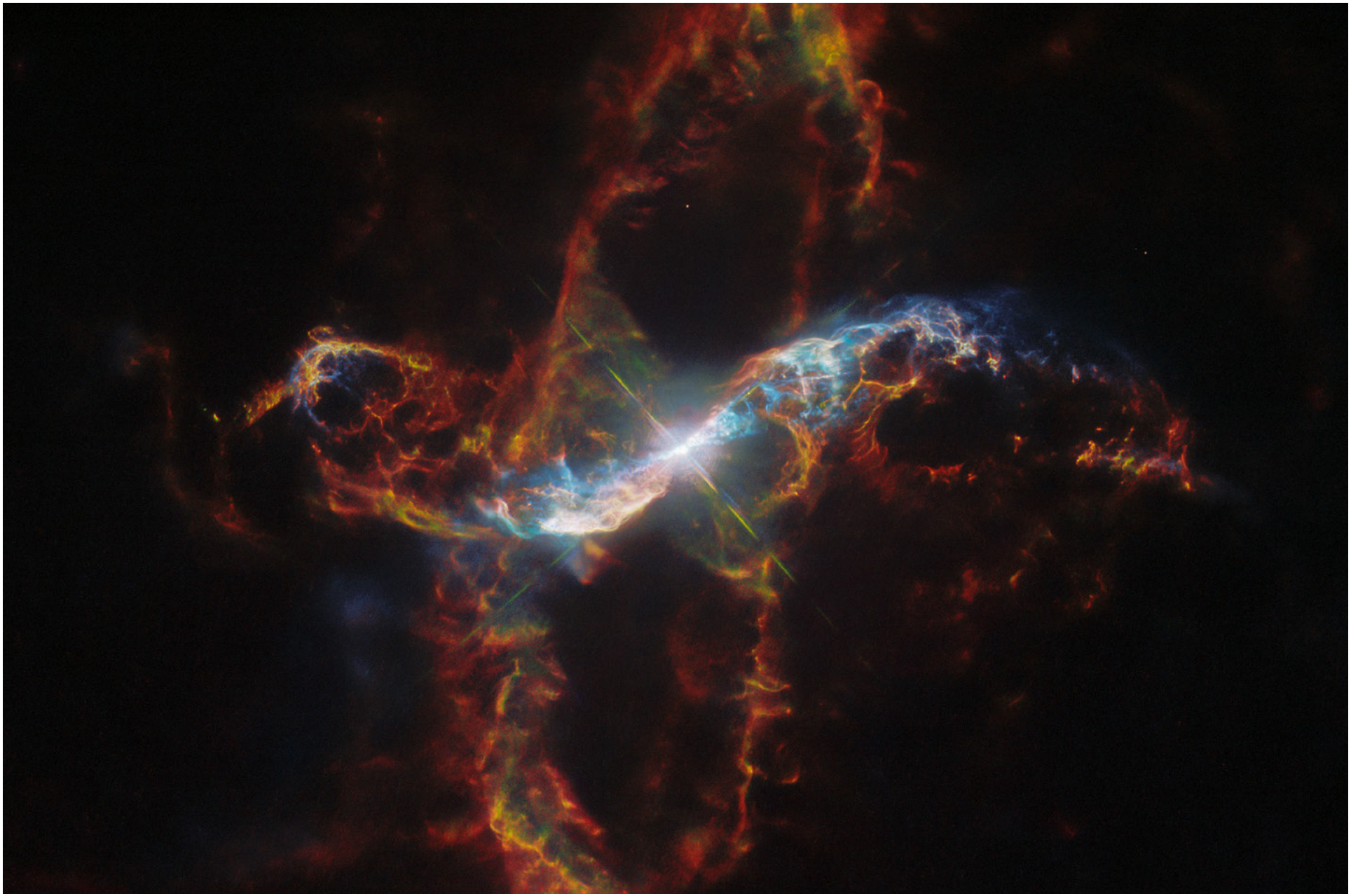


R Aquarii

A Stellar “Volcano”

