What's the (dark) matter with Euclid?

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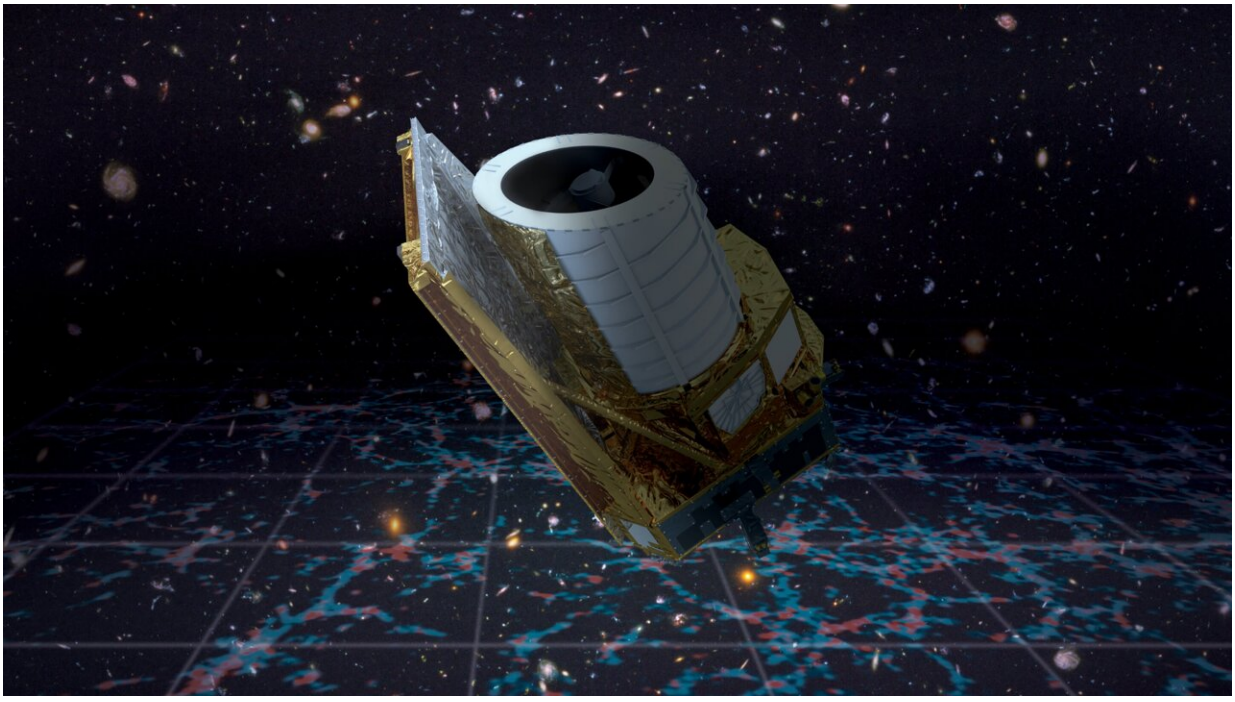


Artist impression of the Euclid mission in space. The spacecraft is white and gold and consists of three main elements: a flat sunshield, a large cylinder where the light from space will enter, and a 'boxy' bottom containing the instruments. The spacecraft is shown half in the shadow, because the sunshield will always be faced in the direction of the Sun and thus protecting the telescope from the light of the Sun. The background is a realistic representation of a deep field view of the night sky, with many galaxies visible. On the bottom half of the image, an artistic representation of the cosmic web is overlayed over the galaxies. The cosmic web is the scaffolding of the cosmos on which galaxies are built, consisting primarily of dark matter and laced with gas. The cosmic web is here represented with a grid and a two-dimensional representation of a cosmological simulation. Credit: ESA/Euclid/Euclid Consortium/NASA. Background galaxies:

Currently about halfway through the Euclid simulations campaign, the key focus in the Main Control Room is the Launch and Early Orbit Phase (LEOP) and spacecraft commissioning.

These are the two most critical moments in a mission's life; as it wakes up after the rigors of launch, makes its first maneuvers towards its target destination and as its instruments are commissioned.

