

# Researcher unveils time crystal as new form of matter

A University of California, Berkeley, researcher has described how to make and measure the properties of a crystal that have a structure that repeats in time, namely a time crystal.

Norman Yao, a UC Berkeley assistant professor of physics, has also predicted what the various phases surrounding the time crystal should be akin to the liquid and gas phases of ice in a paper published online recently in the journal Physical Review Letters.

While conventional crystals have an atomic structure that repeats in space, like the carbon lattice of a diamond, time crystals repeat in time because they are kicked periodically, sort of like tapping Jell-O repeatedly to get it to jiggle, Yao was quoted as saying in a news release from UC Berkeley.

The breakthrough, Yao argued, is less that these particular crystals repeat in time than that they are the first of a large class of new materials that are intrinsically out of equilibrium, unable to settle down to the motionless equilibrium of, for example, a diamond or ruby. "This is a new phase of matter, period, but it is also really cool because it is one of the first examples of non-equilibrium matter," he said. "For the last half-century, we have been exploring equilibrium matter, like metals and insulators. We are just now starting to explore a whole new landscape of non-equilibrium matter."

Two groups followed Yao's blueprint and have already created the first-ever time crystals. The groups at the University of Maryland and Harvard University reported their successes, using two totally different setups, in two papers posted online last year, both with Yao as a co-author.

Time crystals were first proposed in 2012 by Nobel laureate Frank Wilczek, and last year theoretical physicists at Princeton University and UC Santa Barbara's Station Q independently proved that such a crystal could be made. According to Yao, the UC Berkeley group was "the bridge between the theoretical idea and the experimental implementation."

The time crystal created by Chris Monroe and his colleagues at the University of Maryland employs a conga line of 10 ytterbium ions whose electron spins interact, similar to the qubit systems being tested as quantum computers. To keep the ions out of equilibrium, the researchers alternately hit them with one laser to create an effective magnetic field and a second laser to partially flip the spins of the atoms, repeating the sequence many times.

As the spins interacted, the atoms settled into a stable, repetitive pattern of spin flipping that defines a crystal.

Yao worked closely with Monroe as his Maryland team made the new material,

helping them focus on the important properties to measure to confirm that the material was in fact a stable or rigid time crystal. Yao also described how the time crystal would change phase, like an ice cube melting, under different magnetic fields and laser pulsing.

From the perspective of quantum mechanics, electrons can form crystals that do not match the underlying spatial translation symmetry of the orderly, three-dimensional array of atoms, Yao said. This breaks the symmetry of the material and leads to unique and stable properties we define as a crystal. A time crystal breaks time symmetry. In this particular case, the magnetic field and laser periodically driving the ytterbium atoms produce a repetition in the system at twice the period of the drivers, something that would not occur in a normal system.

“Wouldn’t it be super weird if you jiggled the Jell-O and found that somehow it responded at a different period?” Yao said. “But that is the essence of the time crystal. You have some periodic driver that has a period ‘T’, but the system somehow synchronizes so that you observe the system oscillating with a period that is larger than ‘T’.”

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## [Toddler rescued 15 hours after abduction prior to NYE](#)

A boy is seen taken away by a woman in this surveillance video.  
[Photo/Weibo]

A three-year-old boy was rescued by police just 15 hours after he was kidnapped by a woman on Thursday, two days before the Spring Festival.

A Shenzhen resident surnamed Zhao reported shortly after 17:00 on Thursday that his son had gone missing while playing near home. The family searched for him for over an hour but could not find him.

The local police found via surveillance video that shortly after 15:40 the boy was taken away in a taxi by a middle-aged woman, whom the family did not know.

The police identified the woman as 34-year-old migrant worker from Guangxi Zhuang autonomous region. She was unemployed and lived in a hotel in Shenzhen. When the police arrived at her hotel, they found that the woman surnamed Wei took the boy to the hotel but had checked out and left.

Police found that Wei appeared at the Luohu Railway Station in Shenzhen shortly after 17:00 and they concluded that she had left Shenzhen by train. With help from railway police, they found that Wei boarded a train with the boy to Wuchang, Hubei province, at 18:00.

Wei was spotted on the train. When the train arrived in Wuchang shortly after 6 am Friday, the police arrested the woman and rescued the boy.

Wei said she took the boy to fake as her own son to repair the relationship with her former boyfriend. Wei gave birth to a boy in 2015 in Shenzhen, who died shortly after. Wei broke up with her boyfriend soon after the birth however the boyfriend was unaware of the baby's death. This year she wanted to meet her ex-boyfriend in Hubei for Spring Festival.

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## [WeChat data reveals Chinese passion with monetary gift](#)

Giving monetary gift through WeChat, China's major instant messaging app, has become a popular holiday custom, with people born in the 1980's being the most active group, according to latest data of WeChat.

On Friday alone, the eve of 2017 lunar new year, a record of some 14.2 billion electronic hongbaos, or red packets containing gift money, were given and received, according to WeChat, which is operated by Tencent.

Those who were born in the 1980s have sent and received the most red packets last year compared to those born in the 1990s and 1970s.

WeChat data also showed that men tend to give out more hongbaos than women. Geographically, people in Guangdong, Jiangsu, Zhejiang and Hunan lead in giving and receiving red packets.

It is a tradition of Chinese to give hongbao to friends and relatives during Spring Festival. Nowadays, Valentine's Day, Father's Day and other local festivals are also the peak times for red packets.

This year, new forms of red packets such as "face-to-face and AR red packets" were adopted. Lin Yuwen, a Beijing resident, said he distributed red packets totaling 1,200 yuan (175 U.S. dollars) on Friday, almost double the amount last year.

Analysts say the electronic red packets are used by Internet giants to expand their shares in the mobile payment market.

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## [Man killed in tiger attack in east China zoo](#)

A man has died in hospital after he was attacked by a tiger in a zoo in the eastern Chinese city of Ningbo on Sunday afternoon.

The attack occurred around 2 p.m. at the Tiger Hill enclosure in Ningbo Youngor Zoo, according to the administrative committee of Dongqian Lake Tourist and Holiday Resort in the city, where the zoo is located.

The tiger was shot dead by the police. The surveillance footage is currently being reviewed.

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## [China unveils top names for Mars spacecraft](#)

China has released a short list of eight names for the country's first Mars spacecraft, which is scheduled to launch by 2020.

The eight names— "Fenghuang" (phoenix), "Tianwen" (questions for heaven), "Huoxing" (Mars), "Tenglong" (soaring dragon), "Qilin" (Kylin), "Zhuque" (rose finch), "Zhuimeng" (chasing dreams) and "Fengxiang" (flying phoenix), were the top names chosen from over 14,500 choices submitted through more than 35,900 proposals entered by people worldwide.

China plans to launch its first Mars spacecraft by 2020, which will orbit, land and explore the Red Planet.

Proposals were accepted from August last year.

The eight names were selected via a jury review and online polls.

The final choice will be announced around Space Day, April 24, according to a moon probe and space program center under the State Administration of Science, Technology and Industry for National Defence, which solicited the proposals.