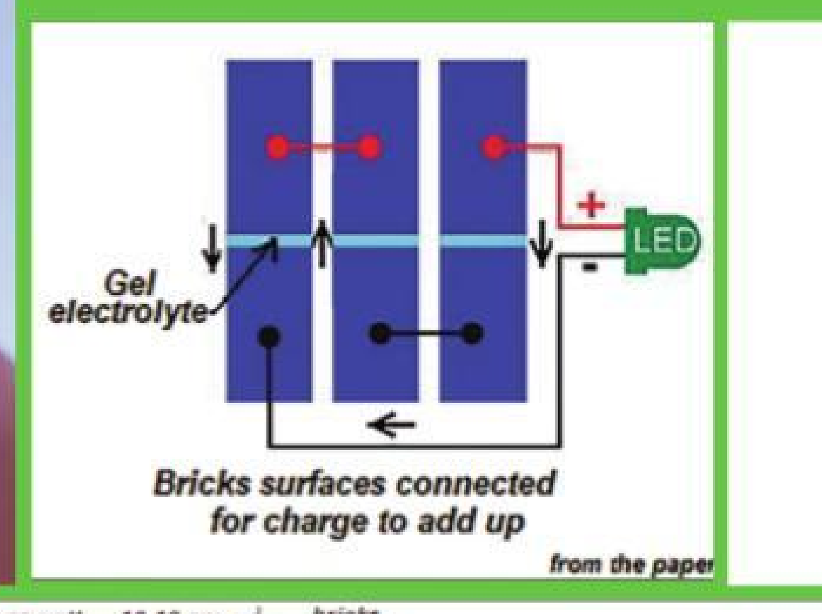
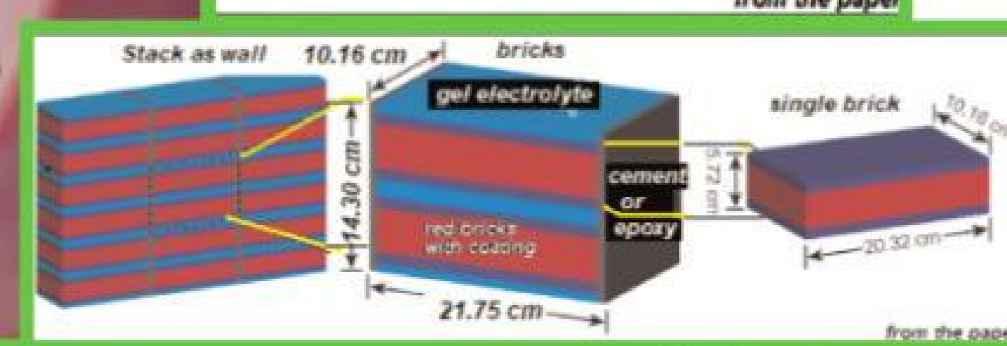
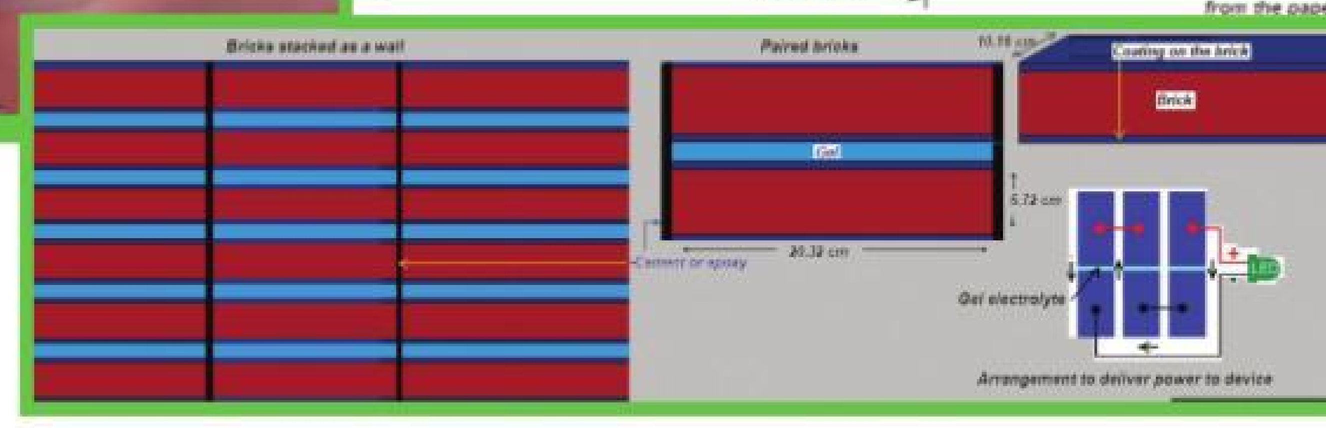
Battery in the brickwork

The walls in our buildings could double as a store of electric energy







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A disadvantage of green ways of generating electricity is that they are intermittent. Wind power, for instance, is there only while the wind blows and solar power is there only in the daytime.

