

A decade of planets

Origins, Worlds, and Life is the title of the US Planetary Decadal Survey for 2023–2032. The completion of the Mars sample return and the exploration of the outer Solar System icy worlds crown a varied programme that touches all the diverse aspects of planetary science.

The 2040s will be the decade of Uranus if everything goes according to the indications of the new [Planetary Science and Astrobiology Decadal Survey 2023–2032](#), unveiled on 19 April 2022. In the US, setting the scientific priorities for the next ten years is an exercise common to many fields. In a bottom-up approach, the community itself tells the policymakers where they think the precious limited resources for space exploration should be invested. It's a laborious project, involving the writing of [hundreds of white papers](#), the work of a committee, several panels and many scientists with varied and sometimes conflicting interests for about two years, but it usually works. The previous Decadal proposed a Mars rover to collect samples for sample return and a mission to Europa for the most expensive class of missions, called Flagships, and now we have Perseverance roaming Mars and Europa Clipper in the works. The chances for a complex mission to Uranus are thus pretty high.

Contrary to astronomy, planetary science is very object-driven. Projects and missions are usually conceived to answer general questions on how planetary bodies work by the exploration of a specific place or similar objects. This Decadal employed a different approach from the previous ones, organizing the discussion around 12 broad priority science questions on three overarching scientific themes: origins; worlds and processes; and life and habitability. The various mission white papers proposed for the Decadal were analysed through this prism. Still, deciding which planets will get the main attention (and money) is a big part of the Decadal, with huge practical implications for the careers of many current and future planetary scientists. And, after giving the highest scientific priority to the completion of the Mars sample-return programme, the Decadal put its weight behind a Uranus Orbiter and Probe (UOP).

This decision is not exactly a surprise. It was, after all, the third Flagship choice of the previous Decadal, after Mars and Europa. Uranus is also one of the two planets that was visited only by a single flyby of Voyager 2, together with its sibling Neptune. Long neglected compared to other Solar System bodies, Uranus and Neptune

have enjoyed a change in narrative in recent years. Now they are not seen as just minor brothers of Jupiter and Saturn, but worlds of a class of their own, the ice giants, that have different properties and host different processes to the gas giants and which we know surprisingly little about: we are not even sure if their interiors are mainly rocks or ices. Each has unique characteristics: a tilted system of moons in the case of Uranus, a captured Pluto-like trans-Neptunian moon (Triton) for Neptune. They are also representatives of what is probably the most populous family of exoplanets. Uranus and Neptune are equal in terms of scientific value, but the committee ended up preferring the former for a very practical reason: timing and flexibility. Optimal trajectories to send a heavy spacecraft to Uranus have well-timed windows of opportunity for launch throughout the 2030s, something that Neptune does not. There are many similarities between the UOP and Cassini–Huygens. Like Cassini, UOP will transform our view of its target. It will also probably have an important ESA collaboration, as the Decadal suggested. And it will be a multi-decade effort involving future generations: with its ~13-year cruise, UOP will arrive at Uranus in 2044–45 at the earliest.

A very different kind of icy world got the other main spotlight. The small moon Enceladus not only got the second priority spot for a Flagship — an ambitious 'Orbilander' mission to arrive no earlier than the early 2050s — but was also included in the list of recommended mission themes for the medium-class mission category selection (called New Frontiers). Enceladus provides something that no other body has: direct access to its interior ocean that hosts salts, organics and the bases for amino acids. The abundance of ocean worlds in the outer Solar System is one of the most striking discoveries of the past 15 years, but only Enceladus among them has continuously active plumes that eject material from its ocean into space. The serendipitous passage through the plumes by Cassini has provided evidence that these oceans are a prime astrobiology target.

A Planetary Decadal is not just big Flagship missions. The 750-page report

covers everything from science to planetary defence. Appropriately, their recommended programme forecasts a budget of around 41 billion dollars for the next ten years: ambitious, considering that NASA spent ~22 billion dollars for planetary exploration for the period covered by the past Decadal, but not unrealistic considering NASA's expanding portfolio in the field. The committee is not shy to tackle uncomfortable topics, like the integration of science into the human exploration programmes. The recommendation of a lunar rover, called Endurance-A, that could travel for ~1,000 km through various terrains, gather samples and deliver them to a location for collection by the astronauts is one of the various innovative ideas to create a fruitful synergy between the human and the robotic exploration of the Moon.

Some parts of the community think that the committee could have been bolder regarding the state of the profession, with special attention to inclusivity, diversity, equity and accessibility (IDEA). The importance of this topic was acknowledged and specific recommendations were included in a Planetary Decadal for the first time. Yet, there was no specific data collection and no dedicated panel, contrary to the Astronomy Decadal, and according to some the recommendations to fight the existing barriers within the field did not push the envelope enough. The community will take up the slack on this topic, as shown by the conference on [advancing IDEA in planetary science](#) that happened one week after the unveiling of the Decadal.

Origins, Worlds, and Life displays a thriving landscape for US planetary science. Its scope is wider than ever and touches global issues like improving our planetary defence capabilities, developing ad-hoc infrastructures and acting for a more equitable and inclusive workforce. It is now the time to translate all these intentions to reality so that we will explore our planetary system in a sustainable and diverse manner. □

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