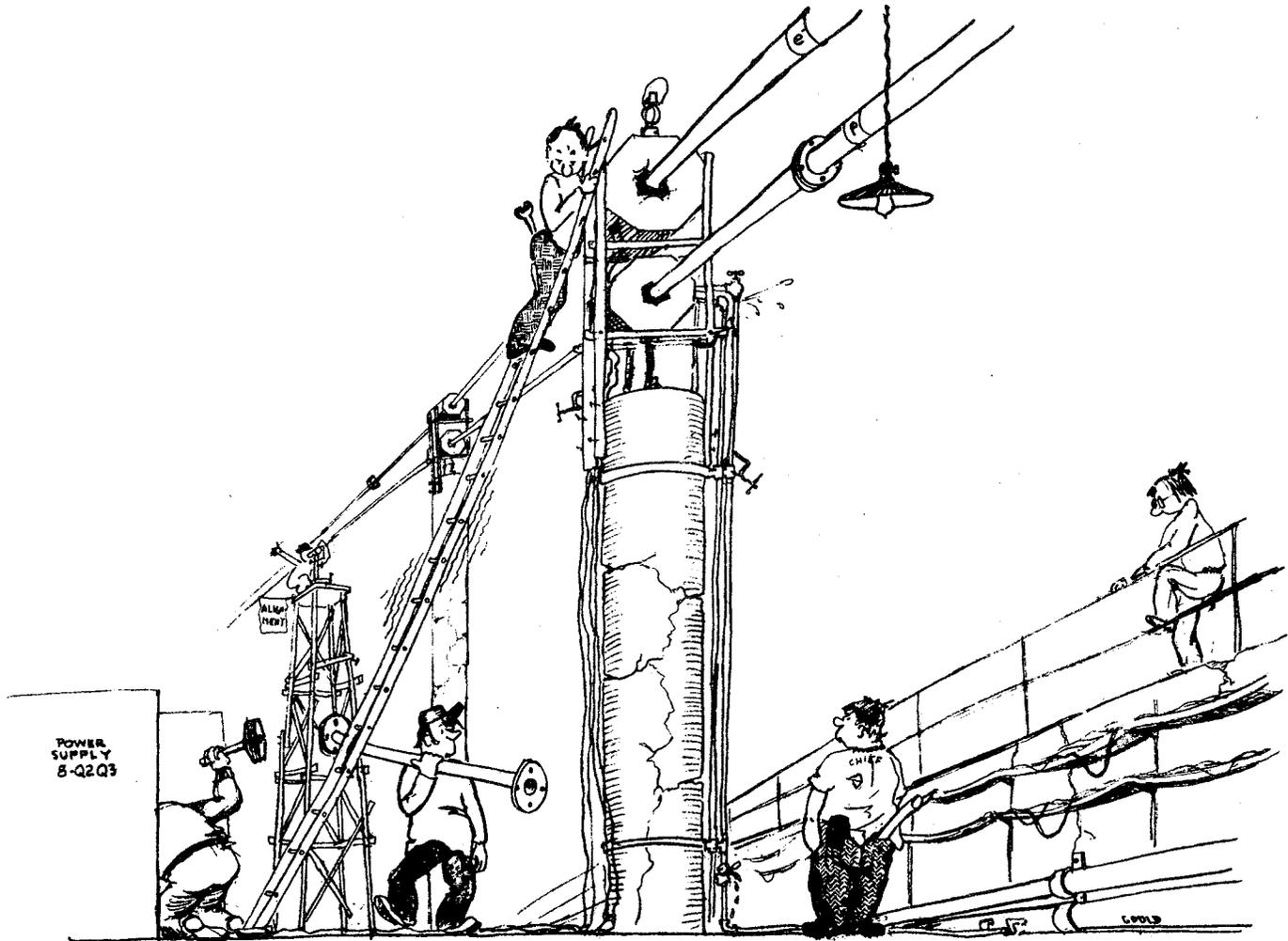


# SLAC BEAM LINE

"There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. And it is the Business of experimental Philosophy to find them out."--Isaac Newton, Opticks (1704)

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PEP - 6 METRE BEAM HEIGHT

		<u>5A: IN THIS ISSUE</u>	
MAY	Catalyst for change	2-4	
	Charming (from CERN COURIER)	5-10	
ISSUE	SPEAR repairs	11-14	
	Change your tax withholding?	14,15	
IN	Youth Opportunity Program	16	
	An invitation to dinner	16	
		<u>5B: MAY 20 ISSUE</u>	
TWO	Women at SLAC: A report and a response		
PARTS:	Computer control of the SLAC accelerator		

The large storage-ring project, PEP, that the Lawrence Berkeley Laboratory and SLAC have jointly proposed would have six interaction regions in which the beams collide and the physics experiments are carried out. In one of these regions the planned height of the beam above floor (basement?) level would be 6 meters --which is about a foot and a half higher than the world pole-vault record. It is rumored that the installation crew for this region will be trained by Weyerhaeuser Lumber Company. The precision alignment group, we're told, is already spending the weekends in Yosemite on the North America face of El Capitan.

# CATALYST FOR CHANGE: A CONVERSATION

KEN STEWART is a computer programmer in Experimental Group B at SLAC. He has been at SLAC for 2½ years. Prior to coming here, he worked for 5 years at Lockheed. Aside from his purely professional interests, Ken has been investing a goodly amount of effort and energy in his participation in various SLAC and University people-oriented activities. He serves on SLAC's Minority and Women's Committee, the Emergency Loan Committee, as an Affirmative Action Coordinator, and is also active in the University-wide Black Employment Committee. In addition, he recently appeared on a television panel discussion, "Blacks in Science and Technology," which was a part of Channel Four's weekly series called *Youth Inquires*. (SLAC has obtained a videotape of this program for future showing.)

JOE SODJA, a member of SLAC's Accelerator Operations Group, came to know Ken Stewart through their joint participation on the Minority and Women's Committee.

The following article is Sodja's account of a recent conversation he had with Stewart.

JS: Your participation in the various organizations mentioned above indicates a very active concern with social issues, and particularly "minority" problems. Since I have a feeling that many people--and, therefore, institutions--have reached a "fatigue" level, if not downright apathy, in regard to these matters (you know: "Haven't we done enough?" "Haven't you all made enough progress?" "We're sick and tired of hearing more complaints about the poor plight of minorities." "Why can't you all be nice and happy like us?), I'd like you to respond to this frame of mind: What can you say to that kind of person to explain your own obvious motivation?

KS: What can I say? . . . Walk a mile in my shoes. . . . That is, personal experience is irreplaceable. . . . There are problems now that exist for minorities because of decades--even centuries--of repression. The problems aren't eliminated by a decade of social reform. . . .

JS: An example that comes to mind is the school desegregation battles in Boston in 1975 America viewed from the perspective of the Supreme Court decision outlawing school segregation, and that was back in 1954.

KS: I can remember being refused admission to gamble at Harrah's in Reno in 1957. Although in the area of public accommodations there has been a lot of progress, nevertheless this fact mustn't give us false illusions about the need for further efforts. I think there are many well-meaning liberal whites who see a lot of progress in terms of public accommodations: being able to sit on a bar stool at a soda fountain or at a "Denny's" in Mississippi or Alabama. And these are really tangible, meaningful achievements of progress. Beyond that, however, there are problems that still exist. These may be difficult for a non-minority person to appreciate or understand. Within institutions, for instance, including SLAC, there is this "racism" which is difficult to convey to a non-minority person because it is outside their realm of experience.

JS: In other words, we're talking about the inner psychological toll that racism takes on all people. And of course, this *psychological* underpinning inevitably affects the very real *material* conditions. Statistics on unemployment, job levels, incomes, and "chronic" social ills substantiate this latter.

KS: Right. And that's the kind of thing that is very difficult to describe in terms of overt activities. It's not as though you're threatening me with lynching or calling me a "bad" name. This kind of racism puts some special constraints on struggling for an identity within society. The problem of identity, of course, is something that every individual in the society has to resolve, be he/she a minority or not. But I think that for a minority there are some special strings attached to seeking an identity.

JS: I think you've said it, but it's hard for people--as you stated previously--without that subjective experience to really know what you're talking about. It's easy enough for

someone who doesn't have that experience to dismiss it all as being part of a distorted perception of reality on your part. That's how someone can "wash his/her hands" of it even in the face of the stark realities that *do* exist. . . . and any view that would deny these is grossly naive.

KS: It's that path of least resistance that is so tempting to all of us.

JS: To change the subject to more concrete matters, what was discussed by the panel on the television program in which you participated recently?

KS: We tried to develop answers to such questions as: Why are there so few blacks pursuing careers in science and technology? To what extent does counselling of blacks play a role in career choices? Is the counselling available in the schools improper or misleading? Is the lack of examples and leadership in the home a dominant factor? We also discussed the academic careers of three students on the panel and their particular problems in pursuing engineering careers at the University of California in Berkeley--their career aspirations, what had inspired them to pursue technical careers.

