“LIGO Scientists Detect Another Cosmic Collision” Transcript

Excerpt from June 2, 2017 episode of Science Friday.

IRA FLATOW: You may remember last February, scientists revealed the chirp heard around the world. That is the sound of the first gravitational wave detected by the LIGO detector in 2015. Scientists are starting to amass a bit of a collection of chirps. The second gravitational wave was detected last June, and this week they announced a third wave. So what are these chirps telling us?

My next guest is here to help decipher the sound in the data. Priyamvada Natarajan is a theoretical physicist who studies black holes. And she is a professor in the Department of Physics and Astronomy at Yale University. She's not a part of the LIGO team, but we're always happy to have Priya back with us. Welcome back to Science Friday.

PRIYAMVADA NATARAJAN: Happy to be back Ira.

FLATOW: So tell us what is so-- OK, so it's the third time. Is the third time a charm in this case? What is so exciting about having it the third time?

NATARAJAN: Well, first of all, it's a another combination of black holes doing the tango and hooking up. So this one was an event detected on the 4th of January this year. And you had two black holes that were about 31 solar masses, and about 19 times the mass of the sun, kind of in this death spiral, and hooking up, and then merging and producing these gravitational waves.

So the first thing is that, of course, it ratifies the earlier detection. And truth be told, this is not the most massive pair. The first one that was detected was the most massive pair. If you remember, that was like 36 and 29 times the mass of the sun. So the issue here is that we never expected this mass range of black holes to be all that common. They're sort of bulkier than you would expect from the end states of stars.

So that's what is kind of special, that we found a second one with roughly the same mass range as the first detection. And we never believed that these were going to be the common kinds of merging events.

So one exciting thing about this particular event is that it occurred farther away, three billion light years away. The other events occurred a billion light years away. We have a been pushed to a new sort of distance, which allows us to do a new fundamental test of general relativity.

So when you have light, optical light, and you put it through a prism, it disperses and it gives you rainbows. So gravitational waves are not like light. So according to Einstein's theory of general relativity, they should not disperse. And so because this is farther away, we can put some tighter constraints on whether there is dispersion.

There's actually no dispersion detected. So we are still very consistent with Einstein's idea of general relativity. So this event ratifies that.

So the other fun thing about this event is that from the in-spiral, from the template in-spiral, and the data match, you can actually figure out the spin alignment or misalignment. So black holes can spin, and they'll have a spin vector. And the plane that contains the orbit of the two that are tangoing, the two black holes that are tangoing, also has a spin vector.

And the question is are they all aligned? If they're all aligned, there's a lot of angular momentum that has to be lost before these chaps can actually hook up. And so the event would last longer. And so you would see sort of these signatures. So what they found with this event is that actually it was quite short. And it suggested that the spins were actually misaligned.

This is cool because then it offers a clue to how these black holes might have ended up as a binary pair. So you know, there are a bunch of different scenarios. They could start out as binary stars, and then one of them becomes a black hole, and then they could hook up when the second one becomes a black hole. Or they could hook up after becoming black holes. And the thing is, if they hook up stars first, then because the binary star orbits are large, there's enough time for their spins to line up. They would be lined up, aligned. Whereas if they hook up after becoming black holes, their spins could be random, because this is what's called sort of a dynamical formation.

FLATOW: You know why are scientists so interested in black holes? What will they tell us that we don't know, or what could they explain?

NATARAJAN: Well, first of all, they're the most enigmatic objects in the universe. I mean, they're crazy cool objects. Given what they do to light, what they do to matter around them, and so on.

And then, we also know that the end states of massive stars would give you this kind of dense compact state. So we know that they correspond in a very real way to physics. So stars would burn up all their fuel, and if they're about 10 to 15 times the mass of sun, they would end up as a black hole, and then we see the supermassive black holes everywhere.

So the question is what's the link, how do these black holes grow? They seem to be a very important participant in the universe.

The only disappointing thing at the moment is because the LIGO arms in India and Italy have not switched on, the we can't quite find electromagnetic counterparts to this merger and gravitational waves. Looking for other signatures that would signal the environment. Because the outer box is still too big, the swath of sky is just too big. So we just have to wait for more events.

FLATOW: Go over there and kick it on. Go ahead Priya, just turn on those machines. All right, thank you. It's always a pleasure to have you on. Please come back and talk with us soon. OK?

NATARAJAN: Thank you so much for inviting me.

FLATOW: You're welcome. Dr. Priya Natarajan, theoretical astrophysicist and professor in the Departments of Physics and Astronomy at good old Yale University in New Haven.