PHYSICS
THE CHINESE UNIVERSITY OF HONG KONG
中大物理
從基本粒子到宇宙 明萬物之理
中大物理通訊
CU Physics Newsletter
2015年 10月 第25期

系主任的話

中大物理系的系友和朋友們：

中大物理系通訊於2005年11月創刊，由最初的四版紙篇幅，增至現時的八版紙，內容更加豐富。這份通訊主要介紹2015年4月至10月期間物理系的活動（包括學生及教職員）及物理科研上的最新發展，有助於物理系與系友們及公眾，特別是中學生的聯繫，加深他們對本系的認識，以及提高他們對物理學科的興趣，早點確立自己的喜好，找到更適合自己的大學主修科目。


系主任吳恆亮教授

作為新一任系主任，我期望學系能吸引海外傑出學者到本系任教，並藉以推動學術發展。與此同時，亦吸引更多本地及海外的優秀學生加入物理系的大家庭。

最後，我想藉此機會衷心感謝上任系主任－夏克青教授對物理系作出的努力及貢獻。

系況速遞

- 根據大學統計數字，2014年物理本科畢業生有54%選擇繼續升學，當中包括北京大學（Peking University）和美國加州大學聖地牙哥分校（University of California, San Diego）；另有28%選擇就業，當中投身教育界和工商界的各佔14%。

- 2014-15年度暑期本科生研究交流計劃（SURE）共有10位同學獲選，他們已於6月至8月期間前往美國、瑞士及荷蘭的著名學府進行研究工作。此外，共有4位同學獲選參加物理系的OPUS交換生計劃，前往美國加州大學柏克萊分校修課一至兩個學期。

- 2014-15年度暑期教師學徒計劃（STAR）共有6位同學獲選。是次參與計劃的學校包括聖母無玷聖心書院、路德會呂祥光中學、基督教宣道會宣基中學、聖公會李炳中學、聖公會聖本德中學、德望學校和基督書院。此外，2015年共有2位同學獲天文台頒贈獎學金，到天文台參與有關氣象的研究工作，為期一年。

- 今年本系共有8個項目獲得研究資助局的優配研究金（General Research Fund）撥款，款項總和達港幣500萬元。研究課題包括「超冷原子泥和物」、「金剛石脈澤」和「異質成核結晶與均質成核結晶的不同」等。

獎項與殊榮

徐磊教授 榮獲國家教育部2014年度高等學校科學研究優秀成果獎自然科學獎二等獎。

自然科學獎二等獎—「複雜系統中場效應誘導的湧現現象及其物理機制」

徐磊教授(中)

項目簡介：複雜系統是一門重要的科學研究領域，涵蓋範圍甚廣，包括通訊網絡、物流網絡、神經系統，以至整個人類社會都可看作複雜系統。徐磊教授與復旦大學及香港科技大學的不同研究小組合作，從統計物理的角度探討複雜系統中個體之間的相互作用，以及他們如何在外界刺激下引發整個體系的集體行為。徐教授利用複雜膠體體系及皮克林乳液系統展開研究，發現了一種全新的皮克林乳液液滴振盪合並模式，並闡明了膠體系統的低頻準局域振盪模式的物理機制。這些研究成果對很多重要領域如石油開採、藥物輸運、玻璃化轉變及擁塞現象等可產生重要的推動作用。

博士畢業生黃仕迪同學 榮獲香港中文大學2014年度年青學者論文獎。

黃同學的論文題目為「Experimental Studies of Rayleigh-Benard Convection and Horizontal Convection」，而他的研究導師是夏克青教授。

本科生陸萃雯同學 獲頒2015年度創新科技獎學金。

「創新科技獎學金計劃」獲創新科技署及滙豐銀行贊助及支持，由香港青年協會主辦，並在多位具成就的名人及學者，和多家從事相關科學與科技的企業及機構支持下成立。獎學金頒授予在本地大學主修有關科學、工程及醫科學系，而成績突出的本科生，藉以鼓勵及栽培對科技有熱誠的青年人，將來能夠為社會作出貢獻。