JS: What inspired you to a technical career?

KS: I guess it started in high school. I did well in mathematics, and at that time the aerospace industry was just blossoming in southern California, where I grew up. So I thought that science and engineering would be a good way of survival for me--and of course any idyllic notions of the "University" were subjugated to the needs of survival in my case. I was also motivated in a negative kind of way by the "realistic" counselling I received in high school. In other words, I didn't want to be brainwashed into the more "conventional" professions of teaching or mechanic or cook or custodian. I always reacted to that kind of programming with defiance. This not only motivated me toward a technical career but also gave me drive to compete and to seek my own identity without--or, better, *despite*--any constraints imposed by others. Even though this was a negative stimulus, in actuality it inspired me to greater heights, perhaps. . . . I suspect that this is not an uncommon experience among many of my peers.

. . . criticism: that activity which consists not only in knowing ourselves but, just as much or more, in freeing ourselves. Criticism unfolds the possibility of freedom and is thus an invitation to action.

--Octavio Paz  
*The Other Mexico*



--Photo by Dan Nevius

I have three children who are growing up in a society that I feel can be changed for their benefit--and not only for their benefit, for that matter, but for all children growing up. That's at least part of my motivating force. Apart from that, I am simply concerned that there are injustices and racism in the world. And I think that the consciousness of all people, minority and non-minority, is shaped by the pressures arising from these conditions --whether they know it or not.

--Ken Stewart

JS: Except that maybe some people, by the time they are in high school and become aware of this kind of negative programming, are by that time so derailed by mis-education that even though they might desire the proper thing, they find themselves so hopelessly crippled in terms of educational preparedness that they cannot achieve the aspirations they might otherwise want to follow.

KS: To be sure, I don't feel that anyone needs this kind of negative stimulus. We can all do without it. Although it sometimes works for the best, this is the exception rather than the rule. It can destroy you psychologically. In spite of the fact that one can persevere, it still affects you in a life-draining way, because it distracts you. You have to spend a certain amount of energy to deal with this part of your reality. That energy could better be spent on more positive, constructive things.

JS: Can we talk about some other major formative influences in your life? Your parents, for instance? Was there a strong figure in your family who gave you support and the strength of character to help you achieve as well as you obviously have? After all, how many of your contemporaries growing up in similar circumstances have been able to do the same?

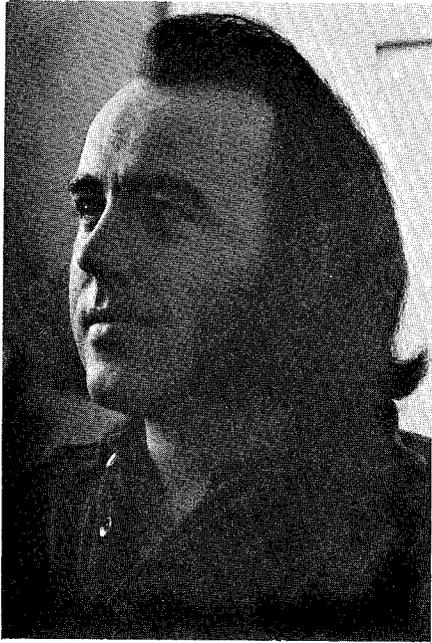


Photo  
by Joe  
Faust

Our vision of reality is definitely affected by the position which we occupy in society. Whether we view reality from a position of "privilege" or from that of the "underdog" has a great deal to do with *what* and *how* we see.

--Joe Sodja

KS: When I consider the time when I graduated from UCLA in 1957, I must say that there were very few of my peers there at the time. In regard to my parents, they gave me the kind of support that every child deserves and needs to survive and grow up. They were good parents, but neither of them was college-educated, and they didn't have any special appreciation of what the technical career I was pursuing was all about. At the same time, though, they supported me because they realized that education was a good way to ensure my survival.

There were other influences from my external environment. . . . When I was very young I was fairly perceptive of a lot of things. I think that as a child I began very early to recognize the significance of what being black was all about, and I reacted to it in very specific ways. A lot of my motivation came from within. Why it was there, I don't really know how to articulate. . . . As I said before, I got support from my parents, but my life was in many ways a reaction to the prevailing social conditions--which inspired me.

JS: Would you say, then, that it was your perception of yourself as a black in a white society that had a lot to do with your life--and might be considered a major formative influence?

KS: Oh, very definitely. It had a profound effect on my life. As a result, I felt that it was for me to decide and seek my own destiny.

That was very important to me, even as a child of a very tender age. . . . I couldn't articulate my feelings as a young child, of course. I just felt that way.

JS: This feeling seems to have played a positive role in your life in that you perceived a situation of adversity and decided what you were going to do about it. But of course that sword is double-edged, and not everyone lands on the right side of it.

KS: I can appreciate that not everyone lands on that side of it, because it's not a simple choice to make, as a matter of fact. The path of least resistance is always the one that we naturally tend to be seduced into.

JS: The fact that some individuals, when subjected to adversity, come out on top is sometimes used as a scapegoat for absolving ourselves from working for social change. This is temptation that people so often fall into--saying, you know, "Joe Blow made it to a very high position in society, and he's black, so what's wrong with society?" In other words, if they can find one individual who has "made it" despite the circumstances, then people are sometimes tempted to rationalize that everything must be all right. Do you find people taking that attitude sometimes in regard to what they construe as your success?

KS: Yes, that's true. That's why I must emphasize that "making it" for me was an "obsession." It required an inordinate amount of perseverance, discipline, and "stick-to-it-iveness." I don't think it's fair to expect that from everyone. I really don't like to hear that "John. Q. Black made it, so why haven't you?" That just isn't very reasonable. My reaction to the perception of myself as a black can be seen as one of many possible outcomes. Others may react in many different ways.

JS: Even though adversity sometimes breeds very admirable character traits in a person, it certainly should not be used as a rationalization for making things more adverse than anyone of us would like to have them. . . . You know, we're all looking for that "sweet life."

KS: I think it's true that ten minutes of adversity might be worth ten years of tranquility in terms of growth. . . .

JS: If you make it through those ten minutes--but that's not guaranteed. . . .

We still have not learned how to think with true freedom. The fault is not intellectual but moral: the worth of a spirit, Nietzsche said, is measured by its capacity for enduring truth.

--Octavio Paz  
*The Other Mexico*

# Charming

*Note: The following article is reprinted from the April 1975 issue of the CERN COURIER.*

We have observed a very sharp peak in the number of theoretical papers attempting to make sense of the world of particles. They have been stimulated by the discoveries at the high energy accelerators in the past two years which have opened up completely new interpretations about the fundamental components of Nature and their behaviour. These interpretations in their turn have pointed in a multitude of directions, where experiments can look to give further important input so as to select those interpretations which are going along the right lines.

This article will touch on some of the main ideas which have emerged and report some of the experiments which are attempting to check them. It is hard to give a thorough review when so much is going on but we will try to get across some of the humming excitement which pervades high energy physics at the moment.

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## *The neutral current route to charm*

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Completely fresh insights in particle physics came in 1973. They added significantly to the picture of how Nature behaves rather than just decorating the existing one.

On the experimental side, things began with the discovery at CERN of the existence of neutral currents in weak interactions. We have covered this topic many times before (see for example May 1974, page 165).<sup>\*</sup> In essence, it means that when particles interact by the weak force, the leptons involved (particles which do not feel the strong force) need not change the sign of their electric charge. Thus a neutrino interacting with a proton can remain as a neutrally charged neutrino and not convert (as it usually does) to a negatively charged lepton. The interpretation of what is happening in such a neutral current interaction is that a neutral particle (called the neutral intermediate boson or  $Z^0$ ) passes between the neutrino and the proton communicating the weak force from one to the other. With the more common charged currents, the communicator is a charged particle (charged intermediate boson or  $W^\pm$ ).

On the theoretical side, this tied in nicely with theories about the weak interaction which were then maturing. These ideas tried to extend to the weak force the basic ideas which work so brilliantly in understanding the electromagnetic force. (Those interested in ab-

<sup>\*</sup>References in parentheses () are to earlier issues of the COURIER.

sorbing this in more detail could try the May issue of last year.) They weld the weak and electromagnetic interactions together as being different manifestations of the same phenomena. This is in itself philosophically satisfying since the separation of Nature's behaviour under the headings of four separate forces (adding the strong force and gravity) was never a happy situation. In addition, the theories required the existence of neutral currents (and/or heavy leptons) which added to the joy of the experimental discovery of neutral currents.

But the discovery of neutral currents opened Pandora's box in another direction which has led to the present furore. If the weak force can manifest itself via neutral currents, then other neutral current interactions besides the neutrino ones should be seen. A particular example, is the decay of the neutral kaon into two muons. This has been carefully looked for but not seen at the rate expected for the direct decay (it has only been seen at a much lower rate which corresponds to the kaon going to two gammas with muons then coming from the gammas). What is stopping this decay?

