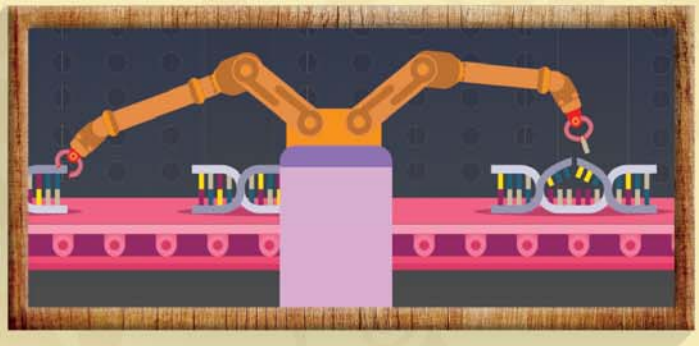
SCIENCE FOCUS 科言

Issue 013, 2018



School of 理學院 Science

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Contents

Science Focus Issue 013, 2018

Message from the Editor-in-Chief 主編話語

Dear Readers,

Welcome to the latest issue of *Science Focus*! After serving as a scientific advisor of this magazine in the last two years, this is the first time I write as the Editor-in-Chief. As usual, we hope to bring you interesting scientific stories that connect closely with daily lives. Have you used hand warmers in the past winter? Do you know the chemistry behind these heat-emitting pouches? The import of drugs to treat rare genetic diseases was widely covered in the local news. Do you know gene editing may provide alternative treatment options in the future?

Looking forward, we strive to increase our digital presence by posting in our website and on social media. Please leave us your feedback and suggestions so that *Science Focus* can better serve you. And don't forget our writing competition. You may submit your articles by email at sciencefocus@ust.hk for a chance to have them published in future issues.

Lastly, I would like to thank Professor Yung Hou Wong for laying a solid foundation for *Science Focus*. Our staff and student editors will continue to work closely together for many issues to come.

Yours faithfully,
Prof. Ho Yi Mak
Editor-in-Chief

親愛的讀者：

歡迎閱讀最新一期的《科言》！在過去兩年，我一直擔當這本雜誌的科學顧問，這是我第一次以主編的身份和大家見面。一如既往，我們希望帶給你各個與生活息息相關的有趣科學故事。你在剛過去的冬天有用過暖手包嗎？你知道這些發熱小包背後的化學原理嗎？最近以進口藥物治療罕見遺傳疾病的新聞被大篇幅報導，你是否知道基因編輯未來有機會可以成為另一治療方案？

展望將來，我們會致力加強網上工作，並於我們的網站及社交媒體上發佈新消息。歡迎你們提出意見及建議，讓《科言》可以更進一步。請不要忘記我們的寫作比賽，你可以將作品電郵至 sciencefocus@ust.hk，並有機會獲刊登於未來的《科言》中。

最後，我想感謝王殷厚教授為《科言》奠下了穩健基礎，而我們的團隊及學生編委亦會為《科言》繼續緊密合作。

主編 麥晧怡教授
敬上

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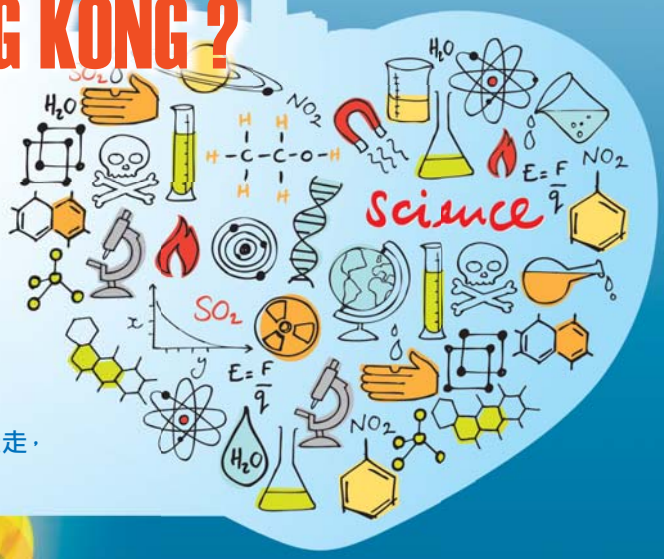
Homepage: **http://sciencefocus.ust.hk**

WHAT'S HAPPENING IN HONG KONG?
香港科技活動



Let Your Love for Science Flourish!

The cold winter has passed, and it's time for you to go out and have some fun in the following selected events with your family and friends in this spring!

盡情展現你對科學的喜愛！

寒冷的冬天已經過去，是時候趁著這個和暖的春天與家人朋友到處走走，一起參加以下精選活動吧！

HK SciFest 2018

The annual HK SciFest is back again! A wide range of over 160 scientific activities are available during the event, including science demonstrations, fun experiment classes, science drama shows, film appreciation, visits and guided tours, etc. You will surely enjoy the SciFest while enhancing your understanding of science through these interesting activities!

Date: Now – 25 April 2018

Venue: Hong Kong Science Museum

Website: *http://www.hk.science.museum/scifest2018/eintroduction.php*

"SOPHIE – IVE's Solar Cars Driving the Future" Special Exhibition

Ever wonder how solar energy works in green cars? The locally developed solar car series – SOPHIE is now on display. You will get to see the fourth generation of this series, SOPHIE IV, and find out more about solar cars and its related technologies through this interactive exhibition!

Date: Now – 12 September 2018

Venue: 2/F Exhibition Hall, Hong Kong Science Museum

An Adventure to the Amazon

Wonder what you will find in the mysterious Amazon? The Hong Kong Space Museum is running an OMNIMAX Show "Amazon Adventure" until 31 August 2018. Let's join an adventure there now! For details, please visit *https://goo.gl/nJCQC7.*

香港科學節2018

一年一度的香港科學節現正舉行！大會籌備了多達160項不同類型的科學活動，包括科學示範、趣味實驗班、科學劇場、電影欣賞、參觀及導賞等，保證你能透過這些有趣活動加深對科學的認識，盡興而歸！

日期：即日至2018年4月25日

地點：香港科學館

網址：*http://www.hk.science.museum/scifest2018/introduction.php*

「SOPHIE - IVE的太陽能車驅動未來」專題展覽

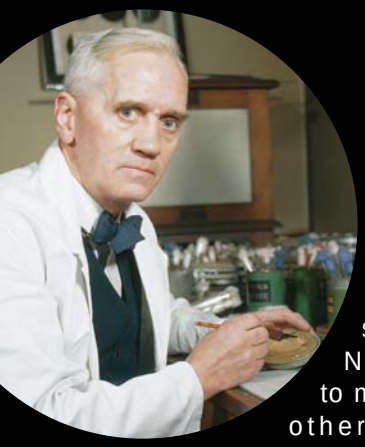
你有否想過太陽能是如何驅動環保車輛？於本地研發的太陽能車系列SOPHIE現正公開展覽，展覽將展示系列的第四代太陽能車SOPHIE IV，你亦可以透過這個互動展覽加深對太陽能車及其相關科技的認識！

日期：即日至2018年9月12日

地點：香港科學館二樓展覽廳

亞馬遜歷險

你是否好奇在神秘的亞馬遜內，究竟會遇見什麼事情呢？香港太空館現正上映全天域電影《尋謎亞馬遜》，映期至2018年8月31日。現在一起到那裡歷險吧！詳情請參閱 *https://goo.gl/45wLmR*。



Penicillin: Beyond Fleming

盤尼西林的幕後英雄

By Chantelle Sullivan 蘇盈安

Alexander Fleming is a household name synonymous to the discoverer of Penicillin, one of the most widely used antibiotic agents that has saved countless people. Nevertheless, unbeknownst to many people is that many other scientists, with the key ones being Howard Florey, Ernst Chain and Norman Heatley, also made significant contributions towards the success of the discovery and production of penicillin.

It all started in September 1928, when Fleming left his laboratory for a few days without cleaning up the plates on which he grew some samples of bacteria. Upon his return, he noticed a mold growing on one of the plates. However, there was a ring free of bacteria surrounding it. He postulated that the mold – which he then found to be *Penicillium notatum* – might contain a substance that killed bacteria, and named the substance penicillin. However, *P. notatum* was difficult to grow, and introducing it to the human body orally proved to be ineffective. The idea of mass-producing penicillin as an antibiotic seemed too difficult and expensive to achieve.

Now that Fleming has provided the scientific community with the first clue in solving the puzzle of antibiotic extraction and production, further problems had to be solved by other scientists. In 1938, Florey and Chain, two scientists from Oxford University, stumbled across Fleming's papers on penicillin and decided to research on improving antibiotic extraction. One of the trainees of Chain, Norman Heatley, was able to produce penicillin of a much higher purity with a method called back-extraction. The method began with mixing an acidified mold solution with amyl acetate, which left behind some unwanted impurities. Next, the solution was introduced back into water via a countercurrent system [1]. Upon freeze-drying of the mixture, a 1% pure penicillin powder was obtained. With this method, the team had enough penicillin to test on mice that were injected with Streptococcus bacteria. The promising results showed that the mice recovered after receiving a dose of penicillin [2].

By 1941, Britain was suffering immensely from damages done by the Second World War. Resources for scientific research were depleted, and Florey was left with no choice but to make his way to the United States to further his research. A team was assembled in Peoria, Illinois, which Heatley was also a part of. A growth medium based on liquid extract was used to grow the mold, and gave a tenfold increase in yield [1]. However, the team was determined to find another strain of bacteria that was capable of producing a higher amount of penicillin, to solve the problem of mass-producing the antibiotic.

In 1943, the team was still hard at work in finding a new strain. A new mold, *Penicillium chrysogenum*, was found in cantaloupe. It produced penicillin 200 times more than Fleming's strain did. Additional refining gave rise to a further five-fold increase in yield [1].

The mass production of penicillin was in near success when Heatley surprised the team with his innovation – by mechanizing his back-extraction method by using whatever materials he could find, including drink bottles and milk churns, to speed up the production process and reduce manual labor. Furthermore, another problem was tackled when glyceryl monoricinolate, an antifoaming agent, was added to the mixtures to prevent severe foaming when sterile air was bubbled, to provide the mold with fresh air for penicillin production [1].

At this point, penicillin could be produced in quantities large enough to be packaged for soldiers of the war, preventing further deaths caused by bacterial infections. The antibiotic was only made available to the general public in 1945, upon the end of the Second World War. Following their pivotal achievement, other scientists combined efforts into creating different kinds of antibiotics that targeted other bacteria, some of which could not be killed by penicillin.

While Heatley unfortunately did not receive the recognition he deserved for his key contribution to the development of the antibiotic, Florey and Chain shared the Nobel Prize for Medicine with Alexander Fleming in 1945 [3], for their joint efforts on their work on penicillin, and for paving the way for future studies on antibiotics. Their groundbreaking discovery of penicillin and subsequent invention of antibiotics proved to be a revolutionary turning point in medical science, changing the way in which medicine was practiced, and undoubtedly saving the lives of millions.

