





pic credit: XinhuZhao Yingquan

THE COUNTRY'S STRESS ON BASIC SCIENCES HAS HELPED HOME GROWN RESEARCH BLOOM TO MATCH THE WORLD'S BEST, WRITES S ANANTHANARAYANAN

decade of focus on science and technology and innovation, as well as expansion of universities and facilities, has led to important research being carried out by Chinese scientists working in China. From space science to biotechnology, genetics, oceans, neuroscience, neutrinos, artificial intelligence, quantum computing and managing the environment, the levels of pure research in the country reflect a successful science policy.

A snapshot of the work being done is presented in the profiles of 10 Chinese scientists selected by the editors of the journal *Nature*. "These ten individuals highlight the breadth and promise of innovation in China as the country continues its strong push to become a leader in science," says Richard Monastersky, Nature's features editor.

■ Wu Ji, director general of the Chinese National Space Science Centre in Beijing since 2003, has lobbied hard for the the country's space pro-



gramme to change direction and promote basic research. In December 2015, the centre launched the Dark Matter Particle Explorer, a 1,400-kg satellite that can detect electrons and gamma rays with greater resolution

than other facilities available.

The next mission, due this year, is to launch the Hard X-Ray Modulated Telescope, which uses an innovative technique to build up highresolution images of events in the vicinity of black holes and neutron stars. The collaborative project was conceived by China, which is providing the spacecraft and the main, hard X-Ray

glucose to provide energy to the cell. The structure of this protein had evaded researchers for over 50 years because it rapidly changes its shape. Yan used a series of innovative devices to restrict troublesome movements of the protein, and, "bingo — she hit it", says biochemist Ronald Kaback at the University of California, Los Angeles.

Cui Weicheng of the Shanghai Ocean University is a deep-sea diving expert and was there in 2012 when China's Jiaolong submersible craft went deeper than 7,000 metres into the Mariana Trench in the Pacific. Only a



handful of nations have deepsea capability and the *Jiaolong* is the most powerful device in operation. China has increasing leader-

ship in deep-sea research and Cui and his team are building a more pressureresistant, three-person submersible, the Rain*bow Fish*, to reach the Challenger Deep Valley at the bottom of the Mariana Trench, 11,000 metres down.

When it is completed in 2020, the vessel will be available for use by scientists around the world, says Cui. "The oceans belong to humanity rather than individual nations."

■ Wang Yifang is director of the Beijing-based Institute of High Energy Physics and he is spearheading the plan to build a 50-100 km particle accelerator, successor to the 27-km facility

at Cern, Geneva. The LHC at Cern was a col-

laboration of over 10,000 scien-

in ancient bones, and the science of how DNA changes when different races mingle. She then turned her attention to other early human migration in Eurasia and she has to her credit the sequencing of the earliest human DNA. This was from a 45,000-year-old thigh bone found in Siberia and a 40,000-year-old jawbone. Her study of 14,000-37,000-year-old remains shows that there were waves of migrants in the Ice Ages who contributed to the genetic heritage of present day Europeans. She now heads an ancient-DNA lab at the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing and hopes to unearth even more dramatic goings and comings in early Asia.

Satelite launch at Xichang, southern China.



in academia, rising to be president of Tsinghua University in Peking, Chen turns his attention to managing China's huge pollution problem, which blacks out cities, contaminates

PLUS POINTS

TheStatesman

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Wearable technology

Solar panels so flexible and thin that they can be wrapped around the frame of a pair of glasses have been developed by scientists in a potential breakthrough for wearable electronics. The panels, developed by a team of researchers in South Korea, are just a single micrometre across much thinner than the average human hair or a coat of paint, which are both



typically about 100 micrometres. These are hundreds of times thinner than standard solar panels and three to four times thinner

than most of the slimmest solar cells currently available.

Professor Jongho Lee, an engineer at the Gwangju Institute of Science and Technology, said their panels were "less fragile under bending, but perform similarly or even slightly better" to panels 3.5 micrometres across. The researchers said the new material was easily flexible enough to wrap around a pencil. And in tests they found it would still work when wrapped around something just 1.4 mm wide.

It is thought the panels could be used to provide power for smart glasses or incorporated into clothing to power wearable technology, which is often limited by the size and weight of the battery. The scientists, who published their findings in the journal Applied Physics Letters, wrote that they had made the ultra-thin solar cells using a semiconductor, gallium arsenide.

