

# Which Do you Trust More and Why?

The New York Times | <https://nyti.ms/2yEiRyM>

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Selected for a Viewpoint in Physics  
PHYSICAL REVIEW LETTERS

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SCIENCE

## 2017 Nobel Prize in Physics Awarded to LIGO Black Hole Researchers

By DENNIS OVERBYE OCT. 3, 2017

Rainer Weiss, a professor at the Massachusetts Institute of Technology, and Kip Thorne and Barry Barish, both of the California Institute of Technology, were awarded the Nobel Prize in Physics on Tuesday for the discovery of ripples in space-time known as gravitational waves, which were predicted by Albert Einstein in a century ago but had never been directly seen.

In announcing the award, the Royal Swedish Academy called it "a discovery that shook the world."

That shaking happened in February 2016, when an international collaboration of physicists and astronomers announced that they had recorded gravitational waves emanating from the collision of a pair of massive black holes a billion light years away. It mesmerized the world. The work validated Einstein's longstanding prediction that space-time can shake like a bowlful of jelly when massive objects swing their weight around, and it has put astronomers on intimate terms with the deepest levels of physical reality, of a void booming and rocking with invisible cataclysms.

## Observation of Gravitational Waves from a Binary Black Hole Merger

B. P. Abbott et al.  
(LIGO Scientific Collaboration and Virgo Collaboration)

(Received 23 January 2016; published 11 February 2016)

On September 14, 2015, at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational Wave Observatory simultaneously observed a transient gravitational-wave signal. The signal sweeps upwards in frequency from 35 to 250 Hz with a peak gravitational-wave strain of  $1.0 \times 10^{-21}$ . It matches the waveform predicted by general relativity for the coalescence and merger of a pair of black holes and the ringdown of the resulting single black hole. The signal was observed with a matched-filter signal-to-noise ratio of 24 and a false alarm rate estimated to be less than 1 event per 200,000 years, equivalent to a significance greater than 5. In the source frame at a luminosity distance of  $400^{+120}_{-80}$  Mpc corresponding to a redshift  $z = 0.09^{+0.02}_{-0.02}$ , the initial black hole masses are  $36^{+5}_{-4} M_{\odot}$  and  $29^{+3}_{-4} M_{\odot}$ , and the final black hole mass is  $62^{+4}_{-4} M_{\odot}$ , with  $3.6^{+0.4}_{-0.4} M_{\odot} c^2$  radiated in gravitational waves. All uncertainties define 90% credible intervals. These observations demonstrate the existence of binary stellar-mass black hole systems. This is the first direct detection of gravitational waves and the first observation of a binary black hole merger.

DOI: 10.1103/PhysRevLett.116.061102

### 1. INTRODUCTION

In 1916, the year after the final formulation of the field equations of general relativity, Albert Einstein predicted the existence of gravitational waves. He found that the linearized weak-field equations had wave solutions—transverse waves of spatial strains that travel at the speed of light, generated by time variations of the mass quadrupole moment of the source [1,2]. Einstein understood that gravitational-wave amplitudes would be strikingly small; moreover, until the Chapel Hill conference in 1957 there was significant debate about the physical reality of gravitational waves [3].


The discovery of the binary pulsar system PSR B1511-10 by Hulse and Taylor [20] and subsequent observations of its energy loss by Taylor and Weisberg [21] demonstrated the existence of gravitational waves. This discovery, along with emerging astrophysical understanding [22], led to the recognition that direct observations of the amplitude and phase of gravitational waves would enable studies of additional relativistic systems and provide new tests of general relativity, especially in the dynamic strong-field regime.

Experiments to detect gravitational waves began with Weber and his resonant mass detectors in the 1960s [23].

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## Reviewing Papers & Writing Referee Reports

(Brian DeMarco, Lance Cooper, Tony Liss, Doug Beck, Celia Elliott)



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Referees, who are generally unpaid volunteers, play an essential role in the scientific enterprise. It is part of every scientist's obligation to the community to serve as a referee if requested, to the extent that his or her expertise allows.

Today we'll look at the various duties and responsibilities of referees and how to write referee reports.

The terms "referee" and "reviewer" are used interchangeably in US English to mean an expert who provides an objective opinion about the scientific and technical merit of a paper, nomination, or application.

An excellent resource for novice referees is "Introduction to refereeing," IOP Publishing, <http://images.iop.org/referees/>.

