

# **Who's Afraid of the Referee?**

## **Einstein and Gravitational Waves**

Daniel Kennefick, October 2005

The concept of gravitational waves arose in the early days of relativity theory, in the first years of the 20<sup>th</sup> century.

Einstein presented the first concrete theory of gravitational waves in 1918. It was based on a linearized approximation of his general relativity theory, but it is still considered correct today for application to systems such as LIGO, the Laser Interferometric Gravitational-wave Observatory.

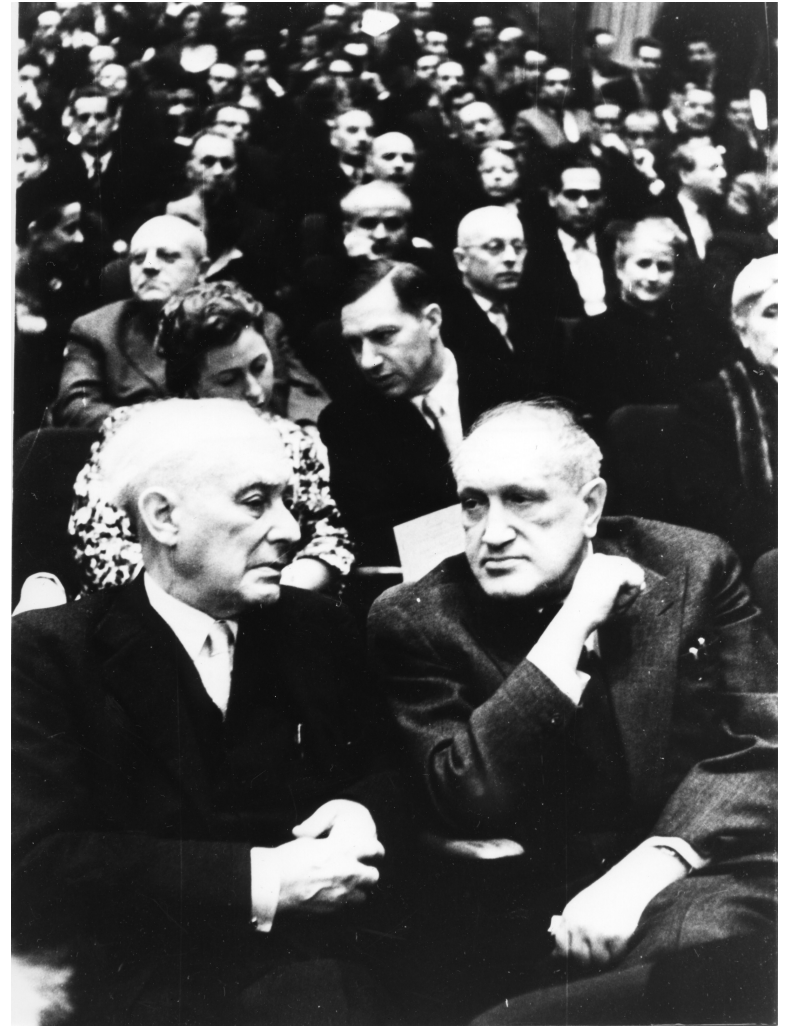


**LIGO facility  
at Hanford,  
Washington**

## Second Thoughts

“Next term we are going to have your temporary collaborator Infeld here in Princeton, and I am looking forward to discussions with him. Together with a young collaborator, I arrived at the interesting result that gravitational waves do not exist, though they had been assumed a certainty to the first approximation. This shows that the non-linear general relativistic wave field equations can tell us more or, rather, limit us more than we had believed up to now.”

-Albert Einstein to Max Born, written in mid-1936.



**Born and Infeld after the war**

THE PHYSICAL REVIEW  
REVIEWS OF MODERN PHYSICS  
PHYSICS

Conducted by  
THE AMERICAN PHYSICAL SOCIETY  
JOHN T. TATE, *Managing Editor*

*University of Minnesota, Minneapolis, Minn., U. S. A.*

July 23, 1936

# Title: "Do Gravitational Waves Exist?" Answer: No!

In June 1936 Einstein and his "young collaborator," Nathan Rosen had sent a paper on gravitational waves to *The Physical Review*. This was their third joint paper submitted to that journal. The first two are very famous, the EPR paper and the Einstein-Rosen bridge (aka Wormhole) paper.

