EXTRA!

California Tech

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Associated Students of the California Institute of Technology

Volume LXVII | Pasadena, California, Friday, October 22, 1965 | Number 5½

Dr. Richard Feynman Nobel Laureate!

October 21, 1965 (9 a.m.)
Professor Richard Feynman:
Royal Academs of Sciences today awarded you and Tomonaga and Schwinger jointly the 1965 Nobel Prize for physics for your fundamental work in quantum electrodynamics with deep ploughing consequences for the physics of elementary particles. Prize money each one-third. Our warm congratulations. Letter will follow.
Erik Rundberg
The Permanent Secretary

Erik Rundberg:
Your cablegram has made me very happy!
Richard P. Feynman

Earlier, at 3:45 a.m.:

" 'Hello, Dr. Richard Feynman? May I congratulate you on your Nobel Prize.'

"Look. This is a heck of an hour—

" 'But aren't you pleased to hear that you've won the Prize?'

"I could have found out later this morning.

" 'Well, how do you feel, now that you've won it?'

"Look, some other time . . . "

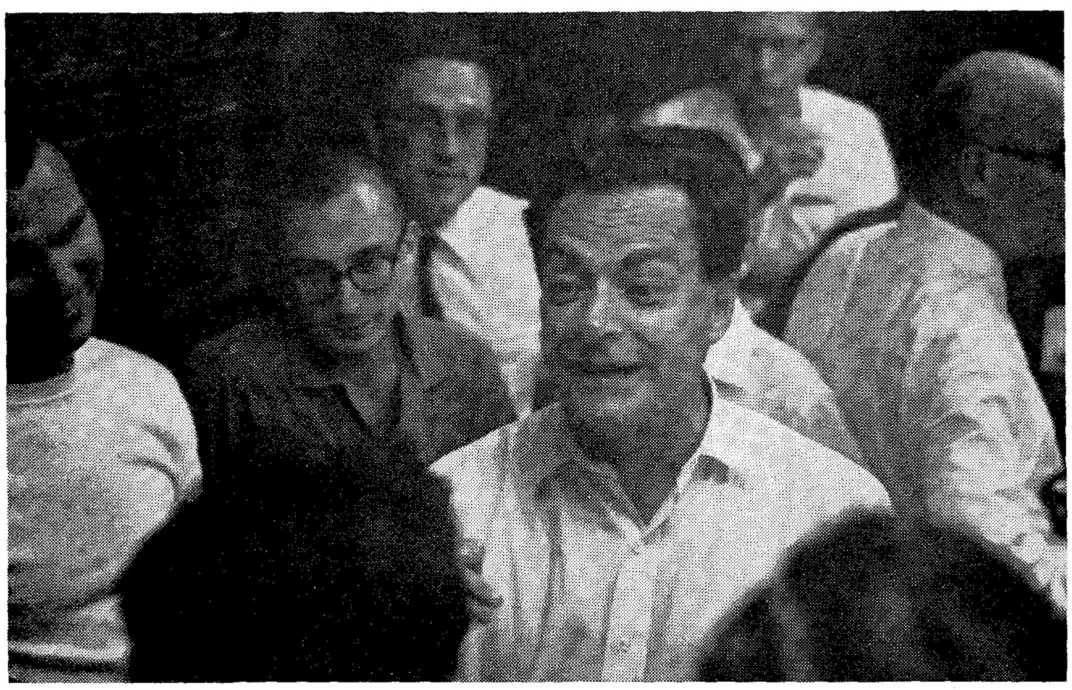
And so Richard P. Feynman, PhD, FRS, and Richard Chace Tolman Professor of Theoretical Physics at Caltech, first sleepily learned that he was an awardee of the 1965 Nobel Prize in physics.

Later yesterday morning, as growing realization brought greater excitement, Feynman learned that Schwinger and Tomanaga shared the award with him, and will also be making the December 10 trip to Stockholm. All three received the Prize as the result of simultaneous, independent theoretical work conducted during 1947-1949 in quantum electrodynamics.

Though the results of the three were later shown to be equivalent, Feynman introduced the pioneering "Feynman diagram," a powerful tool greatly simplifying quantum-dynamical calculations. As Feynman himself explained:

"It was the purpose of making these simplified methods of calculating more available that I published my paper in 1949, for I still didn't think I had solved any real problems, except to make more efficient calculations. But it **does** turn out that if the efficiency is increased enough, it itself is practically a discovery. It was a **lot** faster way of doing the old thing."