陸萃雯同學(右)

本科畢業生羅育庭同學 在「科學一叮」2015年香港區總決賽中榮獲季軍。

「科學一叮」(FameLab)是一年一度的國際比賽。香港區的選拔賽由英國文化協會主辦。參賽者要在限時三分鐘內用淺白易明而且能夠吸引廣泛觀眾的方法講述一個與科學有關的題目。決賽當日，羅同學在短短三分鐘內生動地介紹了太陽是如何發光的。大家可在以下網址重溫精彩片段:
https://www.youtube.com/watch?v=-dtqnDRJ4Ck

羅育庭同學(左三)及本系
系主任吳恆亮教授(右二)

活動回顧

學術會議

會議與會者大合照

由中大理學院、學術交流處（國內事務）及理論物理研究所贊助，物理系主辦的海峽兩岸粒子物理及宇宙學會議（Cross-Strait Particle Physics Meeting），已於7月6日至8日於中大校園舉行。超過80位來自中、港、台三地的科學家和研究員，於會中展示和交流他們的研究工作報告。從希格斯機制到暗物質、核子到宇宙學，參會者就這些學科的未來發展彼此交換意見，分享經驗和知識。

楊振寧物理學講座


施一公教授(左)及本系夏克青教授

本系於4月23日舉辦了第一屆「楊振寧物理學講座」。我們很榮幸邀請到清華大學生命科學院院長施一公教授作為我們的講者。施教授當天以「生命的星球」為題向中大師生探討結構生物學在人類嘗試明白大自然的過程中所擔當的角色，以及分享了他對人類探索宇宙的一些哲學性思考問題。

物理學公開講座

本系分別於5月8日、5月23日、6月13日、6月26日及7月19日舉辦了五場物理學公開講座：李華白教授－「恆星的誕生」、楊綱凱教授－「宇宙大爆炸」、練立明博士－「廣義相對論一百年： 從致密天體到重力波」、吳藝林教授－「生物的物理－細菌的運動」及鄭啟明博士－「X行星「再發現」？！」。其中，楊教授、練博士及鄭博士的講座是與香港太空館合辦，並在太空館演講廳舉行。

本系亦於暑假期間舉辦了一個為期3天的短期課程給中學同學。課程導師練立明博士以「A taste of quantum physics」為題向來自不同中學的高中生介紹了量子力學中的基本物理概念及應用。

為讓普羅大眾對2015年度「邵逸夫獎」天文學獎得獎者William J Borucki及其團隊的研究有所認識，本系和中大逸夫書院在9月23日合辦了一場公開講座「地球2.0」。本系朱明中教授和中大生命科學學院許浩霖教授在講座中介紹系外行星及太空生命的探索。

物理夏令營

本系於7月20日至23日舉辦了物理夏令營，對象是申請於明年秋季入讀哲學博士及哲學碩士課程的本科生；內容包括講座、參觀實驗室、遊覽校園和生活分享。經篩選後我們邀請了當中30位來自不同院校的本科生參加，物理系並為參加者提供免費住宿。我們透過是次活動錄取了10位成績優秀的申請人。

Dr. Frank Otto

Magnetic Fields Regulate the Formation of Massive Stars

Interstellar space is filled with gas and dust. Over time, gravity pulls this material together into more and more dense structures. If the density becomes high enough, nuclear fusion will set in, and a star is born. But there are also forces at work which prevent or slow down this process. Turbulent motions tend to disperse the gas, and magnetic fields restrict the flow of gas by channeling it along the field lines. Which of these forces is more dominant? This question has long been debated by astrophysicists, and is still a matter of active research.

Led by CUHK Professor Hua-bai Li, our team has recently answered this question in favor of magnetic fields, at least for the star-forming region NGC6334, also known as the Cat's Paw Nebula (depicted in Figure 1). There, gas with a total mass 200,000 times that of our sun has gathered into a huge cloud spanning a length of 70 lightyears. New stars continue to be born there, many of them much more massive than our sun. While the region is about 5,500 lightyears away from us, it is close enough for astronomers to observe it in great detail.

