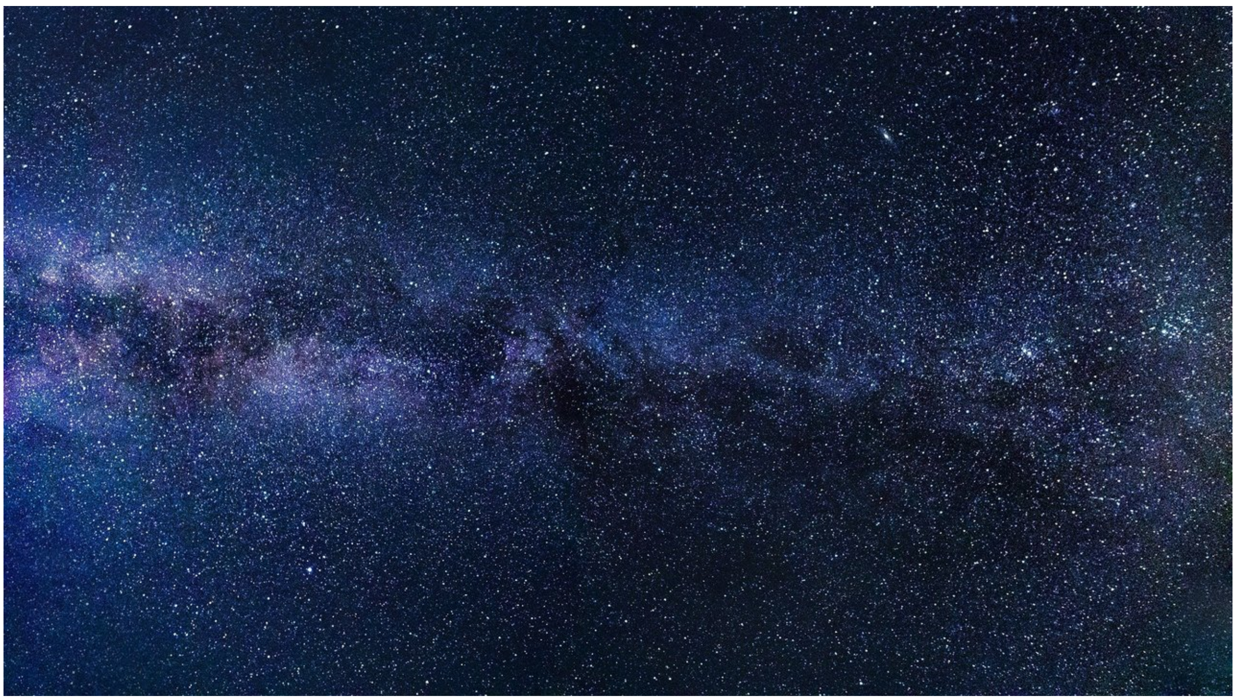
Imagining the possibility of life in a universe without the weak force

February 5 2018, by Bob Yirka



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A team of researchers at the University of Michigan has conducted a thought experiment regarding the nature of a universe that could support life without the weak force. In their paper uploaded to the *ArXiv* preprint server, the researchers suggest life could be possible in such an alternative universe, but it would definitely be different from what we observe in ours.

Physicists have debated the possibility of the existence of alternate universes for some time, though there is no evidence they exist. In this new thought experiment, the team at UM wondered if one or more of the laws of physics that we have discovered in this universe might not exist in others—if they do exist. Because it would be hard to imagine a universe that could exist without gravity and the strong and electromagnetic forces, the team instead focused on the weak force—the one behind such things as neutrons decaying into protons.

The team wondered what a universe without the weak force would look like. To visualize it, they created a simulation of such a universe starting from the Big Bang. In the simulation, matter was still created and condensed into stars, but from there on, things would be different, because in our universe, the weak force is responsible for the creation of the heavier elements. In a universe without the weak force, the existence of anything other than stars would require more free protons and fewer neutrons (because they could not decay). In such a universe, neutrons and protons could link up to make deuterium.

Stars fueled by deuterium instead of hydrogen, the researchers note, would still shine, they would just look different—likely redder and larger. But such stars could also serve as the source of all of the elements in the periodic table prior to iron, and the stellar winds could carry them out into space. If planets happened to form, they further note, they could hold water made from deuterium rather than hydrogen—and it is not impossible to imagine, they suggest, life forms made with deuterium water.

More information: Universes without the Weak Force: Astrophysical Processes with Stable Neutrons, arXiv:1801.06081 [astro-ph.GA] arxiv.org/abs/1801.06081v1

Abstract

We investigate a class of universes in which the weak interaction is not in operation. We consider how astrophysical processes are altered in the absence of weak forces, including Big Bang Nucleosynthesis (BBN), galaxy formation, molecular cloud assembly, star formation, and stellar evolution. Without weak interactions, neutrons no longer decay, and the universe emerges from its early epochs with a mixture of protons, neutrons, deuterium, and helium. The baryon-to-photon ratio must be smaller than the canonical value in our universe to allow free nucleons to survive the BBN epoch without being incorporated into heavier nuclei. At later times, the free neutrons readily combine with protons to make deuterium in sufficiently dense parts of the interstellar medium, and provide a power source before they are incorporated into stars. Almost all of the neutrons are incorporated into deuterium nuclei before stars are formed. As a result, stellar evolution proceeds primarily through strong interactions, with deuterium first burning into helium, and then helium fusing into carbon. Low-mass deuterium-burning stars can be long-lived, and higher mass stars can synthesize the heavier elements necessary for life. Although somewhat different from our own, such universes remain potentially habitable.

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