SHORT SCIENCE

Eating greens reduces breast cancer mortality

WASHINGTON – Chinese women who ate cabbage, broccoli and leafy greens saw improved survival rates after breast cancer compared with women who did not eat these cruciferous vegetables, a US study shows. The findings come from data on 4,886 Chinese breast cancer survivors aged 20 to 75. Women who ate more cruciferous vegetables over the three years following their diagnosis saw their risk of dying from any cause decrease by 27 per cent to 62 per cent compared to women who reported eating little or none of these vegetables. AFP

Alternative for sperm whale wax in perfume

VANCOUVER – A product from fir trees and yeast may soon replace ambergris – the wax-like substance secreted by sperm whales – in the manufacture of expensive perfume, researchers say. Scientists have long sought alternatives to ambergris as it is rare, costly at US$10,000 a kilogram, and could "be a factor in whale hunting", Joerg Bohlmann, a professor at the University of British Columbia, said. He and colleague Philipp Zerbe have found a balsam fir gene that, when introduced into yeast and grown on a large scale, produces an alternative to ambergris called cis-abrienol. Until now, isolating cis-abrienol from sage or fir plants has been difficult. AFP

US medics call for fewer tests in order to cut costs

WASHINGTON – Leading US medical associations have urged fewer tests for patients with mild health conditions and less aggressive treatment for advanced cancers in a bid to cut costs. They say that: patients with advanced tumours who showed no benefit from prior treatments should not be given chemotherapy; hi-tech scans for patients with early prostate or breast cancer that appears at low risk of spreading should be avoided; patients' exposure to radiation should be minimised; ECGs of patients with low risk for heart disease are of no benefit, as are CT and MRI scans for people with low back pain, or for those with fainting symptoms in the absence of signs of seizure or other neurological symptoms; colonoscopies could be done less often in patients who show no signs of disease; and doctors should not prescribe antibiotics for sinus infections unless they last more than seven days. The recommendations are detailed at http://choosingwisely.org. AFP

Ambergris, secreted by whales, has been used in perfume for centuries

PHYSICS

NOW THE INVISIBLE MAN CAN TAKE THE HEAT

Scientists who specialise in the dark art of invisibility have succeeded in creating secret cool spots hidden from the glare of intense heat

Adrian Wan
adrian.wan@scmp.com

The science of invisibility has now thrown its cloak over heat – hiding it in a way that objects close to scorching temperatures remain cool to the touch.

It's another step towards making things invisible in reality – with one Hong Kong physicist leading the quest to, magician-like, make whole objects disappear.

The latest breakthrough came from a French team. So far, tests have cloaked areas of just 300 micrometres, about a third of a millimetre, bending heat around the "invisible" spot.

Most previous work on invisibility has revolved around manipulating trajectories of waves – light, sound and the waves that travel through the earth and oceans. With heat, no waves are involved.

The French scientists used a "thermal" cloak to split space into a visible and a dark domain, with the object hidden in the dark domain shielded from heat.

The new approach was released in the journal *Optics Express* last week.

Sabestien Guenneau, who works with both the University of Aix-Marseille and France's National Centre for Scientific Research, did the study to see if they could control the way heat diffused in a manner similar to those achieved for waves.

"Heat isn't a wave – it simply diffuses from hot to cold regions," he said. "The mathematics and physics at play are much different. For instance, a wave can travel long distances with little attenuation, whereas temperature usually diffuses over smaller distances."

The trick, he said, was to apply the mathematics of transformation optics to the equations describing diffusion. The result, Dr Guenneau and his colleagues found, was a means to shuttle heat around at will.

In the study, the researchers propose a cloak made of 20 rings of material, each with its own "diffusivity" – the degree to which it can transmit and dissipate heat.

"We can design a cloak so that heat diffuses around an invisibility region, which is then protected from heat," he explained. "Or we can force heat to concentrate in a small volume, which will then heat up very rapidly."