This "old thing," as Feynman described it during a press conference held at 10:30 a.m. in the Atheneaum, was the solution of Dirac's equations, formulated in 1929. Previous attempts to get more accuracy through second-order approximations led to infinite solutions. What the three Nobel Prize winners did, in the words of Feynman, was "to get rid of the infinities in the calculations. The infinities are still there, but now they can be skirted around . . . We have designed a method for sweeping them under the rug."



"And so he sez, 'Can you explain in a few words just what you did to win the Prize?' So I say, 'I made marks on a piece of paper.' "

Later in the morning Feynman went through another press conference. In his words:

"A group came who couldn't get to the press conference because they were late.

> Dear Dick:
> Congratulations on the Nobel Prize Award. No one ever deserved it more and no award ever pleased more people. At Caltech and throughout the country there is great rejoicing.
> Lee

This guy comes into my office, and says to me: 'I'll tell you what I'm going to ask you, so you're ready when the cameras start. One of the questions is: What applications does this paper have in the computer industry?'

"I said, 'The answer to that will be "none." '

" 'Well, then, does it have application?'

"It hasn't got any—

" 'Oh, you're kidding, sir.'

"No." I knew that this interview was going to be a mess.

" ' Well, I'm going to ask you also to comment on the statement that your work was to convert **experimental data** on strange particles into **hard mathematical fact.**'

"No, I'm not going to comment on **that.**"

"Finally, 'All right. What time did you hear about the Award?'

"Ok, now turn on the cameras!"

In the afternoon spirited undergraduates raised a **"Win big, RF"** banner on the dome of Throop. And naturally, Feynman was the center of attention at a packed Physics Department seminar tea held in Bridge at 4:15, where he was formally inducted into the Nobel elite by Dr. Carl D. Anderson. "I feel," confided Feynman, "that the Nobel Committee was very wise in its Prize selection." Three hip-hip-hoorays followed.

Feynman told how a telephone caller from New York had asked him to comment on the New York school system. "It was all right when I was going to it 30 years ago," he answered. And Feynman has already decided how to spend his one-third of the $55,0000 Prize money: "I'll use it to pay my income tax for the next years, so that my income is tax-free."

The **California Tech** visited Feynman at his home in the evening for a special interview. In describing some of his more recent work, Feynman told how his quantum

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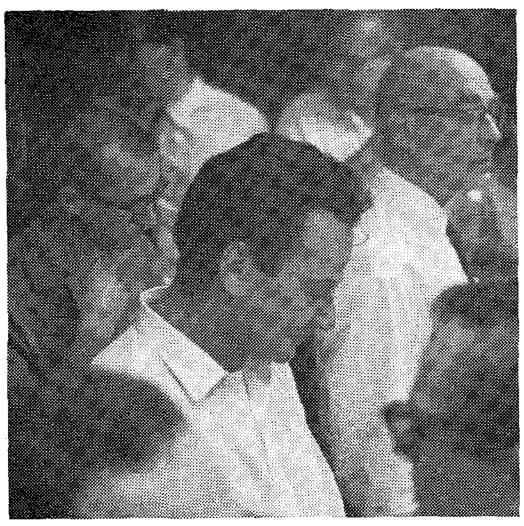
The Work That Won The Prize



Caltech Nobel Laureates Anderson and Feynman. It's been a long, happy day.

The 1965 Nobel Prize in physics was awarded for accomplishments of years ago. In order to understand what advance the trio actually made in its historical context, it is necessary to go back almost four decades.

Quantum electrodynamics (qed) was born around 1928-30 of a marriage of the new quantum mechanics with the old equations of Maxwell's classical electrodynamics. The midwives for the tremendous theoretical development of this time were the same giants of physics whose names have become so familiar: Heisenberg, Pauli, Fermi, and Dirac. The new qed theory did a beautiful job of explaining all sorts of electrodynamical events on an atomic scale by quantizing everything.

Infinite problems

In the later thirties, certain "divergence difficulties"—getting infinite answers for quantities that should be finite and physical—reared their ugly heads. In particular the theoretical predictions about how an atom emits light from its electron structure ran into trouble. As an electron moves to a lower-energy orbit about the nucleus, a photon is emitted, and the wavelength of that photon could be predicted easily by the theory, but only approximately. A harder calculation produced a small correction to the first answer, thus giving more accuracy to the result, but in trying to find a second (even smaller) correction, the theory produced infinite answers. Physicists worried vaguely about the problem for a decade, but experimental results at the time had not achieved sufficient accuracy to require the addition of the extra terms in order to satisfactorily explain the observed phenomena.

