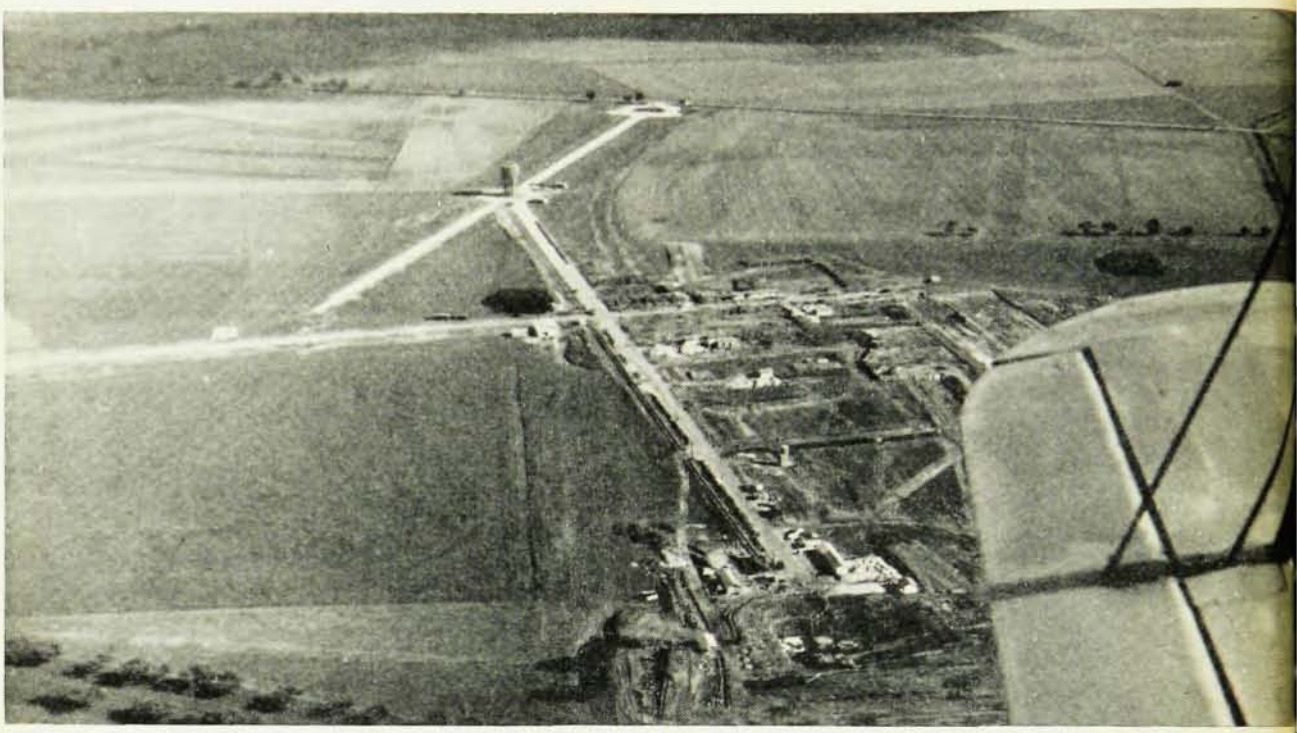
a physicist's Holiday



The center of nuclear studies being built at Saclay as seen from the air. Photograph shows progress after three months of construction.

Nuclear physics research in France and Italy is conducted in a considerably different atmosphere than in this country. In the following a touring American physicist gives his impressions after a visit last summer to laboratories in each of these countries.

By ***Alexander Zucker***

On a recent trip to France and Italy the writer has visited many of the physics laboratories there, and talked to a large number of physicists. It is not the purpose of this article to provide the reader with a careful survey of European physics; any number of Europeans are certainly more qualified for that sort of study. Rather, I shall try to present the impressions of a tourist, in this case a physicist.