IAN JOHNSTON/THE INDEPENDENT

Ingenuity from 60 BC

imager. China has also planned the launch of five new space science satellites, including a Sino-European joint mission, in the next five years, apart from a Mars mission in 2020.

Nancy Ip, dean for science at the Hong Kong University of Science and Technology, has trained in neural biology and worked in biotechnology. The large research team she works with mixes these fields with clinical



Her work, which spans different fields, has won her honours and awards, including the L'Or-

éal-Unesco Women in Science award.

She now plays a leading role in China's Artificial Brain Project, which seeks to simulate a vast array of "neural nets" and connect them to create artificial brains. The "neural" modules evolve, like their biological counterparts, but in a supercomputer, and the artificial brain will contain thousands of pattern recogniser and decision modules to control a walking, talking robot.

■ Nieng Yan returned from Princeton to work as a structural biologist in Tsinghua University

in Beijing and she looks at how proteins act at the level of atoms. She is known for her work on the membrane that separates the interior of the cell from the surrounding plasma, particularly one that carries



Bres

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lider, which would be seven times more powerful, would clearly be more complex and is estimated to cost a cool \$ 6 billion. Wang may still be able get the project through on the basis of his impressive success in leading the Daya Bay Reactor neutrino experiment, an international collaboration that beat competitors in the far frontier field of measuring neu-

trino parameters. Plant biologist Caixia Gao is a gene editing specialist. She uses the new CRISPR technique for versatile genetic engineering and developing valuable new traits in plants. She has returned to China after a long and successful spell of wor-

king with strains of grasses in Denmark, and is busy working with strains of wheat. Wheat is legendary for being difficult to work with, but Gao is making a mark, just like she did with grasses in Denmark.

Public fears about GM crops have been a damper in allowing gene editing progress to get to the market. But she believes this can be overcome and she is happy to be back in China where agricultural research is a greater priority than in Europe.

Qiaomei Fu is a geneticist historian who has returned to China fresh after rewriting the history of the earliest humans in Europe, where she used methods of harvesting shreds of DNA

Qin Weijia, executive deputy director of the Chinese Arctic and Antarctic Administration

in Beijing, has been to the Antarctic half a dozen times. Last December, he led an international team that traversed thousands of square kilometres with ice-penetrating radar and other sensors mounted aboard China's first fixed-wing aircraft

to map features under the ice.

The team discovered the longest canyon on earth and one of the largest areas of melt under the ice sheet, says Qin. He hopes that China will be able to retrieve the oldest ice on the planet to uncover the history of the Antarctic ice sheets and how they have changed. "Only then," says Qin, "can we predict how they will respond to a

Chen Jinning, as minister for environmental protection, has probably the most challenging clean-up job in the world. After 19 years

drinking water and poisons cropland.

While the country on one hand continues to grow in industry, aggravating impact on the environment, Chen manages the complexity of regulation, inspection, implementation, information and innovation, to contain both pollution as well as carbon emission, which has a global dimension. China's ambitious wind and solar energy programme is but one aspect of the transformation of practices and mindsets that are needed in the world's most populous nation. Chaoyang Lu, at the University of Science

and Technology of China at Hefei, was described by Anton Zeilinger, pioneering in quantum information theory, as a "wizard of entan-

gled photons". Quantum entanglement is when two separate particles behave as being in a single, combined state so that measurement of one affects the state of the other. It is the property that allows the different photons striking a green leaf to

find the most efficient way for all of them to come together and deliver the best energy to the leaf. Achieving this state in practice could lead to computers of unimaginable speed.

The best efforts have resulted in "entanglement" of just four photons, but Chaoyang, who is back to work in China, holds the world record at eight, and is working on doing it with 10.

Touchscreens for dogs... MANY PEOPLE LAUGH WHEN THEY HEAR ABOUT ANIMAL TECHNOLOGY BUT THERE'S NO DISREGARDING THE BENEFITS, SAYS ILYENA HIRSKYJ-DOUGLAS

T magine leaving your dog at home while it turns on the smart TV and chooses a programme to watch. Meanwhile, you visit a zoo where you play interactive touchscreen games with the apes and watch the dolphins using sonar to order their lunch. In the field behind you, a farmer is stroking his flock of chickens virtually leaving the drones to collect sheep while the cows milk themselves. Welcome to the unusual world of animal technology.