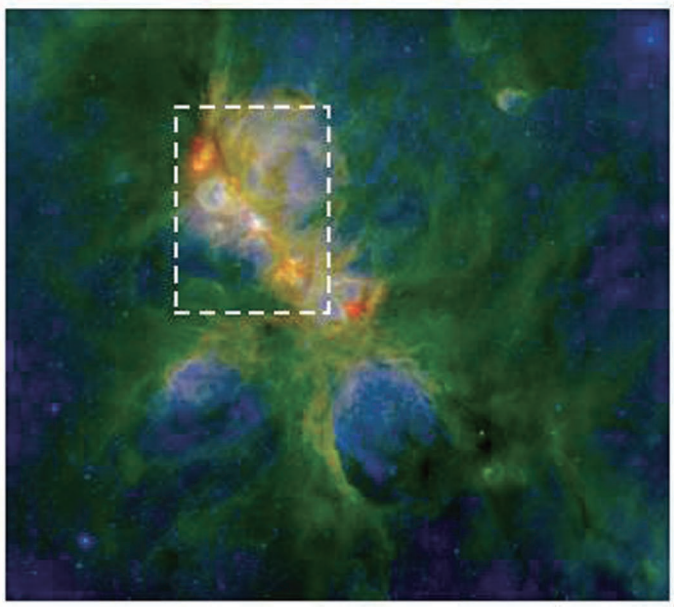


Fig. 1: False-color image of the star-forming region NGC6334. The region inside the dashed rectangle is more closely shown in Fig. 3a. (Image credit: Sarah Willis, Harvard-Smithsonian Center for Astrophysics)

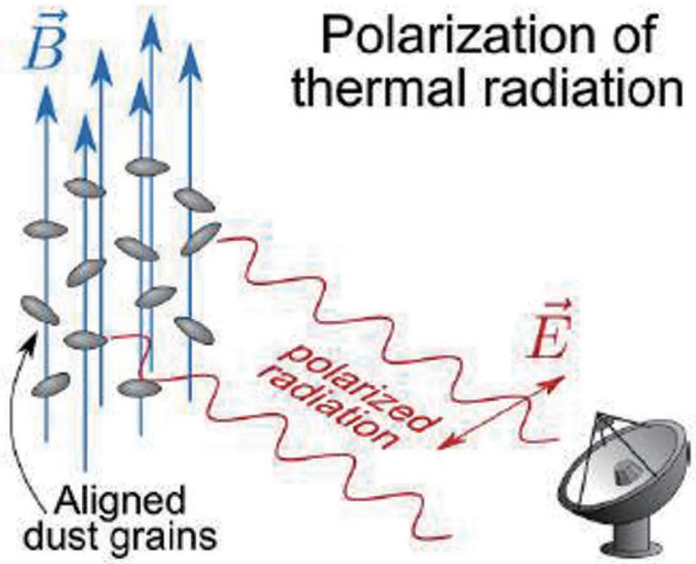


Fig. 2: Irregularly shaped dust grains precess around the magnetic field lines and emit radiation which is preferentially polarized orthogonal to the direction of the field.

For any object in space, the only information we have about it is carried by the light which it emits. With the naked eye, we only see the visible light emitted by stars. But dust also emits light, though in the far infrared region of the spectrum. This thermal radiation informs us about the distribution of the dust in space – the more intense the radiation, the more dust and gas there is. Yet the light carries more information, because some of it is polarized. The grains of dust contain small amounts of iron and other ferromagnetic substances, which open them to the influence of the ever-present magnetic fields. Over time, the grains align their short axis (around which they spin) parallel to the field, so that the thermal radiation's polarization (which is parallel to the long axis) comes to be perpendicular to the magnetic field (see Figure 2). By observing how the dust radiation is polarized, we can infer the direction of the interstellar magnetic field.