Laboratories in Paris

French physics research is located mostly in and around Paris. This has the obvious advantages of centralization: communication between laboratories is simple, personal contact is kept up among the physicists in the various institutes, and publication is extremely rapid. An article submitted to the *Comptes Rendus de l'Académie des Sciences* will appear the same week. American journals can boast of no such efficiency. On the other hand, the vices of centralization are also present: all physicists are trained in the same schools, guiding ideas are transmitted from one generation to another, techniques tend to become stereotyped, and a two hundred and fifty-year-old examination system tends to perpetuate one type of physicist. To gain entrance into a

good school, the young aspirant must primarily display an aptitude for fast and accurate arithmetic. It is questionable whether this is the most important qualification of a good research worker.

In Paris physics research is scattered through many institutions. First to mind comes the Sorbonne, famed and old first lady of France's universities. Primarily the Sorbonne is an educational institution, research being carried on as a sideline. Here one finds experiments in classical physics, and spectroscopy is the main research tool. A group is working on Raman spectra of crystals and powders. They are very proud of the fact that their optical instrumentation is so excellent and their techniques exact and meticulous. Four day exposures are sometimes necessary in Raman spectra research, the Sorbonne group points out. There is a great deal of activity in the field of infrared spectroscopy directed by M. Lecomte. The Sorbonne laboratory, like most physics laboratories in Europe, is hampered by lack of money. The yearly budget of $10,000 permits a continuation of established research programs, but makes new ventures a financial impossibility. Still, the amount of published research is prodigious: in the academic year 1948–1949, the physicists of the Sorbonne published fifty-two papers, by some twenty-five authors.

The Collège de France is not, as the name implies, a college in our meaning of the word, but an institution resembling the Institute for Advanced Study at Princeton. Here a physics student takes no courses, is not required to pass any exams, but merely works under one of the two professors (F. Joliot and F. Perrin). When these advisors think that the student is a competent physicist, that he has done enough work for a PhD, they approve his dissertation and the degree is then awarded by the Sorbonne.

At the Collège de France there are two groups which are of interest to the physicist. The nuclear chemistry laboratory, headed by F. Joliot, and the experimental physics laboratory directed by F. Perrin and M. Magnan.

Professor Joliot's laboratory is perhaps the most important center of nuclear physics in France. It boasts the only cyclotron in the country, a machine delivering 18 micro amperes of deuterons at 6.7 Mev energy. At the time of my visit the cyclotron was inoperative, apparently the shielding was insufficient, and the only control panel was in an above-tolerance area. Along with the cyclotron one finds here a program for the study of artificially radioactive sources, concerned with such things as branching ratios in beta decay schemes, the detection of possible positrons in the P^{32} activity, and metastable states of a half-life between one second and one microsecond. About thirty research workers constitute Joliot's group, and among these is one American, John Major, formerly of Yale University.

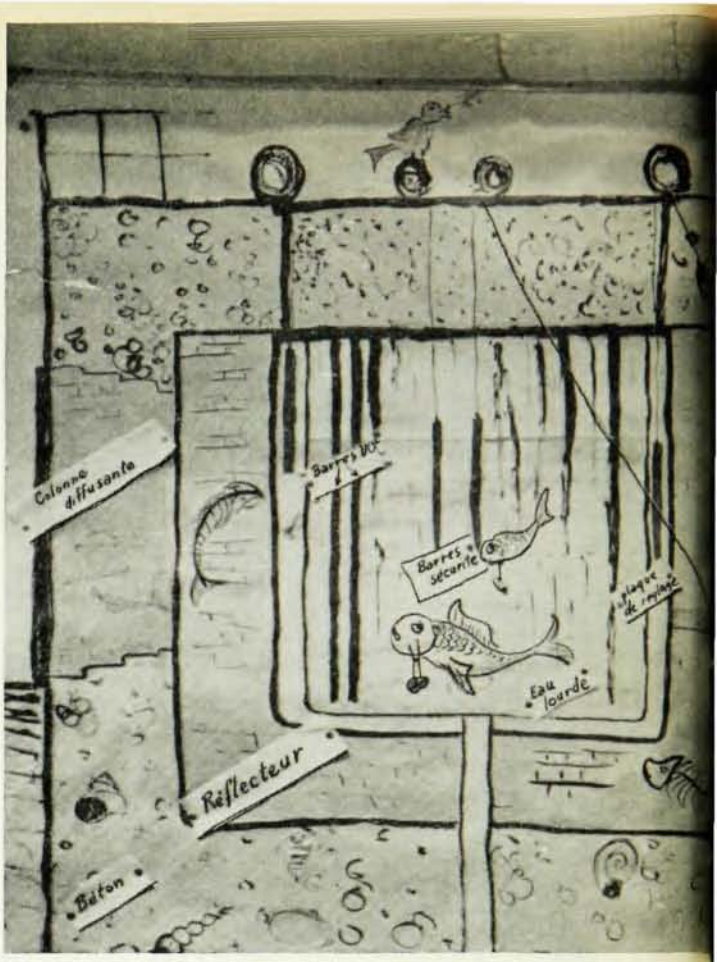
In the laboratory of Professor Perrin there is a more varied program, mostly, however, in the construction stage. Work is almost completed on a proton microscope which should give a resolving power of 0.1 millimicron. The protons used are to have an energy of 100 Kev, stabilized to one part in ten thousand. A magnetic isotope separator is being built. It is a 180° instrument of 80 cm radius, in a field of 2000 oersteds and employing an accelerating potential of 10,000 volts. The predicted resolution at the collector for the U 235–U 238 separation is 8 mm. There need be no fear, however, of the Perrin laboratory producing its own private atomic bomb; the expected positive ion current in the separator is only one milliampere. In addition to these projects there is also a program studying scintillation counters and their properties.

