The SLAC Summer Institute
50th Anniversary
Early Years

Fred Gilman

August 19, 2022

The Beginnings

- The idea of the SLAC Summer Institute was born at a special time and at a unique place in the history of particle physics.
  - Why have yet another "summer school" when there were plenty of existing schools in beautiful places, like Les Houches, Erice, … ?
  - Why aim the SSI for postdocs?
  - Why the mixture of lectures and a topical conference ?

- To understand why, you need to understand multiple aspects of the context of the creation of the SLAC Summer Institute with regard to both particle physics and SLAC itself.

Particle Physics in the mid-60s I

- mid-50s to the mid-60s: An amazing array of phenomena were found: new mesons and baryons of different strangeness interacting through strong, electromagnetic and weak interactions; the violation of P and CP in the weak interactions; … Phenomenology and early work on symmetries flourished.
- Many despaired of finding a renormalizable theory of strong interactions, let alone weak interactions. Much of theoretical particle physics was devoted to S-matrix theory, the analytic properties of scattering amplitudes, and seeing if a self-consistent "bootstrap theory" of the strong interactions existed.
- But as Arthur Wightman insisted in his QFT course at Princeton: the central issue of particle physics was whether we could construct renormalizable, well-defined QFTs, involving fundamental fields, to describe nature generally.

Particle Physics in the mid-60s II

- 1964: Murray Gell-Mann and George Zweig introduced the idea of quarks. There were successes in understanding hadron spectroscopy, but two major, major problems: <u>Why aren't quarks seen in high-energy collisions</u>? <u>How can the ground state of three quarks be symmetric and not anti-symmetric</u>?
- Quarks were not in the allowed vocabulary in Princeton where I was a grad student. People who came and talked about quarks as constituents were regarded as crazy and/or not true particle physicists and told so.
- I was at the seminar at the IAS where O. W. Greenberg presented his ideas on para-statistics (think of para-statistics without real para-particles ~"color") to solve the ground state problem. He was stopped mid-seminar and not allowed to continue talking about "nonsense."

Particle Physics in the mid-60s III

- Gell-Mann proposed that while quarks might not be observable, they could be used to abstract a set of commutation relations for the weak vector and axial-vector currents constructed out of quark fields, forming a local $SU(3)_R \times SU(3)_L$ current algebra, which would be valid.

- For me, the miracle years began with 1965 with the calculation by Steve Adler (then at Harvard) and by Bill Weisberger (then at SLAC) that turned the relationship between the commutator of two axial-vector charges being equal to a vector charge into a sum rule involving then-measured quantities. The sum rule was satisfied! For the first time, we had something that was not an extrapolation, a dogma, … , but <u>fundamental, exact, predictive, and testable</u>

Feynman's Calculation After Adler-Weisberger
(From copy to FJG, 1965)

Feynman's notes

(16)

6/30/65

COMMUTATION LAW & AXIAL VECTOR RENORM

ADLER
Phy Rev Letters

Murray says $\left[\int A_t^+(x,t)\,d^3x\,,\ \int A_t^-(x',t)\,d^3x\right] = 2\int V_t^3(x,t)\,d^3x$

That is, the commutation law for space integrals of time components of axial vector current A_μ, and vector currents V_μ commute exactly as expected in SU_3 group $\times\ \gamma_5$. $+,-,3$ refers to I-spin component.

Express in terms of Fourier transforms $A(Q,\omega) = \int A(x,t)\,e^{iQ\cdot x}e^{i\omega t}\,d^3x\,dt$, etc.

$$\int [A_t^+(0,\omega'),\ A_t^-(0,\omega'')]\,e^{i(\omega'+\omega'')t}\,d\omega'\,d\omega''/(2\pi)^2 = 2\int V_t^3(0,\omega)\,e^{i\omega t}\,d\omega/2\pi$$

or $\int [A_t^+(0,\omega'),\ A_t^-(0,\omega-\omega')]\frac{d\omega'}{2\pi} = 2V_t^3(0,\omega)$

Particle Physics in the mid-60s IV

- Current algebra sum rules (and other sum rules) quickly became all the rage in theoretical particle physics worldwide.
- By the time of the 1966 International Conference on High Energy Physics in Berkeley, there was already a separate parallel session and rapporteur's talk on current algebra.
- This ICHEP was unusual in a different way, in that effectively the summary talk was given at the very beginning of the conference, by the person who was recognized as the outstanding person to give that talk,

Murray Gell-Mann

Opening Session of the 1966 ICHEP at Berkeley
Gell-Mann, Goldberger, …, Bjorken, Beg, Ne’eman, Glashow, …
… J. R. Oppenheimer, F. Oppenheimer, Salam, … Drell … Feynman …