## What does a referee do for science?

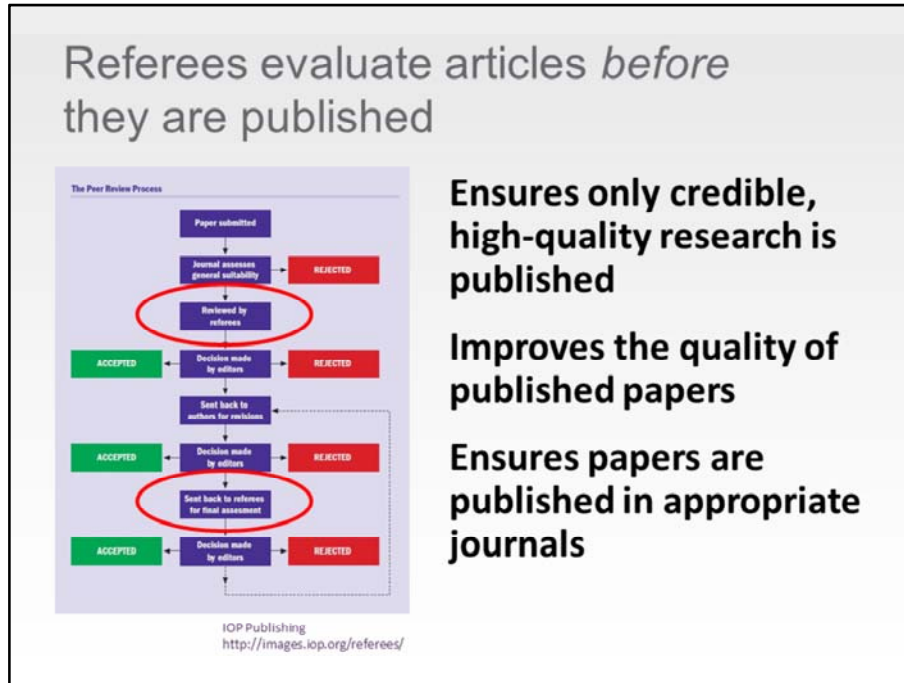


**Safeguards the integrity  
of the archival literature**

**Ensures \$\$ invested in  
research are spent wisely**

**Ensures that people are  
rewarded on the merits  
of their work**

Today we're going to focus specifically on reviewing scientific articles. But referees also evaluate proposals for funding agencies and nominations for prizes and awards. They evaluate the suitability of candidates for jobs and for promotion and tenure.



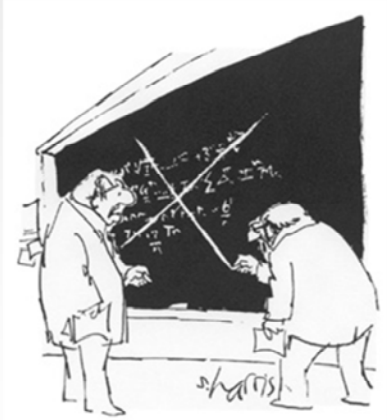
Journal editors generally have established criteria for the suitability of publications in their journals.

These criteria vary from journal to journal and generally depend on the nature of the journal's readership.

The job of the referee is to provide an objective, expert opinion on whether the submitted paper satisfies the stated criteria of the journal. The reviewer must thus understand not only the scientific methods and results presented in the paper, he or she must also understand the aims, scope, and general readership of the journal.

Most journals will provide very specific instructions to referees about the criteria that are to be applied when evaluating a manuscript for publication.

## Why referees are needed



That's it? That's peer review?"

An enormous number of scientific articles are submitted yearly (about 10,000 to Physical Review Letters)

Most journals rely on impartial external reviewers to help evaluate and decide the fate of submitted papers

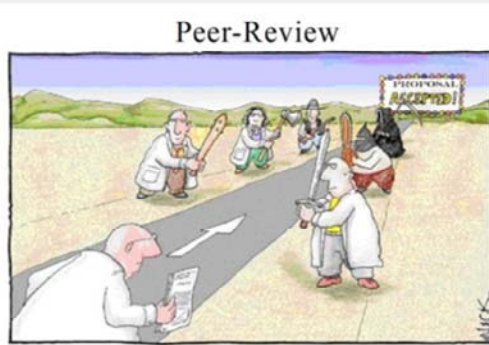
This is generally performed as a service to the community, i.e., you don't get paid to referee papers!

To provide an adequate review, you must be sufficiently familiar with the research topic to adequately assess the originality of the research, the quality of the work, the validity of the conclusions, and the significance and impact of the work being presented. If you do not have the necessary expertise, you should immediately notify the editor that you cannot review the paper because it is outside your area. You *can* suggest the names of other scientists who might be better suited to review, but you **may not** forward the manuscript to someone else to review.

If you have a prior relationship with one of the authors or if you are in direct competition with one of them, you should immediately tell the editor that you have a conflict of interest, disclose the nature of the conflict, and let the editor decide if you should review.

If you have pre-existing opinions about an author that would affect your objectivity—either positively or negatively—you should recuse yourself from review.

## A referee is not your average reader



The average reader relies on peer-review to weed out questionable papers.

The referee (a peer) should be much more skeptical than the average reader.

Being skeptical is different from not believing.

Referees must be more skeptical than readers. The referee is the first defense against the proliferation of bad science and the wasting of people's time and funders' resources.

## Reviewing vs. reading a paper

As a reader, you are more likely to presume the details presented in the paper are true and correct (experts have already signed off on it)

As a referee, you have an obligation to carefully evaluate:

1. the “truth” of what is being presented
2. the originality and significance of the work
3. the suitability of the methods used
4. the validity of the conclusions drawn

Is it clear what problem the authors were trying to solve and why it is important?

