March 22, 1982

COPY

Professor Andre Weil
School of Mathematics
Institute for Advanced Study

Dear Andre:

Just a short note to thank you for the copy of your talk to the Trustees on April 1, 1960. I enjoyed reading it very much, and was pleased to learn that much of what I have been saying to the Trustees and others in talking about the Institute echos your own judgments. It is comforting and supportive to discover in a scholar of your distinction one's own intuitive understanding and beliefs.

With warm regards.

Sincerely yours,

Harry Woolf

With cordial regards
A Weil

Talk to the Trustees of the Institute for Advanced Study by Professor Andre Weil, April 1, 1960.

As the Director says, I am a relative newcomer. I have as yet only quite hazy notions about the nature and functions of the Institute as a whole. I think it is my duty as a professor of the Institute to acquire some ideas and some views on those matters, but two years is rather a short time. But I have quite clear and definite views about the nature and functions of the School of Mathematics, in the narrow sense, meaning mathematics and excluding physics, for the simple reason that ever since the Institute was started, I had quite close contact, sometimes directly, sometimes indirectly, with mathematics and the mathematicians at the Institute. Many of the people who have been here have been among my closest friends; I was a member here myself in 1936; also, it has been impossible to keep in touch with the mathematics of the last 30 years without at the same time being in close contact with the mathematics at the Institute. This means that I am going to invade the province of my colleagues the historians, because the history of the mathematical school of the Institute, is an essential chapter of the history of modern mathematics, and the two cannot be dissociated. It is unthinkable that anyone would write the history of mathematics in the 20th century without devoting a large portion of it either to the Institute, or to the mathematics which have been done at the Institute, which comes very much to the same thing.

The first point to keep in mind (a very gratifying one to a mathematician) is that even now, in spite of anything you may hear to the contrary, mathematics has remained one subject. If you ever hear anyone saying that mathematics has split up into a number of fragments which are isolated from one another, this is simply not true. Of course, there are men who have specialized in such a narrow corner of mathematics as to become quite unable to understand what has been going on in some other corner. Nevertheless, mathematics has remained a unified subject. Incidentally, in science it seems to be the one subject which has preserved a continuous tradition. It has a solid, continuous history, of say, twenty-five hundred years. It started much earlier than that, but twenty-five hundred years is the period of continuity during which there has been no interruption. There have been considerable slowdowns, in the Roman period, in the Middle Ages, but not interruptions. It has remained unified in the sense that mathematicians, at least good mathematicians, from whatever

branch they come, still understand each other, and think along parallel lines. Of course, the temperament of an algebraist is not that of an analyst, and everyone has his own personal preferences. But it is all one subject, and it constantly happens that classifications break down; whatever barriers appear at one stage between the various braches of mathematics, they have a way of collapsing, and then things get sub-divided in a quite different manner ten or twenty years later; some of the most important progresses in mathematics, say over the last hundred years, have come about precisely like that, through penetration from one brach of mathematics into another, so that a constant interchange of ideas between all branches is essential.

Even a hundred years ago, certainly a hundred and fifty years ago, the same applied to mathematics and theoretical physics. It was part of the business of a mathematician to know as much as there was to know in those days about theoretical physics, and the people who by temperament were theoretical physicists had to know practically all that was then going on in mathematics. Here a barrier has appeared which, at any rate at the moment, seems essential. We mathematicians do not profess to understand anything, we are completely ignorant, so far as theoretical physics are concerned, and the converse is true. We may occasionally make an effort - of course it is very interesting to have theoretical physicists physically close to us, and to hear them talk since they do try to talk to us sometimes; but it does not seem to be particularly informative so far as our actual work is concerned. But within mathematics (pure mathematics as some people prefer to say), there is absolutely no barrier, and it is essential that a constant interchange of ideas should take place.

This need has always been there, all the time through the history of mathematics. Presumably, in the time of Archimedes, it was there, whatever machinery there may have been to satisfy it in those days;certainly it was there in the nineteenth century. There has to be some spot where the interchange of ideas takes place. Personal correspondence has always played an important role. The correspondence of Newton, that of Leibniz, of Bernoulli, are an essential part of the history of mathematics in their time. But physical communication has always been even more important. It has always been necessary for the progress of mathematics that there should be somewhere a physical location for a clearing house in mathematical ideas. In the nineteenth century, immediately after the Napoleonic wars, the clearing house was Paris.

When Abel or Dirichlet wanted to hear what was going on in the branches of mathematics of special interest to them, they came to Paris. This, roughly speaking, went on until around 1880, when Göttingen came into prominence; it became the main clearing house, while a secondary center subsisted in Paris; this lasted until the first world war. After that, for about ten years, Göttingen was the only place to play that role; somehow Paris had disappeared from the picture.

When Hitler came to power, Göttingen collapsed. By a very lucky accident, this, as you know, was precisely the time when Flexner created this Institute. In doing so, Flexner chose to give particular prominence to mathematics, for a number of reasons which it is not for me to try to guess. There must have been in his mind one obvious consideration which, it seems to me, was a very sensible one, namely, that mathematics is probably, nowadays, the field where, with a given outlay of money, you can get the most far-reaching results. This is quite obvious, because mathematics depends only upon salaries and a rather modest library, nothing like the libraries which historians require in order to do their work; nothing like the experimental apparatus required by physicists, chemists and so on. Mathematics, as I said, takes a comparatively very small outlay of money per head, so to say, to achieve maximum results. And, of course, the timing was very fortunate, because Göttingen, and German science in general, had just collapsed, so that Flexner could draw upon the people who had to leave Germany at that time, such men as Von Neumann and Hermann Weyl. I think Hermann Weyl is really the man who made the mathematics at the Institute what it is, because of many qualities that he had, but particularly because, being a true pupil of Hilbert, he shared that belief which I have expressed to you, that mathematics is one science, a unified subject, and must go on as such. And he organized things here, or rather he refrained from organizing things, he created things here in that spirit.