盤尼西林是最常用的抗生素之一，至今幫助了無數的病人。不少人都知道，盤尼西林是由英國科學家亞歷山大·弗萊明發現的。然而，還有不少科學家，例如霍華德·弗洛裏、厄內斯特·錢恩和諾曼·希特里，亦對盤尼西林的發現和生產作出了重大貢獻。

1928年9月的某一天，弗萊明離開實驗室時，忘了清理細菌培養皿。數天後，他回到實驗室，發現其中一個培養皿內長了霉，但霉的周圍並沒有細菌。弗萊明假設這種青黴菌—*Penicillium notatum*—可能帶有能殺死細菌的物質，並將這物質命名為盤尼西林。不過，培養這種霉並不容易，而且透過口服方法使其進入人體亦不奏效。大量生產盤尼西林似乎太困難，成本亦太昂貴。

弗萊明的發現可謂為科學家帶來了解決提取和生產抗生素問題的第一個提示。1938年，兩名牛津大學的科學家——弗洛裏和錢恩，看到弗萊明關於盤尼西林的文章，決定研究改善抗生素的提取。錢恩的下屬希特里成功運用逆萃取的方法生產純度較高的盤尼西林。希特里先將酸化霉液和乙酸戊酯混合，以遺留一些多餘的雜質。然後，該液體透過逆流系統引入到水中[1]。透過冷凍乾燥法，便能得到1%純度的盤尼西林粉末。這方法讓科學家得到足夠的盤尼西林去對老鼠進行實驗。結果顯示，被注射鏈球菌屬細菌的老鼠得到盤尼西林後便痊癒了[2]。

到了1941 年，英國因為第二次世界大戰受到重大打擊，科學研究的資源不足，弗洛裏唯有到美國繼續研究。他在伊利諾州皮奧里亞城組成了團隊，希特里亦是成員之一。科學家用以玉米提取物為基礎的培養基來培養霉，產量提升了十倍[1]。但是，研究團隊決心找出另一品系的細菌，以生產更多的盤尼西林，解決大量生產抗生素的問題。

1943年，團隊依然致力尋找新的品系。他們在哈密瓜中發現金黃青黴，它能生產比弗萊明的品系多200倍的盤尼西林，額外的提煉更能使產量提升五倍[1]。

希特里的創新主意讓科學家離大量生產盤尼西林又再接近一步。希特里運用任何他找得到的材料，例如飲料瓶和牛奶攪拌器，使他的逆萃取方法機械化，加快生產速度和減少人手工作。此外，加入一種名為甘油單蓖麻油酸酯的消泡劑能預防嚴重的起泡情況出現，讓黴菌有新鮮空氣生產盤尼西林[1]。

此時，盤尼西林已經可以被大量生產，產量足以供應參與戰爭的士兵，防止因細菌感染造成的死亡。直到1945年第二次世界大戰結束，抗生素才供給大眾使用。接著，其他科學家亦合力生產不同種類的抗生素，針對其他種類的細菌，當中亦包括一些盤尼西林不能殺死的細菌。

基於弗洛裏、錢恩和弗萊明在這項研究中取得的成果，以及為將來抗生素研究所鋪下的路，他們在1945年共同得到了諾貝爾生理學或醫學獎。可惜的是，希特里並沒有因著他對盤尼西林發展的重大貢獻得到相稱的認可[3]。盤尼西林的發現和之後其他抗生素的發明，是醫學科學領域中的重大轉捩點，大大改變了藥物的使用，並拯救了數以百萬計的生命。

References 參考資料：

[1] American Chemical Society. Discovery and Development of Penicillin. American Chemical Society International Historic Chemical Landmarks. Retrieved from *https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/flemingpenicillin.html*

[2] Bédoyère, G. The Discovery of Penicillin. London: Evan Brothers Limited, 2005.

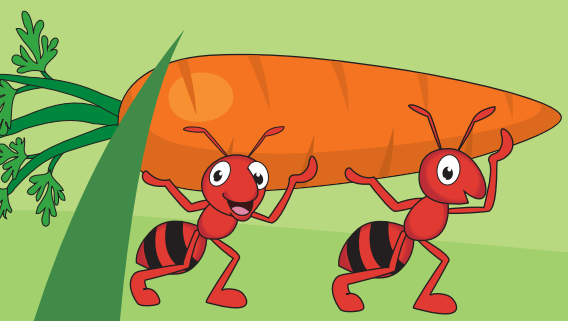
[3] Rooney, Anne. The Story of Medicine. London: Arcturus Publishing Limited, 2009.

Lazy Ants Are Far From Useless

By Twinkle Poon 潘晴

Ants are arguably the world's most productive organisms. However, are all ants as relentlessly hardworking as they apparently are? Studies have shown that typically over 50% of workers in a social insect colony (for example, ants, honey bees, wasps, termites) are inactive at any one time [1]. Daniel Charbonneau and Anna Dornhaus, entomologists of the University of Arizona, investigated a group of "lazy" members of the ant species *Temnothorax rugatulus*. When tracking the behavior of 250 ants, the researchers found that 40% of them were inactive consistently [1].

In another study with biologist Takao Sasaki of the University of Oxford, the scientists collected 20 colonies of *Temnothorax rugatulus* [1]. They painted the ants with special color codes so that they could track the behavior of each individual over time with an HD camera. The ants were observed and classified into three broad categories according to the tasks they performed: active, inactive and undifferentiated. The active class refers to ants performing tasks such as building, foraging, eating and grooming, while inactive ants are those that are completely immobile and not engaged in any of the active tasks mentioned before. Ants are undifferentiated when they are mobile inside the nest and not engaged in any active task.



The scientists then removed some of the workers to observe how the colonies were affected. Each colony received either of these treatments: removal of the 20% most active workers, that of the 20% most inactive, and that of 20% randomly picked workers.

Overall, the activity of the affected colonies was re-established, with no significant difference between pre-removal and post-removal stages. The colonies seemed to compensate the loss of workers after the most active ones were removed. Within two weeks of removal, some of the inactive ants became the most active workers. On the other hand, upon removal of the inactive workers, the colonies did not seem to replace them.

This observation supports the hypothesis of reserve labor, one of the most common explanations for social insect "laziness". It is suggested that inactive ants can serve as standbys to replace active workers when necessary, allowing a colony to respond quickly and flexibly to changes in labor. The reserve labor force could be crucial to a colony's survival in case of emergency, such as being attacked.

Apart from being reserve labor, other potential functions of "lazy workers" have been proposed, such as acting as food storages or energy reserves for production. It is also possible that the seemingly inactive insects are indeed performing crucial tasks that have not been observed and identified yet.

並非毫無貢獻的懶惰螞蟻

The research team speculated that age could be one of the determining factors of "reserve" ant workers. For example, it makes sense for young workers to be inactive as they are the most vulnerable members of the colony [2].

Despite the relatively large proportion of inactive individuals in a colony, ants remain one of nature's most successful organisms. The "laziness" of the ants might play an important role in maintaining long-term sustainability in the complex insect society. Indeed, the studies show that there is still plenty for us to learn about insects' "laziness".

螞蟻可說是世界上生產力最高的有機體。然而是否所有螞蟻都無間斷地勤奮工作呢？研究顯示，典型的社會性昆蟲的巢穴中（例如螞蟻、蜜蜂、黃蜂與白蟻），超過百分之五十的工兵都會在某些時間處於非活躍狀態[1]。亞利桑那大學的昆蟲學家Daniel Charbonneau和Anna Dornhaus進行的螞蟻（*Temnothorax rugatulus*）研究顯示，在250隻螞蟻中，約百分之四十經常處於非活躍狀態[1]。

其後兩位科學家聯同牛津大學的生物學家Takao Sasaki收集了二十個*Temnothorax rugatulus*的巢穴，在螞蟻身上塗上不同的顏色，再配合高清攝像機觀察並記錄螞蟻的行為[1]。根據螞蟻的主要活動性質，大致可將牠們分為三類：「活躍型」、「非活躍型」和「無差異型」。「活躍型」是指螞蟻的活動包括建造巢穴、覓食、進食及整理等；如果螞蟻一般是靜止狀態，並沒有進行上述任何活動，就屬於「非活躍型」；如果螞蟻只在巢穴中走動，但並非進行任何活躍活動，便屬於「無差異型」。

研究團隊做了一連串實驗：移走百分之二十最活躍的工蟻、移走百分之二十最不活躍的工蟻、及隨機抽選百分之二十的工蟻，觀察對蟻群的影響。

總括來說，在移走工蟻後，蟻群會重新建立活動，與之前沒有明顯差異。最活躍的工蟻被移走的兩星期後，部分非活躍工蟻會變成最活躍工蟻；反之，非活躍工蟻被移走後卻沒有補充。

這些實驗證實了社會性昆蟲怠惰的最常見解釋——後備勞動力的補充。假設非活躍工蟻作為後備，在有需要時補充成為活躍工蟻，讓蟻群迅速及靈活地應付工作的需要。後備勞動力對蟻群的存亡尤其重要，特別是如受襲擊的緊急情況下。

除了作為後備勞動力，「懶惰工蟻」的其他作用可能包括儲存食物或保存能量，這些看似非活躍的工蟻亦可能正進行一些我們尚未觀察或辨識到的重要工作。

研究團隊推斷年齡也許是決定後備工蟻的重要因素之一，由於年輕工蟻在蟻群中屬最弱小的成員，牠們不活躍的特性尤其有利[2]。

儘管蟻群中似乎有相當多的「懶惰」個體，但螞蟻依然是大自然中最成功的生物之一。螞蟻的「怠惰」在維持複雜的社會性群體扮演至關重要的角色。事實上，研究顯示了我們對昆蟲的「怠惰」習性仍然有很多未知數。

References 參考資料：

[1] Charbonneau, D., Sasaki, T., Dornhaus, A. Who needs "lazy" workers? Inactive workers act as a "reserve" labor force replacing active workers, but inactive workers are not replaced when they are removed. PLoS ONE 12(9): e0184074. (2017). *https://doi.org/10.1371/journal.pone.0184074*

[2] Stolte, D. Lazy Ants Make Themselves Useful in Unexpected Ways. UANews (2017). Retrieved from *https://uanews.arizona.edu/story/lazy-ants-make-themselves-useful-unexpected-ways*

The Mystery of the Universe — Negative Mass

By Long Him Cheung 張朗謙

Mass seems to be something trivial for all of us – it is obvious that a heavier object should have a greater mass. Nonetheless, the concept of mass was introduced so late in the 16th century by Sir Isaac Newton in his famous Newton's Law of motion. Before Newton, although people had the idea of heaviness, they did not come up with a systematic way to define it.

People are often confused with the terms weight and mass, which are two completely different ideas. Weight refers to the gravitational force acting on an object, yet mass is a measure of the tendency for an object to remain in uniform motion. An alternative way to describe mass is that an object with greater mass requires a greater force to accelerate.

From our daily experience, if we push an object, it should move away from us. This seems to be a stone-cold fact. However, it is not always the case – it is only true for positive mass. All the objects we normally encounter have positive mass, that is, the object would accelerate in the same direction as the applied force. It is counterintuitive to imagine an object accelerating towards you when you push it away. Nevertheless, like how matter can have a positive or negative charge, there is no physical constraint preventing the existence of negative mass. Although negative mass is absent from our daily lives, negative mass may have an important role in astrophysics and cosmology [1].

Recently, led by Peter Engels, professor of physics and astronomy from Washington State University, researchers have created a fluid composed of rubidium atoms which exhibit the property of negative mass at extremely low temperatures. Using a technique called laser cooling, the rubidium atoms are slowed down and trapped by lasers until they are cooled to a temperature near absolute zero. At such a low temperature, the particles obey the principles of quantum mechanics, which govern the interaction between particles under low energy regime. The fluid thus forms a state of Bose-Einstein condensate, which refers to an ultra-cooled dilute fluid, where most particles are in their ground state as the energy is too low for any excitation [2]. It is as if the lasers-trapped atoms are experiencing great pressure – once the laser trap is disturbed, the atoms may rush out. Making use of this property, the researchers shot a second set of lasers to shake the atoms. Under such conditions, the rubidium atoms tended to rush out in the opposite direction as the applied force, showing traits of negative mass [1].

Negative mass seems to be a weird concept, yet it is closely related to astrophysics and cosmology. In theory, it is expected to have a kind of substance called dark energy, which exhibits repulsive gravitational force, and plays an important role in the expanding universe. It is predicted that if dark energy really exists, it should have negative mass. Up till now, there is no experiment available to study the analogous physics related to dark energy. Nevertheless, with the newly developed rubidium fluid that shows traits of negative mass, scientists may be on the brink of a breakthrough for the study of fundamental forces, as well as cosmological phenomena such as black holes [1].

