Radiating to space

A method to keep things cool without burning energy is getting a practical look

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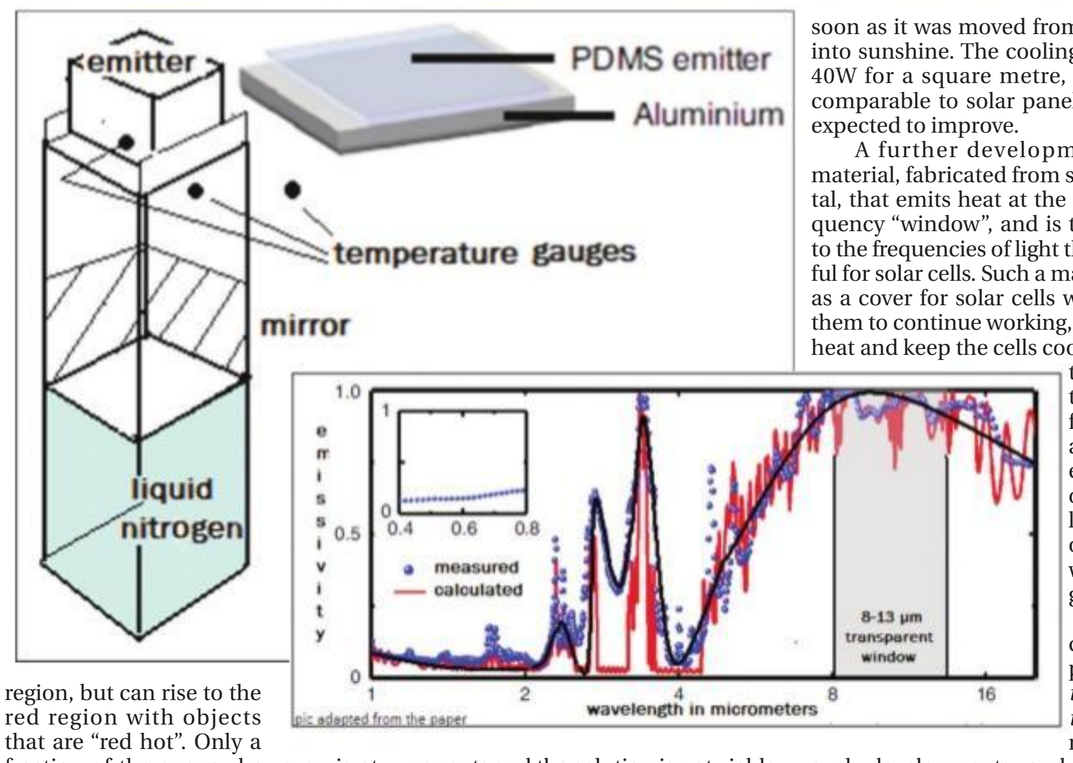
It takes energy to pump out heat and cool a thing to a lower temperature than its surroundings. This is the energy that is used in refrigeration and air conditioning. Air conditioning accounts for 15 per cent in the US, and 70 per cent in West Asia, of the total energy consumption and that is set to quadruple by 2050.

There has hence been the greatest interest in finding ways to bring about cooling without the use of energy. While this appears to be an impossible quest, as heat always flows from hotter to cooler things and not the other way around as in refrigeration, hope has been held out with the discovery of a channel where the flow of heat is not to the surroundings but to the extreme cold of outer space. In recent years, a number of devices have shown that it is indeed possible for an object to radiate and lose heat despite the environment being warmer than it is.

Lyu Zhou, Haomin Song, Jianwei Liang, Matthew Singer, Ming Zhou, Edgars Stegenburgs, Nan Zhang, Chen Xu, Tien Ng, Zongfu Yu, Boon Ooi and Qiaoqiang Gan, from the State University of New York at Buffalo, King Abdullay University of Science and Tech, Saudi Arabia, University of Wisconsin and Hangzou Dianzi University, China, describe in the journal, *Nature Sustainability*, an improvement that makes this idea of "passive cooling" both economical and scalable.

The reason why things on the surface of the Earth stay warm is that the Earth is enveloped by an atmosphere, which absorbs the heat it radiates and in turn, radiates most of it right back. Scientists, however, have noted that not all the heat is radiated back. There is still a portion, a specific frequency band, which passes clean through the atmosphere. If we could manage a larger part of the radiation from objects at this "window" frequency of radiation, they could cool by themselves without the heat lost being radiated back.