Animals have interacted with technology for a long time, from tracking devices for conservation research to zoos with early touchscreen computers. But more recently, the field of Animal-Computer Interaction has begun to explore in more detail exactly how animals use technology like this. The hope is that better understanding animals' relationship with technology will mean we can use it to monitor and improve their welfare.

The explosion of research in ACI has been followed by products that allow owners to monitor their pets when out of the house and even play games with them. For example, the Petcube toy lets owners control a laser that the pets can chase while talking to them using a video app on their smartphones. Other apps allow owners to monitor their pets' health, exercise and habits. Research into the app CompanionViz showed this data gave owners an enhanced understanding of their pets' health and strengthened their com-



An astronomical calculator dating back to 60 BC ancient Greece may have also been used to predict the future, according to researchers. The Antikythera Mechanism. described as "the world's first analogue computer", was created 2,000 years ago and discovered in 1901 in a shipwreck off the Greek island of the same name.

Remaining fragments of the device have been pieced together over the past 12 years using X-Ray imaging technology, revealing the secrets of the device. It was previously



revealed that the calculator had been used by the Greeks to map the movements of the planets and stars across the sky, as a means of navigation. However, scientists have now decoded the broken inscriptions on the surface of the device, which

appear to reveal an astrological purpose. Professor Mike Edmunds, from the University of Cardiff's astrophysics department, told a conference in Athens, "We are not quite sure how to interpret (the inscriptions), but they could hark back to suggestions that the colour of an eclipse was some sort of omen or signal. Certain colours might be better for what's coming than other colours. This is the first instance we have in the mechanism of any real mention of astrology rather than astronomy."

The Antikythera Mechanism is a complex clockwork device consisting of over 30 meshing bronze gears designed by Greek scientists sometime between 150-100 BC. Before its discovery, researchers thought such technology had not existed for well over 1,000 years after. All known fragments of the Antikythera Mechanism are currently held for research at the National Archaeological Museum in Athens.

GABRIEL SAMUELS/THE INDEPENDENT

Resilient reefs

In the face of mass bleaching events wiping out vast swathes of coral reef, researchers are looking for factors that contribute to the colonial animals' ability to withstand the warming waters that often instigate the problem. Analysing the conditions of more than 2,500 reefs, Joshua Cinner of James Cook University in Townsville, Australia, and colleagues have identified 15 "bright spots" — marine ecosystems that are faring better than expected — as well as 35 "dark spots", where the organisms are doing surprisingly poorly, according to a study published recently in Nature.

CHEMICAL TREATMENTS TAPAN KUMAR MAITRA EXPLAINS HOW PESTICIDES ARE COMBINED TO PROTECT PLANTS

he combination of various chemical means of plant protection is widely employed in agriculture. Mixtures of pesticides are used to expand the spectrum of action on various species of harmful organisms, increase the toxicity of a formulation, prolong the duration of protective action, lower the toxicity of a formulation on the plant being protected, eliminate the adverse consequences of chemical treatments and obtain the maximum economical effects.

Combined formulations include pesticides intended for application against objects either close or remote in their nature. Agents such as mercurhexan whose composition includes ethylmercury chloride (fungicide and bactericide), hexachloroben-zene (fungicide), and HCH (insecticide) make it possible to protect seeds and shoots of cultivated plants against diseases and pests. The combined herbicides banlen and cambilene, having a broader spectrum, are good killers of weeds resistant to 2,4-D and MCPA on cereal crop fields. In plant protection, the periods of controlling various pests often coincide; therefore the joint treatment with several pesticides is done. Mixtures of acaricides and organochlorine insecticides are used to kill insects and mites. A group of measures for protecting a garden may provide for combined treatments with insecticides to control codling moths and with fungicides to control diseases. The joint application of organophosphorus and organochlorine insecticides and herbicides (derivatives of 2,4-D) is possible on spring cereal crops for controlling weeds and diminishing the harm posed by fruit flies. The reaction of the components of a pesticide mixture may increase the toxicity of one of them. Antagonism is extremely undesirable when using mixtures of

physiologically active substances. The phenomenon of synergism is of the greatest significance for improving the effectiveness of plant protection. A synergetic effect is exhibited

in a pesticide mixture in the following cases. □ When one of the components facilitates the better penetration of a toxic substance into a harmful organism. The high effectiveness of the formulation trichlorol-5 against scales and wintering stages of other insects is due to the mineral oil in it, which facilitates the penetration of the trichlorometafos-3 under the scutellum

of the San Jose scale or through the egg shells of insects. It also underlies the use of herbicide oils with an addition of DNOC to kill vegetation. □ When one substance prevents the

the second substance.

