幾何意象
Shapespheres Unveiled

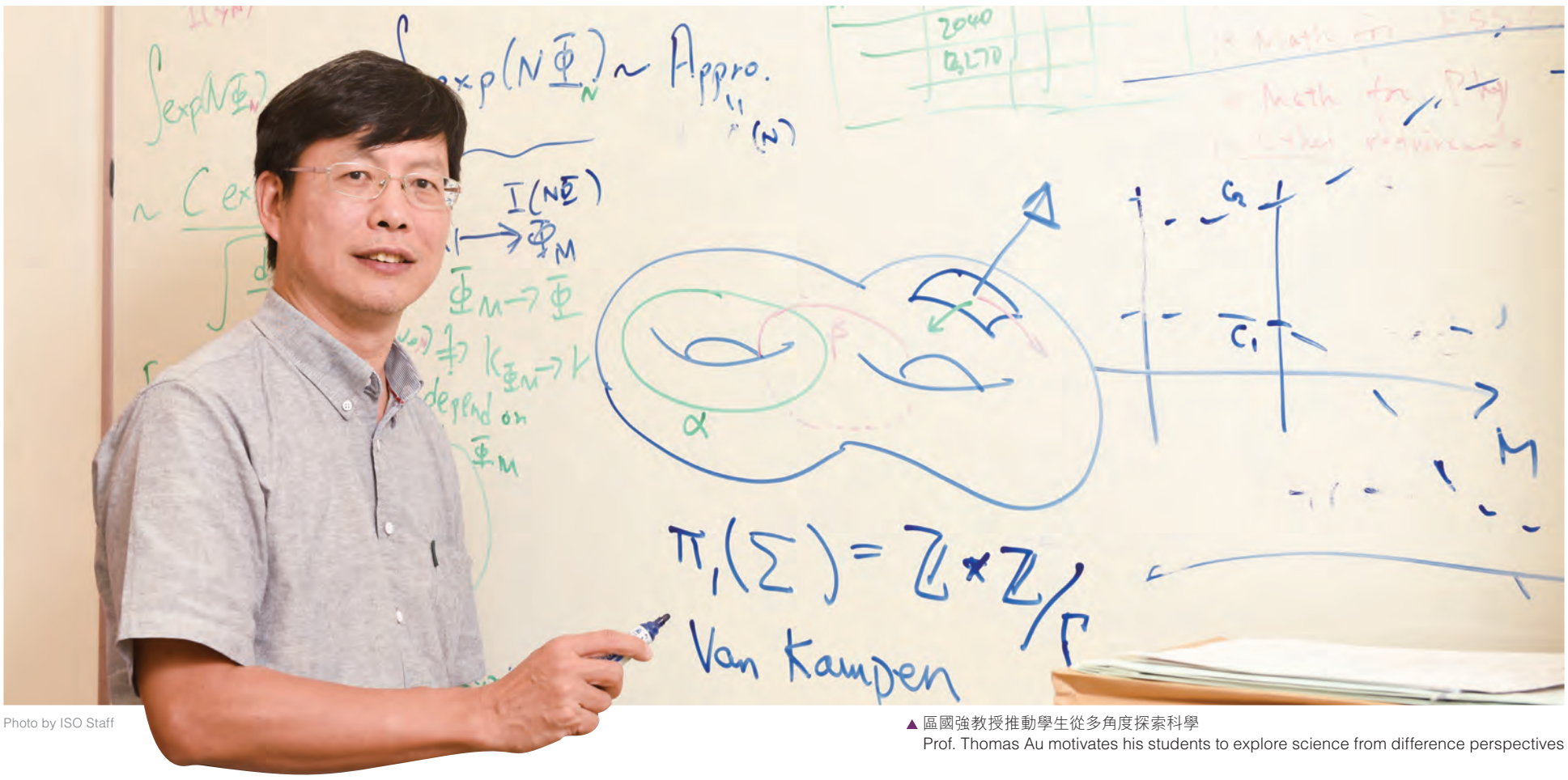


Photo by ISO Staff

▲ 區國強教授推動學生從多角度探索科學
Prof. Thomas Au motivates his students to explore science from difference perspectives

古希臘人認為算術和幾何是靈魂的音樂，連柏拉圖和亞里士多德都不願把數學與美學分開。欣賞荷蘭版畫家艾雪的畫作，便能感受畫家匠心獨運，將幾何對稱之美展示得淋漓盡致。數學系吳彥琪是應屆畢業生，她獲該系區國強教授支持，在科學館地面舉辦「璀璨數學之美」展覽，展現數學與藝術的完美融合，展區地面的幾何花樣圖案，正是從艾雪的《貝殼與海星》得到啟發。