Now, since 1932 (it took a few years to get started, so it would be more accurate to say since around 1935), Princeton has played its role as the main clearing house for mathematics in the world. In recent years (for the last seven or eight years perhaps) Paris has again become a world center in the same sense, not quite the equal of Princeton, but also very important. What I want to emphasize is that it is absolutely essential for the progress of mathematics that there should be such a center, that it is very fortunate for mathematics that such a center has appeared in Princeton, that it is there, and, so far

as one can see, there is every reason why it should go on being there. The only shadow in this picture is that of the communications with so-called iron curtain countries. Now we have good communications with Poland, at any rate; Polish mathematicians do come here to our and their mutual benefit. So far we have not had a single Russian mathematician, and all our effort in that direction has not led to anything; this is too bad, because they need contact with such a clearing house just as much as we do. They know it very well, and I am quite sure that they deplore the fact that they cannot use it. They do have their own internal clearing house in Moscow, but that is not enough to give them full contact with world mathematics.

Now, to describe the way in which this center, this clearing house, is actually functioning, is quite easy. But first, it must be quite clear to you that what is essential to our clearing house is not so much the people who are here permanently as the people who come here for periods of, sometimes one term, more frequently two terms, occasionally two years. So, the essential thing in the Institute, as I see it, is the temporary member. The permanent faculty plays an essential role in several ways. Of course, there is the work they are doing, but that goes without saying, and wherever they would be they would presumably do more or less the same work. If, occasionally, there is a man on the faculty who thinks of the Institute as an ivory tower, where he can shut himself up in his study and do his work undisturbed by the outside world, that is fine. We can well afford to have occasionally a man of that type if he is of the proper caliber. But he does not contribute anything special to the life of the Institute. Such a man just has to be left alone. Apart from such people, who, naturally, will occur from time to time, and for whom I have, of course, a great respect, the essential role of the permanent faculty, it seems to me, is to serve as nuclei around which temporary constellations of temporary members will gather; it is to establish a contact between the temporary members. Sometimes, when they come here, they have not even a common language to begin with; usually they know some English, but sometimes not too much. Apart from such unavoidable language difficulties, it can very well happen that the ideas of one man are highly relevant to the work of another, but they do not know it, and they may never discover it unless there is someone, preferably someone on the permanent faculty to tell them. That is one of the best things that a faculty member can do; he knows about those people, because he has taken part in appointing them; so he is in the best position to put them in contact with each other, and tell A, "Now, you should hear what B has to

say". Of course, this also happens through informal contacts, through lectures, through seminars; there are lots of ways in which this can happen, but we have to act as catalysts, whenever possible, to favor that.

Of course, we also have a basic role in making the selection of those temporary members, and, in order to do that, it is essential that we know what is going on in mathematics, in all fields of mathematics. Up to a point, coverage of the various branches of mathematics is far less important to us than it is in a university. A university must have a man, for instance, to teach algebra, or to teach partial differential equations, and if they do not have a man of the proper caliber, since the teaching has to be done, they take the next best person. We would not do that. We are all agreed that we would not and should not do that; but whenever possible, it is very desirable, and even important, that we have between ourselves, within the permanent faculty, a reasonably complete coverage, so as to have some idea between ourselves of what is going on in all branches of mathematics, and to be in a position to send for the people who are doing really advanced work in all directions; naturally, this also requires a certain amount of judgment, which we hope to possess; otherwise we are doomed to failure.

Here I have a list of mathematicians, the temporary members for this year; I have broken it down into categories, and this gives, I think, a fairly good picture of the work we are doing. I have divided it up into Americans up to the age of 32, Americans above the age of 32, and foreigners. Let us begin with the foreigners. That is where our role as a clearing house for mathematical ideas is most prominent, and this is inseparable from our role in world mathematics. Our foreign members, by and large, are the most prominent people, doing the most advanced work, in every direction, all over the world, wherever and whenever we can get hold of them. We have absolutely no rule in our School, no mechanical criteria of selection. For instance, we do not say:"This man has no permanent job, therefore we cannot have him, because that would be dangerous, we might be stuck with him." We just do not care. We invite whomever we want. As I said, the Russians, unfortunately, have not responded. Everywhere else, we have no problems. Firstly it is generally considered an honor, all over the world, to receive an invitation to the Institute; secondly, and this is more significant, there is hardly any mathematician in the world who is not quite sure that there is a great deal for him to learn in Princeton that he would find it hard to learn anywhere else; so it is very unusual, when we want to have somebody here, that he should not respond. Maybe he says, "I cannot come next year; I prefer to come the year after that". But he comes. This incidentally, was a decisive

factor in my decision to leave Chicago and come to the Institute. There were other factors; but there is nothing so pleasant to me, I must say, as to think that whenever there is a man anywhere, be it in France, be it in Japan, be it in Scandinavia, whose work interests me, I do not have to go to him; I just tell my colleagues, "This is an interesting man, who is doing interesting work in such and such a field". And then he is invited. It is automatic. It is automatic as long as I show reasonably good judgment, of course. If the man I recommended was considered by my colleagues as a flop, then they would certainly not let me have my way about him; but this has not happened to me yet.

Now the majority of our foreign members are very distinguished people, each one in his particular branch, and contacts with them are likely to be exceedingly fruitful. Occasionally we also make some invitations under the heading "Aid to underdeveloped countries". We invite a man who is not so prominent, not so active, but who is isolated. We think it is very important that a man who is working as a teacher in a scientifically underdeveloped country should have a chance to discover what is going on in world mathematics, and then go back home; even if he does not do much active work himself, he can pass this knowledge on to his students, and we hope that there will be a better man turning up later, as a consequence of that. Occasionally we also get a very young man from a foreign country if he shows sufficient promise, even though he may not have much to his credit in the way of actual achievements; but that is rather an exception.

Now I come to the Americans. Last year there were about 24 foreigners, 19 Americans below 32, 16 Americans above 32; roughly, therefore, the three groups are about equal. What is the role of the Institute in American mathematics, as distinguished from world mathematics? This role is no less essential; in fact, if one looks at the Institute purely from the American angle, its usefulness is even more striking. I think you will get an idea of this if I tell you that there are very few mathematicians of any distinction in this country who have not spent some of their young years, one year, more frequently two years, at the Institute. They may not have come always on our funds. Very frequently, more and more so in recent years, they come with NSF fellowships, or other support. But we are making no distinction; this purely financial distinction is of importance to the people who make the budget; it is of no importance at all to the mathematicians. So those young men are essentially the young men in American mathematics who give some promise of becoming somebody. Of course, there we have much less data to go by, and therefore, we have much more frequently to take a chance; that means that the rate of efficiency

