

# Synopses of HKUST Virtual Science Talks (March to April 2022)

Offered by the faculty members from the five academic units of the HKUST School of Science, the topics emphasis on the frontier scientific developments as well as the applications of science in our daily life. The target audiences are mostly secondary 3 to 5 students.

## Department of Mathematics

### Mathematics of Digital Image Processing

#### 圖像處理的數學

Speaker: **Prof. Tim LEUNG**

Department of Mathematics

Language: Cantonese

Image processing has a wide range of applications from medical imaging, denoising pictures taken from your cellphone and detecting objects from video. This talk introduces some fundamental mathematical tools of digital image processing. We will relate linear algebra and calculus from the secondary school mathematics curriculum to some modern applications from image recovery, segmentation, and big data technology.

圖像處理有着很多重要的應用。他們包括醫療圖像成形，手機圖像去除噪音，甚至乎從影片中找出物品。這個演講會介紹圖像處理裏面一些基礎的數學工具。我們會使用中學數學課程內的線性代數和微積分解決一些現代科技的問題。同學們可以接觸到圖像修復、圖像分割，和一些大數據技術的應用。

### Game Theory and its Application in

#### Decision Making

#### 博弈論及其在決策中的應用

Speaker: **Dr. Chi Man LEUNG**

Department of Mathematics

Language: Cantonese

Many decision making problems in real life, such as resource allocation, commercial strategy, involve the interaction with other people. As a result, the outcome will also be affected by the strategy taken by those people. Therefore, it is essential for decision maker to consider “his rival’s” strategy when determining his/her optimal strategy. Mathematically, this can be solved using the concept of game theory.

In this talk, we will first present some basic concepts about game theory. Then we will present several simple applications in economics such as electoral competition, price competition etc.

許多日常生活中的決策問題，例如資源調配、商業策略等，都涉及到與他人的互動。這些決策結果會受到其他人所採取的策略影響。因此，決策者在制訂最優策略時，必須考慮其對手的策略，這時候於數學界廣為研究的博弈論可以大派用場。

在本次講座中，我們會先探討博弈論的基本概念，然後介紹幾個簡單的經濟學應用，如選舉競爭、價格競爭等，讓大家更了解博弈論在日常生活中的決策應用。

## Math in Anime

### 動漫 · 數

Speaker: **Prof. Chi Wai YU**

Department of Mathematics

Language: Cantonese

"Imagination" is one of the elements in the intersection of mathematics and anime. Therefore, it is natural to learn mathematics from anime. For instance,

- (i) in "Naruto", the main character Naruto can use a "Multiple Shadow Clone" technique to create massive amount of copies of himself. The features of this ninjutsu look very similar to an important concept "iid" in statistics. How do we link them together?
- (ii) in "One Piece", Edward Newgate has an ability of producing an earthquake. So, what is the chance that he will make five earthquakes in the coming year?

In this talk, I will discuss how to find out / learn such "Math" from different animations.

「想像力」是數學和動漫交集中的元素之一。故此，從動漫去學習數學很理所當然。例如，

- (i) 在動漫《火影忍者》裡，主角鳴門可以使用多重影分身術創造大量自己的分身。這個忍術的特點看起來很像統計學上一個重要的概念"iid"。我們如何將它們連接在一起？
- (ii) 在動漫《海賊王》裡，白鬍子擁有發生地震的能力。那麼，他在未來一年會產生五次地震的可能性有多大？

在這次講座中，我們將討論如何從不同的動畫中找出/學習這樣的「數學」。

## Department of Physics

### From Invisibility Cloaks to Metalenses

#### 從隱形斗篷到超透鏡

Speaker: **Prof. Jensen LI**

Department of Physics

Language: Cantonese

The advance of nanofabrication allows us to design nanostructures in building up metamaterials, which derive their optical properties from structures rather than constituent materials. These nanostructures, as a new form of materials, allow us to explore unimaginable applications from making objects invisible to integrating compact and multifunctional lenses to portable applications.