This approach still employed the same fundamental theory, called transformation optics, that was first introduced for light in 2006, when physicists and mathematicians for the first time succeeded in designing invisibility cloaks.

The invisibility cloaks introduced in 2006 work for a set of wave equations – Maxwell equations – that govern the propagation of light and electromagnetic waves, for instance microwaves.

The French team extended the concept for their diffusion equation, which governs the flow of heat from one place to another.

It is very different from the method used by a team of physicists at the Hong Kong University of Science and Technology.

Chan Che-ting, chair professor of physics at the university, said their approach, called scattering compensation, uses artificial materials that are able to scatter light in an opposite fashion to how light is scattered by the original object.

Every object scatters light shone on it to form a pattern. Our eyes detect the pattern and see the object.

Chan uses metamaterials – man-made substances that possess properties not found in nature – that are able to scatter light in this opposite way. Both scattering effects simply cancel out each other. Thus, no light can now be detected and the original object is apparently invisible.

He gave an example: X + (-X) = 0. "The X is scattering due to the object we want to hide. Our cloak is the (-X) that undoes the scattering due to that object. The hidden object cannot be seen by the outside world, but it can see the outside world," he said. "And so it has an advantage."

When we are making something invisible, we are changing the way light is scattered

PROFESSOR CHAN CHE-TING, HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Along with Lai Yun, Chen Huanyang and Zhang Zhaoqing, he published the idea in *Physical Review Letters* in 2009. His team has even gone a step further to create other forms of illusions, for instance, "design cloaks that make an object look like another object".

"We are just at the beginning. We now know how to make things invisible in principle, but in practice, there are still many challenges to overcome," said Chan, also a director of the university's William Mong Institute of Nano Science and Technology.

For instance, "the operational bandwidth is very narrow – you can make an object invisible at one frequency but it remains visible at other frequencies". Expanding the operational bandwidth is very difficult for light, and the artificial materials that can do invisibility cloaking are very difficult to make.

The interest in accomplishing the "mission impossible" is shared by many scientists in different fields. "Physicists have come up with innovative ideas. Mathematicians have developed the mathematical tools needed to design these novel materials. Scientists in nanoscience and nanotechnologies have invented the fabrication techniques needed to make these artificial materials for cloaking. Engineers are trying to make real samples and worry about applications," he said.

"Solving these problems is part of my mandate as a professor to generate new knowledge. These research activities are very exciting as they satisfy my quest for curiosity. This new knowledge can be the foundation of future technologies," he said.

It is this curiosity which has, for several years, prompted Chan and his team to ask: "Can we make an object invisible? Can we create an optical illusion so that an apple would look like a banana? Can we create 'optical tracker beams' as those depicted in the movie *Star Trek*?"

For those who, for instance, want a bite of that apple, the idea may seem dreadful. But Chan said: "It is not scary if we look at the bright side of the possibilities.

"When we are making something invisible or making an apple look like a banana, what we are doing is changing the way light is scattered or absorbed by an object," he said.

"The same technology can protect us from harmful or unwanted radiation. If a coating can enhance the absorption for light, it will facilitate light harvesting. If a coating can enhance the absorption for sound, it will be a potent sound absorber. If a material can focus waves better, it can help us see better. There are a lot of potential applications that are good for mankind."

Physicists lift hopes for 'Big Bang' progress

CERN researchers smash sub-atomic particles at record speed in quest for the 'God particle'

Reuters in Geneva

Scientists came closer than ever to witnessing "Big Bang"-style conditions last week after revving up the Large Hadron Collider at the CERN research centre to smash sub-atomic particles together faster and harder than ever before.

Physicists in the control rooms punched the air as multi-coloured arcs flashed across their screens, debris thrown up by the collisions of some of the millions of protons flung around the vast underground circuit at close to the speed of light.

