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SCIENCE FOCUS 科言

Issue 030, 2025

School of 理學院 Science

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

Contents

Science Focus Issue 030, 2025

Message from the Editor-in-Chief 主編的話

Dear Readers,

Welcome to a new issue of *Science Focus*. The end of the academic year is on the horizon. In the summer, I hope our articles will stimulate extended learning in science, not just for exams, but for fun!

In this issue, we bring you two contrasting stories on food. It is up to you to decide if you prefer pizzas or asteroids for dinner. Moving onto yet more domestic issues, we consider the many ways to use baking soda and the harmful effects of dust mites when they invade your home. Do you know that dust mites are not insects? On physics, we tell the story of a lab accident that led to the invention of laser eye surgeries. We also connect with past and present HKUST physics students, who shine in different arenas.

Finally, I am excited to report a record number of entries to this year's "Science in Cha Chaan Teng Food" Writing Competition. The winning articles would surely stimulate interesting conversations in your next visit to cha chaan teng. Many congratulations to our prize winners, and I am sure they will appreciate your support and comments on Instagram.

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

親愛的讀者：

歡迎閱讀最新一期《科言》！本學年即將結束，在暑假裡希望我們的文章能鼓勵大家探索課外的科學題材 — 不為考試，只求樂趣！

今期我們會為大家講述兩個截然不同的食物故事：晚餐您想吃薄餅還是小行星呢？接著關於家居的題材，我們會介紹蘇打粉的各種用處，以及塵蟎入侵家居所帶來的有害影響。您知道塵蟎不是昆蟲這個冷知識嗎？在物理範疇，我們會細說實驗意外導致激光矯視誕生的故事，亦會與現在和過去的科大物理系學生對談，讓大家認識在不同地方閃閃發亮的科大人。

最後，我很高興宣佈「茶餐廳美食的科學」寫作比賽的參加人數再次打破歷年紀錄，得獎作品定能給您靈感，啟發您在下次到訪茶餐廳時與親朋好友展開知識性的對話。在此恭喜各位得獎者，相信他們會感謝大家在 Instagram 上的支持和留言。

主編 麥皓怡教授
敬上

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What's Happening in Hong Kong? 香港科技活動

Fun in Summer Science Activities 夏日科學好節目

Any plans for this summer? Check out the following events!
計劃好這個夏天的課餘節目了嗎？不妨考慮以下活動！

Innovative Pathway : Hong Kong's New Era of Industry
創 · 造未來 — 香港工業新時代

Explore the future of Hong Kong's industry at this special exhibition that put together over 50 exhibits, showcasing cutting-edge technologies and innovative solutions. Discover how local researchers and industrialists are revolutionizing fields like green technology, life sciences, and advanced manufacturing. From electricity-free cooling material to intelligent building robot, these innovations demonstrate the power of Hong Kong's thriving innovation and technology ecosystem. The exhibition also delves into how new industrialization is driving sustainable development and economic growth.

Period: Now – July 2, 2025
Venue: Special Exhibition Hall, Hong Kong Science Museum
Admission fee: No extra fee is required for museum visitors of Permanent Exhibitions.

這個專題展覽展出 50 多組展品，以先進技術及創新方案探索香港工業的前景，揭示本地科研人員和工業家如何革新綠色科技、生命科學及先進製造等範疇。由無電製冷材料到智能建築機械人，這些創新科技展示了香港創科生態圈的活力。展覽亦探討新型工業化如何推動可持續發展及經濟進步。

展期： 現在至 2025 年 7 月 2 日
地點： 香港科學館特備展覽廳
入場費： 常設展覽廳參觀人士不另收費。

T. REX — 暴龍傳奇

Embark on a thrilling journey with the dome show *T. REX*, where prehistoric giants come to life. Follow a paleontological team as they uncover *Tyrannosaurus rex* fossils in Montana's Hell Creek Formation in the United States. Through stunning computer-generated imagery and the latest scientific insights, experience the evolution of *T. rex* into apex predator of the Cretaceous period, and witness dramatic scenes of the dinosaur pack-hunting *Edmontosaurus* and battling with *Triceratops*.

Show period: Now – December 14, 2025
Time: 5:00 PM (Mon, Wed to Fri)
11:00 AM, 3:30 PM and 8:00 PM (Sat, Sun and public holiday)
Venue: Space Theatre, Hong Kong Space Museum
Admission fee: Standard admission: $40 (stalls), $30 (front stalls)
Concession admission: $20 (stalls), $15 (front stalls)

球幕電影《暴龍傳奇》邀請大家展開驚險旅程，跟隨考古隊伍深入美國蒙大拿州地獄溪組發掘君王暴龍化石，探訪這種在電影中栩栩如生的史前巨獸。透過結合電腦特效和最新科學發現，觀眾可以見證君王暴龍演化成白堊紀最強狩獵者的皇者之路，親歷其成群狩獵埃德蒙頓龍，以及與三角龍展開生死決鬥的戲劇性場面。

放映日期： 現在至 2025 年 12 月 14 日
時間： 下午五時正（一、三至五）
上午十一時正、下午三時半及八時正（六、日及公眾假期）
地點： 香港太空館天象廳
入場費： 標準票：40 元（後座）；30 元（前座）
優惠票：20 元（後座）；15 元（前座）

Can Asteroids Serve as a Food Source for Astronauts?

小行星能成為太空人的食物來源嗎？

By Sam Fan 樊潤璋

Can We Eat Rocks?

Imagine you're an astronaut, floating in the cold, infinite void of space. The isolation is overwhelming, the stars are your only company, and every pre-packaged meal reminds you of the tether that ties you to Earth. Bid a farewell to the crusty steak and crunchy toast — nothing is worse than life without the delicious Maillard reaction. Yet, an even more daunting scenario could be the future of dining for astronauts as we explore the possibility of turning asteroid material into sustenance. None of the people on Earth would ever think to ask, "Can we eat rocks or dirt?" — unless you are running out of money. However, always relying on Earth-dependent resupply missions is impractical for prolonged journeys to deep space.

Innovative approaches, such as bioregenerative systems that grow plants, algae, mushrooms, or even cultured meat onboard spacecraft, could be promising. However, these systems require a significant amount of resources, including water, light, and nutrients [1, 2]. In comparison, applying the mining concept to food is tantalizing. Could the vast resources of space itself provide sustenance? Scientists are now exploring the possibility of mining asteroids to create food. The carbon-rich asteroids may hold the key, offering a potential source of organic materials that could one day be converted into food for astronauts [2].

The Science Behind Asteroid Food

These carbon-rich asteroids, including the famous Murchison meteorite that crash-landed in Australia in 1969, contain organic substances in various forms, such as aliphatic hydrocarbons and insoluble organic matter (IOM) [2]. The food mining process involves feeding relatively short hydrocarbons to bacteria, ideally with carbon lengths from 10 to 40 [2]. Previous studies have identified bacteria that can convert the thermal breakdown products of high-density polyethylene plastic to human edible biomass [3]. Given the similarity in composition between the breakdown products of the plastic and the asteroid material, the microbial consortium is expected to work like a team of microscopic chefs, converting raw asteroid material into food rich in carbohydrates, proteins, and other nutrients humans need to survive [2–4].

Let's Do Some Math!

In the following calculation, asteroid Bennu is chosen to illustrate how much food an asteroid can offer [2]. Bennu is a small, near-earth carbon-rich asteroid with a mass of 7.329×10^{13} g. It was also the target of NASA's first asteroid sample collection mission [5]. A few assumptions are made for the calculation: First, the proportion of organic substances is based on data from the more extensively studied Murchison meteorite. Second, the maximum amount of food is calculated by considering the total amount of insoluble organic matter (IOM) in the asteroid, assuming that they can be extracted and converted into edible biomass.

Let's first find out the mass of IOM in Bennu:

Mass of Bennu × Proportion of IOM

$= 7.329 \times 10^{13} \times 0.096$

$= 7.036 \times 10^{12}$ g

The extraction and conversion processes are expected to be somewhat inefficient. Assume the proportion of mass extractable for food production e is 0.32 [3], the conversion efficiency by the bacteria consortium k_1 is 0.2 [3], and the extraction efficiency of carbon material from Bennu k_2 is 0.008 [6]. The estimated mass of edible biomass offered by Bennu is:

Mass of IOM in Bennu × e × k_1 × k_2

$= 7.036 \times 10^{12} \times 0.32 \times 0.2 \times 0.008$

$= 3.602 \times 10^9$g

Given that every 100 grams of edible biomass contains a total of 442 Calories, the estimated total Calories offered by Bennu is:

Mass of edible biomass ÷ 100 × 442

$= 3.602 \times 10^9 \div 100 \times 442$

$= 1.592 \times 10^{10}$ Calories

A NASA's standard diet provides 2,500 Calories for one astronaut per day. How many years can Bennu support the need of one astronaut?

Calories offered by Bennu ÷ 2,500 ÷ 365

$= 1.592 \times 10^{10} \div 2{,}500 \div 365$

= 17,447 years

So, the result is around 17,447 years for one astronaut (or 17,447 astronauts for one year). We're talking about an asteroid with a volume of around 62.3 million cubic meters — equivalent to about 25,000 Olympic-size swimming pools [7, 8]. To sustain just one astronaut, the daily volume of material required would be roughly the size of a quarter of a 19-seater minibus in Hong Kong [9].

A Long Way to Go

A sheer volume of asteroid material would need to be processed daily to sustain even a single astronaut. Handling such a volume in space, where every kilogram of equipment and material must be carefully managed, presents enormous logistical hurdles. For a whole crew of astronauts, demanding storage and processing capacities are almost unfeasible with current technology. So to this day, even if asteroid-based food production is an exciting concept, it is still in its infancy.

Future advancements must focus on improving the efficiency of extraction and conversion processes, reducing the asteroid material required, and developing compact, energy-efficient systems that can operate in the unique environment of space [2]. The food will also need to undergo toxicology analysis, animal studies and finally human trials to ensure safety [2]. Only then can this vision become a practical solution for long-term space exploration.

