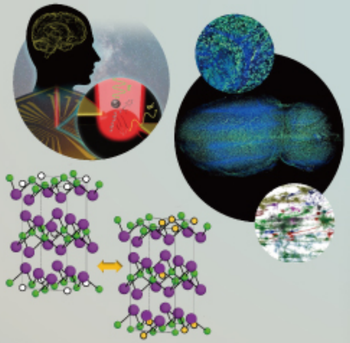
1928 創立

# 中央研究院物理研究所

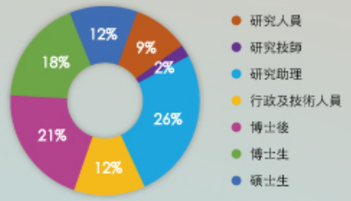


臺北市南港區研究院路二段128號

電子摺頁 2023年版

1928 創立於上海
1962 於臺北南港復所
1966 與國立清華大學、國立臺灣大學合辦「物理研究中心」(現物理研究推動中心)，推動臺灣之物理發展
1983 將原有的二層樓舊館增建為四層，研究領域擴充至場論與粒子物理、原子核物理、以及統計與計算物理
1999 於舊館東側增建新館樓高十層
2000 於舊館四樓設立「吳大猷紀念館」，為紀念已故前所長吳大猷先生，全館取名為「大猷館」
2002 研究群重新整合為三大組，正式分為「奈米科學組」、「複雜系統組」及「中高能物理組」
2003 所徽誕生，用光的藍、綠、紅三元色增出I、O、P，能隱約看出G，c，h，k代表古典、電磁、量子、統計四大力學之重要常數
2015 三大研究組重新命名為「量子材料物理組」、「中高能物理組」及「生物與動態系統組」
2015 與財團法人水清基礎科學發展文教基金會共同創辦「李水清物理講座」
2019 設立「中央研究院物理所學者養成優良論文獎」


Credit: Martin Wolf, IceCube/NSF




- 研究人員
- 研究技師
- 研究助理
- 行政及技術人員
- 博士後
- 博士生
- 碩士生

## 社會關注議題之 重要計畫

- 建置分散式區域規模之大型儲能系統，推動綠能產業發展計畫（計畫主持人：吳茂昆博士）
- 去碳燃氫（計畫主持人：陳洋元博士）
- 建構一台可擴充的超導量子電腦（計畫主持人：陳啟東博士）

## 重要研究成果



ⓐ 奈米電極對用於澱粉樣蛋白分子捕捉及電場子增強拉曼頻譜之分析

ⓑ 具鐵空位有序之$Fe_xSe_y$的電磁傳輸行為及驗證其為FeSe超導之絕緣母體

ⓒ 神經科學同步加速器 - 亞太科學聯盟：大腦成像國際監測

ⓓ 質子內反夸克成分不對稱性的探討

ⓔ 證據顯示NGC 1068附近的活躍星系發射中微子

ⓕ 圓洞井可控制間葉細胞生長停止，也能作為上皮類器官的培養

## 研究設施

### 大數據分析與科學計算

科學計算已成為與實驗及理論研究相輔相成的研究支柱。中研院網格中心（ASGC）在物理所支持下，自 2000 年，即參與歐洲粒子物理研究中心（CERN）主導之全球網格研發及導入，2005 年於本院設置全球網格第一個亞洲一級中心，以先進的分散式雲端計算架構與技術，與院內研究團隊合作將大數據分析流程最佳化，提供物理所及全院科學計算支援，以增進研究效能。全球網格為 Large Hadron Collider 實驗 2012 年發現上帝粒子（Higgs particle）的重要一環，正持續研發支援後續更多新物理的研究。ASGC 藉持續參與全球網格等國際合作，從實際研究應用中增進大數據與智慧化分析方法、效能與系統，提升核心技術自主能力，培育人才，強化資源與能源效能。網格中心於 2019 年改隸物理所，並自 2023 年起，成立全院科學計算與大數據分析核心設施，提供全院穩定高效能的科學計算資源，與研究團隊合作解決大數據分析之挑戰。