By applying this method to data which had been collected over the past decade at various observatories in Hawaii and in Antarctica, our team was able to create a map of NGC6334's magnetic field structure over a large range of scales (see Figure 3). Remarkably, at each scale we see the same pattern: the cloud has contracted into a flattened structure perpendicular to the magnetic field; at the edges of this structure, the gas contracts further into clumps, slightly pinching the magnetic fields lines. Zooming into one of the clumps, we see a similar pattern, but on a smaller scale. This self-similar fragmentation continues down to a scale where the gas becomes dense enough to eventually form new stars.

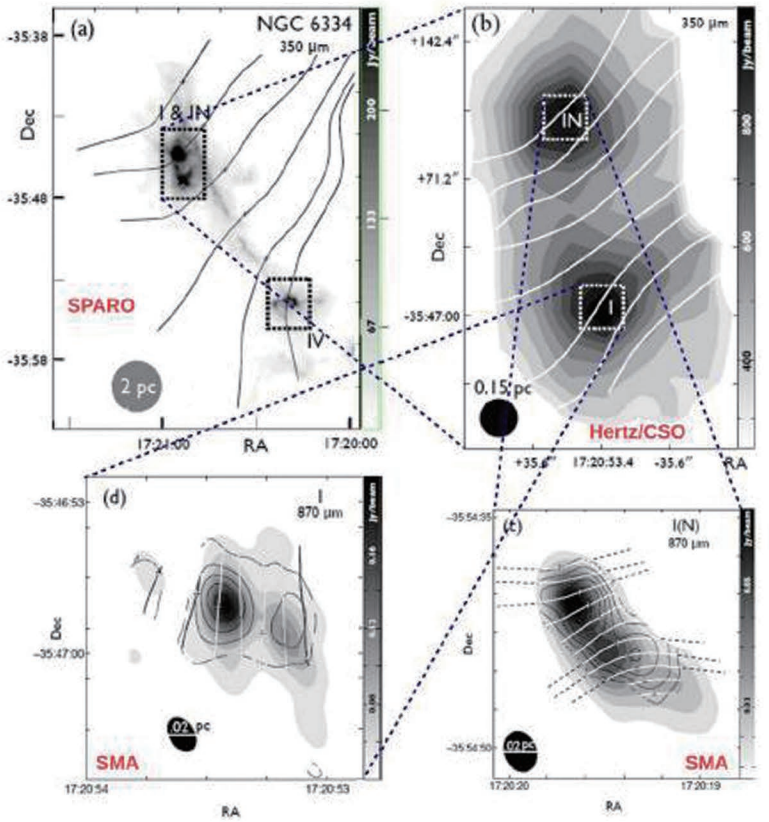


Fig. 3: Successive zoom into NGC6334, showing the distribution of dust and the structure of magnetic fields. Shades of grey show the intensity of the infrared radiation. Magnetic field lines are superimposed in black (a) and white (b,c,d).

About the author:

Dr. Frank Otto is currently a postdoctoral researcher in Prof. Li Huabai's group.

What can we learn from these observations? First, the magnetic field is quite well ordered and maintains its overall direction over all scales. This indicates that turbulence is weak in NGC6334, otherwise the field would appear rather tangled. Second, the flattened cloud shape shows that gravity and magnetic forces are almost in balance. With a weaker magnetic field, the cloud would simply contract spherically, forming a ball-like shape. Together, these two results show that magnetic fields play a dominant role in shaping the structure of NGC6334 at all scales, and hence regulate how fast stars can form. Moreover, these results allow us to estimate the magnetic field strength at each scale, by balancing the forces due to gravity, magnetic pressure, and magnetic tension. This is a novel method for measuring the strength of the magnetic field, using only observations of its direction.

Interpreting astronomical observations can be very tricky, because we only see a 2D projection of the actual 3D structures. Computer simulations can be very helpful, for example for validating assumptions made in the interpretation. This approach was already used in our NGC6334 study, and will continue to play an important role in the future. A new compute cluster with more than 1000 CPU cores, which was recently installed at the CUHK Physics department, will be instrumental for carrying out such simulations and for supporting our future research.

The NGC6334 study was published recently in the journal Nature (vol. 520, page 518, 2015).

