Gamma

Herwig Schopper

and

Parity Violation

CERN 2009

time reversal

1956
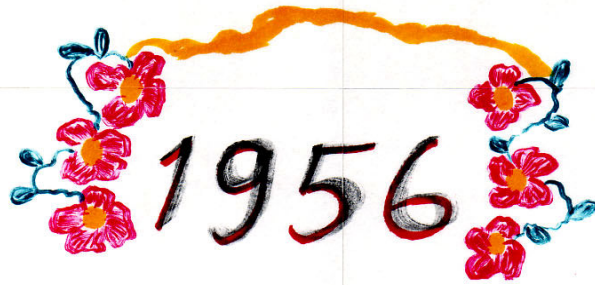
Geneva

let's go to "CERN"

CERN Symposium on High Energy Accelerators and pion physics

~ 250 people

I see 18 Nobel Laureates

go to some sessions

"Theoretical theory"
Gunnar Källén

Excitement

Wolfgang Pauli is making
an announcement

Pauli's announcement, 21 June

I received on June 15th the following telegram ...

We are happy to inform you that we have definitely detected neutrinos ..

I make this announcement because otherwise everybody would ask me separately.

Back to the conference

π π π

n P

Where is HS ???

Cambridge

Erlangen

a few years further back in
time , find him in a

Lightful

environment

Cambridge

Erlangen
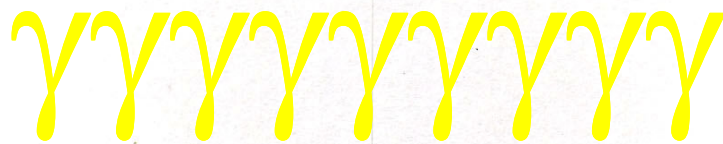
a few years further back in time , find him in a

Lightful

environment

γγγγγγγγγ

374

Phase contrast method

'␣t Hooft's grand uncle,
Fritz Zernike, NP 1953

- 🌸 a large number of experiments

- 🌸 Many solo "collaborations"

- 🌸 finds the equipment he needs, borrows radio-active sources, ...

- 🌸 a master of light and β-spectra

(Lise Meitner Laboratory, Stockholm)

ISI

WEB

OF

KNOWLEDGE

361. Title: DIE OPTISCHE UNTERSUCHUNG DER DIFFUSION VON METALLEN INEINANDER

Author(s): **SCHOPPER H**

Source: **ZEITSCHRIFT FUR PHYSIK** Volume: **143** Issue: **1** Pages: **93-117** Published: **1955**

362. Title: OPTISCHE UNTERSUCHUNGEN DER DIFFUSION VON METALLEN

Author(s): **SCHOPPER H**

Source: **ANGEWANDTE CHEMIE** Volume: **66** Issue: **19** Pages: **607-607** Published: **1954**

363. Title: EIN OPTISCHES KALKSPATINTERFEROMETER MIT WELLENLANGENUNABHANGIGEM INTENSITATSAUSGLEICH

Author(s): **SCHOPPER H**

Source: **ZEITSCHRIFT FUR PHYSIK** Volume: **135** Issue: **5** Pages: **516-522** Published: **1953**

364. Title: ZUR DEUTUNG DER OPTISCHEN KONSTANTEN DER ALKALIMETALLE

Author(s): **SCHOPPER H**

Source: **ZEITSCHRIFT FUR PHYSIK** Volume: **135** Issue: **2** Pages: **163-167** Published: **1953**

365. Title: DIE ERZEUGUNG VON LINEAR POLARISIERTEM LICHT DURCH REFLEXION AN BESCHICHTETEN METALLEN

Author(s): **SCHOPPER H**

Source: **OPTIK** Volume: **10** Issue: **9** Pages: **426-438** Published: **1953**

366. Title: DIE ERZEUGUNG VON LINEAR POLARISIERTEM LICHT DURCH REFLEXION AN EINER DUNNEN ABSORBIERENDEN SCHICHT

Author(s): **SCHOPPER H**

Source: **ANGEWANDTE CHEMIE** Volume: **65** Issue: **3** Pages: **85-85** Published: **1953**