### 量子材料公用實驗室

本公用實驗室提供各式量子材料量測分析及微奈米製程服務。其主要設施包括 Class 6 無塵室，內有電子束微影、雷射直寫和光罩對準紫外光微影系統，以及蒸鍍及蝕刻等設備。量測則有物理性質量測系統、超導量子干涉儀、X-ray、掃描式電子顯微鏡、震動樣品磁化儀及表面測量等提供使用。

### 生物與軟物質物理公用實驗設施

本公用實驗設施為物理研究所和中央研究院的生物物理和軟物質物理研究提供重要公用設備，並促進跨學科合作交流與開拓新實驗工具。

### 精工室

精工室的功能是協助製造研究需要的精密機械零件。除此之外，也定期舉辦訓練課程，以提升學生及助理的設計及製造能力。

CNC車床

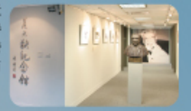
### 氦氣液化/純化設施

液化室可將回收的氦氣重新純化及液化。純化氦氣可達 99.999%，液氦生產量約為 35 公升 / 小時。所生產的液氦提供本所的低溫物理實驗，以及奈米核心設施：物理性質測量系統（PPMS）及超導磁性量測系統（SQIUD）等。

## 教育&延伸計畫

### 吳大猷紀念館

本館成立於 2001 年，紀念本所在臺第一任所長（1962-1976）及中央研究院院長（1983-1994）吳大猷。吳大猷院士（1907-2000）是近代中國著名的學者及享譽國際的物理學家，對臺灣及中國大陸的物理發展有卓著的貢獻。



### 臺灣國際研究生學程：奈米科學與技術學程

此跨領域教育學程成立於2004年，為中央研究院臺灣國際研究生學程的子學程之一，共同合作的機構為國立臺灣大學及國立清華大學。奈米科學與技術學程至今已吸引超過250名來自全球20多個國家的學生就讀，研究領域包括奈米結構及奈米元件的合成與特性研究、理論模型及計算、奈米生物科技，以及奈米元件等。

### 暑期大學生及研究實習培訓計畫

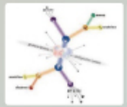
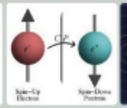
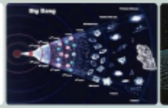
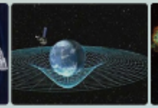
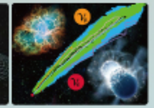
為加強吸引國內外的年輕學子對物理科學的研究興趣，本所於每年暑假期間提供國內外大學、研究所碩、博士生研習機會，並給予研究實習津貼。期能於學習物理基礎科學知識外，啟發有潛力的研究人才，未來從事物理科學研究。每年3-5月相關申請資料，都公布於本所網頁中。

# 中高能物理

## 理論粒子物理、粒子天文學及宇宙學

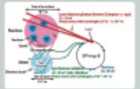
(安納托里、吳孟儒、吳建宏、李湘楠、阮自強、楊建倫)

理論研究題目包括：粒子現象學、高能對撞機物理、重離子碰撞物理、微中子天文學、核子天文學、高能天文學、宇宙射線、早期宇宙演化、重力波

## 實驗核子與粒子物理

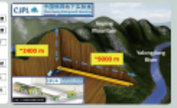
(王子敬、王惠銘、灰野禎一、侯書雲、張元翰、章文箴)



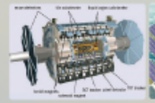
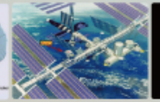
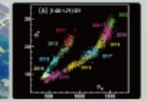
- 參加日本SPring-8的LEPS實驗，研究質子的奇異夸克成分
- 參加美國FNAL的SeaQuest實驗，研究質子反夸克分布不對稱性
- 參加歐洲CERN的COMPASS實驗，研究質子夸克橫向動量分布
- 參加日本J-PARC的E16實驗，研究強作用力的手徵對稱性恢復


