the nation's nuclear programme. The restrictions prevent other nations from training the Asian state's researchers in the nebulous field of "advanced physics".

SISSA became concerned that the sanctions covered the PhD topics of four North Korean students who were studying cosmology there. To prevent the students having to return home, Ruffo arranged for them to switch their subjects. "Emotionally it was a very tough moment for me," he says. "These were all exceptional students."

Two students switched to study neuroscience. One of them, Chol Jun Kang, joined the group of computational neuroscientist Alessandro Treves at SISSA. After receiving his PhD, Kang returned to Kim Il-sung University.

Treves helped to broker the new deal when he visited Pyongyang last September. He was there to attend a rare international conference at the university on science, and found himself one of only a few Western scientists attending.

Treves says that the deal is valuable for science diplomacy, but also offers extra benefits for both parties. It gives young scientists from North Korea "opportunities to grow in a booming field of research", he says. They represent talent that "selfishly, I would like to bring to SISSA before their country opens up and they are snatched by our competitors".

In a speech last April, leader Kim Jong-un said he wished to boost the economy through science and education. ■

POLICY

Pollution rules under siege at US environment agency

Adviser attacks EPA decision-making ahead of major review of air-pollution standards.

BY JEFF TOLLEFSON

A quarter of a century of research has shown that breathing in fine airborne particles emitted by cars, power plants and other sources shortens people's lifespans. But that scientific consensus is now under attack from a top adviser to the US Environmental Protection Agency (EPA), just as the agency is rushing to revise the national air-quality standard for such pollution before the end of President Donald Trump's first term. Scientists fear that the result could be weaker rules on air pollution — based on politics, not science — that are bad for public health.

The national air-quality standards are designed to limit the amounts of six common pollutants — including airborne particles — in the air that people breathe. The EPA must review the science and, if necessary, revise the standard for each pollutant every five years, although the process often takes longer.

The current review began in 2015, but delays had pushed the deadline to 2022. Then former EPA head Scott Pruitt announced early last year that the agency would push to complete the task by December 2020. To meet that deadline, the EPA will have to curtail its normal review and revision process. In October 2018, the agency also dismantled a scientific advisory panel that works in parallel with the EPA's Clean Air Scientific Advisory Committee (CASAC), which advises officials on air-quality standards.

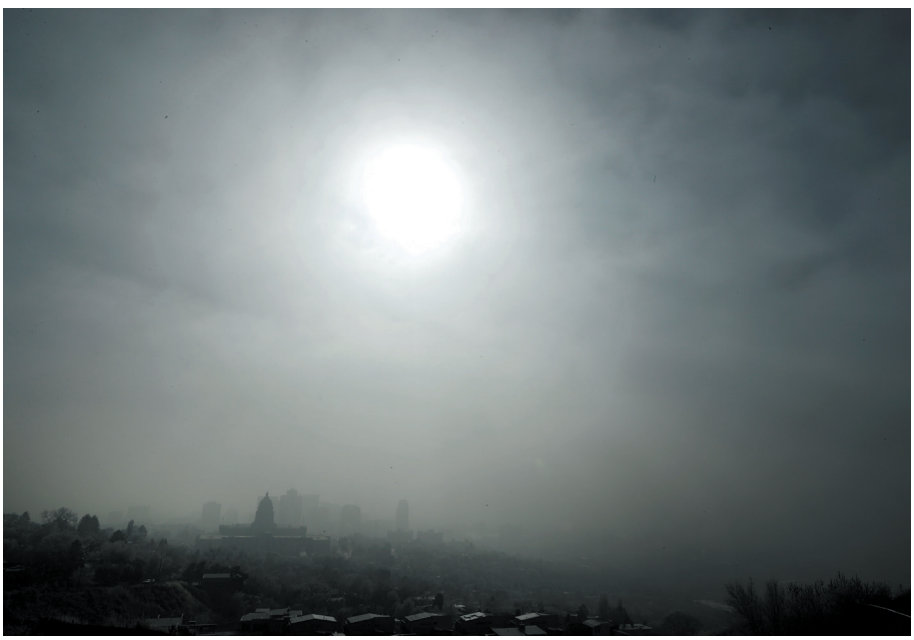
The latest development came on 28 March, when CASAC met to discuss a draft letter it had released several weeks earlier that blasted agency scientists for relying on "subjective judgments" and "unverifiable opinions" in their evaluation of particulate-pollution research. The head of CASAC, Tony Cox, is a statistician who has long questioned the evidence linking fine particulate pollution to premature deaths, and the draft letter reflected this scepticism. It also called on the EPA to do another research assessment looking at the uncertainties and inconsistencies in the scientific literature on air pollution.

