

# Sterile Neutrino Dark Matter Catalyzed by a Very Light Dark Photon

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Sterile neutrinos are hypothetical particles that have no interactions with standard model particles, apart from mixing with the usual neutrinos. They are widely believed to exist since they could explain neutrino masses. In the past, they were good candidates for the dark matter of the Universe. Recent astronomical X-ray observations have excluded them as dark matter, by looking for their decays into X-ray photons plus light neutrinos. Prof. Cline's team explored a novel way of reopening the possibility of sterile neutrino dark matter, involving another popular hypothetical particle, dark photons with very small masses.

In this scenario, the interactions of dark photons with ordinary neutrinos give the latter an effective mass in the early universe, allowing them to more easily convert into sterile neutrinos through the famous neutrino oscillation

mechanism. This lets the mixing angle, that controls how fast sterile neutrinos decay, to be much smaller than in the standard mechanism. In this way we were able to open a large region in the space of parameters (mixing angle versus sterile neutrino mass) that was previously excluded, shown in the figure (white region). This is important for understanding the true potential for sterile neutrinos to be the dark matter of the universe.

An interesting prediction of the model is that the neutrino-dark matter interactions could have a measurable effect on terrestrial neutrino oscillation experiments. We are investigating this with undergraduate student Katarina Bleau, in a forthcoming publication.

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## Why is this important?

Sterile neutrinos are hypothetical particles that could explain neutrino masses. They were good candidates for dark matter in the Universe until recently, when astronomical observations excluded them as candidates. This study reopens the possibility of sterile neutrino dark matter using dark photons (another hypothetical particle).

Right: The white region shows newly reopened parameter space for sterile neutrino dark matter. The red region is ruled out by X-ray telescope observations. The grey region would have too much or too little dark matter.