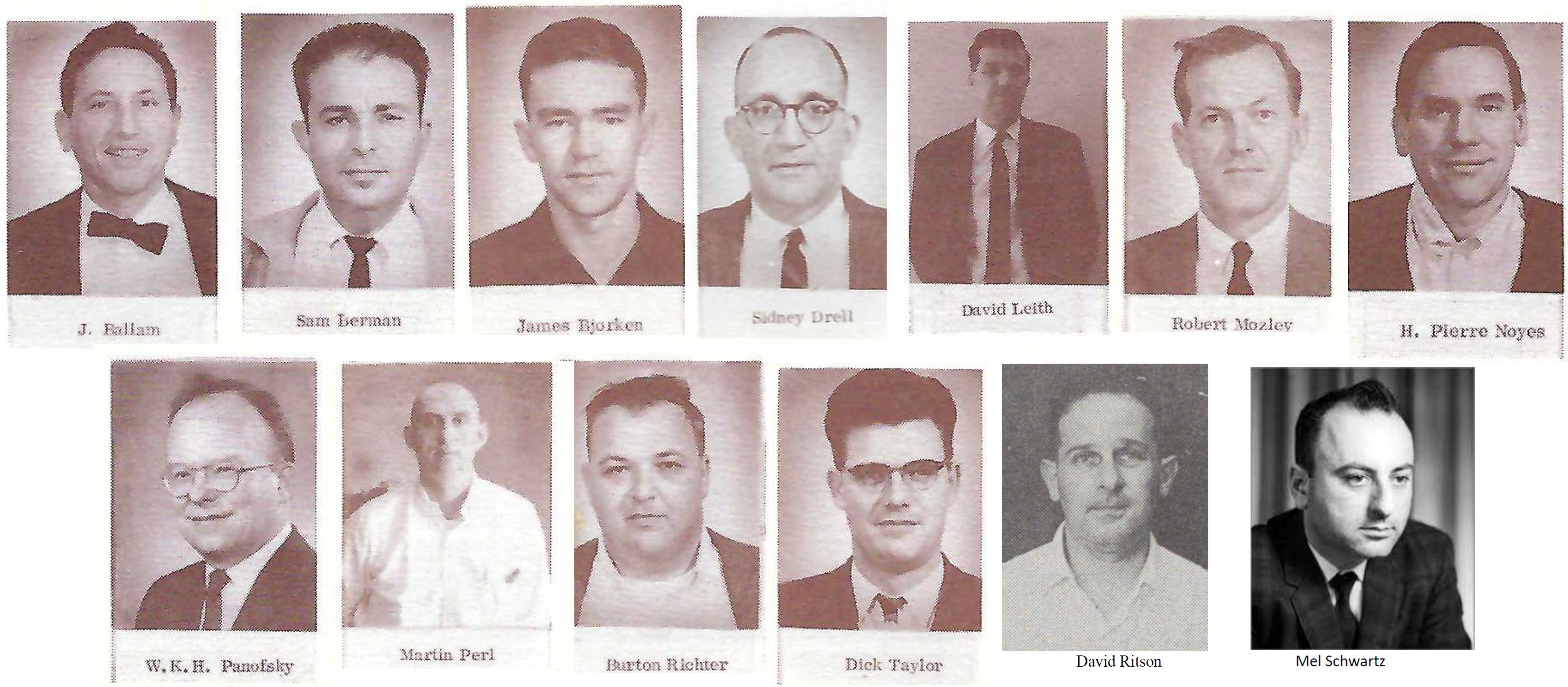
SLAC Beginnings I

• Meanwhile, back at the Stanford ranch, a two-mile, 20 GeV linear electron accelerator, originally called Project M (for monster), was brought from an initial meeting in Panofsky's living room in1956 to authorization at a cost of $114M by the Joint Committee on Atomic Energy in 1961.

(Please read the uncertain path to SLAC construction in *Pief Remembers*)

- Construction started in 1962; first-beam occurred in 1966.
- SLAC was regarded by many outside of SLAC as a sideline to the main route for exploration of the high-energy frontier with proton machines by studying two body elastic and inelastic scattering at high energies, hadron spectroscopy, … at that time.

SLAC Picture Book 1968
12 SLAC + 2 Physics Faculty



- Out of the 8 experimental group leaders, 4 would win (different) Nobel Prizes in Physics.
- Out of the 1960s and early 1970s postdocs, at least 7 became HEP laboratory directors or deputy directors.

SLAC Picture Book 1968
Two More Key People

Louise Addis

SLAC Library

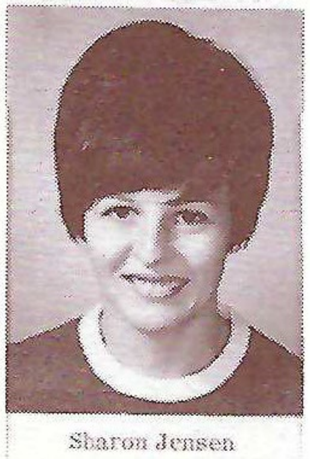
Vision of a Digital Library

Weekly preprint lists (with Rita Taylor) to

the first WWW website outside CERN with Paul Kunz,

and the initial "WWW killer app" = SPIRES HEP

(description of Tim Berners-Lee)



Sharon Jensen

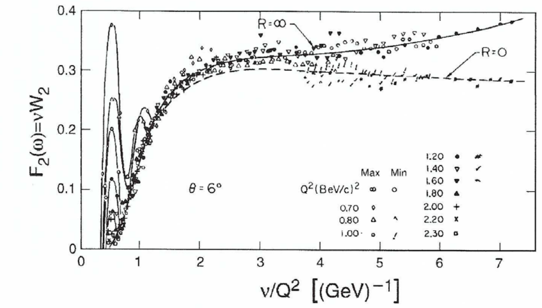
Theory Group Secretary

super-secretary and psychologist

Major contributions to TeX, Macros

SLAC Beginnings II
Great Discoveries Begin and Quarks Become Real

- 1967 Bjorken presents “quasi-elastic peak” for point constituents in inelastic ep scattering at the 1967 ISLPIHE at SLAC
- 1967–1968 The SLAC-MIT Collaboration measures “big” cross-sections; rather than elastic and inelastic swamped in the bremsstrahlung mud
- 1968 ICHEP Vienna First “test” of scaling a la Bj is shown in parallel session and was “flashed” near the end of Panofsky’s plenary talk. <u>Here is the slide</u>:



- 1968 During the Vienna meeting, Feynman visits his sister and was briefed on the SLAC-MIT results and scaling during a stop at SLAC. Feynman’s parton model soon became the standard language worldwide.

