one proved very fruitful for its further development. Each of the three brought a different viewpoint and a different style, and so the theory gained in breadth and richness. Tomonaga was most concerned with basic physical principles; his papers were simple, clear, and free from elaboration of detail. Schwinger was most concerned with the construction of a complete and massive mathematical formulation; his papers were monuments of formal ingenuity. An unkind critic once said: "Other people publish to show you how to do it, but Julian Schwinger publishes to show you that only he can do it." It was in fact Schwinger who was the first to hack his way through the mathematical jungle and arrive at a definite numerical value for the magnetic moment of the electron.

Feynman's approach was the most original of the three; he was willing to take nothing for granted, and so he was forced to reconstruct almost the whole of quantum mechanics and electrodynamics from his own point of view. He was concerned with deriving simple rules for the direct calculation of physically observable quantities. His invention of "Feynman graphs" and "Feynman integrals" made it easy to apply the theory to concrete problems. In the end, Feynman's rules of calculation have become standard tools of theoretical analysis, not only in quantum electrodynamics but in high-energy physics as a whole. And Feynman's insistence on discussing directly observable quantities led to the growth of the "S-matrix point of view," which now dominates current thinking about the fundamental particles and their interactions.

The theory which came to triumph in 1948 is not an easy one to describe in nontechnical language. It must be placed in the context of some earlier history. The pioneers of quantum mechanics—Dirac, Heisenberg, Pauli, and Fermi—had worked out the physical basis for quantum electrodynamics during the late 1920's. The basis consisted in a direct application of the methods of quantum mechanics to the Maxwell equations describing the electromagnetic field. The resulting theory seemed to give a qualitatively correct account of radiation processes, but it failed to give exact predictions. When pushed beyond the first approximation, it always gave infinite or meaningless answers. In the face of this situation, the physicists of the 1930's mostly looked for radical changes in the theory. It was generally believed that the "divergence difficulties" were symptoms of fundamental errors, and were only to be escaped by altering the theory drastically. So from 1935 to 1945 there was a succession of fruitless attempts to cure quantum electrodynamics of the divergence disease by methods of radical surgery.

Tomonaga, Schwinger, and Feynman rescued the theory without making any radical innovations. Their victory was a victory of conservatism. They kept the physical basis of the theory precisely as it had been laid down by Dirac, and only changed the mathematical superstructure. By polishing and refining with great skill the mathematical formalism, they were able to show that the theory does in fact give meaningful predictions for all observable quantities. The predictions are in all cases finite, unambiguous, and in agreement with experiment. The divergent and meaningless quantities are indeed present in the theory, but they appear in such a way that they automatically eliminate themselves from any quantity which is in principle observable. The exact correspondence between quantities which are unambiguously calculable and quantities which are observable becomes, in the end, the theory's most singular virtue.

The theory, as Tomonaga, Schwinger, and Feynman left it, has stood the test of time for 17 years. It describes only a part of physical reality, and it makes no claim to finality. But its success within its area of applicability has been so complete that it seems sure to survive, at least as a special limiting case, within any more-comprehensive theory that may come later to supersede it.

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Speaker Ban (I): North Carolina Law Stirs Unrest at University

Chapel Hill, N.C. Controversies over who shall be permitted to speak on university campuses are not unusual, and communists and other radicals of various hues often have been barred from campuses across the country. Sometimes a board of trustees has been the one to deny a university forum to speakers of dubious political coloration; in other instances, administrators, particularly at public institutions, have kept the radicals out for fear of incurring the displeasure of trustees or politicians. The "speaker ban" imposed more than 2 years ago by the General Assembly of North Carolina is believed to be unique, however. It has created severe strains between the University of North Carolina and the legislators. UNC officials say no other state has imposed so restrictive and inflexible a law. The speaker-ban statute, passed almost frivolously in the closing days of the 1963 session of the Assembly, without hearings and under suspension of the rules, proscribes not only "known communists" but persons who have pleaded the Fifth Amendment in loyalty investigations. UNC, a prophet in its region and perhaps the most distinguished of southern universities, has been warned by the Southern Association of Colleges and Schools that its accreditation is in danger because of the "political interference" in its affairs.