of the system is less; the proportion of flops is much greater. This is part of the system; we do not have to regret it. If we were to exclude all the young men of whom we are not quite certain that they would become distinguished mathematicians, then perhaps we would not have any at all, or extremely few. We can do much better by taking a proportionately rather large group of young American mathematicians, giving them the chance of coming here into contact with all that is best in world mathematics (incidentally also with ourselves, with the faculty, but that may not be so important). Then, given that chance, it is up to them to take it up and show what they can do; and I think on the whole that we have every reason to be pleased with the results; it is not only that, in all American universities, most of the serious mathematicians are people who have spent some time at the Institute; but I am sure there are few of them who would not honestly say that the time they spent at the Institute has been a decisive influence; and to verify this, one has only to see how often, when they have a student of some real promise, their advice to this young man is "Go to the Institute". In recent years, a young American mathematician who wants to learn more than he could learn from his own professors, who wants to broaden his ideas, has had the choice between going to Princeton or going abroad, frequently to France, occasionally to Germany, depending on his field. Also, with federal support, contract money, and so on, it has become much easier for such a young man to go to places like Harvard or Berkeley; but even now there is no place where a young man has quite the same opportunity of coming into contact with the best in world mathematics, as he gets in Princeton.

About the third group, there is much less to say. It consists of the more mature American mathematicians; they mostly come to Princeton because they have already been there in their younger years; they know what to expect. They happen to have sabbatical leave or some other opportunity for doing work undisturbed for a year; such people divide themselves, roughly speaking, between Europe and Princeton. It goes without saying that they are among the most distinguished people in American mathematics; many of them make the same important contributions that the foreigners make. I put them into a different category, because practically all the foreigners have to come here on our initiative, and our funds; so, of course, from our point of view the machinery is rather different. The foreigners have to be invited; we have to offer stipends to them, whereas in the case of the Americans, what mostly happens is that we get a letter, "Next year I have a sabbatical, or a Guggenheim fellowship, or a contract; I do not require any support; I should like to spend a year as a member at the Institute". And the request is granted as a matter of course if the man has any distinction at all as a mathematician.

This seems to complete what I had to say. Maybe one small thing more, which touches on our method in selecting the people we bring here. Particularly in recent years, we try to make ourselves more useful by bringing about temporary constellations, as I said, in this or that subject. This is more delicate than just inviting the best men we can find in every direction. We make some additional effort to combine things so that, if during the next two or three years we expect to invite some men who are working in one particular direction, those invitations are synchronized; we try to avoid that a man should come here, as has happened repeatedly before and say, "Well, it is too bad this other person is coming here next year, and I did not know it. I should have preferred to wait another year and be in contact with him". Then, having those temporary constellations in various directions, things arrange themselves automatically. No organizing effort is necessary or desirable. Automatically people with a common interest will arrange seminars, lectures, or get together informally, according to what may appear most profitable to them. I could mention some of the seminars that have been going on this year on this or that branch; they were of the highest possible interest to those who took part in them; but to hear details about them would be of no interest to you at all, I am sure, so I think I will stop now.

POSTSCRIPT

During the discussion which followed the talk, the question was raised whether (assuming adequate financial resources) the School of Mathematics might increase its usefulness by having more temporary members. My answer was in the negative. This, of course, reflects only my personal views, but I believe it would be shared by most of my colleagues. Given the present state of American and world mathematics, we are inviting as many temporary members as we care to. Some of us, occasionally, may find themselves favoring a slight increase, while some may feel that a slightly more restrictive policy than is followed now could work to our advantage; but the percentages involved in such disagreements are small. To me, at any rate, any substantial departure from our present numbers is unthinkable as long as the general picture, in American and world mathematics, remains more or less what it is now.

Finally, I wish to repair here one important omission (in my talk and the ensuing discussion). Speaking of the Institute, I made no mention of the University and of our relations with it. Of course the mathematical center in Princeton would not at all be what it is, and we could not function

as we do, if there were not here, side by side with us, a University with a strong department of mathematics. In this respect, too, Flexner showed his wisdom, by creating the Institute, not in a vacuum, but as a next-door neighbor to Princeton University. Of our relations with our colleagues and with the students there, there is nothing to say except that "happy people have no history". We share seminars, lectures, library facilities, scientific information with them; our relations with them, personal and scientific, are close, free and informal; our best hope is that things will go on like that in the future and there is every reason to expect that they will.

Talk to the Trustees of the Institute for Advanced Study by Professor Andre Weil, April 1, 1960.

As the Director says, I am a relative newcomer. I have as yet only quite hazy notions about the nature and functions of the Institute as a whole. I think it is my duty as a professor of the Institute to acquire some ideas and some views on those matters, but two years is rather a short time. But I have quite clear and definite views about the nature and functions of the School of Mathematics, in the narrow sense, meaning mathematics and excluding physics, for the simple reason that ever since the Institute was started, I had quite close contact, sometimes directly, sometimes indirectly, with mathematics and the mathematicians at the Institute. Many of the people who have been here have been among my closest friends; I was a member here myself in 1936; also, it has been impossible to keep in touch with the mathematics of the last 30 years without at the same time being in close contact with the mathematics at the Institute. This means that I am going to invade the province of my colleagues the historians, because the history of the mathematical school of the Institute, is an essential chapter of the history of modern mathematics, and the two cannot be dissociated. It is unthinkable that anyone would write the history of mathematics in the 20th century without devoting a large portion of it either to the Institute, or to the mathematics which have been done at the Institute, which comes very much to the same thing.

The first point to keep in mind (a very gratifying one to a mathematician) is that even now, in spite of anything you may hear to the contrary, mathematics has remained one subject. If you ever hear anyone saying that mathematics has split up into a number of fragments which are isolated from one another, this is simply not true. Of course, there are men who have specialized in such a narrow corner of mathematics as to become quite unable to understand what has been going on in some other corner. Nevertheless, mathematics has remained a unified subject. Incidentally, in science it seems to be the one subject which has preserved a continuous tradition. It has a solid, continuous history, of say, twenty-five hundred years. It started much earlier than that, but twenty-five hundred years is the period of continuity during which there has been no interruption. There have been considerable slowdowns, in the Roman period, in the Middle Ages, but not interruptions. It has remained unified in the sense that mathematicians, at least good mathematicians, from whatever

branch they come, still understand each other, and think along parallel lines. Of course, the temperament of an algebraist is not that of an analyst, and everyone has his own personal preferences. But it is all one subject, and it constantly happens that classifications break down; whatever barriers appear at one stage between the various braches of mathematics, they have a way of collapsing, and then things get sub-divided in a quite different manner ten or twenty years later; some of the most important progresses in mathematics, say over the last hundred years, have come about precisely like that, through penetration from one brach of mathematics into another, so that a constant interchange of ideas between all branches is essential.