SLAC Beginnings III
Great Discoveries Begin and Quarks Become Real

- 1968–1969 SLAC-MIT runs over a much bigger kinematic range; checks
- 1969 ISLPIHE Liverpool Scaling, some non-quark theories being ruled out
- 1970 ICHEP Kiev Measurement of n/p << 1; Other theories ruled out;
  Quark-doubters asymptotically approaching zero
- Early1970's The theorists emerge triumphant: SU(3) x SU(2) x U(1)
  for the strong and electroweak interactions
  Inelastic e and ν scattering exhibit scaling, spin ½ quarks
  Polarized electron-and-target deep inelastic scattering

Origins of the SSI Idea I

- As the Standard Model began to emerge and SLAC became a leading particle physics lab, the idea of the SLAC Summer Institute formed in parallel.

– While there were multiple strong reasons behind creating the SSI, in the background was an issue from early SLAC history, now long irrelevant. When SLAC was formed, SLAC faculty did not teach undergraduates; by decree, that was entirely left to the Stanford Physics Department. However, also by decree, Stanford graduate students could have SLAC faculty advisors.

SLAC faculty were occasionally invited by the Department to teach special topics courses to grad students. Some SLAC faculty were quite happy not having to teach; others chaffed at the restrictions, and feeling being less a part of campus intellectual life.

Origins of the SSI Idea II

- After mulling about this situation for several years, the SLAC faculty decided to create our own, unique school where we selected the teachers and the students. Special credit to David Leith, but also to a core of others who promised to make the effort to give continuing effort both to running the SSI and to lecture in it.
- We decided to
  - capitalize on the increasing international stature of SLAC;
  - teach on the biggest possible stage;
  - teach to a different audience, aiming primarily at postdocs;
  - and, in addition, bring to the participants an understanding of the frontier of particle physics in a specific area with a three-day topical conference.

Implementation of the SSI Idea

- Other traditions were added, and unseen benefits occurred naturally:
  - afternoon discussion sessions with the lecturers, a reception following for all;
  - many SLAC scientists “dropped in” to interact and learned about the the science they were creating and also came for the major talks in the topical conference from the beginning;
  - The opening reception at the Rodin Garden was added, and the rotation of dinners from local restaurants with Mariachi bands, chamber music, ... ;
  - SLAC families came together informally at SSI dinners;
  - speakers and participants were invited to our homes;
  - new friendships were made nationally and internationally.

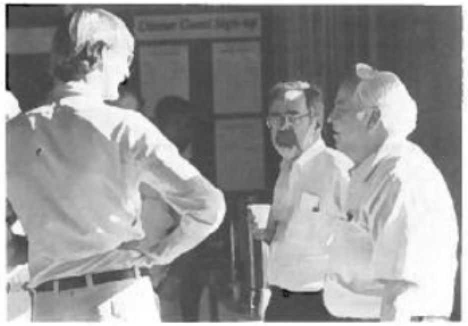
Implementation of the SSI
SLAC Summer Institute Pictures (courtesy of Harvey Lynch)











The SLAC Summer Institute Begins

- 1973

  Topic: Deep Inelastic Electroproduction

  Directors: S. Drell and D. Leith

  Lecturers: J. D. Bjorken, Y. Frishman, F. Gilman, M. Perl
- 1974

  Topics: The Strong Interactions

  Directors: R. Blankenbecler and D. Leith

  Lecturers: D. Leith, L. Jones, M. Davier, R. Cashmore, F. Gilman, D. Sivers, R. Blankenbecler, H. Abarbanel, J.Willemsen

The SLAC Summer Institute 1975
The Standard Model is Born

- 1975

  Topic: Deep Hadronic Structure and the New Particles

  Directors: R. Blankenbecler and D. Leith

  Lecturers: F. Gilman, E. Bloom, J. D. Bjorken, M. Davier, H. Harari, G. Trilling

- All the fermions in the standard model were postulated and named at the 1975 SSI, except for the tau, which was still called U. The fundamental interactions had already been discovered and “certified” at ICHEP 1974 in London.

  EW symmetry breaking was usually thought to be outside the standard model, and unlikely to be a single Higgs boson.

The SLAC Summer Institute 1975
Martin Perl's Talk in the Topical Conference on eμ Events

- The possible heavy lepton was at first called U, for unknown; later officially named τ
- No conventional explanation for all events
- Data consistent with $e^+ e^- \to U^+ U^-$, $M_U \sim 1.8$ GeV, 3-body decay of the U; inconsistent with 2-body

are not complete by any means. However we can draw some conclusions.

(1) We believe that anomalous eμ events described by Eq. 8.1 exist because we have not yet found any conventional explanation for all such events. Only 20 to 35% of them can be explained by various background mechanisms.

(2) The data are consistent with the hypothesis of the production of pairs of new particles of one or more types U_1, U_2 ...

$$\begin{aligned} e^+ + e^- &\to U_1^+ + U_1^- \\ e^+ + e^- &\to U_2^+ + U_2^- \\ &\cdots\cdots\cdots \end{aligned} \qquad (8.2)$$

provided at least one of these types has 3-body decay modes.

(3) The data is not consistent with all the events coming from 2-body leptonic decays of the U's.

(4) We know of nothing which is inconsistent with the hypothesis that all the events come from the 3-body decay of a U particle. In particular the 3-body decay could be the purely leptonic decay of a sequential heavy lepton.