納米製造的進步使我們能夠通過設計納米結構來構建超材料。我將向你展示這些材料如何根據其結構而不是組成材料去賦予其光學特性。這些材料的應用包括從隱形斗篷到製造多功能超材料透鏡。

### Physics in Movies

#### 電影中的物理

Speaker: **Dr. Yee Fai NG**

Department of Physics

Language: English

Movies are for entertainment. Scenes in movies are sometimes described in a grossly exaggerated manner violating the laws of physics. By analyzing the situations portrayed in some movies featuring action, sci-fi, and fantasy, we seek to illustrate the correct or incorrect concepts of physics.

電影能娛樂大眾。一些電影中的場景異常誇張，違反了不少物理定律。透過分析不同的動作電影和科幻電影，我們會為大家介紹電影中涉及到的正確或錯誤的物理概念。

### The Effects of Marine Microbes on Climate Change 海洋微生物與全球氣候變化

Speaker: Prof. Stanley LAU

Department of Ocean Science

Language: English

Marine microbes are the most abundant and ubiquitous organisms on our planet. However, we often overlook their presence and their important functions in the ecosystems because they are too small to be seen by naked eyes. For example, the gaseous and other metabolites produced by bacteria have important impacts on the composition of the atmosphere and hence the climate. It is well known that carbon emission as a result of human activities is an important cause of global climate change. What we often overlook are the impacts of human activities on marine microbes in the natural environment and subsequently the effects of the stressed microbial communities that may have on the climate.

海洋微生物是地球上種類和數量最多的生物類別，牠們在自然環境中無處不在。但由於我們不能用肉眼看見海洋微生物，所以忽略了牠們在地球生態系統運作上的重要性。例如海洋微生物在自然環境中排放出大量的氣體和代謝物，這些排放物對大氣成分和全球氣候有重要的影響。在全球暖化的問題上，大家只著眼於碳排放為人類活動對氣候變化的主要元兇。但是，人類活動同時亦對自然環境中的海洋微生物有極大的影響，這些影響同樣對氣候變化有很大的作用。

### The Marine Biodiversity of Hong Kong 香港的海洋生物多樣性

Speaker: Dr. Cynthia YAU

Department of Ocean Science

Language: English

The waters of Hong Kong are home to a remarkable diversity of marine life that includes such iconic species as the Chinese white dolphin, Green sea turtle, and horseshoe crabs. The very history of Hong Kong is strongly interconnected with the wealth of its natural marine resources, from its early beginnings as a fishing village exploiting the abundance of seafood teeming in local waters to the collection and cultivation of pearls for the Tang emperor. In this talk I will explain the main reasons for Hong Kong's rich marine biodiversity and we will explore some of the nearly one thousand species of fishes, dozens of coral species, as well as countless species of molluscs, crustaceans, and echinoderms that can be found here. We will discuss the threats facing local marine life in terms of their continued survival and how each of us can contribute towards their conservation.

香港水域擁有豐富的海洋生物資源，其中包括中華白海豚、綠海龜和馬蹄蟹等標誌性物種。這些海洋自然資源與其歷史密切相關，從早期的漁村開始，人們在本地水域捕撈海鮮，為唐朝皇帝收集和種植珍珠等，都離不開利用海洋自然資源。在這次講座中，我將講解香港擁有豐富的海洋生物多樣性的主要原因，並將探討在香港水域出沒的近千種魚類、數十種珊瑚，以及無數種類的軟體動物、甲殼類動物和棘皮動物。最後亦會討論本地海洋生物面臨什麼影響到其生存和繁衍的威脅，以及大家如何能夠為海洋保育作出貢獻。

### The Chemistry of Fire and Explosion

### 火和爆炸的化學

Speaker: Prof. Jason CHAN

Department of Chemistry

Language: Cantonese

Fires burn with high-rising flames, explosions go with a bang. Spectacular as they may be, we also know that they can represent significant dangers if they go out of control.

Whether you realise it or not, combustions and explosions are essential to many aspects of our everyday life. In this lecture, we shall explore these phenomena from a chemistry perspective and gain a deeper understanding into these highly energetic forms of chemical reactions.