Paul F. Sharp, chancellor at Chapel Hill, has summed up the speaker ban's consequences: "Faculty morale has suffered, students are restless, administrators are harassed and distracted from essential duties, public controversy mounts, accreditation is threatened, professional organizations refuse to

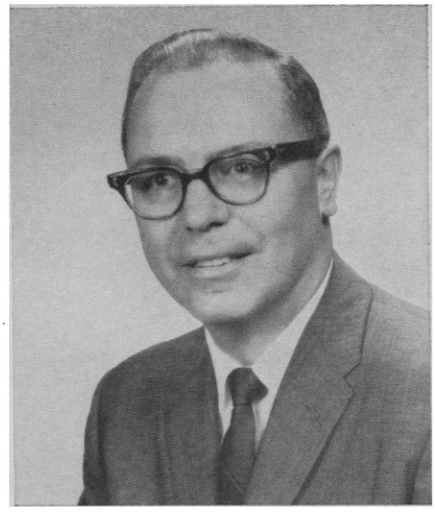
meet on our campus, and we suffer the indignity of unbridled public criticism on the one hand and severe reprimand by our professional colleagues throughout the nation on the other." The question now confronting the state is whether the General Assembly will repeal or amend the speaker ban before the SACS Commission on Colleges meets at the end of November and determines the university's status.

In *Look Homeward Angel*, Thomas Wolfe, a UNC alumnus ('20), described "Pulpit Hill" as a "provincial outpost of Great Rome: the wilderness crept up to it like a beast." The image is no longer as apt as it was in Wolfe's time, partly because of the university's hand in the cutting back of the wilderness. In its political attitudes and adjustment to racial problems, North Carolina has more in common with the North than with such Deep South states as Alabama and Mississippi.

Recent elections suggest that though an avowedly racist candidate can win a substantial vote, he will fall far short of a majority. The state is gradually acquiring a two-party system, and the development of a diversified economy is well under way. The larger cities, if still provincial, are becoming more pleasant and urbane; the transplanted northerner often finds them agreeable.

The wilderness, though it continues to yield before enlightening influences, is not easily conquered, however. It still stands in places, and at times grows more dense and impenetrable. The recent resurgence of the Ku Klux Klan has marked the frustration felt by marginal farmers, store clerks, and other "poor whites" at the federal government's increasingly insistent intervention on the side of the Negro. The speaker-ban controversy itself is not unrelated to the civil rights movement, which many segregationists somehow identify with communism; its deeper origins appear to lie in the universally known wildnerness of ignorance, suspicion, and fear.

The relatively enlightened atmosphere that sets North Carolina apart from most of the states farther south owes much to the university. Established in 1795 as the first state university in the nation, UNC struggled along largely in obscurity until after the turn of the century. Its graduate programs were achieving distinction by the 1920's, and the newly founded UNC Press was bringing the work of the university's faculty to the attention of a wider community of scholars. The Institute for



Paul F. Sharp

Research in Social Science, established in 1924, boldly undertook controversial studies of such regional problems as the Negro, farm tenancy, the one-crop economy, and the impoverished mill village. Though never swarming with radicals and firebrands, the university did not discourage a searching look at the status quo.

This questioning attitude was disquieting to some of North Carolina's more conservative and complacent people. Their suspicion and uneasiness grew during the 1930's and 1940's when Frank Porter Graham was President of the University. Graham was readily identifiable, at least in a Southern context, as a liberal given to promoting the cause of the Negro and the working man. In 1949 he was appointed to the United States Senate by Governor Kerr Scott, a tobacco-chewing agrarian liberal. In his bid for election to a full term in 1950, Graham failed to poll a majority vote against his two opponents in the Democratic primary and had to undergo a bitter run-off contest against Willis Smith, a prominent corporation lawyer strongly supported by the state's conservative business leadership.