When our existing knowledge tells us that something can happen and it does not happen, we invent a mechanism which would stop it. This has worked well in the past. For example to explain why the kaon is such a stable particle and to explain why it is produced in some interactions but not in others (which previously looked equally as good), we say that the kaon has an additional property, called strangeness. The very name indicates how out of the ordinary the property appeared when it was proposed. Strangeness either completely prevents (in the strong interactions where the kaon is produced) or considerably inhibits (in the weak interactions where the kaon decays) the particle being involved in some interactions.

This idea is so crucial to what follows that we will come at it in another frivolous way. Supposing the animals in our everyday world interacted as particles do--transforming and breaking up from one configuration to another in an ever changing pattern. Watching these antics from afar, intelligent beings might make observations such as we make for particles. They might remark that interactions occur such as a dog with a camel producing a cat and a horse, or a mouse and a cow, etc. . . . but never two cats and a horse, or a hydra. Intelligent beings could deduce from this that heads were always conserved in the interactions --if two heads go into the mix, only animals totalling the same number of heads could emerge.

They might then be puzzled as to why it was

not possible to produce a cat and a man, or a centipede and a horse since both interactions would conserve the "headiness" property. They might then postulate another property, "legginess," which also has to be conserved. Thus

$$\text{dog} + \text{camel} \rightarrow \text{cat} + \text{horse}$$

can work since the postulated number of legs adds up the same at both ends of the interaction but

$$\text{dog} + \text{camel} \rightarrow \text{cat} + \text{man}$$

does not. Even though the heads come out right, the legs do not and the interaction cannot go.

Returning to our kaons--a pion interacting with a proton cannot produce a kaon since neither of them have this property of strangeness. The only way a kaon can come out of the interaction is for another particle, such as the sigma, carrying the opposite strangeness property to be produced at the same time (called "associated production"). In expressing these properties mathematically we say that the positive kaon has strangeness quantum number +1 and the sigma has strangeness quantum number -1.

When the kaon breaks up under the influence of the weak interaction, the strangeness property can be lost (not conserved) but it is a struggle to get shut of strangeness and because of this the kaon takes over a million times longer to decay than equivalent particles.

For the decay into two muons which should happen, since we know neutral currents exist, perhaps there is yet another property which inhibits decays. The postulated property has been given the name "charm."

By introducing the property of charm, S. L. Glashow, J. Iliopoulos and L. Maiani were able to deduce that weak interactions mediated by neutral currents and involving a change of strangeness (such as the two muon decay of the kaon) cannot occur. This is the simplest way out of the difficulties though not the only one that has been thought of.

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### *Proliferation of quarks*

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Let us suppose that charm is for real. What does it do to our picture of the particles?

We had a convincing picture of the hadrons (all those particles like the proton, kaon, etc. . . which feel the strong force) as being built out of three components, given the name quarks. Both the "spectroscopy" of the particles--the way in which the relationships of their properties fitted orderly patterns--and the observations of how they scattered projectile particles, indicated clearly that there are constituents in the hadrons (see October issue 1974, page 331).

None of these constituents has been seen in

isolation at the energies with which hadrons have so far been investigated but this does not perturb the theoreticians who have concocted models of the hadrons which "confine" the quarks getting them to cling together so firmly.

The three types of quark we will call  $Q_p$  (proton-like with electric charge +2/3),  $Q_n$  (neutron-like, charge -1/3) and  $Q_\lambda$  (strange or lambda-like, charge -1/3 and strangeness). By shuffling them together in different ways all the known hadrons can be assembled. Thus a proton can be built up from two  $Q_p$  quarks plus a  $Q_n$  quark; a neutron from two  $Q_n$  quarks plus a  $Q_p$  quark; a lambda from a  $Q_p$ , a  $Q_n$  and a  $Q_\lambda$  quark; a positive kaon from a  $Q_p$  quark plus a  $Q_\lambda$  antiquark; and so on.

This works beautifully and doing mathematics on the basis of such quarks gives remarkable agreement with many experimental measurements on particle behaviour.

Complications begin when considering the quantum states or energy states in which quarks can exist. It is a deep seated principle (Pauli exclusion principle, named after W. Pauli its proposer) that you cannot have two identical particles in the same state. (This all started with the atom--if we describe two orbiting electrons as being in exactly the same state, we are just describing a single electron twice.) Thus the two  $Q_p$  quarks in the proton must have something different about them. Searching for a name for this property, we come up with "colour" and the hypothesis is that each quark exists in three coloured forms (say red, white and blue). These words have only been dreamed up to indicate a difference in property--in no way do they mean that quarks are actually tinted and that particle interactions are psychedelic happenings.

Now the proton can be made of  $Q_p$  (red),  $Q_p$  (white) and  $Q_n$  (blue) without violating the exclusion principle. Our familiar particles are those for which colour is averaged out but it is not impossible that colour is behind some of the mysteries of the newly discovered particles that we will discuss shortly. However, the colour interpretation is not the one we are leaning on here so we will leave it aside.

Now we bring in the additional property of charm by increasing the number of quarks. Adding a charmed quark  $Q_c$  to our list, leaves all our spectroscopy information untouched and also the scattering information untouched since we say that  $Q_c$  is not a component of the well-known particles. This is a good start because the previous quark picture was working well and it would hurt to abandon it.

We should mention that the idea of an additional type of quark is not new. Ten years ago, it was put forward by several theoreticians, though for very different reasons (such as an attempt to construct the known particles

The Quark Constituents Of The Hadrons	Some Of Their Major Properties				Each Exists In Three "Coloured" Forms
	Charge	Baryon Number	Strange- ness	Charm	
$Q_p$ proton-like quark	+2/3	+1/3	0	0	$Q_p$ (red), $Q_p$ (white), $Q_p$ (blue)
$Q_n$ neutron-like quark	-1/3	+1/3	0	0	$Q_n$ (red), $Q_n$ (white), $Q_n$ (blue)
$Q_\lambda$ lambda-like (or strange) quark	-1/3	+1/3	1	0	$Q_\lambda$ (red), $Q_\lambda$ (white), $Q_\lambda$ (blue)
$Q_c$ charmed quark	+2/3	+1/3	0	1	$Q_c$ (red), $Q_c$ (white), $Q_c$ (blue)

Our present picture of the basic (?) constituents from which all the hadrons (all the particles which feel the strong force) are built up. Baryons have constituents such that the total baryon number is equal to 1--for example, the proton is made up of  $Q_p Q_p Q_n$  which gives its single positive charge with no strangeness and no charm. Mesons have constituents such that the total baryon number is equal to 0--for example, the negative kaon is made up of  $Q_\lambda \bar{Q}_p$  ( $\bar{Q}_p$  being the antiparticle of  $Q_p$  with all the properties of opposite sign) which gives its single negative charge, strangeness and no charm.

from quarks with integral charges rather than charges which are a multiple of 1/3 of the charge on the electron).

The introduction of  $Q_c$  makes it possible to build still more particles and these particles will show distinctive behaviour.

#### The significance of the new particle discoveries

Let us go back to what experiments have unearthed to see why the spotlight now shines even more strongly on charm.

The dramatic discoveries (see December issue 1974) at the Brookhaven double spectrometer and Stanford electron-positron storage ring, SPEAR, were initially a complete mystery. Particles were found with three times the mass of the proton and yet remarkably stable. It is now the favourite theory that the 3.1 GeV particle is built of a charmed quark and a charmed antiquark ( $Q_c \bar{Q}_c$ ). The combination is sometimes called "charmonium."

(M. B. Einhorn and C. Quigg of the FermiLab had a bit of fun by selecting the name "panda" rather than charm for this new property--"We chose this name because of the panda's well-known shyness and tendency to stay among his own kind. The great mass of the giant panda has also influenced our thinking." This enables them to call the 3.1 GeV particle "pandamonium" which is a fair reflection of its impact on the world of high energy physics.)

A similar case involving the strange quarks is already well documented. The phi meson is surprisingly heavy and surprisingly stable compared with its relatives the omega and rho mesons. The phi is built up of  $Q_\lambda$  and  $\bar{Q}_\lambda$ . (There is incidentally, no deep understanding of how quark and antiquark can live together without annihilating one another but such systems are not unfamiliar--back in atomic physics the electron and positron were known to live orbiting one another for a short time in the positronium system.) With a mass of 1 GeV it has difficulty breaking up into two kaons (mass about 0.5 GeV) and yet this is the way it likes to decay in order not to lose the property of strangeness carried by its two component quarks. Hence its stability. Note that the phi itself does not show strangeness--the quark and antiquark cancel strangeness out and the phi is said to have "hidden strangeness"; only when it splits to the two kaons does the strangeness become apparent.

