

## Nature of Science & Math: Analyzing the Presence in Everyday Communication

Article: *Third Gravitational Wave Detection, From Black-Hole Merger 3 Billion Light Years Away* by Dennis Overbye

Analysis by Deanna Fiorese

### Nature of Science Tenets

#### Scientific Investigations Use a Variety of Methods

**Science investigations use a variety of methods and tools to make measurements and observations and Science investigations are guided by a setoff values to ensure accuracy of measurements, observations, and objectivity of findings** are widely used tenets in this article. The LIGO (Laser Interferometer Gravitational-Wave Observatory) was created to measure the strength and changes of gravitational waves. Without the invention of the LIGO, astronomers would not have been able to detect this black-hole merger which was actually predicted by Einstein's equations! "Because of the merger's great distance, the LIGO scientists were able to verify that different frequencies of gravity waves all travel at the same speed, presumably the speed of light." (Overby, 2017)

#### Scientific Knowledge is Based on Empirical Evidence

The strand **Science knowledge is based upon logical and conceptual connections between evidence and explanations** is present throughout this article. Astronomers felt gravitational waves from the collision of two large black holes. Three billion light-years from Earth, this merge left a deep, dark pit weighing as much as 49 suns. This is the third black hole merger detected since they started monitoring them with a new device called LIGO (Laser Interferometer Gravitational-Wave Observatory). (Overbye, 2017) The author calls this invisible cataclysm. Fortunately, what telescopes cannot see, the LIGO can feel by looking for changes in gravitational waves.

"Astronomers now agree that the sky is dotted with the dense dark remnants of stars that have burned up all their fuel and collapsed, often in gigantic supernova explosions. Until now, they were detectable only indirectly by the glow of X-rays or other radiation from doomed matter heated to stupendous degrees as it swirls around a cosmic drain." (Overye, 2017)

#### Science Models, Laws, Mechanisms. And Theories Explain Natural Phenomena

There are several NOS strands of this tenet represented in this article. **Theories are explanations for observable phenomena** is seen through the fascinating phenomena of black holes as well as Einstein's equations predicting there would be a black hole merger.

**Science theories are based on a body of evidence developed over time** is observed by the fact that we have been attracted to this phenomenon for years. Only recently, can we measure what is happening in space 3 billion light-years away using the LIGO!

**A hypothesis is used by scientists as an idea that may contribute important new knowledge for the evaluation of a scientific theory** is a strand clearly observed in this article by the author asking questions such as: "Where did such massive black holes come from? How were such large black-hole binaries created? How did they form? One possibility is that they were born that way, from a pair of massive stars orbiting each other that evolved, died, blew up

and then collapsed again into black holes – all without either star getting kicked out of the system during on of those episodes of stellar violence.” (Overbye 2017)

## Mathematics Tenets

### Make Sense of problems and persevere in solving them.

Astronomers felt gravitational waves from the collision of two large black holes. Three billion light-years from Earth, this merge left a deep, dark pit weighing as much as 49 suns. Before the use of the LIGO, astronomers thought these holes were remnants of dead stars. The LIGO allowed them to delve deeper into their investigation by detecting the gravitational waves that are 3 billion light-years away. “Colliding black holes, being more massive, would be even easier to detect, but LIGO’s founders and funders at the National Science Foundation mostly did not know if there were any around to detect. Now they know.” (Overbye, 2017) These discoveries led to more questions such as “Where did the black holes come from? How did they form?” Overbye suggests that now they can answer some of these questions.

### Construct viable arguments and critique the reasoning of others.

LIGO “validated Einstein’s longstanding prediction that space-time can shake like a bowlful of jelly when massive object swing their weight around, and it has put astronomers on intimate terms with the most extreme objects in his cosmic zoo and the ones so far doing the shaking: massive black holes.” (Overbye, 2017) As stated in the MP3 math standard, mathematically proficient students make inferences and build a logical progression of statements to explore the truth of their conjectures. The LIGO proved Einstein’s theory that “different frequencies of gravity waves all travel at the same speed, presumably the speed of light.” (Overbye, 2017) Overbye also discusses Einstein’s theory that matter could disappear from the universe. Astronomers can now take that theory a step farther and detect the gravitational waves as they travel at the speed of light.

### Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated. “The current version of the observatory, known as the advanced LIGO, was still preparing for its first official observing run, in September 2015, when it recorded the collision of a pair of black holes 36 and 29 times as massive as the sun. A second collision, on December 26, 2015, was also confirmed to be massive black holes. A third event in October of that year was probably a black hole merger, the collaboration said.” (Overbye, 2017). The author also suggested that the two black holes merged by chance due to overcrowding in the universe. The LIGO research is leading astronomers to believe that massive, brightening stars are collapsing into a black hole.

## References

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