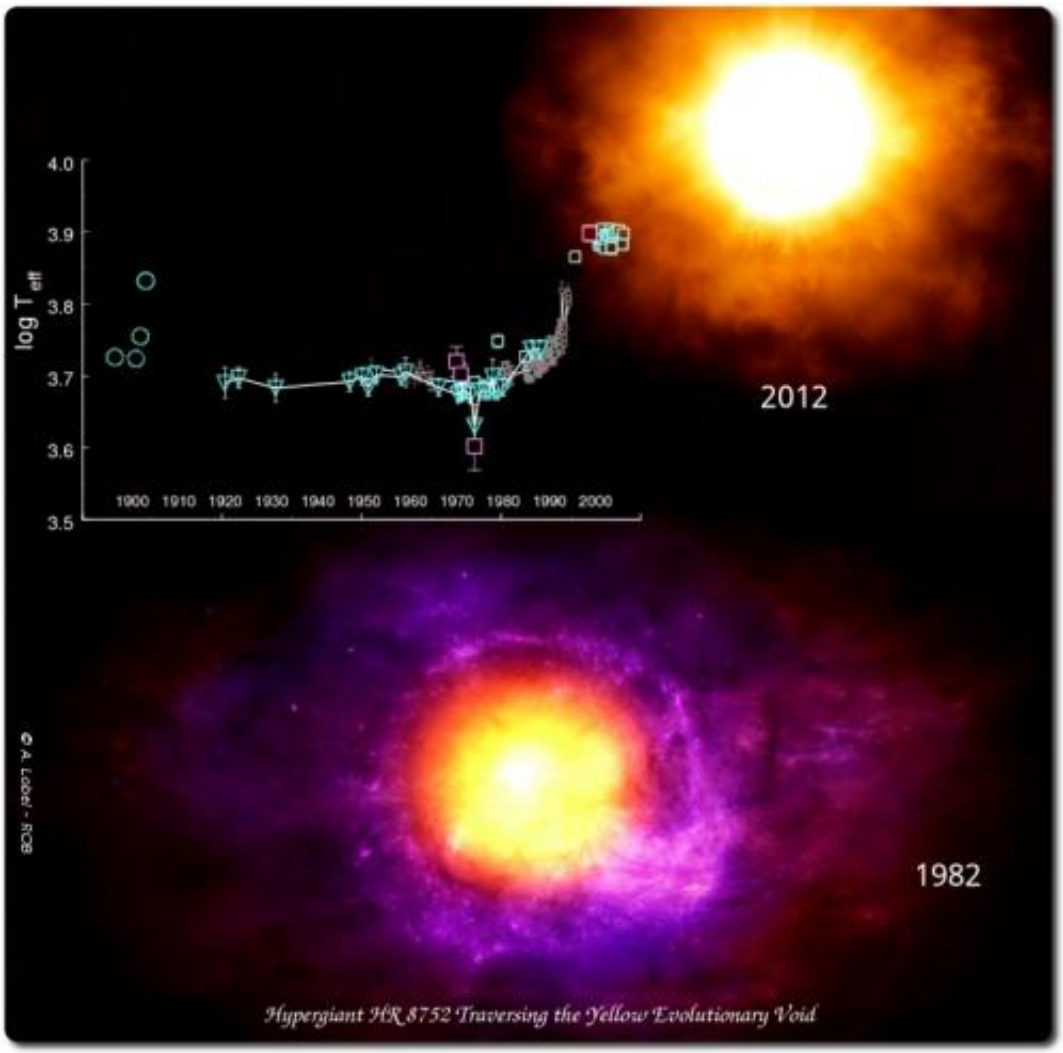
Hypergiant star studied

December 10 2012



Artist's rendition of the hypergiant HR 8752 traversing the 'Yellow Evolutionary Void'. The graph plots the temperature at the surface of the star observed over a century. It rose from 5000 to 8000 degrees between 1985 and 2005, while the radius of the hypergiant decreased from 750 to 400 times the radius of the Sun. Credit: © A. Lobel, Royal Observatory of Belgium

A European research team has published the results of a 30-year study of an extraordinary hypergiant star. They have found that the surface temperature of the super-luminous star HR 8752 increased by about 3000 degrees in less than three decades, while it went through an extremely rare stage called the 'Yellow Evolutionary Void'. The discovery marks an important step closer to unravelling the evolution of the most massive stars.

