

Astrowatch

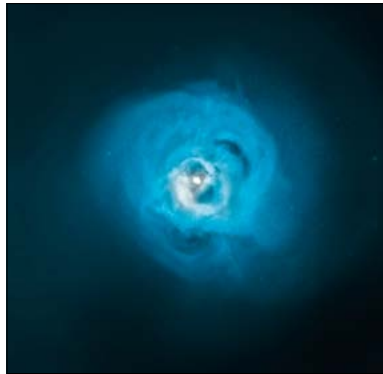
COMPILED BY MARC TÜRLE, ISDC AND OBSERVATORY OF THE UNIVERSITY OF GENEVA, AND UNIVERSITY OF ZÜRICH

Do X-rays reveal a sterile neutrino?

A detailed study of galaxy clusters using NASA's Chandra X-ray Observatory and ESA's XMM-Newton has found a mysterious X-ray signal. One intriguing possibility is that the X-rays are produced by the decay of sterile neutrinos – a candidate particle for dark matter – although there is doubt that this is the correct interpretation.

The mystery surrounds an unidentified X-ray emission line at energy $E = 3.56 \pm 0.03$ keV, found in the Perseus galaxy cluster, during a study of data from both the Chandra and XMM-Newton missions led by Esra Bulbul from the Harvard-Smithsonian Center for Astrophysics. The team also found the line in a combined study of 73 other galaxy clusters observed with XMM-Newton. As these clusters have different redshifts, this finding excludes, a priori, the possibility that the line is an instrumental artifact. The authors of the study admit, however, that the detection is at the limit of the current instrumental capabilities.

The researchers argue that there should be no atomic transitions in thermal plasma at this energy. They therefore suggest that this emission line could be a signature from the decay of a sterile neutrino with a mass of $m_\nu = 2E = 7.1$ keV. Sterile neutrinos are a hypothetical type of neutrino predicted to interact with normal matter via gravity only. They have been put forward as candidates to explain dark matter, at least partially.



A new study of the Perseus galaxy cluster, shown in this image, and others using Chandra and XMM-Newton, has revealed a mysterious X-ray signal in the data, which might be from sterile neutrino decay. (Image credit: Chandra: NASA/CXC/SAO/E.Bulbul et al.; XMM-Newton: ESA.)

The paper on these findings was submitted to *The Astrophysical Journal* in February and posted on the arXiv preprint server, igniting a flurry of activity, with 60 new papers having cited this work in the four months from March to June. Some of these papers explore the sterile neutrino interpretation, while others suggest that other types of candidate dark-matter particles, such as axions, might have been detected.

What makes many researchers doubt the results, is that the intensity of the emission line is significantly different from one cluster to the other. While the detection in the full sample of clusters corresponds to a mixing angle for the decay that is below previously determined upper limits, the line in Perseus is much brighter than expected for this mixing angle (based on the cluster's mass and distance), deviating significantly from other subsamples. The fact that the detected signal is very weak (with an equivalent width in the full sample of about 1 eV only) and located within 50–110 eV of several known faint lines is also suspicious. However, the authors recognize that “the dark matter explanation is a long shot” and that they “have a lot of work to do before they can claim, with any confidence, that they have found sterile neutrinos”.

This study on a possible dark-matter signal follows the report on the excess of gamma-ray emission from the Galactic Centre observed with Fermi, which strengthened the case for a signal from annihilating dark matter (*CERN Courier* April 2014 p13). In this case, it is still early days. Have the researchers stumbled on something really interesting? Future studies and better instrumentation are needed to settle the issue.

● **Further reading**
E Bulbul *et al.* 2014 *ApJ* **789** 13.

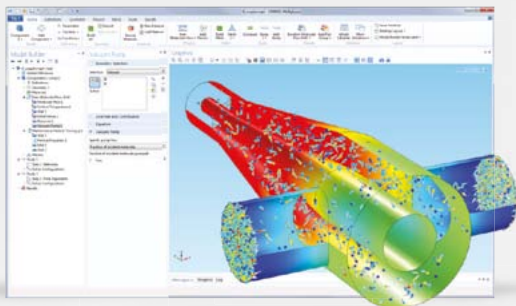
Picture of the month

This colorful image of the Whirlpool Galaxy is a composite of X-ray observations (in purple) from the Chandra X-ray Observatory superimposed on the optical image from the Hubble Space Telescope. With more than 10 days of overall observing time, Chandra revealed about 500 X-ray sources in this beautiful spiral galaxy, also known as Messier 51 (*CERN Courier* July/August 2010 p14). Most of these sources are X-ray binaries consisting of pairs of objects where a compact star, either a neutron star or a black hole, is capturing material from an orbiting companion star. The infalling material is accelerated by the intense gravitational field of the compact star and heated to millions of degrees, producing a luminous X-ray source. The more diffuse, or fuzzy, X-ray emission in this interacting galaxy comes from gas that has been heated to multi-million degrees by supernova explosions of massive stars. (Image credit: X-ray: NASA/CXC/Wesleyan Univ./R Kilgard *et al.*; optical: NASA/STScI.)



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