

Chandra X-ray Observatory identifies new stellar danger to planets

April 20 2023



Credit: Science: NASA/CXC/Univ. of Illinois/I. Brunton et al

Astronomers using data from NASA's Chandra X-ray Observatory and other telescopes have identified a new threat to life on planets like Earth:

a phase during which intense X-rays from exploded stars can affect planets over 100 light-years away. This result, as outlined in our latest press release, has implication for the study of exoplanets and their habitability.

This newly found threat comes from a supernova's blast wave striking dense gas surrounding the exploded star, as depicted in the upper right of our artist's impression. When this impact occurs it can produce a large dose of X-rays that reaches an Earth-like planet (shown in the lower left, illuminated by its host star out of view to the right) months to years after the explosion and may last for decades. Such intense exposure may trigger an extinction event on the planet.

A new study reporting this threat is based on X-ray observations of 31 [supernovae](#) and their aftermath—mostly from NASA's Chandra X-ray Observatory, Swift and NuSTAR missions, and ESA's XMM-Newton—show that planets can be subjected to lethal doses of [radiation](#) located as much as about 160 light-years away. Four of the supernovae in the study (SN 1979C, SN 1987A, SN 2010jl, and SN 1994I) are shown in composite images containing Chandra data in the supplemental image.

The paper describing this result appears in the April 20, 2023 issue of *The Astrophysical Journal*.



Illustration of an Earth-like planet before and after radiation exposure. Credit: NASA/CXC/M. Weiss

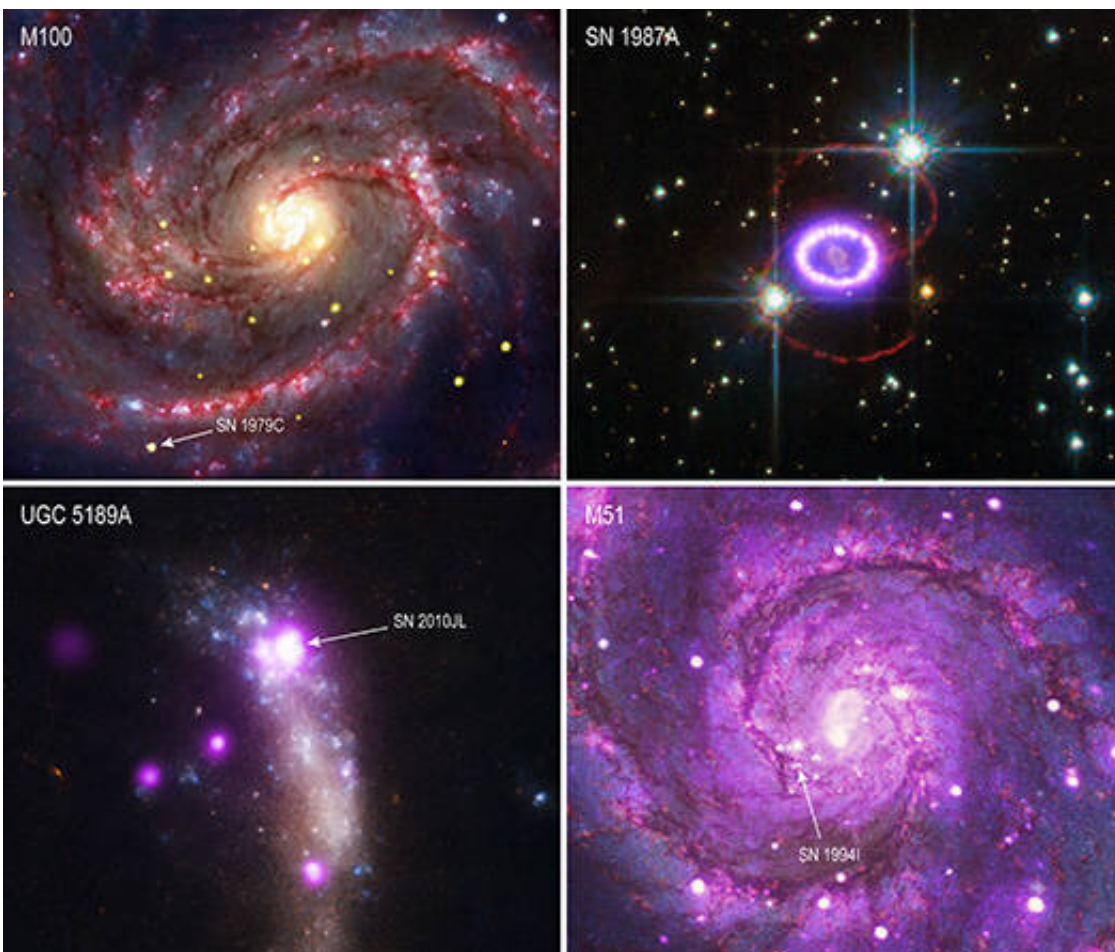
Prior to this, most research on the effects of supernova explosions had focused on the danger from two periods: the intense radiation produced by a supernova in the days and months after the explosion, and the energetic particles that arrive hundreds to thousands of years afterward.

If a torrent of X-rays sweeps over a nearby planet, the radiation could severely alter the planet's atmospheric chemistry. For an Earth-like planet, this process could wipe out a significant portion of ozone, which ultimately protects life from the dangerous ultraviolet radiation of its host star. It could also lead to the demise of a wide range of organisms, especially marine ones at the foundation of the food chain, leading to an

extinction event.

After years of lethal X-ray exposure from the supernova's interaction, and the impact of ultraviolet radiation from an Earth-like planet's host star, a large amount of nitrogen dioxide may be produced, causing a brown haze in the atmosphere, as shown in the illustration. A "de-greening" of land masses could also occur because of damage to plants.

A separate artist's impression (panel #1) depicts the same Earth-like planet as having been abundant with life at the time of the nearby supernova, years before most of the X-ray's impacts are felt (panel #2).



4 of the 31 supernovas in the study. Credit: NASA/CXC/Univ. of Illinois/I.

Brunton et al

Among the four supernovae in the set of images, SN 2010jl has produced the most X-rays. The authors estimate it to have delivered a lethal dose of X-rays for Earth-like planets less than about 100 light-years away.

There is strong evidence—including the detection in different locations around the globe of a radioactive type of iron—that supernovae occurred close to Earth between about 2 million and 8 million years ago. Researchers estimate these supernovae were between about 65 and 500 light-years away from Earth.

Although the Earth and the solar system are currently in a safe space in terms of potential supernova explosions, many other planets in the Milky Way are not. These high-energy events would effectively shrink the areas within the Milky Way galaxy, known as the Galactic Habitable Zone, where conditions would be conducive for life as we know it.

Because the X-ray observations of supernovae are sparse, particularly of the variety that strongly interact with their surroundings, the authors urge follow-up observations of interacting supernovae for months and years after the explosion.

More information: Ian R. Brunton et al, X-Ray-luminous Supernovae: Threats to Terrestrial Biospheres, *The Astrophysical Journal* (2023).
[DOI: 10.3847/1538-4357/acc728](https://doi.org/10.3847/1538-4357/acc728)

Provided by NASA

Citation: Chandra X-ray Observatory identifies new stellar danger to planets (2023, April 20)
retrieved 19 April 2024 from

<https://phys.org/news/2023-04-nasa-chandra-x-ray-observatory-stellar.html>

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