融會數學與藝術之美

數學既有嚴密的邏輯運算，又有千姿百態的分形幾何圖案，結構之美教人目眩神迷。吳彥琪展出的三件雕塑品源於正幾何體和分形兩個幾何學中重要又極具美學價值的分支，前兩件分別是菱形六十面體及五角化六十面體，第三件是用銀色鐵線扭成的謝爾賓斯三角形，中間用綠色與黃色鋁線扭成的是希爾伯特曲線，是一條能夠填滿正方形空間的曲線，由德國數學家希爾伯特在1891年提出。分形與日常生活息息相關，除了葉脈構成的分形，人體血管分布和大腦的皺褶等地方都有各種分形或類似分形的幾何特徵。

甚具藝術天賦的吳彥琪鍾愛數學，自小學開始積極參與數學比賽，早已視考入數學系為目標。她最喜歡英國數學家哈代的名言——「美是最首要的標準：不美的數學在世上永不會找到容身之所。」吳彥琪習慣每次考試前透過繪畫減壓，去年更為數學系的網頁設計精緻的平面圖，以優美的線條繪出克萊因瓶（Klein bottle），形態看似數學上「無限大」的符號「∞」，帶人走進數學的海闊天空。在中大科學館地面舉辦展覽是吳彥琪的夢想，她早前向區國強教授提出，想不到教授十分支持，除了贊助展覽的材料費，也透過理學院職員為她統籌場地安排，她對此由衷感激。

點線面創新無疆界

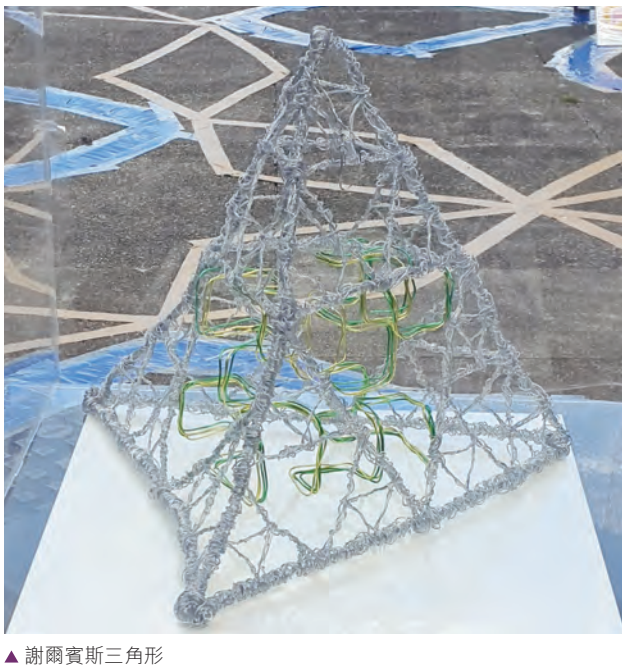
區國強教授說：「吳彥琪的展覽是Science Crossover計劃的頭炮活動。」顧名思義，這個計劃是支持學生用科學以外的方式探索和展示科學的本質，對象是理學院所有學生。「我鼓勵學生放膽嘗試，把新構思寫成建議書，凡是經面試獲計劃取錄的學生，會獲撥款支持；款項可用於舉辦展覽、製作科學紀錄片、修讀與建議書相關的課程等。除了培育優秀的學生外，我的心願是透過跨學科實踐發揮學生的創意，進而深化他們的科學思維。」區教授相信科學探索的過程，以至在創作期間學得的技巧，足以讓學生受益一生。

數學家認為數學是萬物之本。柏拉圖深信幾何多面體是宇宙的根源，在1600年，有德國天文學家以「柏拉圖多面體」精密地推算行星與太陽之間的距離。區教授說：「連薯片本身都有數學原理，它一面彎曲向上，相反的那面彎曲向下，我們稱之為『雙曲拋物面』。因為它雙重彎曲，有助於平衡物件的張力和壓力，任何一處受壓，都可以把壓力傳遞至四周，所以薯片雖然薄，卻有令人意想不到的強度。」建築界亦巧妙地應用薯片的幾何原理，讓建築物可以把重量分散，這些重量最終會傳遞到地面。區教授鼓勵學生多觀察身邊事物，便能體會數學天地之無垠。

▲ 位於倫敦奧林匹克公園的室內自行車館，也是採用「雙曲拋物面」的幾何設計
The velodrome cycling arena located in the London Olympic Park also adopts 'hyperbolic paraboloid' in its design