367. Title: *DIE BESTIMMUNG DER MITTLEREN ENERGIE VON BETA-SPEKTREN AUS DER FORM DER ABSORPTIONSKURVE

Author(s): **SCHOPPER H**

Source: **ARKIV FOR FYSIK** Volume: **3** Issue: **4-5** Pages: **441-454** Published: **1952**

368. Title: DIE ERZEUGUNG VON LINEAR POLARISIERTEM LICHT MIT HILFE EINER DUNNEN ABSORBIERENDEN SCHICHT

Author(s): **SCHOPPER H**

Source: **OPTIK** Volume: **9** Issue: **11** Pages: **498-511** Published: **1952**

369. Title: ZUR OPTIK DUNNER DOPPELBRECHENDER UND DICHROITISCHER SCHICHTEN

Author(s): **SCHOPPER H**

Source: **ZEITSCHRIFT FUR PHYSIK** Volume: **132** Issue: **2** Pages: **146-170** Published: **1952**
Times Cited: **70**

370. Title: *DIE BESTIMMUNG DER OPTISCHEN KONSTANTEN UND DER DICKE ABSORBIERENDER SCHICHTEN MIT HILFE DER ABSOLUTEN PHASE
Author(s): **SCHOPPER H**

Wilhelm Tell's conjecture

Der Starke ist am
mächtigsten allein !

back to **GVA-56**

conference ends 23 June

participants & HS don't
know that something GREAT
has happened the day before

Physical Review

has received a paper that
is going to have a GREAT
impact on their lives

$\Theta - \tau$ -Puzzle

Question of Parity Conservation in Weak Interactions

T. D. Lee and C. N. Yang

Parity has not been tested in weak interactions
Suggest experiments to do so

(One might even say that the present theta-tau puzzle may be taken as an indication that parity conservation is violated in weak interactions.

Lee and Yang

GREAT Scientists

careful

This argument is, however, **not to be taken seriously** because of the paucity of our present knowlegde concerning the nature of strange particles. It supplies rather an **incentive for an examination** of the question of parity conservation.)

Already on 9 July PR receives a new paper

Suggest that strange particles with odd strangeness come in

Parity Doublets

Pauli was willing to bet against PV

Källén supported him

A number of other suggestions

theta – tau – oscillation

twin neutrinos

neutral pion is strange

Close our minds

ONE YEAR LATER

(1957)

1957

Rehovoth conf.

nuclear structure

25% proceedings on

Parity Violation

Some pictures from
Pauli Archives, CERN

Pauli
Rehovoth Conference

"A woman gives a talk at the International Congress in Rehovoth"

„There's the woman, again!

not just any

woman

but the GREAT
LADY

Mme Wu

She appreciated
Herwig's work

TABLE 2

$\beta-\gamma$ (circularly polarized) correlation

Radioactive Nuclides	Co^{60}	Na^{22}	Na^{24}	Co^{58}
Transitions	$5^+(\beta^-)4^+(\gamma)2^+(\gamma)0^+$	$3^+(\beta^+)2^+(\gamma)0^+$	$4^+(\beta^-)4^+(\gamma)2^+(\gamma)0^+$	$2^+(\beta^+)2^+(\gamma)0^+$
Types of β-Interactions	Pure G-T	Pure G-T	Mixed	Mixed
A_{exp}	-0.41 ± 0.07 -0.40 ± 0.09	$+0.39 \pm 0.08$	-0.068 ± 0.047	-0.14 ± 0.07
Authors	H. Schopper, F. Boehm and A. H. Wapstra -0.35 ± 0.04 -0.32 ± 0.07 Bloom and Schopper Lundby, Patro, Stroot	H. Schopper	H. Schopper	F. Boehm and A. H. Wapstra