increases the duration of plant protection against pests. For example, a mixture of malathion with tetradifon ensures the reliable protection of cucumber plants against the spider mite during 30-40 days. Malathion has a low persistence and effectively eradicates adult mites and their larvae in seven to 10 days while tetradifon protects the plants from the appearance of the mites for a longer period. Cuprosan (a mixture of copper oxychloride with zineb) burns plants to a smaller extent than copper oxychloride alone.

Dichloroacetamide, being itself a substance with a low biological activity, protects corn from harm by herbicides of the thiocar-bamate group without lowering their effectiveness against weeds.

The use of mixtures of acaricides and organochlorine insecticides prevents the mass reproduction of phytophagous mites observed after appli-

changing climate."



differing in their mechanism of action inhibit the same vitally important physiological reaction of an organism at different stages or parallel reactions. The combined application of pesticides in a number of cases

rapid detoxification of an active comcation of only the latter. Mixtures of ponent in a harmful organism or soil. specific acaricides with organophos-When a mixture of organophosphophorus compounds are an effective rus compounds enters the organism means for preventing the appearance of specific resistance in mites. of an insect, one of them may greatly inhibit the activity of aliesterase, □ Finally, the combined use of pestithus preventing the decomposition of cides makes it possible to substantially reduce the cost of treating agricultural crops and obtain cheaper • When the toxicants of a mixture

products. The combined use of pesticides, however, may sometimes lead to negative results. The toxicity of formulations lowers because of chemical reactions with the formation of non-toxic products. For example, in connection with the fact that organophosphorus compounds rapidly decompose in an alkaline medium, they must never be combined with Bordeaux mixture, lime, or lime sulphur. The period of the protective action of these insecticides dim-

inishes simultaneously.

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evolves by learning what media it likes. This isn't to create a toy for indulgent pet owners. Dogs are often left at home alone during the day or isolated in kennels. So interactive media technology could improve the animals' welfare by providing a stimulus and a source of entertainment. As this research is so new, these effects are only just beginning to be analysed. But we hope they will improve dogs' welfare by keeping them away from potentially harmful behaviour due to boredom.

Orangutans are highly intelligent. In captivity they require mental stimulation to stop them from getting bored and depressed. Apps Apes is a project that gives the animals access to touchscreen technology, allowing them to access cognitive games, art and drawing, and musical instruments, as well as photos and videos, in a similar way to humans. This isn't just good for their welfare but also helps educate zoo visitors about the animals' needs and intelligence and creates opportunities to interact with them, raising awareness of conservation efforts.

A project led by Adrian Cheok from the Imagineering Institute in Malaysia is attempting to provide physical comfort to animals who often suffer poor welfare conditions: chickens. Chickens have high levels of cognition and feelings and so benefit from the kind of physical contact that isn't possible with modern largescale farming methods. To artificially reproduce physical interaction between the birds and their farmers, the researchers have developed a jacket that allows human users to give the animal wearing it a virtual hug. When the farmer strokes a touch-sensitive chicken model it sends a signal via the Internet to the jacket, which replicates the feeling of being stroked.

Many people laugh when they hear about animal technology and point out, for example, that an animal cannot type. This doesn't stop many humans from using technology, so why should it stop animals?

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absolutely a novel approach that brings together ecological and

"It's

social information and bridges approaches from human health and development to conservation," Emily Darling, a marine conservation scientist at the Wildlife Conservation Society, an environmental group in New York, told *Nature*. "Identifying what conditions create bright spots is incredibly hopeful for coral-reef conservation and sustainable fisheries."

Study co-author Nicholas Graham of Lancaster University in the UK agreed. "We can learn things from the bright spots about what to encourage," he said.

The bright spots, which included the Chagos Islands in the Indian Ocean and Kiribati and the Solomon Islands in the Pacific, tended to have good resource management, local dependence on marine resources and a culture that fostered protecting the ocean. The dark spots, which included Montego Bay in Jamaica and Lord Howe Island between Australia and New Zealand, tended to be closer to urban areas.

JEFF AKST/THE SCIENTIST





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