By 1946 experimental techniques had so developed that carefully designed experiments, by such people as Lamb and Retherford, yielded extremely accurate results which demanded that the troublesome corrective term be added. Methods were outlined by Bethe and others whereby the divergence difficulties could be overcome. By using tricks and devices—like constructing the difference of two "infinite" quantites to be finite—the theory could be persuaded to give nondivergent answers.

The actual elaboration of this beginning work was done more or less independently by the three men who share the Nobel Prize: Feynman (then at Cornell), Schwinger at Harvard, and Tomonaga in Tokyo. The latter two went along traditional lines, using the electric and mangetic fields that everyone accepted implicitly at that time. Feynman took a radical approach with a theory that treated all events in terms of particles. Most physicists thought this a wild idea at the time. Feynman was able to eliminate most of the divergence difficulties, but not quite all of them. Gradually, through considerable intuition and trial and error, he learned rules for making simplified calculations which produced correct results.

"It WORKS!"

From time to time he would meet Schwinger at a conference somewhere and compare results, but not methods. Their approaches remained largely independent because of their practice of not learning each other's approaches, but instead comparing final results and discussing trouble areas in general terms.

Eventually Feynman believed he had produced something valuable, even though it was not yet perfect because some of the infinities refused to be resolved away. The test of his theory was not only in that it gave answers that were correct; but it gave correct answers in **every** instance he tried it.

Feynman tells the story of his coming upon an informal discussion at a physics conference about the correctness of some physicist's answer to a problem. The man, who had spent a year and a half arriving at his answer, described the problem to Feynman, who proceeded that evening to apply his own methods to it. He came back the next day with his own answer, and dumbfounded the other physicist with the fact that, in addition to the phenomenal speed with which he had done the calculations, Feynman's method gave the answer as a function of the electromagnetic mass, where the other man had only been able to solve the problem in the special case where the electromagnetic mass was zero.

"Hard mathematical facts . . . "

Feynman and Schwinger decided to present their theories at a conference at Pocono in 1948. Schwinger went first, giving a very mathematical presentation of his methods; whenever he tried to give a physical example, the audience threw so many questions at him that he postponed the example and went back to the math. Then Feynman came to bat. His ideas were greeted with even less enthusiasm, largely because the field theory was then in vogue and his theory relied upon particle analysis. He found it very difficult to explain his formulations because they relied heavily upon physical arguments and intuition.

At each step he was asked to justify his procedure; instead he offered to work out a physical example to demonstrate the correct results it produced. But the audience objected to the time this would require and the hair involved, even though these had been drastically reduced by his methods. The culmination of the audience's feeling that Feynman was running amok without being rigorous came when Niels Bohr stood up, objected to Feynman's use of trajectories for small particles, and started reminding him about Heisenberg's uncertainty principle. Here Feynman gave up in despair, realizing that he couldn't communicate the fact that his analysis was justified by its correct results.

End not in sight

Feynman then decided to publish what he had so far, without waiting to remove completely the divergence difficulties, as he had originally planned. It turned out to be a good idea, because the difficulties have yet to be removed, even after 17 years. Schwinger and Tomonaga published papers at about the same time. It was for this work that they were all awarded the Nobel Prize 16 years later.

In the interim, opinion gradually shifted away from the field theory view used by Schwinger and Tomonaga and more toward Feynman's particle approach. Perhaps the most important result of his work was the development of Feynman diagrams (pictures of interaction trajectories) which vastly simplify the formerly lengthy and tedious calculations of qed interactions.

Feynman himself believes that the discrepancies of the few remaining infinities in his theory will never be resolved. Instead, he feels personally that when a satisfactory explanation is finally achieved, it will require physicists to discard most of the old ideas and to formulate an entirely new approach.

Laureate Feynman

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theory of the gravitational field is "so far along, but not perfect." As of late, Feynman has turned his attention to the rules of strong nuclear interaction.

Later Feynman told about phoning Tomonaga:

"Congratulations.

" 'Same to you,' replied Tomonaga.

"How does it feel to be a Nobel prize winner?

" ' I guess you know.'

"Can you explain to me in laymen's terms exactly what it was you did to win the prize?

" ' I am very sleepy.' "

California Tech, 1201 E. California Blvd., Pasadena, Calif. 91109
Second Class postage paid at Pasadena, California
Printed by Bickley Printing Co., 25 So. Fair Oaks Ave., Pasadena