Even a hundred years ago, certainly a hundred and fifty years ago, the same applied to mathematics and theoretical physics. It was part of the business of a mathematician to know as much as there was to know in those days about theoretical physics, and the people who by temperament were theoretical physicists had to know practically all that was then going on in mathematics. Here a barrier has appeared which, at any rate at the moment, seems essential. We mathematicians do not profess to understand anything, we are completely ignorant, so far as theoretical physics are concerned, and the converse is true. We may occasionally make an effort - of course it is very interesting to have theoretical physicists physically close to us, and to hear them talk since they do try to talk to us sometimes; but it does not seem to be particularly informative so far as our actual work is concerned. But within mathematics (pure mathematics as some people prefer to say), there is absolutely no barrier, and it is essential that a constant interchange of ideas should take place.

This need has always been there, all the time through the history of mathematics. Presumably, in the time of Archimedes, it was there, whatever machinery there may have been to satisfy it in those days;certainly it was there in the nineteenth century. There has to be some spot where the interchange of ideas takes place. Personal correspondence has always played an important role. The correspondence of Newton, that of Leibniz, of Bernoulli, are an essential part of the history of mathematics in their time. But physical communication has always been even more important. It has always been necessary for the progress of mathematics that there should be somewhere a physical location for a clearing house in mathematical ideas. In the nineteenth century, immediately after the Napoleonic wars, the clearing house was Paris.

When Abel or Dirichlet wanted to hear what was going on in the branches of mathematics of special interest to them, they came to Paris. This, roughly speaking, went on until around 1880, when Göttingen came into prominence; it became the main clearing house, while a secondary center subsisted in Paris; this lasted until the first world war. After that, for about ten years, Göttingen was the only place to play that role; somehow Paris had disappeared from the picture.

When Hitler came to power, Göttingen collapsed. By a very lucky accident, this, as you know, was precisely the time when Flexner created this Institute. In doing so, Flexner chose to give particular prominence to mathematics, for a number of reasons which it is not for me to try to guess. There must have been in his mind one obvious consideration which, it seems to me, was a very sensible one, namely, that mathematics is probably, nowadays, the field where, with a given outlay of money, you can get the most far-reaching results. This is quite obvious, because mathematics depends only upon salaries and a rather modest library, nothing like the libraries which historians require in order to do their work; nothing like the experimental apparatus required by physicists, chemists and so on. Mathematics, as I said, takes a comparatively very small outlay of money per head, so to say, to achieve maximum results. And, of course, the timing was very fortunate, because Göttingen, and German science in general, had just collapsed, so that Flexner could draw upon the people who had to leave Germany at that time, such men as Von Neumann and Hermann Weyl. I think Hermann Weyl is really the man who made the mathematics at the Institute what it is, because of many qualities that he had, but particularly because, being a true pupil of Hilbert, he shared that belief which I have expressed to you, that mathematics is one science, a unified subject, and must go on as such. And he organized things here, or rather he refrained from organizing things, he created things here in that spirit.

Now, since 1932 (it took a few years to get started, so it would be more accurate to say since around 1935), Princeton has played its role as the main clearing house for mathematics in the world. In recent years (for the last seven or eight years perhaps) Paris has again become a world center in the same sense, not quite the equal of Princeton, but also very important. What I want to emphasize is that it is absolutely essential for the progress of mathematics that there should be such a center, that it is very fortunate for mathematics that such a center has appeared in Princeton, that it is there, and, so far

as one can see, there is every reason why it should go on being there. The only shadow in this picture is that of the communications with so-called iron curtain countries. Now we have good communications with Poland, at any rate; Polish mathematicians do come here to our and their mutual benefit. So far we have not had a single Russian mathematician, and all our effort in that direction has not led to anything; this is too bad, because they need contact with such a clearing house just as much as we do. They know it very well, and I am quite sure that they deplore the fact that they cannot use it. They do have their own internal clearing house in Moscow, but that is not enough to give them full contact with world mathematics.

Now, to describe the way in which this center, this clearing house, is actually functioning, is quite easy. But first, it must be quite clear to you that what is essential to our clearing house is not so much the people who are here permanently as the people who come here for periods of, sometimes one term, more frequently two terms, occasionally two years. So, the essential thing in the Institute, as I see it, is the temporary member. The permanent faculty plays an essential role in several ways. Of course, there is the work they are doing, but that goes without saying, and wherever they would be they would presumably do more or less the same work. If, occasionally, there is a man on the faculty who thinks of the Institute as an ivory tower, where he can shut himself up in his study and do his work undisturbed by the outside world, that is fine. We can well afford to have occasionally a man of that type if he is of the proper caliber. But he does not contribute anything special to the life of the Institute. Such a man just has to be left alone. Apart from such people, who, naturally, will occur from time to time, and for whom I have, of course, a great respect, the essential role of the permanent faculty, it seems to me, is to serve as nuclei around which temporary constellations of temporary members will gather; it is to establish a contact between the temporary members. Sometimes, when they come here, they have not even a common language to begin with; usually they know some English, but sometimes not too much. Apart from such unavoidable language difficulties, it can very well happen that the ideas of one man are highly relevant to the work of another, but they do not know it, and they may never discover it unless there is someone, preferably someone on the permanent faculty to tell them. That is one of the best things that a faculty member can do; he knows about those people, because he has taken part in appointing them; so he is in the best position to put them in contact with each other, and tell A, "Now, you should hear what B has to

say". Of course, this also happens through informal contacts, through lectures, through seminars; there are lots of ways in which this can happen, but we have to act as catalysts, whenever possible, to favor that.

Of course, we also have a basic role in making the selection of those temporary members, and, in order to do that, it is essential that we know what is going on in mathematics, in all fields of mathematics. Up to a point, coverage of the various branches of mathematics is far less important to us than it is in a university. A university must have a man, for instance, to teach algebra, or to teach partial differential equations, and if they do not have a man of the proper caliber, since the teaching has to be done, they take the next best person. We would not do that. We are all agreed that we would not and should not do that; but whenever possible, it is very desirable, and even important, that we have between ourselves, within the permanent faculty, a reasonably complete coverage, so as to have some idea between ourselves of what is going on in all branches of mathematics, and to be in a position to send for the people who are doing really advanced work in all directions; naturally, this also requires a certain amount of judgment, which we hope to possess; otherwise we are doomed to failure.