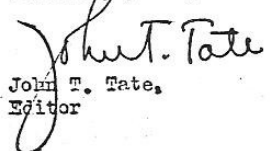
The gravitational wave paper met with a different response from the journal than the previous two, which had been published promptly.

Professor A. Einstein  
Saranac Lake, New York

Dear Professor Einstein:

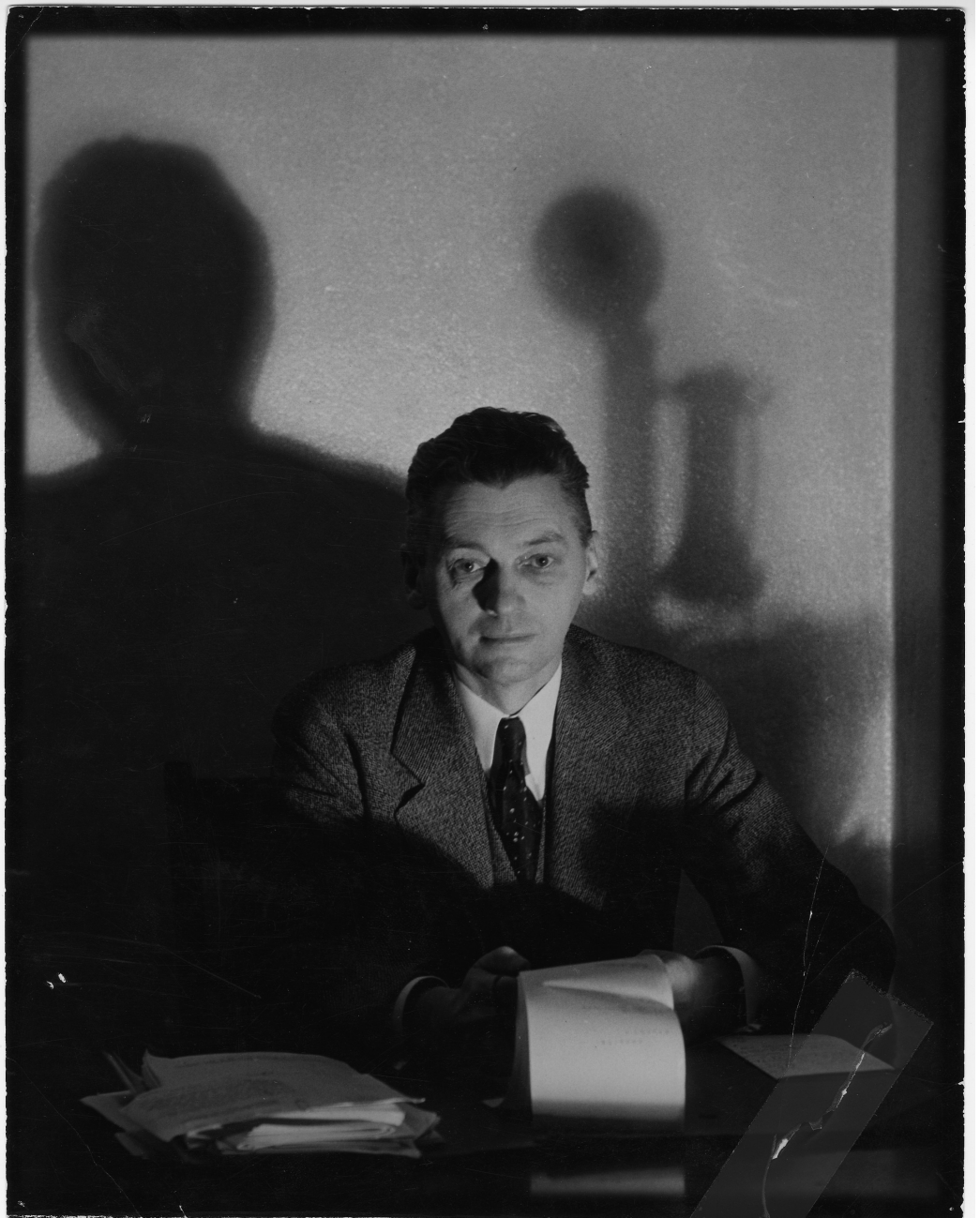
I am taking the liberty of returning to you the paper by yourself and Dr. Rosen on gravitational waves together with some comments by the referee. Before publishing your paper I would be glad to have your reaction to the various comments and criticisms the referee has made.