▲ 菱形六十面體
Rhombic hexecontahedron

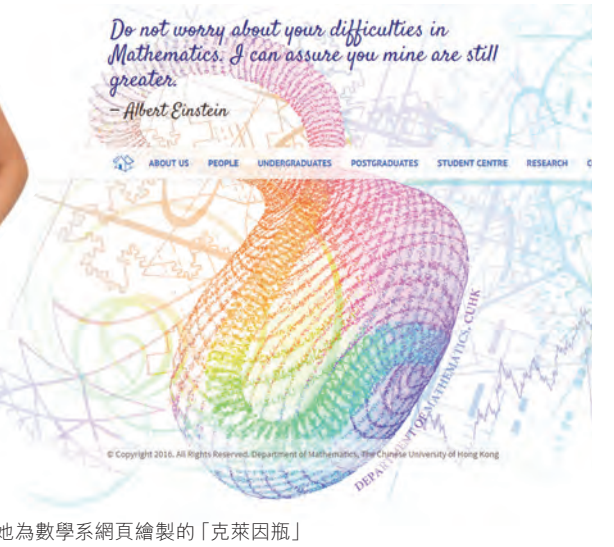
▲ 五角化六十面體
Pentagonal hexecontahedron



▲ 謝爾賓斯三角形
Sierpinski triangle

The ancient Greeks believed that arithmetic and geometry are the soul of music. Even Plato and Aristotle were reluctant to separate mathematics from aesthetics. The works of the Dutch printmaker M.C. Escher exemplify how an artist's mind makes manifest the beauty in geometry. Kiki Ng, who just graduated this year from the Department of Mathematics and with the help of Prof. Thomas Au of the same department, held the 'Shining Beauty of Mathematics' exhibition in front of the Science Centre to pay homage to the inherent beauty in mathematics and art. The geometric floral pattern on the ground of the exhibition zone was inspired by Escher's *Shells and Starfish*.

◀ 吳彥琪
Kiki Ng



▲ 她為數學系網頁繪製的「克萊因瓶」
The Klein bottle she illustrated for the department's website

Inherent Beauty in Mathematics and Art

No one would deny the algorithmic precision in mathematics, but few know that its fractal geometric shapes are pleasing to the eye as well. Two of Kiki's exhibits, a rhombic hexecontahedron and a pentagonal hexecontahedron, drew their inspiration from the concept of regular polyhedron, an important branch of geometry fraught with aesthetic potential. A third exhibit was a fractal display in the form of a Sierpinski triangle. The triangle was made of twisted silver wires, itself encasing a Hilbert Curve (named after the German mathematician who invented it in 1891) of green and yellow aluminum wires. Fractal geometry is closely interwoven into our daily life—leaf veins, blood vessels and brain folds, to name a few, are all expressed in different fractal shapes or fractal-like characteristics.

The artistic Kiki is also a mathematics lover. She has been actively taking part in mathematics competitions since primary school, and aimed at studying mathematics in university. Her favourite quote is from the British mathematician G.H. Hardy: 'Beauty is the first test: there is no permanent place in the world for ugly mathematics.' Drawing was Kiki's way of coping with pre-examination pressures. Last year, she contributed a sophisticated graphic design to the department's new website—a Klein bottle with refined strokes. With its shape like the mathematical symbol '∞' for infinity, the design welcomes the website visitors to the infinite world of mathematics. To organize an exhibition at the Science Centre had long been Kiki's dream. When she brought the idea to Professor Au, she was surprised by and grateful for his staunch support: from sponsoring the materials cost to venue arrangement.

Connecting the Dots to Fathom the Unfathomable

'Kiki's exhibition is the kick-off event of the Science Crossover Programme,' said Professor Au. As the name suggests, the programme supports students of the Faculty of Science to explore the essence of science in non-scientific ways. 'I encourage the students to be bold in translating their new ideas into proposals. Students who were selected by an interview panel would receive financial support. The funding could be used for organizing exhibitions, producing documentaries, or taking courses relevant to the proposed subjects. On top of grooming students, I wish to unleash their creativity by cross-disciplinary try-outs through which they could deepen their scientific thinking.' Professor Au reckoned that the scientific exploration itself and the skills acquired from scientific crossover productions would benefit the students for life.

Mathematicians believe that mathematics is the basis of everything. Plato believed that geometric polyhedrons were the origin of the universe. In 1600, a German astronomer came up with an ingenious system of nested Platonic solids to approximate the distances of the known planets from the Sun. 'Even potato chips embed a mathematically hyperbolic paraboloid: the parabola of a saddle-shape faces upward, and the opposite side faces downward,' explained Professor Au. 'The double curvature of a potato chip strikes a delicate balance between different pulls and pushes. The different forces would be spread to the edges of the chip whenever any part undergoes tension or compression, which allows the chip to remain thin yet surprisingly strong.' Architects also apply the chip principle to evenly distribute the forces buildings are put under, which will all be eventually transmitted onto the ground. Professor Au thought that if the students were keen observers of the things around them, they would begin to appreciate the boundless world of mathematics.