In the same way it is suggested that the new particles, at 3.1 GeV and 3.7 GeV, have "hidden charm." The 3.1 GeV is ( $Q_c \bar{Q}_c$ ) and the 3.7 GeV is ( $Q_c \bar{Q}_c$ ) plus some other quarks. It seems that the charmed quark is significantly heavier than the others and that the particles built out of  $Q_c$  will be heavy. Thus the charmed mesons into which the 3.1 GeV might decay (carrying charm in evidence rather than hidden--like the kaons from the phi carrying strangeness) are probably too heavy for the decay to be possible. This would explain the great stability of the 3.1 GeV

particle. It has been seen going into lepton pairs but is not fond of this decay since it has to do away with charm (just as the phi is reluctant to go to pions and do away with strangeness) and hence hangs around a long time before breaking into leptons.

Here we can get a first stab at the mass of a charmed particle. Neither the 3.1 GeV nor the 3.7 GeV (which goes to 3.1 GeV plus pions) decays readily into charmed mesons called D particles. Thus the D must be greater than  $\frac{1}{2}(3.7)$  GeV in mass. However, at the Stanford SPEAR storage ring a more blurred peak has been found around 4.1 GeV indicating a particle of much less stability. This is possibly another variant of  $(Q_C\bar{Q}_C)$  plus other quarks but this time having enough mass to decay into two charmed mesons. We can therefore pitch the D particle mass at below  $\frac{1}{2}(4.1)$  GeV, that is around 2 GeV.

Coming at the D mass by theoretical calculation also lands us in the 2 GeV ballpark. Knowing that particles exist at 3.1 GeV and 3.7 GeV makes it possible to calculate others just as it was possible in the "old" particle spectroscopy tables to predict other masses when some were known.

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#### *Layman's guide to finding charmed particles*

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How are we going to identify particles with charm? First of all, the existence of a new quark will mean the existence of new particles which will not fit into the particle classification schemes that we have so successfully built up on the basis of the three quarks. There are two possible groups of particles--charmed mesons like the Ds where  $Q_C$  is joined to another anti-quark or  $\bar{Q}_C$  is joined to a quark, and charmed baryons, where  $Q_C$  replaces one of the more familiar quarks in the known baryon configurations. We would see them via unusual features when such mesons or baryons decay.

i) In the decay, which goes by the weak interaction, charm need not be conserved (just as strangeness can, with an effort, be lost in weak interactions). This means that the charmed quark is converted to another type and the theory can write down equations for the probabilities that  $Q_C$  will convert to one or other of the familiar quarks. What emerges from this is that  $Q_C$  much prefers to change to  $Q_\Lambda$ . This gives us an important signature. If charmed particles are being produced, we can expect to see strange particles around in unusually high numbers from their decays.

ii) Particle decays generally involve the production of leptons, so another signature of charmed particles could be the appearance of leptons in unusual ways from the charmed particle decays. For example, spotting leptons in association with a high number of strange particles could point to charmed parent particles.

Spotting lepton pairs which do not have the characteristics of normal pair production could indicate that one or both has charmed parentage.

iii) In the particle decays where leptons are not involved, the violation of the normal rules governing such decays could again signal that a charmed particle is present.

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#### *Experimental results so far*

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An important search using signature number (i) is going on at the SPEAR storage ring. If we believe that charmed D particles are being produced in the decay of the "hidden charm" particle of mass around 4.1 GeV, then we can expect to see the number of strange particles emerging from the interactions at this energy to increase suddenly and markedly.

At the time of this writing, no news on the measurement of the kaon to pion ratio when crossing 4 GeV has come from SPEAR. (SPEAR has been held up for some weeks due to a fire which caused damage in the West experimental region on March 15. They hope to be back in action well before the end of April.)\* The double spectrometer at Brookhaven is also looking for kaons but, again, no news up to now. The latest results from DESY are reported separately later in this issue.

Several searches are under way at the CERN Intersecting Storage Rings using signature number (ii). At the ISR the extremely high energies of the proton-proton collisions should yield many charmed particles but the profusion of hadrons being produced is likely to drown any signature which is purely hadronic.

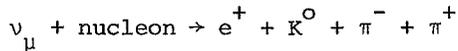
The very low background for leptons around the storage rings, however, makes this a promising route. Since we are dealing with strong interactions, we expect that the charmed particles from the proton-proton collisions would appear in associated production (as described for strange particles above)--in other words, a particle carrying positive charm will be produced together with one carrying negative charm. These could be spotted via leptons, for example if one charmed particle decayed with an electron and the other with a muon, or if leptons were seen in events with high production rates for strange particles. No news at the time of writing.

At the CERN Gargamelle bubble chamber a neutrino event is under scrutiny as being a strong candidate for the production of a charmed particle. (Note that since we are dealing with a weak interaction, associated production is not necessary.) It has precisely the two

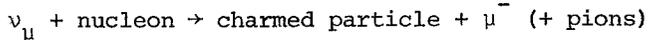
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\*SPEAR was in normal operation on 25 March and the West region on 8 April. The peak beam energy is now raised to 4 GeV.

lepton/one strange particle signature mentioned above. If the tracks have been correctly assigned, what is recorded is



This looks like the production of a charmed particle



and the subsequent decay of the charmed particle yielding  $K^{0} + e^{+} + \nu_{e}$  (+ pions). The event was discussed at the Paris neutrino meeting on 18-20 March. The probability that it has been produced by other means (for example, an electron-type neutrino contaminating the muon-type neutrino beam and being the source of the positron) is regarded as below one in a hundred if the tracks are correctly assigned.

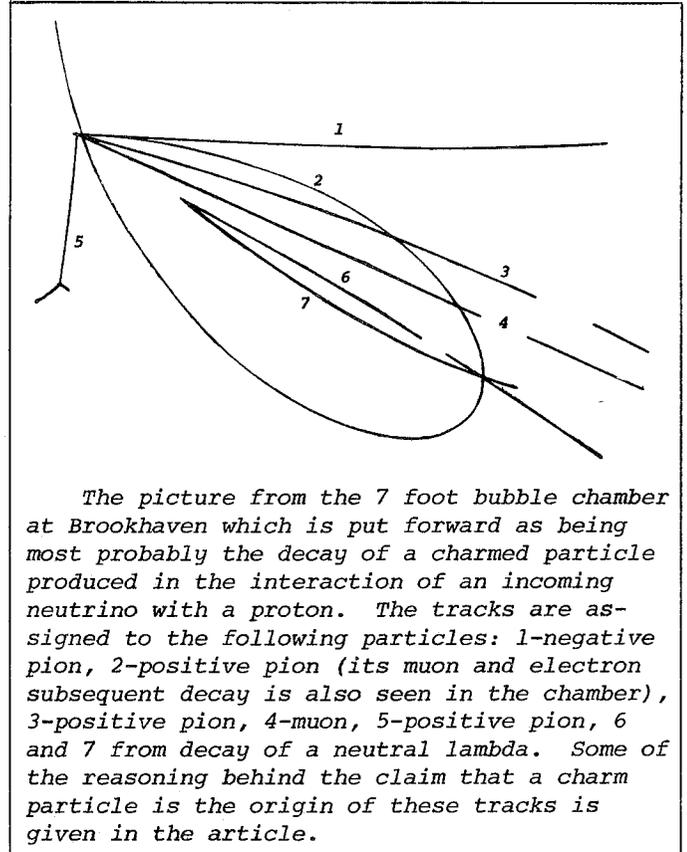
At the FermiLab, two experiments are seeing unusual effects in neutrino interactions yielding two muons. They are the FermiLab/Harvard/Pennsylvania/Wisconsin experiment of D. Cline, A. K. Mann and C. Rubbia, and the Cal. Tech./FermiLab experiment of B. Barish. The first has over 30 and the second has 4 mysterious di-muon events. They are convinced that the muons are not originating from the initial neutrino-nucleon interaction and the other from the decay of a pion or a kaon. Things such as the rate at which they occur, the fact that they are always of opposite sign, etc. . . . seem to rule out this possibility.

The combined muon masses show no peak (indicating that they are not, for example, from the decay of a particle like the 3.1 GeV) but are rather evenly distributed over a range of several GeV. There are also inexplicable features such as the fact that the negative muon is always of higher momentum than its positive counterpart in seeming violation of charge symmetry.

The favoured explanation is that new particles, given the name  $\chi$  (not "Why") particles, are being produced in the energy range 2 to 4 GeV. They could be charmed baryons, produced together with a single muon in the initial neutrino-nucleon interaction, which then subsequently decay via the weak interaction yielding a second muon. Details of these di-muon events have been published in Physics Review Letters.

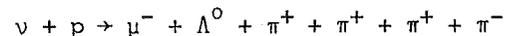
Signature number (iii) is being looked for in bubble chambers where detailed information on the particles emerging from an interaction is often more readily available. A strong candidate for a charmed particle event, which is being published in Physics Review Letters, has been put forward by the group of N. P. Samios at Brookhaven and more Gargamelle pictures are also under study.