A team of astronomers from six European countries, including the Royal Observatory of Belgium (ROB), has investigated the hypergiant star HR 8752 for 30 years while it traversed the 'Yellow Evolutionary Void'. The 'Void' is a short stage in the lives of the most massive stars when they become very unstable. The team finds that the surface temperature of HR 8752 rose surprisingly fast from 5000 to 8000 degrees in less than 30 years. The research results were very recently published in the journal Astronomy and Astrophysics. The discovery is an important step forward to resolve the enigma of the hypergiants, the most luminous and massive stars of the Galaxy.

Hypergiants can shine millions of times brighter than the Sun, and they often have a diameter several hundred times greater. HR 8752 is a quarter million times more luminous than the Sun. The powerhouse is therefore visible with normal binoculars at large distance from the Earth in the Northern constellation of Cassiopeia. There are currently only 12 hypergiants known in our Galaxy.

The 'Yellow Evolutionary Void' is a unique stage in the short life of a hypergiant when its temperature and luminosity can quickly change. The team has discovered that the atmospheres are very unstable inside the Void because outwardly directed forces act equal or sometimes even stronger than the force of gravity. Due to the unstable atmosphere, hypergiants lose tremendous weight in this 'forbidden zone', which can sometimes amount to the mass of the Sun in a year. When a hypergiant

enters the 'Evolutionary Void' the star tries to it leave as quickly as possible. That is why almost all hypergiants are found outside the Void.

The team finds that HR 8752 is a very rare hypergiant which has partly traversed the Void. The changes of its atmosphere were closely monitored with regular observations over 30 years.

Alex Lobel, co-author of the study and ROB scientist explains that "HR 8752 was around 1980 identical to the eruptive hypergiant Rho Cas of spectral type F, but then the temperature of HR 8752's atmosphere rapidly increased by 3000 degrees and now shows the spectral properties of a hotter A-type star. We are baffled about the tremendous changes of HR 8752 in that period of time."

Between 1900 and 1980 the atmospheric temperature of HR 8752 stayed almost constant around 5000 degrees, but it rose very rapidly to 8000 degrees between 1985 and 2005. The team calculates that the stellar radius decreased from 750 to 400 times that of the Sun. In 1985 the team embarked on a long-term spectroscopic observing program when it found that the remarkable hypergiant was exactly at the border of the 'Yellow Void' and started to cross over. "HR 8752 had to struggle through the Void which has changed the physical properties of its atmosphere", Lobel adds.

The team further demonstrates that the Void actually consists of two parts in which the atmosphere of the hypergiant is unstable. They result from ionization of large amounts of hydrogen and helium gas in the atmosphere, divided by a small zone around 8000 degrees where it becomes more stable.

The fate of HR 8752 is currently unclear but there are strong hints that these massive hypergiants may perish in a powerful supernova explosion. Or they quickly traverse the Void and transform into a hotter type of

erratic stars known as the "Luminous Blue Variables". In either case that will not pass unnoticed according to Kees de Jager and Hans Nieuwenhuijzen, the astronomers of the Netherlands Institute for Space Research in Utrecht who directed the research of HR 8752 over the past three decades.

The discovery is an important new step for explaining the existence of these extreme stars. A number of other hypergiants with similar spectacular properties is expected to exist in the Milky Way. The search for these remarkable stars with dramatic changes over human timescales has just begun, but has been forever put on track.

More information: Arxiv pre-print: dx.doi.org/10.1051/0004-6361/201117166

Provided by Royal Observatory of Belgium