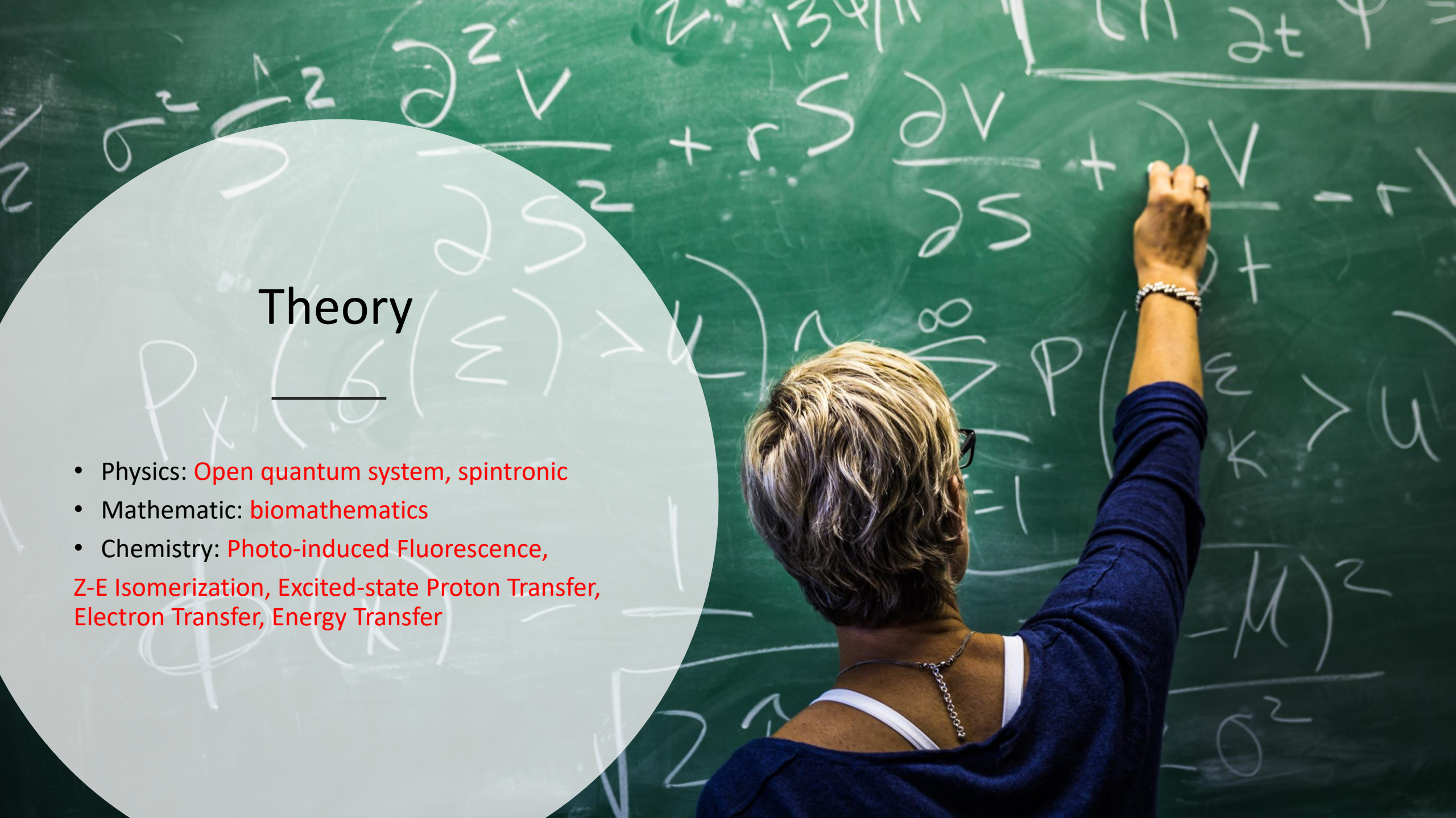
- Medical: **Neuron, physiological data**
- Bio: **Fluorescent Protein, Neuron**
- Chemistry: **O-Chem stuff**
- Photonics: **Opto-electronic devices**



A person with short blonde hair, wearing a dark blue long-sleeved shirt and a necklace, is seen from behind, writing mathematical equations on a green chalkboard. The chalkboard is filled with various mathematical expressions, including partial derivatives, integrals, and summations. A large, semi-transparent white circle is overlaid on the left side of the image, containing the word 'Theory' and a list of topics.