A Whole New Horizon

While the technology is still theoretical and faces significant challenges, its potential to revolutionize space travel is undeniable. This approach could reduce reliance on Earth's resources, enabling longer missions to explore the cosmos. Though far from reality, the idea reminds us of humanity's ingenuity and determination to adapt and thrive, even in the vast, inhospitable reaches of space.

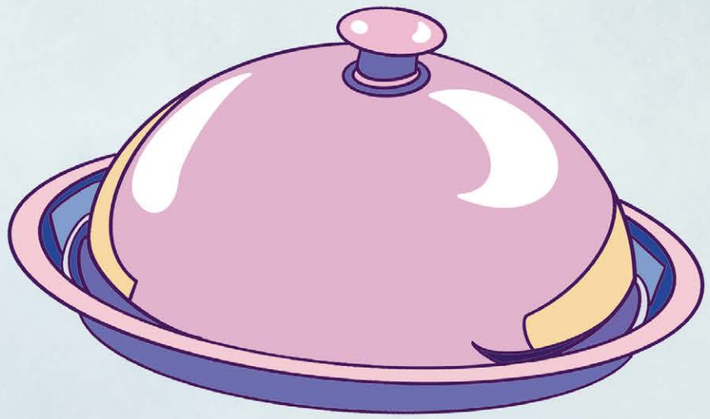
我們能吃石頭嗎？

想像一下，你是一名太空人，漂浮在淒冷幽寂、茫無邊際的虛空中。孤獨感席捲而來，深空中只有天體、星雲作伴，每份預製餐點都是你與地球有所連結的僅有依據。向焦香的牛排和香脆的多士告別吧 — 人生在世最糟糕的事，莫過於失去梅納反應所帶來的絕頂美味。然而，未來太空人的味蕾可能面臨更嚴峻的挑戰，因為科學家正探索如何將小行星物質轉化為食物。地球上應該從不會有人問：「我們能吃岩石或塵土嗎？」- 除非你已經花光這個月的零用。不過對於漫長的深空任務來說，一直依賴地球的補給是不切實際的。

一些創新方案，例如在太空船上培育植物、藻類、蘑菇，甚至是人造肉的生物再生系統等，也許能被寄予厚望，但這些系統需要大量資源，包括水、光和養分 [1, 2]。相較之下，將「開採」的概念用於食物上光想就令人躍躍欲試了。到底太空豐富的資源能否提供食物來源？科學家正在研究透過開採小行星來製造食物的可行性，一些富含碳元素的小行星也許是關鍵，它們蘊含著把有機物轉化為太空人食物的潛力 [2]。

小行星食物背後的科學

富含碳元素的小行星，包括 1969 年墜落在澳洲的著名默奇森隕石（Murchison meteorite），含有各種形式的有機物，例如脂肪族烴（aliphatic hydrocarbons）和不溶性有機物（insoluble organic matter）[2]。從小行星開採食物的過程正正涉及將較短的碳氫化合物餵給細菌，理想的碳鏈長度為 10 到 40 個碳原子 [2]。先前的研究發現一些細菌能將高密度聚乙烯塑膠的熱分解產物轉化為可供人類食用的生物質 [3]。由於那些塑膠的熱分解產物與小行星物質的成分相似，因此我們能預期微生物群能像一支微型廚師團隊，將小行星原料轉化為富含碳水化合物、蛋白質和其他人類生存所需營養的食物 [2–4]。



算算看！

在以下的計算中，我們選擇以小行星貝努（Bennu）來展示一顆小行星到底可以提供多少食物 [2]。貝努是一顆小型、富含碳元素的近地小行星，質量為 7.329×10^{13} 克。這顆小行星也是美國太空總署首次執行小行星樣本收集任務的目標 [5]。以下是一些關於計算的假設：第一，貝努中有機物所佔之比是從已被廣泛研究的默奇森隕石的數據中推斷；其次，食物最大產量是基於貝努的不溶性有機物總量來計算，我們假設這些物質能被提取並轉化為可食用的生物質。

讓我們先計算貝努中不溶性有機物的質量：

貝努的質量 × 不溶性有機物所佔之比
$= 7.329 \times 10^{13} \times 0.096$
$= 7.036 \times 10^{12}$ 克

提取和轉化過程的效率預計不會太高。假設不溶性有機物中可被提取作生產食物之用的質量比 e 為 0.32 [3]、細菌群落的轉化效率 k_1 為 0.2 [3]，以及從貝努提取有機物的效率 k_2 為 0.008 [6]。貝努能提供的可食用生物量估計為：

貝努中不溶性有機物的質量 $\times e \times k_1 \times k_2$
$= 7.036 \times 10^{12} \times 0.32 \times 0.2 \times 0.008$
$= 3.602 \times 10^{9}$ 克

已知每 100 克可食用生物質含有 442 千卡，貝努可提供的總熱量估計為：

可食用生物質的質量 ÷ 100 × 442
$= 3.602 \times 10^{9} \div 100 \times 442$
$= 1.592 \times 10^{10}$ 千卡

美國太空總署每天的標準膳食為每名太空人提供 2,500 千卡。那麼，貝努能滿足一名太空人多少年的食物需求？

貝努可提供的總熱量 ÷ 2,500 ÷ 365
$= 1.592 \times 10^{10} \div 2{,}500 \div 365$
$= 17{,}447$ 年

計算結果顯示是長達 17,447 年（或是為 17,447 名太空人提供一年所需的食物）。我們正在談論的是體積約為 6,230 萬立方米的小行星，即大小相當於約 25,000 個奧運標準泳池 [7, 8]。如果僅為一名太空人提供一天的食物，每天所需的原材料體積就相當於約四分一輛香港 19 座公共小巴 [9]。

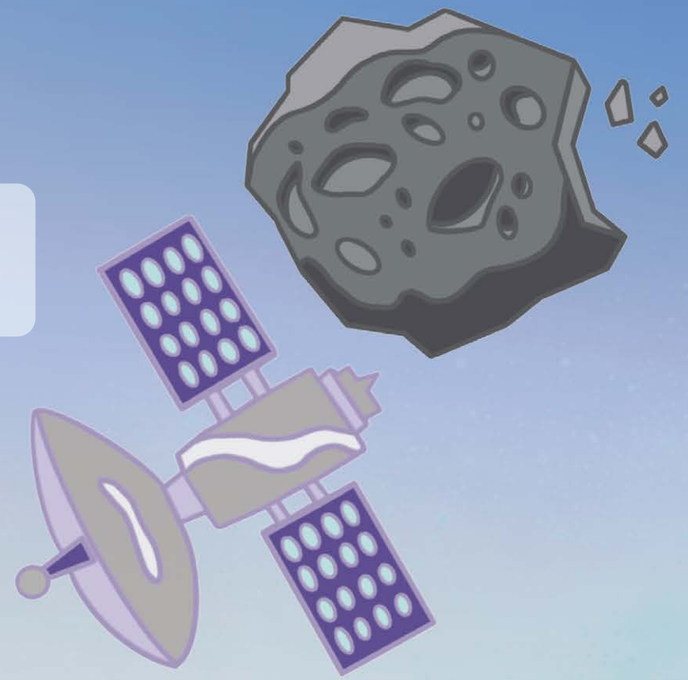
漫漫長路

僅為一名太空人提供食物，每天就需要加工大量的小行星物質。在太空中每公斤的設備和物資都必須受到嚴格管理，因此要進行這種大規模的處理在安排上並不簡單。對於餵飽整個太空人團隊來說，所需要的儲存與加工能力遠遠超出當前技術的可行範圍，因此儘管利用小行星來生產糧食是個令人興奮的概念，但目前它仍處於構想階段。

未來發展必須專注於提高提取和轉化過程的效能，減少所需的小行星原料量，並集中開發精密、節能，且能適應太空獨特環境的系統 [2]。生產的食品還需經過毒理分析、動物試驗以及最終的人體試驗，以策安全 [2]。只有全部達到標準，這構想才能被實際採用於長期太空探索之中。

嶄新領域

儘管這項技術仍處於理論階段，並且面臨諸多挑戰，無可否認的是其具備重新定義太空旅行的潛力。這種方法有望減少對地球資源的依賴，使人類能夠執行更長時間的宇宙探索任務。雖然目前看來還遙不可及，但這個構想展現了人類無限的創意與決心，即使在廣闊、荒蕪且嚴酷的太空，也希望找到生存與發展的方式。



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THE ACCIDENT THAT LED TO MODERN-DAY LASER CORRECTIVE EYE SURGERIES

意外發現：現代激光矯視手術的誕生故事

By Roshni Printer

It is fascinating to note that some of the most groundbreaking scientific discoveries happened by chance. Awarded a Golden Goose Award in 2022, one such "accident" in the medical field led to the invention of "bladeless laser-assisted *in situ* keratomileusis," a laser corrective eye surgery commonly known as bladeless LASIK.

What is LASIK?

LASIK is a procedure in which a laser is used to reshape the cornea to treat a range of vision problems, such as myopia (near-sightedness), hyperopia (far-sightedness) and astigmatism [1]. Myopia is a condition where individuals struggle to see distant objects, due to an excessive length of the eyeball or excessive curvature of the lens, leading to the formation of image in front of the retina. In contrast, hyperopia allows individuals to see distant objects but not close objects, due to the short length of the eyeball or insufficient curvature of the lens, so the image forms behind the retina. Another common type of refractive error, astigmatism, is caused by the irregular shape of the cornea or lens. In these conditions, images cannot be sharply focused on the retina, leading to blurry vision. Through a corrective eye surgery, the shape of the cornea can be altered by precisely cutting off some part of the deeper cornea (corneal stroma), so that light can be correctly refracted onto the retina.

From a technical point of view, the upper layers of cornea have to be removed before reshaping the stroma. This required a mechanical blade – until a seemingly unrelated lab accident happened [2, 3].

From a Lab Accident to a Successful Startup

Back in 1985, physicists Gérard Mourou and Donna Strickland invented a groundbreaking optical technique called "chirped pulse amplification," which can produce ultrashort laser pulses as short as a femtosecond (10^{-15} second) with an intensity higher than ever [4]. Mourou later founded the Center for Ultrafast Optical Science at the University of Michigan, and took advantage of this technique to understand chemical reactions [3].

In 1993, one of Mourou's graduate students working in the center sustained an accidental laser injury to his eye during an experiment [3]. Recalled that he "must have been tired" that evening, Detao Du accidentally lifted his safety goggles, and a stray beam (fortunately not the main beam) of the femtosecond laser produced circular burns to the his retina. Upon examination by Ron Kurtz, a doctor on duty at the University's eye center, the burns were found to be perfectly circular and precise without damaging any surrounding tissue. Du and Kurtz were both fascinated by the perfect nature of the laser cut, so they decided to collaborate and investigate further.

In an optics conference where Du and Kurtz presented their findings, the duo met Tibor Juhasz, a previous member of Mourou's lab, who was seeking femtosecond laser applications in ophthalmology. This was where the development of bladeless LASIK began. Together they founded a successful startup to commercialize bladeless LASIK, and the company was acquired a decade later for US$808 million in 2007. Notably, Mourou and Strickland were awarded a Nobel Prize in Physics "for their method of generating high-intensity, ultrashort optical pulses" in 2018.

LASIK vs SMILE

Bladeless LASIK is a well-established option considered to be effective with more than 95% of patients satisfied with the outcome of the surgery [1]. In the surgery, a femtosecond laser is used to create a thin, circular flap of the upper layers of cornea, after which the underlying stromal tissue is reshaped using an excimer laser [5]. The ultraviolet energy (greatly amplified ultraviolet light) emitted by the excimer laser functions to break the organic molecular bonds in the stromal tissue without causing any thermal damage [6]. After precisely removing the stromal tissue, the corneal flap is flipped back to its original position and the cornea is allowed to heal naturally.

Recently, a novel refractive surgery procedure known as "small incision lenticule extraction" (SMILE) has also gained popularity since its introduction in 2016 [7]. This minimally invasive procedure adjusts the refractive power of the cornea by carving out a lenticule from the corneal stroma with a femtosecond laser, followed by the extraction of the lenticule through a small incision also made by a femtosecond laser [8].

Primary advantages of SMILE come from its small incision size. LASIK requires cutting a 270 degree, 20 mm circular flap [7], while SMILE involves only a 2–4 mm incision [7, 9]. This greatly reduces the transection of corneal nerves, and hence lessens the experience of dry eyes after the surgery [8]. SMILE also suits contact sport players (e.g. soccer and martial arts) more because it does not involved a corneal flap which may move in some unlikely cases [8, 10]. Additionally, SMILE was also found to be more stable in high myopia [8].

For the downside, LASIK allows touch-ups to fine-tune vision after some years, but this is not possible for SMILE [7]. If an enhancement procedure is needed for an eye treated by SMILE, the options are to perform LASIK or an older PRK technique (footnote 1) on the SMILE cap. In addition, SMILE has not been approved to treat hyperopia in the US, so LASIK remains the only choice for people with far-sightedness at the moment [8].

While both procedures demonstrate efficacy and safety, the choice between SMILE and LASIK ultimately depends on individual patients and specific eye conditions. Please seek medical advice from your eye doctor if you are considering one of these corrective eye surgeries.

Summary

While what happened to be an accidental discovery turned into one of the most sought-after medical procedures in modern-day ophthalmology, many researchers, including Kurtz and Juhasz, continue to explore novel applications of the femtosecond laser for eye diseases such as glaucoma and cataract [3]. This story shows the impact of chance on scientific progress, standing testament to the fact that life-changing discoveries can occur any time of the day – so keep an eye out!

1. PRK: Photorefractive keratectomy (PRK) is an older technique which requires scraping off the upper layers of cornea (instead of creating a flap which will be flipped back to its original position). The tissue will then be allowed to regrow, but the healing process can take several weeks [11].

一些重要的科學發現往往出於偶然。獲頒 2022 年金鵝獎的醫學界發明正正出於一件意外，最終啟發科學家開創「無刀雷射屈光角膜層狀重塑術」(bladeless laser-assisted *in situ* keratomileusis)，亦是街知巷聞的「無刀 LASIK」激光矯視手術。

甚麼是 LASIK？

LASIK 是一種矯視手術，透過使用激光重塑角膜形狀來治療一系列的視力問題，例如近視、遠視和散光 [1]。近視患者由於眼球過長或晶體曲率過大，導致影像在視網膜前方形成，使患者難以看清遠物。相反，遠視患者能看清遠物而非近物，這是由於眼球過短或晶體曲率不足，導致影像在視網膜後方形成。另一種常見屈光不正的類型是散光，它是由於角膜或晶體形狀不規則造成。在這三種情況，影像皆無法清晰聚焦在視網膜上，導致視力模糊。矯視手術是透過精確切除角膜內層 (角膜基質) 的部分組織來改變角膜的形狀，使光線能正確折射到視網膜上。

技術上，重塑基質前必先移除表層角膜，這得用上手術刀 — 直到一次看似無關的實驗室意外 [2, 3]。

從實驗室意外到成功的初創企業

1985 年，物理學家 Gérard Mourou 和 Donna Strickland 發明了一種名為「啁啾脈衝放大」的突破性光學技術，製造出短至飛秒 (10^{-15} 秒)，但強度前所未有地高的超短激光脈衝 [4]。Mourou 其後在密歇根大學創立了超快光學科學中心 (Center for Ultrafast Optical Science)，利用這項技術研究化學反應 [3]。

1993 年，Mourou 的研究生杜德濤在一次實驗意外中被激光所傷 [3]。他憶述當晚「肯定是太累」，所以不慎移除了護目鏡，結果被一束飛秒激光的雜散光 (幸好不是主光束) 擊傷視網膜，造成了圓形的燒傷。經大學眼科中心值班醫生 Ron Kurtz 的檢查後，發現燒傷的形狀是完美的圓形，而且精確得很，絲毫沒有破壞周邊組織。杜德濤和 Kurtz 都為這種完美的激光切割特性所著迷，因此決定合作對此進一步研究。

杜德濤和 Kurtz 在一次光學會議上匯報發現，二人在此遇見 Mourou 實驗室的前成員 Tibor Juhasz，後者剛好正尋找飛秒激光在眼科上的應用。他們一拍即合，為無刀 LASIK 的發展揭開序幕。他們共同創立了一家成功的初創公司，將無刀 LASIK 技術推出市場。該公司最終於十年後的 2007 年以 8.08 億美元被高價收購。另一方面，為故事畫龍點睛的是 Mourou 和 Strickland 亦因「研發出製造高強度超短光脈衝的方法」於 2018 年獲得諾貝爾物理學獎。

LASIK 與 SMILE

無刀 LASIK 是發展成熟的技術，超過 95% 的患者對手術結果感到滿意 [1]。手術中，醫生會使用飛秒激光在角膜表層切出一個薄的圓形角膜瓣，然後使用準分子雷射 (excimer laser) 重塑底層基質組織的形狀 [5]。準分子激光發出的紫外線能量 (經大幅增強的紫外光) 能打破基質組織中的有機分子鍵而不造成任何燒傷 [6]。在精確打磨基質組織後，角膜瓣會被掀回原位，允許角膜自然癒合。

近年，名為「小切口透鏡切除術」(small incision lenticule extraction / SMILE) 的新型激光矯視手術自 2016 年引入以來也受到廣泛關注 [7]，這種微創手術利用飛秒激光在角膜基質中刻出一個透鏡狀的組織，然後從同樣由飛秒激光切割出的微細切口將組織取出，從而調整角膜的屈光能力 [8]。

SMILE 的主要優勢來自其微細的切口大小。LASIK 需要切割長達 20 毫米的 270 度圓形角膜瓣 [7]，但 SMILE 僅需要二至四毫米的切口 [7, 9]，這樣能避免大量切斷角膜神經，有效減少手術後眼乾的情況 [8]。另外如果患者熱衷於身體接觸較多的運動，例如足球或武術等，SMILE 會更為適合，因為過程中不需要切出角膜瓣，所以角膜瓣不會在運動中被意外掀開 [8, 10]。此外，SMILE 在近視度數較高的情況下也能維持更穩定的效果 [8]。

至於缺點，LASIK 允許在手術後數年進行輕微修正以調整視力，但 SMILE 則不支援後續微調 [7]。如果接受 SMILE 後需要進一步調整視力，選擇只有接受 LASIK 手術，或在 SMILE 的結構上進行第一代的 PRK 手術 (註一)。此外，SMILE 在美國尚未獲得批准治療遠視，因此 LASIK 目前仍是遠視患者的唯一選擇 [8]。

儘管 SMILE 和 LASIK 的療效和安全性均被認可，但最終選擇何者取決於患者意願及其眼部狀況。如果有意進行矯視手術，請諮詢眼科醫生以獲取專業意見。

總結

雖然這個偶然的發現已成為了現代眼科最受歡迎的醫療程序之一，但包括 Kurtz 和 Juhasz 在內許多研究人員仍在探索飛秒激光於青光眼和白內障等眼科疾病中的嶄新應用 [3]。這個故事展示了始料不及的意外也能為科學發展帶來深遠影響，證明了改變人類生活的發現隨時都可能發生 — 所以請細心留意周遭一切！

1. PRK：屈光角膜切除術 (photorefractive keratectomy / PRK) 是一種較舊的技術，當中表層角膜會被完全移除 (而不是切出一個稍後會被掀回原位的角膜瓣)，然後等待組織重新生長，但癒合過程可以長達數週 [11]。

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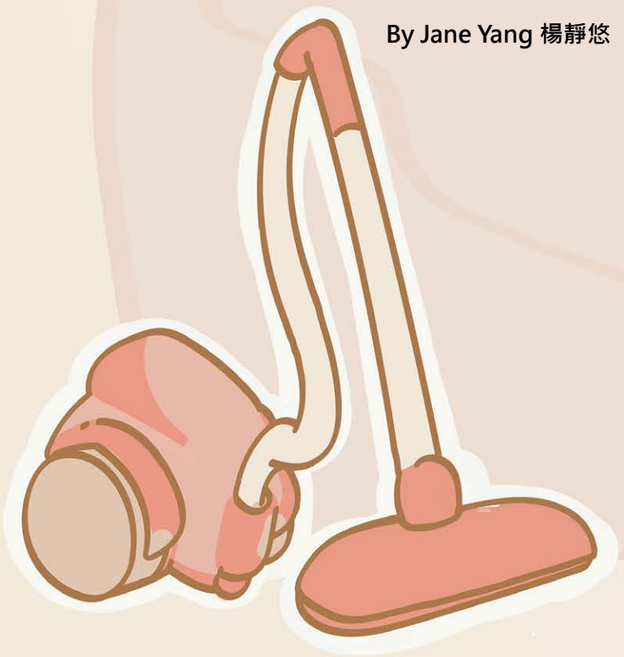
The Tiny Invaders in Your Home:

DUST MITES

家居的微小入侵者：

塵蟎

By Jane Yang 楊靜悠



When it comes to allergies, many people think of pollen or pet dander. But did you know that one of the most common culprits might be lurking in the dust? Meet the dust mite, a tiny creature that can wreak havoc on your immune system. In this article, we will answer some common questions about dust mites, why they are so problematic, and how you can reduce their presence in your home.

