



THE INSTITUTE FOR ADVANCED PHYSICS

The Institute News

- **Historic Discovery Announced: Gravity Waves!**
- **Rizzi & Pearle: uncovering one of the Seven Wonders of the World**
- **IAP Mars Calendar free download**
- **Randy Nichols, Associate Member, Level II**
- **EWTN Live: *Physics for First Communion* DVD series**

Historic Discovery Announced: Gravity Waves!

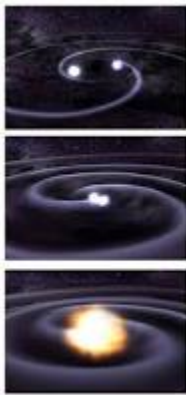
Detected: September 14, 2015, Announced: February 11, 2016 by Anthony Rizzi, PhD

Dr. Rizzi, our director, was an important member of the team that found gravity waves this year. The following article consists of excerpts from IAP's:

Physics & Culture magazine

<http://www.iapweb.org/iapmagazine.htm>

gives you more information on this discovery of the century.



Gravity waves have been detected for the first time! Einstein's theory of general relativity predicted these waves. This is the first time the direct action of gravity waves on earth instruments has been measured. But, what are gravity waves? Why is it important? We will tackle these two key questions and in the process learn about

how they are detected.

Why is this important?

The physical world reveals the glory of God! Every new discovery of science tells us something new about the world around us and through that something new about God. Indeed, the three greatest scientists of the modern era, Newton, Maxwell, and Einstein, all said that their goal was to better see the beauty and intelligibility of God. As we know, we must have the eyes to see and the ears to hear this beauty, but we also must have someone explain

it to us. We cannot hear and see what is not put in front of us.

Everything we know is known through our understanding of the physical world. It is only through the physical world that we know that God exists. Indeed, everything we know comes through what we get through our senses (see *Kid's Introduction to Physics and Beyond* by Anthony Rizzi). In case you doubt, note you are only learning about this article by using your sense of sight to look at this page! So, what then did we learn about the physical world by this historic discovery?



LIGO, Livingston, Louisiana

What was found?

We found something new about that common everyday force, gravity, that gives

impetus to bodies to fall to the ground and holds you and I to the earth even against our strongest efforts to jump away from it. We found that it can transmit in a way similar to light.

New physics

We have verified another element of Einstein's general theory of relativity with this detection. It is a complicated theory, but beautiful when understood. Beauty springs from the whole; beauty is the goodness of the truth. The beauty of a woman's face or mountain scene cannot be summarized by pointing to "that part of the nose" or "this tree there." One must see the whole. Now, all the above (see full article) explanation of the stretching and smashing can be described in terms of stretching of "space," which provides a natural way of working with Einstein's equations of general relativity. Here are the equations:

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}.$$

This is actually a very complicated system of equations for 10 variables that are a function of time and space. These equations need to be unpacked, which is what I have done for you, but only in one realm of the area of gravity waves. It gives you a glimpse of its wonder.

Gravity waves are predicted by these equations, but you cannot easily tell that there are such things as gravity waves: even if you write out all the complicated equations. In fact, no one took gravity waves seriously until the 1960's, which was 45 years after Einstein's 1915 discovery of these equations. Even people that found the right equations for gravity waves thought they were just artifacts of Einstein's equations, not real!

My work on angular momentum (roughly: understanding how things rotate) in Einstein's theory relates to this issue of gravity waves; it is only by understanding how energy moves around in space that one can understand how spinning works in general relativity. Angular momentum is a key aspect of physical reality, so

it is important in understanding all aspects of general relativity including gravity waves.

Did we expect to find gravity waves? Yes, but like with the recently discovered Higgs boson, we did not know they were there till we detected them. We had indirect evidence. But direct evidence is better. That is, evidence in which one's own instruments are being influenced by gravity waves is better than previous evidence. Previous evidence was from watching binary stars fall inward and deducing that they were giving their energy to gravity waves. Furthermore, the more we can probe the details of gravity waves the more we learn about the nature of gravity. LIGO lets us look directly, and in detail, at the wave as it passes by.

We expected Einstein's theory to be correct; so, we came up with a whole bunch of "fingerprints." That is, each type of astrophysical object will emit gravitational waves that are unique in some way to it. This is how we knew that we had found two black holes falling into each other (and, for example, not a supernova). It matches the "fingerprint" of the changing gravity wave frequency predicted using Einstein's equations. In particular, the signal matches the "fingerprint" of a black hole pair (one of 29 and the other 36 times the mass of the sun), one of which is spinning fairly fast!