The Brookhaven team have been chewing on the event shown in the [sketch], recorded in the neutrino experiment with the 7 foot bubble cham-



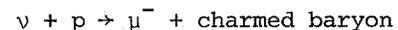
The picture from the 7 foot bubble chamber at Brookhaven which is put forward as being most probably the decay of a charmed particle produced in the interaction of an incoming neutrino with a proton. The tracks are assigned to the following particles: 1-negative pion, 2-positive pion (its muon and electron subsequent decay is also seen in the chamber), 3-positive pion, 4-muon, 5-positive pion, 6 and 7 from decay of a neutral lambda. Some of the reasoning behind the claim that a charm particle is the origin of these tracks is given in the article.

ber, for about nine months and are now convinced that, to a high probability, they know the identity of the particles which gave the tracks. The event is:



Such an event cannot be explained under the normal conservation laws of particle interactions. In particular, it violates the rule which says that the strongly interacting particles will change their total strangeness by the same amount as they change their total charge (the  $\Delta S = \Delta Q$  rule). In the event, the proton ( $S = 0$ ) has gone to a lambda ( $S = -1$ ). The charge has changed by +1, the proton ( $Q = +1$ ) has gone to the lambda and four pions (total charge  $Q = +2$ ).

The proposed explanation is that a charmed baryon was produced



and that it was the charmed baryon decay which gave the lambda and pions. The mass of the baryon can be calculated by measurements on the tracks as about 2.4 GeV. If we do sums on feeding a charmed quark into a baryon, since the new particles have given us a good estimate of what to use as the charmed quark mass, we arrive at about 2.4 GeV for a charmed baryon.

The interpretation looks tantalisingly right. What is surprising is that the event has been found in the examination of a few hundred photographs. Gargamelle would then expect a good

handful of such hadronic decays in the number of photographs examined. However statistics are difficult with a single event. As the authors themselves say, "the validity of the above conjectures can only be verified by the accumulation of additional such events."

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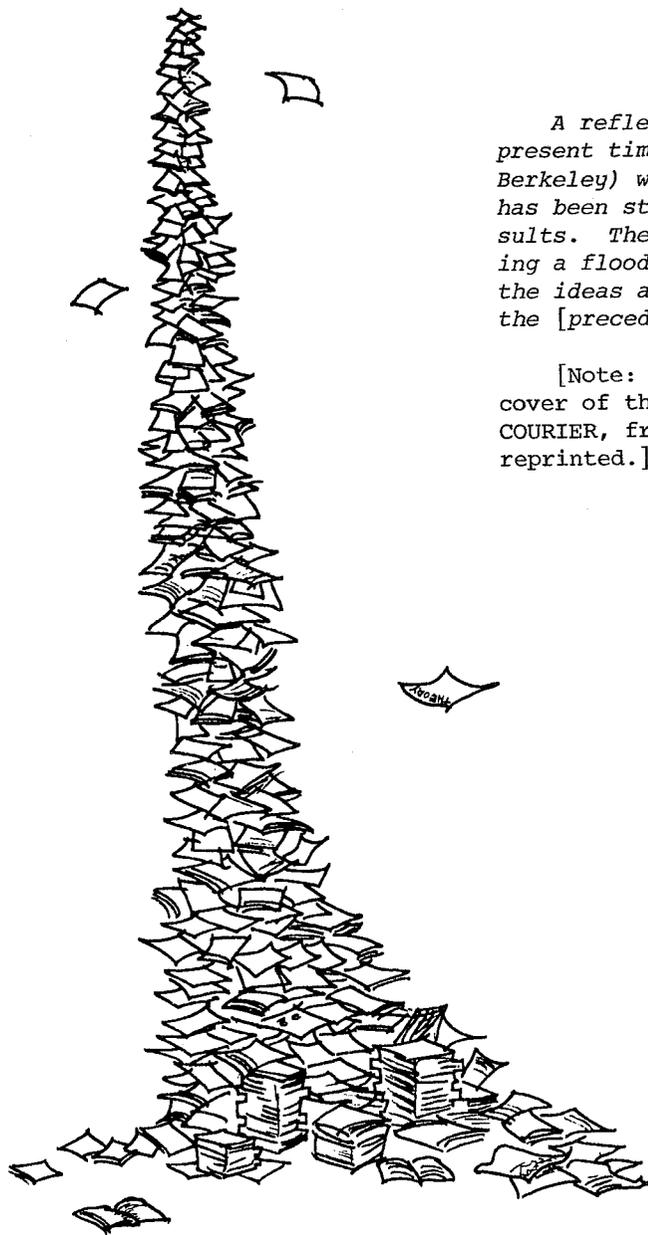
*Pastures new*

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We have concentrated on the "charm" interpretation of the present excitement in physics. This could be wrong--the amount of experimental evidence is still flimsy--but it does hang together in a convincing way.

V. Weisskopf is fond of a Columbus story-- "The accelerator physicists and engineers are the ones who built the boat. The experimental physicists are the ones who set sail and discovered America. The theoreticians are the ones who stayed in Madrid and predicted the boat would land in India."

At the moment, the theoreticians are predicting quite a number of countries where the boat will land. The only thing that we can be absolutely sure of is that it has sailed beyond all the continents we have explored up to now and is bound to come ashore in a completely new land.



*A reflection of high energy physics at the present time (from an idea of J. D. Jackson at Berkeley) where a flood of theoretical ideas has been stimulated by a few experimental results. These ideas in their turn are stimulating a flood of subsequent experiments. Some of the ideas and experiments are the subject of the [preceding] article in this issue.*

[Note: This illustration was used on the cover of the April 1975 issue of the CERN COURIER, from which the preceding article was reprinted.]

THEORY

EXPERIMENT

# SPEAR REPAIRS

Crises often bring out the best in individuals and institutions. This was certainly the case with regard to the recent electrical fire in the west experimental pit at SPEAR [the fire, on March 16, was described briefly in the April issue of the *Beam Line*]. Teamwork was the key to getting the storage ring back in operation in a minimum time. Within a matter of hours after the fire the repair work had already been started.

Many different groups within the laboratory brought their expertise to bear on the job of restoring the damage. The following partial list of major tasks indicates some of the more noteworthy efforts.

The *Experimental Facilities Department* had the unenviable job of chopping, splicing, connecting or replacing the hundreds of signal and control cables that were damaged in the fire. Even under normal circumstances a complex experimental apparatus like the large magnetic detector at SPEAR resembles a kind of Fellini nightmare in a gigantic spaghetti factory. The trouble with spaghetti is that each piece has two ends, and cutting a chunk out of the middle of each strand in a bundle of hundreds creates an end-matching problem that is enough to tax the patience of even the most ardent spaghetti freak. To compound the difficulty, there was also the requirement that many of the spliced signal cables had to be "timed" to an accuracy of about 5 nanoseconds (.000000005 second), which is the amount of time it takes light to travel 5 feet! (The particle counters and spark chambers need this kind of synchronization because the particles that they detect are often traveling near the speed of light.)

The *Electronics Shops* took on the task of rebuilding the high-voltage pulsers that had been destroyed in the fire, along with that of carrying out certain recommended circuit modifications to the undamaged units.

With some help from physicists, technicians in *Experimental Groups B, C and E* and in the *Spectrometer Facilities Group* carried out the work of identifying, tagging and reconnecting the damaged cables. Groups C and E handled the rewinding of the charge-line "pancakes" used in the pulsers and the associated couplings.

The *Metal Shops* took on a variety of tasks, shifting some of their priorities around in order to be able to do so. This work included fabrication of new pulser chassis racks, mechanical reworking of the damaged muon chambers, support for the winding of the new charge lines, and several others.

The riggers from *Plant Maintenance* and several people from *Labor Services* had the important job of dismantling the damaged roof structure over the west pit and replacing it with new structural materials.

Turning now to some of the individuals who did yeoman work, particular mention should be made of Al Gallagher, Frank Stella and Bill Black, who were responsible for many different chores (not the least being general coordination of the various repair groups that kept shuffling in and out of the west pit). Their major tasks included complete disassembly and reassembly of the massive muon "tower" on top of the detector, the erection of suitable scaffolding for safe access to the detector, and the inevitable jockeying of shielding blocks and iron doors as the need arose.

(Rumor has it that the muon "tower" mentioned above, which was once called *The Tower Of Power*, has now been rechristened as *The Tower-ing Inferno*.)

Norm Dean and his *SPEAR Vacuum Group* got the storage ring on and off the air with their usual smooth precision during those periods when the machine was running split shifts-- 12 hours on for machine physics studies, 12 hours off for the continuing repair work.

Ewan Paterson, Roy Schwitters and Bill Davies-White of SPEAR took the lead in laying out the overall repair program and schedule. The first priority was to get SPEAR back in



--Photo by Joe Faust

Ken Johnson is shown examining some of the burned cables that were removed, along with a section of the metal cable tray, from the West experimental pit at SPEAR.

