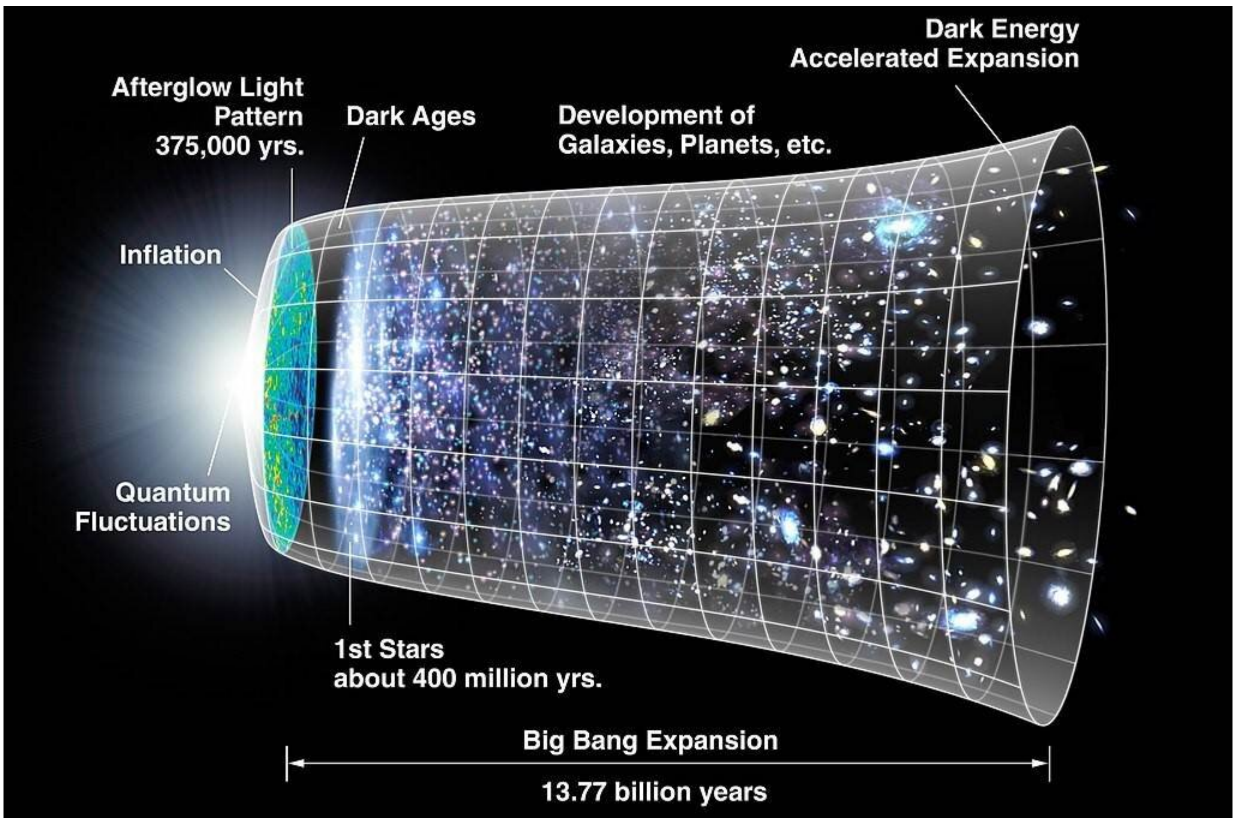
PHYS.ORG

An early dark energy model could solve an expanding cosmological conundrum

October 29 2020, by Robert Lea



A diagram of the expansion of the Universe. This accelerating expansion of the Universe could be explained by an early dark energy model. (NASA/ WMAP Team). Credit: NASA

Much mystery surrounds dark energy and the cosmological constant, the proxies used to explain the accelerating expansion of the Universe. New research suggests that an early model of dark energy presents a competing theory that offers all the benefits of current models without the baggage that comes associated with the cosmological constant.

The Universe is not only expanding but doing so at an accelerating rate. Yet, despite the fact that astronomers, cosmologists and physicists have been aware of this for two decades, the force driving this expansion is still an unknown. A placeholder or proxy for this force, dark energy—a smooth fluid-like component that fills the Universe with a negative pressure—has been inserted into standard cosmological models with the cosmological constant (represented by the symbol lambda) used to define that acceleration.

But still, the true nature of this important element of the Universe evades us. New research published in New Astronomy by Luz Ángela García, physicist and astronomer at Universidad ECCI, Bogotá, Colombia and her co-authors, Leonardo Castañeda and Juan Manuel Tejeiro from Observatorio Astronómico Nacional, Universidad Nacional de Colombia,Colombia, suggests a novel approach to solving this cosmic conundrum.

"Our work is a proposal for a candidate dark energy model, as an alternative to the standard cosmological constant," says García, the corresponding author of the study. "This theoretical model provides a possible explanation for the current accelerated expansion of the Universe." She goes on to explain that the novel aspect of the paper is that it suggests that the cosmological constant may not be needed to describe dark energy, thus avoiding some difficulties that it presents—namely the massive divergence between the constant's theoretical prediction and its experimental value.

"The cosmological constant has serious theoretical issues. Plenty of alternative models have been proposed, but some of them need to be very mathematically complex in order to provide a physical interpretation of the phenomena," says García. "We present a completely different form of dark energy that by construction produces the accelerated expansion in this stage of the Universe, but also evolves with redshift; therefore, it can be linked to other astronomical observations in the past." Thus, the 'early dark energy model' (EDE) – a group of models that see dark energy acting in the early Universe—proposed by García and her co-authors emulates the behavior described by the cosmological constant and could help researchers understand if alternative models to current dark energy theories are possible.

Yet, while suggesting a radical shake-up to the dark energy paradigm, García's work builds greatly upon the findings and methods that preceded it. "We used luminosity distances from supernovae type Ia—named standard candles because their regularity in terms of luminosity means they can be used by astronomers to make distance measurements—in the same way that the Nobel laureates from 2011 used them to discover the accelerated expansion of the Universe," says the astronomer. "In addition, we impose constraints from the cosmic microwave background and measurements of the Hubble parameter from baryon acoustic oscillation(fluctuations in the density of everyday baryonic matter, that is, matter made up of protons and neutrons)."

The time is right for a critical assessment of dark energy and the cosmological constant. while the mystery surrounding the accelerating expansion of the Universe persists, modern cosmology has improved to such an extent that finding its solution looks more plausible than ever. "It is a very interesting time for cosmology, with many ongoing and future surveys that are aiming to discover dark energy and its nature. Projects like DES (Dark Energy Survey), DESI (Dark Energy Spectroscopic Instrument), eBOSS (extended Baryon Oscillation Spectroscopic Survey), and Euclid, among many others, are imposing tight constraints on plausible candidates for dark energy," says García. "In the near future, we will have a spectacular 3-D map with the distribution of the galaxies in the Universe, and with it, we will unveil the ultimate features of dark energy."

García adds that she and her co-authors find that their theoretical model is a compelling description of dark energy and its effects, comparing well with the standard cosmological constant while not incurring the fundamental issues still open with the latter. "The Universe is full of mysteries and dark and unexplained matter-energy components. I feel very honored and excited that I can think about these fundamental aspects of the Universe for a living," concludes García. "I was inspired to pursue a career in astronomy since I was little, and that is not easy for a woman and especially in a developing country, but I am convinced science will pay off and the Universe will continue surprising us."

More information: Luz Ángela García et al. A novel early dark energy model, *New Astronomy* (2020). DOI: 10.1016/j.newast.2020.101503

Provided by SciencePOD