expected about three weeks after launch, with science data arriving several weeks after that. The IRIS team plans to start by answering some long-standing questions about the chromosphere, says McIntosh, such as how many photons are emitted as solar plasma rises up through the chromosphere and how many form as it falls back down, cooling and condensing along the way.

Title says that one of the reasons IRIS is happening now is because modelling work carried out over the past decade has given solar physicists the confidence that they could actually understand the data flowing from a chromospheric mission. The mission team includes modellers such as Mats Carlsson of the University of Oslo, who says that IRIS will help him to understand why his models don't come up with the right amount of heating for the upper chromosphere. "Finally we have some hope of being able to understand these things, by combining simulations and observations," says Carlsson.

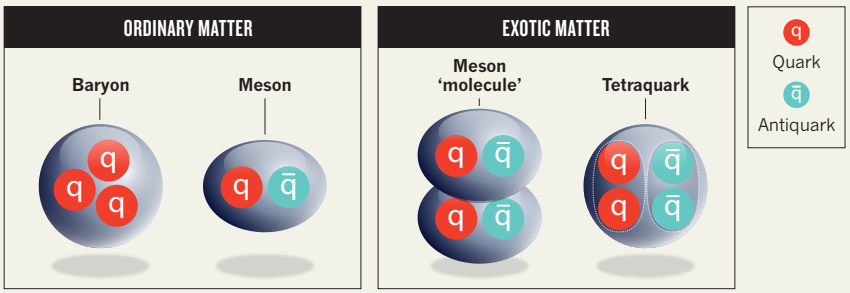
The spacecraft will begin its mission at an opportune time: the Sun is now at the peak of its 11-year cycle of activity, although this peak is much less impressive than the last one. By one measure of solar activity — the amount of radiation emitted by solar storms to reach Earth — the current maximum looks about the same as 1996's solar minimum, says Dean Pesnell, a solar physicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

IRIS didn't necessarily have to fly at a solar maximum, but it will be a boon should the Sun flare up during the two-year mission, says de Pontieu. One of the mission's scientific goals is to better understand how kinked magnetic field lines at the Sun's surface trigger big eruptions of matter and energy. IRIS will be able to track these large flares up into the corona, connecting the dots through the earliest phases of a flare's life cycle.

And there is another way in which the mission's timing will be auspicious. In November, the comet ISON is expected to have a close brush with the Sun. IRIS, along with other solar missions, will be in a prime position to watch this happen and could spot unexpected events. There is precedent: in December 2011, a comet named Lovejoy flew through the solar corona, and surprised physicists with the way its waving tail interacted with the Sun's magnetic field. ■

QUARK SOUP

Researchers at colliders in China and Japan have succeeded in making exotic matter comprising four quarks, but are still debating whether the fleeting particles are meson pairs or true tetraquarks.



PARTICLE PHYSICS

Quark quartet opens fresh vista on matter

First particle containing four quarks is confirmed.

BY DEVIN POWELL

Physicists have resurrected a particle that may have existed in the first hot moments after the Big Bang. Arcanely called $Z_c(3900)$, it is the first confirmed particle made of four quarks, the building blocks of much of the Universe's matter.

Until now, observed particles made of quarks have contained only three quarks (such as protons and neutrons) or two quarks (such as the pions and kaons found in cosmic rays). Although no law of physics precludes larger congregations, finding a quartet expands the ways in which quarks can be snapped together to make exotic forms of matter.

"The particle came as a surprise," says Zhiqing Liu, a particle physicist at the Institute of High Energy Physics in Beijing and a member of the Belle collaboration, one of two teams claiming the discovery in papers published this week in *Physical Review Letters*[1,2].

Housed at the High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan, the Belle detector monitors collisions between intense beams of electrons and their antimatter counterparts, positrons. These crashes have one-thousandth the energy of those at the world's most powerful accelerator, the Large Hadron Collider (LHC) at CERN near Geneva, Switzerland, but they are still energetic enough to mimic conditions in the early Universe. Collision rates at KEK are more than twice those at the LHC, and they occasionally give birth to rare particles not found in nature today — ephemeral creatures that wink into existence for an instant and then fall to pieces.

"They have clear evidence of a particle with four quarks."

Some of that subatomic shrapnel matches what would be expected from the breakdown of a particle containing four quarks bound together: two especially heavy 'charm' quarks and two lighter quarks that give the particle a charge. With 159 of these $Z_c(3900)$ particles in hand, the Belle team reports that the chance that its result is a statistical fluke is less than 1 in 3.5 million[1]. "They have clear evidence of a particle with four quarks," says Riccardo Faccini, a particle physicist

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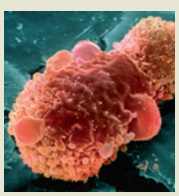

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STEVE GSCHMEISSNER/SPL

at the Sapienza University of Rome.

The new particle has also been vouched for by a second experiment, the Beijing Spectrometer III (BESIII) at the Beijing Electron Positron Collider. BESIII found 307 $Z_c(3900)$ particles, sifted from 10 trillion trillion electron–positron collisions[2].

"This gives credence to all of the other particles that Belle has seen," says Fred Harris, a particle physicist at the University of Hawaii in Manoa and a spokesman for BESIII. In 2008, Belle found another four-quark candidate[3], and in 2011, it saw two other particles that may have been made of four 'bottom' quarks[4] — but no other particle colliders have confirmed those sightings.

No one questions the number of quarks in the latest particle. More controversial is their arrangement, which could have implications for quantum chromodynamics, the theory describing the strong force that connects quarks. Theorists fall primarily into two camps.

One side proposes that the particle is actually a union of two ordinary particles called mesons, which contain one quark and one antiquark. $Z_c(3900)$ particles could be made up of two mesons joined by a loose connection to form a molecule-like structure (see 'Quark soup').

Other theorists have tentatively labelled the new particle a true tetraquark — four quarks stuck together tightly to form a compact ball. Within the ball, two quarks are bound together, as are two antiquarks. Such pairings do not occur in any known particle and would thus introduce new building blocks of matter — with the potential to guide computer simulations aimed at working out all the structures that quarks can form.

Proponents of the tetraquark theory point out that a 'molecule' made of mesons should split easily into two halves, and that such a breakdown has not appeared in the data. "The signature of a molecule is not seen, which favours the tetraquark picture," says Ahmed Ali, a particle physicist at DESY, Germany's high-energy physics laboratory in Hamburg. But the experiments' margin of error is still too great to rule out the possibility of molecular mesons breaking down. Another way to test the two theories would be to look for other particles that each predicts should exist.

Hoping to end the debate, researchers at BESIII are continuing to dig through data collected since their first experimental run in December and January. Depending on what they find, the unmasking of $Z_c(3900)$ may have to wait for the new, more powerful version of the Belle detector planned to come online in 2015. ■

1. Liu, Z. Q. *et al. Phys. Rev. Lett.* **110,** 252002 (2013).
2. Ablikim, M. *et al. Phys. Rev. Lett.* **110,** 252001 (2013).
3. Chen, K.-F. *et al. Phys. Rev. Lett.* **100,** 112001 (2008).
4. Adachi, I. *et al.* Preprint at http://arxiv.org/abs/1105.4583 (2011).

BIOTECHNOLOGY

Myriad ruling causes confusion

Change to gene patents leaves US biotech in a lather.

BY HEIDI LEDFORD

There was a party waiting for Elizabeth Chao when she arrived for work last week at Ambry Genetics, a medical-diagnostics company in Aliso Viejo, California. On 13 June, the US Supreme Court ended the 30-year-old practice of awarding patents on human genes — an outcome that Chao, a geneticist and chief medical officer of Ambry, had wanted for a long time. "It's such a win for patients," says Chao. "Everyone was crying, jumping up and down and shouting."

In Washington DC at law firm Sughrue Mion, patent lawyer William Simmons was having a rather different day, fielding phone calls from agitated clients in the US biotechnology industry. Although the Supreme Court case was limited to human DNA, the ruling will probably be applied to other molecules such as proteins, as well as to other organisms — including agriculturally important plants. "It's a mess," says Simmons. "We had a lot of clients saying, 'What are we going to do?'"

The Supreme Court decision ended a long-running, emotionally charged legal challenge to gene patents held by Myriad Genetics, a genetic-testing company in Salt Lake City, Utah, on two cancer-associated genes: *BRCA1* and *BRCA2*. The court's first point rang clear — that naturally occurring human genes cannot be patented — and seems poised to broaden the genetic-testing market (see 'Competitors stake their claims').

Yet the grey area between this ruling and the court's second point — that patents can be claimed on modified DNA — has puzzled observers. Gene patent holders, including Myriad, had long argued that the mere act of isolating a piece of DNA from a genome was enough modification for a patent claim, because isolation requires severing the chemical bonds that tether the gene to its surroundings. The Supreme Court justices — and many scientists — disagreed. But patent lawyers are now tearing their hair out over the issue of how much modification is enough. "They've created this bizarre rheostat about the amount of change that would need to take place chemically in order to justify a patent," says Simmons.

Some of the confusion stems from how the Supreme Court justices defined the term synthetic DNA. The court seemed to use it to refer to DNA that had been modified ▶

GENE TESTING

Competitors stake their claims

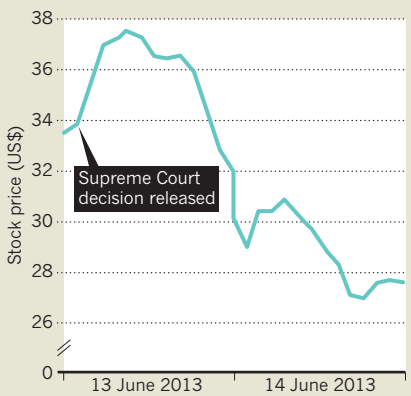
Despite the US Supreme Court decision, Myriad Genetics still has more than 500 claims covering its tests for breast-cancer genes. This reassured investors, and its stock price soared (see 'Patently unclear').

But the price later slumped as firms including California's Ambry Genetics and Quest Diagnostics in Madison, New Jersey, said that they plan to launch their own tests. Myriad's test costs US$4,000, but competitors' tests could cost half that.

Some lawyers say that firms are risking lawsuits by infringing Myriad's patents, but others think that the competitors could design genetic tests that avoid the remaining narrow claims. Any lawsuits could last for years — by which time many of Myriad's patents will have expired. **H.L.**

PATENTLY UNCLEAR

The stock price for Myriad Genetics initially rose after the US Supreme Court ruled against five of its human gene patents, but has since fallen.



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