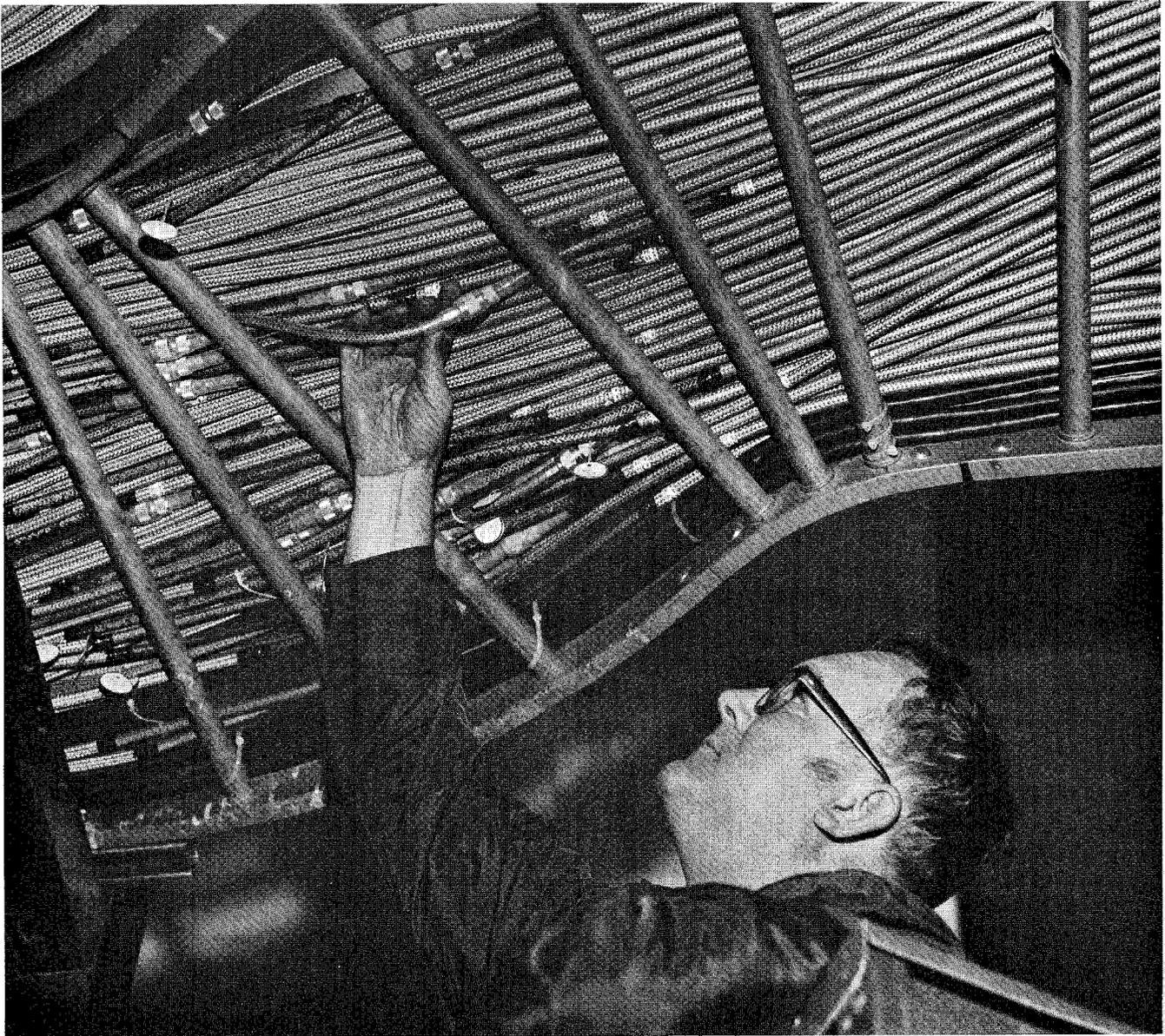
operation as quickly as possible--hopefully within one week--so that the machine physics studies associated with the recent upgrading program (SPEAR II) could be resumed. The second priority was to put the large magnetic detector back into operation within a three-week period. Both of these objectives were accomplished. The final part of the repair work is the replacement of the high-voltage pulsers, which now appears to be on track for a scheduled completion date of about May 1.

We now turn to a description, in a little more detail, of several of the major aspects of the repair work. Perhaps these examples

can serve to illustrate the kinds of cross-connections and cooperative efforts that exist among various SLAC groups in getting the lab's business carried out--and never more so than when unexpected problems arise.

#### High Voltage Pulsers

The big detector at SPEAR can be thought of as a magnetic box whose interior is pretty well filled with gadgets (counters and spark or wire chambers) that respond to the presence of an energetic particle. In the case of the chambers, a high voltage is applied across an open gap, and if a charged particle passes

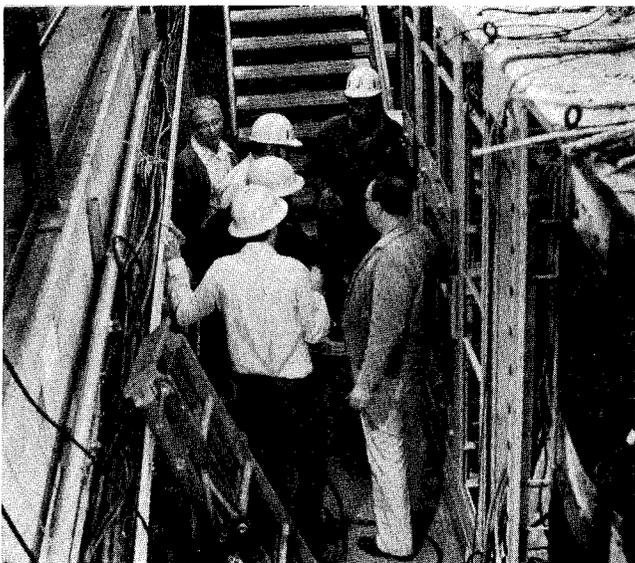


Ed Stephenson, crew leader of the electronics technicians responsible for for the cable re-installation, is shown here checking out cable tags and connectors. The damaged portions of the cables have been cut away, and connectors have been installed on the remaining "good" cables. Additional lengths of new cable were connected here and extended to the large magnetic detector. (Photo by Joe Faust.)

through that gap the voltage will cause a flow of current along the path followed by the particle. The pulsers are the electronics devices that provide the high voltage to the chambers. SPEAR had 12 such pulser units for use with the large detector, and the output from these 12 units was distributed among three major systems: A, B and C. The fire destroyed 4 of the pulsers and put system C, which included the muon chambers, out of action. Although systems A and B were undamaged, they did need some clean up and simple refurbishing. This clean-up work, together with the complete system C rebuilding job, was handled by a group consisting of Carl Olson, Rudy Ecken, Ray Larsen, Ken Bailey, Joe Fish and Morris Beck, who had all the help they needed from the Metal Shops and from Frank Generali's Electronics Shop. The system C rebuild was somewhat hampered by the lack of up-to-date drawings of certain subsystems, but John Kieffer supplied some schematic sketches of the pulsers, and Rudy Ecken was able to use some of the undamaged parts as a model for rebuilding. On the day after the fire Rick Hamman, Larry Womack and Wilson Becker were already beginning to chase down long-lead-time critical parts-- a 15 kV power supply and "banana" connectors, for example.

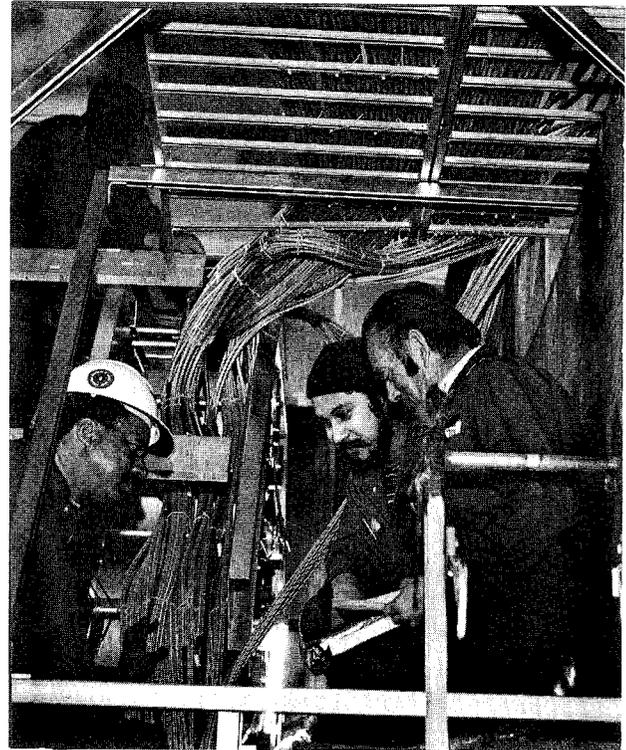
#### Signal Cables

Ed Stephenson, Jim Porter and crew had the job of replacing or repairing the several hun-



--Photo by Ken Johnson

A discussion at the power supply racks. Facing the camera are Ken Bailey on the left and Wal Cross on the right. John Bernstein is at the lower right, and the vertical row of hard-hats consists of (top to bottom) Gary Feldman, Rudy Ecken and Roy Schwitters. One of many impromptu meetings during the repair job, this particular group was discussing the replacement power supplies that are to be mounted in these racks.



