Chien-Shung Wu: Overlooked for the Nobel Prize despite 23 nominations!

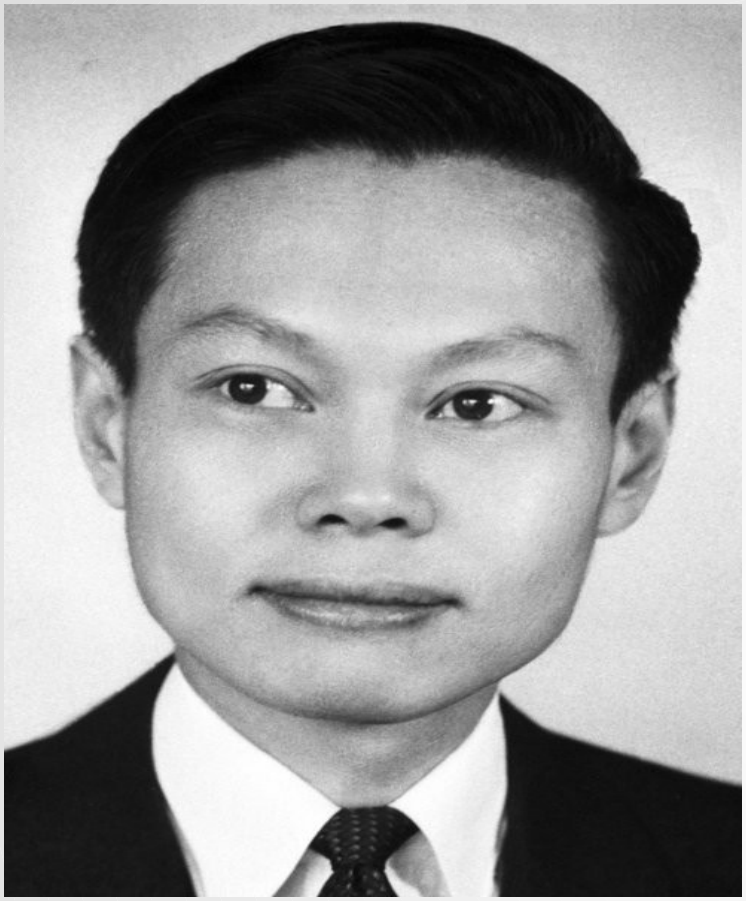
Mats Larsson
Department of Physics
Stockholm University

Situation in 1956

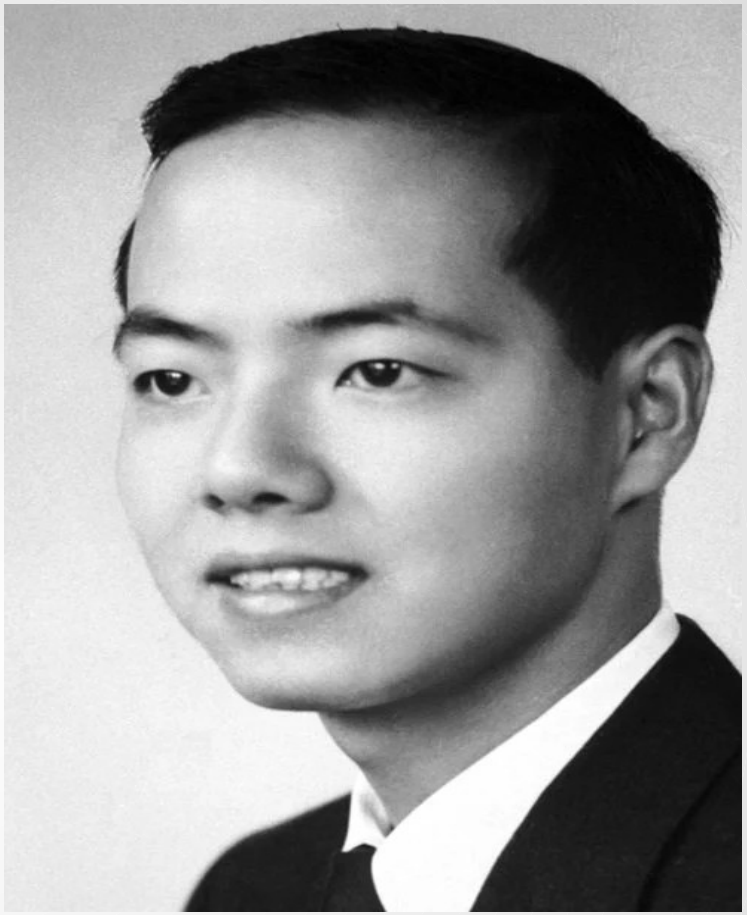
- The τ - Θ puzzle
- τ and Θ the historical names for what is now the K^+ kaon
- τ and Θ had very similar masses and lifetimes, but decayed differently into pions in weak interaction
- Parity was known to be conserved in electromagnetic and strong interaction, and assumed to be preserved in weak interaction
- Thus, τ and Θ could be different particles, which would solve the puzzle