Sincerely yours,

  
John T. Tate,  
Editor

JTT:B  
Enc.

**John Torrance Tate** (1889-1950) became editor of the *Physical Review* at a young age in 1926 and rapidly turned it into the world's leading journal of physics, during the period of the quantum mechanics revolution. He remained editor until his death.



# Einstein's Reply

Herrn John T. Tate  
Editor The Physical Review  
University of Minnesota  
Minneapolis, Minn.

Sehr geehrter Herr:

Wir (Herr Rosen und ich) hatten Ihnen unser Manuskript zur Publikation gesandt und Sie nicht autorisiert, dasselbe Fachleuten zu zeigen, bevor es gedruckt ist. Auf die - übrigens irrtümlichen - Ausführungen Ihres anonymen Gewährsmannes einzugehen sehe ich keine Veranlassung. Auf Grund des Vorkommnisses ziehe ich es vor, die Arbeit anderweitig zu publizieren.

Mit vorzüglicher Hochachtung

P.S. Herr Rosen, der nach Sowjet-Russland abgereist ist, hat mich autorisiert, ihn in dieser Sache zu vertreten.

# Einstein's Reply

Dear Sir,

We (Mr. Rosen and I) had sent you our manuscript for publication and had not authorized you to show it to specialists before it is printed. I see no reason to address the - in any case erroneous - comments of your anonymous expert. On the basis of this incident I prefer to publish the paper elsewhere.

respectfully,

P.S. Mr. Rosen, who has left for the Soviet Union, has authorized me to represent him in this matter.

# Peer Review

In fairness to Einstein, this was likely his first experience of anonymous peer review. It was not the normal practice in the German journals where he was used to publishing.

As we now know, his two previous submissions with Rosen to *The Physical Review* were not refereed.

Other European émigré physicists at this time made reference to the “rigorous criticism common for American journals.” In Germany it was considered an insult to reject a paper by an established physicist.

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THE AMERICAN PHYSICAL SOCIETY  
JOHN T. TATE, *Managing Editor*

*University of Minnesota, Minneapolis, Minn., U. S. A.*

July 30, 1936

Dr. A. Einstein  
Glenwood  
Saranac Lake, New York

Dear Dr. Einstein:

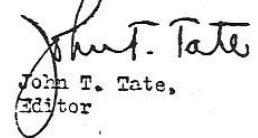
I regret the circumstances which led to your decision to publish elsewhere the paper by yourself and Dr. Rosen.

Perhaps I was personally at fault in that I assumed you were familiar with the publication policies of the American Physical Society and that you would receive the comments of our Editorial Board in the spirit in which they were written.

All papers submitted for publication in THE PHYSICAL REVIEW are subject to editorial supervision by a Board of Editors elected by the American Physical Society. I could not accept for publication in THE PHYSICAL REVIEW a paper which the author was unwilling I should show to our Editorial Board before publication. I assumed that you knew this or I would have returned your paper to you at once.

I regret that you found the editorial comments on your paper erroneous and unworthy of reply.

Sincerely yours,

  
John T. Tate,  
Editor



## What Happened Next?

Einstein submitted the paper to the *Journal of the Franklin Institute* in which he had already published a paper the previous year.

In October of that year Leopold Infeld arrived to replace Rosen as Einstein's new assistant (Rosen left for the Soviet Union in late July).