What Are Dust Mites?

Dust mites are microscopic creatures with a body size as small as a quarter of a millimeter that you can hardly see them without a microscope [1, 2].

Unlike insects, which have six legs, adult dust mites are close relatives to spiders and ticks, so they have eight legs [2]. Another key difference between insects and arachnids also lies in their anatomy. Insects have three main body segments – head, thorax and abdomen, whereas arachnids only have two – cephalothorax and abdomen (footnote 1) [3].

While dust mites don't spin webs like spiders or suck blood like ticks, they are just as persistent. These tiny creatures thrive in warm, humid environments. A relative humidity of 75% is ideal for their proliferation, at which they can absorb sufficient water vapor with their specialized glands, the supracoxal glands, above the first pair of legs [2, 4]. The hypertonic sodium and potassium chloride solution secreted by the glands facilitates water absorption through osmosis. This body feature enables dust mites to survive for 65–100 days and lay 30–80 eggs during their lifetime at room temperature. At a higher temperature of 30°C, dust mites mature into adult and start reproducing much faster (from 35 to 17.5 days for *Dermatophagoides farinae*) [2, 5], making them a tough opponent in the battle for a clean home.

Dust mites feed on dead skin cells shed by humans and pets. This means they love to settle into places like bedding, mattresses, carpets, curtains, and upholstered furniture [1, 2]. If you've been sneezing or itching at home, dust mites might be the hidden cause.

How Can Dust Mites Cause Allergies?

Despite their tiny size, dust mites can cause massive problems for allergy sufferers. The trouble comes from certain proteins found in their feces, urine and dead bodies [6]. Inhaling these proteins, known as allergens, may trigger an overreaction of the immune system in some people. In these cases, your immune system mistakenly identifies them as invaders and sets off an allergic reaction, inducing the following typical allergy symptoms [1, 6]: sneezing, runny or stuffy nose, watery eyes, itchy skin or rashes, and coughing. In severe cases, it can trigger asthma attacks.

The allergens are microscopic, so they can easily become airborne when you vacuum, sit on furniture, or make your bed, which makes them hard to avoid. However, there are still methods to reduce the threat of dust mites.

How Can You Reduce the Level of Dust Mites?

1) Keep humidity low

Dust mites thrive in warm, humid environments. Using a dehumidifier or air conditioner to keep indoor humidity below 50% makes them harder to survive and reproduce [6] because the water balance can't be maintained at the supracoxal glands, so adult dust mites will dehydrate and eventually die [2].

2) Wash bedding frequently

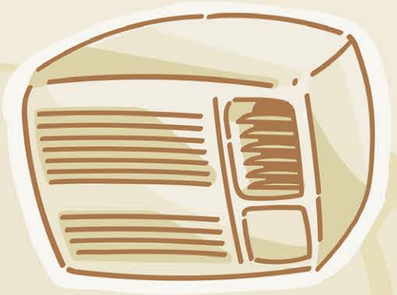
Since dust mites love to live in your bedding, make it a habit to wash your sheets, pillowcases, and blankets in hot water every week. A water temperature higher than 60°C can effectively kill dust mites and their eggs [1, 2].

3) Dust regularly

Dust hard surfaces regularly with a damp cloth to avoid stirring allergens into the air [6].

4) Minimize dust-collecting surfaces

Reduce clutter and avoid heavy fabrics like curtains or upholstered furniture [1, 6]. Opt for washable shades and hard flooring, such as wood or tile instead of carpets. If this is not possible, vacuum your carpets and rugs by using a vacuum cleaner with a HEPA (high efficiency particulate air) filter, which can trap dust mites and their allergens [6].



Remember, while you can't see dust mites, you can certainly feel their effects — and now, you know how to fight back!

1. Cephalothorax: The prefix "cephalo-" means head in Latin, so "cephalothorax" refers to the fused head and thorax of arachnids.

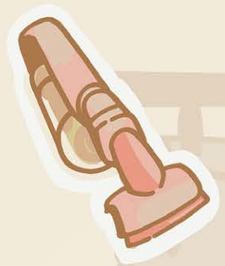
談到過敏，許多人會想到花粉或寵物皮屑。但你知道嗎？另一個常見的元兇就隱藏在灰塵中 — 牠就是塵蟎，這種微小生物可以搞亂你的免疫系統。在這篇文章，我們將回答一些關於塵蟎的常見問題，解釋牠們為何如此令人困擾，並提供一些減少家中塵蟎的方法。

甚麼是塵蟎？

塵蟎是一種微小的生物，體型僅有四分之一毫米，幾乎無法用肉眼看見，要用顯微鏡觀看 [1, 2]。

與有六隻腳的昆蟲不同，塵蟎是蜘蛛和蜱蟲的近親，因此成蟲有八隻腳 [2]。昆蟲和蛛形綱動物之間的另一個關鍵區別在於牠們的身體結構，昆蟲有三個主要身體部分 — 頭部、胸部和腹部，而蛛形綱動物只有兩個 — 頭胸部和腹部（註一）[3]。

雖然塵蟎不像蜘蛛那樣結網，也不像蜱蟲那樣吸血，但牠們同樣頑強。這些微小生物會在溫暖潮濕的環境中快速生長，75% 的相對濕度是牠們繁殖的理想條件。在這種濕度下，牠們可以通過位於第一對腳上方，名為「基節上腺」的特殊腺體吸收足夠的水分 [2, 4]，這些腺體分泌的高滲鈉



和氯化鉀溶液能促進經滲透作用的水分吸收。這個身體特徵使塵蟎能在室溫下存活 65 至 100 天，並產下 30 至 80 顆卵。在比正常室溫高的 30°C 下，塵蟎會成熟得更快並更早開始繁殖（以 *Dermatophagoides farinae* 為例，成熟時間會從 35 天縮短到 17.5 天）[2, 5]，使牠們成為保持家居清潔的戰鬥中一個難纏的對手。

塵蟎以人類和寵物脫落的死皮為食，意味著牠們喜歡棲息在床單、床褥、地毯、窗簾和軟墊家具等地方 [1, 2]。如果你在家裡經常打噴嚏或發癢，塵蟎可能就是隱藏的元兇。

塵蟎如何引發過敏？

儘管塵蟎體型微小，但牠們可以對過敏患者構成極大困擾。問題來自牠們的糞便、尿液和屍體中的某些蛋白質 [6]，吸入這些稱為過敏原的蛋白質可能會引發某些人免疫系統的過度反應。在這種情況下，你的免疫系統會錯誤地將這些蛋白質識別為入侵者，並啟動過敏反應，導致以下典型的過敏症狀 [1, 6]：打噴嚏、流鼻水或鼻塞、流淚、皮膚瘙癢或皮疹，以及咳嗽；在嚴重的情況下更能引發哮喘發作。

這些過敏原非常微小，因此當你吸塵、坐到沙發上或整理床鋪時，它們很容易就會飄散到空氣中，使得它們難以避免，但仍然有一些方法可以減少塵蟎的威脅。

如何減少塵蟎？

1) 控制濕度

溫暖潮濕的環境有助塵蟎繁殖。使用抽濕機或空調將室內濕度保持在 50% 以下能使牠們不易生存和繁殖 [6]，因為基節上腺再無法維持水分平衡，塵蟎成蟲會最終會因脫水而死亡 [2]。

2) 經常清洗床單

由於塵蟎喜歡居住在床單上，我們應養成每週用熱水清洗床單、枕套和毯子的習慣。高於 60°C 的水溫可以有效殺死塵蟎及其卵 [1, 2]。

3) 定期除塵

定期用濕布清潔家居以免將過敏原揚到空氣中 [6]。

4) 減少積塵的表面

減少雜物，並避免使用厚重的窗簾或軟墊家具 [1, 6]。選擇可清洗的窗簾和硬地板，如木地板或瓷磚等，避免使用地毯。如果不得不使用地毯，請使用帶有 HEPA 過濾器（高效率粒子空氣過濾器）的吸塵器清潔地毯和地墊，這種過濾器可以捕捉塵蟎及其過敏原 [6]。

記住，雖然你看不到塵蟎，但你一定能感受到牠們的影響 — 現在，你知道如何反擊了！

1. 頭胸部：蛛形綱動物頭部和胸部融合在一起的結構。

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The Versatile Baking Soda: From Baking to Graffiti Cleaning

多用途的蘇打粉：從烘焙到清除塗鴉

By Daria Zaitseva

What is Baking Soda?

Baking soda, scientifically known as sodium bicarbonate ($NaHCO_3$), can be found in almost every household counter. Despite its name, most people keep baking soda in their homes not because of their baking passion, but due to its wide applications. Sodium bicarbonate is a weak base that has an alkaline pH range of eight to nine when dissolved in water. This article will explore some uses of baking soda within and beyond your home.

Baking Fluffy Pastries

In baking, sodium bicarbonate serves primarily as a leavening agent [1, 2]. When reacted with the acidic ingredients in a recipe — such as cream of tartar, lemon juice, or yogurt — baking soda undergoes an acid-base reaction to produce carbon dioxide gas, causing the dough or batter to rise and create the fluffy texture of baked goods. The acid-base reaction alone can take place at room temperature, but sodium bicarbonate also undergoes thermal decomposition at temperatures above 50°C to produce extra carbon dioxide (table 1).

Acid-base reaction:

$NaHCO_3(s) + H^+(aq) \rightarrow Na^+(aq) + CO_2(g) + H_2O(l)$

Thermal decomposition:

$2\,NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(l)$

Table 1 The two reactions of sodium bicarbonate that produce carbon dioxide during baking.

However, it is crucial to strike a balance between the amount of acid and base in a recipe. An excess of baking soda can lead to a bitter and metallic taste due to the unreacted sodium bicarbonate. In fact, a product called baking powder aims to ease this task, as it consists of both sodium bicarbonate and powdered acids already mixed in a right proportion [1].

Combating Foul Smell from Trash Bin

Another handy household application of baking soda comes from its ability to neutralize odors. The offensive smells produced by the anaerobic decomposition of organic waste in your trash bin can be attributed to volatile fatty acids and ammonia [3, 4]. A study found that spreading 50 grams of baking soda at the bottom of an eight-liter food waste bin could reduce odors by 70% [3]. Baking soda can mitigate the unpleasant odors by neutralizing odor-producing acids, turning the volatile acids into involatile salts [5]. For example, as a volatile acid with a boiling point of 164°C [6], the vaporization of a small portion of butyric acid can already give an odor like rancid butter. Sodium bicarbonate can neutralize the acid to sodium butyrate, a solid with a melting temperature of 250°C, so it will require a much higher temperature to vaporize [7]. This simple method showcases the practicality of

the compound in maintaining a fresher environment within kitchens, with a possibility of extension to local food waste collection points.

Maintaining Dental Hygiene

Baking soda doesn't just shine in kitchens; it can also safeguard our dental health. It is used as an abrasive agent in dental air polishing by dentists to remove teeth stains [8]. Similarly, you might have seen baking soda as an ingredient in a toothpaste formula; it is added to polish and remove dental plaque and stains with the help of a toothbrush [9].

While other common abrasives in toothpaste, such as hydrated silica and calcium pyrophosphate, rely solely on physical scrubbing, the alkaline and bactericidal properties of baking soda can provide additional protection against cavities (tooth decay) [9]. After the ingestion of sugary foods, oral bacteria will metabolize the carbohydrates and produce organic acids which lower the oral pH. It is known that the solubility of enamel significantly increases when the pH is lower than 5.1–5.5, causing the demineralization (or the loss) of enamel [9, 10]. Research has shown that brushing teeth with a baking soda-based toothpaste after a meal can prevent cavities by restoring the oral pH. In addition, baking soda was also found to have bactericidal effects on various bacteria found in dental plaque, such as *Streptococcus mutans*, especially when used in combination with hydrogen peroxide [9].

Removing Graffiti and Stains by Soda Blasting

Akin to how dentists use baking soda as abrasives to clean our teeth, soda blasting is a technique that rids the streets from graffiti paint and other stains [11]. By shooting fine particles of baking soda in compressed air or water at a pressure as low as 140 kPa, paint or rust on delicate materials like wood, masonry and copper can be removed. It is a milder method than sandblasting, which operates at 550–1,050 kPa and optimized for tougher surfaces like aircraft parts and concrete. In addition, compared to other common abrasive blasting substances, such as slags [12], soda blasting poses less risk to the respiratory health of workers, and is kinder to the environment as a non-toxic compound.

The Versatile Baking Soda

Summing up, baking soda is a remarkable compound with diverse applications in culinary, cleaning, and many other fields. Not only does it produce fluffy pastries, but it is also applied to keep our environment clean, our bins fresh, and our oral cavity healthy. As researchers continue to look for broader applications, baking soda will remain a versatile compound for us all.

甚麼是蘇打粉？

蘇打粉在科學上又名碳酸氫鈉（$NaHCO_3$），幾乎可以在每個家庭的料理枱上找到。儘管它是眾所周知的烘焙用品，但大多數人家裡擁有蘇打粉的原因並不是因為他們熱愛烘焙，而是因為它在其他範疇上的用途。碳酸氫鈉是一種弱鹼，當溶解在水中時，其酸鹼值範圍為鹼性的八至九。本文將探討蘇打粉在家庭內外的應用。

烘焙蓬鬆糕點

在烘焙中，碳酸氫鈉主要被用作膨脹劑 [1, 2]。蘇打粉會與食譜中的酸性成分（如他他粉、檸檬汁或乳酪等）發生酸鹼反應，產生二氧化碳，使麵團或麵糊膨脹而造出糕點蓬鬆的質地。酸鹼反應可以在室溫下進行，但碳酸氫鈉在超過 50°C 的溫度下也會進行熱分解，產生額外的二氧化碳（表一）。

酸鹼反應：

$NaHCO_3(s) + H^+(aq) \rightarrow Na^+(aq) + CO_2(g) + H_2O(l)$

熱分解：

$2\,NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(l)$

表一 碳酸氫鈉在烘焙過程中產生二氧化碳的兩種反應。

可是，在食譜中平衡酸和鹼的量至關重要，因為沒有與酸反應的過量蘇打粉會使成品出現苦味和金屬味。事實上，一種名為「泡打粉」的產品旨在避免這種情況，因為它是由已按正確比例混合的碳酸氫鈉和粉狀酸組成 [1]。

消除垃圾桶異味

蘇打粉另一個實用的家用用途是中和氣味。垃圾桶中的惡臭主要來自厭氧分解有機廢物時產生的揮發性脂肪酸和阿摩尼亞 [3, 4]。研究發現在八公升廚餘桶底部撒 50 克蘇打粉能減少 70% 異味 [3]。蘇打粉透過中和脂肪酸減輕異味，過程將揮發性脂肪酸轉化為不帶揮發性的鹽 [5]，以丁酸為例，作為一種沸點為 164°C 的揮發性酸 [6]，少量丁酸揮發就能引起腐敗牛油的氣味，而碳酸氫鈉可以將丁酸中和產生丁酸鈉，它是一種熔點為 250°C 的固體，因此需要高很多的溫度才會揮發 [7]。這種簡單方法展示了蘇打粉在消除廚房異味方面的實用性，此做法更有可能在未來被擴展到社區廚餘收集點。

保持口腔衛生

蘇打粉不僅在廚房發光發亮，亦能守護我們牙齒健康。它在噴砂洗牙中被牙醫用作研磨劑去除牙齒污漬 [8]。同樣地，你可能也看過牙膏配方中含有蘇打粉，它的作用是在牙刷的幫助下打磨並去除牙菌膜和污漬 [9]。

相對於牙膏中其他常見的研磨劑（例如水合二氧化矽和焦磷酸鈣）僅靠物理研磨，蘇打粉的鹼性和殺菌特性能進一步降低齲齒（蛀牙）的風險 [9]。在攝取含糖的食物後，口腔細菌會代謝碳水化合物並產生有機酸，降低口腔的酸鹼值。已知當酸鹼值低於 5.1 至 5.5 時，琺瑯質的溶解度會顯著增加，導致琺瑯質流失 [9, 10]。研究顯示飯後使用含蘇打粉的牙膏刷牙有助恢復口腔酸鹼值，預防蛀牙。此外，尤其在與過氧化氫發揮共同作用的情況下，蘇打粉也對牙菌膜中包括變形鏈球菌（*Streptococcus mutans*）在內的多種細菌具殺菌作用 [9]。

去除塗鴉和污漬的蘇打噴砂

類似於牙醫使用蘇打粉作為研磨劑清潔我們的牙齒，蘇打噴砂是一種可以清除街道上塗鴉和其他污漬的技術 [11]。透過把幼細的蘇打粉加入壓縮空氣或水中，並以低至 140 kPa 的壓力射向木材、磚石和銅等較脆弱的材料，其表面上的油漆或鏽蝕便能得以清除。傳統噴砂的操作壓力為 550–1,050 kPa，主要用於更堅硬的表面，例如飛機部件和混凝土等，因此蘇打噴砂是比傳統噴砂更溫和的方法。此外，與礦渣等其他常見的研磨材料相比 [12]，由於蘇打粉是不帶毒性的化合物，所以蘇打噴射對工人的呼吸健康風險較小，亦對環境更為友善。

用途廣泛的蘇打粉

總結來說，蘇打粉是具有多用途的化合物，涵蓋烹飪、清潔及其他許多領域。它不僅能製作鬆軟的糕點，亦能用於保持環境清潔，對付垃圾桶異味和維持口腔健康。隨著研究人員不斷尋找更廣泛的應用，蘇打粉將繼續是我們實用的好幫手。

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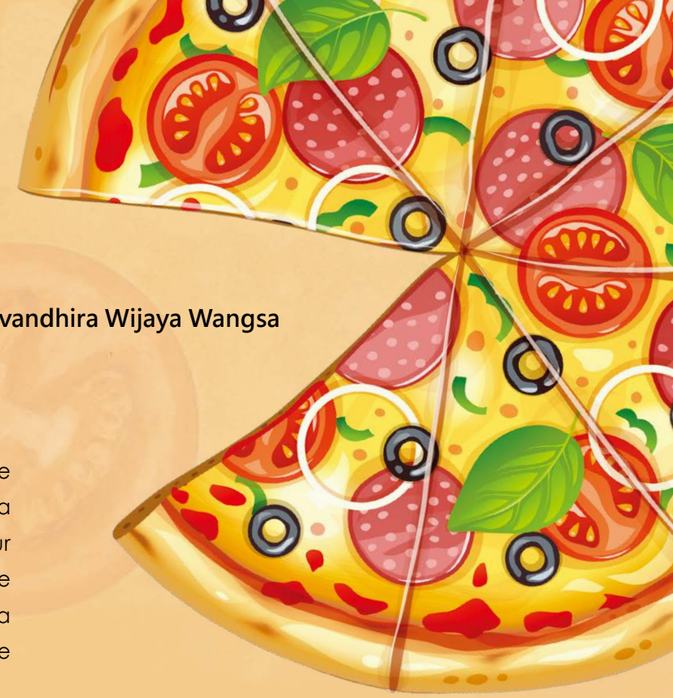
How to Eat a Pizza Slice Properly?