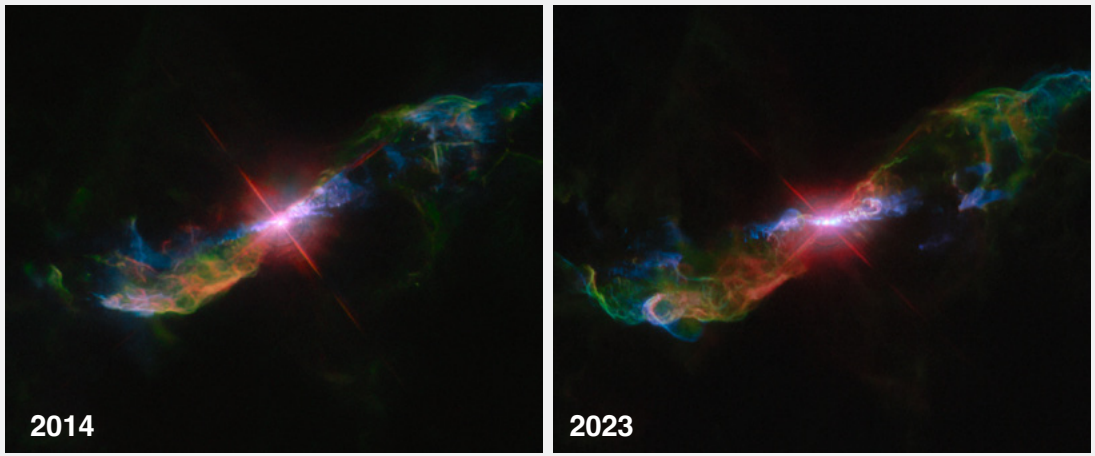
A lively binary star system weaves a vast spiral pattern in the cosmos in this NASA Hubble Space Telescope image. The duo of stars, known as R Aquarii, produces geyser-like outbursts of plasma that shoot into space at over 1 million miles (1.6 million km) per hour – fast enough to travel from Earth to the Moon in 15 minutes. The plasma is twisted by the force of the explosion and directed upwards and outwards by strong magnetic fields before apparently bending back on itself into spiraling loops and trails. The scale of the outburst is immense: material can be traced out to at least 248 billion miles (399 billion km) from the stars, or 24 times the diameter of our solar system.

R Aquarii is made up of an aging red giant more than 400 times larger than our Sun and a small, dense, burned out star called a white dwarf. The pair are about 1.6 billion miles (2.6 billion km) apart. When the white dwarf swings closest to the red giant in its 44-year orbit, its strong gravity pulls hydrogen gas from the red giant. This material builds up on the dwarf star’s surface, where it heats up. When it reaches a critical temperature, a rapid, runaway fusion reaction begins. This sudden increase in energy causes the surface to explode in a tremendous outburst that ejects the white dwarf’s outer layers in what astronomers call a “nova.” Once the volcano-like explosion is over, the cycle begins again.

These types of paired red giant and white dwarf stars that interact with one another are called “symbiotic stars.” Symbiotic stars can be very bright, making them easy to observe. In the case of R Aquarii, the red giant star fluctuates in brightness and can reach 5,000 times our Sun’s brightness during its roughly 390-day cycle.

At only 700 light-years from Earth, R Aquarii provides an excellent opportunity to study the way stellar explosions release chemical elements heavier than hydrogen and helium into space. In this visible-light image, blue indicates oxygen, green hydrogen, and red nitrogen. Heavier elements like carbon, nitrogen, and oxygen are critical building blocks of planets like Earth and its life forms, including our own. They form in the deep interiors of stars where the temperature is high enough to fuse hydrogen and helium – and where they are locked away until an explosion flings them into the universe.

Front Image Credit: NASA, ESA, M. Stute, M. Karovska, D. de Martin & M. Zamani (ESA/Hubble)



These Hubble images of R Aquarii, taken in 2014 and 2023, show the brightness of the central binary fluctuating over time due to strong pulsations in the red giant star, as well as changes in the star’s spiraling structures. Blue, purple and cyan capture UV wavelengths while green and red show visible light. (Fainter details and structures visible in the main image cannot be seen here due to the shorter exposure times used to create these images.)

Image Credit: NASA, ESA, M. Stute, M. Karovska, D. de Martin & M. Zamani (ESA/Hubble)

VOCABULARY

Plasma: A fourth state of matter after solid, liquid, and gas, in which matter has been superheated until its atoms split into charged particles called ions and electrons. It is rare on Earth, but is the most common form of matter in the universe.

Binary star system: Two stars that are gravitationally bound to each other and orbit around their common center of mass.

Nova: A star that suddenly increases in brightness, eventually fading away in a few months or years.

Nuclear fusion: A process in which the nuclei of two atoms merge to form a new nucleus, unleashing a tremendous amount of energy.

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