Stress as Euclid thrusters fail

Joe Bush, simulations officer for Euclid, has spent months meticulously planning all the ways that Euclid could fail. From problems on the spacecraft to human issues like team cohesion, confidence and morale.

You'd be forgiven for thinking, that on 23 March this year, he went too far. Joe broke not just one, but two sets of thrusters on the Euclid spacecraft simulator. It was up to the Flight Control and Flight Dynamics Teams to decide which they could and should use.

"All of a sudden, a suspected mechanical failure meant one of Euclid's attitude thrusters was stuck shut, producing no force at all, forcing us to use the backup set of thrusters. But then, the orbit control thrusters, part of that backup set, began behaving strangely, one overperforming by 10% and the other underperforming by the same amount," recalls Tiago Loureiro, Euclid Flight Operations Director.

Structural and thermal model of the Euclid satellite. Credit: ESA–S. Corvaja

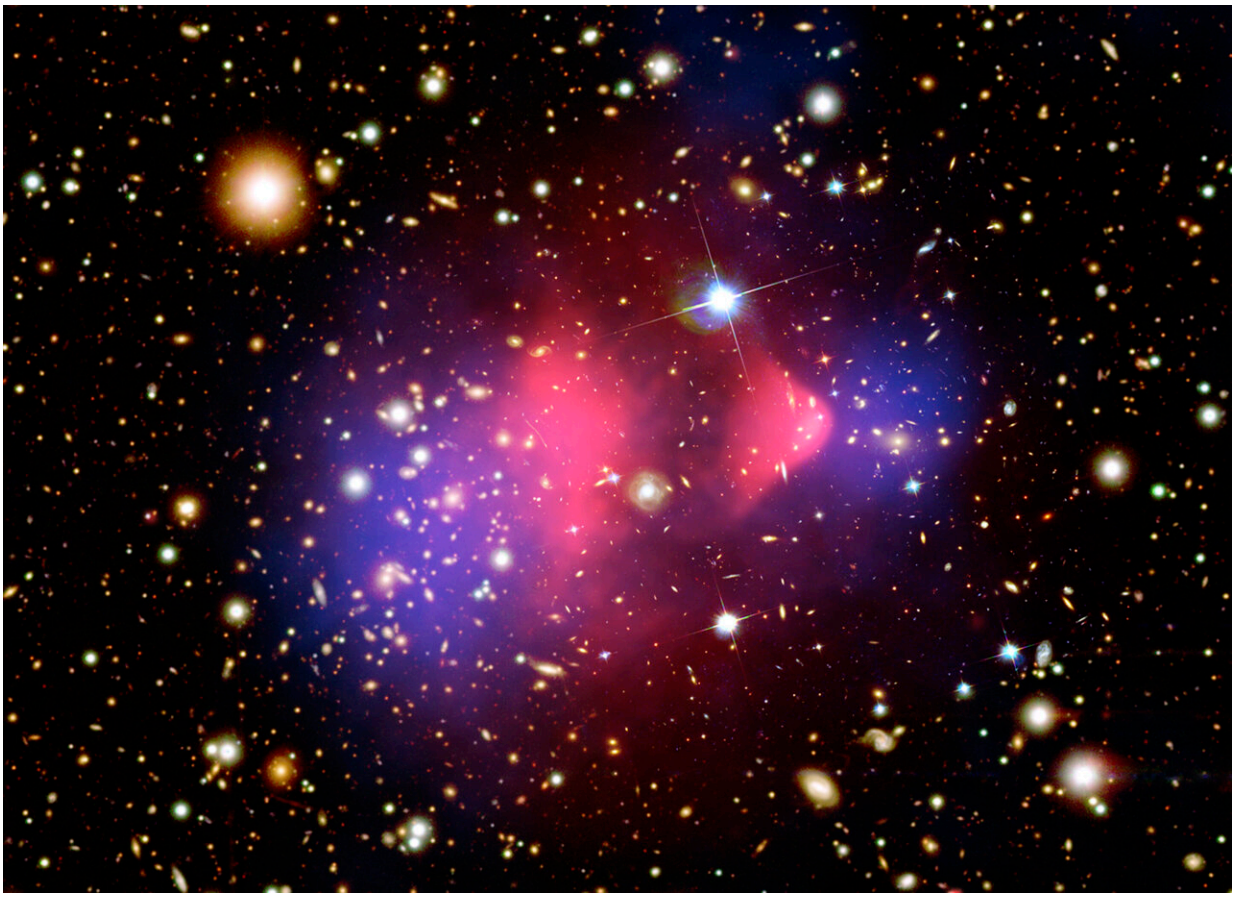
The team discussed a potential hybrid solution that would make use of both sets of thrusters, but for this, there was no procedure in place, and to create one would require input and advice from the Science project at ESA's Technical heart (ESTEC) and industry partners. While not involved in this earlier simulation, these teams have now joined simulations and of course, will be on hand throughout Euclid's life in space.

