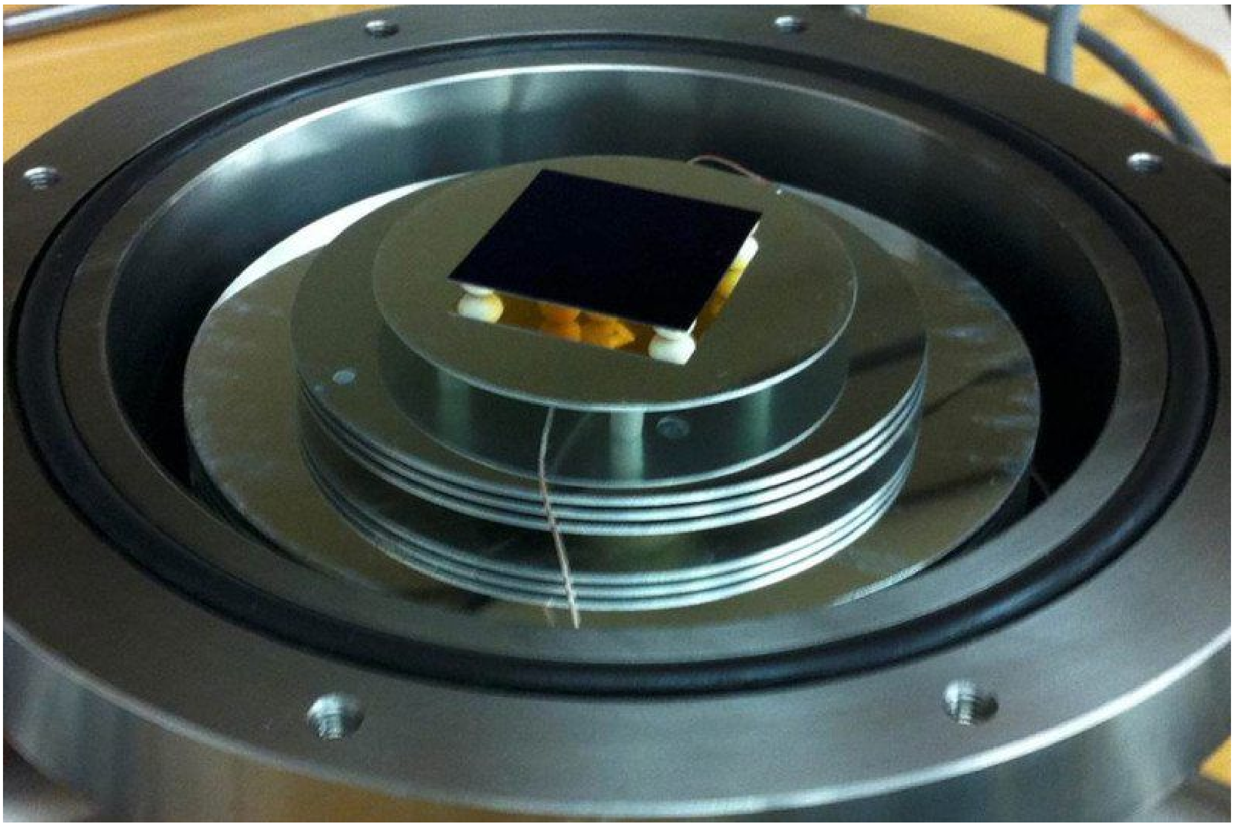
DAILY NEWS 13 December 2016

Future air conditioning could work by beaming heat into space



Zhen Chen

By **Matt Reynolds**

With temperatures as cold as -270 °C, space is one hell of a heat sink.

Physicists have achieved record levels of temperature reduction using the process of radiative cooling, by which heat is beamed from Earth's surface into outer space. Zhen Chen and his colleagues at Stanford University lowered the temperature of a thermal emitter – a device designed to give out more heat than it takes in – to 42.2 °C below that of the surrounding air

"To achieve high-performance cooling, the key is to couple whatever object you want to cool with outer space and to decouple it from the ambient environment," says Chen. The researchers placed the emitter in a vacuum chamber, isolating it from the atmosphere and cutting off almost any heat transfer through conduction or convection, which could cause the emitter to warm up. Heat from the emitter was radiated out of a specially designed window on top of the vacuum chamber, which was directed at a clear patch of sky.

Earth's atmosphere allows thermal radiation of wavelengths between 8 and 13 micrometres to pass through it into outer space – but most objects release heat at different wavelengths. The Stanford emitter, however, was specifically designed so that most of the heat it emits falls within that range, meaning that on a clear day it will pass straight out into space without being bounced back by the atmosphere

Within half an hour of pumping air out of the vacuum chamber, the temperature of the emitter plummeted to 40 °C below that of the surrounding air. Over the next 24 hours, it averaged 37 °C below the air temperature, and reached its biggest reduction of 42.2 °C when exposed to the peak of the sun's heat.

Bigger reduction

Previous attempts at radiative cooling have achieved maximum temperature reductions of up to 20 °C, unless they are at high altitude and with very low humidity.

Jeremy Munday at the University of Maryland in College Park, says the team's record-breaking results are down to their use of vacuum chambers and sun shades, which prevent sunlight from directly hitting the emitter. "They're getting significantly below water-freezing temperature during daylight by improving their set-up," he says.

Similar technology could be used to refrigerate food and medicine in areas where the ambient temperature is high, or in air-conditioning units on top of buildings, says Chen. To scale the technology up for these applications, however, they will need to find a cheaper alternative to the zinc selenide used in the window of the vacuum chamber, a material that is very effective at allowing radiation through at the right wavelengths to be transferred into space.

For situations in which it is not necessary to achieve such dramatic levels of cooling, however, zinc selenide could be substituted for less effective materials. "In the real application, you don't need such transparent material – you can use cheaper material such as silicon or aluminium," says Chen.

The researchers have launched a start-up company to explore commercial use of the technology, but Chen warns that it won't be able to completely replace existing air-conditioning units because overcast skies almost eliminate the effect of radiative cooling.

Journal reference: *Nature Communications*, DOI: 10.1038/ncomms13729