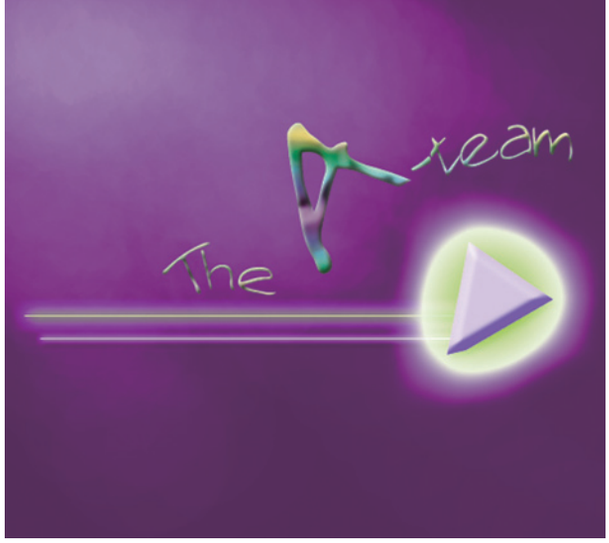


It might be a long 16-hour flight from Germany to Taiwan. Yet to Dr.Tjeng and his research team, the distance simply means an important nano-meter closer to the truth of the electron orbital behavior.

Facing the growing demand of advanced synchrotron radiation usage, scientists are forced to hunt for weeks, even days, of beamtime around the world. Sometimes this implies transportation of your own special equipments to the synchrotron facility across half of the planet in order to hook up with the beamline for a 2-week study.

Success never comes easily in today's research in basic science. It requires many factors to work well together. And, most importantly, the people. If we study Tjeng's research team hoping to identify a formula of producing successful materials research from an analytical viewpoint, several facts surface. The collaboration between fine scientists who study theory and researchers with hand-on expertise and no compromise of data quality is one of the essential characteristics of an outstanding research team. Others include strong financial backing that sets scientists free from stumbling into the off-and-on situation when proceed the project; direction defined by a team leader who has a clear vision, matured management skills, and understanding of the domain itself; and members who can work independently and persistently apply solutions to any unexpected challenge.

A professor of Institute of Physics, University of Cologne, Dr. Liu Hao Tjeng devotes his time in the area of highly correlated transition-metal oxides and thin films in nanometer range. These oxides and nano-films are highly complex but they have the nice feature that their properties are extremely sensitive to external parameters such as temperature, pressure, magnetic and electric fields. This makes them to be ideal candidates for use in sensors and electronic devices since they have a lot of 'knobs' with which one could tune their property and thus their functionality. Sounds remote and unfamiliar? Think again. The key beneficiary, for instance, is the device industry in the foreseeable future.

The experimental methods used by team of Tjeng include soft X-ray absorption spectroscopy, photoemission, and resonant diffraction. The research members have been active users of the NSRRC (National Synchrotron Radiation Research Center), ESRF (European Synchrotron Radiation Facility) in Grenoble, NSLS (National

研究特攻隊

單單想像橫越歐亞大陸16小時的行程，就使不少人累歪了。然而對Dr. Tjeng所領導的研究組員而言，每回往返台灣和德國的同時，意味著在探索電子領域裡更向前邁進數奈米尺距離的可能，直逼未曾被了解的領域，多麼令人振奮不已。

近年來，使用同步輻射進行先進研究的人數急速的增長，世界各國現有的光源中心於是普遍呈現供不敷求的情況。爲了能夠繼續從事高科技研究，許多科學家奔走於許多光源中心，爲的只是能得到短短一個禮拜的時間，得以使用儀器、專心的做實驗。更有些研究人員大老遠運送精密實驗站、遠渡重洋至國外光源中心繼續進行極具挑戰性的研發計畫。不禁令人驚嘆科學誠偉大，然而科學家的精神與不屈不撓的毅力亦令人佩服。