Radioactive Nuclides	Sc^{46}	Au^{198}	Zr^{95}	Sb^{124}
Transitions	$4^+(\beta^-)4^+(\gamma)2^+(\gamma)0^+$	$3^-(\beta^-)2^+(\gamma)0^+$	$\frac{5^+}{2}(\beta^-)\frac{7^+}{2}(\gamma)9^+$ $\frac{5^+}{2}$	$3^-(\beta^-)2^+(\gamma)0^+$
Types of β-interactions	Mixed	Mixed	Pure G-T Mixed	Mixed
A_{exp}	$+0.33 \pm 0.04$	$+0.52 \pm 0.09$	-0.46 ± 0.09	-0.13 ± 0.06
Authors	F. Boehm and A. H. Wapstra $+0.23 \pm 0.06$ Steffen Sc^{44} -0.02 ± 0.04 Hg^{203} -0.06 ± 0.22 F. Boehm and A. H. Wapstra	F. Boehm and A. H. Wapstra V^{48} $+0.06 \pm 0.05$ F. Boehm and A. H. Wapstra	H. Appel and H. Schopper	H. Appel and H. Schopper

Co-60

Na-22, Na-24

Zr-95

Sb-124

Sr&Y-90

- - -

הכנוס הבינלאומי לסבנה הגרעין. מכון ויצמן למדע. רחובות. ישראל
INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE
AT THE WEIZMANN INSTITUTE OF SCIENCE. REHOVOTH. ISRAEL. — SEPTEMBER 8-14, 1957
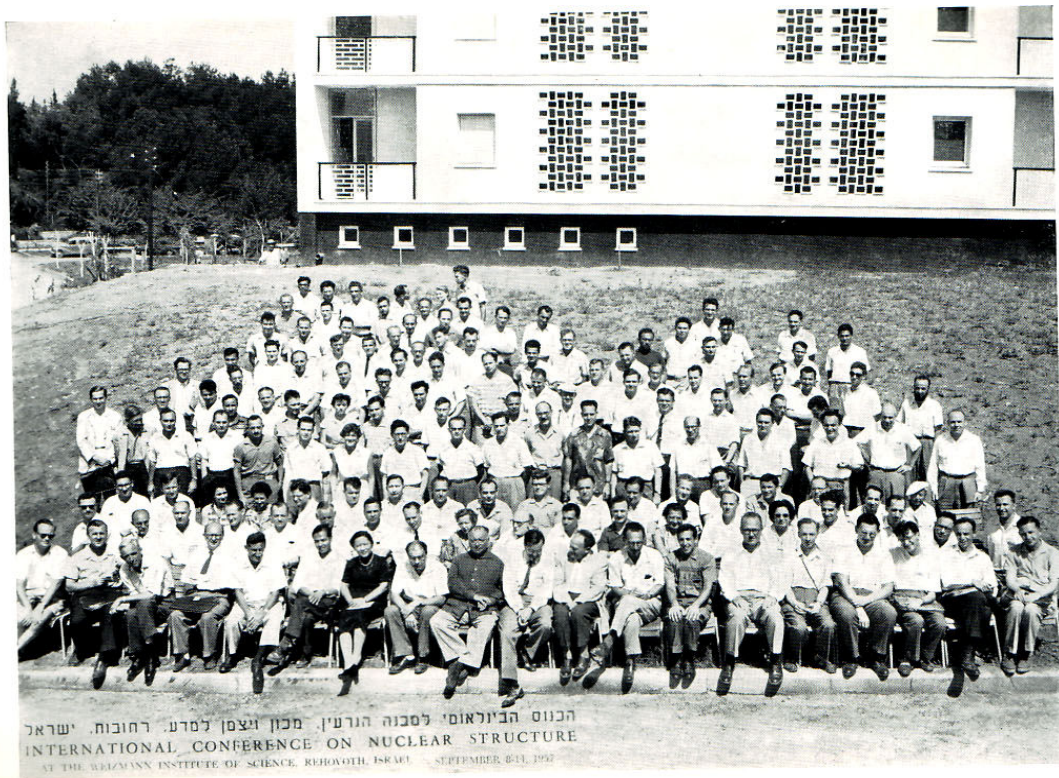
CONFERENCE PARTICIPANTS APPEARING IN GROUP PHOTOGRAPH

1st row seated:

Temmer, Konopinski, Staub, Rosenfeld, Rose, Lee, Wu, Racah, Pauli, Bohr, Rosenblum, Goldhaber, Mottelson, Brueckner, Eden, Moshinsky, Cohen, Deutsch, Sherr.