(5) The observed production cross section does not determine the nature of the U. In Fig. 12 $\sigma_{e\mu,\text{observed}}$ is fitted with three different hypotheses:

(a) The U is a sequential heavy lepton ℓ of mass 1.8 GeV/c^2 with V-A coupling and a massless neutrino. The production cross section is given by Eq. 1.8.

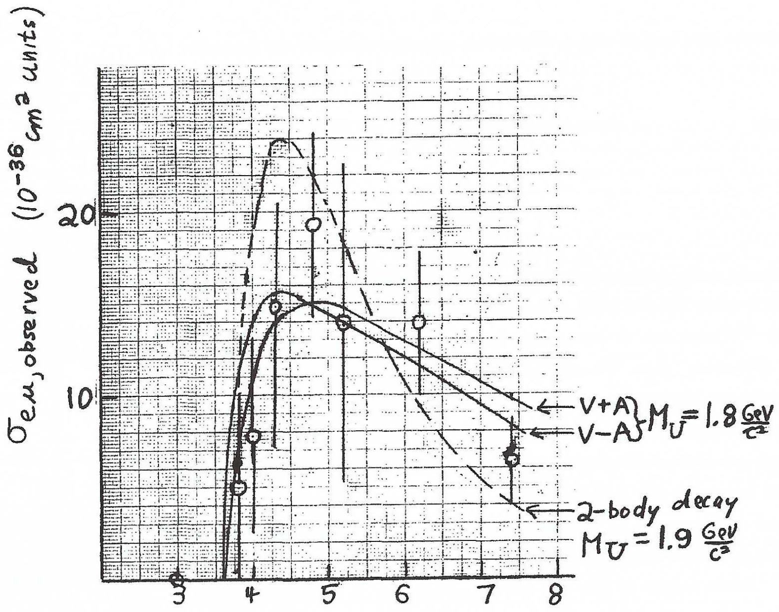


Fig. 12 Fits to $\sigma_{e\mu,\text{ observed}}$. The solid curves are for the production of a pair of 1.8 GeV/c^2 mass leptons (U) assuming purely leptonic decay with V+A or V-A for the U - γ_U current as indicated. The dashed curve is for the production of a pair of 1.9 GeV/c^2 mass bosons (U) assuming 2-body, purely leptonic decay modes, a production form factor F = constent/s, and a production cross section given by Eq. 8.5. All neutrinos are massless.

350

The SLAC Summer Institute 1975
Gail Hanson's Talk in the Topical Conference
Polarized Beams + Quark Jets + Quarks Have Spin 1/2

− Spin-flip bremsstralung polarizes the storage ring beams => virtual photon perpendicular to the ring => φ dependence around beam.

− At 6.2 GeV, $\gamma(g_e - 2)$ resonance depolarizes the beams! At 7.4 GeV, P ~ 70% from the μ+ μ− φ dependence.

− Jets were seen at the highest SPEAR energies. The angular distributions for jet pairs are like those for muon pairs => quarks have spin 1/2

− In my talk on the Theory of e^+e^- Annihilation at ISLPIHE, I noted that the sphericity of the jets in momentum space at 7.4 GeV were

~ my-then-sphericity(!) in 3-D.

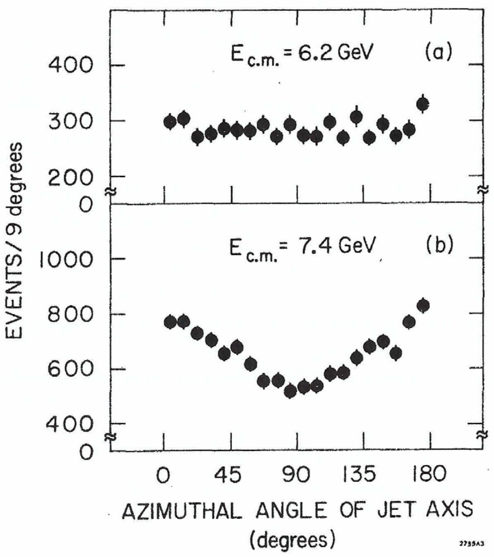


Fig. 9 Observed distributions of jet axis azimuthal angles from the plane of the storage ring for jet axes with $|\cos\theta| <$ 0.6 for (a) $E_{c.m.}$ = 6.2 GeV and (b) $E_{c.m.}$ = 7.4 GeV.

determine the azimuthal asymmetry expected for a pair of jets with angular distribution

$$\frac{d\sigma}{d\Omega} \propto 1 + \alpha \cos^2\theta + P^2 \alpha \sin^2\theta \cos 2\varphi \quad , \qquad (1)$$

where

$$\alpha = \frac{\sigma_T - \sigma_L}{\sigma_T + \sigma_L} \quad ,$$

σ_T and σ_L are the transverse and longitudinal cross sections which describe the production of the jets, φ is the azimuthal angle from the plane of the ring, and P is the average magnitude of polarization of each beam.[9,10] For the data at $E_{c.m.}$ = 7.4 GeV P^2 as determined from $e^+e^- \to \mu^+\mu^-$ was 0.47 ± 0.05. The observed azimuthal asymmetry of the jet axis for jet axes with $|\cos\theta| \lesssim 0.6$ was 0.11 ± 0.01. From the limited-transverse-momentum model Monte Carlo simulation we found that the ratio of the observed to the produced azimuthal asymmetry for $|\cos\theta| \lesssim 0.6$ was 0.57 ± 0.02 for values of P^2 and α which gave observed azimuthal asymmetries in agreement with the data. This reduction in asymmetry is due to the geometric acceptance and angular resolution of the detector and the fact that we did not detect neutral particles. In addition, our method of reconstructing the jet axis does not give exactly the produced jet axis even for perfect detection. Using the measured value of P^2, the measured jet axis asymmetry, the theoretical produced jet axis asymmetry as a function of P^2 and α (obtained by integrating Eq. (1)), and the ratio of produced to detected jet axis asymmetry from the Monte Carlo simulation, we determined α. We found $\alpha = 0.82 \pm 0.13$ and $\sigma_L/\sigma_T = 0.10 \pm 0.08$. The errors are statistical only; however, we have estimated that the systematic errors are small compared