- 重力波天文觀測研究 – 參加KAGRA及LIGO觀測站實驗





- 在台灣善里核電廠微中子實驗室研究微中子物理及搜尋低質量的暗物質
- 在四川錦屏地下實驗室尋找暗物質

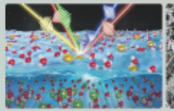
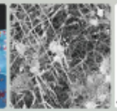
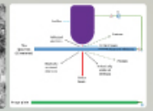
- 參加歐洲CERN(LHC)的ATLAS實驗，尋找希格斯粒子及標準模型以外的新物理現象
- 參加置於國際太空站上的AMS實驗，尋找太空中的反粒子及暗物質

# 量子材料物理

## 開發尖端顯微術與能譜術

(胡宇光、張嘉升、莊天明、黃英碩、溫昇傑、蘇維彬)

發展各種顯微鏡及能譜技術以探索奈米尺度與異質介面的量子現象，研究範圍包括超薄膜、奈米管線、奈米元件及固液態的界面等

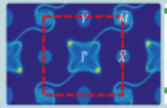
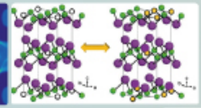
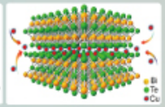




(由左至右)非線性光學顯微；X光斷層掃描影像重建；脈衝磁場製術

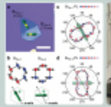
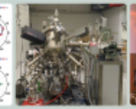
## 量子材料成長與鑑定

(吳茂昆、李尚凡、林新、柯忠廷、陳洋元)

利用理論及實驗方法研究量子材料中電子關聯、自旋軌道耦合等物理現象，探索重費米子物理、熱電效應、高溫超導物理機制、拓樸超導與拓樸物質系統

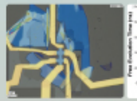
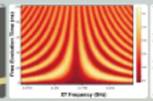
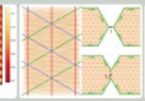
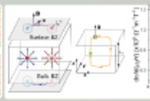
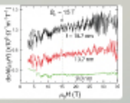
(上-由左至右)密度泛函理論對費米子行為預測；鐵基高溫超導材料；熱電材料
(下-由左至右)二維反鐵磁材料中激子偏光強度具有各向異性；氧化物基晶薄膜成長系統；新穎量子材料單晶成長


## 奈米結構中之量子位元物理與量子現象

(李偉立、徐晨軒、陳啟東、葉崇儒)

研究奈米結構內中的量子現象，包括電性傳輸、磁學、光學等現象以及傳統超導穿隧結構製作實用量子計算核心部件

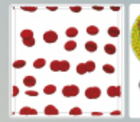
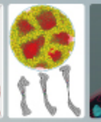
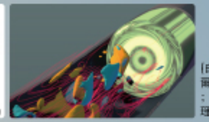
(由左至右)量子霍爾效應元件光學影像；超導量子位元干涉條紋測量；奈米結構中量子現象理論研究；非局域性Weyl量子震盪現象

# 生物與動態系統

## 理論模型建構及數值模擬

(平岩敏也、施宏森、梁鈞泰、陳彥龍)

我們致力研究以下課題：細胞液中的結構與流動力學關係，細胞中之染色體、骨架和組織的自組動態過程，細菌運動和傳染病的傳播模式，以致在生物、演化生態學和湍流等複雜系統的理論建構

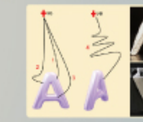




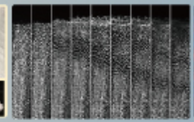
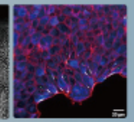
(由左至右)紅血球細胞被剪切流誘導而跳起"草莓芭舞"；染色體的自組形態和細胞集團的遷移；為解釋消波相變現象而建構的非平衡統計物理模型