TD Lee and CN Yang had other idea

- Maybe parity is not conserved in weak interaction
- They started to review the literature and found no compelling experimental evidence for parity conservation in weak interaction



Yang at Princeton University



Lee at Columbia University

Some Nobel rules

- The Nobel archive (nominations, special reports, the Nobel Committee report the Royal Swedish Academy of Sciences (KVA), the decision by KVA in pleno)
- However, if a laureate is alive after 50 years, the archive remain closed until no laureate is alive
- Lee lived to become 98 years, Yang died October 2025 at age 103

Some more Nobel rules

- In order to be eligible for a Nobel Prize, you need minimum one valid nomination a particular year
- The deadline for nominations are January 31
- Nomination arriving too late will be registered as a nomination for the following year
- Your discovery or invention must be in print (thus, preprint, press conference, conference presentation do not count)

The strategy of Lee&Yang

- “The basic principles involved in these experiments are all the same: *One constructs two sets of experimental arrangements which are mirror images of each other, and which contain weak interactions. One then examines whether the two arrangements always give the same results in terms of the readings of their meters* (or counters). If the results are not the same, one would have an unequivocal proof that right-left symmetry, as we usually understand it, breaks down.”
- From Yang’s Nobel lecture 1957

Chien-Shiung (Madame) Wu

Madame Wu

- Born in China in 1912
- University studies in China
- Moved to the US in 1936
- PhD in 1940 at UC Berkeley
- Joined the Manhattan project in 1944
- Joined Columbia University in 1945
- Conducted the first experiment on entanglement of two particles (gamma) over macroscopic distance and became an expert on beta-spectroscopy

Article by Lee&Yang

PHYSICAL REVIEW VOLUME 104, NUMBER 1 OCTOBER 1, 1956

Question of Parity Conservation in Weak Interactions*

T. D. LEE, *Columbia University, New York, New York*

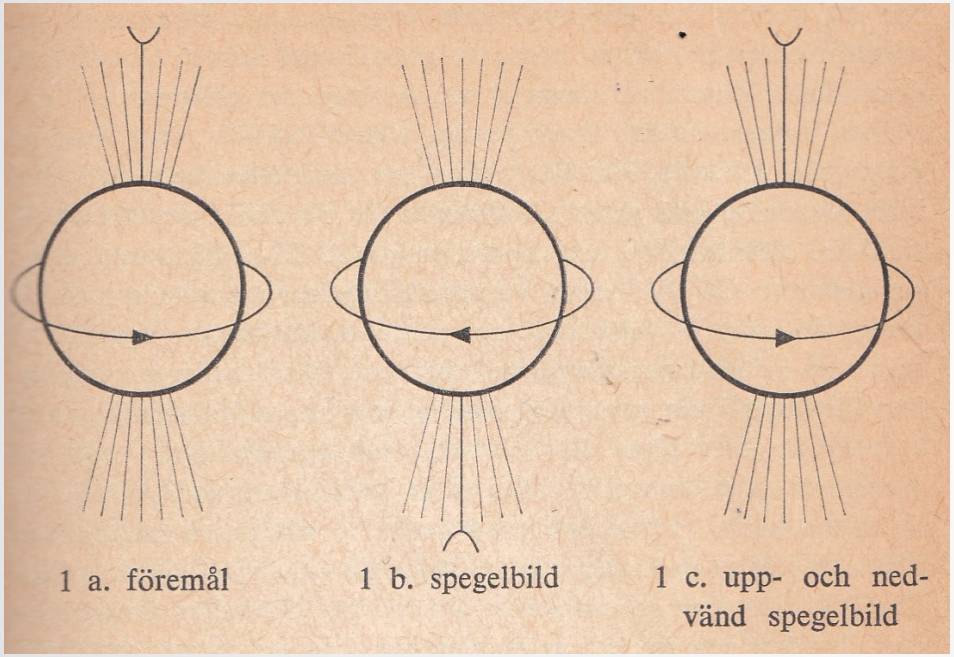
AND

C. N. YANG,† *Brookhaven National Laboratory, Upton, New York*

(Received June 22, 1956)

The authors wish to thank M. Goldhaber, J. R. Oppenheimer, J. Steinberger, and C. S. Wu for interesting discussions and comments. They also wish to thank R. Oehme for an interesting communication.