如何不失禮地吃薄餅？

By Devandhira Wijaya Wangsa



The Pizza Tragedy

If you were to eat a pizza slice right now, how would you do it? Typically, it goes as such:

1) *You grab a slice of pizza by its crust.*
2) *The pizza droops and dangles on your hand.*
3) *The topping falls on the table, and you sit in despair as you struggle with the mess!*

For centuries since its invention, this is how pizza is tragically eaten. However, if you bend the crust to vertically fold the pizza into half, it can be held straight and easily eaten. I call this the "Gaussian hold," inspired by the mathematician Carl Friedrich Gauss!

The secret behind this trick – in the mathematical point of view – relates to a concept called curvature. The idea of curvature is not that foreign to us; it is simply a value measuring how "curved" or "bent" something is. For a one-dimensional curve, the more curved it is at a certain point, the greater its curvature. To give a numerical sense, a circle of radius r has curvature $1/r$ everywhere, so a large circle is "less curved" than a small circle. It is also natural to say that any point on a straight line has no curvature, i.e. zero curvature. Note that it is more accurate to describe the curvature at a certain point, because a curve can have different curvatures at different points.

Nevertheless, in our original question, we are dealing with a surface (well, strictly speaking, a pizza is not exactly a surface because it has thickness, but we can view it as one). So how does the concept of curvature relate to the laws of bending surfaces? The answer relies on a remarkable result related to a specific kind of curvature called the Gaussian curvature.

Enter the Gaussian Curvature

Let's discuss how we describe the curvature of a surface. Think about the surface of a three-dimensional object such as a piece of paper, a ball, a cylinder, a pringle chip, or even a donut. For a certain point on the surface, notice that you will get a different curvature depending on the orientation of the surface you are considering. To get a more concrete example, take a look at the surface in figure 1 and find the curvature at the center (origin) of the graph.

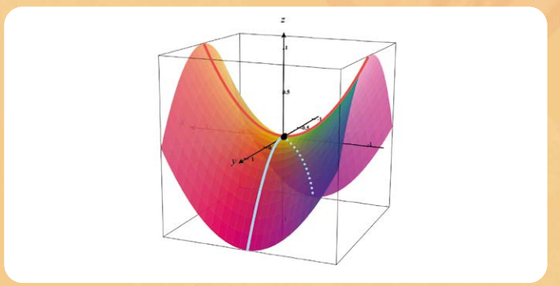


Figure 1 A surface with both a positive (red) and a negative (blue) normal curvature at the center (origin) (footnote 1).

Depending on which orientation of the surface we take (red or blue), we have a different curvature with the red curve going upward on both sides, while the blue curve going downward on both sides. In this case, at the center point, we can say the red curve has a positive curvature, whereas the blue curve has a negative curvature (the definition of positive and negative curvature depends on the convention we use). Note that even though the curves span across the surface, we are considering only the curvature at the center point.

We call this the "normal curvature" – the curvature at a certain point on the surface with respect to a curve passing through the point (footnote 2); in our example, the surface has a positive normal curvature with respect to the direction of the red curve, and a negative normal curvature with respect to that of the blue curve.

Now imagine we take all possible normal curvatures at a point by drawing every curve with respect to all possible directions. From all such possibilities, there has to be the greatest normal curvature and the least normal curvature (footnote 3), multiplying these two curvatures gives the Gaussian curvature.

Let's look at the three examples in figure 2. The first surface has a positive Gaussian curvature at the labelled point because both the maximum and minimum normal curvatures are positive, hence their product is also positive. The other two shapes have zero and negative Gaussian curvature respectively for the same reasoning. While there are other ways to describe the curvature of a surface at a point, such as mean curvature, Gaussian curvature is the way relevant to our question.

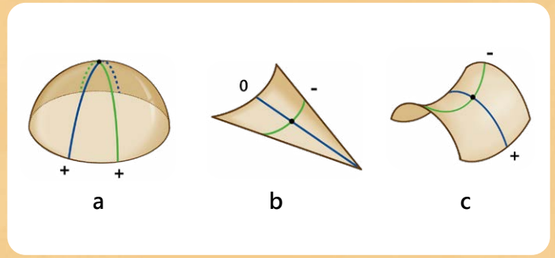


Figure 2 The Gaussian curvature is obtained by multiplying the maximum (blue) and minimum (green) normal curvatures at a point of a surface. The three surfaces have a (a) positive, (b) zero and (c) negative Gaussian curvatures respectively at the labelled point.

The Remarkable Theorem

Then why is Gaussian curvature important? We have to understand the "*Theorema Egregrium*" established by Gauss, which is Latin for "remarkable theorem". The theorem states that the Gaussian curvature is an intrinsic measure of a surface, meaning that the Gaussian curvature at every point of the surface does not change by bending the surface, as long as you do not stretch it.

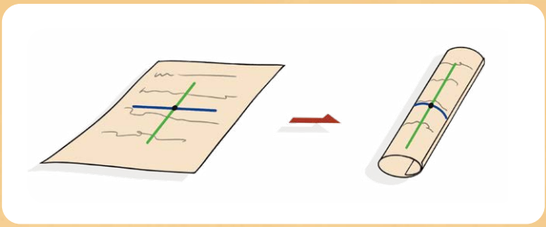


Figure 3 A flat piece of paper (left) and a cylinder resulted from rolling the paper (right). Both have a zero Gaussian curvature, with a minimum (= 0) and maximum normal curvature of the cylinder at the black dot labelled in green and blue, respectively.

To demonstrate this idea, imagine rolling a piece of paper into a cylinder. Since a flat piece of paper has a zero Gaussian curvature everywhere (with normal curvatures being zero in all directions), by the *Theorema Egregium*, we know the cylinder also has a zero Gaussian curvature everywhere. And in fact, it is true as you can see in figure 3. The minimum normal curvature is always zero, so multiplying zero always gives zero.

A significant consequence of *Theorema Egregium* is that a ball cannot be completely laid flat since the Gaussian curvature of a ball is positive while a flat plane is zero. In particular, it is impossible to create a flat map of the Earth without any stretching, so the world map must be distorted to compensate for the Gaussian curvature. More interestingly, although there is no area-preserving map, there are still maps which preserve angles, such as maps on the Mercator projection (figure 4). These maps are crucial especially for marine navigation to ensure that one can reach the destination by heading to the angle shown on the map.

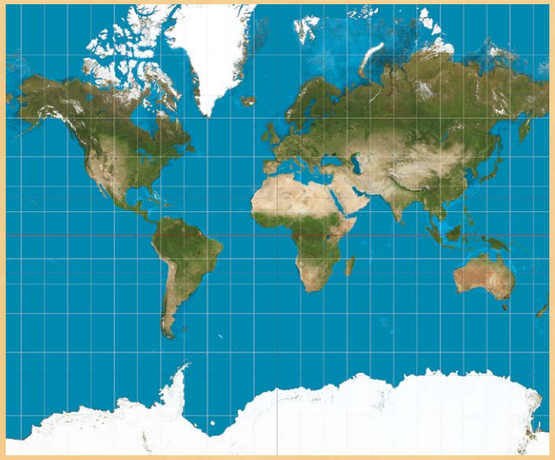


Figure 4 The world map on Mercator projection, which preserve angles but not area. Regions at high latitudes are largely distorted.
Photo credit: Daniel R. Strebe [1]

How to Eat a Pizza Decently?

Finally, we go back to the Gaussian hold of pizza. A pizza slice has a zero Gaussian curvature everywhere since the dough was rolled out flat before baking. By bending the crust to fold the pizza slice sideways and not in any other direction, we preserve a zero normal curvature everywhere of the pizza slice to maintain its zero Gaussian curvature (refer to figure 2(b) again), in a way that keeps the pizza "straight" so that the tip of the pizza can safely arrive at our lip.

Congratulations! Now you know not only how to eat a pizza elegantly, but also the reason behind the technique. This problem regarding the curvature of surfaces is in the field of differential geometry, which deals with the geometries of smooth shapes and involves mathematical techniques from calculus and linear algebra. Now try it yourself, the Gaussian hold for pizzas!

1. Fun fact: By rotating the surface around the center, you should also be able to find a curve with a zero normal curvature, i.e. a straight line. Can you find it?
2. Technically, there is a specific way to find out the normal curvature with respect to a certain direction, that is to create a perpendicular plane along that direction, and the normal curvature at that point is exactly the curvature of the point on the line of intersection between the plane and the surface.
3. This is possible due to the extreme value theorem. Since the surface is smooth, rotating it to consider every direction is a continuous process so the normal curvature must attain a maximum and a minimum each at least one.

薄餅慘劇

如果你現在要吃一塊薄餅，你會怎樣做？通常事情會這樣發生：

1) 你握住薄餅邊緣。
2) 薄餅從你手中垂下，來回搖晃。
3) 配料掉到桌上，你無奈地坐在那裡，看著桌子變成一團糟！

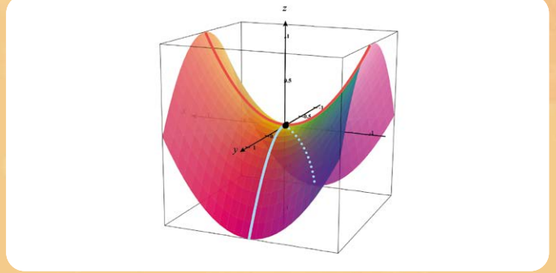
自薄餅誕生多個世紀以來，這一直都是我們吃薄餅的悲慘宿命。然而，你只要從批邊將薄餅沿長邊對折，就能使薄餅保持筆直，然後輕鬆地吃掉薄餅。姑且讓筆者稱這個方法為「高斯握法」，靈感來自數學家卡爾．弗里德里希．高斯（Carl Friedrich Gauss）！

從數學角度看，這個秘技與一個叫曲率的概念有關。曲率的概念對我們來說並不陌生，它是衡量「彎曲」程度的一個值。對於一維曲線，曲線在某一點上越為彎曲，其曲率就越大。從數字上量化的話，一個半徑為 r 的圓在每一點上的曲率均為 $1/r$，因此大圓的「彎曲程度」比小圓要小。那很自然地，直線上任何點的曲率皆為零，即是沒有彎曲。此處要注意的是描述某一點的曲率是較為可取的做法，因為曲線在不同點上可以有不同的曲率。