Warm objects radiate heat over a range of frequencies, distributed around a middle frequency at which the radiation is the greatest. This peak frequency is usually the infrared region, but can rise to the red region with objects that are "red hot". Only a fraction of the energy, however, is at the "window" of interest.



The rule, fortunately, is not followed in all cases and there are specific nano-structured materials that have greater emission in given frequency bands. Creating structures like these, however, takes complex fabrication of very small dimension components and the solution is not viable. A development of this method uses layers of specific materials whose atomic structure ensure emission at the desired frequency band. An arrangement with a seven-layer stack of these materials, mounted on a silver reflector, and insulated from external heat, was found to drop by 4-5 °C, as soon as it was moved from the shade into sunshine. The cooling was some 40W for a square metre, which was comparable to solar panels, and was expected to improve.

A further development was a material, fabricated from silicon crystal, that emits heat at the correct frequency "window", and is transparent to the frequencies of light that are useful for solar cells. Such a material used as a cover for solar cells would allow them to continue working, but radiate heat and keep the cells cool. As rise in temperature is a factor that affects the efficiency of solar cells, this kind of cover would have great value.

The current paper in *Nature Sustainability* recounts such developments, and others, but says they are effective at night, their manufacture is complex and they are not economical or capable of being widely used. In contrast, the authors of the paper present a low cost material, a film of which can be easily laid on a reflecting metal surface, and which enables substantial, daytime cooling of large structures like buildings, even in crowded, urban regions.

The emitting material is a thin film of polydimethylsiloxane, a common silicone, a transparent, soft and pliable material that is found in contact lenses, medical devices, as a lubricant, sealing agent, water repellant coating and even in shampoos. In 2017, PDMS was reported to selectively emit at the frequency range, which can get through the atmosphere, with potential for passive cooling by 12°C, under the night sky.

A thin film of this inexpensive material is coated on a plate of aluminium or silver using a simple process that can be adapted for mass production. A layer that is 100 microns thick, and hence a hardy layer, is found to be an effective selective emitter. The graph in the picture shows that the emissivity is high in the relevant region of eight to 13 micrometres. As it is low in the visible and other regions of solar energy, the absorption of energy at these wavelengths is low, which makes the material suitable for use in the daytime.

Whether the arrangement is effective was tested, both in the laboratory and in the field. For the laboratory test, the extreme cold of outer space was simulated by a liquid nitrogen bath, with a black, aluminium base, while the PDMS/plate was fixed facing down, towards the cold bath. Temperature gauges helped confirm that the presence of the cold bath did not affect the temperature around the emitter.

Another thing the gauges confirmed was that the emitter sent out the radiation not as a beam, but in all directions. As this would limit the effective loss of energy by the emitter to the cold absorber, the mirrors of aluminium foil were fitted to the sides of the container, to act as guides to beam the radiation. The measurement using the temperature gauges showed that with guiding the radiation, the arrangement could attain a cooling of 9.5°C.

In the outdoor trial, the effect of surrounding buildings was simulated using a window placed above the emitter, which was narrowed or widened, to limit or extend the exposure to the clear sky. The result, the paper reports, was cooling of 11°C. Even without the window that blocked external influences, there was cooling of up to 9°C, using a vertical, reflecting sunshade.

In both, the indoor and outdoor trials, the theoretical cooling expected was calculated, and it was found that the cooling in practice was in close agreement. "In summary," the paper says, "we developed a highly efficient and low-cost passive cooling technology by exploiting the sky as the cold source... with disruptive potentials in transforming cooling solutions in a wide range of industrial and residential applications."

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PLUS POINTS

Varied impact

A team from the Indian Institute of Technology in Hyderabad, Harvard University, US, and Fisheries and Oceans Canada (a Canadian government agency), has been researching how climate change impacts mercury accumulation in fish. Their work has been published in the August issue of the international peer-review journal, *Nature*. The research was led from India by Asif Qureshi, associate professor, department of civil engineering, IIT Hyderabad, and co-authored by Amina Schartup, Colin Thackray, Clifton Dassuncao, Kyle Gillespie, Alex Hanke and Elsie Sunderland.