Has the work already been done by somebody else? Has it been published elsewhere? Is it sufficiently new and different from the authors’ previous papers?

Have the authors adequately referenced previous work to provide a background and context for the work they are reporting?

Have the authors provided meaningful results and adequate evidence for their conclusions? Are there any unsupported claims?

Is the work correct? Are there errors or gaps in the data? Have the authors made unwarranted assumptions? Have any treatments or selection data been fully disclosed? Have inappropriate methods been used? Are there known sources of error that have not been accounted for?

Are the mathematics and statistics correct? (Yes, re-derive the equations.)

You should have three objectives when refereeing a paper:

1. “Protecting the cathedral by testing the brick”
2. Helping the authors produce a better paper (clearer, more persuasive, more concise, more complete)
3. Maintaining your objectivity and professional ethics


Can you realistically do an adequate review in the time the editor has suggested? If you cannot, either ask the editor if you can have more time or decline the review. It is not fair to the authors either to take an unreasonable amount of time to do the review or to provide a hasty, superficial, ill-considered review.

One benefit to referees for performing this service is they learn about innovative new work before it is published. However, it is a breach of ethics to use information obtained in the review process for your own personal benefit.

It is an absolute obligation of a referee to preserve the anonymity of review. Under **no** circumstances should a referee contact the authors or disclose that he was a referee. If you have a question for the authors, send it to them via the editor.



Essential Components of a Good Referee Report




- (1). Brief summary of the main points of the paper
  - to educate the editor
  - to convince the editor and other referees that you've actually read the paper (no joke!)
- (2). Brief evaluations of the different criteria provided by the journal
  - the quality/appropriateness of the research methodologies and techniques
  - the quality of the logical arguments made to arrive at the key conclusions of the paper
  - the clarity of the presentation
- (3). Highlights of the paper's strengths as well as its weaknesses

Do the results reported significantly advance the field? Do the authors explain the significance of their work? Is it clear what they've contributed?

Is the work being reported of interest to the journal's readership? Would it be more appropriately published in a different journal?

Should the editor get an opinion from an expert in another field?

**Essential Components of a Good Referee Report**  
(continued)



(4). An explicit recommendation for or against publication

Your recommendation can be equivocal if you provide sufficient discussion of the pros and cons of publication.

If you do recommend rejecting a paper, you can suggest alternative journals to which the paper might be more appropriately submitted.

(5). List essential and suggested changes to the paper

Even if you recommend rejecting the paper, your suggestions might allow the paper to be published elsewhere, or even in the same journal after revision.

**Be clear and specific about your questions and suggestions so the authors can respond appropriately.**

While it is helpful to mark obvious spelling and grammatical errors for the authors, your job is to be a referee and assess the quality of the research, not to be a copy editor and correct every comma. However, do point out language that is imprecise, ambiguous, or misleading.

If the English is so poor that you cannot understand what the authors are trying to convey, you are not obliged to struggle to parse or “translate” every sentence. Simply return the ms. to the editor with the notation that you are unable to review it because the English is sufficiently bad that you cannot understand it.

For any review

- 1. Briefly summarize the main points of the paper**
- 2. Provide brief evaluations of the different criteria provided by the journal**
- 3. List essential and suggested changes to the paper**
- 4. Make an explicit recommendation about publishing the paper**

Begin your review with a summary of the most important points in the paper to 1) show that you've actually read the paper, and 2) help the editors understand it.

Next, go down the list of review criteria provided by the journal and address each point; state how well the paper meets each criterion.

At some point in the review, explicitly state your recommendation for or against publication. Put the recommendation at the beginning or the end of the report and highlight it so the editor can see it immediately. Common recommendations are:

- Accept paper for publication as written.
- Publish after the authors have considered optional suggestions (and provide the editor with those suggestions).
- Publish after the authors have made mandatory corrections (and specify what those corrections are).
- Reject the paper.

If you make suggestions for how the paper could be improved, be sure to tell the editor whether the suggested changes are optional or mandatory.

If you want to re-review any revisions to the ms. before it is published, so state in your report.

“Review unto others...”\*

Do not personally criticize the authors; focus on improving the paper, not straightening out the researchers

Do not make statements or claims without providing examples, explanations, and evidence

Strive for the highest standards of objectivity and honesty

Do not use information obtained through review for personal benefit—ever!

\*Professor Lance Cooper’s “Golden Rule for Referees”

Your report should be written constructively, in a collegial tone, to benefit the understanding of both the authors and the editors.

In a positive, respectful, constructive way, point out experimental problems, flaws in the authors’ arguments, or alternative interpretations not proposed by the authors.

Provide appropriate references if inadequate credit is given to previous work.

Excellent resource for novice referees: “Introduction to refereeing,” IOP Publishing, <http://images.iop.org/referees/>.

For HW #6...

You will be assigned two articles to review

For each article, provide a written assessment, using the posted review criteria

First, write a one-paragraph summary of the article

Next, evaluate the contents of the article using the rubric; address each criterion

Finally, give specific suggestions for how the article could be improved

Remember to make positive comments as well as critical ones

Notes: