

## Areas to watch in 2016

News writers live partly in the future. They may not know exactly what lies ahead, but, like old-time whalers, they do keep a sharp eye on the horizon. Here are a few items on the Breakthrough team's "watch list" for the next year.

### FALLING BODIES

French researchers plan to launch a satellite that in the next 2 years will recreate in space possibly the most famous experiment that never happened. Most likely, Galileo didn't really drop balls made of two different materials from the Leaning Tower of Pisa—his legendary demonstration that all objects accelerate at the same rate under the pull of gravity. However, physicists with MicroSCOPE (an acronym for the French equivalent of the Drag-Compensated Microsatellite for the Observation of the Equivalence Principle) actually will test whether two free-falling cylinders of different materials, titanium and platinum-rhodium, experience a different pull from Earth's gravity and orbit at ever-so-slightly different heights. Any difference would violate the equivalence principle, which says that gravitational mass equals inertial mass and lies at the heart of Einstein's general theory of relativity. The experiment's a long shot, but a fun one.

### WHO LET THE DOGS IN?

Could 2016 be the year we finally figure out where dogs came from? For decades, scientists have debated where and when wolves were domesticated into our canine pals. The proposed epicenters range from Europe to Asia, and the time frames span 15,000 to more than 30,000 years ago. In 2013, the

major warring factions declared a truce and began pooling their resources and scouring the globe for every ancient wolf and dog specimen they could get their hands on. Now, they may be close to a definitive answer, one that could solve one of the greatest mysteries of domestication. One of the collaboration's leaders says significant findings should come next year.

### GRAVITATIONAL WAVES

Newly upgraded detectors could finally give physicists a glimpse of gravitational waves: ripples in space and time set off by, say, two neutron stars spiraling into each other. This year, scientists with the Laser Interferometer Gravitational-Wave Observatory (LIGO) completed rebuilds of their kilometers-long facilities in Livingston, Louisiana, and Hanford, Washington, to make them up to 10 times more sensitive than when they ran from 2002 to 2010. LIGO took 3 months' worth of data this year. However, the physicists are still tuning up their detectors and will make a longer data run later next year. Meanwhile, European researchers plan to bring their upgraded VIRGO detector near Pisa, Italy, on line. Scientists say that when LIGO and VIRGO reach their design sensitivities in a few years, they are virtually certain to pick up a passing ripple. With luck, they might see one sooner.

## Breakdown of the Year: Assault on the past

For 2000 years, the imposing colonnades of the great temple of Baal rose from the desert in the ancient city of Palmyra, in today's Syria. The temple's friezes recorded the story of this ancient crossroads of East and West, and had weathered centuries of conflict, from the warrior queen Zenobia's ill-fated rebellion against Rome to two world wars. But in August 2015, a lethal combination of 21st century explosives and a twisted, 7th century worldview erased that history, when the group known as the Islamic State (IS) group deliberately blew up the temple.

"Palmyra symbolizes everything that extremists abhor—cultural diversity, dialogue between cultures, the encounter of peoples of all origins in this caravan city between Europe and Asia," UNESCO Director-General Irina Bokova said in October, after the group, also known as Daesh, felled the ancient city's iconic Arch of Triumph.

Palmyra, a UNESCO World Heritage Site, was but one of the archaeological wonders that suffered this year as the IS group rampaged through parts of Syria and Iraq, brutalizing local populations and destroying their culture, including archaeological sites. What wasn't destroyed was often plundered and sold, lost either way to humanity and to archaeological research. "I believe [it] is the worst cultural heritage crisis since World War II," says Michael Danti, academic director at the Cultural Heritage Initiative of the American Schools of Oriental Research.

The region is the birthplace of some of humanity's greatest innovations—among them the first agricultural societies, the first writing, and the first empires; it's also home to major World Heritage Sites from later periods. So archaeologists were horrified when, in February, the IS group released a video of men taking sledgehammers to statues in the Mosul Museum in northern Iraq, and drilling away the features of a great winged bull, a Neo-Assyrian sculpture dating to the 8th century B.C.E. In early April, the group



Dogs evolved from wolves, but where and when? We may soon know.