The SLAC Summer Institute 1975
Haim Harari's Lectures + ISLPIHE: 6 Leptons and 6 Quarks
3 doublets of leptons including U, ν_U + cancellation of triangle anomalies
=> another quark doublet: t (top) and b (bottom)

It is therefore, clear that if (V+A) currents are present, the threshold for the b-quark must be above the energies available at the Fermi laboratory.

We may now summarize our conclusions at this stage:

(A) At least four leptons and four quarks are produced at present SPEAR energies.

(B) In addition, at least one more quark with charge 2/3 <u>or</u> one more charged lepton are produced at present energies. We may also have two more quarks (a total of six) or one new lepton <u>and</u> one or two new quarks.

(C) The ψ-spectrum hints that the fourth charmed quark is sufficient.

(D) The $e\mu$ events probably necessitate a new charged lepton.

(E) (V+A) currents may be present, only if six or more quarks exist. Such currents are not required by the data. One or two of the six quarks may be produced only above the SPEAR and Fermi Laboratory energies.

XVI. <u>Model Building: Summary</u>

The present experimental information and its phenomenological analysis, teach us[37] that the <u>SPEAR data</u> is consistent with a model including four tricolored quarks and six leptons with V-A interactions. The left handed quarks and leptons belong to weak SU(2) doublets:

$$\begin{pmatrix} u \\ d' \end{pmatrix} \quad \begin{pmatrix} c \\ s' \end{pmatrix} \quad \begin{pmatrix} \nu_e \\ e^- \end{pmatrix} \quad \begin{pmatrix} \nu_\mu \\ \mu^- \end{pmatrix} \quad \begin{pmatrix} \nu_U \\ U^- \end{pmatrix}$$

This can be viewed, at present, as a "minimal" scheme. It is undoubtedly the simplest scheme which is more or less consistent with all the data.

A fundamental theory based on these fermions will, however, be inadequate. A condition for the renormalizability of a gauge theory of weak and electromagnetic currents is the cancellation of the triangular anomalies[51] (figure 19). In a pure (V-A) theory the necessary and sufficient condition for such a cancellation is:[52]

$$\sum_{\text{fermions}} Q_i = \sum_{\text{quarks}} Q_i + \sum_{\text{leptons}} Q_i = 0$$

For each weak doublet of leptons, $\Sigma Q_i = -1$. For each weak doublet of tricolored quarks $\Sigma Q_i = 3\left(\frac{2}{3} - \frac{1}{3}\right) = 1$. Consequently, the overall $\Sigma Q_i = 0$ condition requires an equal number of quarks and leptons in a V-A theory. The minimal extension of the above theory would therefore be to add the two additional quarks[34] (t,b). Their production threshold may very well be above the SPEAR and Fermilab energies.

There is no experimental or phenomenological need for V+A currents. However, such currents may well exist, and there are intriguing theoretical possibilities related to them. Of particular interest is the hypothesis that in the limit of vanishing fermion masses, the theory of the weak interactions is a parity conserving, pure vector theory.[48,49] Only the presence of masses breaks the vector current into (V-A) + (V+A) combinations. According to this line of thinking, the same mechanism which creates the fermion masses, and induces their mass differences and Cabibbo angles, is also responsible of parity violation.

This interesting possibility has its theoretical complications, and it requires much more study. Among other things, it requires the existence of additional neutral leptons, and the violation of lepton number conservation.

Each of the three theoretical models mentioned in this section require between 18 and 27 different types of "fundamental" fermions. This is comparable to the number of known hadrons when SU(3) symmetry was introduced in

The SLAC Summer Institute 1976
Celebration of the Discovery of Charmed Particles

- 1976

Topic: Weak Interactions at High Energy and the Production of New Particles

Directors: F. Gilman and D. Leith

Lecturers: J. D. Bjorken, S. Wojcicki, G. Feldman, J.D. Jackson, D. Hitlin

Shelly Glashow came to give the concluding talk at the topical conference and do his victory lap, all the while complaining that the SLAC-LBL group should have found charm much earlier.

The SLAC Summer Institute 1976 -1989

- Starting in 1976, David and I worked together as co-directors of the SLAC Summer Institute for the next fourteen years. In addition, I gave lectures in four of those SSIs. In 1980, Gary Feldman joined us and we were all partners through the 1980s, after which I left to build the Physics Research Division at the Super Collider. I spoke once again in 2005 on the future of HEP.