In his autobiography Infeld describes his first meeting with Einstein, at which Einstein explained to him, and to Tullio Levi-Civita, who was also present, his proof of the non-existence of gravity waves. The two famous men communicated, according to Infeld, "in a language which they thought to be English."

This meeting presumably took place in October, because in his book Infeld describes his arrival at Princeton, finding the place deserted as a home football game was being played. Admittedly Infeld is not always an entirely reliable memoirist, as he makes a joke based on the fact that Notre Dame were the opponents. However Princeton have not played the Fighting Irish since the 1920s.

## A Timely Intervention

In his memoir, Infeld tells how he came to accept Einstein's claim, and even came up with his own version of the proof.

However when he mentioned this to his new friend, the Princeton relativist

**Howard Percy Robertson**, Robertson did not believe him.

Robertson found an error in Infeld's argument.



When Infeld told Einstein, Einstein said he had found an error in his argument also.

# Finding the Solution

Einstein quickly realized, apparently with the help of Robertson, that the spacetime metric used in his paper with Rosen could be transformed from a geometry suitable for visualizing plane waves, to one suitable for describing cylindrical waves.

In the new coordinate viewpoint, the singularities which existed in the spacetime, could be identified with the source of the cylindrical waves. Actually, as was shown later, the singularities involved were only apparent (being coordinate singularities) and the entire argument is incorrect from a modern standpoint.

## ON GRAVITATIONAL WAVES.

BY

A. EINSTEIN and N. ROSEN.

### ABSTRACT.

The rigorous solution for cylindrical gravitational waves is given. For the convenience of the reader the theory of gravitational waves and their production, already known in principle, is given in the first part of this paper. After encountering relationships which cast doubt on the existence of *rigorous* solutions for undulatory gravitational fields, we investigate rigorously the case of cylindrical gravitational waves. It turns out that rigorous solutions exist and that the problem reduces to the usual cylindrical waves in euclidean space.

### I. APPROXIMATE SOLUTION OF THE PROBLEM OF PLANE WAVES AND THE PRODUCTION OF GRAVITATIONAL WAVES.

It is well known that the approximate method of integration of the gravitational equations of the general relativity theory leads to the existence of gravitational waves. The method used is as follows: We start with the equations

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = -T_{\mu\nu}. \quad (1)$$

We consider that the  $g_{\mu\nu}$  are replaced by the expressions

$$g_{\mu\nu} = \delta_{\mu\nu} + \gamma_{\mu\nu}. \quad (2)$$

**Einstein and Rosen's article as it actually appeared in the Journal of the Franklin Institute**

# Timeline

early summer 1936 - Einstein and Rosen submit paper

mid-to-late July- Rosen departs for the Soviet Union

July 23 - Paper returned by Physical Review

early October - Infeld arrives at Princeton as Einstein's new assistant

He is convinced by Einstein that gravitational waves do not exist

His new friend H. P. Robertson convinces him that the proof is wrong.

Einstein (independently) realizes the proof is mistaken

Robertson shows Einstein how to construct a solution for cylindrical waves out of the calculations he has made

November 13 - Einstein makes changes in proof to the paper, now with the Journal of the Franklin Institute in Philadelphia

late 1936/early 1937 - Rosen also realizes proof is mistaken

# Who Was The Referee?

The 10 page referee's report survives. The spelling used follows the American fashion, and at this time there were very few American physicists capable of writing this review, which shows a thorough familiarity with the General Theory of Relativity and its literature.

The chief three candidates would be Robert Oppenheimer, Richard Tolman, and H. P. Robertson.

What about Robertson himself? Interestingly he was not in Princeton for the first half of 1936, when Einstein and Rosen were writing the paper. He was on sabbatical at Caltech, his alma mater. He only returned to Princeton in August. Perhaps his encounter with Infeld was his first opportunity to broach the matter with Einstein or his assistants.

# The First Evidence

February 18, 1937.