The two groups at the Collège de France jointly run a high voltage laboratory at Ivry, where Joliot and Magnan have an electrostatic generator.

Some French Research Projects

Cosmic rays have been the mainstay of recent European physics research. Paris is well represented in this field by LePrince-Ringuet at the Ecole Polytechnique. The laboratory has a vertical square Wilson cloud chamber, 50 cm × 30 cm × 10 cm, in

Alexander Zucker, a nuclear physicist on the staff of Oak Ridge National Laboratory's Electromagnetic Research Division, received his doctorate at Yale last year. During the interval between this event and the beginning of his work at Oak Ridge, he writes, he decided to take advantage of the opportunity for what might be his last two-month vacation for some years to come. He recommends a trip to Europe for anyone, pointing out that there is a good deal more than physics to be found there.



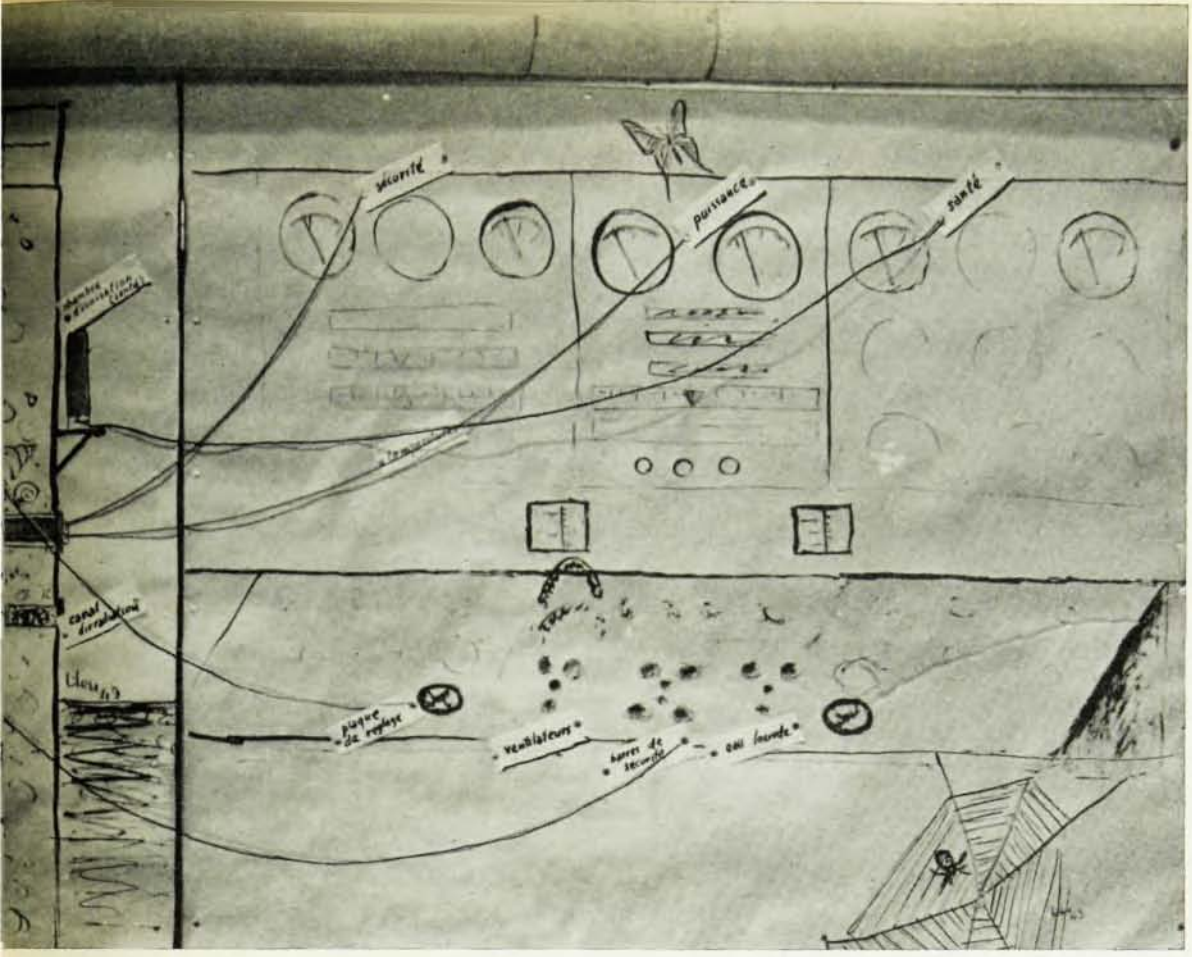
The cheerful drawing at right (courtesy L. Kowarski and L. Vautrey) shows Zoé, the nuclear reactor at the French Atomic Energy Commission Fort Chatillon Laboratory, as a heavy water aquarium. The drawing hangs on one face of the pile. In the photograph above it is covered by a protective curtain.

a magnetic field variable up to 5000 oersteds. The work is mostly concerned with μ-meson disintegrations. The mass of the μ-meson, according to the opinion of this laboratory, is 212 ± 5 electron masses. Experiments are conducted by balloon flights, and also in a high altitude laboratory in the Alps. Some of the counters used were novel to me; the cathode consisted of a film of aquadag painted on the outside of the counter. This, of course, greatly simplifies counter construction, and also effects a large saving in a country where there are no bountiful contracts with the Navy or the Atomic Energy Commission.

