was later absolved after the academic filed an objection. The 8 other academics, along with the 9 identified in the latest report, bring the total accused to 17.

In South Korea, research misconduct can carry harsh penalties. The education ministry says that disciplinary actions under consideration for the cases include reprimands, a one-year limitation on participating in national research activities, and dismissal. At least one academic, at Sungkyunkwan University in Seoul, has reportedly been dismissed, and another academic at the same university has been reprimanded over the allegations, the ministry says. When asked to confirm this, the university pointed *Nature* to the ministry report.

Misconduct uncovered

The practice of adding children to papers came under scrutiny in late 2017, when a case of child co-authorship was uncovered at Seoul National University. After that, the government launched an investigation, and in January 2018 the ministry said that it had identified 82 academic papers with child co-authors. On about half of the papers, the ministry said, students seemed to have participated in the research as part of a school programme, whereas on the other half they had not. At the time, the ministry did not say how many academics were involved, but said that it would refer the cases to university ethics committees to confirm whether the children's involvement was legitimate.

The ministry and universities have now identified a total of 794 publications with child co-authors, of which 549 have been reviewed, the education minister Yoo Eun-hae said in a statement on 17 October. Of those, the ministry found that 24 papers had unjustified authorship. The ministry's report did not say in which journals the problematic papers had been published.

Of the 11 university academics referred to in the latest report, the ministry highlights several cases in which a child got into university after citing an allegedly problematic co-authorship in their application.

So Young Kim, a science and technology political scientist at the Korea Advanced Institute of Science and Technology in Daejeon, thinks the problem is likely to go well beyond those cases uncovered so far. "My impression is that this practice is more widespread than we might think," she says.

Changgu Lee, a materials scientist at Sungkyunkwan University's Suwon campus, says that he doesn't agree with papers being used for university entry. "I don't like colleges emphasizing publications in admission process because high-school students cannot be involved in research seriously, and because publication achievement can be misused for admission," he says.

SPACEX

SpaceX sent 60 communications satellites into orbit on 11 November.

SPACEX LAUNCH HIGHLIGHTS THREAT OF 'MEGACONSTELLATIONS'

Astronomers fear that plans to send tens of thousands of satellites into orbit will disrupt observations.

By Alexandra Witze

Space-flight company SpaceX launched 60 communications satellites into orbit this week as the basis for a web of spacecraft designed to provide global Internet access. But many astronomers worry that such 'megaconstellations' – which are also planned by other companies that could launch tens of thousands of satellites in the coming years – might interfere with crucial observations of the Universe. Researchers fear that the satellites could disrupt frequencies used for astronomical observation, create bright streaks in the sky and increase congestion in orbit, raising the risk of collisions.

SpaceX sent its second set of these satellites – called Starlinks – into orbit from Cape Canaveral, Florida, on 11 November. The first 60 went up in May. But these launches are just the beginning: by the end of 2020, there could be hundreds of Starlinks in orbit, and SpaceX envisions thousands in the years to come. Other companies, such as Amazon, headquartered in Seattle, Washington, and London-based OneWeb, are planning launches that altogether could more than double the number of existing satellites. They are meant to bring reliable Internet to under-served communities worldwide, and have other potential applications, including improving satellite Internet for military planes.

Although it's not clear how many of the planned megaconstellations will actually be built, several researchers have begun to analyse how the satellite networks could affect astronomy. The situation doesn't seem as bad as initially feared, but might still dramatically shift how some astronomers do their jobs.

Sky streaks

Satellites are not a new challenge for astronomy; the US military tracks and releases information on nearly 20,000 objects that are in orbit. Many are small and don't interfere with observations. "What's really concerning is how bright all these new satellite constellations will be," says Patrick Seitzer, an astronomer at the University of Michigan in Ann Arbor.

Within the next year or so, SpaceX plans to launch an initial set of 1,584 Starlink satellites into 550-kilometre-high orbits. At a site such as Cerro Tololo, Chile, which hosts several major telescopes, six to nine of these satellites would be visible for about an hour before dark and after dawn each night, Seitzer has calculated.

Most telescopes can deal with that, says Olivier Hainaut, an astronomer at the European Southern Observatory (ESO) in Garching, Germany. Even if more companies launch megaconstellations, many astronomers might be able to continue their work, he says. Hainaut has calculated that if 27,000 satellites are launched, then ESO's Chile telescopes will lose about 0.8% of their long-exposure observing time near dusk and dawn. "Normally, we don't do long exposures during twilight," he says. "We are pretty sure it won't be a problem for us."