Modelling studies by the international team of scientists found that although there has been a decrease in levels of mercury pollution due to various environmental regulations, the amounts of mercury found in fish have been different in different species — some types of fish have less mercury than before, and some, alarmingly more. These variations have been a result of changes in sea temperature in recent years and in dietary pattern due to overfishing.

The researchers focused on whether these and other environmental measures have alleviated or overall exacerbated the problem of elevated mercury levels in fish. They chose the Gulf of Maine, a well-studied but also exploited, marginal sea in the Atlantic Ocean, to study the trends in mercury accumulation in fish. The team used three decades of data on ecosystem and mercury concentrations and developed a model for mercury bioaccumulation.

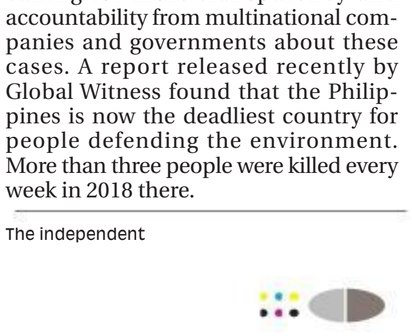
Explaining the complexity of the problem, Qureshi, who wrote the first versions of the model code, said, "There are three factors that affect mercury accumulation in fish — overfishing, which leads to dietary changes among marine animals; variations in the temperature of the sea water, which leads to changes in fish metabolism that gears towards survival rather than growth, and changes in the amounts of mercury found in sea water as a result of pollution."

The researchers modelled the changes in mercury levels in tissues of the Atlantic cod and spiny dogfish that would result from the three factors. For example, the team found that for Atlantic cod, although an increase of 1°C in seawater temperature would lead to an increase in mercury concentrations, dietary disturbances due to overfishing, and reductions in mercury pollution could compensate. Modelling showed a 10 per cent decrease in tissue mercury concentrations for this type of fish.

The situation was reverse for dogfish. A 70 per cent increase in tissue mercury concentrations was seen given the same conditions as for the Atlantic cod.

Although this study was carried out in the Atlantic Ocean, mercury levels in fish in other seas and oceans are likely to have a similar relationship with sea temperature, fishing practices and mercury pollution levels.

Silenced voices



Four people are being killed every week for defending the environment and the rate of deaths has doubled in 15 years, a new report warns. Only 10 per cent of these murders will result in a conviction, according to the paper published in *Nature Sustainability*. Globally, 43 per cent of all murders result in conviction.

Lead researcher Nathalie Butt, from the University of Queensland in Australia, said, "In many instances, weak rule of law means that cases in many countries are not properly investigated, and sometimes it's the police or the authorities themselves that are responsible for the violence."

Scientists say 1,558 deaths were recorded in 50 countries between 2002 and 2017, which is more than double the number of British and Australian armed service personnel killed during active duty in the same period.

Scientists — who used data from international NGO Global Witness — are calling for more transparency and accountability from multinational companies and governments about these cases. A report released recently by Global Witness found that the Philippines is now the deadliest country for people defending the environment. More than three people were killed every week in 2018 there.

The independent

Lots in a name

A recent experiment found out how people judge a name and whether it matters what someone or something is called

PENNY PEXMAN & DAVID SIDHU

What's in a name? That which we call a rose by any other name would smell as sweet. — William Shakespeare, *Romeo & Juliet*

There has always been an interest in how the name of a thing affects our interpretation of it. Does it matter what something or someone is called? Imagine that you are going to meet either "Anne" or "Kate" (or "Owen" or "Kirk"). Would you expect different kinds of people, based on their names? Who would you expect to be kinder? Who would you expect to be more outgoing?

Across three recent experiments conducted with our colleagues from the University of Calgary in Canada — Joshua Bourdage and Kristen Deschamps — we found that people with softer-sounding names like "Anne" or "Owen" were expected to be more agreeable, emotional and hardworking; while people with harder-sounding names like "Kate" or "Kirk" were expected to be more outgoing.

Why might the name of a person suggest different kinds of personality? Over the last century or so, research on sound symbolism has demonstrated that people will associate certain language sounds with particular properties. For example, the two words — "maluma" and "takete" were first used in 1929 by linguist researchers. How would you pair them with the two shapes in the picture?

If you're like 90 per cent of the people studied worldwide, you probably paired "maluma" with the round shape, and "takete" with the jagged shape. Something about the sounds in these words (or maybe even how they feel as you say them) makes them seem to go along better with the round or the jagged shape. There have also been demonstrations of certain language sounds seeming like better fits for shapes of certain sizes, colours and even those travelling at certain speeds.