Dear Tate:

Thanks for your felicitations on my becoming a member of your revered staff. I celebrate my canonization by holding this first refereeing job more than the allowed ten days - at which, considering what it is, I expect no kicks from you. I am glad to recommend an unequivocal rejection - he might be advised to try to get the Oxford or Cambridge University Presses to allow him to expand it into a book, concerning the sort of stuff they have been flooding the market with lately.

You neglected to keep me informed on the paper submitted last summer by your most distinguished contributor. But I shall nevertheless let you in on the subsequent history. It was sent (without even the correction of one or two numerical slips pointed out by your referee) to another journal, and when it came back in galley proofs was completely revised because I had been able to convince him in the meantime that it proved the opposite of what he thought.

You might be interested in looking up an article in the Journal of the Franklin Institute, January 1937, p. 43, and comparing the conclusions reached with your referee's criticisms.

I have to confess a great scandal in connection with that paper of Swicky's, which I maintained I never saw. But imagine my chagrin last July in discovering it, unopened, in the attic of our house on our return from a fifteen months leave. The only solution I can give is that (1) it was rather inappropriately delivered at my home address, (2) it was lost in the pile of junk destined for the attic or the incinerator (I wish it had gone to the latter so I could go to my grave protesting my innocence), and, (3) discovered in the attic after a leave of 18 months, during which I waxed indignant at the postal authorities. I can only say I am sorry it occurred, and make what amends I can by returning this in your stamped self-addressed envelope, instead of soaking off the stamps and using them for air mail letters as I was at first inclined to do.

Sincerely yours,

H. P. Robertson.

Professor John T. Tate,  
University of Minnesota,  
Minneapolis, Minnesota.

# The Smoking Gun

1936

NAME	DATE IN	REFEREE	DATE IN	TO AUTHOR	TO N.Y.	ISSUE	RE-JECTED
Chadron	5/29	Feynman 6/4	6/8				6/12
Einstein & Rosen	6/1	Robertson 7/6	7/17	7/23			
Dirac	5/22				4/14	MAY 15, 1936	
Wigner & Weiss	2/28		4/6	4/5	4/12/36	JUNE 15, 1936	

*The Physical Review* Logbook from the 1930s, a scan from which has been kindly provided by the current editor of the *Review*, Martin Blume.

It shows that the Einstein and Rosen paper was received on June 1, sent to the referee Robertson on July 6, arrived back from Robertson on July 17 and was returned to Einstein on July 23.

By contrast, the same logbook shows that neither of the previous two Einstein and Rosen submissions were refereed at all, and the EPR paper was sent "TO N.Y." the day after its submission.

July 14, 1936

## When it rains it pours

Professor J. T. Tate  
University of Minnesota  
Minneapolis, Minn.

Dear Tate:

Well, this is a job! If Einstein and Rosen can establish their case, this would constitute a most important criticism of the general theory of relativity. But I have gone over the whole thing with a fine-tooth comb (mainly for the sake of my own soul!), and can't for the life of me see that they have established it. It has long been known that there are difficulties in attempting to treat infinite plane gravitational disturbances in general relativity - even in the classical theory the potential acts up at infinity in such cases - and as far as I can see the additional, much more serious, objections of Einstein and Rosen do not exist. I can only recommend that you submit my criticisms to them for their consideration, and with this in mind I have written up in duplicate a series of "Comments" which you can, if you are so minded, send them. The alternative would be to publish it as it stands, taking account only of Comments (a) and (b), which deal with typographical errors of a minor sort. Such a paper would be certain to give rise to a lot of work in this field of gravitational waves, which might be a good thing - provided they didn't flood you out of house and home, as in the case of the Page excitement!

If you do decide to refer it back to the authors with my comments, please send them the copy written on white paper, keeping the yellow copy for your files.

Very sincerely yours

Address until Aug. 1:  
Box 213, Univ. Sta.  
Moscow, Idaho.

H. P. Robertson

Until Aug. 15:  
Montesano, Wash.

Thereafter: Princeton

When I returned to the Robertson papers at Caltech, I found that new material had been added to the archive since my previous visit, 10 years before.