But an upcoming, cutting-edge telescope could be in bigger trouble. The US Large Synoptic Survey Telescope (LSST) will use an enormous camera to study dark matter, dark energy, asteroids and other astronomical phenomena. It will survey the entire visible sky at least once every three nights, starting in 2022. Because the telescope has such a wide field of view, satellites trailing across the sky could affect it substantially, says Tony Tyson, an astronomer at the University of California, Davis, and the LSST's chief scientist.

He and his colleagues have been studying how up to 50,000 new satellites – an estimate from companies' filings with the US government – could affect LSST observations. Early findings suggest that the telescope could lose significant amounts of observing time to satellite trails near dusk and dawn.

Paint it black

There are other impacts beyond losing observing time. Bright satellite streaks can saturate camera sensors, creating false signals. This problem would be worse in summer, when satellites are visible for longer – introducing a seasonal bias that would harm LSST studies for which statistical significance must be built up over time, including studies of dark matter.

These issues can be managed, says Paul Dabbar, the under-secretary for science at the US Department of Energy, which funds the LSST camera. Operators could provide astronomers with detailed information on where the satellites are in the sky at any time, so that observers could schedule around expected satellite trails. Companies could also paint the crafts' Earth-facing surfaces a dull black, which would make them fainter.

SpaceX says that it is "taking steps to make the base of Starlink satellites black to help mitigate impacts on the astronomy community", but did not say whether this applies to the set just launched. The company also told *Nature* that it is sharing satellite-position information with the US military catalogue, and talking to astronomy groups to assess the effects and evaluate mitigation strategies.

Radio interference

Radio astronomers face a second set of challenges. They observe the Universe in wavelengths of light that are also used for satellite communications. The use of such frequencies is regulated, but the huge number of planned satellites complicates the situation, says Tony Beasley, director of the US National Radio Astronomy Observatory in Charlottesville, Virginia. As satellites communicate with ground stations, their signals could interfere with radio-astronomy observations, rendering the astronomy data useless.

"What's really concerning is how bright all these new satellite constellations will be."

The observatory is talking to SpaceX and OneWeb about the frequencies that their megaconstellations will use for broadcasting. Companies might decide to shift these away from those used for radio astronomy. Another idea is for satellites to pause communications when they pass over radio-astronomy facilities.

The sheer number of satellites could also worsen Earth's space-junk problem. The first batch of Starlinks has already caused some congestion. In September, the European Space Agency (ESA) had to manoeuvre its Aeolus wind-mapping satellite out of the way of a Starlink craft. The Starlinks are supposed to move away from potential collisions automatically, but a communications glitch between ESA and SpaceX meant neither knew what the other was doing. The incident highlighted the fact that satellite operators don't have a universal strategy if two active satellites are on a potential collision course, says Holger Krag, head of ESA's space-debris office in Darmstadt, Germany.

He and his colleagues are hoping to help develop a global collision-avoidance system that automatically detects potential crashes and orders satellites to move to safer locations. "We would like to see that in two to three years," Krag says.

PROTON-SIZE PUZZLE LEAPS CLOSER TO RESOLUTION

Precise measurement affirms that the particle's radius is smaller than physicists once thought.

By Davide Castelvecchi

A long-awaited experimental result has found the proton to be about 5% smaller than the previously accepted value. The finding[1] has helped to prompt a redefinition of the particle's official size and seems to spell the end of the 'proton radius puzzle', which has enthralled physicists since 2010.

The result, published in *Nature* on 6 November, puts the particle's radius at 0.831 femtometres. This measurement, together with a concurring one made using a different technique that was published[2] in *Science* in September, has been known to experts since last year. The findings led the Committee on Data for Science and Technology (CODATA) – which records the most up-to-date measurements of the fundamental constants of nature – to revise its handbook at the end of 2018, says Krzysztof Pachucki, a theoretical physicist at the University of Warsaw who chairs a CODATA task group. Although some researchers are still cautious, he thinks the latest papers have "definitely resolved the puzzle".

Physicists use two main techniques to measure the size of the proton. One relies on how electrons orbit atomic nuclei. Because some electron orbits pass through the protons in the nucleus, the size of the protons affects how strongly the electrons bind to the nucleus. Precise measurements of the differences between various electrons' energy levels – a technique known as spectroscopy – therefore provide a way to estimate the proton's radius. The second technique involves hitting atoms with a particle beam and seeing how those particles scatter off the nuclei.

About ten years ago, it seemed that both techniques had converged on a proton radius of 0.8768 femtometres (millionths of a millionth of a millimetre).

But in 2010, a new twist on spectroscopy