G. Feldman, F, Gilman, and D. Leith listening to an afternoon discussion with our colleagues, J. Dorfan and H. Lynch

The SLAC Summer Institute 1976
Dave Jackson – A Tutorial on Charm

- Dave Jackson and Dave Hitlin gave excellent theory and experimental lectures on charm. Jackson presented what became a famous cartoon as his conclusion:

SSI 1976: Dave Jackson II

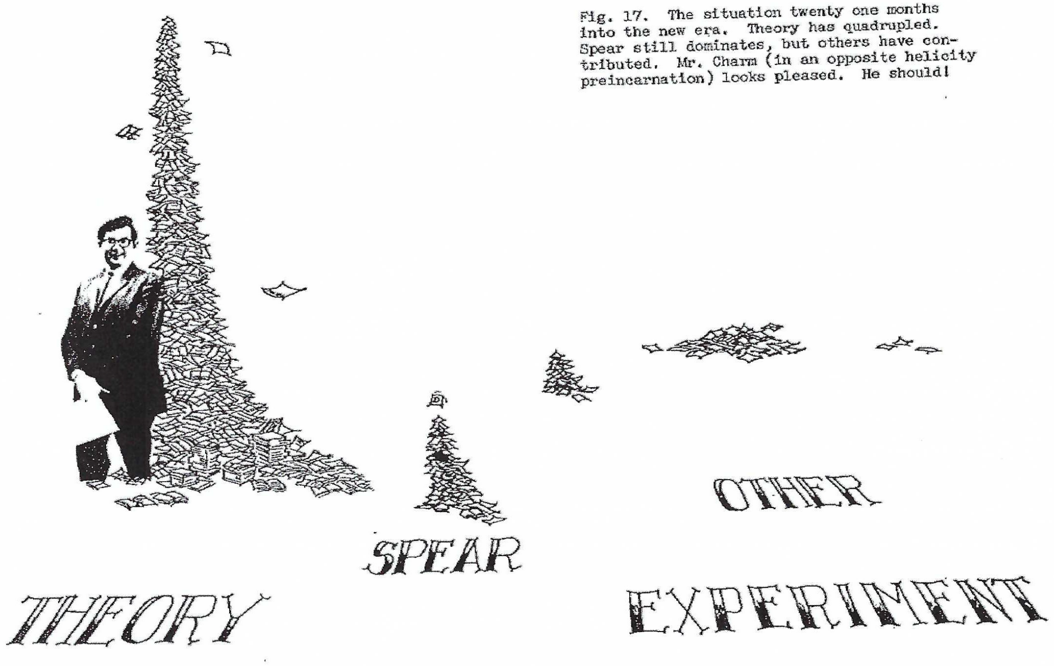


Fig. 17. The situation twenty one months into the new era. Theory has quadrupled. Spear still dominates, but others have contributed. Mr. Charm (in an opposite helicity preincarnation) looks pleased. He should!

XBB 767-6522

The SLAC Summer Institute 1984

- 1984

  Topic: The Sixth Quark

  Directors: G. Feldman, F. Gilman, D. Leith

  Lecturers: E. Eichten, C. Damerell, T. Himel, G. Kane, S. Wojcicki,
  T. Ekelof, H. Harari

  + PIEF - FEST with talks by
    S. Drell, R. Wilson, T. D. Lee, F. Press, J. Steinberger,
    B. Richter, J. Weisner

The SLAC Summer Institute 1984
SLAC Beamline Announcement
+ A Softball Game?

Sixth-Quark Theme

TWELFTH SLAC SUMMER INSTITUTE

The twelfth annual *SLAC* Summer Institute on Particle Physics will be held here from July 23 to August 3. The program is designed primarily, but not exclusively, for post-doctoral experimental physicists and is sponsored jointly by the US Department of Energy and Stanford University.

The theme of this year's school is *The Sixth Quark*, selected in view of the productive results of the past ten years' study of the charm- and bottom-quark systems and the recent work to discover the top quark.

The first seven days of the school will consist of background physics lectures:

- *Weak Interactions of Quarks and Leptons: Theory*, by H. Harari;
- *Weak Interactions of Quarks and Leptons: Experiment*, by S. Wojcicki;
- *The Last Hurrah for Quarkonium Physics: the Top System*, by E. Eichten;
- *Production and Uses of Heavy Quark States*, by G. Kane;
- *Experimental Methods of Heavy Quark Detection*, by T. Himel;
- *Imaging Čerenkov Counters*, by T. Ekelöf; and
- *Solid State Precision Vertex Detectors*, by C. Damerell.

The following two days are devoted to shorter talks on current work in the field. The final day of the school will be devoted to the physics and policy topics of special interest to W.K.H. Panofsky, as part of the *Pief-Fest* being held on the occasion of his retiring as director of *SLAC* (see story on page 3).

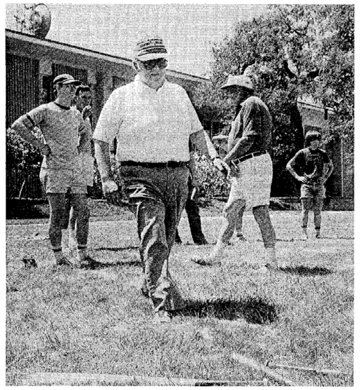
NEW PROGRAM COORDINATOR

Clive Field of experimental group BC was named Program Coordinator in March. He is responsible for coordinating the running schedule of *PEP, SPEAR*, and the Linac experimental programs. Field takes over the post from Hobey DeStaebler whose term began in November 1982.

SLC TUNNEL BREAKS THROUGH TO THE LINAC

High-energy physics is a science of exquisite delicacy and refinement, of precision machinery and white-glove cleanliness. And sometimes it's not.

The cover photograph is an example of the second case. A few weeks ago the machine tunneling the north collider arc arrived at the linac tunnel, separated from the accelerator hall by several feet of concrete. After drilling around the seams of the desired connecting doorway, this block was dragged out, up, and away. (Photo by Joe Faust.)



Burt Richter ponders which of three linear colliders to use in the annual Research Division softball game. The experimentalists played a great game. The full story is in the sporting section on page 6.