Graham had run well among the farm people of eastern North Carolina, a "black belt" area which is unusual in that its whites sporadically manifest a preference for liberal candidates. As a friend of labor, Graham had also done well in the mill towns of the Piedmont. To cut into his farm and labor support, the Smith forces attacked Graham as an integrationist and a well-meaning but muddleheaded leftist from the ivory tower at UNC.

This strategy worked, and Graham was defeated. Graham became a United Nations mediator and never returned to the university; but the charges of the 1950 campaign were not easily forgotten and gave wider currency to gossip that something was amiss at Chapel Hill. The widely publicized trial and conviction in 1955 of a former UNC student for violation of federal antisubversion laws was taken by some as another discouraging sign of an unhealthy condition at the university.

The university remained out of real trouble, however, until the speaker-ban issue arose in 1963, and even that controversy may be resolved in its favor. Friends of the university, many of them UNC graduates who now hold prestigious positions in their communities, are spread throughout the state. They remember fondly the ancient buildings, the tree-shaded quadrangles, and the casual charm of Chapel Hill, which retains a village atmosphere even though the university enrollment has grown from less than 7000 students in 1950 to about 12,500 today.

Despite the concern expressed by some UNC alumni in the state legislature, it is not easy for many of the old grads returning for football weekends to think of the UNC campus as a hotbed of radicalism. The sandaled and bearded beatniks common on some campuses are much the exception at UNC. The few students who hand out get-out-of-Viet-Nam leaflets often are found locked in debate with defenders of U.S. policy. Typically, a student comes to UNC from a church-going, solidly middle class family from a farm market town of eastern North Carolina or from one of the burgeoning cities of the Piedmont. His political proclivities, if he has any, are likely to reflect those of the grown-up politicians back home. Left-wing groups spring up on campus from time to time, but they have tended to be small and without substantial influence in student affairs. No UNC student now on campus has been identified as a member of the Communist Party.

UNC is saved from provincialism by its wise policy of drawing most of its faculty and a substantial minority of its students from outside the state. The general rule is to limit the proportion of students from other states to 15 percent of the new undergraduates enrolled, but actually about a third of the student body is from out of state. This is so because no quota applies to the children of alumni or to candidates for the graduate schools, and because of a

comparatively low drop-out rate among the carefully screened nonresidents.

A survey made a few years ago showed only one-fourth of the faculty members of professional rank to be native North Carolinians; the remainder had come from 40 states and 15 foreign countries. Faculty members with their Ph.D.'s from Ivy League universities easily outnumbered those who had earned theirs at UNC; 58 were from Harvard alone.

UNC's academic strength was attested to recently when the university emerged with a high rating from an American Council on Education's evaluation of the graduate programs at 107 institutions. The evaluation, based on 5400 questionnaires sent to department chairmen and other scholars, gave UNC an "A" rating in ten departments, a "B" in four, and a "C" in two, for a higher average standing than that of any other southern university (though Duke and the University of Texas were close behind). UNC was strongest in the social sciences and humanities, but the mathematics, psychology, and chemistry departments were among those receiving an "A."

The current controversy, which places in hazard all the university's attainments, might never have developed except for the naiveté of the sponsors of the speaker-ban law. Some appear dumbfounded at the furor they have aroused. The measure was introduced by Representative Phil Godwin, a legislator from a rural eastern county. "When the bill was prepared, I just couldn't see anything wrong with it or that anybody in the State of North Carolina would ever object to it," Godwin said recently. Godwin's explanation that he meant only to protect students from the influence of communist visitors is puzzling. The communist speakers who have appeared in Chapel Hill have not been numerous, even when one goes back to the Depression years of the 1930's to begin counting them. A few known or suspected communists, including a left-wing poet invited by a group of English graduate students, spoke at UNC during the 3 years preceding enactment of the speaker ban. These appearances generated no great excitement on campus. A student leader recalls that only 14 people were present to hear an extreme leftist labor leader, and that this modest audience included three newspaper reporters and two monitors from the American Legion, both of them red-blooded, 100-percent Americans. Even the students were unsympathetic; the speaker found himself ringed by hostile questioners.