然而，在我們原本的問題中，我們處理的是一個表面（嚴格來說，因為薄餅有厚度，所以並不是一個表面，但我們可以暫且將其視為一個表面）。那麼，曲率的概念如何與屈曲表面的法則相關呢？須知道有種曲率叫「高斯曲率」，答案就在於一個與其相關的絕妙結果。

高斯曲率

讓我們討論如何描述一個表面的曲率。試想像一個三維物體的表面，譬如紙張、球體、圓柱體、品客薯片，甚或是甜甜圈。對於表面上的某一點，你會發現曲率會根據所考慮的表面方向而有所不同。更具體的例子請看圖一的表面，試找出圖表中心點（原點）的曲率。



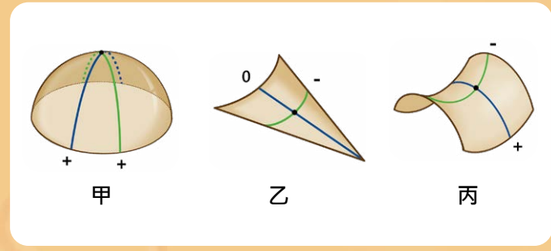
圖一 一個在中心點（原點）同時具有正（紅）和負（藍）法曲率的表面（註一）。

根據我們所考慮的表面方向（紅或藍），我們會得出不同曲率：紅色曲線兩側向上彎，而藍色曲線兩側向下彎。這麼，在中心點上，我們可以說紅色曲線具有正曲率，而藍色曲線具有負曲率（正負純粹取決於慣用定義）。此處要注意的是即使這些曲線跨越整個表面，但我們只考慮中心點的曲率。

我們稱之為「法曲率」— 即是在考慮穿過該點的某曲線下，一個表面在該點的曲率（註二）。在我們的例子中，該表面在朝紅色曲線的方向上具有正法曲率，而在朝藍色曲線的方向上具有負法曲率。

現在想像一下，我們透過繪畫朝向每個可能方向的所有曲線，來考慮某一點上的所有可能法曲率。在這些可能性中，必然存在最大和最小法曲率（註三），將這兩個曲率相乘便能得出高斯曲率。

讓我們看看圖二的三個例子。第一個表面在標記點上具有正高斯曲率，因為最大和最小法曲率皆為正數，因此它們的乘積也是正數。以相同道理推敲，可以得知其餘兩個形狀分別具有零和負的高斯曲率。儘管還有其他方法可以描述某一點上的表面曲率，例如平均曲率等，但只有高斯曲率與我們的問題相關。



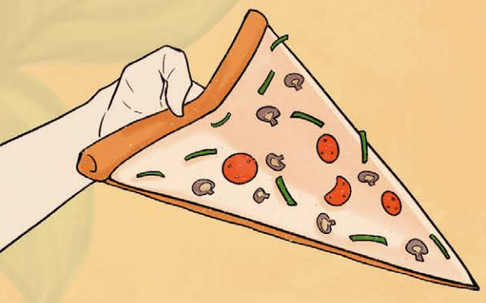
圖二 高斯曲率是透過將表面上某一點的最大（藍）和最小（綠）法曲率相乘所得。圖中三個表面在標記點上分別具有（甲）正、（乙）零和（丙）負高斯曲率。

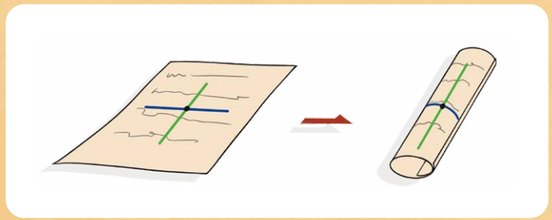
絕妙定理

那麼，為甚麼高斯曲率重要呢？我們必須了解高斯所提出的「*Theorema Egregium*」，這在拉丁語中解作「絕妙定理」（remarkable theorem）。該定理指出，高斯曲率是一個表面的內在本質，意味著只要不把表面拉長，單單屈曲表面是不會令表面上每一點的高斯曲率改變。

為了理解這個概念，試想像將一張紙卷成圓柱狀。由於在平坦紙張上各處的高斯曲率都是零（所有方向的法曲率均為零），根據絕妙定理，我們知道圓柱上每一點的高斯曲率也是零。事實上正如圖三所示，確實如此，因為每一點的最小法曲率均是零，因此乘以零得出的積亦是零。

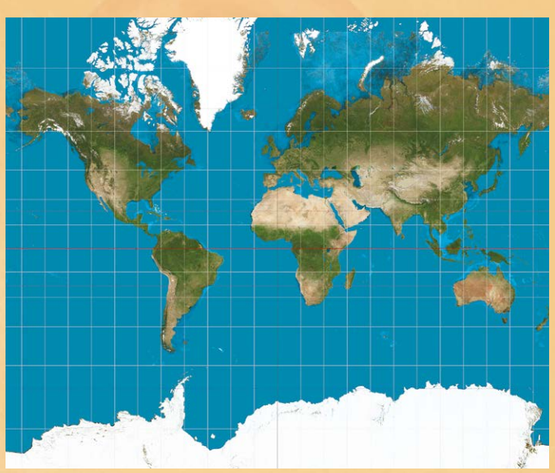
絕妙定理帶來的重要啟示是球體無法被完全攤平，因為球體的高斯曲率為正，而平面的為零，所以我們無法在沒有「拉伸」的情況下建立平面的世界地圖，故此世界地圖





圖三 扁平的紙張(左)和由其卷成的圓柱(右)。兩者的高斯曲率均為零,圓柱在標記點上的最小(= 0)和最大法曲率分別以綠色和藍色表示。

必須失真以補償高斯曲率。更有趣的是,儘管沒有地圖能按實際面積比例繪畫所有國家,但我們仍能編製出方位正確的地圖,例如以麥卡托投影法(Mercator projection)製作的地圖(註四)。這種地圖對航海等用途至關重要,因為它能確保人們按照地圖上顯示的角度行駛就能到達目的地。



圖四 以麥卡托投影法編製的世界地圖。它能保留實際角度,但不反映實際面積,明顯地高緯度地區嚴重變形。

圖片來源 : Daniel R. Strebe [1]

如何不失禮地吃薄餅?

最後回到我們吃薄餅的高斯握法。由麵團在烤焗前被擀平的一刻,薄餅每一點的高斯曲率均注定為零。透過屈曲批邊將薄餅沿長邊折疊,而不是沿其他方向,我們就能保持薄餅在每一點上均有零法曲率來維持其零高斯曲率(再次參考圖二),使薄餅能穩定地沿長邊挺直,令薄餅的尖端能安全抵達到我們的嘴巴。

恭喜!現在你不僅知道如何優雅地吃薄餅,還知道背後的原理。這個關於表面曲率的問題屬於微分幾何的範疇,該範疇探討光滑形狀的幾何,並涉及微積分和線性代數上的數學技巧。事不宜遲,就試用高斯握法吃薄餅吧!

1. 知多一點點:透過圍繞中心旋轉表面,你應該能找到一條法曲率為零的曲線,亦即是一條直線。你能找到嗎?
2. 事實上,有更嚴謹的方法找出相對於某一方向的法曲率,那需要沿該方向建立一個垂直平面,該點的法曲率正是垂直平面與表面相交線上該點的曲率。
3. 這是由於極值定理(extreme value theorem),因為旋轉光滑表面以考慮每個方向是一個連續過程,因此法曲率必定會達到最大值和最小值各至少一次。

References 參考資料 :

[1] Strebe, D. R. (2011, December 16). [The world on Mercator projection between 85°3'4"S and 85°3'4"N]. Wikimedia Commons. *https://commons.wikimedia.org/wiki/File:Mercator_projection_Square.JPG*

Q&A with HKUST Physics Majors 讀物理系的人:與科大學子對談

By Sam Fan 樊潤璋

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What inspired you to major in physics?
甚麼啟發你選擇主修物理？

Minnie

I was a self-taught student before entering HKUST. This gave me the freedom to explore a wide range of subjects. Initially, I was interested in biology, and later, I also delved into English literature. However, what truly sparked my interest in physics was an accidental encounter with a physics-related video on YouTube.

I still remember the first topic that deeply fascinated me was the double-slit experiment. It introduced the concept of wave-particle duality, which I found utterly mind-blowing. At the time, I simply couldn't comprehend how such a phenomenon could exist. This sense of curiosity and my eagerness to understand it better motivated me to start studying physics, beginning with IGCSE-level content. Over time, my interest in the subject grew stronger, and ultimately, this passion led me to choose physics as my major in university.

我在入讀科大前是自修生，這給予我自由去探索不同科目。一開始我對生物學感興趣，之後也探究過英國文學。然而，真正令我對物理產生興趣的是一次偶然在 YouTube 看到的物理學影片。

我還記得第一個深深吸引我的主題是雙縫實驗，它講述了波粒二象性的概念，令我感到不可思議。我當時無法理解為何這個現象會發生，正是好奇心驅使我想進一步理解它，最終使我翻開書本從 IGCSE 程度的內容開始學習物理。隨時間過去，我對物理的興趣日益加深，最終這份熱愛令我在大學選擇主修物理。

Dr. Tam 譚博士

I wanted to better comprehend the world, and what makes physics special is its ability to use simple and elegant mathematics to describe complex phenomena and even make predictions. Through deep thinking and hard work, it's possible to explain many seemingly complex phenomena, which I find incredibly cool. In fact, I've been determined to become a physicist since I was a child, so choosing physics as my major in university was a natural decision for me.

我想理解這個世界多一點，物理學的特別之處在於可以用簡潔而優雅的數學去描述複雜的現象，甚至作出預測。透過深入思考和努力，就能解釋許多看似複雜的現象，令我覺得非常酷。其實我從小就立志要成為一名物理學家，所以在大學選擇主修物理對我來說是一件順理成章的事情。

Dr. Leung 梁博士

Actually, there wasn't a particularly special reason why I chose physics. When I was in primary school, I already had a strong interest in mathematics, especially in the process of logical deduction, starting from the basics and deriving different results. However, mathematics itself is quite abstract. It wasn't until I encountered physics in secondary school that I realized it could establish a connection with reality. I particularly enjoy using equations and mathematical models to explain phenomena in the actual world. Then the results were no longer just numbers but were linked to everyday life.

