New theory on the origin of dark matter

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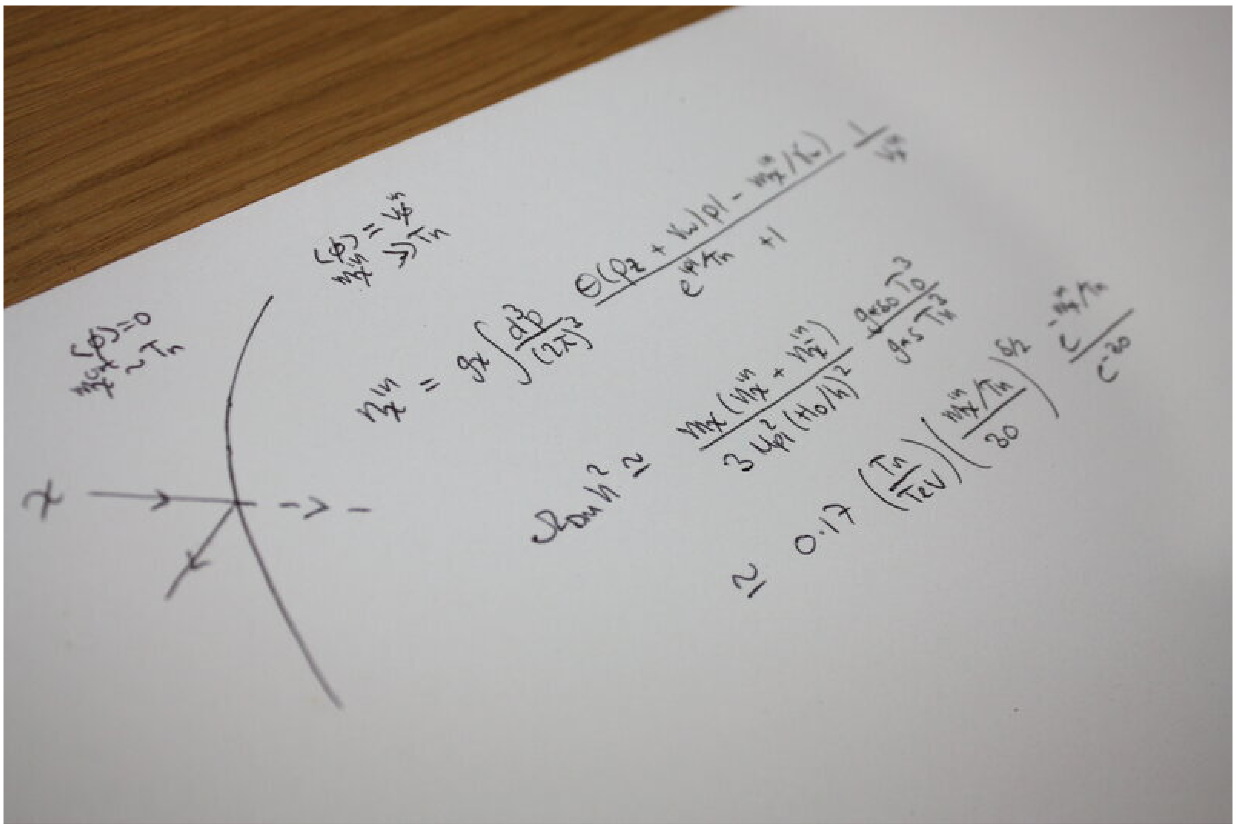

While portions of the work were completed by hand, made possible by a series of simplifying approximations, the results for the study were validated by sophisticated computational calculations. Credit: Michael Baker

A recent study from the University of Melbourne proposes a new theory for the origin of dark matter, helping experimentalists in Australia and abroad in the search for the mysterious new matter.

The work has been published in *Physical Review Letters* and describes how expanding bubbles in the early universe may be the key to understanding dark matter.

"Our proposed mechanism suggests that the dark matter abundance may have been determined in a cosmological phase transition," said Dr. Michael Baker, a postdoctoral research fellow at the University of Melbourne and one of the authors.

"These phase transitions are expected to have taken place in the early universe and can be similar to bubbles of gas forming in boiling water. We show that it is natural to expect dark matter particles to find it very difficult enter these bubbles, which gives a new explanation for the amount of dark matter observed in the universe."

Although many experiments have searched for particle dark matter, none have yet been successful. Most experiments have searched primarily for Weakly Interacting Massive Particles, which has been the favored dark matter candidate for decades. However, these experiments have not yet seen anything, which really motivates theorists to think outside the box.

"We know dark matter is out there, but we don't know much else," said Dr. Baker. "If it's a new particle then there's a good chance that we could actually detect it in a laboratory. We could then pin down its properties, like its mass and interactions, and learn something new and deep about the universe."

The research, which was done in collaboration with Assistant Professor Andrew Long from Rice University, Texas, and Professor Joachim Kopp from CERN and the University of Mainz, points the way for new experimental strategies for searching for dark matter.

"One exciting aspect about the idea is that it works for dark matter particles that are much heavier than most other candidates, such as the famous weakly interacting massive particles, on which most experimental searches in the past were focused," said Professor Kopp. "Our work, therefore, motivates the extension of dark matter searches towards heavier masses."

The findings could be especially important for the future of experimental dark matter searches in Australia.

The Stawell Underground Physics Laboratory, which is currently under construction in regional Victoria, one kilometer beneath the ground in a disused gold mine, will be the first underground particle physics laboratory in the Southern Hemisphere, and will house several dark matter search experiments in the years to come.

New theoretical proposals will help drive design experiments that can test the widest range of dark matter candidates, giving scientists the best chance of uncovering the mystery of dark matter.

More information: Michael J. Baker et al. Filtered Dark Matter at a First Order Phase Transition, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.125.151102

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