課程與教學

中大物理系新課程收生理想！

鄭啟明博士

中大物理系在 2015 年開辦的新課程「理論物理精研」(JS 4690) 首年收生成績理想，共取錄了二十三位新同學，其中二十位來自聯招，三位來自非聯招，當中一位是外地生。以「香港中學文憑試」(HKDSE)最佳五科成績計算，循聯招入讀的同學成績中位數達29分[1]，是中大十個收生成績最高的課程之一。同時，今年入讀中大物理系的同學（理論物理精研及大類收生物理課程）只要符合資格，將可獲頒新設立的「物理入學獎學金」(Physics Admission Scholarships)[2]及／或「本科生研究經驗資助金」(Undergraduate Research Experience Grant - UREG)[2]，以支持及鼓勵他們積極參與物理系內外的各種科研活動，為未來從事物理科學研究工作做好準備！

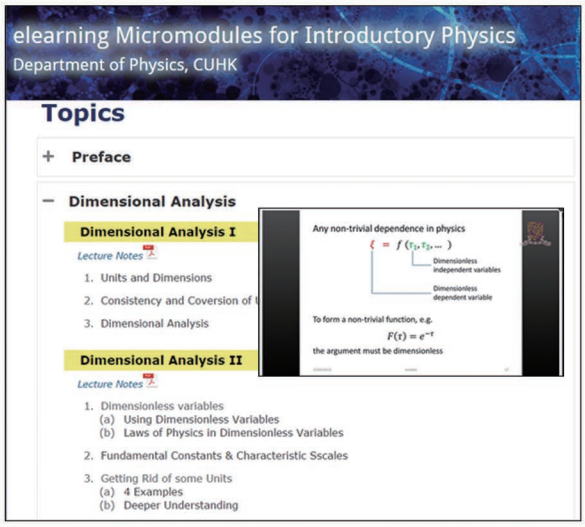
註[1]: http://www.oafa.cuhk.edu.hk/adm/jupas/hkdse/admission-requirements/important-information-for-applicants/best5-scores

註[2]: http://www.phy.cuhk.edu.hk/jupas/index6.html

物理系的 eLearning

湯兆昇博士

中大正著手加強電子平台學習。有見及此，中大物理系亦推出一系列的電子學習小型模組(eLearning micro-modules)，讓學生隨時隨地利用電腦甚至是手機進行學習。這些模組主要是一些精簡的錄音簡報，部分附以互動程式或練習。老師可利用這些模組協助學生重溫課堂內容，為一年級同學補充如數學方法等基礎知識，及為能力較好的同學提供課程以外的延伸教材，開拓更廣闊、更深入的學習。此外，大學更有計劃推廣「翻轉課堂」(Flipped Classroom)—上課前學生先利用小型模組學習基礎知識，讓老師在課堂上有更多時間教授深入的內容，或進行討論等雙向活動。現時物理系已經完成或正在製作的小型模組系列包括「物理的基本分析方法」、「大學物理」、「大學物理延伸模組」及「通識天文」等。其中「大學物理延伸模組」是對外開放的，從基本數學方法出發，延伸至較複雜的應用，藉此介紹物理研究的思考方法，適合大一修讀物理、工程或相關科目的同學參考。有興趣的朋友可登入以下網址參觀：http://www.phy.cuhk.edu.hk/elearning/year1phy/。



人事動態

這個學期我們有一位新老師加入本系，在這裡讓他向大家作自我介紹。

黎冠峰教授/中大物理系研究助理教授

I received my BA and MSci in Natural Sciences from the University of Cambridge (2009), and my PhD in Physics from the Dutch National Institute for Subatomic Physics (Nikhef)/VU University Amsterdam (2013). After my PhD, I spent 2 years at the California Institute of Technology as a Rubicon Fellow.