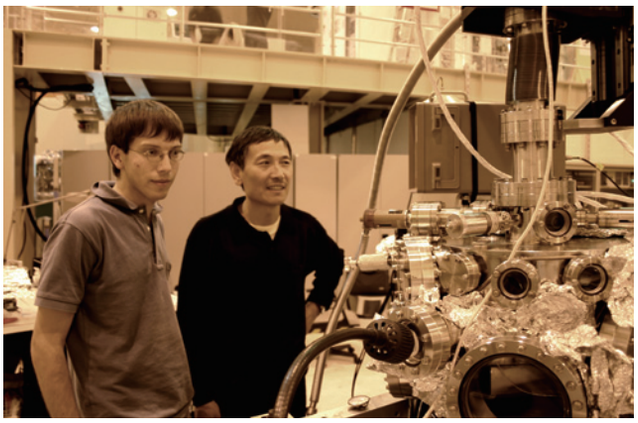
研究科學是一個不斷嘗試的過程，是否能有豐富的成果，有時還帶點俗語所說「天時地利人和」的成分。若我們嘗試找出成功的秘訣，可以拿成果豐碩的研究小組爲例，做進一步瞭解與分析，或許能找出蛛絲馬跡，成爲後進借鏡與鼓勵呢！

以任職德國Cologne大學物理學院之Dr. Liu Hao Tjeng所領導成果豐碩的研究組爲例子，他們給人第一個印象即是組員之間的默契與合作無間。成員裏不但有專攻理論、實驗技術爲主，並加上精於資料處理的研究員。Dr. Tjeng平易近人的解釋：「眞是缺一不可」。身爲計畫主持人，他極盡其力向德國研究機構及政府爭取充裕的研究經費，爲的是避免因經費不足造成實驗過程走走停停的風險，亦是成功的主因之一。在小心策劃分工下，各個研究人員分批持續進行實驗，配合無間，一心投注於研究奈米世界裏電子於多種氧化薄膜材料間的行爲互動。本文章爲讀者進一步介紹這組NSRRC用戶、及其於2005年間發表的研究結果。Dr. Tjeng研究組網站爲www.ph2.unikoeln.de/en/gruppen/Tjeng/Mitarbeiter/

訪問、整理　林克瑩

Synchrotron Light Souce) in Brookhaven, and BESSY (Berliner Elektronenspeicherring-Gesellschaft fur Synchrotronstrahlung) in Berlin since the 90s. Over the years, the team entrust their important soft X-ray absorption experiments to be conducted at the NSRRC where plenty of extremely stable beam were made available. Eventually, in 2001, the Tjeng team transported their thin-film molecular beam epitaxy system to the NSRRC. Since then, the group became prominent users of the Dragon Beamline at lot 11A.

The objective of the experiments is to unravel the complex micro world of the electrons in these oxides and thin films. Details concerning the charge, spin, and orbital state matter here. In fact, each new compound may open up a universe by itself. Two complementary strategies are followed. One is to study existing materials with fascinating properties in order to understand the underlying physical mechanisms. The other is to create new materials in thin film form as an implementation of a model system to test theoretical models relevant in the field of strongly correlated solid state physics and nanotechnology. The ultimate goal of the research program, not to mention unexpected new discoveries and invention of new techniques during the process, is to develop new concepts for materials science and to set-up a rich scientific databank, by which one could design and engineer materials or material combinations for a specific set of desired functionalities. And, it' s value? Invaluable.



Members of Dr. Tjeng's reserach team next to the experimental station connected to Dragon Beamline. From left to right, Tobias Burnus and Dr. Zhiwei Hu.

Members of Dr. Tjeng's reserach team next to the Dragon Beamline at NSRRC. From left to right, Rommy Sutarto, Dr. Hong-Ji Lin (NSRRC Dragon Beamline Manager), Dr. Liu Hao Tjeng, Dr. Holger Ott, Tim Haupricht

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- Aligning spins in antiferromagnetic films using antiferromagnets [Phys. Rev. B; cond-mat/0504520, submitted, 2005]
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- Determination of the Orbital Moment and Crystal-Field Splitting in $LaTiO_3$ [Phys. Rev. Lett. **94**; 056401 (2005)]
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