If general thesis is correct, work is of first rate importance. But I do not believe authors have established their case - see attached "Comments of Referee".  
Typographical: see Comments (a), (b). Logical: see Comments (d), (e), (f).

## Cover Page to the Referee's Report

Part I could be shortened without loss by referring to previous results - see Comment (c).

Not sent to Einstein

[Comment e]  
If desired, "complete wave" solution could be taken over bodily from previous work but that would leave "incomplete wave" hanging.

Analysis is unexceptionable up to middle of p. 13, but I cannot agree with the crucial analysis on last half of p. 13, first half of p. 14, middle of p. 15; and without this the whole point of the paper is lost. See detailed "Comments of Referee" attached hereto.

Specifically, I maintain that the field defined by <sup>my</sup> eq. (v), (vi), satisfying eq. (31)-(34) of the authors' paper, is a "Gegenbeispiel" which shows their argument to be fallacious. See Comment (e).

Referred back to authors for consideration of referee's criticisms.

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# The Diligent Referee's Reward

## Another Tricky Assignment

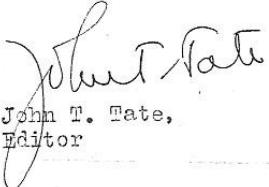
Professor H. P. Robertson  
Box 213, University Station  
Moscow, Idaho

Dear Robertson:

Thank you very much for your careful reading of the paper by Einstein and Rosen. I have sent to Professor Einstein the detailed comments which you made and shall let you know what he replies. I am now enclosing a letter written to me by E. G. Bougin which is by way of being a reply to your criticisms of his paper entitled "A New Relativity". I shall be glad for your advice as to how best to reply to him.

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Sincerely yours,

  
John T. Tate,  
Editor

JTT:B  
Enc.

June 1 - Paper submitted to Physical Review by Einstein and Rosen

July 6 - Paper sent to Robertson to be refereed

July 17 - Robertson submits referee's report

mid July - Rosen departs for Soviet Union

July 23 - Paper returned to authors by Physical Review editor Tate

July 27 - Paper withdrawn by Einstein

August - Einstein returns from holiday in Lake Saranac, New York

August 15 or so - Robertson returns from sabbatical at Caltech

early October - Infeld arrives at Princeton as Einstein's assistant

October - Robertson convinces Infeld that proof is wrong

November 13 - Einstein alters paper in proof with Franklin Journal

February 1937 - Robertson (to Tate) and Rosen (to Einstein) respond to appearance (January issue) of paper in Franklin Journal

# How did Einstein twig?

Can we believe Infeld's claim that Einstein realized his proof was wrong just at the same moment that Robertson convinced Infeld?

Another recent find shows that Einstein began a draft of a follow-up paper to the original Einstein-Rosen paper.

He wanted to explore whether there were other instances where a solution to the linearized field equations did not exist as a solution to the exact Einstein equations. The solution in question was that for a stationary rotationally symmetric gravitational field.

This 11 page draft ends abruptly and it is reasonable to speculate that at some point he realized that his argument couldn't be right, casting doubt on the truth of the earlier paper.

Incidentally, Infeld also tells us that the day after Einstein realized his proof was wrong, he had to give a seminar on it at Princeton, even though he had not yet realized how to convert his metric into the cylindrical solution.