--Photo by Joe Faust

Left to right, Wal Cross, Sal Alvarado and Mel Sylvia check out the cable-routing instructions while gathered on the temporary staging at the north end of the detector. Bob Burnside looks on from his position on top of the detector.

dred signal cables that had melted in the fire. The 6-to-8-man crew put in about ten hours a day, often starting at 6:30 AM. With help from Groups B and SFG, they got the job done in time to meet the detector start-up schedule in the second week of April. An interesting aspect of this work was the fact that nearly all of the replacement cable that was needed was already on hand at SLAC--thanks mainly to the vigilant excess (surplus) procurement program that Larry Womack, Bob Baker and others have been steadily engaged in for many years. Thus the cable and wire that had been picked up at bargain prices over the years from other government-sponsored activities really paid off in the aftermath of the fire. When the needed material was not on hand, feelers sent out to the labs at Berkeley and Livermore (along with a little judicious expediting of our commercial suppliers) usually got a rapid response on critical items (but where are the gold-plated banana jacks?).

Repair of the damaged control cables followed about the same pattern as that of the signal cables. This particular aspect of the work was coordinated by John Bernstein.

#### Muon Chambers

The nest of wire spark chambers and shield-



--Photo by Joe Faust

Ken Moore is shown terminating a 27-pair cable in the EFD Electrical Installations Group shop. Much painstaking work of this kind was needed to provide replacements for the cables that were damaged in the fire.

ing material on top of the magnetic detector is sometimes called the "muon tower." This installation was rather badly damaged by the fire. Although only one of the four damaged chambers had been repaired by the time the detector was ready to start up again, the SPEAR crew managed to put together an improvised system that was able to provide identification of muons during the resumed experimental running. This involved dismantling the tower, using some new chambers that had not been in the system before, and re-wiring some of the circuitry in the remaining high-voltage pulsers in order to switch them over to muon-chamber duty. The damaged chambers themselves were sent on to the Metal Shops for rebuilding, and they are expected to go back into the SPEAR detector system during the next scheduled accelerator down period.

To conclude, the combined efforts of many SLAC people and groups succeeded in getting SPEAR back on the air in about one week and the large magnetic detector back on in about three weeks. Thus the lost experimental time was kept to a minimum. All in all a job well-done.

--Bill Lockwood

## TIME TO LOOK AT YOUR WITHHOLDING ALLOWANCES



Reproduced in reduced size on the next page is the new Form W-4, "Employee's Withholding Allowance Certificate," which has been issued by the Internal Revenue Service and is to be used for wages paid after April 30, 1975 and before January 1, 1976. The table on page 2 of the form (right-hand side) has been revised to reflect the changes made by the Tax Reduction Act of 1975.

The attachment is intended to provide you with the information necessary to determine whether you should change the withholding allowances you are now claiming. *If you decide that changes are in order, the full-size copies of Form W-4 on which changes are to be submitted are available in the Benefits Section of the Personnel Office.*

The purpose of the table on Page 2 is to enable you to determine the number of withholding allowances for large itemized deductions to which you are entitled. Under the new withholding rules, some employees may no longer be entitled to as many withholding allowances for large itemized deductions as they are now claiming.

Since the income tax reductions in the new law are effective only for 1975, all employees, particularly those claiming additional allowances for estimated itemized deductions, should review their withholding position and, if necessary, file new Forms W-4 showing the correct number of withholding allowances prior to the time that the new withholding tables go into effect for wages paid after April 30. (As a practical matter, please submit revised forms during the early part of May.) Any changes submitted on revised Forms W-4 will also affect the withholding of California State Tax.

If the status of your withholding allowances remains unchanged from that appearing on your Form W-4 which is now on file, you do not need to submit a revised form.

--Walt Messing  
x2305

### CREF UNITS - A TURN FOR THE BETTER

In the February 1975 issue of the *Beam Line* we reported (for those who are on the CREF-TIAA retirement plan) that the value of a CREF unit had shrunk during 1974 from \$40.75 in January to \$28.35 in December. For 1975 the story is a little more encouraging so far:

January	- \$28.35
February	- 30.67
March	- 32.80
April	- 33.77

SEE ARTICLE ON PREVIOUS PAGE

**Form W-4 (Rev. 4-75)**  
**Table for Determining Number of Withholding Allowances Based on Itemized Deductions**

Number of additional withholding allowances for the amount of itemized deductions shown in the appropriate column (See Line 1 on other side)

Estimated salaries and wages	0		1		2		3		4		5		6*	
	Under	At least	Under	At least	Under	At least	Under	At least	Under	At least	Under	At least	Under	At least
\$10,000	2,200	\$2,200-\$2,950	2,950	\$2,950-\$3,700	3,700	\$3,700-\$4,450	4,450	\$4,450-\$5,200	5,200	\$5,200-\$5,950	5,950	\$5,950-\$6,700	6,700	\$6,700-\$7,450
10,000-15,000	2,800	2,800-3,550	3,550	3,550-4,300	4,300	4,300-5,050	5,050	5,050-5,800	5,800	5,800-6,550	6,550	6,550-7,300	7,300	7,300-8,050
15,000-20,000	3,200	3,200-3,950	3,950	3,950-4,700	4,700	4,700-5,450	5,450	5,450-6,200	6,200	6,200-6,950	6,950	6,950-7,700	7,700	7,700-8,450
20,000-25,000	4,000	4,000-4,750	4,750	4,750-5,500	5,500	5,500-6,250	6,250	6,250-7,000	7,000	7,000-7,750	7,750	7,750-8,500	8,500	8,500-9,250
25,000-30,000	5,000	5,000-5,750	5,750	5,750-6,500	6,500	6,500-7,250	7,250	7,250-8,000	8,000	8,000-8,750	8,750	8,750-9,500	9,500	9,500-10,250
30,000-35,000	6,000	6,000-6,750	6,750	6,750-7,500	7,500	7,500-8,250	8,250	8,250-9,000	9,000	9,000-9,750	9,750	9,750-10,500	10,500	10,500-11,250
35,000-40,000	7,000	7,000-7,750	7,750	7,750-8,500	8,500	8,500-9,250	9,250	9,250-10,000	10,000	10,000-10,750	10,750	10,750-11,500	11,500	11,500-12,250
40,000-45,000	8,000	8,000-8,750	8,750	8,750-9,500	9,500	9,500-10,250	10,250	10,250-11,000	11,000	11,000-11,750	11,750	11,750-12,500	12,500	12,500-13,250
45,000-50,000*	8,000	8,000-8,750	8,750	8,750-9,500	9,500	9,500-10,250	10,250	10,250-11,000	11,000	11,000-11,750	11,750	11,750-12,500	12,500	12,500-13,250

**Part II Married Employees (When Spouse Is Not Employed)**

Under	At least	Under	At least	Under	At least	Under	At least	Under	At least
\$15,000	2,900	2,900-3,650	3,650	3,650-4,400	4,400	4,400-5,150	5,150	5,150-5,900	5,900
15,000-20,000	3,400	3,400-4,150	4,150	4,150-4,900	4,900	4,900-5,650	5,650	5,650-6,400	6,400
20,000-25,000	3,700	3,700-4,450	4,450	4,450-5,200	5,200	5,200-5,950	5,950	5,950-6,700	6,700
25,000-30,000	4,300	4,300-5,050	5,050	5,050-5,800	5,800	5,800-6,550	6,550	6,550-7,300	7,300
30,000-35,000	5,200	5,200-5,950	5,950	5,950-6,700	6,700	6,700-7,450	7,450	7,450-8,200	8,200
35,000-40,000	6,200	6,200-6,950	6,950	6,950-7,700	7,700	7,700-8,450	8,450	8,450-9,200	9,200
40,000-45,000	7,200	7,200-7,950	7,950	7,950-8,700	8,700	8,700-9,450	9,450	9,450-10,200	10,200
45,000-50,000*	8,200	8,200-8,950	8,950	8,950-9,700	9,700	9,700-10,450	10,450	10,450-11,200	11,200

**Part III Married Employees (When Both Spouses Are Employed), and other employees who are holding more than one job**

Under	At least	Under	At least	Under	At least	Under	At least	Under	At least
\$10,000	3,200	3,200-3,950	3,950	3,950-4,700	4,700	4,700-5,450	5,450	5,450-6,200	6,200
10,000-15,000	4,200	4,200-4,950	4,950	4,950-5,700	5,700	5,700-6,450	6,450	6,450-7,200	7,200
15,000-20,000	5,000	5,000-5,750	5,750	5,750-6,500	6,500	6,500-7,250	7,250	7,250-8,000	8,000
20,000-25,000	5,600	5,600-6,350	6,350	6,350-7,100	7,100	7,100-7,850	7,850	7,850-8,600	8,600
25,000-30,000	6,200	6,200-6,950	6,950	6,950-7,700	7,700	7,700-8,450	8,450	8,450-9,200	9,200
30,000-35,000	7,000	7,000-7,750	7,750	7,750-8,500	8,500	8,500-9,250	9,250	9,250-10,000	10,000
35,000-40,000	7,900	7,900-8,650	8,650	8,650-9,400	9,400	9,400-10,150	10,150	10,150-10,900	10,900
40,000-45,000	8,900	8,900-9,650	9,650	9,650-10,400	10,400	10,400-11,150	11,150	11,150-11,900	11,900
45,000-50,000*	10,200	10,200-10,950	10,950	10,950-11,700	11,700	11,700-12,450	12,450	12,450-13,200	13,200

**HOW TO USE THE TABLE**

If you expect to itemize deductions for the current year, you may use the amount and that shows your status as either a single employee (Part I), a married employee whose spouse is not employed (Part II), or a married employee whose spouse is employed (Part III). Also use Part III if you are an employee who is holding more than one job currently.