宇宙之謎—負質量

質量好像是一樣眾所周知的東西，人們都明白質量愈大的物件就愈重。可是，質量這一概念其實是於16世紀始由牛頓在其著名的牛頓運動理論中提出。在牛頓之前，雖然人們對重量有表面上的理解，卻未能有系統地為其作出定義。

很多人都會把質量與重量有所混淆；重量指的是地球向物件所作出的重力，而質量則是指物件傾向處於統一運動的慣性。以另一種說法來形容質量的話，就是質量愈大便需要愈強的力去使其加速。

日常生活的經驗告訴我們，如果我們用力推一件物件，物件便會遠離我們。然而，這並不一定是對的，這只適用於擁有正質量的物件。我們日常接觸到的物件全都擁有正質量，亦即是代表它們受力時會順向加速。若果物件擁有負質量的話，那麼事情就相反了，物件受力時會逆向加速。這似乎有點難以想像，但就像電荷有正有負一樣，理論上物件是可以帶有負質量的。儘管負質量與我們的日常生活毫無關連，但其在天文學及宇宙學中扮演著不可取替的角色 [1]。

在華盛頓州立大學，一組由天文物理學家彼得·恩格斯所帶領的研究人員成功創造出一種由銣原子組成的特殊流體，而這種流體在極低溫下會展現出和負質量一樣的特質。通過鐳射冷卻的技術，科學家們可利用激光令銣原子減速，並將其困住，直至溫度下降至接近絕對零度。在如此低溫下，粒子遵循量子力學的原理，在低能量狀態下粒子之間的相互作用會出現量子效應。由於能量太低，大多數粒子都處於基態，因此銣原子流體會進入玻色–愛因斯坦凝聚體的狀態 — 指超冷的稀釋流體 [2]。這些用鐳射困着的原子就好像處於高壓狀態一樣，一旦這個系統受到干擾，銣原子便會一湧而出。研究人員利用這一特性，以第二套激光來震動被困住的銣原子；當銣原子被激光推動時，便會向反方向衝出激光困牢，呈現尤如負質量一樣的特性 [1]。

If you kick a ball with negative mass to the right, the ball would fly to the left instead.

負質量似乎是一個奇怪的概念，但其與天體物理學及宇宙學有密切關係。理論上，科學家預測宇宙中存在一種名為暗能量的物質，具有相互排斥的引力，並在宇宙膨脹中有著重要的作用。如果暗能量真的存在，它應該擁有負質量。然而到目前為止，還沒有任何實驗可以用來研究與暗能量有關的物理現象。隨著這新開發、具有負質量特性銣流體的出現，科學家對於黑洞等宇宙學現象以及基礎力的研究或許能有所突破 [1]。

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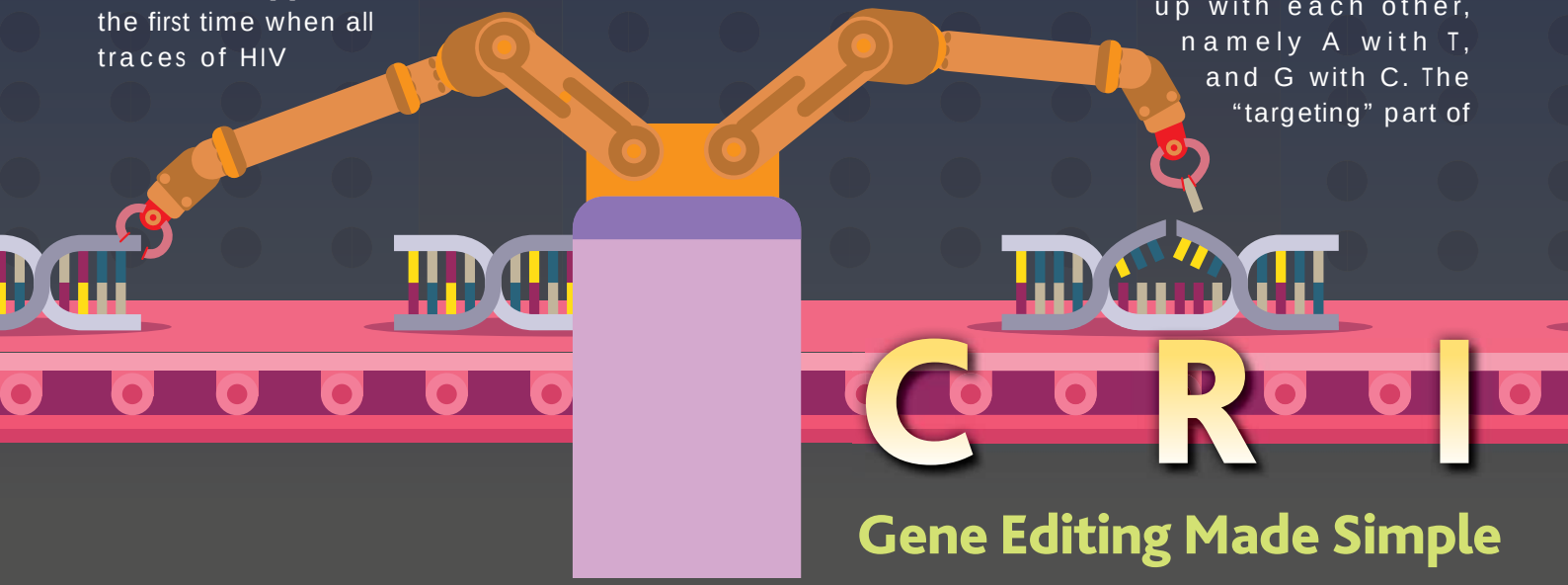
Have you heard of Golden Rice? Do you know it has a higher nutritional value than your regular rice? The key to its success lies in gene editing. DNA is the genetic blueprint of living organisms. Specifically, DNA harbors instructions on how to form proteins, the fundamental building block in life, in units called genes. Scientists are rewriting the language of life through gene editing. In this process, the genes of an organism are altered to produce useful products like Golden Rice. Gene editing may also be used to cure diseases in the not too distant future.

One of the most exciting breakthroughs in gene editing was its application in curing HIV infections, a condition previously thought to be incurable. Researchers at Temple University have succeeded in using CRISPR Cas9 to remove the HIV-associated DNA sequences from the genome of three different mice models [1]. This marked the first time when all traces of HIV were successfully removed from an animal model at different stages of the disease – a promising step towards the dream of gene therapy.

So how did they do it? CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats. CRISPR is used in nature by bacteria to protect themselves against viral infections - by chopping up the DNA of the invading virus. Scientists have been able to modify this process for gene editing in plants and animals.

CRISPR Cas9 gene editing system consists of three main components: a Guide RNA (gRNA), the Cas9 protein and a donor DNA. The gRNA has “scaffolding” and “targeting” parts. The “scaffolding” part associates with Cas9 protein to form a complex. There are four bases in DNA, namely A, T, C and G. In a process called “complementary base pairing”, DNA bases pair up with each other, namely A with T, and G with C. The “targeting” part of



CRI

Gene Editing Made Simple

你聽過黃金米嗎？你知道它的營養價值比一般的米高嗎？黃金米的秘密在於基因編輯。去氧核糖核酸（DNA）是生物的藍圖。DNA裡的基因蘊含著製造蛋白質的指示，而蛋白質則被喻為生命的基本積木。除了製造如黃金米的有用產品，科學家亦正嘗試透過基因編輯，希望在不久的將來用作治療疾病。

基因編輯其中一個最令人興奮的突破，是它在治療人類免疫缺陷病毒（HIV）感染方面的應用。HIV病毒會引致愛滋病，在過往被認為是無法醫治的。美國天普大學的研究人員成功運用CRISPR Cas9技術，在三組不同的老鼠基因組上移除和HIV相關的DNA [1]。這是科學家第一次成功在不同疾病階段的動物身上去除所有HIV病毒的痕跡，可謂朝基因治療的夢想踏出了充滿希望的一步。

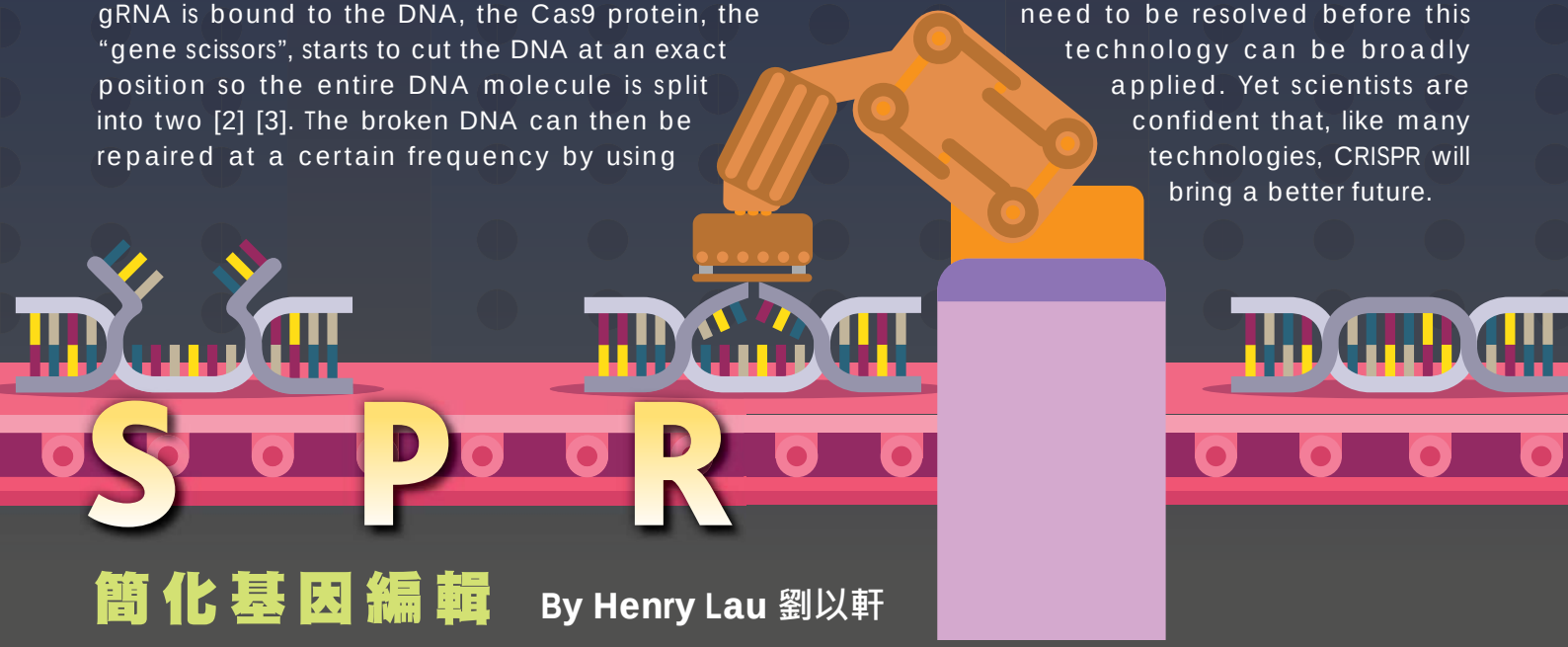
CRISPR的中文全名為「群聚且有規律間隔短回文重複序列」。大自然中的細菌會透過CRIPSR把入侵病毒的DNA「剪斷」，以對抗病毒感染。科學家發現這機制後，便將其運用到動植物基因編輯的技術上。

CRISPR Cas9基因編輯系統由三個主要部分組成：引導用的核糖核酸（gRNA）、Cas9蛋白質和外來的DNA。gRNA包含「支架」和「目標」兩部分。「支架」部分即與Cas9蛋白質合組成一個複雜的結構。DNA有四種鹼基，分別稱為A、T、C和G。在「互補鹼基配對」的過程中，DNA鹼基互相配對，即A和T配對，G和C配對。gRNA的「目標」部分能使gRNA和目標DNA獨一無二地結合。gRNA可以根據研究員希望編輯的目標DNA而被度身設計而成。Cas9則是核酸內切酶，它能發揮類似限制酶的「基因剪刀」角色，在特定的位置剪斷DNA。外來DNA則是指科學家希望引入

the gRNA is designed to bind uniquely to the target DNA sequence. The gRNA is custom-made and designed to be complementary to the target DNA sequence researchers wish to change. Cas9 is an endonuclease. It is similar to restriction enzymes that act as "gene scissors" to cut the DNA at specified points. Lastly, the donor DNA contains the desired modifications to be introduced to the target cell. These three ingredients are delivered to the target cell where they can interact with the host genome to facilitate gene-editing.