We are now set to begin seeing all kinds of objects in the sky through our new window: gravity waves. Perhaps we will find things that we never thought could exist, but, certainly, we will find out more about the amazing things we already know exist. Remember the song: *What a Wonderful World!*

For the complete article and to view the animation of the effect of gravity waves on man, go to: <http://www.iapweb.org/iapmagazine.htm>

These topics were excised in the above:

What are gravity waves?

Gravity waves are like light waves.

Detecting gravity waves

Where did the wave come from?

A new branch of astronomy

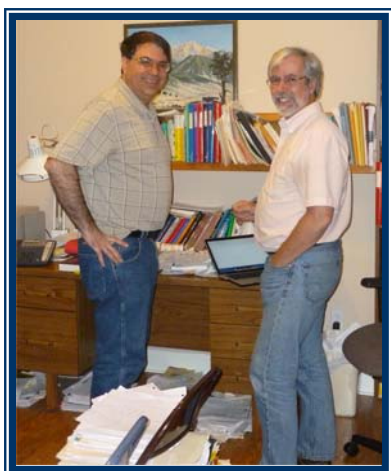
Rizzi & Pearle: second paper uncovering one of the Seven Wonders of the World

Anthony Rizzi, Institute for Advanced Physics, and **Philip Pearle**, retired, **Hamilton College**, Clinton, NY, have completed a second paper on the Aharonov–Bohm effect (which has been called one of the Seven Wonders of the World because it appears to imply a cause acting instantly over a distance). “Our Quantum Mechanics research continues with great success,” says Rizzi. Dr. Rizzi also has additional papers in the final stages. The work includes answers to deep questions posed by the great discoveries of the 20th century. IAP has completed significant work in this area and Quantum Field Theory research has also been advancing.

Quantizing the Vector Potential Reveals Alternative Views of the Magnetic Aharonov-Bohm Phase Shift, submitted May 12, 2016 arxiv.org/abs/1605.04324

The second paper has been submitted for publication in *Physical Review A* and is under review.

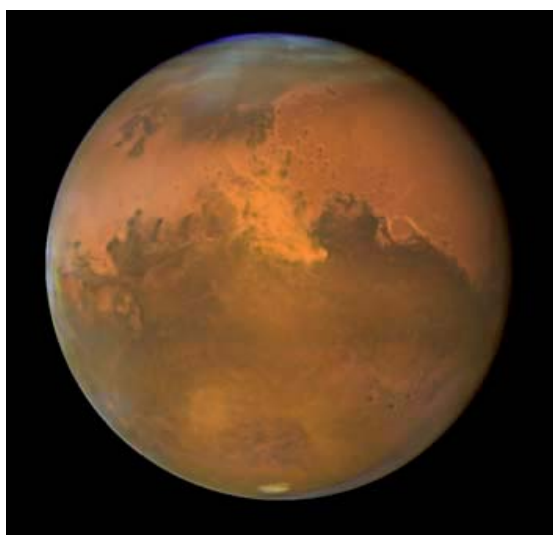
(This line is now correct; previously, it incorrectly stated that the paper was already accepted in PRA.)



Murray Daw, **Clemson University** and **IAP faculty**, and Anthony Rizzi continue research in this area. “All this material is helping us move towards the writing and production of our third textbook, *Physics for Realists: Quantum Mechanics*,” Rizzi says. “Of course, much more research and writing must be done in both Quantum Mechanics and Quantum Field Theory. There is much to learn, much captured in the wonderful, but somewhat opaque equations of these two central areas of physics.”

Photo: Anthony Rizzi and Murray Daw, June 2016

INSTITUTE FOR ADVANCED PHYSICS MARS CALENDAR



Ready for free download

<http://www.iapweb.org/MartianCalendar/>

(as seen on NASA education web site)

With the Mars Calendar you can:

- Find the Martian date for any historical Earth date
- Find the historical Earth date for any Martian date
- Navigate forward or backward by year, month, day, etc. based on the Earth calendar
- Navigate forward or backward by year, month, sol, etc. based on the Martian Calendar
- Find out about *Erday*

Mars image courtesy Space Telescope Science Institute

Randy Nichols, Associate Member, Level II



Randy Nichols retired in 2012 from the **Aerospace Division of Honeywell International** after a rewarding 33-year career in design engineering. He has contributed to the development of several NASA and Department of Defense (DoD) aerospace programs, which include America's Space Shuttle and the International Space Station (ISS). While on the Space Shuttle program, Randy was a member of a design team that developed the Space Shuttle Main Engine Controller (SSMEC). SSMEC's were ruggedized high speed digital controllers, strapped to the Shuttle main engines, which automatically controlled all engine functions during launch and provided continuous engine health monitoring and reporting throughout the launch phase of Shuttle missions.