Here I have a list of mathematicians, the temporary members for this year; I have broken it down into categories, and this gives, I think, a fairly good picture of the work we are doing. I have divided it up into Americans up to the age of 32, Americans above the age of 32, and foreigners. Let us begin with the foreigners. That is where our role as a clearing house for mathematical ideas is most prominent, and this is inseparable from our role in world mathematics. Our foreign members, by and large, are the most prominent people, doing the most advanced work, in every direction, all over the world, wherever and whenever we can get hold of them. We have absolutely no rule in our School, no mechanical criteria of selection. For instance, we do not say:"This man has no permanent job, therefore we cannot have him, because that would be dangerous, we might be stuck with him." We just do not care. We invite whomever we want. As I said, the Russians, unfortunately, have not responded. Everywhere else, we have no problems. Firstly it is generally considered an honor, all over the world, to receive an invitation to the Institute; secondly, and this is more significant, there is hardly any mathematician in the world who is not quite sure that there is a great deal for him to learn in Princeton that he would find it hard to learn anywhere else; so it is very unusual, when we want to have somebody here, that he should not respond. Maybe he says, "I cannot come next year; I prefer to come the year after that". But he comes. This incidentally, was a decisive

factor in my decision to leave Chicago and come to the Institute. There were other factors; but there is nothing so pleasant to me, I must say, as to think that whenever there is a man anywhere, be it in France, be it in Japan, be it in Scandinavia, whose work interests me, I do not have to go to him; I just tell my colleagues, "This is an interesting man, who is doing interesting work in such and such a field". And then he is invited. It is automatic. It is automatic as long as I show reasonably good judgment, of course. If the man I recommended was considered by my colleagues as a flop, then they would certainly not let me have my way about him; but this has not happened to me yet.

Now the majority of our foreign members are very distinguished people, each one in his particular branch, and contacts with them are likely to be exceedingly fruitful. Occasionally we also make some invitations under the heading "Aid to underdeveloped countries". We invite a man who is not so prominent, not so active, but who is isolated. We think it is very important that a man who is working as a teacher in a scientifically underdeveloped country should have a chance to discover what is going on in world mathematics, and then go back home; even if he does not do much active work himself, he can pass this knowledge on to his students, and we hope that there will be a better man turning up later, as a consequence of that. Occasionally we also get a very young man from a foreign country if he shows sufficient promise, even though he may not have much to his credit in the way of actual achievements; but that is rather an exception.

Now I come to the Americans. Last year there were about 24 foreigners, 19 Americans below 32, 16 Americans above 32; roughly, therefore, the three groups are about equal. What is the role of the Institute in American mathematics, as distinguished from world mathematics? This role is no less essential; in fact, if one looks at the Institute purely from the American angle, its usefulness is even more striking. I think you will get an idea of this if I tell you that there are very few mathematicians of any distinction in this country who have not spent some of their young years, one year, more frequently two years, at the Institute. They may not have come always on our funds. Very frequently, more and more so in recent years, they come with NSF fellowships, or other support. But we are making no distinction; this purely financial distinction is of importance to the people who make the budget; it is of no importance at all to the mathematicians. So those young men are essentially the young men in American mathematics who give some promise of becoming somebody. Of course, there we have much less data to go by, and therefore, we have much more frequently to take a chance; that means that the rate of efficiency

of the system is less; the proportion of flops is much greater. This is part of the system; we do not have to regret it. If we were to exclude all the young men of whom we are not quite certain that they would become distinguished mathematicians, then perhaps we would not have any at all, or extremely few. We can do much better by taking a proportionately rather large group of young American mathematicians, giving them the chance of coming here into contact with all that is best in world mathematics (incidentally also with ourselves, with the faculty, but that may not be so important). Then, given that chance, it is up to them to take it up and show what they can do; and I think on the whole that we have every reason to be pleased with the results; it is not only that, in all American universities, most of the serious mathematicians are people who have spent some time at the Institute; but I am sure there are few of them who would not honestly say that the time they spent at the Institute has been a decisive influence; and to verify this, one has only to see how often, when they have a student of some real promise, their advice to this young man is "Go to the Institute". In recent years, a young American mathematician who wants to learn more than he could learn from his own professors, who wants to broaden his ideas, has had the choice between going to Princeton or going abroad, frequently to France, occasionally to Germany, depending on his field. Also, with federal support, contract money, and so on, it has become much easier for such a young man to go to places like Harvard or Berkeley; but even now there is no place where a young man has quite the same opportunity of coming into contact with the best in world mathematics, as he gets in Princeton.

About the third group, there is much less to say. It consists of the more mature American mathematicians; they mostly come to Princeton because they have already been there in their younger years; they know what to expect. They happen to have sabbatical leave or some other opportunity for doing work undisturbed for a year; such people divide themselves, roughly speaking, between Europe and Princeton. It goes without saying that they are among the most distinguished people in American mathematics; many of them make the same important contributions that the foreigners make. I put them into a different category, because practically all the foreigners have to come here on our initiative, and our funds; so, of course, from our point of view the machinery is rather different. The foreigners have to be invited; we have to offer stipends to them, whereas in the case of the Americans, what mostly happens is that we get a letter, "Next year I have a sabbatical, or a Guggenheim fellowship, or a contract; I do not require any support; I should like to spend a year as a member at the Institute". And the request is granted as a matter of course if the man has any distinction at all as a mathematician.

This seems to complete what I had to say. Maybe one small thing more, which touches on our method in selecting the people we bring here. Particularly in recent years, we try to make ourselves more useful by bringing about temporary constellations, as I said, in this or that subject. This is more delicate than just inviting the best men we can find in every direction. We make some additional effort to combine things so that, if during the next two or three years we expect to invite some men who are working in one particular direction, those invitations are synchronized; we try to avoid that a man should come here, as has happened repeatedly before and say, "Well, it is too bad this other person is coming here next year, and I did not know it. I should have preferred to wait another year and be in contact with him". Then, having those temporary constellations in various directions, things arrange themselves automatically. No organizing effort is necessary or desirable. Automatically people with a common interest will arrange seminars, lectures, or get together informally, according to what may appear most profitable to them. I could mention some of the seminars that have been going on this year on this or that branch; they were of the highest possible interest to those who took part in them; but to hear details about them would be of no interest to you at all, I am sure, so I think I will stop now.