There are three steps in CRISPR Cas9 gene editing: binding, cutting and repairing [2]. Firstly, the binding of the gRNA to the target DNA sequence occurs through complementary base pairing [2] [3]. One can imagine the gRNA as a tow truck, pulling Cas9 to the target site. Then, once the gRNA is bound to the DNA, the Cas9 protein, the "gene scissors", starts to cut the DNA at an exact position so the entire DNA molecule is split into two [2] [3]. The broken DNA can then be repaired at a certain frequency by using the donor DNA as a "repair template" [2] [3]. Upon the completion of all three steps, the sequence specified in the donor DNA is incorporated into the host genome.

CRISPR is hailed as a revolutionary technology due to its unparalleled precision and ability to simultaneously edit different spots in the genome. However, it is not as simple as it seems. It has taken researchers years to achieve the feat. The system has yet to be perfected; complications can easily arise in any of the three steps, causing unwanted harmful mutations. Scientists are still exploring safer ways to apply the technology. Other than technical challenges, there are many ethical questions concerning gene editing in general, such as whether the purpose of application contradicts ethical norms. These ethical and technical issues need to be resolved before this technology can be broadly applied. Yet scientists are confident that, like many technologies, CRISPR will bring a better future.



CRISPR

簡化基因編輯

By Henry Lau 劉以軒

目標細胞內作理想修補的DNA。這三個部分會被引入目標細胞，藉著和原來的基因組互動來進行基因編輯。

CRISPR有三個步驟，分別為結合、剪輯和修補 [2]。首先，透過互補鹼基配對，gRNA和目標DNA序列結合 [2] [3]。然後，試想像gRNA是一輛拖車，把Cas9拖到目標的位置。當gRNA和DNA結合，Cas9蛋白質，即「基因剪刀」，便會在特定的位置剪斷DNA，使整個DNA一分為二 [2] [3]。剪斷的DNA由此可以在特定的頻率下，利用外來DNA作「修補樣式」[2] [3]。完成這三個步驟後，新的外來DNA序列便可被引入原來的基因組。

因為它的準確度和能夠同時編輯基因組不同地方的能力，CRISPR被視為革命性的技術。不過，這技術看似簡單，其實不然。科研人員花了數以年計的時間，才能成功達致現時的技術。這系統仍不是完美的，三個步驟都很容易出現問題，有機會導致有害的突變，科學家仍在尋求更安全的應用方法。除了技術困難外，基因編輯亦面對很多道德問題，例如應用這技術的目的是否違背道德標準。這些道德和技術問題必需先解決，這技術方能被廣泛應用。儘管如此，科學家相信CRISPR和其他技術一樣，將會為人類帶來更美好的將來。

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How Underwater Waves May Solve an Aviation Mystery

可望解決航空史上之謎的聲重力波

By Melody Ma 馬嘉怡

Have you ever thrown pebbles into the sea? Have you ever imagined that you can trace the time and location that they fall into the ocean? It seems impossible; however, it may be an easy task from now on.

Researchers from Cardiff University have just developed a method to find out the precise time and location that objects fall into the sea – by analyzing the underwater sound waves emitted when an object hits the surface of the ocean.

Termed acoustic gravity waves, these sound waves are generated by a sudden change in water pressure as objects hit the ocean surface. In other words, they can be caused by "anything from submarines, earthquakes and landslides, to falling meteorites or other objects impacting the sea surface", as the researchers explain. The waves occur naturally and travel at the speed of sound across the deep ocean, thousands of meters beneath the surface. They can also travel very long distances of up to hundreds of kilometers [1] [2]. Acoustic gravity waves can be picked up by hydrophones, which are underwater microphones.

The researchers' proposed technique is not to be confused with sonar. Short for Sound Navigation and Ranging, sonar detects objects in the ocean by emitting pulses. Instead of measuring acoustic gravity waves, the technique measures acoustic frequencies varying from infrasonic to ultrasonic.

In their study, the research team started off by using a water tank. They dropped 18 spheres from different heights and locations onto the water surface, and measured the emitted acoustic gravity waves using hydrophones [1] [2].

The team found that the sound wave profile for each impact seemed similar, consisting of three parts. "The first part seems to be the initial impact itself, followed by the second part — as the object enters the water, it traps some air, which eventually rises back to the surface. The last part seems to be secondary waves that impact the bottom of the tank, before reflecting back up," explains Usama Kadri, one of the lead authors of the study [3].

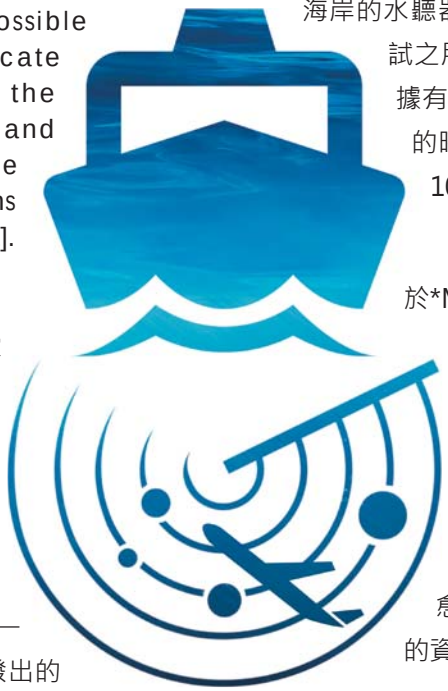
As the waves travel through the ocean, they disperse because higher frequency sound waves travel more quickly than waves at lower frequency. Observing the dispersion of the waves thus allows researchers to estimate the distance the waves have travelled, which could help them locate the origin location.

The team also analyzed data from the hydrophones of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) off the coast of Western Australia. The microphones are used to detect underwater nuclear tests, but they can also pick up acoustic gravity wave signals. The data collected allowed the team to determine the time and location of earthquakes in the Indian Ocean with satisfactory accuracy (with errors of around 100-150 km) [1].

The research was originally motivated by the scientists' hope to gain more knowledge about the *MH370 (Malaysian Airlines Flight MH370) flight incident. Using the method developed, the team

succeeded in locating two points around the time of the aircraft's disappearance. However, the researchers could not be certain that the discovery had any real association with the plane. "Just like in a busy restaurant, it gets more and more difficult to pick up individual voices as the noise in the room gets louder," they write in the study. That said, the team have passed all the information acquired to the authorities [1].

While it remains uncertain whether the method could offer assistance regarding the MH370 incident, researchers believe that the technique can open up a wide range of possible applications. It can be used to locate items that might have fallen into the ocean, such as meteorites, satellites and even debris of aircrafts. It can also be used to locate underwater explosions and the epicenter of earthquakes [1].



每逢到郊外遊玩的時候，我們總愛把小石頭扔到水裡。你又有沒有想像過我們能夠追蹤它掉進水裡的確實位置和時間呢？這聽起來有點不可思議，但隨著新技術的出現，這可能會是一件易如反掌的事了。

最近，卡迪夫大學的研究人員研發了一種方法，透過分析物件撞擊海洋表面時發出的聲波，可以準確地找出物件掉進海洋的位置和時間。

這種聲波名叫聲重力波。當物件撞擊水面，水壓突然變化，便會產生出這種聲波。換言之，潛艇、地震、山泥傾瀉、以至隕石和其他衝擊海洋表面的物體，都會產生聲重力波。這些自然產生的聲波可以聲音的速度到達數以千米深的海洋深處，橫跨長達數以百公里計的距離 [1] [2]。如果我們想接收這些聲重力波，可以使用水聽器，亦即是水底麥克風。

小心不要把這種新技術和聲納混淆。聲納透過發出訊號並接收反射回來的訊號，來探測海洋中的物體，運用的聲音頻率由次聲波到超聲波不等，而不是量度聲重力波。

在實驗當中，卡迪夫大學的研究團隊從不同高度和位置把18個球體掉進一個水缸，然後利用水聽器去探測釋出的聲重力波 [1] [2]。

研究團隊發現，每一次撞擊所產生的聲波都有其相似的地方，並由三個部分組成。這份研究報告的主作者Usama Kadri表示：「第一部份好像是由最初撞擊水面而成；第二部份則是當球體進入水裡，保存了一些空氣，而空氣最終升到水面；第三部份則似是衝擊水缸底部而被反射的次波。」 [3]

因為高頻率的聲波傳播速度比低頻率的要快，當聲波在海洋傳播時，它們會分散開。透過觀察聲波的分散，研究人員可以估計聲波傳播的距離，從而找出原來的撞擊位置。

研究團隊也分析了全面禁止核試驗條約組織於西澳州海岸的水聽器數據。這些水底麥克風被用作偵測核測試之用，但它們亦能接收聲重力波。收集到的數據有助研究團隊找出最近在印度洋發生的地震的時間和位置，準確度亦令人滿意（偏差約為100至150公里） [1]。

這項研究的最初目的是希望得出更多關於*MH370（馬航客機事件）的資料，以助相關人員盡快找出事件的來龍去脈。研究團隊成功找到兩個和飛機消失時間相近的訊號，但他們仍未能確定這發現是否和馬航客機有關聯。他們在研究報告裡解釋說：「就像一間熱鬧的餐廳，當一個地方的聲浪愈來愈大，要聽到個別的聲音便愈發困難。」儘管如此，研究團隊已把得到的資料全數交給有關人員 [1]。

雖然我們不知道研究的結果能否真的有助事件調查，但科學家相信，這種技術有望為人們帶來不少的應用。它可以被用來找出掉進水裡的物件的位置，譬如是掉落的隕石、衛星，甚至是飛機碎片。其次，它可以被用來探測水底爆炸和地震震央的位置 [1]。

* Malaysian Airlines Flight MH370, carrying 239 people, disappeared on 8 March 2014 when it was en route to Beijing from Kuala Lumpar. Despite extensive searches of the Indian Ocean floor, the main wreckage has not been found. This incident has become one of the biggest mysteries in aviation history.
載有239名乘客的馬來西亞航空客機MH370於2014年3月8日由吉隆坡飛往北京途中消失。儘管印度洋海床已被徹底搜索，調查人員仍未能尋回客機殘骸。事件成為航空歷史上最大的謎團之一。

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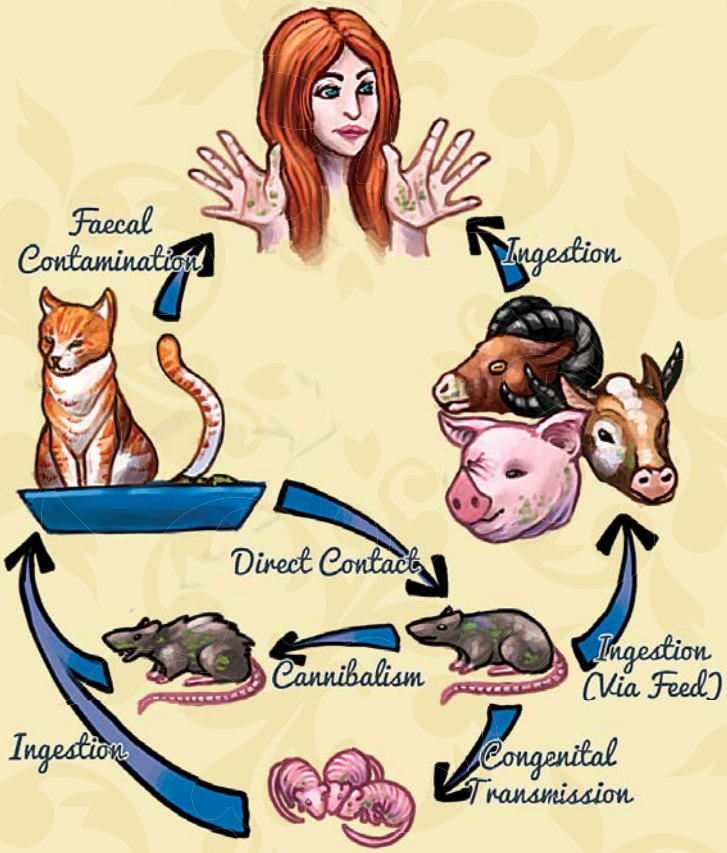
LOVE THY PARASITE MAKES RATS

What would you do when a ravenous lion approaches, threatening to devour you whole? Naturally, you flee, fearing for your life. Preys have evolved to avoid their predators. And hence, one would expect a rat to flee upon smelling the scent of cats – the scent of imminent doom.