THIS ISSUE ...

SLAC Beam Line, x2979, Mail Bin 94

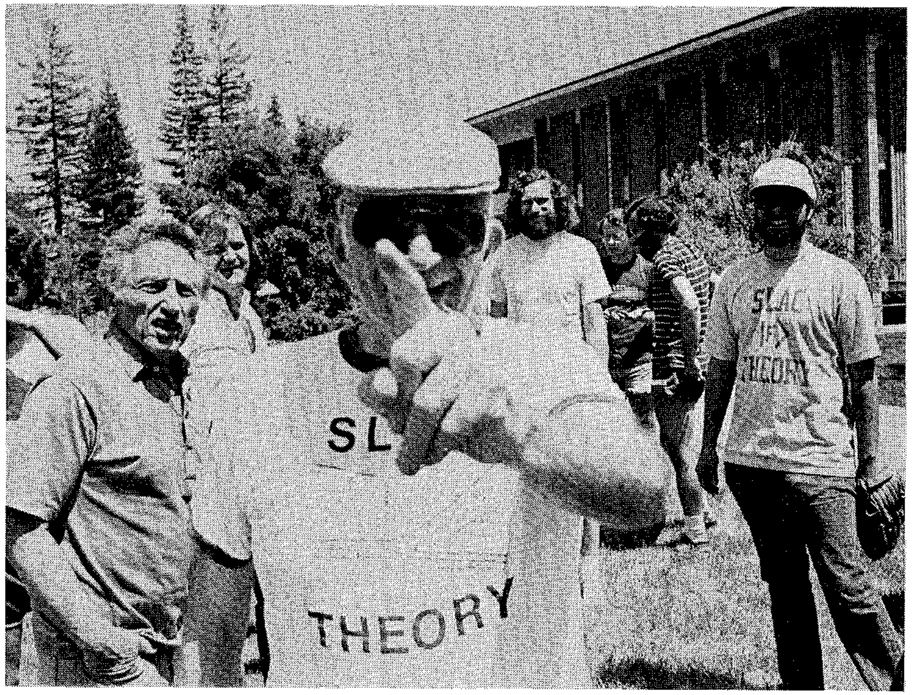
Editorial Staff: Bill Ash, Jan Adamson, Dorothy Edminster, Bob Gex, Janet Sauter, Herb Weidner.
Photography: Joe Faust.
Graphic Arts: Walter Zawojski.
Illustrations: Publications Department.

Stanford University operates SLAC under contract with the US Department of Energy.

SLAC Beamline, July 1984
Annual Theorists vs Experimentalists Softball Game
"The score is a tie within statistical errors"

THEORETICAL PHYSICISTS SQUEAK BY

On Saturday, June 16, 1984, the Annual Research Division Softball Game & Beer Party was held. This affair features a contest between a team of theoretical physicists and a team of experimental physicists. That fact alone should make it overwhelmingly likely that the experimentalists would win the softball game, although the theorists were of course the heavy favorites in the beer-drinking competition. After all, the record shows 22 experimental victories out of 24 previous games played. You could look it up. There were, however, some mitigating circumstances for this year's game. First was the fact that the theorists' team consisted of an assortment of vigorous young jocks who had actually put in some practice time before the game.



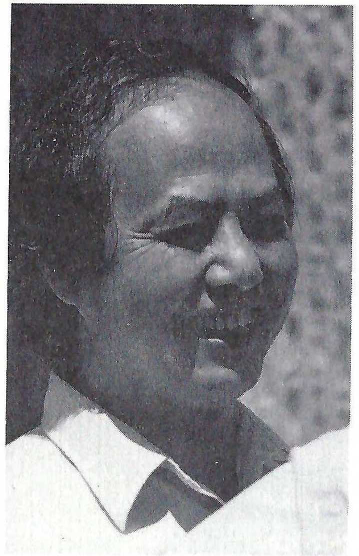
Theorist Sid Drell claims the victory as experimentalist Joe Ballam protests that the score is a tie within statistical errors. Phooey.

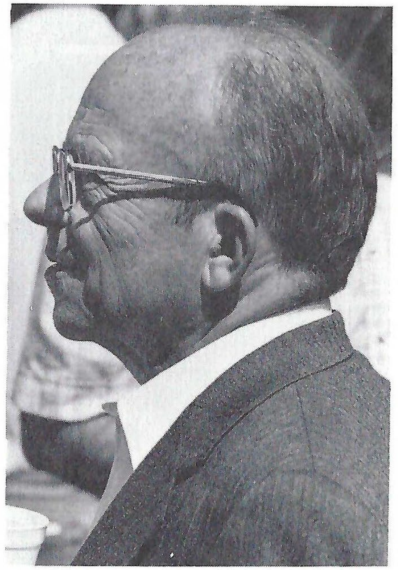
Second was the fact that the experimentalists' team was made up largely of the lame, the halt, and the aged, relieved only by the presence of a few talented offspring. In addition, the theorists several times put their training in applied quantum mechanics to use by causing weakly hit pop-ups to escape the potential wells of the experimentalists' gloves by tunneling directly through to ground. Embarrassing.

So the theorists eked out a crummy victory — their third in a Quarter of a Century. There is no need to give the final score. No one would be interested. Well, maybe experimental families would like to know that their stalwarts scored a big 10 runs. The theorists lucked out with one or two more than that. A few more. Fifteen, actually. 15 to 10. The hell with it.