Beta-spectroscopy



If parity conserved

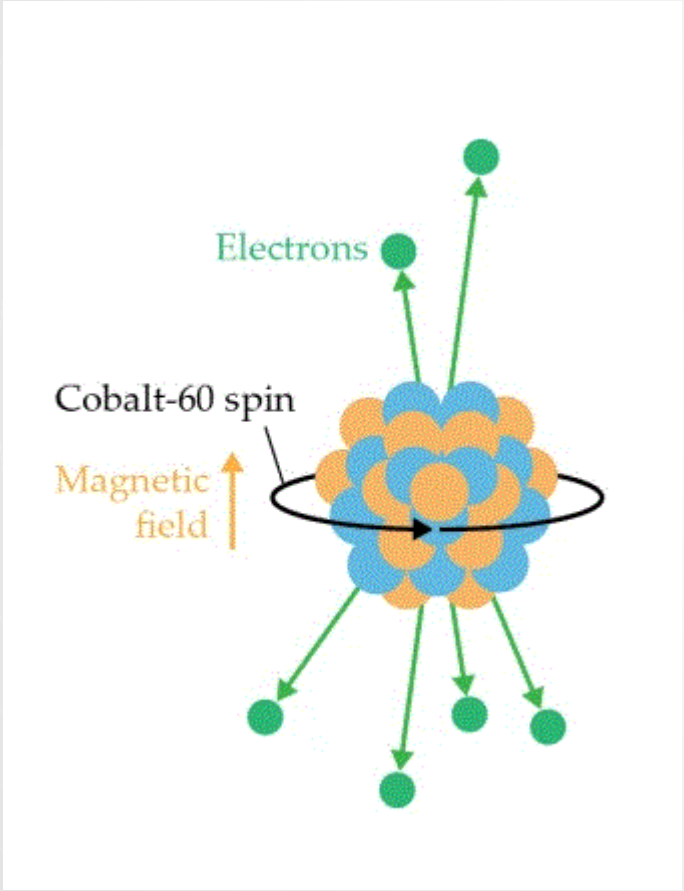
From TR Gerholm “Fysiken och människan”

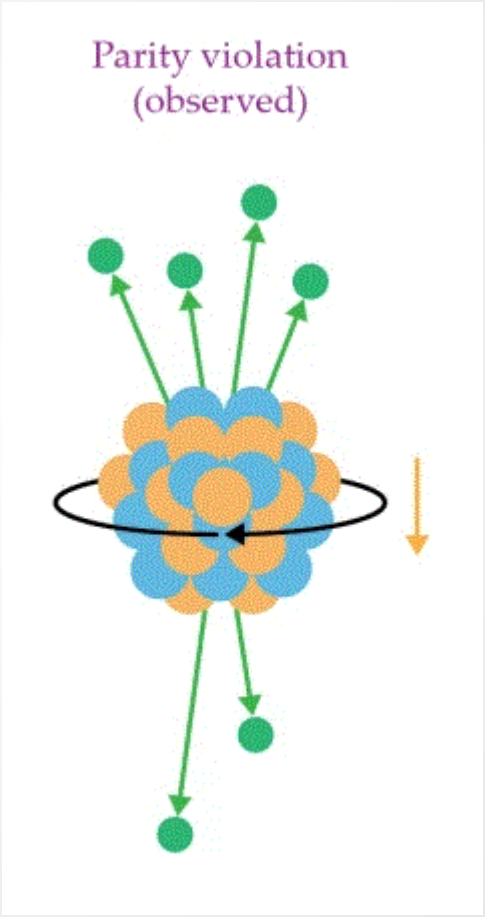
Note: Gerholm nominated Mme Wu in 1974

Beta-spectroscopy

- There had been decades of beta-spectroscopy work
- Why didn’t these experiments reveal any possible parity violations?
- Because thermal motion in room temperature experiments would wash out any effects of parity violation
- Low temperature needed. Wu teamed up with group at NBS in Washington DC that had the low-temperature (0.01 K) technology

Experimental result, Co-60





Mme Wu's experiment

- In beta decay, one could measure the the angular distribution of the electrons coming from beta decays of polarized nuclei. If an asymmetry in the distribution between θ and 180˜ θ (where θ is the angle between the orientation of the parent nuclei and the momentum of the electrons) is observed, it provides unequivocal proof that parity is not conserved.