This avoidance behavior is, however, only the case for healthy rats. Rats infected by the parasite *Toxoplasma gondii* are attracted to cat odors. By manipulating specific neural circuits in the rat brain, the parasite renders a rat incapable of perceiving fear in the presences of cat odors, and activate pathways that cause the rat to "fall in love" with cats, making it brave enough to chase after the scent of cats.

T. gondii is a single-celled pathogenic protozoan capable of infecting virtually all warm-blooded animals and causes a disease called toxoplasmosis [1]. Once the host is infected, the protozoan divides rapidly and spread throughout the body, especially to muscles and brain, where they become latent intracellular cysts. These intracellular cysts protect the protozoan from the host immune system and antibiotics. In humans, it has been estimated that 30-50% of the global population has been exposed to and may be chronically infected with *T. gondii*. However, this infection has no readily observable symptoms in healthy adult humans.

What makes *T. gondii* unique is its reproductive cycle – sexual reproduction must take place in a cat's intestine. After entering the cells that line the cat's small intestine, the parasites undergo sexual development and produce millions of zygote-containing cysts. Each cyst is capable of surviving and spreading for months, once shed through cat feces. The most common pathway for *T. gondii* to enter the cat intestine is by accidental ingestion of cysts. If you were a *T. gondii* cell, how would you smuggle yourself there? The best way is perhaps for you to hide inside their favorite meal – rats.



This brings us back to the curious case of the fearless rats. By changing the behaviors of infected rodents, *T. gondii* increases their chances of being preyed upon by cats, and in turn raising the probability of ingesting the cysts inside the

愛上敵人 —
寄生蟲令老鼠被貓隻吸引

當一隻餓極的獅子靠近，威脅要把你吞掉，你會如何反應？自然地你會為自己的安全而逃跑。獵物已演化至有逃避捕食者的能力，因此你會預期當老鼠嗅到貓的氣味—厄運逼近的氣味，便會立即逃跑。

然而這種躲避行為只會在健康的老鼠身上發生。當老鼠感染名為*Toxoplasma gondii*的寄生蟲，牠們反而會喜歡貓的氣味。寄生蟲透過操控老鼠特定的神經線路，令老鼠不能感受到自己對貓氣味的恐懼，使牠們「愛上」貓，並勇敢地追尋牠們的氣味。

*T. gondii*是一種可致病的單細胞原蟲，能夠感染所有溫血動物，引致住血原蟲病 [1]。寄主一旦受到感染，原蟲會急速分烈及擴散至全身，特別是肌肉及腦部，發展成潛在細胞內的囊胞，而囊胞會為原蟲提供對抗寄主免疫系統及抗生素的保護。現估計有百分之三十至五十的全球人口已曝露在*T. gondii*之下，甚至可能已受嚴重感染。不過，健康的成年人即使受到感染亦沒有明顯病癥。

*T. gondii*的獨特之處在於其繁殖周期—有性繁殖必須在貓的腸臟內發生。寄生蟲通過感染貓隻小腸的細胞，進行生殖發展及產生數以百萬計的受精囊胞。每個囊胞透過貓隻的排泄物排出後，能夠在體外生存和擴散數個月。意外感染囊胞是*T. gondii*進入貓隻腸臟最普遍的途徑。如果你是一個*T. gondii*細胞，你會如何偷運自己到那裡？最好的方法或許就是躲在牠們最喜愛的老鼠中。

讓我們再談談無畏老鼠。*T. gondii*透過改變受感染齧齒動物的行為，增加牠們被貓隻捕食的機會，從而提高貓隻吸收囊胞的可能性。一份2000年的研究顯示，*T. gondii*操控老鼠與生俱來對於貓隻活動或痕跡的焦慮，使牠們魯莽地受這些痕跡所吸引。在一個包含老鼠自身的氣味、新鮮稻草、貓隻及兔子氣味等多種獨特氣味的迷宮內，受感染的老鼠特別偏愛散發著貓隻氣味的區域，牠們會比未受感染鼠隻較常走過這些區域，相反未受感染鼠隻則明顯會避開 [2]。

ENEMY –
ATTRACTED TO CATS

By David Iu 姚誠鵠

LOVE THY ENEMY – PARASITE MAKES RATS ATTRACTED TO CATS

rodents. In a 2000 study, *T. gondii* was shown to manipulate the rats' inherent perception of anxiety in the presence of cat activity or marks, making them imprudently attracted to these marks. By designing a labyrinth of bricks containing unique odors including the rat's own smell, fresh straw, cat odor, and rabbit odor, a non-trivial preference for cat-scented areas was found. *Toxoplasma*-infected rats traverse the labyrinth to these areas more often than non-infected rats which demonstrated marked avoidance [2].

Such behavioral alterations may stem from an imbalance of neurotransmitters in a region of the brain called the amygdala. The amygdala is responsible for memory processing, decision making, and emotional reactions. One of the consequences of disrupted regulation of amygdala function is abnormal, erratic behaviors.

This is one brilliant example of how smart adaptations like this could help with survival and proliferation. In fact, changing one's hosts' behaviors to enhance species competitiveness is not strictly *Toxoplasma*'s specialty. For example, certain species of nematomorph hairworm develop parasitically in grasshoppers and crickets as larvae. Once grown, the larva manipulates its host into jumping into water, where the host will likely drown and the parasite can return to its usual aquatic habitat.

When learning about evolution we might often fall into the trap of viewing it through rose-tinted glass where nature seemed elegant and noble, with smart features emerging with generations of progress. Nevertheless, we should be reminded that nature can be a bleak and unforgiving place, and organisms could go to extreme ends to survive.

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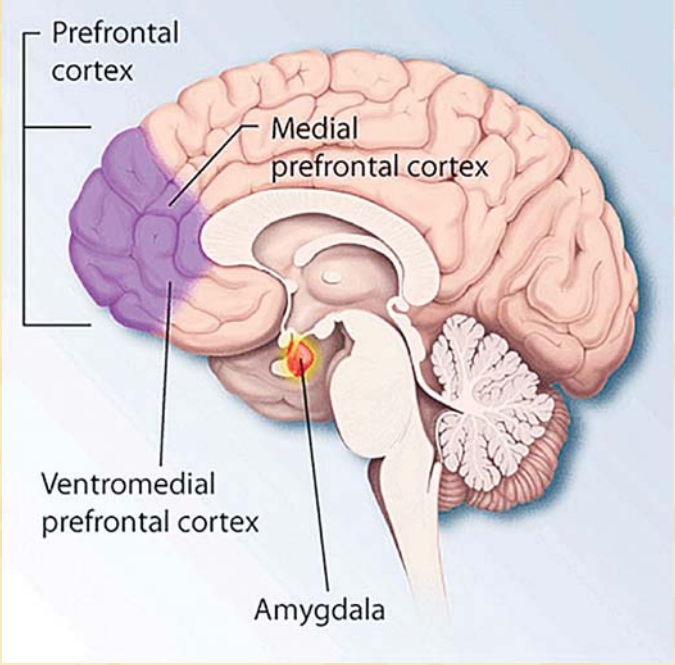
這樣的行為改變可能是因為腦部杏仁核中的神經傳導物質失去平衡。杏仁核負責記憶處理、作出決定及情緒反應，因此杏仁核功能受干擾的後果之一就是反常及古怪行為。

這異常的老鼠行為其實是有助牠們身上寄生物的生存和繁殖。事實上，改變寄主行為去提升物種競爭力並非只是*Toxoplasma*的特長。例如某些金線蟲品種的幼蟲會寄生於草蜢及蟋蟀中，當牠們長成後，幼蟲會操控寄主使牠跳進水中淹死，從而回到牠們熟悉的水中棲息地。

當我們在學習進化時，可能單純地以為大自然只是優雅而高貴，各種生物因應世世代代的發展而進化出一些特徵。其實我們亦應該提醒自己，大自然可以是一個荒涼而無情的地方，生物為了生存會不惜一切。



The amygdala is a major component of the brain's fear circuit.
Image credit: NIH Medical Arts. CC BY 4.0 pbio.1002283.g001. https://openi.nlm.nih.gov/detailedresult.php?img=PMC4623976_pbio.1002283.g001&req=4

愛上敵人——寄生蟲令老鼠被貓隻吸引

THE CHEMICAL MAGIC

During freezing winter days, a pocket-sized hand warmer can be a life saver. You probably have a hand warmer to get yourself through winter. Have you ever wondered why a tiny pouch can generate so much heat without fire or electricity? The answer lies in some simple chemistry principles.

Popular hand warmers rely on heat-releasing chemical reactions, also known as exothermic reactions. There are two common types of hand warmers, one producing heat by the oxidation of a metal and the other by the crystallization of a salt.

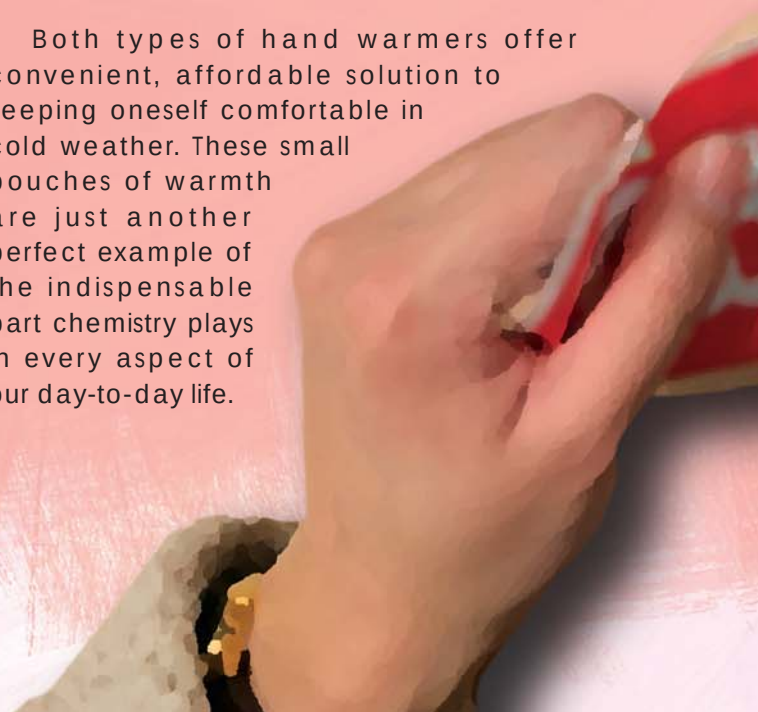
Oxidation-based hand warmer packs usually contain iron powder, water, salt, activated carbon and vermiculite [1]. A hand warmer starts to heat up once it is taken out of the sealed package and is exposed to air. Iron is oxidized, forming rust (iron oxide/hydroxide) and releasing heat. This process is indeed the same as the rusting of iron that you may observe in daily life. Iron rusting under normal circumstances, however, takes place at a much slower pace so the heat released is rarely noticeable.

