botanist Rafaël Govaerts at the Royal Botanic Gardens, Kew, in London. Govaerts started the database in 1988 to track the status of every known plant species. He mined the scientific literature and created a list of seed-bearing plant species that had been ruled extinct, and noted which species scientists had deemed to be extinct but later rediscovered.

In 2015, Govaerts, plant evolutionary biologist Aelys Humphreys at Stockholm University, and others began analysing the data. They found that 1,234 species had been reported extinct since the publication of Carl Linnaeus's compendium of plant species, *Species Plantarum*, in 1753. But more than half of those had been either rediscovered or reclassified as a living species; 571 are still presumed extinct.

A map of plant extinctions since 1900 produced by the team shows that flora in areas of high biodiversity and burgeoning human populations, such as Madagascar, Brazil, India and South Africa, are most at risk (see 'Extinction pattern'). Islands are particularly sensitive because they are likely to contain species found nowhere else and are especially susceptible to environmental changes, says Humphreys.

Although the team curated the database carefully, the numbers are almost certainly an underestimate, says Jurriaan de Vos, a phylogeneticist at the University of Basel in Switzerland. Some plant species are "functionally extinct", he notes, and live only in botanical gardens or in such small numbers in the wild that researchers don't expect the population to survive.

"You can decimate a population or reduce a population of 1,000 down to one and the thing is still not extinct," says de Vos. "But it doesn't mean that it's all OK."

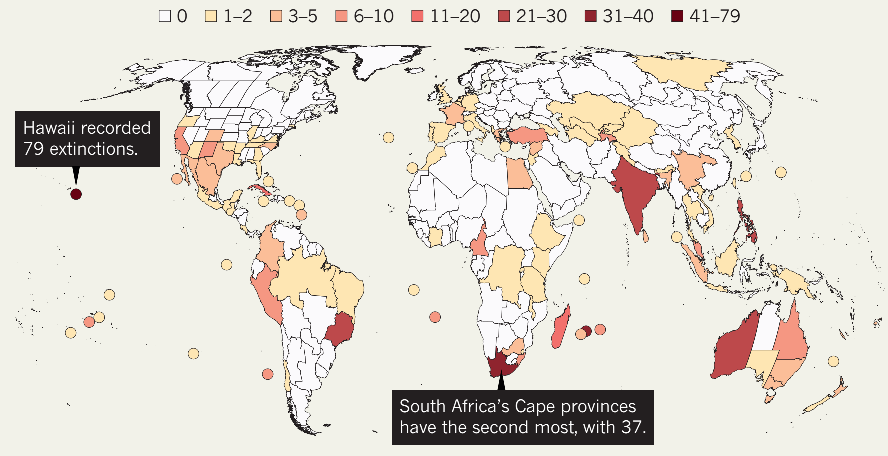
And few researchers have the money or time to launch efforts to find a plant species that they think might have gone extinct. Landscapes can change a lot in a relatively short amount of time, so it's difficult to know whether a species has truly disappeared without an extensive follow-up, de Vos says.

He recalls his own hunt through Cameroon to gather species of yellow-flowering begonias for DNA sequencing. De Vos visited several sites where records indicated that other researchers had collected the plants in decades past. But sometimes he would arrive at a site to find a radically changed landscape.

"You know that it's a rainforest species, but you're standing in a city," de Vos says. "Then you realize just how massive the scale of destruction or land-use change has been over the past 50 or 80 or 100 years." ■

EXTINCTION PATTERN

The number and locations of seed-bearing plant species that have disappeared since 1900.



SOURCE: HUMPHREYS *ET AL.*

ASTROPHYSICS

Mission to map Universe in high-energy X-rays

German–Russian space telescope will detect millions of supermassive black holes.

BY DAVIDE CASTELVECCHI

"Have you seen your body in X-rays? It looks completely different," says Rashid Sunyaev. "We will do the same with the Universe." Sunyaev, a Soviet-born cosmologist at the Max Planck Institute for Astrophysics in Garching, Germany, could be about to get his long-held wish.

On 21 June, a joint German–Russian mission called Spektrum-Roentgen-Gamma (SRG) will launch into space to create an unprecedented map. It won't be the first space telescope sensitive to high-energy 'hard' X-rays. But it will be the first to create a full map of the sky in this part of the spectrum, one that will give astrophysicists a new way to track the Universe's expansion and acceleration over the aeons. "Within a half year, we will cover the whole sky," says Peter Predehl, an X-ray astronomer at the Max Planck Institute for Extraterrestrial Physics, also in Garching, and a principal investigator for the mission.