Additionally, I loved reading science fiction as a child, particularly stories about time travel. This sparked my strong interest in physics. I was always curious to understand the principles behind things that seemed magical, and that curiosity ultimately led me to physics.

其實我選擇物理並沒有特別的原因。我小學的時候已經非常喜歡數學，特別是邏輯推導的過程，從基礎事實推導出不同結果。不過數學本身比較抽象，直到上了中學接觸到物理，才發現原來它能與現實建立聯繫。我享受通過方程式和數學模型來解釋現實世界中各種現象，因為計算結果不再只是單純的數字，而是和日常生活相關。

另外，我小時候也喜歡看科幻小說，尤其是關於時間旅行的題材，都令我對物理產生濃厚的興趣。我總想了解那些神奇東西背後的原理，那份好奇心使我最終選擇物理。

How do you see the role of physics graduates in today's job market/society?
你認為物理系畢業生在目前的就業市場和社會中扮演著怎樣的角色？

Minnie

I am aware that there is a general lack of understanding in the society about what qualities physics graduates hold. Beyond that, through my involvement in sports and business-related events, I've noticed three common reactions when people ask about my major: The first one is no reaction at all, as if they don't see how physics relates to their world. For the other two, they would either be "Wow! That must be hard!" or they mistake my major for physical therapy.

However, I believe that physics students possess valuable soft skills, including analytical thinking, data processing, logical reasoning, and the ability to learn new concepts quickly. These skills are highly relevant in fields like technology, finance and data analysis — areas where strong problem-solving abilities and quantitative reasoning are essential.

我發現社會普遍不太了解物理畢業生擁有甚麼特質。除此之外，在參與體育活動或出席商業場合時，當有人問及我主修科目，常見的反應有三種：第一種是沒有任何反應，好像他們不理解物理與自己生活有甚麼關聯似的，其餘兩種是「哇！那一定很難！」，或是直接誤會我讀的是物理治療。

但我認為物理系學生擁有很多寶貴的軟技能，例如分析能力、數據處理能力、邏輯推理能力，以及快速學習新事物的能力。這些能力在科技、金融和數據分析等需要極強解難和數據推理能力的領域都非常有價值。

Dr. Tam 譚博士

From my point of view, physics students have a unique attitude: Even if we don't know something initially, we are able to learn it as we go and quickly apply it to real-world problems. Physics training also teaches us how to use mathematics and data to model and describe a system. This quantitative modeling skill is incredibly valuable in many modern professions. For example, developing new drugs requires simulating molecular interactions, policymaking involves understanding societal dynamics, and financial market modeling shares many similarities with the methods used in physics research — using data, math, and models to analyze and explain phenomena.

Studying physics cultivates a distinctive way of thinking, enabling us to approach problems and the world from unique perspectives. It's precisely this perspective and these abilities that allow physicists to play a special role in the workplace and society.

我認為物理系學生有一種獨特的態度：即使我們起初不懂某些事情，在著手做的過程我們就能很快學會，然後迅速地將所學的應用到解決現實問題中。物理系提供的訓練還教會我們如何用數學和數據去建立模型來描述一個系統，這種利用量化數據建模的能力受到現代很多行業所珍視，譬如開發新藥需要模擬分子間的作用，制定政策需要理解社會運力學（societal dynamics），為金融市場建模都與物理研究所用的方法有很多共通點。以上談及的種種都是用數據、數學和模型來分析並解釋現象。

學習物理令我們養成了獨特的思維方式，使我們能以獨特的視角去看待問題和這個世界。正是這種慧眼和能力，令物理畢業生在職場和社會上扮演非凡的角色。

Dr. Leung 梁博士

Physics majors are highly competitive in the job market. The training provided in physics equips students with a unique skill set that is highly transferable to a wide range of fields.

In addition, physics graduates are known for their adaptability. They excel at analyzing problems and finding practical solutions, quickly understanding work contexts and applying their skills effectively. This makes them well suited for roles that require problem-solving or analytical expertise. That's why a physics degree is highly valued in North America where I currently reside.

物理系學生在職場上非常具競爭力，物理系的訓練為學生注入可以活用到不同範疇的技能。

此外，物理系畢業生有著極強的適應能力，擅長分析問題和尋找解決方法，亦能快速理解工作情境，並將所學的技能應用其中，使他們能勝任需要解難或分析的行業，因此物理系學位在我現在居住的北美受到僱主高度認可。

What are some stereotypes surrounding physics majors/ physics that you would like to dispel?

想為一些關於物理或物理系的刻板印象澄清嗎？

Minnie

Many people stereotype physics students as bookish, rigid, and lacking creativity. However, physics itself is a highly imaginative and creative field — without these qualities, it would be impossible to truly grasp its concepts. Because of this, I find that physics students are often far more interesting than people assume. Their way of thinking is unique, allowing them to see the world from entirely different perspectives and offer unexpected insights.

Rather than viewing physics as merely a collection of numbers and equations, many physics students appreciate the elegance and beauty within it. Sometimes, when deriving formulas, the steps may initially seem unrelated, but when the result emerges, it reveals unexpected connections. This element of "unexpected connections" is one of the most captivating aspects of physics. The idea that a single equation can elegantly describe and explain multiple complex natural phenomena is simply breathtaking.

很多人對物理系學生的刻板印象是覺得他們是一群只會埋頭讀書、性格古板和缺乏創意的人，但物理學本身是一門講求想像力和創意的學科，讀物理的人要是沒有想像力，就根本無法真正理解當中的概念。正因如此，我認識的物理系同學往往比人們想像的有趣。他們的思維方式非常獨特，能從一個完全不同的角度觀察世界，亦能帶來意想不到的見解。

很多物理系學生並不把物理視為一堆數字和公式，而是欣賞當中簡潔優雅的美。有時候我們在推導公式時，步驟可能看似毫無關聯，但當最後結果出現，才會發現意想不到的關聯性。這種意想不到的關聯正是物理最吸引的地方之一。僅用一條公式就能概括並解釋多個複雜的自然現象這點令人嘆為觀止。

Dr. Tam 譚博士

Many people might think that physics students are introverted or even a bit bookish, but that's not necessarily true. The field of physics is incredibly broad, encompassing individuals with a wide range of personalities, backgrounds, and traits. While some may indeed be more reserved, there are also many who are outgoing and excellent communicators. Having attended countless conferences and met a diverse range of colleagues, I've come to realize that succeeding in the academic world of physics requires more than just technical research skills. Strong communication and presentation abilities are equally essential. Many top physicists excel in social interactions, public speaking, and writing. They can deliver clear and engaging talks, breaking down complex ideas into simple, accessible terms — this is a crucial skill for anyone aiming to make an impact in the field.

Some may assume that physicists spend all their time calculating or conducting experiments in isolation, but communicating and promoting one's research is just as important for success. The academic world is highly competitive, and if you can't articulate the value of your research, collaborate effectively, or share your ideas in a compelling way, it becomes much harder for your work to gain recognition and make a broader impact.

大家可能覺得讀物理的人比較內向，甚至有點書呆子的感覺，但不一定是這樣的。物理這個領域非常廣闊，裡面有各種性格、背景和特質的人；有些人可能相對比較內斂，但也有很多非常外向和擅於溝通的人。在參加過無數次會議和見過形形色色的同行之後，我逐漸發現，要在這個領域的學術界成功，不僅需要研究技巧，還需要良好的溝通和表達能力。很多頂尖的物理學家都擅於社交、演講和寫作；他們的演講條理清晰且引人入勝，能用簡單易懂的語言傳遞複雜的想法 — 對於要在這行闖出一片天的人，這是不可或缺的技能。

有人可能認為物理學家只會獨自埋頭計算和進行實驗，但懂得與人溝通和推廣自己的研究成果同樣是成功的關鍵。學術界競爭激烈，如果你不能清楚地解釋自己研究工作的價值，無法有效地與人合作，或未能以令人信服的方式分享想法，就很難令自己的研究獲得認可，從而失去其發揮更大影響力的機會。

Dr. Leung 梁博士

In universities in Hong Kong, the gender ratio in physics departments is highly imbalanced, with significantly fewer women than men. However, as a female physicist, I believe it's a complete misconception to think that women are not good at physics or are unsuited for the field. More often than not, it's a matter of perception of the environment. When you're a high school girl and see that physics appears to be dominated by men, the lack of female representation can make the field seem less appealing or even intimidating. When I pursued my PhD in United States, I noticed that the proportion of women in physics was relatively higher compared to Hong Kong. Through interactions with my male and female peers, I observed no fundamental differences in thinking or research capabilities between genders. Most of the differences I noticed stemmed from individual personalities rather than gender itself.

From my experience, there is no inherent gender barrier when it comes to studying physics. My motivation for choosing physics was simple: I was fascinated by it. As long as someone has a genuine interest in physics, regardless of their gender, they can and should pursue it. That said, it's undeniable that societal stereotypes and the current gender imbalance in the field still make women a minority in physics. I hope this phenomenon will change over time, inspiring more women who are passionate about physics to step into the field and thrive.

在香港的大學裡，物理系的男女比例非常不平衡，女性的數目遠比男性少。可是，如果有人認為女生不擅長物理或不適合進入物理界，作為一名女性物理學家，我覺得這完全是一種誤解，因為更多時候這只是環境氛圍的影響。當你是一名女高中生，看見物理似乎是由男生主導，缺乏女性的情況可能減低你對物理的興趣，甚至因而感到卻步。我在美國讀博士時，發現那裡物理系女性的比例相對香港高。從與同學的互動中，我並沒有感受到男女在思維模式或科研能力上有任何本質上的差別；大部分差別反而來自個人性格不同，而非性別本身。

從我的經歷來看，修讀物理並不存在性別上的阻礙。我選擇物理的初衷很簡單，就是我被它深深吸引。只要對物理感興趣，無論男女，都可以和應該投身這個學科。儘管如此，無可否認由於社會上的刻板印象和現時這個範疇上的性別比例不平衡，女性在物理領域上仍然是少數，但我希望這種現象能隨時間改變，讓更多有熱誠的女生選擇物理，並在這個領域中發光發熱。

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