The 1800-year-old Roman Arch of Triumph in Palmyra, Syria, is gone—demolished by the Islamic State group.

destroyed monuments and bulldozed ruins in the World Heritage Site of Hatra, Iraq, then raced on to do the same at Nimrud, an ancient Assyrian city and also a World Heritage Site. Claiming to wish to “purify” the region of anything “un-Islamic,” the militants have also systematically destroyed countless smaller sites, including mosques, churches, and shrines that testify to the diversity of religions both now and in ancient times.

Many of the major sites had previously suffered looting and collateral damage from conflict. But the IS group treated them as targets in a campaign of cultural cleansing. At major sites, explosions were set off as scripted performance pieces, with the release of photos and videos timed for maximum public relations value. Meanwhile, the group has set up industrial-scale looting operations to dig up and sell artifacts, which provide a sizable portion of its income. Satellite images show looters’ holes poking key sites, signaling a loss of priceless archaeological knowledge.

In May, in a raid in eastern Syria, U.S. special forces killed a militant known as Abu Sayyaf who was apparently deeply involved in the antiquities trade. They found a cache of archaeological objects, including coins, suggesting large-scale looting. Some turned out to be fakes, but others still bore inventory numbers from

an Iraqi museum. Much of the looting has been market-driven, Danti says, with Hellenistic, Roman, and Byzantine periods especially targeted.

In Palmyra, the IS group wove the attacks on archaeology into its brutal treatment of locals. The group executed 50 captured soldiers in the ancient city’s amphitheater and tied captives to columns, then exploded the columns. The group also beheaded Khaled al-Asaad, an 82-year-old Syrian archaeologist who had spent his life studying and protecting Palmyra’s ruins. Many other Iraqis and Syrians have risked and lost their lives to protect sites.

UNESCO and several partners now have a program to put 5000 cameras on the ground to document threatened sites and artifacts, including many in the Middle East. Agencies are also working to reduce the trade in looted objects. Another program, run by the University of Pennsylvania Museum of Archaeology and Anthropology and partner institutions, has trained Iraqi locals to protect threatened sites and swiftly pack up artifacts, employing techniques last widely used during WWII. When the conflict raged around the Ma’arra museum outside Aleppo in June, its delicate frescoes had been sandbagged and mostly survived—a minor victory in a terrible year for world heritage. —*Elizabeth Culotta*

## Breakdown runners-up

### SEXISM IN SCIENCE

This year exposed an underbelly of sexist attitudes in science. In April, a Twitterstorm erupted when a reviewer for *PLOS ONE* suggested that what two (female) scientists really needed to improve their paper was a male co-author. Twitter exploded again in June, when Nobel laureate Tim Hunt told an audience that when women are in the lab, “you fall in love with them and they fall in love with you,” although many defenders argued that his remarks were a failed joke. Then in October, prominent University of California, Berkeley (UC), astronomer Geoff Marcy was found to have repeatedly violated the university’s sexual harassment policy over a decade, groping, kissing, and touching female students. Despite the bad news barrage, the revelations had a salutary effect: *PLOS ONE* removed the reviewer and editor involved, and women countered Hunt under the hashtag #distractinglysexy, posting photos of themselves doing science bedecked in field and lab gear. As for Marcy, the national tide of outrage proved too great, and he resigned from the UC system on 14 October.

### THIRTY METER TELESCOPE

This year, a project to build the largest optical telescope on U.S. soil collided head-on with the rights and beliefs of indigenous people.

The builders of the Thirty Meter Telescope (TMT) got an inkling of trouble in October 2014, when protesters disrupted the project’s groundbreaking ceremony on the Hawaiian mountain of Mauna Kea. The mountain is considered sacred in the Hawaiian religion, and—although 13 telescopes already crowd the summit—opponents claim the enormous TMT would desecrate it.

Since March 2015, protesters have been blocking construction crews from reaching the site, and dozens have been arrested. A 1-week halt in construction has grown into an indefinite hiatus. Then, in December, Hawaii’s Supreme Court ruled that the TMT’s construction permit was invalid because opponents hadn’t been given time to make their case before it was awarded in 2011—a setback that could delay construction for years. The outlook for the telescope—meant to deliver some of the clearest ever views of the cosmos—appears distinctly cloudy.