2nd row seated:

Zweifel, Radicati, Orsten, Siegbahn, Mitchell, Bakker, Langer, Gorodetsky, Mayer, Jensen, Pines, Devons, Faraggi, Wilkinson, Ajzenberg–Selove, de–Shalit, Pauli, Yekutieli, Talmi.

3rd row seated:

Yeivin, Foley, Benoist, N. Marty, Goldring, Steffen, Skyrme, Brolley, Sheline, Bromley, Rozental, Preiswerk, Jancovici, Bloch, De–Dominicis, Tauber, Cotton, ?.

4th row standing:

Peierls, Eisenberg, Meyer, Samuel, Fraenkel, Ross, Shalitin, Cuperman, Alster, Cavanagh, Bennett, Gallman, Low, Jean, Szamosi, ?, Lipkin.

5th row standing:

Kemmer, Lehrer, Lehmann, Yiftah, Nahmias, ?, M. Rakavy, Shima, Sack, Goldstein, Nordheim, Pursey, Church, Cook, Schopper, C. Marty, Verlet, Bayman.

At this point the rows become indistinct. The names will be presented in an overlapping order, roughly resembling the picture.

6th row:

	Banerjee,		Frauenfelder, Duffield,		Soltan,	
Flowers,		Erdos,		Alder,		Kofoed–Hansen,
	Rosendorff,	Fleischmann,		Winther,		
			Wegener,			
	Teitelbaum,		Mandeville,			
Glaubman,		Alburger,	Lindqvist, ?, Bisgard, Olsson, Alaga, ?.			
	?,					

7th row (left side):

?, Zeldes, G. Rakavy,   Titeica,   Kurath,   Koički, Novakov,
            Rosen,   Adler,   Tolhoek,   Schneidmesser.

8th row (left side):

Lane, Nir, Thieberger, Ritter, ?.

9th row (left side):

Nag Chaudhuri, Rothem, Pelah, Wolfson, Angel, Sadeh.

Right side corner (from behind Mandeville):

	?,		Schmorak,	
Eisinger, ?,	?,			Baruch.
Mandeville,		?,	Levêque,	

SHORT CONTRIBUTION

β−γ-**CIRCULAR POLARIZATION CORRELATION**

BY

H. SCHOPPER
Physikalisches Institut der Universität, Erlangen

The general principle of the method has been described in the paper given by Dr. Wu. Here the various possibilities to measure the circular polarization of γ-rays are discussed. The only feasible way to determine such a polarization seems to be the Compton-scattering on polarized electrons. As a scatterer containing polarized electrons one can use magnetized iron. As, however, only 8 percent of the electrons can be oriented even at saturation only a small change in the counting rate is to be expected on reversing the magnetization.

Four methods have been used or proposed so far.

1. FORWARD SCATTERING

The polarization dependent part of the Compton-cross-section possesses a maximum for scattering angles around 55⁰ (dependent somewhat on energy) [1] the electron spin being approximately parallel to the direction of the incoming γ-quantum. If one uses a ring geometry [2,3,4] large solid angles can be used. For a completely polarized 500 keV-γ-ray one obtains an asymmetry of about 5.5 percent. This method was applied to $\beta—\gamma$-circular polarization measurements by Schopper [2] for the first time.

2. BACK SCATTERING

In this case even a higher change in counting rate is to be expected on reversing the magnetization. As, however, the energy of back-scattered quanta is low, one cannot discriminate against γ-rays scattered by the surroundings by pulse height selection. If one uses thin magnetized foils as a scatterer one could count the knock-on electrons. In this case, however, the efficiency turns out to be very low. For these reasons this method has not yet been used successfully.

