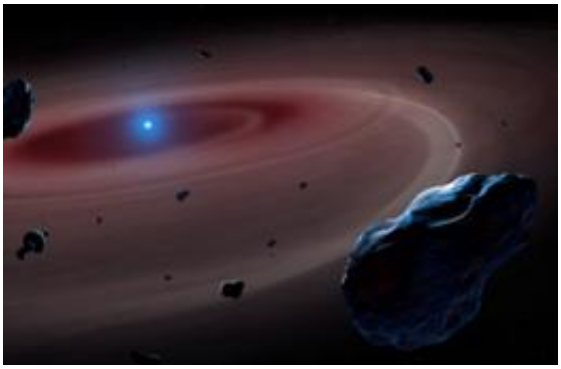
Four white dwarf stars caught in the act of consuming 'earth-like' exoplanets

May 3 2012



Rocky material in orbit around a white dwarf star (centre). Collisions turn larger material into dust, some of which then rains down on to the white dwarf. Credit: © Mark A. Garlick / space-art.co.uk / University of Warwick

University of Warwick astrophysicists have pinpointed four white dwarf stars surrounded by dust from shattered planetary bodies which once bore striking similarities to the composition of the Earth. The scientists publish their results in a paper in the journal *Monthly Notices of the Royal Astronomical Society*.

White dwarfs are the final stage of life of stars like our Sun, the residual cores of material left behind after their available fuel for nuclear reactions has been exhausted. Using the Hubble Space Telescope to carry out the biggest survey to date of the chemical composition of the atmospheres of white dwarf stars, the researchers found that the most

frequently occurring elements in the dust around these four white dwarfs were oxygen, magnesium, iron and silicon – the four elements that make up roughly 93 per cent of the Earth.

However an even more significant observation was that this material also contained an extremely low proportion of carbon, which matched very closely that of the Earth and the other rocky planets orbiting closest to our own Sun.

This is the first time that such low proportions of carbon have been measured in the atmospheres of white dwarf stars polluted by debris. Not only is this clear evidence that these stars once had at least one rocky exoplanet which they have now destroyed, the observations must also pinpoint the last phase of the death of these worlds.

The atmosphere of a white dwarf is made up of hydrogen and/or helium, so any heavy elements that come into their atmosphere are dragged downwards to their core and out of sight within a matter of days by the dwarf's high gravity. Given this, the astronomers must literally be observing the final phase of the death of these worlds as the material rains down on the stars at rates of up to 1 million kilograms every second.

Not only is this clear evidence that these stars once had rocky exoplanetary bodies which have now been destroyed, the observations of one particular white dwarf, PG0843+516, may also tell the story of the destruction of these worlds.

This star stood out from the rest owing to the relative overabundance of the elements iron, nickel and sulphur in the dust found in its atmosphere. Iron and nickel are found in the cores of terrestrial planets, as they sink to the centre owing to the pull of gravity during planetary formation, and so does sulphur thanks to its chemical affinity to iron.

Therefore, researchers believe they are observing White Dwarf PG0843+516 in the very act of swallowing up material from the core of a rocky planet that was large enough to undergo differentiation, similar to the process that separated the core and the mantle of the Earth.

Professor Boris Gänsicke of the Department of Physics at the University of Warwick, who led the study, said the destructive process which caused the discs of dust around these distant white dwarfs is likely to one day play out in our own solar system.

“What we are seeing today in these white dwarfs several hundred light years away could well be a snapshot of the very distant future of the Earth. As stars like our Sun reach the end of their life, they expand to become red giants when the nuclear fuel in their cores is depleted.

‘When this happens in our own solar system, billions of years from now, the Sun will engulf the inner planets Mercury and Venus. It’s unclear whether the Earth will also be swallowed up by the Sun in its red giant phase - but even if it survives, its surface will be roasted.

‘During the transformation of the Sun into a white dwarf, it will lose a large amount of mass, and all the planets will move further out. This may destabilise the orbits and lead to collisions between planetary bodies as happened in the unstable early days of our solar systems.

‘This may even shatter entire terrestrial planets, forming large amounts of asteroids, some of which will have chemical compositions similar to those of the planetary core. In our solar system, Jupiter will survive the late evolution of the Sun unscathed, and scatter asteroids, new or old, towards the white dwarf.

‘It is entirely feasible that in PG0843+516 we see the accretion of such fragments made from the core material of what was once a terrestrial

exoplanet.”

The University of Warwick led team surveyed more than 80 white dwarfs within a few hundred light years of the Sun, using the Cosmic Origin Spectrograph onboard the Hubble Space Telescope.

More information: arxiv.org/abs/1205.0167

Provided by Royal Astronomical Society

Citation: Four white dwarf stars caught in the act of consuming 'earth-like' exoplanets (2012, May 3) retrieved 24 April 2024 from https://phys.org/news/2012-05-white-dwarf-stars-caught-consuming.html

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