The belief persists that civil rights demonstrations going on in Raleigh, where the General Assembly was in session, either provoked the speaker ban or provided its emotional impetus, although Godwin has denied this. Five days before the speaker-ban bill was introduced, Albert Amon, an assistant professor of psychology at Chapel Hill, together with a faculty member from the consolidated university's Raleigh campus, was spotted taking part in a demonstration at the Sir Walter Hotel, where most of the legislators were quartered. Some outraged legislators called William Friday, President of the university, and said both men should be fired. Friday replied that faculty members are not dismissed except by an elaborate procedure safeguarding their rights. No action ever was taken against either man, although each was counseled by his chancellor against behavior hurtful to the university. Amon, who had a history of ill health, died the next year. The other demonstrator has left the Raleigh faculty, but for reasons said to be unrelated to his civil rights activities. An appropriate footnote to the incident is that one of the first legislators to complain of the faculty men's part in the Sir Walter demonstration later resigned his seat to become state commander of the American Legion, which is perhaps the speaker ban's most passionate defender.

The General Assembly was sharply criticized by the state press for its hasty enactment of the speaker ban, which applied not only to Chapel Hill but to other campuses (at Raleigh, Greensboro, and, now, a new one at Charlotte) of the consolidated university and to other state-owned colleges as well. Officials and faculty throughout the university system denounced the measure. The Board of Trustees scored it as a preemption of its prerogatives and an impairment of academic freedom. No sustained campaign was mounted against the speaker-ban law until this year, however. University officials hoped that with some quiet prompting the General Assembly would see its error and repeal the law at its 1965 session.

Nothing of the kind happened. Governor Dan Moore, a UNC alumnus who does not favor the law, has been criticized for not moving forcefully at the beginning of the session to get the speaker ban repealed, either outright or by an amendment permitting the law's proponents to save face. Moore held back, however, and by the time he began to count votes the controversy had flared alarmingly and the prospects for repeal were discouraging. A telegram to the trustees from the accrediting agency, the Southern Association of Colleges and Schools, was interpreted by some legislators as a bald threat, to which they would never bow. Enough legislators had had second thoughts about the speaker ban that a majority probably regretted its passage; but to vote for repeal of this "anti-communist" measure, which many legislators believed to be popular with their constituents, was quite another matter.

—LUTHER J. CARTER

(A second article in this space next week will discuss the current status of North Carolina's speaker-ban controversy.)

Congress: Higher Education Act Including Scholarship for Needy Passed in Final Days of Session

Last week the House and Senate gave final passage to a higher education bill which tops off 2 years of unprecedented legislative activity in behalf of education.

The new law, authorizing a $2.3-billion potpourri of programs, combines major features of bills passed independently by the House and Senate and exceeds original administration proposals in both variety of programs and cost.

In common with the Elementary and Secondary School Act passed last spring (*Science*, 22 January 1965), the new law has a full educational-opportunity rationale. Such a bill was what President Johnson had in mind when he spoke in his education message of an intention "to extend the opportunity for higher education more broadly among lower and middle income families."

Opening the debate on the House-Senate conference report on the legislation last Wednesday, House Education and Labor Committee chairman Adam Clayton Powell (D–N.Y.) put this sanguinely when he said, "Both Chambers and boths sides of the aisle sought compromise with one goal in mind—the enactment this year of legislation that will revitalize the tired blood of our anemic colleges and universities and pump needy students into the all too upper class main stream of academic life."