火焰的燃燒、爆炸的巨響。儘管可能很壯觀，但我們也知道，萬一失控，火和爆炸也會帶來危險。其實燃燒和爆炸對於我們的日常生活都是非常重要的。在這講座中，我們將從化學的角度探討燃燒和爆炸，好讓學生能對這些高能量的化學反應有更深入的了解。

### Renewable Energy vs. Fossil Fuels

### 可再生能源 vs. 化石燃料

Speaker: Prof. Emily TSANG

Department of Chemistry

Language: English

Energy plays a very important role in our daily lives (i.e., for transportation, cooking, and electricity generation, etc.). Currently, at least 80% of our energy come from the burning of fossil fuels - coal, oil, and natural gas - which are scarce and have generated environmental problems. In this context, alternative renewable energy provides promising solutions to our ever-increasing energy demand. In this talk, some of the recent technological developments in alternative renewable energy will be explored.

能源在我們的日常生活中扮演著重要的角色（例如用於運輸、烹飪、發電等）。目前，至少有 80% 的能源來自化石燃料，例如煤、石油、天然氣等。化石燃料是稀缺的，而燃燒這些燃料所產生的環境問題也為社會所關注。因此，為應付日益增加的能源需求，發展可再生能源就成為了可行的解決方案。在這次講座中，我們將探討可再生能源技術於各個範疇的最新發展。

### New Insights into Plants' Life

#### 植物新知

Speaker: **Dr. Melody LEUNG**

Division of Life Science

Language: Cantonese

Humans and plants have a complex relationship. Plants provide us food, oxygen, pharmaceuticals and many more. Although we know very well that we cannot stay alive without plants, we do feel that humankind is a more superior existence, while plants are easy victims for our exploitation. Through this talk, I want to give you a new prospective to plants. I will introduce several intriguing plant behavior and capabilities that are beyond our imagination. I hope we can restore a sustainable mutualistic relationship with plants.

人類跟植物有著複雜的關係。植物為我們提供食物、氧氣，藥物和更多。我們都清楚知道沒有植物人類根本活不下去，但我們又會覺得人類是較高等的存在，而植物可以任由我們剝削。我會讓大家透過這個講座對植物有新的認識。我會介紹幾個有趣的植物行為和超乎想像的能力。我希望我們可以跟植物重建一個可持續的互惠共生的關係。

### Modeling Human Diseases with Tiny Worms

#### 如何利用細小線蟲模擬人類疾病

Speaker: **Prof. Ho Yi MAK**

Division of Life Science

Language: English

Have you ever thought about how similar we are to a transparent, 1mm-long worm? The use of *Caenorhabditis elegans* to study fundamental questions on physiology was championed by the Nobel Prize winner Sydney Brenner. Importantly, many of our genes look similar to the worms'. Using genome editing techniques, like CRISPR, we can now make precise changes in the worms' DNA so that they carry the equivalent mutations that cause deadly genetic diseases in humans. Attempts to cure the sick worms can then give us clues to new ways for treating these diseases.

有沒有想過我們與一種一毫米長的透明線蟲有多相似？諾貝爾獎得主 Sydney Brenner 提倡用秀麗隱桿線蟲 (*Caenorhabditis elegans*) 研究生理學上的基本問題，這很大程度上是因為不少人類基因都與線蟲的十分相似。利用包括 CRISPR 在內的基因編輯技術，我們現在可以精確地修改線蟲的 DNA，使其攜帶相等於導致人類致命遺傳疾病的突變。透過嘗試醫治這些患病的線蟲，我們可以得到治療相關人類疾病的線索。

## How Vaccines Work: the Science of Recognizing and Killing a Zombie

Speaker: Prof. Angela WU

Division of Life Science

疫苗知多少：身體裡的生化危機與秘密武器

Language: English

With the COVID-19 pandemic not yet over, it is important to use science to protect ourselves against invading pathogens like the SARS-CoV-2 virus. How does our immune system work? How do vaccines protect us? What is the difference between different kinds of COVID-19 vaccines? Learn more about the science behind vaccination and immunity in this talk.

影響全球的新冠病毒疫情尚未完結，人們必須以科學的方法去對抗各種入侵人體的病原體，例如 SARS-CoV-2 病毒。其實我們的免疫系統是怎樣運作的？疫苗如何能夠保護我們？不同的新型冠狀病毒疫苗有什麼分別？讓我們在這個講座裡一起探討疫苗和免疫系統背後的科學吧。