Wu's article, published February 15, 1957

Experimental Test of Parity Conservation in Beta Decay*

C. S. Wu, *Columbia University, New York, New York*

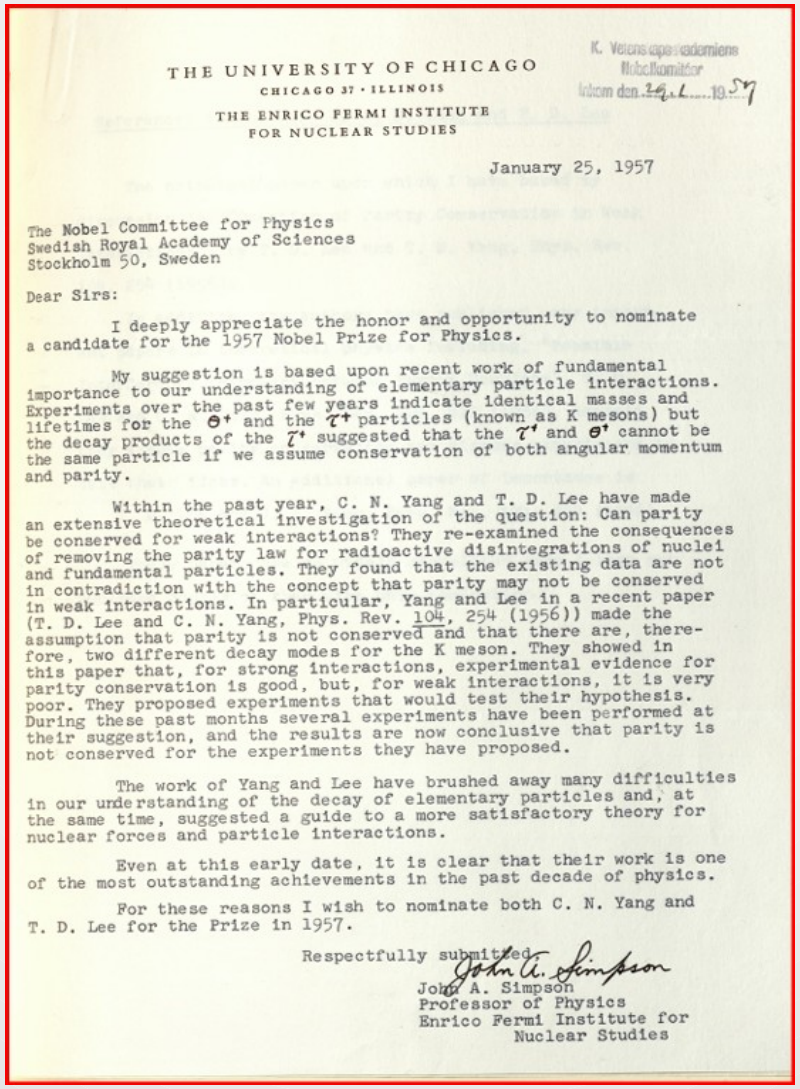
AND

E. Ambler, R. W. Hayward, D. D. Hoppes, and R. P. Hudson,
National Bureau of Standards, Washington, D. C.

(Received January 15, 1957)

The inspiring discussions held with Professor T. D. Lee and Professor C. N. Yang by one of us (C. S. Wu) are gratefully acknowledged.

Nominations of Lee&Yang



THE UNIVERSITY OF CHICAGO
CHICAGO 37 · ILLINOIS
THE ENRICO FERMI INSTITUTE
FOR NUCLEAR STUDIES

K. Vetenskapsakademiens
Nobelkommitté
Inkom den 26 1 1957

January 25, 1957

The Nobel Committee for Physics
Swedish Royal Academy of Sciences
Stockholm 50, Sweden

Dear Sirs:

I deeply appreciate the honor and opportunity to nominate a candidate for the 1957 Nobel Prize for Physics.

My suggestion is based upon recent work of fundamental importance to our understanding of elementary particle interactions. Experiments over the past few years indicate identical masses and lifetimes for the θ^+ and the τ^+ particles (known as K mesons) but the decay products of the τ^+ suggested that the τ^+ and θ^+ cannot be the same particle if we assume conservation of both angular momentum and parity.

Within the past year, C. N. Yang and T. D. Lee have made an extensive theoretical investigation of the question: Can parity be conserved for weak interactions? They re-examined the consequences of removing the parity law for radioactive disintegrations of nuclei and fundamental particles. They found that the existing data are not in contradiction with the concept that parity may not be conserved in weak interactions. In particular, Yang and Lee in a recent paper (T. D. Lee and C. N. Yang, Phys. Rev. 104, 254 (1956)) made the assumption that parity is not conserved and that there are, therefore, two different decay modes for the K meson. They showed in this paper that, for strong interactions, experimental evidence for parity conservation is good, but, for weak interactions, it is very poor. They proposed experiments that would test their hypothesis. During these past months several experiments have been performed at their suggestion, and the results are now conclusive that parity is not conserved for the experiments they have proposed.

The work of Yang and Lee have brushed away many difficulties in our understanding of the decay of elementary particles and, at the same time, suggested a guide to a more satisfactory theory for nuclear forces and particle interactions.