The result is that we cannot do without coal or oil-based power plants. What is worse, these utilities need to be turned on and off, which lowers their efficiency and increases their damage to the environment. Hence arises the industry of batteries, or facilities to store electricity – so that power is available when needed, and the demand on the conventional sources stays steady.

Hongmin Wang, Yifan Diao, Yang Lu, Haoru Yang, Qingjun Zhou, Kenneth Chrulski and Julio M D'Arcy, from Washington University at St Louis, Michigan, write in the journal, *Nature Communications*, of a process of enabling the common brick, which we use to construct buildings with, to store electricity. It is not a large energy store, but individual houses can now store in their walls some electricity, generated, say by rooftop facilities, to work low-power devices. The masonry available all over the city could also serve as batteries for off-grid services.

The principle, the paper says, is that the mud and soil used for making bricks contains some eight per cent of iron oxide, as an ore called hematite (which, incidentally, gives bricks their red colour). Hematite, which is freely available, is the starting point for making alloys, magnets, catalysts and so on. And also in the manufacture of special purpose batteries and electrical equipment, the paper says.

The authors refer to their earlier work, published a year ago, where they made use of ordinary iron rust, again iron oxide, to create fibres and films of conducting, organic chain molecules. In the current paper, they work on the hematite content of the clay, and the microstructure of bricks, to deposit a layer of nano-fibres made of conducting chain molecules and create conducting sheets on opposite sides of the bricks. When these bricks are used to construct a wall, the wall becomes a beehive of conducting surfaces, which can be manipulated to gather and store electric charge.

It is a property of conducting surfaces – when in pairs separated by an insulator – that they can be charged to opposite polarities. What this implies is that the negatively charged surface has an excess of negatively charged electrons, which have been driven there when the pair was charged. As the two surfaces are insulated, the difference in charge can remain for long periods. When the two surfaces are connected by a conductor, like a copper wire, however, the charges equalise and there is an electric current through the wire. And rapid charging and discharging of such an arrangement is often used to control electrical circuits which carry variable or alternating currents.

Large pairs of conducting surfaces can be created, for instance with metallic coating on two sides of a strip of paper, which is rolled up, and these are used in electronic circuits. Arrangements with high capacity, even "banks" where several devices are arrayed and combined, are used to control the effects of rise and fall in demand or supply in the public electricity network. The normal, storage battery, like a car battery, too stores charge that is driven on to lead plates through a reversible chemical reaction. In the same way, the specially processed bricks created by the Washington University team are separated by a gel which can undergo a chemical change, like in the storage battery.

The picture shows how the conducting surface is coated, and the bricks, which have the coat of the conducting film, are stacked, adjacent ones being separated by the gel. And the columns of bricks are separated by a layer of cement, or an adhesive epoxy, to build a wall. And groups of bricks are arranged with the conducting surfaces connected so that the differences in charge add up. "A fired brick's open microstructure, mechanical robustness and eight per cent iron oxide content afford an ideal substrate for developing (the bricks) that readily stack into modules," the paper says. Coated with epoxy, they are stable, stationary and waterproof, the paper says.

The battery, or the interconnected assembly of charged devices, can be charged, the paper says, to deliver power of 1.6 Watt hours of energy for every square metre of wall. This will not amount to a great deal of power, but it is possible to include different kinds of masonry – the bricks, concrete blocks, paver blocks – as storage resources, and this would add up to a large area. The current work is a proof of concept – we can expect improvements both in the coating and in design of bricks, for more effective area. The study also shows that the current coating stays 90 per cent effective for 10,000 cycles of charging and discharging. If the cycle is once a day, that is about 30 years!

Another "green" idea in building technology, recently proposed, is to go back to the use of wood as a construction material. The idea is to save on reinforced cement concrete, as manufacture of steel and cement lead to huge carbon dioxide emissions. Wood has strength comparable with RCC, has less weight and large members are fire resistant, whereas steel begins to buckle at high temperature. And then, the wood is a carbon store, while growing more trees would draw more carbon dioxide out of the atmosphere. Construction of buildings with wood as the material for the structure, while the walls are of brick treated to work as a reservoir of electric charge, would substantially reduce the carbon footprint of residential and commercial buildings. The efficiency of solar panels is rising and innovative methods of harnessing solar power are being developed. If the ideas were integrated by architects and town planners, living spaces could become more sustainable, apart from making the concepts a part of popular understanding.

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PLUS POINTS

Maths for birds

Scientists from the University of Sheffield in the UK have used mathematical modelling to understand why flocks of long-tailed tits segregate themselves into different parts of the landscape.

The team tracked the birds around Sheffield's Rivelin Valley which eventually produced a pattern across the landscape, using maths helped the team to reveal the behaviours causing these patterns.

The findings, published in the *Journal of Animal Ecology*, show that flocks of long-tailed tits are less likely to avoid places where they have interacted with relatives and more likely to avoid larger flocks, whilst preferring the centre of woodland. It was previously unknown why flocks of long-tailed tits live in separate parts of the same area, despite there being plenty of food to sustain multiple flocks and the birds not showing territorial behaviour.

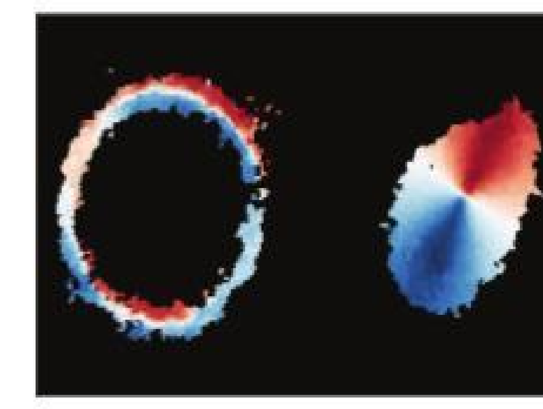
The equations used to understand the birds are similar to those developed by Alan Turing to describe how animals get their spotted and striped patterns. Turing's famous mathematics indicates if patterns will appear as an animal grows in the womb, here it's used to find out which behaviours lead to the patterns across the landscape.

Territorial animals often live in segregated areas that they aggressively defend and stay close to their den. Before this study, these mathematical ideas had been used to understand the patterns made by territorial animals such as coyotes, meerkats and even human gangs. However, this study was the first to use the ideas on non-territorial animals with no den pinning them in place.

Natasha Ellison, a PhD student at the University of Sheffield who led the study, said, "Mathematical models help us understand nature in an extraordinary amount of ways and our study is a fantastic example of this.

"Long-tailed tits are too small to be fitted with GPS trackers like larger animals, so researchers follow these tiny birds on foot, listening for bird calls and identifying birds with binoculars. The field work is extremely time consuming and without the help of these mathematical models these behaviours wouldn't have been discovered."

Surprising find



Astronomers have found a galaxy "surprisingly" like our own Milky Way – further away than any before. The galaxy is 12 billion light-years away, meaning that our image of it comes from when the universe was relatively young, at just 1.4 billion years old.

As such, it offers a way of looking back at galaxy formation in the early universe, when it was only 10 per cent of its current age. But scientists were puzzled to find that it was far more similar than expected.

Galaxies from so early in the universe were expected to be turbulent and unstable, in line with existing theories about galaxy formation. But the newly-discovered one was not nearly as chaotic as predicted.

That surprising discovery could, in turn, lead to a new understanding of how galaxies form and what processes could have been happening in the early universe.

"The big surprise was to find that this galaxy is actually quite similar to nearby galaxies, contrary to all expectations from the models and previous, less detailed, observations," says co-author Filippo Fraternali, from the Kapteyn Astronomical Institute, University of Groningen in the Netherlands.

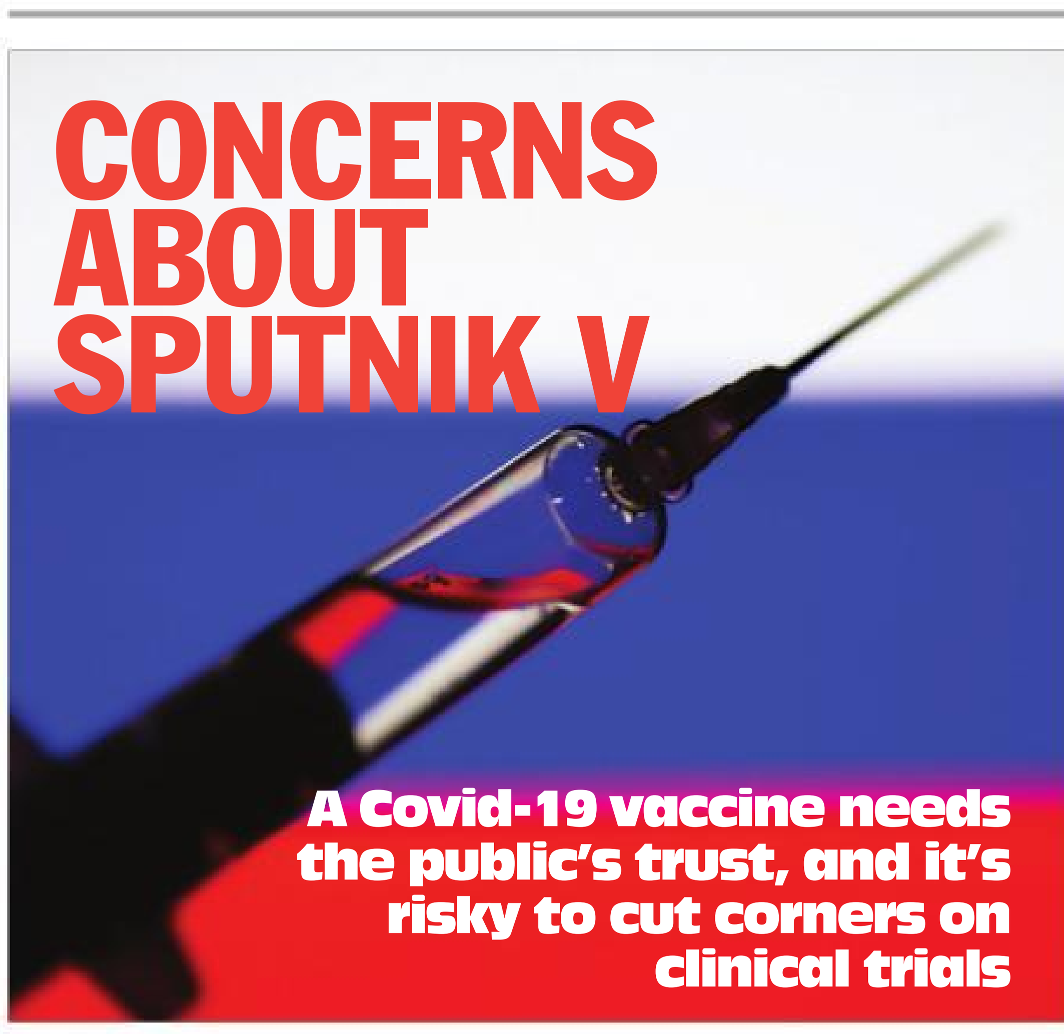
When the researchers looked at the newly-discovered galaxy known as SPT0418-47, they saw that it had features that are characteristic of our own Milky Way. It had a rotating disc and a large group of stars around its middle, which scientists refer to as a "bulge", and which has never been seen before so early in the universe.

"This result represents a breakthrough in the field of galaxy formation, showing that the structures that we observe in nearby spiral galaxies and in our Milky Way were already in place 12 billion years ago," said Francesca Rizzo, from the Max Planck Institute for Astrophysics in Germany, in a statement.

The new paper, "A dynamically cold disk galaxy in the early Universe", has been published in *Nature*.

–The independent

CONCERNS ABOUT SPUTNIK V



A Covid-19 vaccine needs the public's trust, and it's risky to cut corners on clinical trials

Phases of clinical development

	Phase I First application in humans (1)	Phase II Therapeutic trial phase (2)	Phase III Therapeutic confirmation (3)	Phase VI Long-term observation (4)
Goals	• Safety and tolerability testing with low doses of the drug • Analysis of the period of effectiveness of the drug • Analysis of the behaviour of the drug in the human body (degradation products)	• Verification of the therapeutic effect • Ascertaining the optimal dose • Safety (toxicity) testing • Checking the feasibility of the application	• Confirmation of its effectiveness and safety • Review of effectiveness compared to known drugs	• Data "from real life" • Safety monitoring (does the product interact with other drugs?) • Therapy optimisation of approved drugs
Attributes	• Small number of participants (n = 20 – 100) • Healthy volunteers (rarely patients) • Specialised centres • Open	• First application in patients with disease (n = 100 – 500) • Medical institutions and private practices • Open • Blinded • Comparative • Multiple doses	• Extensive studies (n = 1000 – 5000) • Medical institutions and private practices • Multi-centric • Blinded • Comparative	• Very large number of patients • Further development (e.g. new areas of application)

ABRAM L WAGNER

Russia's announcement that a fast-tracked Covid-19 vaccine is registered there, with plans for quick distribution in the general population this fall, is being condemned by scientists worldwide.