CASAC removed a lot of the controversial language from the draft letter during its 28 March meeting. But the members remain divided on the link between fine-particle pollution and premature death. The final text of the letter will reflect that division.

The scepticism from some CASAC members towards the link between particulate pollution and public health has alarmed agency scientists, academics and environmental groups.

"They are just completely dismissing the science," says Gretchen Goldman, an environmental engineer in Washington DC who tracks the issue for the Union of Concerned Scientists. She co-wrote a guest editorial published on 21 March in *Science* urging the EPA not to abandon the scientific evidence on air pollution (G. T. Goldman and F. Dominici *Science* **363**, 1398–1400; 2019). "Without independent science, we risk having public-health decisions made for political reasons."

Cox defended his views in an e-mail to ▶



GEORGE FREY/REUTERS

Weakening the rules that limit the amount of particles in the air could adversely affect public health.

Nature. The EPA process for reviewing air-quality standards is focused on "eliciting, synthesizing, and documenting the opinions and judgments" of agency scientists, which are often based on "ambiguous statistical associations that depended on unverified models and assumptions", he said. Cox's own research has questioned the link between reducing fine-particle pollution and saving lives.

BURDEN OF PROOF

But there is mounting evidence, compiled by scientists from around the world, linking pollution to higher death rates. In a 2017 study of almost 61 million people, for instance, researchers at Harvard University in Cambridge, Massachusetts, used satellite data and computer models to map out daily pollution levels on a 1 kilometre × 1 kilometre grid across the United States for 12 years (Q. Di *et al. N. Engl. J. Med.* **376**, 2513–2522; 2017). After controlling for factors such as income, the scientists found that death rates increased in areas with more fine-particulate pollution and higher levels of ozone, a major component of smog — even if those regions met air-quality standards.

If anything, those results suggest that the national standard should be stricter than it is now, says Francesca Dominici, a biostatistician at Harvard University and a co-author of the 2017 study, as well as the *Science* editorial.

Cory Zigler, a biostatistician at the University of Texas at Austin, says that Cox has effectively declared his own statistical methods king, writing off a variety of studies demonstrating the link between air pollution and public health.

Cox says he is aware of such criticisms and that he is only following the science where it leads, regardless of political consequences. "My sole motivation and commitment is to uphold and apply good science," he told *Nature*.

However, researchers including Christopher Frey, an environmental engineer at North Carolina State University in Raleigh, have pointed out that the current CASAC lacks the scientific expertise to properly evaluate the EPA's work on air-quality standards. Frey is a former CASAC chair and was on the scientific review panel that was dissolved last year.

Cox and other CASAC members have publicly acknowledged this criticism and say that they need access to additional expertise. During the 28 March meeting, CASAC revised its draft letter requesting that the EPA reinstate the previous review panel or create a new one.

What happens next is unclear. Normally, the EPA would revise its evaluation of the scientific research on the pollutant in question after input from CASAC and the scientific advisory panel. Then the agency would assess any health risks and exposure trends. If the EPA found that an update to the standard was justified, it would formally propose a change. But many scientists and environmentalists expect that the EPA will try to consolidate these steps to finalize a new standard next year. ■

GRAVITATIONAL WAVES

LIGO restarts with quantum boost

Detailed data on gravitational waves are set to pour in from the US detector and its European cousin, Virgo.