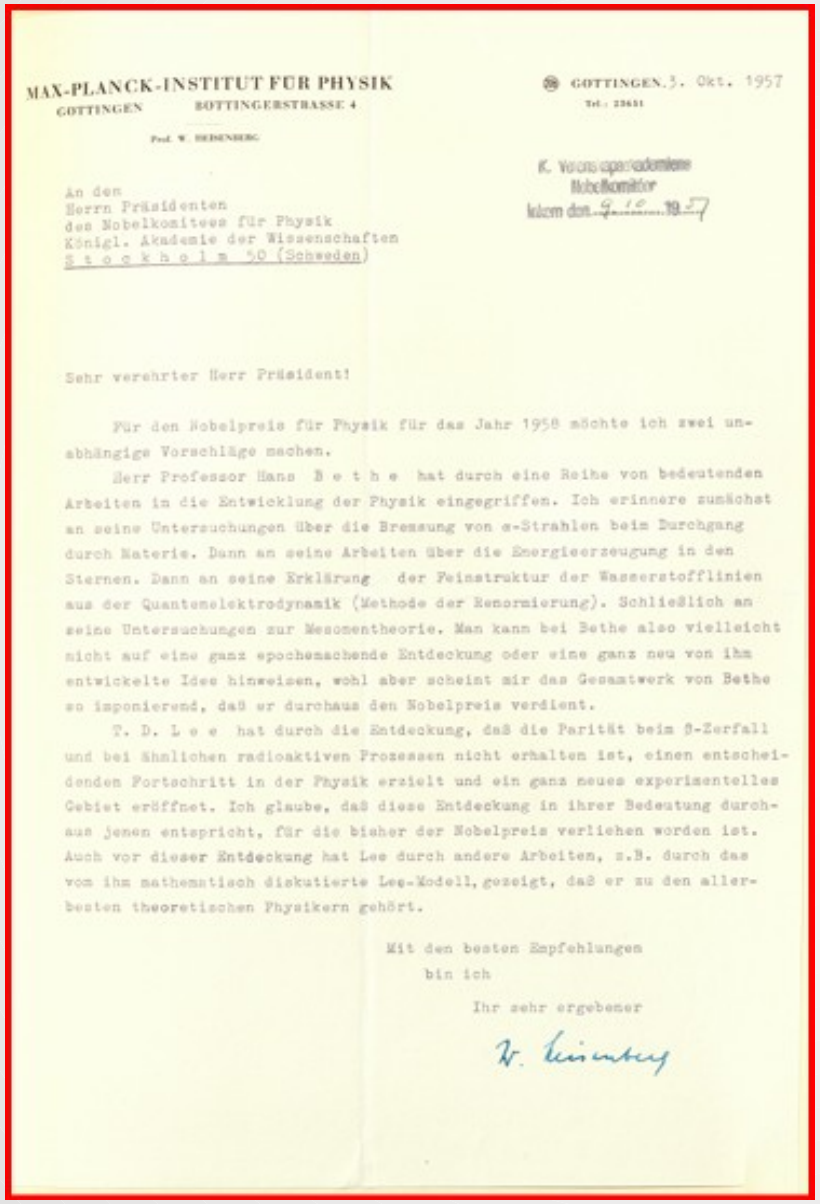
Even at this early date, it is clear that their work is one of the most outstanding achievements in the past decade of physics.

For these reasons I wish to nominate both C. N. Yang and T. D. Lee for the Prize in 1957.

Respectfully submitted,

John A. Simpson

John A. Simpson
Professor of Physics
Enrico Fermi Institute for
Nuclear Studies



MAX-PLANCK-INSTITUT FÜR PHYSIK
GÖTTINGEN BOTTINGERSTRASSE 4

Prof. W. HEISENBERG

GÖTTINGEN, 3. Okt. 1957
Tel.: 23431

K. Vetenskapsakademiens
Nobelkommitté
Inkom den 9.10.1957

An den
Herrn Präsidenten
des Nobelkomitees für Physik
Königl. Akademie der Wissenschaften
S t o c k h o l m 50 (Schweden)

Sehr verehrter Herr Präsident!

Für den Nobelpreis für Physik für das Jahr 1958 möchte ich zwei unabhängige Vorschläge machen.

Herr Professor Hans B e t h e hat durch eine Reihe von bedeutenden Arbeiten in die Entwicklung der Physik eingegriffen. Ich erinnere zunächst an seine Untersuchungen über die Bremsung von α-Strahlen beim Durchgang durch Materie. Dann an seine Arbeiten über die Energieerzeugung in den Sternen. Dann an seine Erklärung der Feinstruktur der Wasserstofflinien aus der Quantenelektrodynamik (Methode der Renormierung). Schließlich an seine Untersuchungen zur Mesonentheorie. Man kann bei Bethe also vielleicht nicht auf eine ganz epochemachende Entdeckung oder eine ganz neu von ihm entwickelte Idee hinweisen, wohl aber scheint mir das Gesamtwerk von Bethe so imponierend, daß er durchaus den Nobelpreis verdient.

T. D. L e e hat durch die Entdeckung, daß die Parität beim β-Zerfall und bei ähnlichen radioaktiven Prozessen nicht erhalten ist, einen entscheidenden Fortschritt in der Physik erzielt und ein ganz neues experimentelles Gebiet eröffnet. Ich glaube, daß diese Entdeckung in ihrer Bedeutung durchaus jenen entspricht, für die bisher der Nobelpreis verliehen worden ist. Auch vor dieser Entdeckung hat Lee durch andere Arbeiten, z.B. durch das von ihm mathematisch diskutierte Lee-Modell, gezeigt, daß er zu den allerbesten theoretischen Physikern gehört.