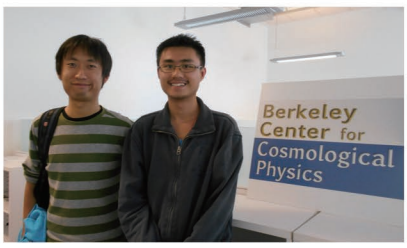
My current research interests are in gravitational-wave physics, and in particular the fundamental and astrophysical questions we can answer by direct detection of gravitational waves using ground-based detectors. I have been involved in the Virgo and LIGO projects since 2009, and I hope to someday 'see' the Universe in the gravitational-wave spectrum.

實習及交流天地

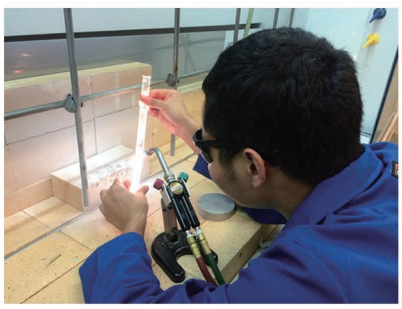
2014-15年度本系有4位同學獲選參加物理系OPUS交換生計劃到加州大學伯克萊分校學習。此外，我們的暑期本科生研究交流計劃(SURE)亦有多達10位同學獲選參加。我們邀請了他們來分享他們的學習體驗。

CHU Man Yat (OPUS)

I was able to study under the supervision of the world's leading physicists. In particular, I was able to engage in cosmological simulation with the help of Uros Seljak and his post-doctoral researcher Yu Feng. It has been a very good introduction for me into the world of Physics research.



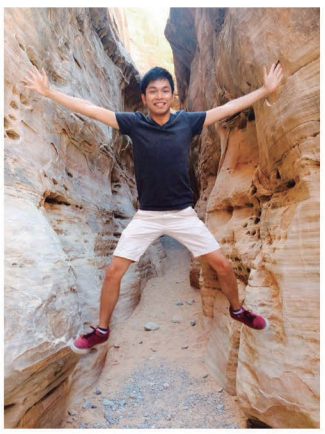
Chu Man Yat（right）



LU Kannan (OPUS)

My research focused on experimental study of Heavy Fermion System. I was supervised by Prof. James Analytis, Kittel Chair of Condensed Matter Physics in UCB. Hopefully, detailed experimental result would come out in the near future and give new insights into this field.

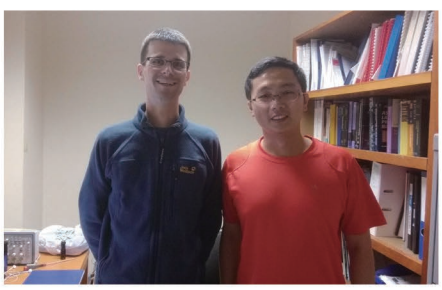
Lu Kannan



TANG Man Ho (OPUS)

From all the new friends I have met, the way they think and act certainly changed my own point of view. Their interests and ambitions are also so diverse that I could rarely hear of in Hong Kong.

Tang Man Ho



Tsui Tsz Chun (right)

TSUI Tsz Chun (OPUS)

I was so excited when I got in touch with the electronics involved in my project. I have to find out the behavior of them when it was not available in the data sheet. It felt like solving puzzle and it was fun!

CHU Kit Sang (SURE; University of Chicago)

The summer research provided me with a good understanding in experimental biophysics. The group atmosphere was really friendly. We even went for a trip to a state park nearby and visited the professor's house for dinner a few times.

Chu Kit Sang (right)

鍾嘉唯 (SURE; 布朗大學)

我在布朗大學主要研究系外行星，適逢當時開普勒計劃公布發現了「地球2.0」的系外行星，令我因能夠參與系外行星的研究而感到興奮。過程中我亦明白到研究工作的艱辛，過程中每一個進展都得來不易。

