

Good things come to those who wait

 Check for updates

It's been an eventful year for robotic missions. From probes of Solar System bodies to large-scale cosmic structures, advances in our understanding of the formation and evolution of the Universe gather speed.

On 1 November when NASA's Lucy mission sent back the first images of main belt asteroid Dinkinesh, the team was delighted to find a small satellite, whose existence they had started to suspect because of brightness variability of Dinkinesh during Lucy's approach. But what nobody expected was a second satellite (pictured on the right-hand side of the image); the contact binary was discovered minutes later after the spacecraft had passed its closest approach. The images were taken during an engineering test of the tracking system designed to work autonomously at 10,000 mph. If that's what happens during a routine technical test on an unremarkable object in passing, just imagine what is in store.

Indeed [Lucy will continue to explore main-belt asteroids](#) en route to the Trojan asteroids in Jupiter's orbit, where it will arrive in 2027. Believed to be primitive bodies from when the Solar System formed over 4 billion years ago, the Trojan asteroids could share the same material as the outer planets and hold clues to the formation of our planetary system. They may also furnish deeper insights into [planetary migration](#). Until its grand finale in March 2033, there will be one more main belt and at least five Trojan asteroids to encounter, and surely (!) more surprises.

In October 2023 another small bodies mission was launched, but to a very different kind of asteroid: 16 Psyche, a metal-rich asteroid. Its surface is believed to be the exposed planetesimal core – rich in iron, and a building block of rocky planets. However, other measurements seem to cast doubts on the high metal content of the asteroid – a debate that can be solved only by in-situ observations. NASA's Psyche mission, named after its target, will take six years to reach 16 Psyche in the outer part of the main asteroid belt. The study of a planetary interior of the inner Solar System



will complement Lucy's focus on primordial material forming the outer planets.

Less than a week after Lucy's unexpected revelation, ESA's Euclid space mission team released stunning [images](#) of the Horsehead Nebula, galaxies and galaxy clusters. Over the next six years, the mission will survey distant galaxies to map the cosmic structure of a third of the sky across a range of wavelengths. The extremely sharp visible and infrared images of billions of galaxies out to 10 billion light years – detailing their shapes, distances and motions – will reveal the effects of dark matter and dark energy over cosmic timescales. Science observations are set to begin in early 2024 and then Euclid will do for the Universe what Gaia is doing for the Milky Way – namely, producing a comprehensive 3D map of our Galaxy of 1.8 billion stars.

Moving on from the dark and cold Universe, the high-resolution X-ray observatory XRISM was launched on 6 September 2023 to probe the hot Universe at tens of millions of degrees. It is a JAXA-led mission, and successor to the Hitomi spacecraft, which failed a month after it was launched on 17 February 2016. As a [general purpose X-ray satellite](#), XRISM will provide exquisite details of outflows from supermassive black holes; clusters of galaxies, including those undergoing energetic mergers; winds from hot stars and large scale supernova remnants, which affect the formation and evolution of the largest structures, and more. Currently in the 'performance and verification' phase, XRISM will enter the General Observer phase in July 2024.

As exciting as shiny new space missions can be, let's not forget 'old' JWST, which is

approaching its two-year anniversary. Its Cycle 3 General Observer programs were nine times oversubscribed. With roughly 5,000 hours of prime time and 1,215 hours of parallel time (those that obtain data from more than one JWST instrument simultaneously) awarded for Cycle 2, we can expect plenty of unprecedented discoveries.

Concerningly, political wranglings in the United States have painted a very uncertain picture for forthcoming NASA-led planetary science missions. The [Venus mission VERITAS](#) has had its budget cut down to subsistence levels, halting any significant progress on the mission with a launch originally slated for late 2027. The Dragonfly mission to Titan is another budget casualty, but to a lesser degree, with a launch delayed from June 2027 to July 2028.

But despite the inevitable slow-down that budget unpredictability will invoke, there are other reasons for astronomers to be optimistic, particularly with the ESA-led Rosalind Franklin project moving ahead after the removal of Russian equipment. Another ESA-led mission with NASA involvement, JUICE, is on its way to the target Jovian system. NASA's Europa Clipper will shortly be making its way to the launchpad. And the much-anticipated Uranus Orbiter and Probe (UOP) concept has been the topic of preliminary discussions with ESA and continues to be a priority amongst scientists. UOP is included in next year's President's Budget Request, so that focused studies can commence. Overall, we have much to look forward to in 2024.

Published online: 14 December 2023