Why is iron in the form of very fine powder in the hand warmer? Iron powder is used instead of a chunk of iron as the large surface area of the fine powder greatly speeds up the oxidation reaction. Chloride ions in salt act as catalysts to further accelerate the oxidation. In the presence of Chloride ions, the formation of a more porous form of rust (β-FeOOH) is favoured [2]. While activated carbon facilitates the dispersion of heat and helps to bring oxygen to the iron particles through gas adsorption. Vermiculite is an inert light-weight mineral that maintains an optimal moisture level for rusting to occur. Generally speaking, the performance of such a hand warmer depends largely on its size and air circulation. The number and size of breathable holes on the package may have a role to play too.

In general, 1 gram of iron can release 1.7 kilocalories of heat. An iron powder warmer can get quite hot so direct contact with the skin should be avoided. Reducing contact with air may help slow down the oxidation, so if you want to save a still-warm iron hand warmer for use later on, you may try sealing it with an air-tight zipper bag, slightly lengthening its lifespan [3]. If you want the warmer to be hotter, however, you can improve air circulation in the pouch of iron powder by shaking it, thus speeding up the oxidation. Whatever you do, once the oxidation is completed, the warmer stops heating and it cannot be reused.

Crystallization-based hand warmers, on the other hand, can be used over and over again, which is why some people consider them a more environmental-friendly option than their counterparts. Such a hand warmer is usually a sealed bag of chemicals in the form of a supersaturated sodium acetate solution with a small metal chip inside. Supersaturation means that the solvent contains more of the dissolved substance (solute) than it can normally hold at the given temperature. When you flex the metal chip, nucleation occurs at the chip surface and the solution crystallizes, releasing heat. To reuse the warmer, simply heat it in hot water and dissolve the crystals again. Crystallization-based warmers are easy to use and recharge, but their heating time is usually shorter than oxidation-based ones.

Both types of hand warmers offer convenient, affordable solution to keeping oneself comfortable in cold weather. These small pouches of warmth are just another perfect example of the indispensable part chemistry plays in every aspect of our day-to-day life.



OF HAND WARMERS

By Twinkle Poon 潘晴

暖手包的化學魔法

在寒冷的冬日裡，暖手包可說是我們的救星。你身上或帶著一個暖手包，助你度過酷寒。你知道為什麼一個細小的暖包不需要電或火，就能帶來這麼多熱力嗎？答案其實和一些簡單的化學原理有關。

一般來說，暖手包利用會發熱的化學反應來為我們保暖，這種化學反應又被稱為放熱反應。暖手包大致可分為兩種，一種透過金屬氧化作用來發熱，另一種透過結晶作用來發熱。

氧化作用的暖手包通常含有鐵粉、水、鹽、活性碳和蛭石[1]。當包裝被撕開，暖手包和空氣接觸後便會開始發熱。鐵會被氧化，因此生鏽（氧化鐵/氫氧化鐵）及產生熱力。這過程其實和平日的生鏽一樣，不過日常情況下的生鏽速度要慢得多，所以我們難以察覺過程散發出來的熱力。

為什麼暖手包內的鐵需要是很細的粉末狀？暖手包會使用鐵粉，而不是鐵塊，是因為細粉末的面積較大，可以大大加快氧化的速度。鹽含有的氯離子是催化劑，可進一步加快氧化速度，因為氯離子會令鐵傾向形成一種多孔狀鐵鏽(β-FeOOH) [2]。而活性碳則有助散熱，並能吸附氧氣分子，為鐵粉提供氧氣。蛭石是一種輕身的惰性礦物，為生鏽過程維持最理想的濕度。這種暖手包的性能往往取決於其大小和空氣流通程度而定，暖手包透氣孔的大小和數量亦對其表現有所影響。

一般情況下，1克的鐵能釋放1.7千卡的熱。鐵粉暖手包散發出的熱力不容小看，所以不應直接與皮膚接觸。減少暖手包和空氣的接觸或有助減慢氧化的速度，因此，如果你想把一個依然溫暖的暖手包留待之後再用，可嘗試把暖手包放在密封的袋子，或有助稍為延長它的壽命 [3]。如果你想暖手包變得更熱，你可嘗試輕搖暖手包，改善空氣流通，加快氧化速度。無論如何，當氧化作用完成，暖手包便不會再發熱，亦無法再重用。

另一方面，透過結晶作用發熱的暖手包則可以重用，因此，有些人認為它比鐵粉暖手包更為環保。這種暖手包是一包密封的過飽和醋酸鈉溶液的化學物質，內裡有一塊小金屬片。將這暖手包加熱時醋酸鈉結晶會溶解，當這熱溶液冷卻至室溫後就會得到過飽和的溶液。換言之，在該溫度下它溶解了比一般情況更多的溶質。當你按壓金屬片時，核晶作用發生，溶液結晶化並釋出熱量。若要重用暖手包，只需把它放在熱水中，待結晶再次溶化。結晶作用的暖手包方便易用，重用方法簡單，不過，它們散發熱力的時間通常比鐵粉暖手包短。

兩種暖手包用法方便，價錢相宜，是冬天保暖的好幫手。小小的暖手包背後蘊藏了有趣的化學知識，只要我們細心觀察，不難發現化學和我們的日常生活其實息息相關。

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Nanotechnology... At a Store Near You

納米技術... 就在你身邊

By Long Him Cheung 張朗謙

In our daily life, we would sometimes encounter products that claim to be powered by nanotechnology, such as sunglasses or body armor. However, do you understand what nanotechnology is?

Nanotechnology refers to the understanding and manipulation of matter of mere nanometers, where 1 nm is equivalent to 10^{-9} m. You can imagine that one nanometer is about a hundred thousandth of the diameter of a human hair, or comparable to the size of an atom. At the nanoscale, some atoms or molecules are found to perform counter-intuitively due to quantum effects, which allow the development of novel applications. Examples of these strange behaviors include the increase in strength and conductivity, and the change in color and refractive index [1].

Nanotechnology requires the ability to "see" and control atoms or molecules in the scale of the nanometer. However, it is impossible for humans to see atoms with the naked eye, even with the help of an optical microscope. In order to observe the nano-world, several new-type microscopes were invented, such as the scanning tunneling microscope (STM) and the atomic force microscope (AFM). These microscopes make use of tiny, yet exact nanoscale movements to ensure a precise mechanical scanning of the surface of a specimen, such that scientists can probe and observe the nano-substances [1].

The earliest example for nanotechnology dates back to 1989 when a group of scientists from IBM spelled the company name in atoms using STM – the team was able to literally position Xenon atoms on a background of copper substrate. This breakthrough demonstrated the possibility of manipulating matter with a precision up to the nanoscale. After more than 20 years of nanoscience research and development, applications of nanotechnology have promisingly improved different sectors of technology and benefitted society in areas including medicine, food safety and the information industry. With the help of nanotechnology, people can now effectively manipulate various traits of different materials [1].

There are many commercial products on the market that depend on nanotechnology. One example is the photochromic eyeglasses, in which its color varies with the background UV intensity. The secret behind the UV sensitivity of the photochromic eyeglasses is the clear nanofilm on the lens. Not only does it provide UV resistance, but it also makes the glasses water-repellent, scratch-resistant, self-cleaning and offers an antifogging property. It is hard to imagine that a film with only a few nanometers thick can be so multifunctional. But nanotechnology makes it possible [1]. Besides nanofilm, carbon nanotube sheets are also a typical application of nanotechnology in daily life. A carbon nanotube is strong and stiff, yet lightweight,

durable and resilient, which makes it an ideal material for many items, such as sports equipment, safety wears, vehicles and even for building and construction. Other products of nanotechnology include automotive catalytic converter, household stain removers, high-power rechargeable battery and high- performance sunscreen [2].

On top of commercial products, nanotechnology has improved our society in different ways. In electronics and the IT section, nanotechnology is applied to diminish the size of transistors and boost their performance. Smaller and faster transistors greatly improve the portability and memory storage of electronic devices. Nanotechnology is also crucial in refining traditional energy sources and enhancing alternative energy. By improving the combustion efficiency and catalytic removal of pollutants of fossil fuels, nanotechnology reduces the burden of fossil fuel consumption to the environment. Moreover, nanoparticles and semiconductors play an indispensable role in the manufacture of solar cells, which advances the renewable energy industry [1].

Nanotechnology has made use of the special properties of nanoscale materials to achieve novel applications in the past years. Furthermore, there are many studies about applying nanotechnology in handling energy crisis, pollution reduction, cancer treatment, and creating superconductors. As a new research field, nanotechnology still has a huge potential to develop and is expected to bring impact to the world.

在日常生活中，我們有時會看到一些聲稱運用了納米技術生產的產品，例如太陽眼鏡和保護衣物等。可是，你又有沒有想過納米技術究竟是什麼呢？

納米是一個長度單位，一納米相當於10^{-9}米，而納米技術是指對納米物料的理解及操作。試想像一下，一納米大約是頭髮直徑的十萬分之一，又與一顆原子的大小相約。在納米尺度下，原子或分子因量子效應的關係，展現出有別於常態的特性，亦因此為研發嶄新科技帶來可能性。納米物質獨有的特性包括強度和導電率的增加，以及顏色和折射率的變化 [1]。

要運用納米技術，人們需觀察並控制納米尺度的原子或分子，然而即使在光學顯微鏡的幫助下，人類亦不可能以肉眼看到原子。為了觀察納米世界，科學家發明了幾種顯微鏡，例如掃描穿隧顯微鏡 (STM) 和原子力顯微鏡 (AFM)。這些顯微鏡利用微小且精確的納米級動作，對樣品表面進行仔細的機械掃描，從而觀察並分析納米物質 [1]。

最早使用納米技術的例子要追溯到1989年，當時一組來自IBM的科學家成功利用STM在銅基板上排列氙原子。這個突破正正展示出以納米級精準度處理物料的可能性。經過20多年的納米科研及發展，納米技術已經成功為醫藥、食品安全和資訊行業等不同領域改善技術，從而提高社會效益。在納米技術的幫助下，人們現在可以有效地操縱不同材料的特性 [1]。

市場上有許多商業產品都是在納米技術的幫助下被創造出來的。其中一個例子是全視線眼鏡，眼鏡的顏色會隨環境的紫外線強度而變化。全視線眼鏡能夠「偵測」紫外線，秘密在於鏡上一層透明的納米膜。這層納米膜除了讓眼鏡可以對抗紫外線外，還有防水、防刮、自我清潔及防霧性能。製造一塊如此多功能的薄膜聽起來或像天方夜譚，然而納米技術能使這一切成真 [1]。除了納米膜，納米碳管亦是納米技術在日常生活中一項典型的應用。納米碳管不但堅固，而且輕及耐用，是運動器材、防護衣物、車輛、甚至是建築的理想材料。其他涉及納米技術的產品包括汽車催化轉換器、家用除污劑、高功率充電池及高性能防曬霜 [2]。

除了商業產品之外，納米技術在不同方面亦為社會帶來了不少進步。在電子和資訊科技方面，納米技術能縮小電晶體，並提高其性能；更小更快的電晶體大幅改善了電子產品的便攜性和儲存容量。納米技術在提煉傳統能源以及開發替代能源方面亦是至關重要的。納米技術可提高化石燃料的燃燒效率以及改良污染物的處理，減輕使用化石燃料對環境所造成的負擔。另一方面，納米粒子和半導體在太陽能電池中扮演著不可或缺的角色，可見納米技術在推動可再生能源產業的發展上亦有重要的影響 [1]。

納米技術利用納米材料的特殊性質，在過去不斷發展出嶄新的應用技術。科學家現在依然積極研究納米技術，希望納米技術可以為處理能源危機、減少污染、治療癌症及製造超導體等方面帶來突破。納米技術作為一個嶄新的研究領域，仍然具有龐大的發展潛力，將來有望以不同方式為世界帶來改變。

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浴火重生：
火山爆發後的生態演替

Rising from the Ashes: Ecological Succession after Volcanic Eruption

By Henry Lau 劉以軒

Just off the coast of Indonesia, the relatively unknown island Krakatoa had been a place of tranquility – until a violent volcanic eruption threw its ecosystem out of balance in 1883. Undoubtedly, reading about volcanic eruptions conjures horrific images of fiery infernos. At first glance, it seemed that nothing was fated to live there again. However, the area was teeming with life in just a few years after the eruption. It even rejuvenated itself as a tropical jungle just 20 years later. Life finds a way, as always. This is usually brought about by ecological succession, which allows new communities to emerge.