POSTSCRIPT

During the discussion which followed the talk, the question was raised whether (assuming adequate financial resources) the School of Mathematics might increase its usefulness by having more temporary members. My answer was in the negative. This, of course, reflects only my personal views, but I believe it would be shared by most of my colleagues. Given the present state of American and world mathematics, we are inviting as many temporary members as we care to.. Some of us, occasionally, may find themselves favoring a slight increase, while some may feel that a slightly more restrictive policy than is followed now could work to our advantage; but the percentages involved in such disagreements are small. To me, at any rate, any substantial departure from our present numbers is unthinkable as long as the general picture, in American and world mathematics, remains more or less what it is now.

Finally, I wish to repair here one important omission (in my talk and the ensuing discussion). Speaking of the Institute, I made no mention of the University and of our relations with it. Of course the mathematical center in Princeton would not at all be what it is, and we could not function

as we do, if there were not here, side by side with us, a University with a strong department of mathematics. In this respect, too, Flexner showed his wisdom, by creating the Institute, not in a vacuum, but as a next-door neighbor to Princeton University. Of our relations with our colleagues and with the students there, there is nothing to say except that "happy people have no history". We share seminars, lectures, library facilities, scientific information with them; our relations with them, personal and scientific, are close, free and informal; our best hope is that things will go on like that in the future and there is every reason to expect that they will.

Fac Weil
(talk to Trustees)

ONE TWENTY FIVE PARK AVENUE
NEW YORK

OFFICE OF
SAMUEL D. LEIDESDORF

September 27, 1960

Dear Professor Weil:

Thanks very much for the transcript of your very interesting talk at the Institute meeting last April. I appreciate your sending me these notes.

With kindest personal regards and hoping to have the pleasure of seeing you soon, I am

Sincerely,

Professor Andre Weil
School of Mathematics
Institute for Advanced Study
Princeton, N. J.

c.c. Dr. Oppenheimer

Talk to the Trustees of the Institute for Advanced Study by Professor Andre Weil, April 1, 1960.

As the Director says, I am a relative newcomer. That is to say that I have as yet only quite hazy notions about the nature and function of the Institute. As such, I think it is my duty as a professor of the Institute to acquire some idea and some views on those matters, but two years is rather a short time. But I have quite clear and definite views about the nature and functions of the School of Mathematics, in the narrow sense, meaning mathematics and excluding physics, for the very simple reason that ever since the Institute was started, I had quite close contact, sometimes directly, sometimes indirectly, mostly in both ways, with mathematics and the mathematicians at the Institute. Many of the people who have been here all the time have been among my closest friends; I was a member here myself in 1936; and also it has been quite impossible to keep in touch with the mathematics of the last 30 years without at the same time being in close contact with the mathematics at the Institute. This means that I am going to invade the province of my colleagues the historians, and speak largely of the history of mathematics, because the history of the Institute, of the mathematical school of the Institute, is an essential chapter of the history of modern mathematics, and the two cannot be dissociated. It is unthinkable that anyone would write the history of mathematics in the 20th century without devoting a large portion of it either to the Institute as such, or to the mathematics which have been done here, which comes very much to the same thing.

Now, the first point to keep in mind is that even now, and this is very gratifying to a mathematician, and whatever you may hear to the contrary, mathematics has remained one subject. It is not true, if you ever hear

anyone saying that mathematics has split up into a number of fragments which are isolated from one another, and especially do not understand each other, this is simply not true. Of course, it is perfectly true that there are men who have specialized in such a narrow corner of mathematics as to become quite unable to understand what has been going on in some other corner. Well, this can happen anywhere. But mathematics has remained a unified subject. Incidentally, in science it has remained the one subject which has a continuous tradition. This it has in common with subjects which are of interest to the historians. It has certainly a solid, continuous history, of, say, twenty-five hundred years. It started much earlier than that, but twenty-five hundred years is the period of continuity during which there has been no interruption. There have been slowdowns, considerable slowdowns, in the middle ages, the Roman period, but no interruptions. There is a continuous history, and it has remained unified in the sense that mathematicians, still, good mathematicians, from whatever branch they come, understand each other, and think along parallel lines. You have to take into account the difference of temperament. Of course the temperament of an algebraist is not the temperament of an analyst, and everyone has his own personal preferences; but it is one subject, and we understand each other; and it constantly happens that classifications, whatever classifications and barriers appear at one moment between the various branches of mathematics, have a way of collapsing, and then the thing gets subdivided in a quite different manner ten or twenty years later, and some of the most important progresses in mathematics, say over the last hundred years, have come about precisely like that, through penetration from one branch of mathematics into another, so that a constant interchange of ideas between all branches of mathematics is essential.

Even a hundred years ago, certainly a hundred and fifty years ago, the

same applied to mathematical and theoretical physics. It was part of the business of a mathematician to know as much as there was to know in those times about mathematical physics and theoretical physics, and the people who by temperament were theoretical physicists had to know practically all that was going on in mathematics in those days. Now, here a barrier has appeared which, at any rate at the moment, seems to be essential. We mathematicians do not profess to understand anything, we are completely ignorant, so far as theoretical physics are concerned, and the converse is true, We may occasionally make an effort - of course it is very interesting to have theoretical physicists physically close to us, and to hear them talk, and we feel that it is also of interest to them to hear us talk, since they are trying to talk to us occasionally, and it is illuminating in a kind of general way, but it does not seem to be particularly informative so far as our actual work is concerned. But within mathematics, by which I mean what is generally known as pure mathematics, there is absolutely no barrier, and it is essential that a constant interchange of ideas should take place.