[7] M. Deutsch, B. Gittleman, R. W. Bauer, L. Grodzius and A. W. Sunyar, Phys. Rev. **107** (1957) 1733
    F. Boehm, T. B. Novey, C. A. Barnes and B. Stech, Phys. Rev. **108** (1957) 1497
[8] A. Lundby, A. P. Patro and J. P. Stroot, Nuovo Cimento **6** (1957) 745
[9] A. Appel and H. Schopper, Zeitschrif. f. Physik in press.

Abstracts

1. H. SCHOPPER and H. APPEL
Physikalisches Institut der Universität, Erlangen

The $\beta-\gamma$-circular polarization correlation of Co^{60} was reinvestigated and the more accurate value $\alpha = -0.35 \pm 0.05$ for the anisotropy coefficient was found. A large anisotropy was detected for Zr^{95} ($\alpha = -0.46 \pm 0.09$). This seems to give evidence for a large ST-interference term. For the forbidden transition of Sb^{124} only a small effect was found. This can only be explained by the assumption that the B_{ij}-matrix elements cancel some of the others.
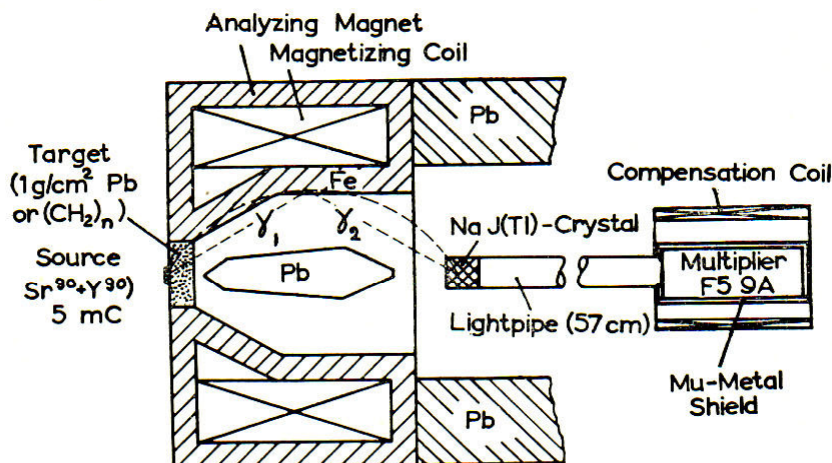

Fig. 1.   Apparatus for measurement of polarization of inner bremsstrahlung

2. H. SCHOPPER, S. GALSTER and G. HARTWIG
Physikalisches Institut der Universität, Erlangen

The circular polarization of the inner bremsstrahlung has been measured for $Sr^{90} + Y^{90}$ as a function of quantum energy with an arrangement shown in Fig. 1. The polarization degree rises from