## 物理生物學

(周家復、林耿慧、郭青齡)

主要研究課題有：用微奈米元件平台來研究分子/細菌生物物理及生醫檢測和組織工程之應用、生命系統生理和病理的定量模式識別、維度對細胞行為的影響和細胞如何利用力來進行生理功能



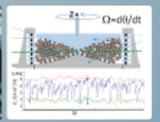



(由左至右)用於製作三維組織工程細胞骨架之紫蘇吐絲自駕單噴流電紡絲；傷口癒合時上皮細胞中骨架的微管排列情形；斑馬魚尾巴在傷口癒合時上皮細胞的集體遷移形成波

## 軟物質及顆粒體

(杜其永、蔡日強)

致力研究軟凝態及顆粒體物理，整合傳統上分散於流變學、固體及流體力學、非平衡態統計力學等的知識及觀念，旨在對物理系統背後普適原理有進一步的突破

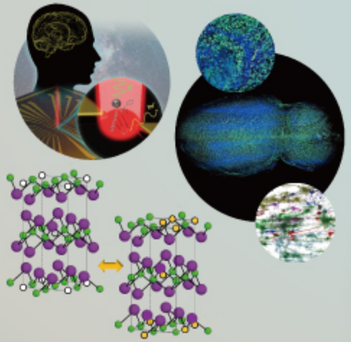



(由左至右)愛玉結膠的理論與實測；研究具旋轉流部的黃倉中細長殼物的流動；探討緊密顆粒的剪切流及狀態變化的實驗裝置與觀測

Founded 1928

# Institute of Physics

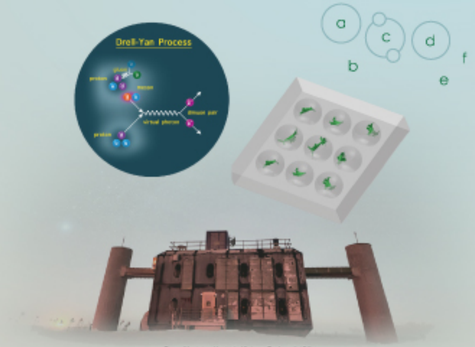
Academia Sinica



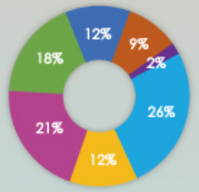
128 Academia Road, Section 2,
Nankang, Taipei 115201, Taiwan

e-brochure (2023)

1928 Founded in Shanghai, China
1962 Re-established in Taipei, Dr. Ta-You Wu as director
1966 Co-organized the "Physics Research Center" with local universities to promote research
1983 4-story physics building completed, scope of institute expanded considerably
1999 10-story new building completed, number of faculty members reached 40
2000 Physics building complex named after its first director as "Ta-You Hall"
2002 Re-integrated into three groups, formally divided into "Nanoscience Group", "Complex System Group" and "Medium and High Energy Physics Group"
2003 The idea of AsIoP's logo was born. The letters I, O, P are drawn with the additive primary colors blue, green, and red, and they are placed in such a way that one can depict G, c, h, k, the 4 fundamental constants which represent classical mechanics, electromagnetism, quantum mechanics, and statistical mechanics
2015 Three research groups were renamed "Quantum Materials Physics", "Medium and High Energy Physics", and "Physics of Active and Biological Systems"
2015 Under the auspices of Institute of Physics, Academia Sinica and Shui-Chin Lee Foundation for Basic Science, "ASIOP & Shui-Chin Lee Physics Lecture Series" were launched
2019 Establishment of the "Best Research Paper Award for Junior Research Investigators, Institute of Physics, Academia Sinica"




Credit: Martin Wolf, IceCube/NSF




- Faculty-Level Researchers
- Research Scientists
- Research Assistants
- Supporting Staff
- Postdocs
- PhD Students
- MS Students