"This is a great start to the 2012 run. It promises to be an amazing year for particle physics," said Oliver Buchmueller, a member of the CMS team that is conducting one of the two main experiments at CERN, which lies on the border between France and Switzerland.

The proton smashers' big prize is the Higgs boson, the particle which – if it exists – explains why things have had mass since the birth of the universe 13.7 billion years ago.

This is a great start to the 2012 run. It promises to be an amazing year for particle physics

OLIVER BUCHMUELLER, PHYSICIST

Ramping the collider up to 8 Tera electron-volts, 15 per cent more energy than last year, should produce up to 10 times more data than the previous two years of work on trying to replicate the conditions of the birth of energy and matter at the dawn of the universe.

More data means more certainty about whether the Higgs lies within the last narrow band of energy yet to be fully explored, or if its existence can be conclusively ruled out, which would entail a rethink of textbook physics and mainstream science.

But the new high speeds also mean more background noise and static for Higgs hunters around the world to overcome.

The first tantalising glimpses of what might be the Higgs, postulated by British theoretical physicist Peter Higgs in 1964, were spotted in the Large Hadron Collider last year and revealed by researchers in December. CERN is now zeroing in.

After discovering the mystery boson – often dubbed the "God particle" to the strong disapproval of most scientists – CERN could turn to more "science fiction" targets such as extra dimensions and the "dark matter" believed to make up about 25 per cent of the cosmos.

SCIENCE FOCUS
WYSS YIM

How volcanic activity has influenced our rainfall

Sometimes they cause our driest years, sometimes our wettest, but erupting volcanoes are among the leading causes of variation in Hong Kong's climate

Since the establishment in 1883 of the Royal Observatory Hong Kong (renamed Hong Kong Observatory after the handover), continuous records have been kept at the headquarters station in Tsim Sha Tsui, except from 1940 to 1946.

From 1884 to 2011, the mean annual rainfall at the station was 2,228 mm, ranging from 901.1 to 3,343 mm. The top 10 wet and dry years are indicated in the chart (right), which shows that eight of the wettest years occurred during the past 60. Five were strong El Nino years, with the two wettest years, 1997 and 1982, ranking the most intense and second-most intense respectively.

Satellite tracking of volcanic clouds has indicated that two wet years, 1982 and 2008, were connected to major volcanic events – the eruption of the El Chichon volcano in Mexico in March and April, 1982, and the Chaitén volcano in Chile in May 2008.

The El Chichon debris took 12 days to reach Hong Kong, contributing condensation nuclei for torrential rainfall in late April to May. Stratospheric warming of the tropics may have been responsible for the intense El Nino episode. In 2008, the Chaiten debris took 35 days to arrive, and caused the wettest June in Hong Kong's history, including the once-in-1,100 year rainstorm on June 7. Besides severe flooding in various locations, the intense rainstorm caused more than 1,600 landslides on Lantau Island.

The 10 driest years are relatively evenly distributed from 1898 to 2011. During 1963, Hong Kong's worst drought year, water supply was reduced to just four hours in over four days. The severe drought has been attributed to air circulation changes resulting from the March-May eruption of the Agung volcano on the Indonesian island of Bali.

The June 1991 eruption of the Pinatubo volcano in the Philippines was a factor in Hong Kong's 11th driest year on record.

Similarly to volcanic eruptions, large nuclear explosions may also cause drought years. The detonation of the world's largest nuclear bomb in the Soviet Union on October 31, 1961, was followed by the 20th driest year on record in 1962. The atomic bomb exploded by France at Mururoa Atoll in September 24, 1966, was followed by the eighth driest year on record in 1967.

As for the 10 heaviest episodes of hourly rainfall recorded by the Observatory, all except 1926 occurred within the past 50 years. The first, the second and the ninth-ranked have occurred within the past five years, which may be attributed to the influence of the urban heat island effect.

Rainstorms accompanying low-pressure troughs are exacerbated by the heat generated by human activities. Additionally, the air pollutants, including aerosols and particulates, may intensify rainstorms by acting as condensation nuclei.