BY DAVIDE CASTELVECCHI

The hunt for gravitational waves is on again — this time assisted by the quirks of quantum mechanics.

Three massive detectors — two in the United States called LIGO and one in Italy known as Virgo — resumed collecting data on 1 April, after a 19-month shutdown for upgrades. Thanks in part to a quantum phenomenon known as light squeezing, the machines promise not only to spot more gravitational waves — ripples in space-time that can reveal a wealth of information about the cosmos — but also to make more detailed detections than before. Researchers hope to observe as-yet undetected events, such as a supernova or the merging of a black hole with a neutron star.

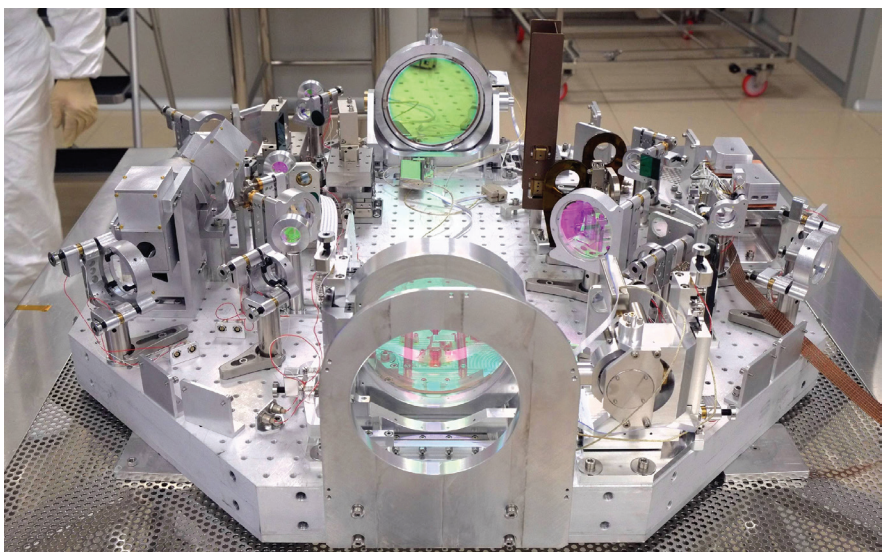
The run, which will last until March, also marks a major change in how gravitational-wave astronomy is done. For the first time, LIGO and Virgo will send out public, real-time alerts on wave detections to tip off other observatories — and anyone with a telescope — on how to find the events, so that they can be studied in different parts of the light spectrum. "Astronomers are really hungry," says David Reitze, a physicist at the California Institute of Technology in Pasadena and director of LIGO (the Laser Interferometer Gravitational-wave Observatory), which made the first detection of gravitational waves in 2015.

In their previous two observing runs, LIGO's twin detectors spotted 11 gravitational-wave signals, each emanating from an epic cosmic collision — 10 of them from mergers between two black holes. The Virgo detector joined the network in 2017 and made contributions to several detections — in particular, to the first sighting, in 2017, of waves created by two merging neutron stars.

The upgraded network should be able to detect an average of one event per week, up from one a month, says Reitze. Most waves will probably be from black-hole mergers, but physicists are eager to see another neutron-star collision.

The increased sensitivity will enable the detectors to better discern signals from background noise, offering physicists more detail on the waves. This could allow for precise tests of the general theory of relativity, which predicted the existence of gravitational waves.

Future detections should reveal secrets about black holes that are in the process of merging, such as how fast they spin and in which direction, says Ilya Mandel, a theoretical astrophysicist at Monash University in Melbourne, Australia. "Maybe we can start teasing out some information about whether



CAPPELLO/ROPI VIA ZUMA

A part of Virgo, a gravitational-wave detector in Italy that now has nearly twice its previous sensitivity.