Los Angeles Times

August 17, 2016

DID PHYSICISTS DISCOVER A PREVIOUSLY UNKNOWN FIFTH FORCE OF NATURE?

By Amina Khan

A tiny, unseen force could potentially alter our basic understanding of the universe -- if it really exists. Theoretical physicists at UC Irvine say they've found evidence for a fifth fundamental force of nature, carried by a particle that until now has gone totally unnoticed.

If supported by the independent work of other teams, the boson described in a paper in Physical Review Letters (and expanded upon in a study posted to arXiv) could move scientists to rewrite the standard model of particle physics.

"If this is true, it would be a really big guide as to what the future would hold as far as the ultimate theory of particle physics," said study coauthor Timothy Tait, a UC Irvine theoretical particle physicist.

There are four known forces that govern the interactions of matter: gravitation, electromagnetism and the strong and weak nuclear forces. A force like gravitation sculpts the universe at the enormous scale of galaxy clusters; the strong and weak nuclear forces prevail in the tiny interactions between subatomic particles. Together, those four forces govern the interactions between all the matter in the universe.
But researchers at UC Irvine say they've found evidence for a fifth force – once carried by a particle that they're calling "boson X." This force is a sort of analogue to electromagnetism — except where electromagnetism acts on electrons and protons (and ignores neutrons), this fifth force works between electrons and neutrons (and ignores protons).

The scientists first got the idea from a paper published by Hungarian researchers who were looking for a "dark photon" (a force carrier for dark matter) and found a strange signal in their data. Could it be a new particle? After analyzing the Hungarians' work and several other teams' experiments, the UC Irvine researchers ruled out the "dark photon" explanation but did conclude that the signal could have been caused by a heretofore undescribed boson.

The scientists described the particle in their first paper now appearing in Physical Review Letters. In the follow-up, they fleshed out the idea, showing how (with a small entourage of additional new particles) it could be stitched into the standard model.

"If it's real, it needs to be studied in gory detail," said David McKeen, a theoretical particle physicist at the University of Washington who was not involved in the study.

The standard model, often represented as an unassuming 17-square chart, describes the fundamental subatomic particles that are the building blocks of all matter. It describes humdrum particles like electrons and protons, and more exotic fare such as muon neutrinos, gluons and quarks, all in terms of three identifying characteristics: mass, charge and spin.

If scientists were to draft a metaphorical map of the known universe, the standard model would be the color-coded legend in the corner -- the key that allows them to make sense of the physical world, from the smallest to the largest of scales.

And scientists have been doing their best to break it.

That's because, as neat as it looks, the standard model fails to describe everything in the universe; in fact, it can barely describe a tiny fraction. For example, it can't explain the existence of dark matter, which doesn't interact at all with normal matter but can sculpt the cosmic web of galaxy clusters with its massive gravitational influence. Nor does it explain why dark energy is causing the universe to expand at an increasingly faster rate.

Dark matter makes up nearly 27% of the universe's mass-energy density; dark energy makes up more than 68%. Normal matter— which can be described fairly accurately by the standard model — is less than 5% of that total.

Tait said that their discovery might be a doorway to eventually creating a model that more accurately describes the universe. It could also help demystify mysterious phenomena such as dark matter.

For example, while dark matter responds to gravity over large scales (just as normal matter does), scientists don't know the extent to which it might interact with itself over smaller scales. This new force-carrying boson could provide the answer.

"This could actually be the dark force," Tait said.

But McKeen was more cautious, adding that much more work needs to be done by other groups looking for this particle before any major conclusions can be drawn about whether this force exists, and what role it has in explaining such mysterious phenomena as dark matter.

"It's not obvious that it helps us with any of these other outstanding problems," he said. "It could have a connection, but it's not obvious to me. But I think it needs to be studied — and then people will understand whether there is or not."