Findings from scientific studies of this vaccine, named Sputnik V, are not available. Large safety and efficacy trials are only now getting underway. But despite only two months of preliminary testing in people, Russian President Vladimir Putin called the vaccine "quite effective" and it's received regulatory approval.

In other places, notably the United States, China and the European Union, even as researchers rush to develop vaccines, they continue to publish studies of these vaccines at a more measured pace than is happening in Russia.

As an epidemiologist who studies vaccine hesitancy and vaccine-preventable disease, I'm concerned about this news from Russia. After essential workers and high-risk groups are vaccinated, I would want to be among the first in line for an approved Covid-19 vaccine, but the medical research system must make sure any vaccine is safe and effective before distributing it to the population at large.

Clinical trials have a valuable role

Before any drug, vaccine or medical device is licensed for use in the general population, it needs to go through several rounds of large-scale testing. These studies are designed to make sure the intervention is safe and effective, and to understand what the appropriate dosage will be.

Under normal conditions, the research required to bring a vaccine to market can take decades. For example, before the HPV vaccine was licensed in the U.S. in 2006, a phase III clinical trial enrolled 18,644 participants in 2004-2005, a phase II clinical trial had enrolled 1,113 participants in 2000, and the laboratory studies that led to a vaccine candidate had been published in the early 1990s.

In the face of the coronavirus pandemic, scientists around the globe are focusing their efforts on developing a Covid-19 vaccine. They're working at an unprecedented pace to move through the necessary clinical trials to end up with a safe and effective vaccine. One of the most time-consuming parts of clinical trials is enrolling participants, and pharmaceutical companies have sped up this process by lining up volunteers early, obtaining important baseline data from them even before a vaccine candidate is available.

Problems if the vaccine is released too early

Carefully conducted clinical trials are necessary to identify any problems with the vaccine. For example, studies of a new type of measles vaccine in the early 1990s found that it was detrimental to baby girls, and so it was never licensed to the general population. The existing measles or measles-mumps-rubella vaccine available in the US and other countries is highly safe and effective.

It could also be that the vaccine is not effective in some categories of people. Phase I and II clinical trials have small sample sizes and may not include individuals from high-risk groups. For example, a recently published phase II clinical trial of a Covid-19 vaccine excluded obese people, those with chronic diseases and pregnant women. However, these are all groups that should be able to get the vaccine in the future. More studies, including phase III trials, are necessary to discover if the vaccine works in the general population. Preliminary results should be available by the end of 2020. The concern is that by introducing the vaccine early, without adequate testing of safety, effectiveness and dosing, the population may be presented with a vaccine which is not safe or not effective, and with little information on which vaccine schedule is best.

Food and Drug Administration Commissioner Dr Stephen Hahn has said the FDA will not "cut corners" in approving a Covid-19 vaccine in the US despite an accelerated programme, dubbed Operation Warp Speed.

Rushing to market

But is there ever an ethical reason to release a vaccine early, even without going through all phases of clinical trials?

Although it would be wonderful to get a vaccine into the population quickly, there could be substantial downsides if researchers and manufacturers cut corners. Imagine a vaccine that often had serious side effects that weren't caught in small trials before it was widely administered.

An untested vaccine wouldn't just harm the people vaccinated. If negative perceptions about the safety or efficacy of a Covid-19 vaccine spread throughout the population, it could limit how many people are willing to get the shot and perpetuate disease transmission.

Trust in vaccination programmes is crucial. Russia, in fact, provides an important historical example. In the 1990s, trust in the country's public health system rapidly decreased, and rates of diphtheria-tetanus-pertussis vaccination fell as a result. A large outbreak of diphtheria then spread through Eastern Europe, leaving over 4,000 people dead.

Hasty rollout of a Covid-19 vaccine could prime people not only to not trust the Covid-19 vaccine, but also to doubt vaccination and public health systems as a whole.

Vaccinations should be developed by impartial scientists and evaluated by nonpartisan government officials. By cutting red tape, procedures can be prioritised and sped up, but they must not be skipped.

The writer is research assistant professor of epidemiology, University of Michigan, US. This article first appeared on www.theconversation.com