## PROJECTS concerning key societal issues

- Project to Promote Green-energy Industrial Development - Construction of District-Scale Distributed Li-ion Battery Energy (MWh) Storage System
  (Principal Investigator: Dr. Maw-Kuen Wu)
- Decarbonize methane to hydrogen
  (Principal Investigator: Dr. Yang-Yuan Chen)
- Building a scalable superconducting quantum computer
  (Principal Investigator: Dr. Chii-Dong Chen)

## Significant ACHIEVEMENTS Research

- Electrode nanogap for amyloids molecular trapping & analysis via plasmon-enhanced Raman scattering
- Magnetotransport studies of Fe vacancy-ordered $Fe_{x+\delta}Se_2$ nanowires:
  Fe-Vacancy-Ordered $Fe_5Se_6$: The Insulating Parent Phase of FeSe Superconductor
- SYNAPSE: an International Roadmap to Large Brain Imaging
- Exploring antiquark asymmetry in the proton
- Evidence for neutrino emission from the nearby active galaxy NGC 1068
- Spherical microwells regulate the cell cycle arrest of mesenchyme cells and serve as platform for organoid growth

## FACILITIES

### Big Data Analysis and Scientific Computing

Computation has been an integral part of science advances process, along with theory and experiment. The Academia Sinica Grid Computing Centre (ASGC) was established in 2005 to join the World-wide Large Hadron Collider Computing Grid (WLCG) as one of the eleven Tier-1 centers and the only one in Asia. WLCG has demonstrated to be an enabler of physics programs according to the Higgs particle discovery in 2012. Additionally, WLCG keeps evolving for future computing challenges from new physics. Apart from supporting ATLAS and CMS computing, ASGC provides scientific computing solutions for the challenges from various disciplines in collaboration with research groups, based on WLCG core technologies. Capacity development on the following aspects to enhance scientific discovery are the perpetual goals of ASGC: efficiency optimization, analysis facility, talent, and supporting infrastructure.

### Quantum Material Shared Facilities

This shared facilities provide services for quantum material characterization and micro and nano device fabrication. Included in the facility is a Class 6 clean room which houses e-beam writer, laser writer, mask aligner, as well as evaporator and etchers. Characterization systems include Physical Property Measurement System (PPMS), Superconducting Quantum Interference Device (SQUID), X-ray, Scanning Electron Microscope (SEM), Vibration Sample Magnetometer (VSM) and surface metrology systems.

### The Biological and Soft Matter Physics Shared Facilities (BSSF)

BSSF provide essential facilities for research in biological physics and soft matter physics at the Institute of Physics as well as in Academia Sinica. BSSF also serve as a platform for promoting interdisciplinary collaborations and developing new experimental tools for studying biological and soft materials.


### Machine Shop

The Machine Shop provides technical support for high precision fabrication and production of mechanical parts required in scientific research. It also organizes short-term training programs to raise the design and production capabilities of students and research assistants.

Computerized Numerical Control lathe

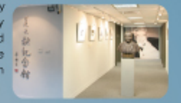
### Helium Liquefier/Purifier

The facilities include: Helium recovery system, purification and liquefaction plants which can be provided high-purity helium gas (>99.999%) and liquid helium of 35 l/h. We offer liquid helium for IOP' s instruments, such as low-temperature STM, PPMS, and SQUID.

## EDUCATION and OUTREACH

### Wu Ta-You Memorial Hall

Wu Ta-You Memorial Hall was established in 2001 to commemorate the first director of the Institute of Physics in Taiwan (1962-1976) and the president of Academia Sinica (1983-1994). Dr. Ta-You Wu (1907-2000) was a renowned scholar in contemporary China and an internationally acclaimed physicist, who had an enormous impact on the development of physics in Taiwan and Mainland China.