There are several possible scenarios. If it is an underwater eruption, the magma that has spewed out will cool and harden once it comes into contact with water, forming new land. Alternatively, if an eruption occurs inland, be it on the mainland or an island, almost all life on the surface surrounding the eruption zone will be wiped out, the coverage of which varies each time, and volcanic ashes will coat its surface. In both cases, succession of life may occur, but through drastically different means.

In the first scenario where the eruption happens underwater, primary succession occurs subsequently. Primary succession is the process of the emergence of life from barren land over a long period of time. At the initial stage of the process, pioneer species such as lichens first grow on the barren land. When they die and decompose, they form soil, enabling the colonization of other plants. This process usually takes a long time. Eventually, seeds carried by ocean currents and in bird droppings lead to the emergence of new plants. The soil also thickens enough to allow a dominant type of vegetation to grow.

As for the second scenario, which involves inland or island eruptions, secondary succession occurs. Secondary succession refers to the repopulation of an area after a cataclysmic disturbance. It is similar to primary succession, except that it already has soil. Therefore, it does not require pioneer species to form the initial layer of soil. Similarly, new plants are able to populate the area until a dominant type of vegetation emerges. As such, disaster-struck areas once again find ways to live.

While volcanic eruptions seem to be a set-back for life due to the long time it takes for ecological succession to occur, studies have actually shown that regions affected by volcanic eruptions have higher biodiversity. It is because the eruption brings forth magma and volcanic minerals to the surface, which contain nutrients for all types of plants. Hence, the soil serves as fertile breeding ground. (Fun fact: The River Nile in Ancient Egypt brought alluvial soil to its banks similarly because of past volcanic eruptions in the mountains upstream.) Furthermore, due to the tectonic shift that accompanies the eruption, the altitude of the surrounding landscape is changed. This change causes a huge shift in climatic conditions, which makes it feasible for a more

diverse range of plants to grow. Plants with different climatic preferences, which were unable to grow previously, can happily thrive there post-eruption.

How then, do volcanic eruptions affect the fauna of the area? Animals on land usually flee from the eruption for survival. New species of animals could be attracted to the post-eruption areas due to the emergence of new plants. However, most animals on islands are not so fortunate. Most of them die since there is nowhere to escape to, unless they are protected by some natural shelter. In a majority of cases, only new species of birds emerge after island or underwater eruptions. A notable example is the eruption on Surtsey Island in 1963, where new species of birds appeared after the eruption. Marine life also benefits from island or underwater eruptions. Nutrients from the magma can flow into the surrounding ocean bed which can give rise to more aquatic flora, thus attracting more marine animals to the area.

Volcanic eruptions are not just stories of destruction. The cycle of life continues, and in greater abundance and diversity for plants and animals alike.

位於印尼不遠處的喀拉喀托火山，曾是一個寧靜的地方——直至1883年，強烈的火山爆發大大影響了當地的生態系統。當我們談及火山爆發，固然會聯想起一些可怕的畫面，受影響的土地似乎必定永遠寸草不生。不過，喀拉喀托火山附近的土地數年後便恢復生機，甚至在二十年後變成森林。這種絕處逢生的故事，往往由生態演替所致，使新的生物群落出現。

讓我們談談兩個生態演替可能出現的情況。如果火山在水底爆發，噴出的岩漿會在接觸水後冷卻及變硬，形成新土地。另一方面，假如火山爆發在內陸或島嶼上的陸地發生，幾乎所有在受影響地區中的生命都不能倖免，受影響的範圍視乎情況而有所不一，而火山灰會蓋過地區表面。在這兩種情況下，生物的演替都有機會發生，但方式卻截然不同。

在第一種水中火山爆發的情況下，原生演替會發生。原生演替是指生物在不毛之地中出現的漫長過程。起初，如地衣的先驅品種會首先在貧瘠的土地生長。當地衣死亡及分解，便會形成泥土，讓其他植物可以定居，這過程往往需要相當長的時間。然後，海波及鳥類糞便會帶來新的植物種子，慢慢地泥土亦會變厚，讓優勢植物得以生長。

而在第二種陸上火山爆發的情況下，次生演替會發生。次生演替是指一個地方在災難後重新有生物居住。這和原生演替相似，不過在次生演替的情況下，該地方已經有泥土，所以不需先驅品種去形成泥土。新的植物可以在那土地生長，直至優勢植物出現。於是，受災難影響的地方可以得以重生。

火山爆發看似是生命的倒退，需要經歷漫長的時間方會出現生態演變，不過研究顯示，受火山爆發影響的地區之後的生物多樣性會較高。岩漿和火山礦物質被帶到表層，為各種植物帶來養分，泥土因此變得肥沃。(小知識：古埃及的尼羅河上游地帶曾發生火山爆發，沖積層的泥土被帶到尼羅河河岸。) 此外，由於火山爆發帶來的地殼移動，鄰近地形的海拔被改變，可以大大影響氣候環境，使更多不同種類的植物得以生長。過往因氣候原因不能在當地落地生根的植物，亦有機會蓬勃生長。

火山爆發又會如何影響當地的動物呢？陸地的動物往往會為生存而逃走，當後來新的植物出現，其他品種的動物或被吸引到當地。可是，島嶼上的動物通常都不能逃過一劫。除非牠們找到自然的庇護所，否則火山爆發會使大部分島嶼上的動物死亡。多數情況下，只有鳥類會在島嶼或水中的火山爆發後出現。敘爾特塞島是較著名的例子，它在1963年經歷火山爆發，其後出現新的鳥類。海洋生物也會從島嶼或水底火山爆發中得益，岩漿的養分會流到附近的海床，令更多的海洋植物能夠生長，吸引更多海洋動物到該區。

火山爆發帶來的並不只是破壞。儘管火山在爆發時消滅了種種生命，但它最後亦會為受影響的地方重新注入生機，帶來更大量和更多樣的動植物。

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Applications of Time Reversal

Have you ever heard of time reversal? The term may spark your imagination of fascinating time-traveling adventures like what you can see in films. While that is impossible in reality (yet), the concept of time reversal has indeed been around for many years. It has led to various helpful applications in fields including medical imaging, telecommunications and tactile objects.

Prof. Mathias Fink has spent nearly 25 years studying the time reversal technique and is one of the leading scientists in the field. He has pioneered the development of time-reversal mirrors and time reversal signal processing. What's more, he has turned many of these concepts into useful applications. He has more than 60 patents, and launched four companies with nearly 270 employees. We talked with Prof. Fink to learn more about his marvelous work after he gave a lecture at HKUST.

Medical imaging, telecommunications, tactile objects... All these applications of time reversal concepts share one thing in common: they are about waves.

The time reversal technique can be used to control waves. "It's a kind of time machine, but it's a time machine for waves," Prof. Fink said. Indeed, there are many forms of waves and they play an indispensable part in various aspects of our lives. Prof. Fink said, "Waves are everywhere. When I speak to you, I send acoustic waves. When I use my telephone, I send electromagnetic waves. When I send ultrasound to the body to make an image, it travels as waves. If you use the time reversal technique, you can get better images, and you can do better communication. This is an interesting concept. It is about how we can better control waves."

Many of you may think that waves go only in one direction. So how does time reversal work on waves? Let's imagine that a source is sending signals to a target. The signals may be scattered in the room. Simply put, when time reversal is applied, the signals received by the target are reversed and then sent out. The first signal received will be sent last; the last signal received will be sent first. When the process is repeated, the waves emitted will eventually focus on the source. The signals will no longer be scattered. In other words, no signals may be picked up anywhere else in the room.

When applied to telecommunications, time reversal can make signal transmission more secure, ensuring that only the destined receiver can get the transmitted message. The technique has

你有沒有聽過時間反演？這詞彙或讓你聯想到科幻電影中的時間旅行情節，雖然時間旅行（暫時）並不可行，但時間反演的概念早已存在多年。這概念能引伸出不少實用的應用，範疇包括醫學成像、電子通訊和觸覺應用。

Mathias Fink教授研究時間反演技術已接近25年，是這方面的專家，帶領了時間反演鏡和時間反演訊號處理的發展。此外，他成功把時間反演的概念轉化成日常應用。他擁有60多項專利及四間擁有接近270名員工的公司。Mathias Fink教授早前到香港科技大學演講，我們和他進行專訪，細聽他的分享。

醫學成像、電子通訊和觸覺應用……這些應用技術都有一個共通點：它們都和波有關。

時間反演技術可以控制波。教授說：「這是一種時間機器，波的時間機器。」其實波的種類不少，而且和我們的生活息息相關，教授解釋說：「波無處不在。當我說話時，我發出聲波。當我使用電話時，會發出電磁波。當我利用超聲波進行醫學成像，它會以波傳送。當你運用時間反演技術，你可以得到更好的成像及更好的通訊。這是一個有關我們如何可以更好地控制波的有趣概念。」

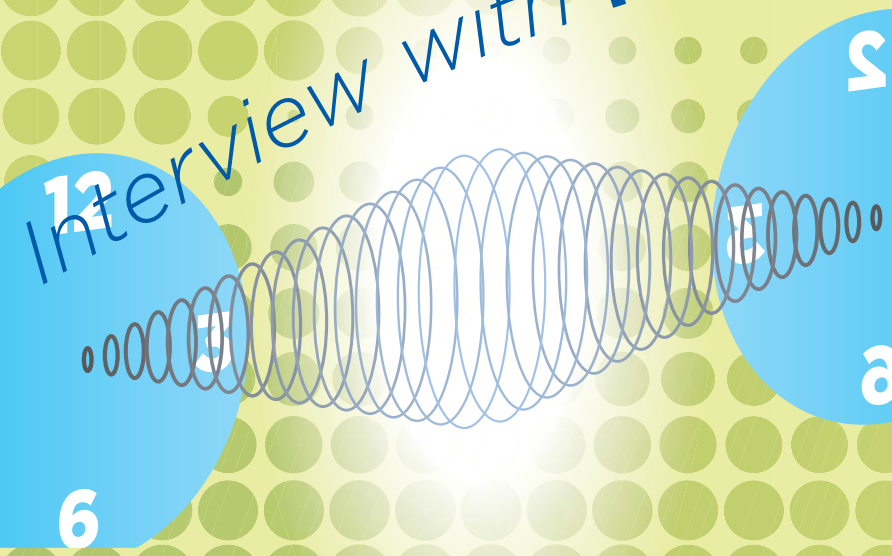
been applied to communication between submarines. In the future, it might even be applied in 5G communications.

Prof. Fink has also developed useful medical applications of time reversal. For example, he has built an apparatus to locate a kidney stone in a human body, so that it can be destroyed accurately. Another apparatus he developed can provide ultrafast imaging (10,000 frames per second). It can measure the stiffness of tissues and thus detect tumors. Better diagnosis can be conducted. The apparatus has been sold and used in medical institutions all over the world.

Prof. Fink believes that collaboration between different disciplines can boost innovation. For example, closer collaboration between pure science and engineering may bring "more opportunities to push new ideas and create new things". As time goes on, there will be more research on time reversal and more applications developed. A new era of technology may be coming.

