

# Detection of mini black holes at the LHC could indicate parallel universes in extra dimensions

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Credit: CERN

(Phys.org)—The possibility that other universes exist beyond our own universe is tantalizing, but seems nearly impossible to test. Now a group of physicists has suggested that the Large Hadron Collider (LHC), the largest particle collider in the world, may be able to uncover the existence of parallel universes, should they exist.

In a new paper published in *Physics Letters B*, Ahmed Farag Ali, Mir Faizal, and Mohammed M. Khalil explain that the key to finding [parallel universes](#) may come from detecting miniature black holes at a certain energy level. The detection of the mini black holes would indicate the existence of extra dimensions, which would support string theory and related models that predict the existence of extra dimensions as well as parallel universes.

"Normally, when people think of the multiverse, they think of the many-worlds interpretation of quantum mechanics, where every possibility is actualized," Faizal told *Phys.org*. "This cannot be tested and so it is philosophy and not science. This is not what we mean by parallel universes. What we mean is real universes in extra dimensions. As [gravity](#) can flow out of our universe into the extra dimensions, such a model can be tested by the detection of mini black holes at the LHC. We have calculated the energy at which we expect to detect these mini black holes in gravity's rainbow [a new theory]. If we do detect mini black holes at this energy, then we will know that both gravity's rainbow and extra dimensions are correct."

## **The search continues**

In some ways, this idea is not new. The LHC has already been trying to detect mini black holes, but has come up empty-handed. This is what would be expected if there are only four dimensions, since the energy required to produce black holes in four dimensions would be much larger ( $10^{19}$  GeV) than the energy that can be achieved at the LHC (14 TeV).

However, if extra dimensions do exist, it is thought that they would lower the energy required to produce black holes to levels that the LHC can achieve. As Faizal explained, this happens because the gravity in our universe may somehow flow into the extra dimensions. As the

LHC has so far not detected mini black holes, it seems that extra dimensions do not exist, at least not at the energy scale that was tested. By extension, the results do not support string theory or parallel universes, either.

In their paper, Ali, Faizal, and Khalil offer a different interpretation for why mini black holes have not been detected at the LHC. They suggest that the current model of gravity that was used to predict the required energy level for black hole production is not quite accurate because it does not account for quantum effects.

According to Einstein's general theory of relativity, gravity can be thought of as the curvature of space and time. However, here the scientists point out that this geometry of space and time responsible for gravity gets deformed at the Planck scale. They have used the new theory of gravity's rainbow to account for this modification of the geometry of space and time near the Planck scale, where the mini black holes are predicted to exist.

Using gravity's rainbow, the scientists found that a little bit more energy is required to produce mini black holes at the LHC than previously thought. So far, the LHC has searched for mini black holes at energy levels below 5.3 TeV. According to gravity's rainbow, this energy is too low. Instead, the model predicts that black holes may form at [energy levels](#) of at least 9.5 TeV in six dimensions and 11.9 TeV in 10 dimensions. Since the LHC is designed to reach 14 TeV in future runs, these predicted energy requirements for black hole production should be accessible.

## **Many interpretations**

If mini black holes are detected at the LHC, then it would arguably support several ideas: parallel universes, extra dimensions, [string theory](#),

and gravity's rainbow—with these last two having implications for a theory of quantum gravity. Most obviously, a positive result would support the existence of mini black holes themselves.

"If mini black holes are detected at the LHC at the predicted energies, not only will it prove the existence of extra dimensions and by extension parallel universes, but it will also solve the famous information paradox in black holes," Ali said. [Solving the paradox](#) is possible because, in the gravity's rainbow model, mini black holes have a minimum radius below which they cannot shrink.

However, if black holes are not detected, the scientists will need to reexamine their understanding of these ideas.

"If [black holes](#) are not detected at the predicted [energy](#) levels, this would mean one of three possibilities," Khalil explained. "One, [extra dimensions](#) do not exist. Two, they exist, but they are smaller than expected. Or three, the parameters of gravity's rainbow need to be modified."

In the world of theoretical physics, there is never just one interpretation, and the same goes for this issue. Remo Garattini, Professor of Physics at the University of Bergamo, has used gravity's rainbow in his work on regulating ultraviolet divergences, which have plagued models of [quantum gravity](#). Although he is sympathetic to many of the ideas in gravity's rainbow, he points out that the current paper relies on only one proposal, which uses an equation that does not eliminate divergences.

"I think that the paper is interesting, but we have to be careful to extrapolate *global* results using only one proposal for the rainbow's functions," Garattini said.

Along these lines, Joao Magueijo, Professor of Physics at Imperial

College London, cautions that the details of the theory that will either make it or break it. And at this early stage, it's difficult to tell what these details should be.

"The work is interesting, but like many other applications of rainbow gravity, it does depend crucially on the chosen free functions of the theory," Magueijo said. "Still, I think this work could be a valuable step in constraining those free functions."

**More information:** Ahmed Farag Ali, Mir Faizal, Mohammed M. Khalil. "Absence of black holes at LHC due to gravity's rainbow." *Physics Letters B*. DOI: [10.1016/j.physletb.2015.02.065](https://doi.org/10.1016/j.physletb.2015.02.065)

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