### Taiwan International Graduate Program: Nano Science and Technology Program

This multi-disciplinary educational program was established in 2004 within the Taiwan International Graduate Program (TIGP), in collaboration with National Taiwan University and National Tsing-Hua University. Currently the program has attracted more than 250 students from twenty-some countries worldwide, pursuing studies in synthesis of new nanomaterials and structures, characterization of nanomaterials and nanostructures, theoretical modeling and calculations, nano-biotechnology, as well as exploration of nanodevices engineering.

Distribution of Students' Nationality

### The Summer Internship Program

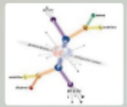
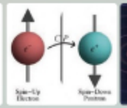
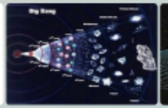
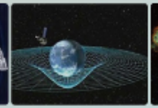
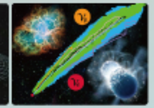
The Institute conducts a summer internship program with funding support to domestic and international university and graduate students. The goals are to provide opportunities to frontier physics research and to inspire them for future research careers. Further information can be found at the Institute website during the March-May application period.

# Medium and High Energy Physics

## Theoretical Particle Physics, Particle Astrophysics, and Cosmology

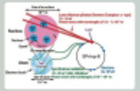
(Fedynitch, Anatoli / Li, Hsiang-nan / Ng, Kin-Wang / Wu, Meng-Ru / Yang, Di-Lun / Yuan, Tzu-Chiang)

Theoretical research topics include particle phenomenology, collider physics, heavy ion collisions, neutrino and nuclear astrophysics, high-energy astrophysics and cosmic rays, early universe, and gravitational waves.

## Experimental Nuclear and Particle Physics

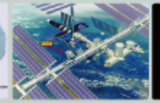
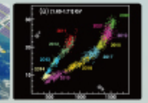
(Chang, Wen-Chen / Chang, Yuan-Hann / Haino, Sadakazu / Hou, Suen / Wang, Song-Ming / Wong, Henry Tsz-King)



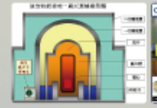
- Strangeness content of proton – LEPS at SPring-8 (Japan)
- Flavor structure of sea quarks in proton – SeaQuest at Fermilab (U.S.)
- Transverse-momentum degree of quarks in proton – COMPASS at CERN (Europe)
- Chiral symmetry restoration of QCD – E16 at J-PARC (Japan)


- Gravitational Wave Physics and Astronomy with KAGRA and LIGO Observatory



- Search for Higgs and new physics beyond Standard Model – ATLAS at LHC (CERN, Geneva)
- Search for antimatter and dark matter in space – AMS (International Space Station)



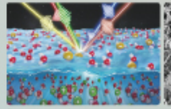
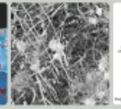
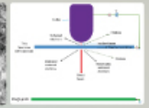

- Neutrino physics and low-mass dark matter search – TEXONO at Kuo-Sheng Reactor Neutrino Laboratory (Taiwan)
- Underground search for dark matter – Jinping Underground Laboratory (China)

# Quantum Materials Physics

## Advanced Microscopy and Spectroscopy

(Chang, Chia-Seng / Chuang, Tien-Ming / Hwang, Ing-Shouh / Hwu, Yeu-Kuang / Su, Wei-Bin / Wen, Yu-Chieh)

To develop and employ various micro-scopic and spectroscopic techniques to explore the quantum phenomena occurred at the nanometer scale in as ultrathin films, nanotubes, nanodevices, and the interfaces of heterostructures as well as solids/liquids.