Hong Kong is particularly sensitive to wind shifts due to its location on the continental margin. Under "normal" monsoon conditions, summer winds are from the southwest and winter winds are from the northeast.

Volcanic eruptions are ... chemistry experiments that enable us to learn about climatic variability

Drought conditions can be explained by the "normal" wind pattern changing to predominantly offshore after volcanic eruptions or large nuclear explosions.

Abnormally wet conditions can be explained by the "normal" wind pattern changing to predominantly onshore. This is supported by satellite tracking of the spread of volcanic debris, as in 1982 and 2008.

Volcanic eruptions are natural atmospheric chemistry experiments that enable us to learn about climatic variability. Nowadays we can study their impacts closely, with Nasa operating five A-train satellites carrying instruments to provide atmospheric observations.

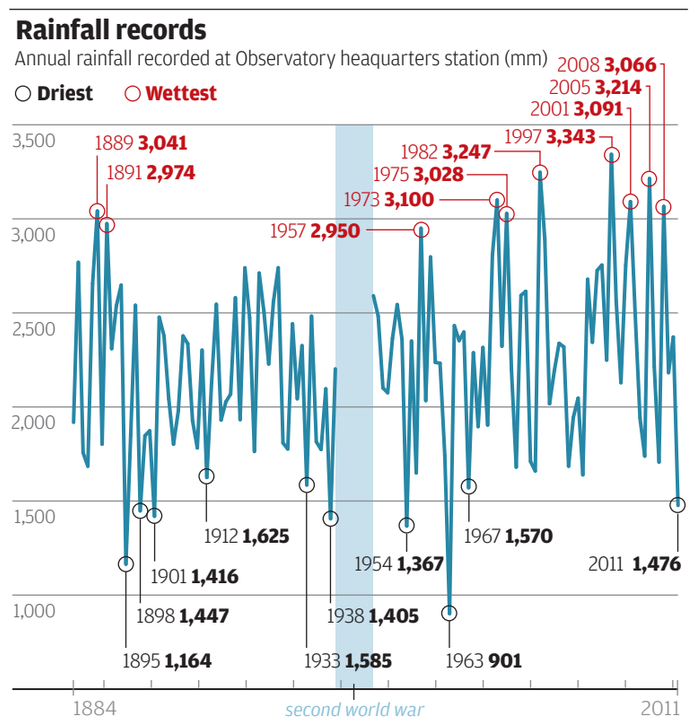
In January last year, the respected *Browning Newsletter* suggested that volcanic eruptions in the northwestern Pacific were responsible for the La Nina episode of 2010/2011. Their impact on circulation changes through strengthening of the onshore trade winds and the offshore westerly winds helped account for the summer floods in Queensland, Australia, and the winter drought in Shandong (山東) province respectively. Locally, 2011 was the seventh driest year on record.

The role of water vapour as a greenhouse gas is underestimated by the Intergovernmental Panel on Climate Change in comparison with carbon dioxide (CO_2). While volcanic eruptions are a natural cause of atmospheric water vapour redistribution, the world's seven billion humans are also changing the natural water cycle through their actions, including deforestation, dams and domestic, agricultural and industrial consumption.

A study of the warming power of CO_2 and water vapour by Paulo Cesar Soares in 2010 concluded that, unlike CO_2, water vapour in the atmosphere is rising in tune with monthly temperature changes.

Volcanic eruptions and nuclear explosions have been overlooked as natural and anthropogenic causes respectively for extreme rainfall variability. My findings support a greater role for water vapour than CO_2 in driving climate change.

Wyss Yim is an earth scientist specialising in environmental change. From 2007 to2009, he served as the deputy chairman of the Climate Change Science Implementation Team of Unesco's International Year of Planet Earth. The views expressed here are his alone, and are based on his research.



Source: Wyss Yim, HKO SMP