Earlier

in

1957

H. Schopper
Cavendish Laboratory
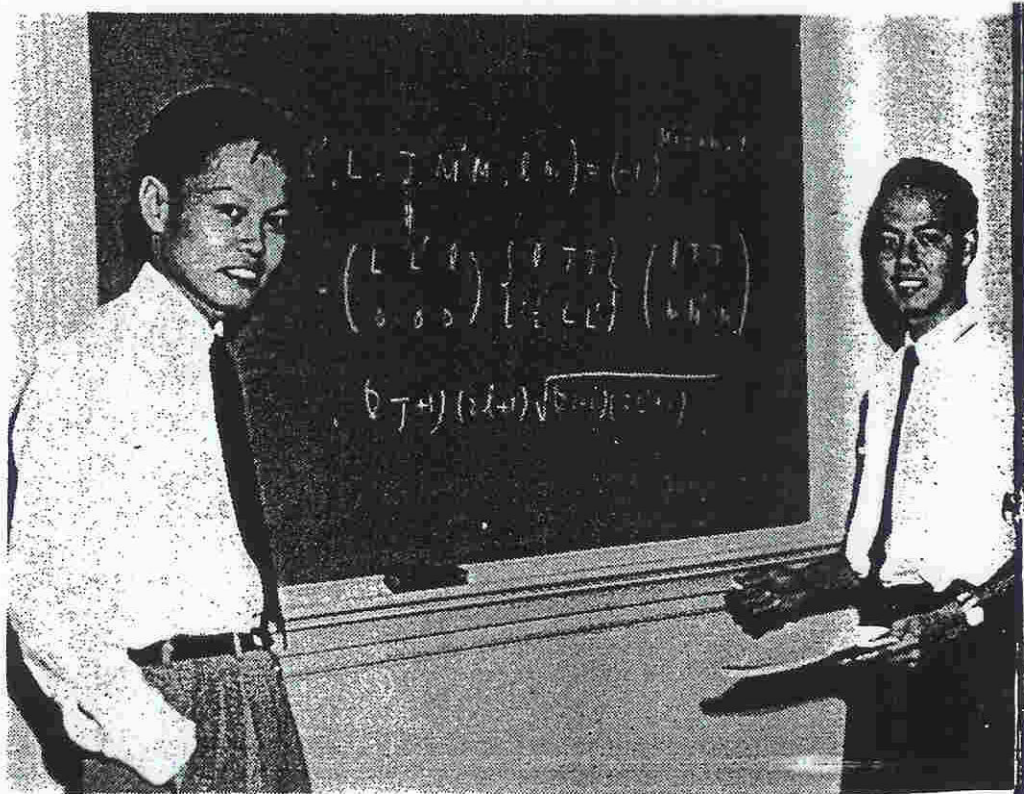
Circular polarization of gamma-rays: Further proof for parity failure in beta decay.

Thanks O. R. Frisch +Bloom.. lending him the coincidence circuit, ..

Outstanding qualities

Nobel Laureates Yang and Lee (*photo by Alan W. Richards*)

C. N. Yang and **T. D. Lee**

striking features

--Maximal parity violation

--Neutrino always involved?

--"Blame it on neutrino"

The two - component
neutrino theory

equations. In the sense of the usual scheme this would signify that the neutrino is always polarized in the direction of its motion (or in the opposite direction). The polarization of the antineutrino is correspondingly reversed. According to this model the neutrino is not a truly neutral particle

In the usual theory the neutrino mass is zero, so to say, accidentally.

vanishes automatically

Lev Landau

1908 - 1968

1958

let's come back to

CERN

a lot of excitement

27 Nobel Laureates

International Conference
on High Energy Physics

a young man from Univ. of
Mainz   HS

known and recognized
for his scientific work

Rapporteurs are asked to provide a reading list

Maurice Goldhaber has on his list (Lee & Yang, Pauli, ..)

Schopper, H.
Fortsch. Phys., 5, p. 581, 1957
  After Goldhaber's talk

Schopper: I would just like to mention that we measured the circular polarization of internal bremsstralung in the K capture of A-37 and find 100% polarization of the whole spectrum. That means that even in K capture parity breaks down completely within the experimental error of 5%.

Keeps on working on PV for several years

Circular polarization of

❀ external bremsstrahl.
❀ internal bremsstral.
❀ electron-emitters
❀ positron-emitters

In the very first volume of PRL, as well as 2 articles in Vol. 4 (1960) , ..(1966)

want to know more?
read his book

" Weak interactions and
nuclear beta-decay "
North-Holland (1966)

☹   not in the library

☺   Amazon 238.09 CHF

WHY PV ???

Lee and Yang 1957

massless photon breakes isospin

massless neutrino breaks parity
(may not be accidental)

Pauli to Mme Wu 1957

What prevented me until now from accepting PV is why this restriction appears only in "weak" interactions, not in the "strong" ones.

interpretation
Do you know somebody in the States, who has real idea about that?

has become
a matter of

WHY

NOT

put it in, don't explain

"Closed our minds"

HS

other outstanding qualities

⇧ **care about theory**

⇧ **care about people, young people**

See Panel disc. **2003**

Thank you