From 2005 through 2012, Randy was the lead mechanical staff engineer on the ISS Multiplexer-Demultiplexer (MDM) program, managing new design development as well as sustaining engineering support to ongoing ISS missions. MDM's are space-flight worthy computers which form the backbone of the control and data handling network for the ISS, with more than 40 MDM's onboard.

Randy received a B.S.M.E. from the **University of South Florida (USF)**, Tampa, in

1978. He received a Florida Professional Engineering (PE) License in 1988 and then an M.S.M.E. from USF in 1994 (100% Honeywell funded).

After retiring from engineering, Randy felt God's call to share his love of science and math with Catholic high school students, as a Physics teacher. In preparing for that, he is now completing a Master's in Education (M.S. Ed.) at **Franciscan University of Steubenville**. While at Franciscan, in 2015, Randy learned about the work of the Institute for Advanced Physics and, since completing IAP's associate membership program with Dr. Rizzi's *The Science Before Science*, is undergoing a life-changing understanding of Physics. His call to help educate high school Physics students is now infinitely more profound and he intends to devote his efforts to promoting the work of the Institute for Advanced Physics at that level.

"Feynman would have loved this [the work of Institute for Advanced Physics]"

Mike Baskes, Sandia National Lab, former student of famed physicist Richard Feynman, who was considered by many to be the Einstein of his day and known for his distinguished work on the NASA Challenger disaster presidential commission

The Institute for Advanced Physics presents
its 14th annual conference

Physics for Realists XIII

**Modern Physics with a
Common Sense Grounding
Vol. III Quantum Mechanics**
A conference for IAP members

July 27 – July 30, 2016
Louisiana State University
Baton Rouge, LA



Physics for First Communion

Fr. Mitch Pacwa interviews Dr. Anthony Rizzi on EWTN Live on March 9, 2016. They discuss the Eucharist and Transubstantiation and how our lost understanding and appreciation of physics needs to be recovered for our children (and most adults) to appreciate Christ's substantial presence and for all of us to become more aware of its profound nature. In the show, Dr. Rizzi discusses the three miracles that happen at every Mass. The show is about the Institute for Advanced Physics' DVD series on *Physics for First Communion* featuring Dr. Rizzi preparing his six year old daughter to receive her first Holy Communion.



<https://www.youtube.com/watch?v=LBedY9XqfcU>

Mr. & Mrs. Friends of IAP

Date: January 28, 2016

1234 Ways to Donate

Generosity, USA

Pay to the order of: The Institute for Advanced Physics \$ 35.00

Thirty-five and no/100 Dollars

Memo donation, received Physics for First Communion DVD series as a gift Friends of IAP

NEW

1...2...3...4 Ways to Donate to IAP

ONE: CHARITY MOBILE donates 5% of your monthly plan price to the Institute for Advanced Physics when you choose IAP as your designated charity. No contracts, no termination fees. Charity Mobile is a pro-life corporation. Phone: 1.877.474.3662 Web: CharityMobile.com

TWO: IAP supporters who shop on AMAZON are encouraged to shop on **AMAZON SMILE** and designate the Institute for Advanced Physics as your charity. AMAZON will **donate 0.5% of your purchase price** to the Institute for Advanced Physics EACH TIME YOU SHOP on Amazon Smile AT NO COST TO YOU. Your total cost will be the same whether you use AMAZON or AMAZON SMILE. smile.amazon.com/ch/56-2324818

THREE: Donate \$35 online and receive IAP's *Physics for First Communion* nine episode DVD series as our gift to you. See our web site store at www.iapweb.org/store/kids.html#video.

FOUR: Donate any amount by credit card online at www.iapweb.org/store/ (bottom of the page) or mail your check to: Institute for Advanced Physics, PO Box 15030, Baton Rouge, LA 70895

IAP is tax-exempt, publicly supported and recognized by the Internal Revenue Service as a 501c(3) organization.

Thank you for your financial support.

Dear Dr. Daw...In talking with other people taking the general sections of both Phys 1220 and 2210, I quickly noticed an incredible distinction in the classes, not only in the material taught, but the method behind the teaching. ..I have come to better understand the importance of actually learning and knowing the fundamental principles [contained in the Physics for Realists textbooks] Clemson University student, May 2016