Mit den besten Empfehlungen
bin ich
Ihr sehr ergebener
W. Heisenberg

Dated October 3, 1957

Received October 9
Counted as Nomination for 1958

Nominations of Mme Wu

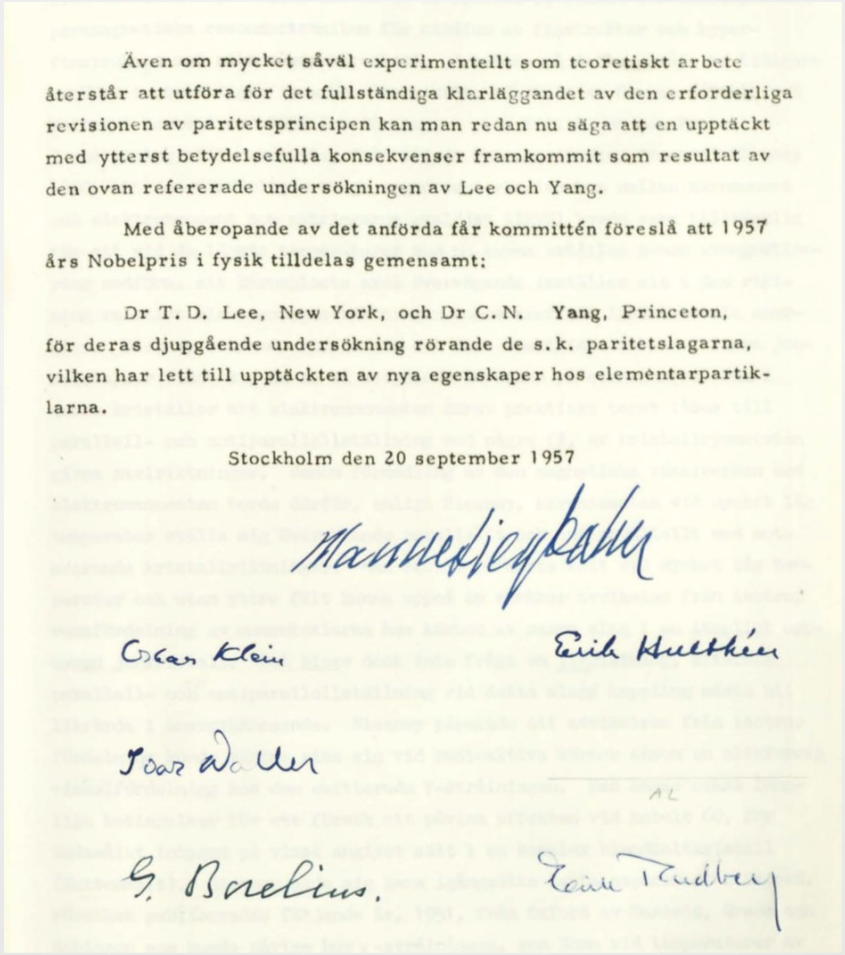
- No nomination during 1957
- Two nominations in 1958: Willis Lamb and Polykarp Kusch. Both Nobel laureates in 1955

Two special reports

- Oskar Klein wrote a special report about theory and devoted much space on Eugene Wigner

- Erik Hulthén wrote about experiments demonstrating parity violation in weak interaction. CS Wu was mentioned first. Thus, the Nobel Committee was fully informed about her experiment

Nobel Committee recommendation



Även om mycket såväl experimentellt som teoretiskt arbete återstår att utföra för det fullständiga klarläggandet av den erforderliga revisionen av paritetsprincipen kan man redan nu säga att en upptäckt med ytterst betydelsefulla konsekvenser framkommit som resultat av den ovan refererade undersökningen av Lee och Yang.

Med åberopande av det anförda får kommittén föreslå att 1957 års Nobelpris i fysik tilldelas gemensamt:

Dr T. D. Lee, New York, och Dr C. N. Yang, Princeton, för deras djupgående undersökning rörande de s.k. paritetslagarna, vilken har lett till upptäckten av nya egenskaper hos elementarpartiklarna.

Stockholm den 20 september 1957

Oskar Klein Erik Hulthén

Ivar Waller

G. Borelius. Erik Rudberg

the proposal on October 23, 1957

- The Physics class fully supported the proposal to award Lee&Yang
- Lise Meitner participated in the meeting

DAGENS NYHETER.

Telefon 22 40 00
A-uppl. Nr 298

Fredagen den 1 November 1957

DN:s Telenytt — 22 84 00

Vardagar 30 öre
Söndagar 35 öre

Zjukov anklagas: Ränker i armén

Kamp om politrukernas makt

UP och TT-AFP. PARIS, torsdag.