## Nathan Rosen and Joe Weber

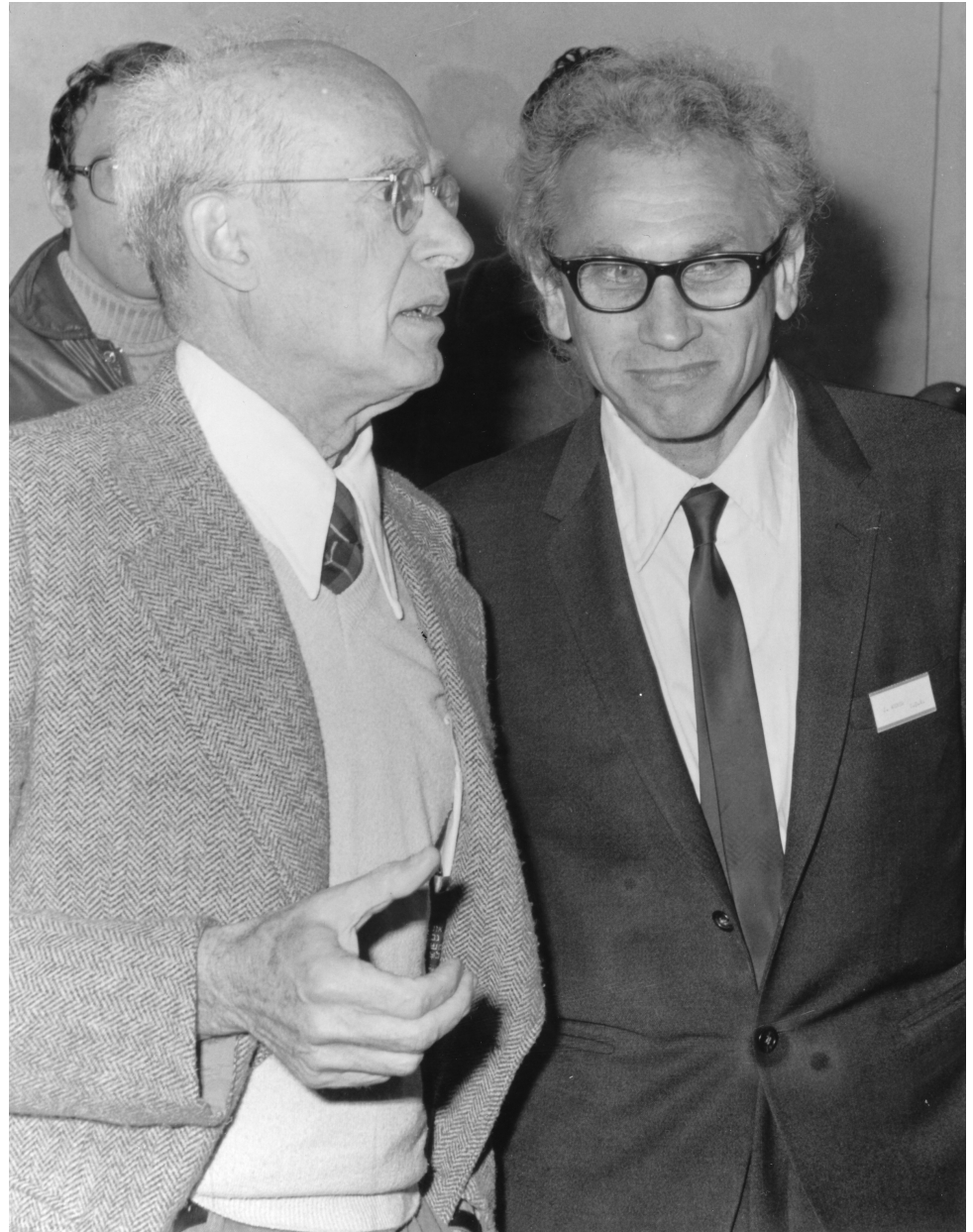
### Everyone Twigs

As it happens, Rosen, in the Soviet Union, also realized that there was something wrong with the proof.

In February 1937 he wrote to Einstein, having realized, from a newspaper report, that the paper had appeared in a different journal with a different title.

Although he agreed that the argument did not hold for all gravitational waves, he still published a new paper trying to prove that plane gravitational waves did not exist. This argument was later shown to be invalid.

After the war both Infeld and Rosen continued the argument that gravitational waves do not exist.



## Would Einstein have cared?

It is certainly clear that Tate and Robertson saved Einstein from a very public controversy.

Given that even the innocuous paper that was eventually published in a relatively obscure journal attracted newspaper coverage, one can only imagine what the press would have made of the retraction of an Einstein paper.

On the other hand, Einstein constantly joked at how he changed his mind every other year about his unified field theory. He would not have been greatly perturbed by a newspaper ruckus.

All the same, he never published in *The Physical Review* again.