–A. Experimental Ringer

The SLAC Summer Institute 1984
PIEF-FEST





HIGH ENERGY THEORY

T. D. Lee
Columbia University, New York, N. Y. 10027

I. Introduction

We all know that the basis of physics is experiment. Without it, theoretical physics would be reduced to mere philosophical speculation. However, it may not be as widely appreciated that the heart of experimental physics is instrumentation: Without appropriate instruments, experiment could hardly flourish. That this has always been the case can be illustrated by the figures on the next two pages. If Archimedes did not have the wonderful circular instrument in Figure 1, it might have been difficult for him to do his famous experiment.

As fully realized, especially at SLAC, linear instruments play an equally important part. In Figure 2 we give one such example. Without this marvelous linear tool, which is now in Florence, it would have been impossible for Galileo to do some of his celebrated experiments. And if we did not have those we might not even have the beginning of classical physics.

The development of linear and circular facilities played an even more basic role in high energy physics. Without these accelerators it would simply not be possible to have today's particle physics. This talk is dedicated to one of the true giants in this field, Wolfgang K. H. Panofsky.

This research was supported in part by the U. S. Department of Energy.

The SLAC Summer Institute 1986

- 1986

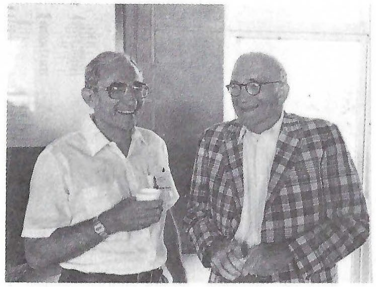
  Topic: Probing the Standard Model

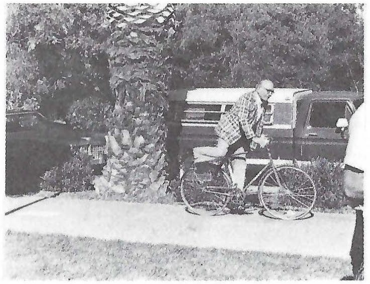
  Directors: G. Feldman, F. Gilman, D. Leith

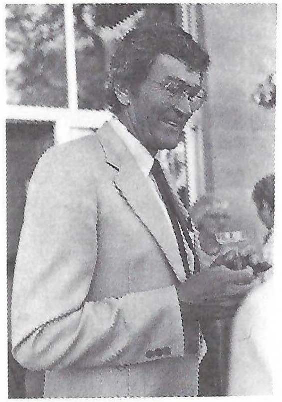
  Lecturers: H. Harari, B. Winstein, R. Field, J. Dorfan, F. Gilman,
  R. Schindler, P. Kunz, M. Breidenbach

  + the DRELL-A-BRATION (Sid's 60th) with talks by
  M. Goldberger, R. Jaffe, and J. D. Bjorken

The SLAC Summer Institute 1986
The DRELL-A-BRATION

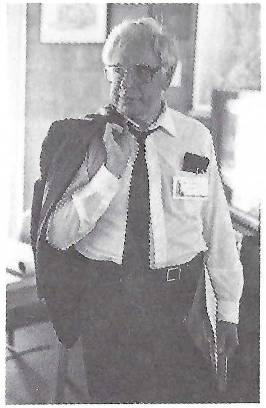






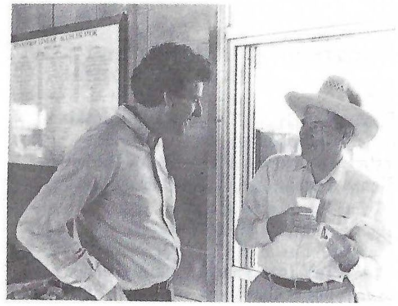
DRELL-A-BRATION

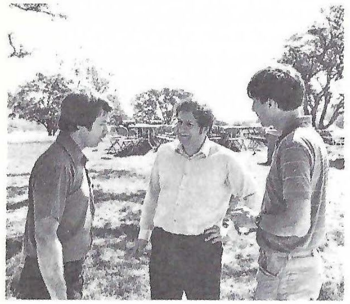
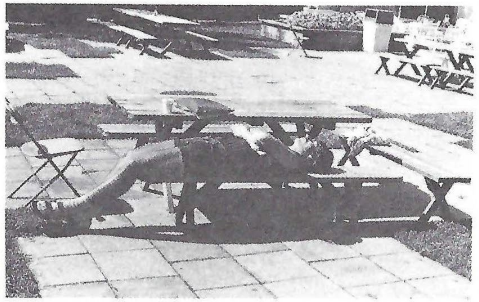
(In Celebration of Sid Drell's 60th Birthday)



The SLAC Summer Institute 1986
Discussions, Meetings, Dinners, …

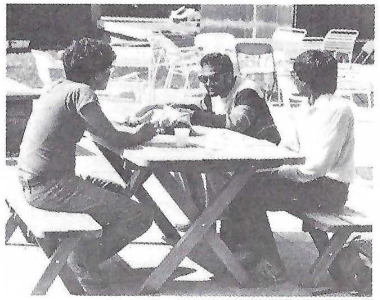










The SLAC Summer Institute 1973 - 1990

- The SSI fulfilled the roles envisioned for it from the beginning as a summer institute for postdocs from around the world, with a topical conference at the end, bringing the participants to the frontier of knowledge in a particular area. Thousands benefitted from attending, building links in the fabric of HEP.
- Beyond that, it provided a recurring venue for all the SLAC science community to interact, to understand the breakthroughs, and feel a part of them, in analogy with the talks in Panofsky's living room in the beginning.
- Beyond our biggest dreams, it helped make SLAC a very special place at a magical time, as one of the intellectual achievements of the 20th century was coming together.

Thanks for Listening