UNIVERSITÉ DE GENÈVE

PRESS RELEASE

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DELTA CEPHEI'S HIDDEN COMPANION

To measure distances in the Universe, astronomers use Cepheids, a family of variable stars whose luminosity varies with time. Their role as distance calibrators has brought them attention from researchers for more than a century. While it was thought that nearly everything was known about the prototype of Cepheids, named Delta Cephei, a team of researchers at the University of Geneva (UNIGE), the Johns Hopkins University, and the European Space Agency (ESA), have now discovered that this star is not alone, but that it has a hidden companion. A revelation published in *The Astrophysical Journal*.

Delta Cephei, prototype of Cepheids, which has given its name to all similar variable stars, was discovered 230 years ago by the English astronomer, John Goodricke. Since the early 20th century, scientists have been interested in measuring cosmic distances using a relationship between these stars' periods of pulsation and their luminosities (intrinsic brightness), discovered by the American Henrietta Leavitt. Today, researchers from the Astronomical Observatory of UNIGE, the Johns Hopkins University, and the ESA show that Delta Cephei is, in fact, a double star, made up of a Cepheid-type variable star and a companion, which had thus far escaped detection, probably because of its low luminosity. Yet, pairs of stars, referred to as binaries, complicate the calibration of the period-luminosity relationship, and can bias the measurement of distances. This is a surprising discovery, since Delta Cephei is one of the most studied stars, of which we thought we knew almost everything.

A secret companion

As the scientists from Geneva and Baltimore measured Delta Cephei's pulsations with the Hermes spectrograph, installed at the Mercator telescope based on La Palma, one of the Canary Islands, an unexpected signal was detected. Using high-precision Doppler spectroscopy (developed and used for researching exoplanets), the researchers discovered that the speed with which Delta Cephei approaches the Sun is not constant, but changes with time in a characteristic fashion. This change of speed can only be explained by the presence of another star, which orbits around Delta Cephei. In other words, there is a secret companion, whose existence we did not suspect. By combining their own observations with data from the scientific literature, the researchers determined the orbit of the two stars and observed that the mass of the companion is low (around 10 times lower than the mass of Delta Cephei).

«We were shocked: despite all the attention Delta Cephei was given over the years, we were lacking an essential piece of information»,

states Richard Anderson, researcher at UNIGE at the time of the discovery, first author of the article and now researcher at Johns Hopkins University, in the United States.

According to the scientists, the data collected in the framework of ESA's Gaia space mission will enable Delta Cephei's orbit to be precisely measured. The presence of the companion must consequently be taken into account when the Gaia team determines the Delta Cephei's distance.

«Although our study does not challenge the cosmic distance ladder as a whole, improving the precision of every one of its rungs will eventually benefit cosmology», explains Richard Anderson. "This discovery reminds us that something is always to be learned. If even one of the closest Cepheids is keeping such secrets , who knows what we will discover about the ones furthest from us!»

A turbulent past?

Due to its excentric orbit, Delta Cephei is sometimes further and sometimes closer to its companion. This suggests a very dynamic evolution, since the two stars are approaching each other to within twice the Earth-Sun distance (astronomical unit) every 6 years, which is a small distance for a Supergiant star such as Delta Cephei whose radius is 43 times larger than that of the Sun. Delta Cephei's excentric orbit thus points to interactions between the two stars due to tidal forces that occur when they are close to each other. This could help the interpretation of other astronomers' work in the past, who have observed a strange circumstellar environment, for which no definitive explanation has been found yet.

This study is likely to inspire further research aiming to better understand the evolution of Delta Cephei, since binarity is an essential property to consider for interpreting the evolution of a star. Studying the evolution of Cepheids is particularly interesting, since it helps to improve the understanding of the structure and evolution of stars in general. «We are waiting for the results from new measurements taken with the Hermes spectrograph and the observations from Gaia. These will allow us to precisely trace the possibly turbulent past of Delta Cephei", the astronomers anticipate. "It is a fascinating adventure!»

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