Marskalk Zjukov skall tilldelas en "teknisk" reträttpost, rapporterar en korrespondent från Moskva. Ryska kommunistpartiets centralkommitté var på torsdagen alltjämt samlad till överläggningar i Kreml, och man väntar inom kort ett tillkännagivande av vissa personförändringar i Sovjets överkommando samt andra militära organ. En av dem som antagligen skall förflyttas är generalsekreteraren i Warszawapaktens rådgivande utskott, general Antonov, vilken tidigare varit chef för röda arméns generalstab.

I en kommuniké som redan föreligger färdig och väntas bli utfärdad om ett dygn lär Zjukov beskyllas för personlig maktlystnad och försök att hindra partiverksamheten inom armén. På grundval av den-

BONNDOKUMENTEN:

Ingen segertro kvar på Slottet, klagar minister

REKORDUNGA FORSKARE DELAR NOBELS FYSIKPRIS

De båda Nobelpristagarna i fysik, professorerna Chen Ning Yang, till vänster, och Tsung Dao Lee, flankerar pristagaren i kemi, professor sir Alexander Todd, Cambridge, vid en modell som åskådliggör nukleinsyremolekylens invecklade uppbyggnad.

Kineser påvisade fel i accepterad naturlag

Professorn i organisk kemi vid universitetet i Cambridge sir Alexander Todd tilldelades på torsdagen 1957 års Nobelpris i kemi för arbeten över nucleotider och nucleotida enzym. Två unga kineser får dela fysikpriset. De är professorerna Tsung Dao Lee vid Columbiauniversitetet i New York och Chen Ning Yang, Princeton, New Jersey. De bevisade genom upptäckter rörande elementarpartiklarna felaktigheter i en allmänt accepterad naturlag.

De två fysikpristagarna hör till de allra yngsta pristagarna genom tiderna, Yang är 35 år, Lee 31. Det är också i Alfred Nobels anda att de erhållit priset för en veten-

Värmlandskrasch kostar De Geer minst en miljon

Trängsel kring Bibeln Knuttar i konseljsalen när regeringen svor

Kupp mot prinsen Skrev på intyg innan polisen kom

Museikupp gav mynt för 100000

Spolledning vid Slussen vattenrenare

Gotland 1:a i polioskydd

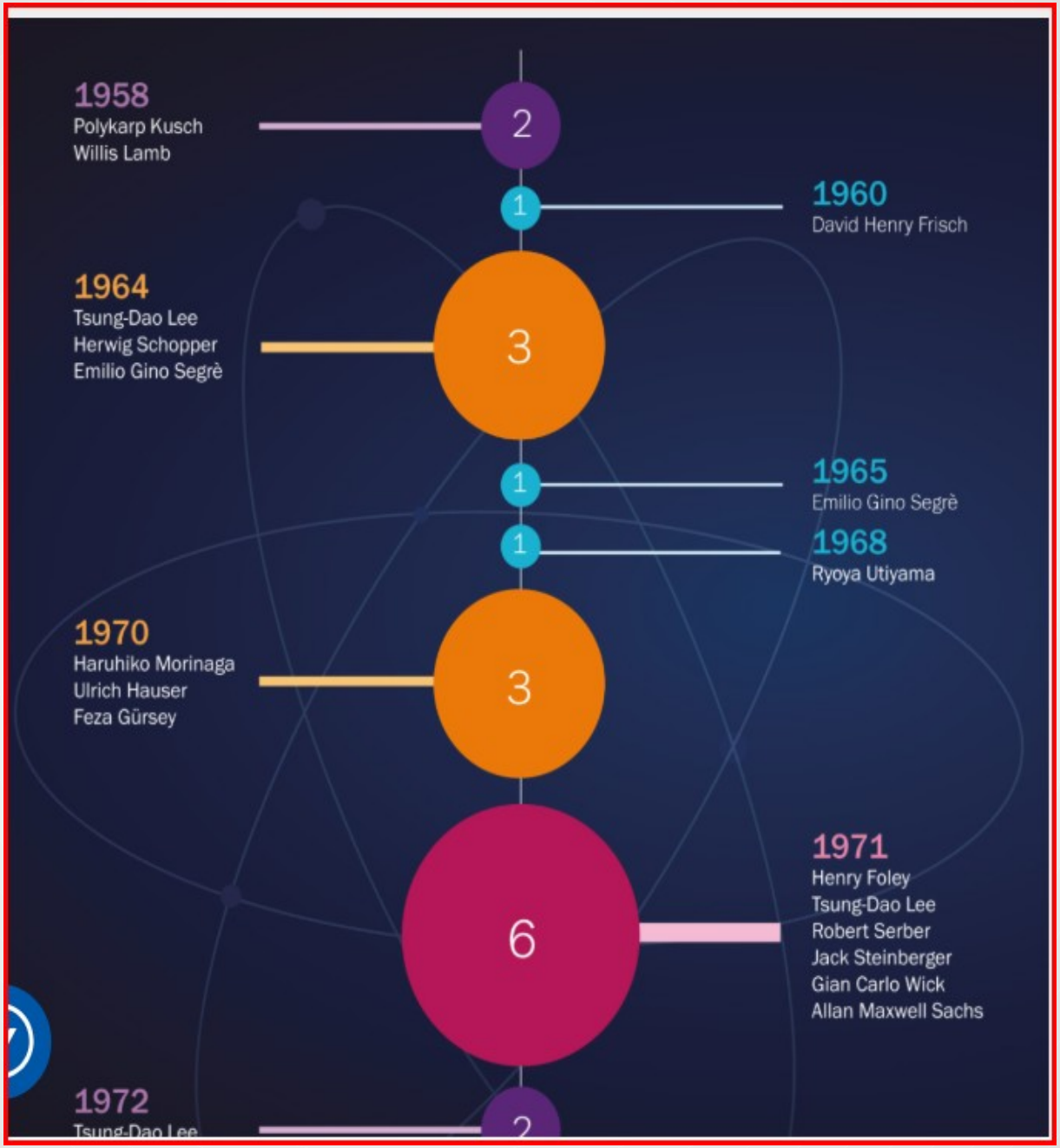
Goda humöret räddade svensk från Atlantdöd