Theory

- Physics: **Open quantum system, spintronic**
- Mathematic: **biomathematics**
- Chemistry: **Photo-induced Fluorescence, Z-E Isomerization, Excited-state Proton Transfer, Electron Transfer, Energy Transfer**

- 
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 - Mathematic: **biomathematics**
 - Chemistry: **Photo-induced Fluorescence, Z-E Isomerization, Excited-state Proton Transfer, Electron Transfer, Energy Transfer**

The background of the slide is a dark, textured surface featuring a network of interconnected gears and lines. Several circular icons are scattered across the scene, including a factory with smokestacks, a leaf with a plug, a robotic arm, and a gear with the letters 'AI'. A bright, glowing light source in the upper right corner creates a strong lens flare effect, illuminating the right side of the slide. A small red horizontal bar is located in the top left corner.

Machine learning

- CSIE: AI, ANN, CNN, optimization, use AI to learn how neuron works

A detailed photograph of a scientific experiment setup, likely in a laboratory. The image shows a complex arrangement of metal components, including cylindrical chambers, pipes, and various electronic modules. A large, dark, cylindrical component is prominent on the right side. The setup is mounted on a metal frame, and numerous wires and cables are connected to different parts of the apparatus. The overall scene is dimly lit, with some highlights on the metallic surfaces.

Experiment

- Photonics: time resolve PL & EL, Temperature dependent PL & EL (with Electric field or/and Magnetic field), Acoustic wave coupling

Results could be...

- 1.A creation of new field
- 2.Biomimicry application
- 3.Novel Medical treatment
- 4.New tools for machine learning
- 5.New tools for measurement
- 6.New tools for fabrication
- 7.New industry
- 8.????

Where the figures come from (with*)

Wikipedia

<https://www.the-scientist.com/features/quantum-biology-may-help-solve-some-of-lifes-greatest-mysteries-65873>

<https://bionumbers.hms.harvard.edu/bionumber.aspx?id=108451>

<http://book.bionumbers.org/how-big-is-a-synapse/>

<https://www.quora.com/Can-there-be-a-virus-of-the-size-of-an-atom-or-only-a-few-atoms>

Others are from: Envato and twenty 20

References (with r)

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- Adapt: How Humans Are Tapping into Nature's Secrets to Design and Build a Better Future
- [PHILO Physics](#)
- [神經發育與幹細胞實驗室](#)
- Neuroscience, 2nd edition, ISBN-10: 0-87893-742-0
- Quantum effects in the brain: A review arXiv:1910.08423
- What Is Life?: Mind and Matter 0-521-42708-8
- [Towards an Understanding of Synapse Formation](#)
- [神經科學領域之研究前沿與學術表現](#)
- [Quantum Biology May Help Solve Some of Life's Greatest Mysteries](#)
- [Physics of life: The dawn of quantum biology](#)
- [仿生計算－以大自然為師](#)
- [Can something be fully quantum and alive at the same time?](#)
- wikipedia

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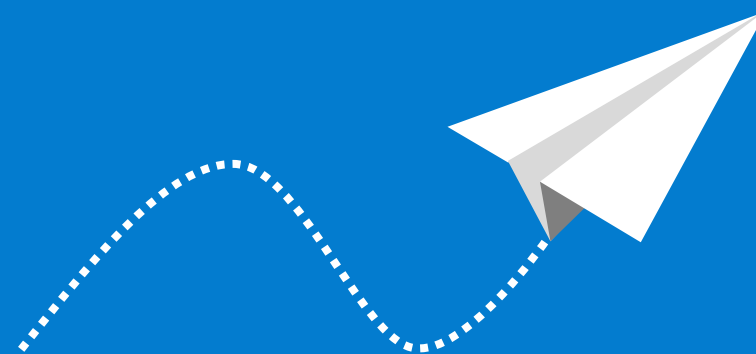
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Thank You



PHOTONICS LAB

by *Chou Research Group*

Unleash the true power of photonic technology

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