

## Academia Sinica Press Release

### Astrophysicists receive 12-meter Radio Antenna from US

#### National Science Foundation

The US National Science Foundation (NSF) announced recently that an international collaboration led by Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) has been selected to receive a 12-meter radio antenna designed for submillimeter-wavelength astronomy. The ASIAA-CfA (Harvard-Smithsonian Center for Astrophysics: CfA) team was selected to receive the antenna from among 3 teams of applicants. The antenna was one of the three antennas built as prototypes for the Atacama Large Millimeter/Submillimeter Array (ALMA), a huge radio observatory currently being constructed in Chile. ASIAA represents Taiwan in participating in the international ALMA project via Japan and North America.

ASIAA and the CfA are long-term partners who have worked together on several projects including the construction and operation of the Submillimeter Array (SMA) on Mauna Kea in Hawaii, and the Taiwan American Occultation Survey on Lulin Mountain in Taiwan. Besides ASIAA and CfA, other participants, other participants in the Prototype Antenna Project include the MIT Haystack Observatory and the US National Radio Astronomy Observatory.

The astrophysicists plan to use the antenna to provide an extremely sharp, high-resolution look at targets of interest, through a process known as Global Very Long Baseline Interferometry (VLBI) at submillimeter wavelengths. In order to do this, they will link the newly acquired antenna with other millimeter/submillimeter telescopes like SMA and ALMA. The set up will provide angular resolution of 20 micro arc-second (1 micro arc-second =  $1/3600000000$  degree), which is equal to the apparent size of a NTD10 coin on the moon, the highest angular resolution astronomers have achieved so far.

Using this submillimeter VLBI, the astrophysicists plan to produce images of supermassive black holes located at the center of galaxies. They hope to obtain direct proof of the existence of black holes, and make possible the testing of General Relativity in the presence of strong gravitational fields, which has been an exciting topic in modern astrophysics. The project will also study the ultra-relativistic jets emanating from the supermassive black holes. The telescope will also be used for

single-dish observations at very short submillimeter wavelengths, or THz frequencies, to study diverse cosmic environments such as cold interstellar gas clouds, dusty star-forming regions, and the cores of giant elliptical galaxies.

The ALMA Prototype Antenna is currently located in New Mexico in the US, but the new owners intend to move the antenna to a new location where the submillimeter VLBI performance and THz observations are most effective. The best site for the instrument will be typically, cold and dry and at very high altitude. One possible location, say the scientists, is a site known as the Summit Station in Greenland. ASIAA is already conducting site testing at a nearby location in Eureka, north Canada, and hopes to deploy test equipment to Greenland this summer. In the meantime, ASIAA and CfA are beginning the process of upgrading the performance of the prototype antenna.

Related website: <http://www.cfa.harvard.edu/news/2011/pr201108.html>

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The Atacama Large Millimeter Array (ALMA) proto-type antenna. Image credit: Image courtesy of NRAO/AUI / Kelly Gatlin/ Patricia Smiley

## 中央研究院新聞稿

### 本院天文所研究團隊自美接收一座 12 米電波天線

美國國家科學基金會宣布，由本院天文及天文物理研究所主導的國際合作團隊，最近獲得了一座次毫米波天文學專用的 12 米電波天線，這支原型天線是為了建造「阿塔卡瑪大型毫米及次毫米波陣列」(Atacama Large Millimeter/Submillimeter Array, 簡稱為 ALMA) 而特製的三座原型天線之一，總共有三支競爭隊伍爭取這座電波天線，最後由天文所與美國哈佛大學史密松天文物理中心團隊脫穎而出，贏得選拔。ALMA 計畫是一個巨型電波天文臺，目前於智利興建中，本院天文所是透過日本和美國等合作夥伴，代表台灣加入 ALMA 國際計畫。

本院天文所和美國史密松中心有長期的良好合作關係，過去合作的成果包括：在夏威夷毛納基山上興建並運營次毫米波陣列 (Sub-Millimeter Array, 簡稱 SMA)，在臺灣鹿林山的「中美掩星計畫」。這次參與 ALMA 原型天線計畫的還有其他兩個合作單位：麻省理工學院赫斯塔克天文臺、美國國家電波天文臺。

這支由天文物理學者組成的團隊計畫將原型天線和全球「甚長基線干涉技術」(Very Long Baseline Interferometry, 簡稱 VLBI) 加以結合，在次毫米波段進行更精確、更高解析度的天文觀測，因此這支 ALMA 原型天線將會和另外 2 個天文計畫——位於夏威夷的「次毫米波陣列」(SMA)，以及位於智利的 ALMA 這兩個毫米及次毫米波觀測站連結，連結完成後可提供達 20 微角秒的解析度 (1 微角秒=1/3600000000 度)。如此高的角解析度相當於從地球看得出月球上的一枚 10 元硬幣，這是目前天文學家能取得的最高角解析度。

透過次毫米波 VLBI 技術，天文物理學家計畫為星系中心的超大質量黑洞拍攝照片。希望針對黑洞的存在取得直接證據，並且能夠對近代天文物理熱門主題——廣義相對論中的「強重力場」，進行測試，此外，也能對超大質量黑洞中噴發的超相對性噴流做進一步研究。以單碟天線形式使用時，能在波長很短的次毫米波段或者太赫茲 (THz, GHz 的一千倍) 波段進行觀測，使人類能跨一大步研究宇宙

中更豐富多樣的主題，包括：低溫的星際氣體雲、塵埃密佈的恆星形成區，以及巨大橢圓星系核。

ALMA 原型天線目前架設地點位於美國新墨西哥州，本院天文所可能將它移放到最適合次毫米波段觀測、甚長基線干涉計畫可發揮最大效能、且有利於進行太赫茲無線電波段觀測的新位址，通常這意味著寒冷、乾燥、高海拔地點。天文所表示，有可能的地點是在格陵蘭島的「峰頂站臺」基地，天文所已在鄰近地區，加拿大北部的尤瑞加展開基本測試，希望今夏可於格陵蘭島上部署測試儀器。於此同時，天文所和史密松天文中心已開始為這支原型天線進行性能升級。

相關網站：

<http://www.cfa.harvard.edu/news/2011/pr201108.html>

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