Could the Higgs mass determine the end of the universe?

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Annihilation of the universe is guaranteed to burst your bubble. Lu Lacerda

You may have heard in the recent media that the world was going to end. Uh, again. Worse still, the devastation wasn't limited to Earth; the whole universe might end. Bad news, right? And you thought 2012 was the year to mark on your calendar.

The science behind the latest prediction isn't particularly new – it was even the plot of a sci-fi novel as long as a decade ago. What *is* fairly new is the connection to the recently-measured Higgs boson mass at the LHC , but we'll come back to that. For now, we need to talk about metastable (temporarily stable) states.

Let's imagine you're at a party with a large group of friends. It's getting late and there wasn't enough food, so it's time to either order in a pizza or head out to a restaurant. Right now, you and your friends are in a metastable energy state – you're not sure what option to go for, and it would only take a slight nudge in one direction to convince everyone to go a particular way ("the garlic bread at that one cafe is worth the trip!").

The food options are all lower energy states – you'll all sit down and eat one way or another, and things naturally tend towards lower energy states. Once one person goes, or makes the call to the pizza place, the party's over: everyone's going to get some food.

So how does this tie in with the end of the universe (aside from the garlic bread not living up to its praise)? According to quantum theory, it's possible that the lowest energy state of our universe – when there's nothing but space and time – isn't the lowest possible state of all.

In this picture, there exists an even lower energy state, one that our universe could transition to. That might not sound too ominous until you learn that in the lower energy state, all the protons in all the matter in the universe decay, with the unfortunate side effect that we cease to exist.

Worse still, the transition could happen at any time, anywhere in the universe, and expand at light speed from a tiny bubble until it annihilates the entire universe as we know it, which would be, you know, bad.

Recently, this idea was re-examined within the context of the Standard Model of Particle Physics – the modern quantum theory of subatomic particles and their interactions. Precise calculations dictate that the stability of our universe is intimately connected to the mass of the Higgs boson (and the top quark), a parameter which – thanks to the efforts of Large Hadron Collider – is now known to be about 125 GeV.

It is the conclusions of this re-examination that have raised a furore in the media: the Standard Model predicts that for our universe to be stable, the Higgs mass needs to be larger than 129.4 ± 5.6 GeV, so it only just fits within the uncertainties.

Ergo the end is nigh, at least in the units of time that cosmologists work with. But don't stock your matter-collapsing-proof shelter just yet – those time scales are billions to trillions of years.

There are of course, as always, objections to unfavourable conclusions. The main issue is that there are very good reasons to believe the Standard Model provides an incomplete description of our universe.

For starters, it doesn't include gravity, the experimentally observed neutrino masses, or explain the nature of the ever elusive dark matter.

These glaring omissions have driven theoretical physicists to construct myriad extensions to the Standard Model that introduce new states of matter. What's important is that these additional states can easily change the conclusions about the stability of our universe.

In models where there are two Higgs fields, the interactions between these fields can lead to a different set of energy states from that which the Standard Model predicts.

If the universe does indeed contain multiple Higgs fields, there are indications from data collected at the Large Hadron Collider that it's very unlikely we live in a metastable regime, and that we're safe.

You might ask what use a theory is that describes the end of the universe, particularly one that predicts it so far in the future that our sun will long since have fizzled out (and in the process obliterated all life on Earth). The best answer we can give is that this is fundamental research into the nature of our universe, and possibly of other universes.

It's impossible to tell what we'll learn about from looking into this, but it's important that we do. Had we not looked into General Relativity, we wouldn't have the GPS systems our world relies on so delicately.

Is there much point worrying about something we won't even see coming? Perhaps not, but it's certainly remarkable that a cosmological question of this nature can be probed by a laboratory experiment on Earth. The notion that we could learn something about another possible universe, otherwise intangible by definition, is truly amazing.

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