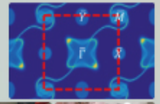
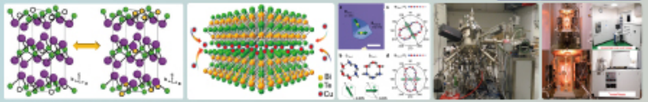




(Left to right)Nonlinear Optical Spectroscopy: Microtomography reconstructed image of neurons in mouse brain: Proximity scanning transmission electron micros-copy

## Quantum Materials Growth and Characterization

(Chen, Yang-Yuan / Ke, Chung-Ting / Lee, Shang-Fan / Lin, Hsin / Wu, Maw-Kuen)

Using theoretical and experimental methods to study quantum materials exhibiting novel phenomena as a result of strong electronic correlation and spin-orbit coupling; for example, heavy fermion physics, thermoelectric effect, the mechanism of high Tc superconductors, topological superconductivity and topological materials systems.

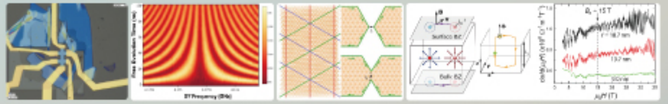



(Top)Prediction of Kramers-Weyl Fermions by DFT
(Bottom-Left to right)The Insulating Parent Phase of FeSe Superconductivity; N type $Bi_2Te_{3-x}Se_x$ : Two dimensional antiferromagnet shows anisotropic exciton photoluminescence; Oxide Molecular Beam epitaxy facility; New Quantum material development and single crystal growth

## Qubit Physics and Quantum Phenomena in Nanostructures

(Chen, Chii-Dong / Hsu, Chen-Hsuan / Lee, Wei-Li / Yip, Sungkit)

To fabricate nanostructures and investigate their quantum phenomena, including electric transport, magnetism, optical properties and etc. as well as to build a practical quantum computer with traditional superconducting junctions.



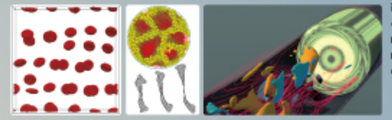
(Left to right)h-BN/graphene/h-BN quantum Hall device: Ramsey fringe plot of a superconducting qubit; Quantum Phenomena in Nanostructures: Nonlocal Weyl-orbit quantum oscillations

# Physics of Active and Biological Systems

## Theories, Modeling and Simulations

(Chen, Yeng-Long / Hiraiwa, Tetsuya / Leung, Kwan-Tai / Shih, Hong-Yan)

Theoretical models and methods are developed to study the structure-dynamics relations in cellular fluids; dynam-ic self-organizing processes in chromatin, cytoskeleton, cells and tissues; bacterial motility, spreading of infectious diseases; non-equilibrium complex systems in biology, evolutionary ecology and turbulence.

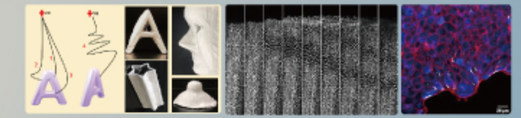


(Left to right)flow-induced "waltzing" of red blood cells in simple shear flow; chromatin organization and migrating cells; non-equilibrium statistical model for phase transition in turbulence

## Physical Biology

(Chou, Chia-Fu / Guo, Chin-Lin / Lin, Keng-Hui)

The main research topics include using nano/microdevices to study biophysics of bacteria, biosensing and tissue engineering application, quantitative pattern recognition on the physiology and pathology of living systems, the effect of dimensionality on cellular behaviors and how cells utilize force to perform biological functions.



(Left to right)Silk-worm like autopilot single jet electrospinning for 3D tissue engineering scaffolds; moving epithelia cells shows changes in microtubule orientation in wound healing; collective cell migration during wound healing on the zebrafish tailfin

## Soft Matter and Granular Materials

(To, Kiwing / Tsai, Jih-Chiang)

In soft matter and granular materials, we combine the knowledge and techniques from rheology, solid and fluid mechanics and non-equilibrium statistics, to deepen our understanding of the generic principles behind complex phenomena.

(Left to right)physics of the gelation of Ai-Yu; movement of elongated grains in silo with rotating bottom; experimental study at intermittency and transitions of packed grains