鍾嘉唯

劉家棟（SURE; 加州理工學院）

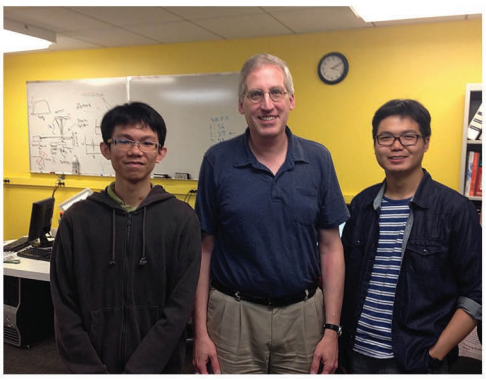
激光干涉重力波天文台（LIGO）是一個全球合作的大型實驗。為的只是想探測重力波帶來小於質子半徑的長度變化，我們都期待人類對重力波的第一次直接探測，並開啟電磁波以外觀測宇宙的新途徑。

劉家棟

接上頁

NG Kwan Yeung (SURE; Brown University)

Involving in the preparation of Balloon-borne Exoplanet Experiment, I learnt about the basic skills in using lab-based Fourier transform spectrometry. It really provided me a good experience and insight about current research.



Ng Kwan Yeung (left)

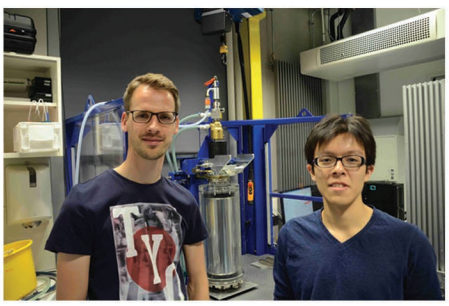
Ng Chi Wing

NG Chi Wing (SURE; CERN)

I attended most of the summer student lectures provided by CERN, in which experts from around the world share their knowledge about particle physics, experimental techniques, electronics, data analysis and many other topics.

鄧浩麟 (SURE; 屯特大學)

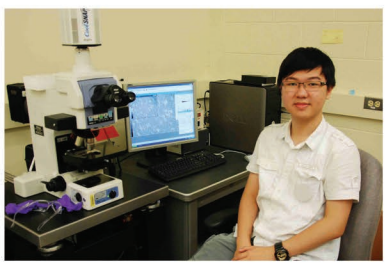
我在這三個月到了荷蘭的University of Twente做有關turbulence的研究。我在這裡體驗到物理的前線研究是如何的，亦令我認識到當地的學術氣氛。



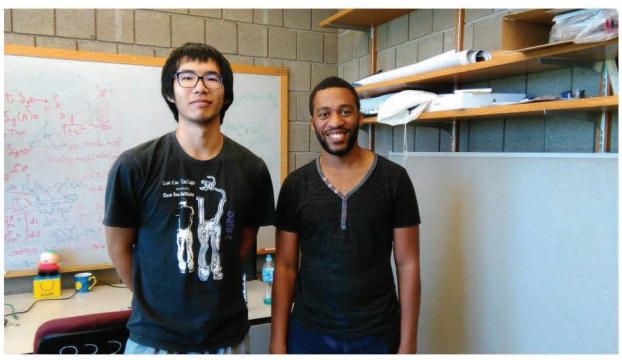
鄧浩麟（右）

TANG Wai Shing (SURE; Brown University)

I have learnt most of my research and laboratory skills from Professor Jay Tang, who had also shared his valuable experience not only on my project, but also on my academic career. I am now more determined to further study biological physics and pursue an academic career.



Tang Wai Shing



WONG Wang Kei (SURE; Carnegie Mellon University)

The McWilliams Centre for Cosmology is a place really worthy to spend a summer there. They have regular journal club three times a week, which give undergraduates like me chances to have discussion about new papers with everyone else in the centre.

Wong Wang Kei (left)

YAO Kaixuan (SURE; California Institute of Technology)

During the summer I worked on two projects. One is to build a model of the exchange of water between the regolith and atmosphere of Mars. The other is to modify an atmospheric circulation model built for Earth to apply to Titan, a satellite of Saturn.

Yao Kaixuan

YIP Long Sang (SURE; CERN)

The international working atmosphere at CERN has allowed me to interact with people from diversified cultures. I have learnt to be a team player and a culturally sensitive person.

Yip Long Sang (third from the right in the middle row)