Trivsam DN-läsning i helgen

DN November 1, 1957

10, 1957 the original in Swedish

confine themselves to this negative statement but devised a number of experiments which would make it possible to test the right-left symmetry in different elementary particle transformations, and proposed them to their experimental colleagues. The first of these experiments was carried out by the Chinese physicist, Mrs. C.S. Wu and her collaborators. Very schematically it consisted in the following. Atomic nuclei of a radioactive isotope of the metal cobalt were exposed at very low temperature to a magnetic field – they are themselves small magnets – whereby they became directed just like compass needles. The distribution as to direction of the electrons due to radioactivity was then investigated.


1958
Polykarp Kusch
Willis Lamb
2
1960
David Henry Frisch
1
1964
Tsung-Dao Lee
Herwig Schopper
Emilio Gino Segrè
3
1965
Emilio Gino Segrè
1
1968
Ryoya Utiyama
1
1970
Haruhiko Morinaga
Ulrich Hauser
Feza Gürsey
3
1971
Henry Foley
Tsung-Dao Lee
Robert Serber
Jack Steinberger
Gian Carlo Wick
Allan Maxwell Sachs
6
1972
Tsung-Dao Lee
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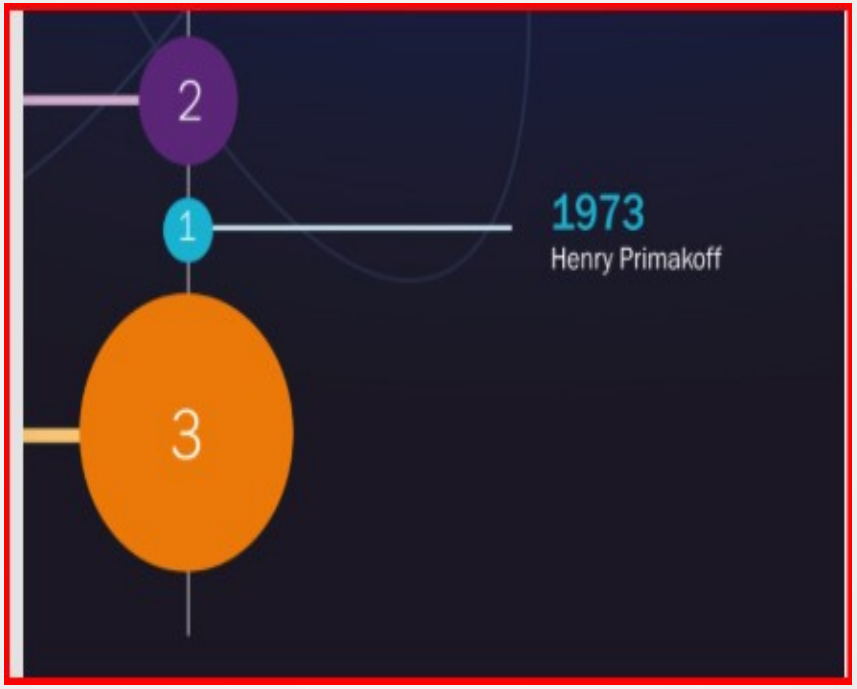
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1
3
1973
Henry Primakoff

Special report by Bengt Nagel 1971

- This is the first special report making comments about Mme Wu since 1957
- Nagel's opinion is that she did the experiment suggested by theorists
- Not on the same level as the discovery of CP-violation in 1964 by James Cronin and Val Fitsch
- Nobel Prize 1980