Scientists provide new data on the nature of dark matter

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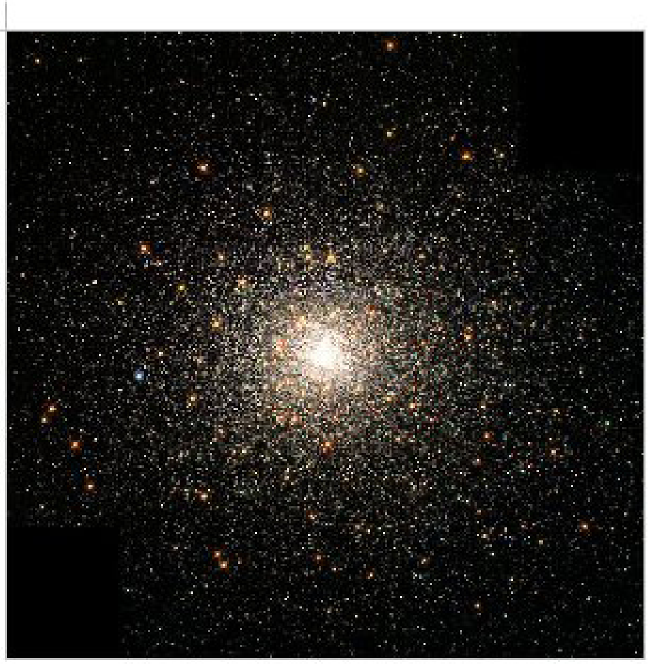

M80 globular cluster. Globular clusters consist of ancient star populations, which contain stars in different phases of evolution (NASA).

Recent research conducted by scientists from the University of Granada sheds light on the nature of dark matter, one of the most important mysteries in physics. As indirect evidence provided by its gravitational effects, dark matter amounts to more than 80% of the universe.

In an article published in the prestigious journal *Physical Review Letters*, Adrián Ayala and her PhD thesis supervisor, Inmaculada Domínguez, both members of the FQM Stelar Evolution and Nucleosynthesis research group, have set limits on the properties of one of the particles considered a dark matter candidate: axions.

Researchers in this project also included Maurizio Giannotti (Barry University, USA), Alessandro Mirizzi (Deutsches Elektronen-Synchrotron, DESY, Germany) and Oscar Straniero (National Astrophysics Institute, INAF-Astronomic Observatory in Teramo, Italy). This project is evidence of the increasing collaboration between particle physicists and astrophysicists, which has originated a relatively new type of science, 'astroparticle physics'

In this project, scientists have used stars as particle physics labs. Thanks to the high temperature inside stars, photons can turn into axions that escape to the exterior, carrying energy with them.

"This loss of energy can have consequences, whether they are observable or not, in some phases of stellar evolution", says Adrián Ayala. "In our research, we have conducted numerical simulations (by computer) of the evolution of a star, since its birth until it exhausts all the hydrogen first and then the helium in its interior, including the processes that produce axions."

Results indicate that the emission of axions can significantly diminish the time for the central combustion of helium, the so called HB (Horizontal Branch) phase—the energy taken by axions is compensated with the energy provided by nuclear combustion, which leads to a much faster consumption of helium.

"Using this influence over the timing that features in this sort of evolution, we can determine the emission of axions, since a high emission rate means a quick HB phase, thus diminishing the possibility of watching stars in this phase", says Immaculada Domínguez.

Maximum axion emission rate

The high quality in the recent observation of globular clusters allows for the contrast between the results of the numerical observations conducted in this project with the actual data. "By comparing the amount of stars observed in HB phase with the amount of stars watched in a different phase not affected by axions (such as the so called RGB, Red Giant Branch, phase) we have made an estimation about the maximum axion emission rate.

The production of axions relies on the constant coupling of axion-photon which characterizes the interaction between axion and photons. "We have obtained a maximum limit for this constant which is more restrictive than those established so far, both theoretically and through experiments", these U. of Granada researchers point out.

The authors of this research point out that the accuracy in the determination of the coupling constant through the method used "critically depends on the accuracy with which the initial helium content within the stars in the globular cluster can be estimated"

More information: "Revisiting the Bound on Axion-Photon Coupling from Globular Clusters" *Phys. Rev. Lett.* 113, 191302 – Nov, 2014 journals.aps.org/prl/abstract/ … ysRevLett.113.191302

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