2. Read across that line until you find the amount of itemized deductions for the preceding year (or 2nd preceding year if you have not yet filed your return for the preceding year), plus additional deductible amounts.

3. Note the number of allowances shown at the top of the column. This is the maximum number of additional withholding allowances you may claim on your return.

4. If you are an employee, you may claim the amount shown in Column 6 (Part I, II, or III) for your salary and wage bracket. When annual salary or wage exceeds \$50,000, "0" column amounts may be determined as follows: for single employees (Part I)—22% of their annual salary; for married employees (Part II)—15% of their annual salary; for other employees who are holding more than one job (Part III)—24% of their combined annual salary. An additional withholding allowance may be claimed for each \$750 or fraction thereof by which itemized deductions exceed the "0" column amount determined in this manner.

**Married Couples**—If you and your spouse are both employed and file a joint return, determine your withholding allowances on the basis of your combined income. If you file a joint return and your spouse is not employed, use Part II. If you are filing a joint return and both are employed, use Part III. The allowances are allocated to each spouse in the amount to which you are jointly entitled (you may allocate such withholding allowances between yourselves). However, if in your last filing you filed separately returns, and if you expect to file separately this year, each of you must make your determination on the basis of your own income. If you are filing a joint return, the number of withholding allowances for each from Part III.

**Form W-4 (Revised April 1975)**  
**Employee's Withholding Allowance Certificate**  
 (Use for wages paid after April 30, 1975 and before January 1, 1976)

The explanatory material below will help you determine your correct number of withholding allowances, and will assist you in completing the Form W-4 at the bottom of this page.

**Avoid Overwithholding or Underwithholding**

By claiming the proper number of withholding allowances you are entitled to, you can fit the amount of tax withheld from your wages to your tax liability. In addition, you are entitled to a refund of any overwithholding allowances, and item (b) "Allowance(s) for itemized deductions." While these allowances may be claimed on Form W-4 for withholding purposes, they are not to be claimed under "Exemptions" on your tax return Form 1040 or Form 1040A.

You may claim the special withholding allowance if you are single with only one employer, or married with only one employer and your spouse is not employed. This special allowance is in addition to the number of allowances you claim. On the other hand, if you and your spouse are both employed or you have more than one employer, you should take steps to assure that enough has been withheld. If you find that you need more withholding, claim fewer exemptions or ask for additional withholding. If you are currently claiming additional withholding allowances based on itemized deductions, check the table on the back to see that you are claiming the proper number of allowances.

**How Many Withholding Allowances May You Claim?**

Please use the schedule below to determine the number of allowances you may claim for tax withholding purposes. In determining the number, keep in mind that you are single with only one employer, or if you are married and both you and your spouse are employed, you may not claim the same allowances with your employers at the same time. A nonresident alien, other than a resident of Canada, Mexico, or Puerto Rico, may claim only one personal allowance.

**Figure Your Total Withholding Allowances Below**

(a) Allowance for yourself—enter 1	.....
(b) Allowance for your spouse—enter 1	.....
(c) Allowance for your age—if 65 or over—enter 1	.....
(d) Allowance for blindness (yourself)—enter 1	.....
(e) Allowance for blindness (spouse)—enter 1	.....
(f) Allowance(s) for dependent(s)—you are entitled to claim an allowance for each dependent you will be able to claim on your Federal income tax return. Do not include yourself or your spouse.	.....
(g) Special withholding allowance—if you are single with only one employer, or married with only one employer and your spouse is not employed—enter 1	.....
(h) Allowance(s) for itemized deductions—if you do plan to itemize deductions on your income tax return, enter the number from the table on back*	.....
(i) Total—add lines (a) through (h) above. Enter here and on line 1, Form W-4 below.	.....

\* If you are in debt as to whom you may claim as a dependent, see the instructions which came with your last Federal income tax return or call your local Internal Revenue Service office.

\*\* This allowance is used solely for purposes of figuring your withholding tax, and cannot be claimed when you file your tax return.

**See Table on Back if You Plan to Itemize Your Deductions**

**Completing Form W-4**—If you find that you are entitled to one or more allowances in addition to those which you are now claiming, increase your number of allowances. If you find that you are overclaiming allowances, you must file a new Form W-4 within 10 days. (Should you expect to owe more tax than will be withheld, you may use the same form to increase your withholding by claiming fewer or "0" allowances on line 1, or by asking for additional withholding on line 2, or both.)

▼ Give the bottom part of this form to your employer; keep the upper part for your records and information ▼

Form **W-4**  
 Department of the Treasury  
 Internal Revenue Service

Your social security number

Home address (Number and street or rural route)

City or town, State and ZIP code

Marital status  
 Single  
 Married (If married but legally separated, or spouse is a nonresident alien, check the single block.)

1 Total number of allowances you are claiming

2 Additional amount, if any, you want deducted from each pay (if your employer agrees)

I certify that to the best of my knowledge and belief, the number of withholding allowances claimed on this certificate does not exceed the number to which I am entitled.

Signature

Date

## DRINKS, DINNER & A TALK: AN INVITATION TO EVERYONE AT SLAC

SLAC employees and their families are cordially invited to come to SLAC on the evening of May 14 and join in the following program:

WEDNESDAY, MAY 14

Time:       Cocktails     6 PM  
              Dinner         7 PM  
              Talk           8:30

Place:   SLAC Cafeteria & Auditorium

Talk:     Prof. Sidney D. Drell  
              Deputy Director, SLAC

"The Vladivostock Accord and Progress  
in the Strategic Arms Limitation Talks"

Host:    Health Physics Society  
              Northern California Chapter

Dinner will feature a 10-ounce steak, barbequed to your order, baked potato, vegetable, tossed salad, dessert and coffee. The price for dinner is \$5.75, and reservations are required. (But not for those who only want to hear Prof. Drell's talk.) For reservations, please phone W. P. Swanson at ext. 2345 by about May 9.

SLAC Beam Line (Bin 80)  
Stanford Linear Accelerator Center  
Stanford University  
P.O.Box 4349  
Stanford, California 94305

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## YOP - YOUTH OPPORTUNITY PROGRAM

In the March issue of the *Beam Line*, we encouraged everyone to spread the word about SLAC's Youth Opportunity Program to any young people who might be interested and who could qualify. Now we'd like to encourage SLAC supervisors who can employ YOP participants to take the next step by sending in Job Requisitions to the Employment Office (Bin 11). Please keep in mind the following information about the YOP:

1. The YOP provides summer employment and work experience for disadvantaged young people between the ages of 16 and 22.

2. Many of these young people have no previous work experience.

3. They may require instruction and fairly close supervision.

4. If you take on a YOP participant, you are responsible for keeping him or her usefully occupied and adequately supervised throughout the term of the program, even when you are personally away on vacation.

5. The majority of supervisors who have employed YOP people in past years have been satisfied with the program, and have been willing to continue it each summer.

6. Most of the YOP participants themselves seem also to have been satisfied with the program. Perhaps their most common complaint has been a lack of meaningful work.

Please have your Group Leader sign any YOP Job Requisitions, after which they should be sent directly to the Employment Office (the rest of the usual control points can simply be by-passed for YOP Reqs.).

--Gerry Renner  
Bin 11, x2353

## BEAM LINE DISTRIBUTION

About 1300 copies of each issue of the *Beam Line* are distributed by the SLAC Mail Room in accordance with the distribution list shown below. If your particular Bin Number is not getting enough copies, or is getting too many, that's easy to fix. Just tell Herb Weidner (x2723) or Bill Kirk (2605).



Beam Line	0-2	6-14	11-19	21-6	26-22	34-4	52-7	60-20	65-35	70-5	75-17	82-12	87-8	92-3
Dist.	1-15	7-2	12-8	22-13	27-3	40-65	53-42	61-21	66-16	71-56	78-24	83-9	88-27	94-12
	2-8	8-4	14-4	23-12	30-41	45-7	54-30	62-47	67-12	72-3	79-85	84-20	89-20	95-37
	3-6	9-3	15-5	24-11	31-7	50-25	55-31	63-19	68-10	73-13	80-8	85-23	90-3	96-15
	4-5	10-9	20-20	25-3	33-17	51-30	56-10	64-15	69-23	74-8	81-50	86-11	91-6	97-88