SRG's main scientific goal is to create a 3D map of the Universe that will reveal how the cosmos accelerates under the mysterious repulsive force known as dark energy. It will do so by probing the distribution of about 100,000 galactic clusters, which can reveal the history and structure of the Universe. SRG will detect the X-ray glow from intergalactic plasma in the clusters, and from the plasma filaments that join them. The mission will also detect up to three million supermassive black holes that spew the radiation — many of which will be new to science — and X-rays from as many as 700,000 stars in the Milky Way.

"It's going to be a great survey," says X-ray astronomer Giuseppina Fabbiano of the Harvard–Smithsonian Center for Astrophysics in Cambridge, Massachusetts. Its data will have a unique role in the field for a long time, she adds.

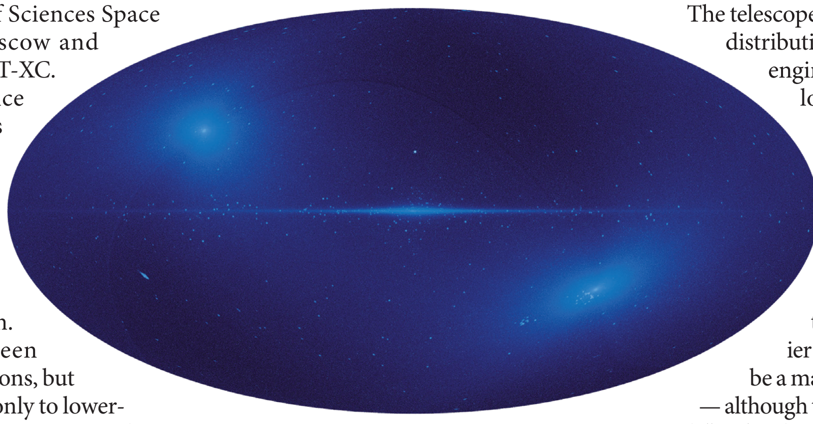
SRG also represents one of Russia's most significant space-science missions for decades. It carries two independent X-ray telescopes: a German-built one called eROSITA (Extended Roentgen Survey with an Imaging Telescope Array) and a Russian-built one called ART-XC (Astronomical Roentgen Telescope — X-ray Concentrator), which is the first scientific instrument of its kind in the history of Russian and Soviet space research, says Mikhail Pavlinsky, a high-energy astrophysicist at ▶

the Russian Academy of Sciences Space Research Institute in Moscow and principal investigator on ART-XC. “Now we have a new chance to return to world-class science,” he says.

X-RAY MAP

The spacecraft will lift off on a Russian-built Proton-M rocket from the Baikonur Cosmodrome in Kazakhstan. X-ray sky surveys have been conducted by previous missions, but these tended to be sensitive only to lower-energy ‘soft’ X-rays. Existing missions, such as NASA’s Chandra X-ray Observatory, can see higher-energy radiation but cover only small parts of the sky.

SRG’s two instruments cover higher-energy bands: 0.2–10 keV for eROSITA, and 5–30 keV for ART-XC. (Despite its name — which was kept for historical reasons — SRG will not detect γ radiation.) Each instrument is a bundle of seven X-ray telescopes that will frame the same swathe of sky simultaneously to collect more photons than a single telescope. X-ray photons from the sky are few and far between, so the telescopes’ semiconductor-based sensors will also be able to estimate the amount of energy contained in individual photons.



A simulation of eROSITA’s expected X-ray map.

REMEIS OBSERVATORY & ECAP

In its four-year mission, SRG will map the sky eight times, and researchers will look for changes. For instance, some of the supermassive black holes at galactic centres become extremely bright when they devour matter at a high rate, and then go back to relative quiescence. Most soft X-rays from these black holes are likely to be absorbed by surrounding dust, but harder X-rays should get through, says Pavlinsky. ART-XC might see the objects appearing and then disappearing again from one year to the next, providing information about how black holes consume matter. “We wish to observe several thousand of these events,” Sunyaev says.

The telescope will also probe the Universe’s distribution of dark matter — the main engine of galaxy formation — and look for hints as to the nature of the substance. SRG will do this by trying to confirm previous signals that showed peaks in X-ray emissions from some galactic centres. Some researchers suggest that these X-rays come from the decay of an unknown, heavier relative of neutrinos that could be a major component of dark matter — although this interpretation is controversial. “So far, the dark-matter explanation is still on the table” as a potential cause of the X-ray signal, says Esra Bulbul, an astrophysicist at the Max Planck Institute for Extraterrestrial Physics and a lead scientist on the mission. ■

CORRECTION

The News story ‘CRISPR twins might have shortened lives’ (*Nature* **570**, 16–17; 2019) erroneously stated that 11% of the UK population carries two copies of a *CCR5* mutation. In fact, that figure applies to people who carry at least one copy of the mutation.