Now, this need has always been there, all the time. All the time, through the history of mathematics, presumably in the time of Archimedes, it was there; and I do not know what macninery there was in those days, but certainly in the nineteenth century it was there. There has to be some place in every period where the interchange of ideas happens physically. Correspondence, personal correspondence, has always played quite an important role. The correspondence of Newton and Leibnitz, and so on, and Bernoulli, is an essential part of the history of mathematics in those days. But physical communication has always been quite important. It has always been very necessary for the progress of mathematics that there should be somewhere a physical location for a clearing house in mathematical ideas. Now, this was done in the

nineteenth century; beginning after the Napoleonic wars, the clearing house was Paris. When Abel or Dirichlet wanted to hear what was going on in the branches of mathematics of special interest to them, they came to Paris. One may say that this, roughly speaking, went on until around 1880, where, for a number of reasons, Göttingen came into prominence. Well, that made Paris, to begin with, less important than Göttingen. Göttingen became the main clearing house, with, I should say, a secondary center which subsisted in Paris for a while, until the first world war. After the first world war, for about ten years, Göttingen was the only place to play that role. For various reasons, which are of no interest to you, Paris disappeared from the picture.

Well, Göttingen collapsed when Hitler came to power, and by a very lucky accident, this, as you know, was precisely the time when Flexner created this Institute. Well, Flexner, apparently, chose to give particular prominence to mathematics when he created the Institute, for a number of reasons, good or bad, which I do not want to pronounce on. There must have been in his mind one very obvious concrete reason which, if this is what he had in mind, was a very sensible one, namely, that mathematics is probably, nowadays, the field where, with a given outlay of money you can reach the biggest results. This is perfectly obvious, because mathematics depends only upon salaries and a rather modest library, nothing like the libraries which historians require in order to do their work; nothing like the experimental apparatus which physicists, chemists and so on require. Mathematics, as I said, takes a comparatively very small outlay of money per head, so to say, to achieve maximum results, And, of course, the period was very fortunate, because Göttingen, and Germany in general, German science, had collapsed, and therefore he could draw upon the people who had to leave Germany at that time. No need to mention the names of von Neumann and particularly Hermann Weyl. I think Hermann Weyl is really the

man who made the mathematics at the Institute what it is, well, because of many qualities that he had, but particularly because, being a true pupil of Hilbert, he also had that conviction, which I have expressed to you, that mathematics is one science, is a unified subject, and must go on as such. And he organized things here, that is, he refrained from organizing things here, he created things here in that spirit.

Now, since 1932, well, of course, it took a few years to get started, but one may say since around 1935, Princeton has occupied that place of the main clearing house for mathematics in the world. In recent years, for the last seven or eight years, one may say, Paris has again become what one might call a secondary center in the same sense, not quite the equal of Princeton, but also an important center. But what I want to emphasize is that it is absolutely essential for the progress of mathematics that there should be such a center, that it is very fortunate for mathematics that such a center has appeared in Princeton, that it is there, and, so far as one can see, there is every reason why it should go on being there. The only shadow in this picture is that of the communications with so-called iron curtain countries. Well, now we have good communications with Poland, at any rate; Polish mathematicians do come here, and profit a lot. So far we have not had a single Russian mathematician, and all our effort has not led to anything, which is very unfortunate because they need contact with such a clearing house just as much as we do. They know it very well, and I am quite sure that they deplore the fact that they cannot use it. And they have their own clearing house, their own internal clearing house in Moscow, but that is not enough to give them contact with world mathematics.

Now, to describe the way in which this center, this clearing house, is actually functioning, is quite easy; and I may start it in statistical terms.

Well, first, when I speak of a clearing house, it must be perfectly clear to you that what is essential to a clearing house is not so much the people who are here permanently as the people who come here for periods of, sometimes one term, more frequently two terms, occasionally two years. So, the essential thing in the Institute, as I see it, is the temporary member. The permanent faculty plays an essential role in several ways, Of course, there is the work they are doing, but that goes without saying, and wherever they would be they would presumably do more or less the same work; and if, occasionally, there is a man on the faculty who thinks of the Institute as an ivory tower, where he can shut himself up in his study and do his work undisturbed by the outside world, that is fine. We can well afford to have occasionally a man of that type if he is of the proper caliber. But that is separate; he does not contribute anything special to the life of the Institute, and such a man just has to be left alone. But, apart from such people, who, naturally, will occur from time to time, and for whom I have, of course, a great respect when they are there, apart from such people, the essential role of the permanent faculty, it seems to me, is to serve as nuclei around which those temporary constellations of temporary members will gather, because to establish a contact between the temporary members - sometimes when they come here they have no common language to begin with. Well, usually they know some English when they get here, but sometimes not too much. Sometimes it can very well happen that the ideas of one man are very relevant to the work of another man, but they do not know it, and they may never discover it unless there is someone, preferably someone on the permanent faculty that is one of the best things that a faculty member can do who knows about those people, because he has taken his part in appointing them, and who will put them in contact with each other, and tell A, "Now, you should hear what B has to say." Of course, this also happens through informal contacts, through lectures, through seminars;

there are lots of ways in which this can happen, but we have to act as catylists whenever possible to favor that.

Of course, we have also a basic role in making the selection of those temporary members, and, in order to do that, it is very essential that we know what is going on in mathematics, in all fields of mathematics. Up to a point, coverage,for us, of the various subjects and branches of mathematics is far less important than it is in a university. A university must have a man, for instance, to teach algebra, or to teach partial differential equations, and if they do not have a man of the proper caliber, since the teaching has to be done, they take a man who is not of the proper caliber, the next best person. We would not do that. We are all agreed that we would not and should not do that; but, whenever possible, it is very desirable, and even important, that we have between ourselves, between the permanent faculty, a reasonably complete coverage so as to have some idea between ourselves of what is going on in all branches of mathematics, and be in a position to send for the people who are doing really advanced work in all directions, which naturally requires a certain amount of judgment, which we hope we possess -- but that is something else again.