"I wanted to get the teams used to making decisions under serious time pressure, and having two faulty sets of thrusters certainly did that," explains Joe.

"The double-thruster nightmare scenario underscored how successful mission operations include a wide array of experts and specialists, able to support and brainstorm with our Control Teams for the plethora of potential issues that can arise."

Tiago adds to this, "The simulations campaign is all about teamwork—nobody can fly a mission on their own. Knowing who or what to rely on for knowledge and advice, and when, for supporting us on those high-stakes decision-making moments, is an important skill in mission operations, but also in life!"

It would be unlucky for something like this to happen for real, but it's certainly not impossible. Whether it's Euclid's thrusters, solar arrays or any number of other critical spacecraft components, the teams' ability to keep cool yet decisive in the midst of a serious problem, to know who to call in and rely on at what time, will be vital for mission success.



The Bullet Cluster is a much-studied pair of galaxy clusters, which have collided head on. One has passed through the other, like a bullet travelling through an apple. In the Bullet Cluster, this is happening across our line of sight, so we can clearly see the two clusters. The optical image from the Magellan and the Hubble Space Telescope shows galaxies in orange and white in the background. Hot gas, which contains the bulk of the normal matter in the cluster, is shown by the Chandra X-ray image, which showst the hot intracluster gas (pink). Gravitational lensing, the distortion of background images by mass in the cluster, reveals the mass of the cluster is dominated by dark matter (blue), an exotic form of matter abundant in the universe, with very different properties compared to normal matter. This was the first clear separation seen between normal and dark matter. Credit: X-ray: NASA/CXC/CfA/M.Markevitch, Optical and lensing map: NASA/STScI, Magellan/U.Arizona/D.Clowe, Lensing map: ESO WFI

Engineers to cajole a sensitive soul

Euclid's exceptionally sensitive 1.2-meter telescope will capture light that is ten billion years old, originating from the early universe and only now reaching us. In doing this, it will shed light on a simple question for which we still don't have an answer: What is the universe made of? Amazingly, this is today a cosmic mystery.

The matter we're made of and the light that lets us see, constitutes just 5% of the universe. The rest is dark: with dark energy making up about 70% and dark matter the remaining roughly 25%.

But what are dark matter and dark energy? Euclid hopes to find out, yet its instruments are only as sensitive as the operations allow them to be. Engineers at ESA's mission control will need to protect the unshielded telescope during and after launch, ensuring no direct sunlight touches it. They will then have to calibrate and point the spacecraft with extreme precision, to ensure it can clearly see.

From launch to Lagrange

Euclid will launch on a SpaceX Falcon 9 rocket from Cape Canaveral, Florida, U.S., no earlier than July. A trajectory correction maneuver will nudge it to "Lagrange point 2"—one of five points around the Sun and Earth where the gravitational forces between the two bodies balance out, creating gravitational "plateaus" around which objects can orbit, stably, without too much work to keep them in place.

All of this will be rehearsed in the ongoing simulations taking place at ESA's ESOC mission control center, first with local teams and later bringing together science teams at ESA's ESTEC technical heart, SpaceX, ground stations and Thales Industry.

Provided by European Space Agency