In our research, we asked the question: what about the sounds in a person's name? Will they also lead to certain expectations about the person? Beyond associations with visual properties like shape or size, could the sounds in names also be associated with different personalities?

People with abrupt-sounding names are seen as extroverted

We compared names containing what are called sonorant consonants (like m or l) to those containing "voiceless stop consonants" (like k or t). Sonorants are characterised by a more smooth and continuous sound, while voiceless stops are more abrupt.

Compare the consonants in "Mom, I'm online now!" to "Pop's kite! It cracked!" These are very different kinds of sounds, and so we asked if names containing these different sounds would be associated with different personalities.

Some examples of names we used include — Kate, Tia, Etta for the voiceless stop names and Anne, Noelle, Laurel for sonorant ones. For men, voiceless stop names included Kirk, Kurt and Tate and sonorant ones were Owen, Noel and Lou.

We looked at the six personality factors from the Hexaco model of personality— honesty-humility, emotionality, extroversion, agreeableness, conscientiousness (how hardworking and organised a person is) and openness (to experience). In our first two experiments, participants were asked how much they expected people with either sonorants or voiceless stops in their names to have these different personalities.

In general, we found that participants expected people with names like "Anne" or "Owen" to be high in agreeableness, emotionality and conscientiousness. Conversely, they expected people with names like "Kate" or "Kirk" to be high in extroversion.

72 made-up names — and how they get judged

In a follow up experiment, we were curious how much this had to do with the names themselves versus the sounds that they contained. For example, maybe participants were just thinking of Captain Kirk when they judged that "Kirk" is highly extroverted.

So, we found uncommon or made up names that still contained sonorants or voiceless stops, but that participants wouldn't associate with existing people. Examples of sonorant names were Ammel, Nilo and Leonne and examples of voiceless stop names we used were Triss, Seka and Treek.

We found the same effects once again. Also, if you are ever looking for an original name for a baby, we have 72 ready to go. And we know what kinds of personalities people will associate with them!

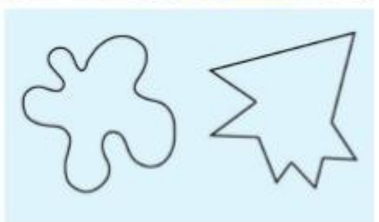
A few ideas — Lona was rated as being very agreeable and shy. Kipus was rated as being very extroverted, but not so agreeable.

At this point we were curious — as you the reader probably are too — to know if these associations are reflected in the real world. Are people with sonorants in their names actually kinder than people with voiceless stops in their names?

This sounds outlandish, but there is recent work showing that individuals might change their appearance over time to look like their names. Might it also work for their personalities?

No truth to the judgment

To find out, we tested over a thousand people, collecting information about their personalities and their names. We found that the answer was a resounding "no." None of the associations that we observed in our experiments existed in the real world. There was no evidence that "Annes" are actually kinder than "Kates," or that "Kurts" are more outgoing than "Owens." But our other experiments show that people might think they are (if all they know about someone is their name).



Which shape of the ones pictured here would you associate with the made-up words 'maluma' and 'takete'?

William Shakespeare

This again suggests that the effect comes from the sounds of the names and is not inferred from the personalities of real people. So what is it about the sound in "Anne" that makes it seem especially kind? The maluma/takete effect is often explained by a sort of metaphorical extension of the qualities of the sounds or feelings of the words to the shapes. "Maluma" feels softer than "takete" as you say it, and it also involves less abrupt changes in sound.

This matches the smooth outline of the round shape we showed you earlier when we asked you to choose which shape best matches which sound. Some researchers have suggested that something similar may be happening when sound is matched with personality. Maybe the smoothness of sonorants metaphorically matches an agreeable personality, while the quick changes in voiceless stops match the energetic nature of an extroverted personality. We'll need more research to know for sure.

This work helps to answer the age-old question posed by William Shakespeare, what's in a name? Our results suggest that names carry information that affects what we expect someone to be like in terms of their personality.

It seems that if "Rose" were to go by another name, she may not seem as sweet.

Penny Pexman is professor of psychology, University of Calgary and David Sidhu is a PhD candidate at University of Calgary. This article first appeared on www.theconversation.com