Interview with Prof. Mathias Fink

By Teresa Fan 樊銘姍



時間反演的應用 — 專訪 Mathias Fink 教授

不少人認為波只能朝一個方向前進，時間反演到底是什麼呢？試想像有一個源頭正在發射訊號，這些訊號或會散射在房間。簡單來說，當你運用時間反演，發射目標收到的訊號會被反轉，再傳送出去。第一個收到的訊號會變成最後一個發出的訊號，最後收到的訊號會首先被傳送。重複步驟，發出的波會漸漸集中於源頭，不會出現散射的情況，房間的其他地方都不會接收到訊號。

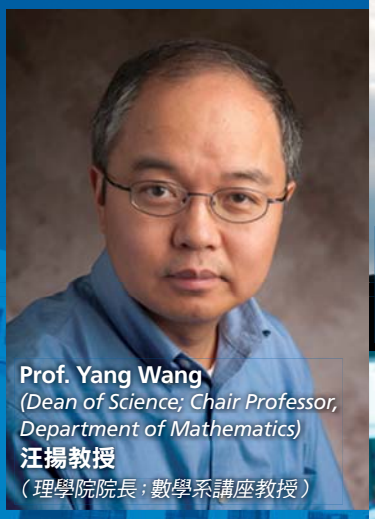
如果應用這技術到電子通訊，訊號傳送可變得更安全，確保只有指定的接收者能夠收到訊息。這技術已經被應用到潛艇通訊，將來甚至有機會應用於5G通訊。

除了電訊方面的進步，Mathias Fink教授亦運用時間反演技術，研發了一些醫學設備。其中一款設備能夠找出人體內的腎石，有助準確地去除腎石。另一款設備則可以做到高速成像（每秒10,000幅），它可以量度組織的堅實程度，從而探測腫瘤，帶來更準確的診斷。這款設備已被世界各地的醫療機構採用。

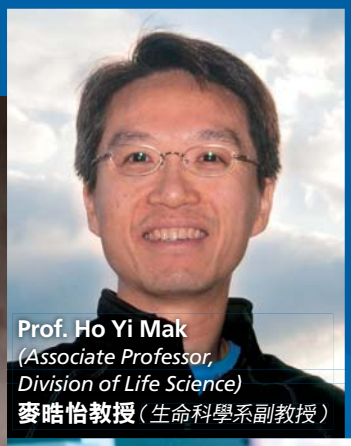
Mathias Fink教授相信，跨界別的合作可推動創新，以科學界和工程界為例，兩方更緊密的合作可帶來「更多創造新意念和新事物的機會」。隨著時間流逝，將會有更多時間反演的研究和應用發展，一個新技術時代或將到來。

Q&A with HKUST Scientists

科大科學家的問與答



Prof. Yang Wang
(Dean of Science; Chair Professor, Department of Mathematics)
汪揚教授
（理學院院長；數學系講座教授）



Prof. Ho Yi Mak
(Associate Professor, Division of Life Science)
麥晧怡教授（*生命科學系副教授*）

Dr. Jason Chan *(Lecturer, Department of Chemistry)*
陳鈞傑博士（*化學系講師*）

Q1 Whose thesis/scientific work would you like to read about? Could you please tell us more about the scientist and his/her work?

Dr. Jason Chan:

It is difficult for me to single out a scientist by name. I think that most PhD theses contain an interesting story and the most exciting ones are those that are currently being written since they represent our latest advances in science.

I am more curious to read some historical works written by alchemists and early-day chemists (ca. 1500-1800). At that time, chemistry or "alchemy" was pretty much a mythical subject. Chemicals and elements were given elegant names, e.g. vitriolated tartar (potassium sulfate) and butter of arsenic (arsenic trichloride), and strange, cryptic symbols. Chemical reactions have been postulated to be a result of the transfer of phlogiston – a fire-like element – that was supposed to give a substance flammability. I find it fascinating to learn about those totally different schools of thinking on chemical reactions before the atomic theory arrived. It also shows me that the later alchemists and modern-day chemists have something in common. They have always been philosophers who carefully observed experiments and summarized their data to arrive at their best logical interpretation of chemical phenomena.

And sometimes, it is just cool to read some old style English, laden with fancy and obscure alchemical terms and drawings.

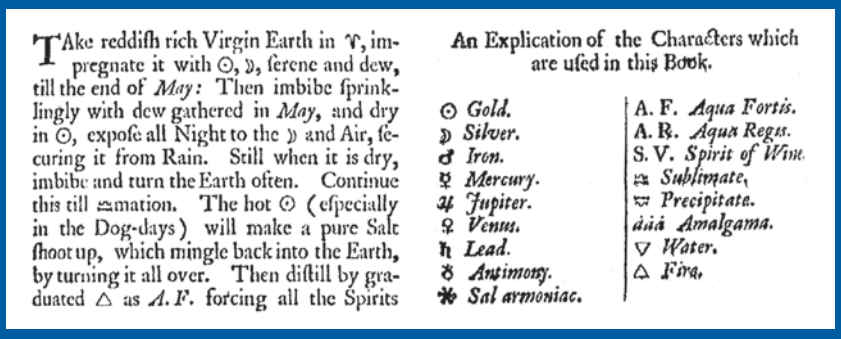
您希望閱讀哪位科學家的論文或著作？能否介紹一下這位科學家及其研究？

陳鈞傑博士：

只能列舉一位科學家的話很困難。我認為大多數博士論文都包含一個有趣的故事，而那些正在撰寫階段的論文則最令人興奮，因為這些論文正正代表著最新的科學進程。

我對一些由煉金術士和早期化學家撰寫的歷史著作（約1500-1800年）更感興趣。當時化學或「煉金術」可算是一個神話般的題目，化學品和元素被賦予了優雅的名稱和奇怪的神秘符號，例如硫酸化的酒石（硫酸鉀）及砷的牛油（三氯化砷）。化學反應被認為是燃素轉移的結果 —— 一種類似火的元素，能賦予物質可燃性。在原子理論出現前，有很多截然不同的化學反應思想學說，這些學說引人入勝，亦顯示出後期的煉金術士和現代化學家有一些共同點。他們一直就如哲學家一樣，仔細觀察實驗並總結數據，以得出對化學現象的最佳邏輯演繹。

有時候閱讀一些帶有華麗而複雜的煉金術語和圖畫的古式英語是很有趣的。



TAke reddiſh rich Virgin Earth in ♈, impregnate it with ☉, ☽, ſerene and dew, till the end of *May*: Then imbibe ſprinklingly with dew gathered in *May*, and dry in ☉, expoſe all Night to the ☽ and Air, ſecuring it from Rain. Still when it is dry, imbibe and turn the Earth often. Continue this till ſ mation. The hot ☉ (eſpecially in the Dog-days) will make a pure Salt ſhoot up, which mingle back into the Earth, by turning it all over. Then diſtill by graduated △ as *A. F.* forcing all the Spirits

An Explication of the Characters which are uſed in this Book.

☉ *Gold.*
☽ *Silver.*
♂ *Iron.*
☿ *Mercury.*
♃ *Jupiter.*
♀ *Venus.*
♄ *Lead.*
♁ *Antimony.*
✻ *Sal armoniac.*

A. F. *Aqua Fortis.*
A. R. *Aqua Regis.*
S. V. *Spirit of Wine.*
♋ *Sublimate.*
♍ *Precipitate.*
ȧȧȧ *Amalgama.*
▽ *Water.*
△ *Fire.*

A Choice Collection of Rare Secrets (1682)

Last October, Stephen Hawking allowed his PhD thesis *Properties of Expanding Universes* to be available online to the public, hoping to inspire others to think, learn and "look up at the stars and not down on their feet". It was accessed more than 2 million times within just a few days. We chatted with three scientists from different fields of science at HKUST to learn more about their favourite scientific work, inspiration and advice for students.

去年十月，斯蒂芬霍金在網上公開了他的博士論文——*宇宙膨脹的屬性*，希望能夠啟發他人思考和學習。在短短幾天之內，論文已被閱讀超過200萬次。我們與科大三名來自不同科學領域的科學家作專訪，了解他們最喜愛的科學研究、獲得的啟發及予學生的建議。

Q2 ***Have you been inspired or intrigued by any particular science discoveries during your journey of science education/research?***

Prof. Ho Yi Mak:

I have always had a keen interest in the discovery of pre-historic human fossils. The evolution of modern humans is a fascinating topic. With the advent of highly sensitive methods to sequence ancient DNA samples, we now have a much better understanding of our own ancestors and extinct "cousins". It is gratifying to incorporate a childhood interest into my classroom teaching of human genetics.

Prof. Yang Wang:

I am a science buff, so I have been inspired and intrigued by many scientific discoveries. I can honestly say that you are not going to find anyone who likes science NOT to be inspired by the discovery of DNA and its broad ramifications. People like Hawkins have inspired millions of people to study science. But as a mathematician, if I have to pick one thing, I would go with something much closer to my heart - the rise of machine learning and AI. In my view, machine learning and AI have dramatically changed how we understand things, which will yield more insight in our pursuit for scientific discoveries. In fact, machine learning and AI have already helped us make groundbreaking new discoveries in medicine, biology, astrophysics and other areas of science and engineering.

在科學教育/研究的過程中，您曾否受任何科學發現所吸引或啟發？

麥晧怡教授：

我一直對史前人類化石的發現有著濃厚興趣。現代人類的進化是一個引人入勝的話題。古代DNA樣本以高敏感度方法得以排序後，我們現在對自己的祖先和已絕種的「表兄弟」有了更深入的了解。能將童年的興趣融入在我的人類遺傳學教學中，我對此感到十分高興。

汪揚教授：

我是一名科學愛好者，因此受許多科學發現所吸引及獲得啟發。我可以肯定地說，你不會找到一個沒有從DNA及其廣泛影響的發現中獲得啟發的科學愛好者。如霍金之類的科學家鼓勵了數以百萬計的人鑽研科學。然而作為一名數學家，如果我必須選擇，我會選擇一樣我更感興趣的東西：機器學習和人工智能的興起。我認為機器學習和人工智能大大改變了我們對事物的理解，有助我們在追求科學發現的過程中得到更多深刻見解。事實上，機器學習和人工智能已助我們在醫學、生物學、天體物理學及其他科學和工程領域取得突破性的發現。

Q3 ***Could you offer some advice to secondary school students who are interested in pursuing education in science?***

Prof. Ho Yi Mak:

Stay curious and be open to topics that fall outside the syllabus.

Prof. Yang Wang:

One of the biggest concerns of mine is that secondary students are taking less and less mathematics, at a time when mathematics plays an increasingly important role in all aspects of the economy and society. Once entering HKUST, many of our students are poorly prepared mathematically to move on to study science and engineering. So if I have to give one advice to secondary school students, I would ask them to go beyond just the mandatory part of the mathematics curriculum. It will be the best investment they can make for their careers.

你能否為有意研讀科學的中學生提供一些建議？

麥晧怡教授：

對事物保持好奇心，並對課程之外的題目持開放態度。

汪揚教授：

我最為擔心的問題之一是現在正值數學在經濟和社會各方面扮演著越發重要角色的時候，學習數學的中學生卻反而越來越少。科大的許多學生都未有適當程度的數學知識，為學習科學和工程做好準備。因此如果要我為中學生提供一項建議，我會建議他們修讀必修數學課程以外的部分，這將是他們為自己職業生涯作出的最佳投資。

Visit our website at *sciencefocus.ust.hk* to read the complete interview with the three scientists!
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Science News 科學新聞

Last Male Northern White Rhino Dies

On 19 March 2018, the world's last male northern white rhino, Sudan, died at the age of 45. With the loss of Sudan, his daughter and granddaughter become the only two female northern white rhinos left in this world, making the subspecies on the verge of extinction. Rhinos have been targeted for their horns due to the alleged medicinal value. Scientists are now exploring ways to save the subspecies by artificial insemination using Sudan's genetic materials or cross-breeding between northern white rhinos and southern white rhinos.

瀕臨絕種的北方白犀牛

世界上最後一頭雄性北方白犀牛蘇丹於2018年3月19日以四十五歲之齡逝世。隨著蘇丹的離去，牠的女兒和孫女兒便成為了世界上僅餘的兩頭雌性北方白犀牛，令此亞種瀕臨絕種邊緣。犀牛角被視為有藥用價值，令犀牛成為獵殺目標。科學家現正設法拯救這亞種，包括以蘇丹的遺傳物質進行人工受孕或在北方白犀牛及南方白犀牛之間進行配種。

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