Now, here I have a list of the mathematicians, the temporary members for this year, and I had the curiosity to break it up into categories, and this gives, I think a perfectly good picture of the work we are doing. I have divided it up into Americans up to the age of 32, American above the age of 32, and foreigners. Well, let us begin, if you wish, with the foreigners. That is where our role as a clearing house for mathematical ideas is most prominent, and this is inseparable from our role in world mathematics. Our foreigners, by and large, are the most prominent people, doing the most advanced work, in every direction, all over the world, wherever and whenever we can get hold of them. We have absolutely no rule in our School, no mechanical criteria of

selection, For instance, we do not say, this man has no permanent job somewhere, therefore we cannot have him, because that would be dangerous, we will be stuck with him, and will not know what to do with it. We just do not care. We invite whomever we want. As I said, the Russians have not responded. For a number of reasons, which is unnecessary to discuss, the Russians so far have not responded. Everywhere else, it is usually considered, well, firstly it is generally considered an honor, all over the world, to receive an invitation to the Institute; secondly, what is probably more significant, is, that there is no mathematician in the world who is not quite sure that there is a great deal that he can learn in Princeton that he could not learn anywhere else, which means that it is very unusual, when we want to have somebody here, that he should not respond. Maybe he says, "I cannot come next year; I would prefer to come the year after that." But that is the most. This, incidentally, was a decisive factor in my decision to leave Chicago and come to the Institute. There were other factors, but there is nothing so pleasant to me, I must say, as to think that whenever there is one man anywhere, be it in France, be it in Japan, be it in Scandinavia, or anywhere, whose work interests me, I do not have to go to him; I just tell my colleagues, "This is an interesting man, who is doing interesting work in such and such a field." And then he is invited. It is automatic. It is automatic as long as I show reasonably good judgment, of course. If the man I recommended were considered by my colleagues as a flop, then it is something else, but this has not happened to me yet.

Now, practically all the foreigners, the majority of them, at any rate, are very distinguished people, each one in his particular branch, with whom contacts are likely to be exceedingly fruitful. Occasionally we make some invitations under the heading "Aid to underdeveloped countries." We invite a man who is not so prominent, not so active, but who is isolated. Sometimes this happens in South America. The last time we discussed a case like that, it

was a man from Israel. We think it is very important that a man who is working as a teacher in an underdeveloped, scientifically underdeveloped country, should have a chance to discover what is going on in world mathematics, and then go back home, and even if he does not do much active work himself, he can pass this knowledge on to his students, and we hope that there will be a better man turning up later, as a consequence of that. Occasionally we get a very young man of some promise from foreign countries, but that is no exception.

Now I come to the Americans. As I said, those three groups are numerically about equal. I find for the last year there were about 24 foreigners, 19 Americans below 32, 16 Americans above 32, meaning, roughly, the three groups are equal. So this means, what is the role of the Institute in American mathematics, as distinguished from world mathematics. Now this role is no less essential, in fact, one might say it is even more striking if one looks at the Institute purely from the American angle. Well, both are very striking, but it is also extremely striking. I think you will get an idea of this if I say, what is firstly objectively a fact: there are certainly extremely few, if any, mathematicians of any distinction in this country who have not spent some of their young years, one year, more frequently two years, at the Institute. They would not have come always on our funds, our stipends. Very frequently, more and more so in recent years, they come with NSF fellowships, or other support. But we are making no distinction; this purely financial distinction is of importance to the people who make the budget; it is of no importance at all to the mathematicians (and disregarded?). So those young men are essentially the young men in American mathematics who give some promise of becoming somebody. Of course, there we have much less data to go by, and therefore we have much more frequently to take a chance; and that means that the efficiency of the system is obviously much less. The proportion of flops is much greater, for obvious reasons. And this is part of the system; we do not

have to regret this. If we were to exclude all the young men of whom we are not quite certain that they would become distinguished mathematicians, then we probably would not have any at all, or extremely few, and that would be very unfortunate. We can do much better by taking a rather large, proportionately large group of young American mathematicians, giving them the chance of coming here into contact with all that is best in world mathematics, incidentally also with ourselves, with the faculty, but I, we hope we can maintain our own (among?) our colleagues, but that is even not so important. And, given that chance, then it is up to them to take it up, and show what they can do; and I think on the whole we have every reason to be pleased with the results, as, well, one could make statistics, and show how, in all American universities, all the distinguished mathematicians not only are people who have spent some time at the Institute, but I am sure there are very few of them who would not honestly say that the time they spent at the Institute has been a decisive influence; and to verify this, one has only to see that whenever one of those people who has been at the Institute in their younger years has a student of some real promise, then his advice to this young man is, " Go to the Institute." That happens invariably. Now, in more recent years, a young American mathematician who wants to learn more than he could learn with his own professors, who wants to broaden his ideas and to acquire a broader outlook, has had the choice, well, the choice has been between going to Princeton or going abroad, frequently to France, occasionally to Germany, depending on his field. Now, with federal support, contract money, and so on, it has become much easier for places like Harvard, and Berkeley, and a few others, to do similar kind of work, in a somewhat more modest way; but even now there is no place where a young man has a similar chance, just as I said, coming into contact with the best in world mathematics as it is in Princeton.

Now the third group - there is much less to say about it. That is the more mature American mathematicians; and they mostly come to Princeton because they have already been there in their younger years, they know more or less what to expect, they happen to have a sabbatical or some opportunity for doing work undisturbed for a year. And, again, that group divides itself, roughly speaking, between Europe and Princeton, and those who come to Princeton obviously know what to expect, they have been there before. As to those people, of course, it goes without saying, they are also among the most distinguished people in American mathematics, and many of them make the same important contributions that the foreigners make. I put them into a different category, because practically all the foreigners have to come here on our initiative, and on our funds, so, of course, from our point of view the machinery is rather different. The foreigners we have to invite, and we have to offer stipends to them, whereas in the case of the Americans, what mostly happens is, we get a letter, "Next year I have a sabbatical; I have a Guggenheim fellowship, or a contract; I do not require any support; I should like to spend a year as a member at the Institute." And the request is granted as a matter of course if the man has any distinction at all as a mathematician.

(RO suggestion that Weil continue without feeling pressed).

I do not feel pressed, but it seems to me that I have said essentially all I had to say. Well, maybe one small thing more, which touches on our method in selecting the people we bring here. Particularly in recent years, we try to make ourselves more useful by bringing about temporary constellations, as I said, in this or that subject. This is more delicate than inviting just the men we can find in every direction. We make some additional effort to best combine things so that if during the next two or three years we expect to

invite some men who are working in one particular direction, we make some effort to make that simultaneous rather than have a man come here, as has happened repeatedly before, and say, "Well, it is too bad this other person is coming here next year, and I did not know it. I should have preferred to wait another year and be in contact with him." So we try to avoid this, which is not always possible, but this also helps. And then, having those, as I said, temporary constellations in various directions, then the thing organizes itself automatically. No organizing effort is necessary or desirable certainly at all. The thing organizes itself automatically into seminars in this and that subject. I could mention some of the seminars that have been going on this year on this or that branch, and those seminars were of the highest possible interest to those who took part in them, and to hear details about them would be of no interest at all to you, I am quite sure, so I think I will stop here.