

# Unusual Binary Star: White Dwarf With a Cool Companion

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An international researcher team under the direction of Dr. Thorsten Nagel of the Institute for Astronomy and Astrophysics of the University of Tübingen recently discovered an unusual close binary star system. It consists of a burned out white dwarf with rare chemical composition and a low-mass star.

In a collaboration with colleagues of the University of Göttingen the Tübingen astrophysicists observed the double star system with the name SDSSJ212531.92-010745.9 in autumn 2005 and measured the variation of its brightness. For this purpose the modern telescopes of the Universities of Tübingen and Göttingen were used.

The burned out white dwarf is a so-called PG1159 star. These hot stars with surface temperatures between  $75000^{\circ}\text{C}$  and  $200000^{\circ}\text{C}$  are characterised by an extremely unusual chemical composition of their atmosphere. Contrary to most stars this is free from hydrogen but dominated by helium, carbon and oxygen. The formation of PG1159 stars is special because they have ignited their energy source again to become once more a red giant although they already have been at the end of their stellar evolution. After that they finally cool down as a white dwarf. A PG1159 star is in the transitional phase of the born-again red giant to the white dwarf.

Right now there are known only 40 such stars. Since the spectrum of the examined white dwarf does not only show the absorption lines of carbon, typical for PG1159 stars, but additionally emission lines of hydrogen the

researchers soon had the suspicion that the light of the PG1159 star is overlaid by the light of a further object. Therefore the Tübingen and Göttingen astrophysicists accomplished an observation campaign with their own telescopes and determined the brightness of the object. They found a regular brightness variation of approximately 25% with a period of about 7 hours. Further analyses showed that this period only could be the orbital period of a binary system.

The discovered double star system consists of a PG1159 star of about 0.6 solar masses with a surface temperature of about 90000°C and a cool companion of about 0.4 solar masses with 3000°C. Due to the intensive irradiation by the PG1159 star the surface of the companion is heated up to 8200°C, from its atmosphere comes the observed emission line spectrum of hydrogen. The distance of the two stars from each other is so small (about 1.4 million kilometers) that almost the entire system would have room in our Sun. Due to this extremely small distance one speaks of a close binary system, and in the group of the PG1159 stars it is the first at all found.

The discovery of this double star system opens the possibility to determine the masses of the two stars directly. This permits it to verify existing theories of stellar evolution and differentiate between different hypotheses. Therefore the spectrum of the star must be observed over one orbital period. The small brightness of the object requires for this one of the large 8m telescopes of the European Southern Observatory in Chile.

The question about the formation of this double star system still remains to clarify. A few hundred thousand years ago, the PG1159 star was in its red giant phase and had a diameter of some hundred sun radii. Its companion orbited at that time possibly nearly within its atmosphere, thereby strongly was braked and approached up to a distance of about two solar radii, the today's distance. How this took place in the detail,

and how the companion could have survived this, has to be investigated by further studies of the object.

Source: University of Tübingen

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