Mme. Joliot heads a physics laboratory at the Institut de Radium. This laboratory is chiefly concerned with the study of naturally radioactive nuclei. Much work is being done on low energy beta ray spectra by means of a low pressure cloud chamber, a permanent-magnet 60° spectrometer, and also a uniform field spectrometer. One of the physicists at this laboratory told me that all the new work was now being done in America with its large accelerators, so that to the French fell the task of filling in the gaps, discovering some little fact that has been overlooked by the Americans. *Physique à l'horlogier,* a watch maker type of physics, very careful, precise, and concerned with minute details.

Zoé of the AEC

These institutes are all, more or less, connected with the French school system; they are the equivalent of our university laboratories. There is, in Paris, also the French Atomic Energy Commission, and its laboratory is located at Fort Chatillon, some ten miles outside the city. The heart of Fort Chatillon is the pile, Zoé by name. It was built by L. Kowarski, who is now scientific director of the commission, and who, incidentally, has taken an uncommon amount of personal interest in my visit. The pile is a small, 5 kilowatt, heavy water type reactor. A new pile, substantially of the same design, but with 15 kilowatts power should be ready by 1952. At present the pile serves three main purposes. First, it is the only producer of radioactive isotopes in Europe, and the Commission does a tidy business selling these to consumers. Second,



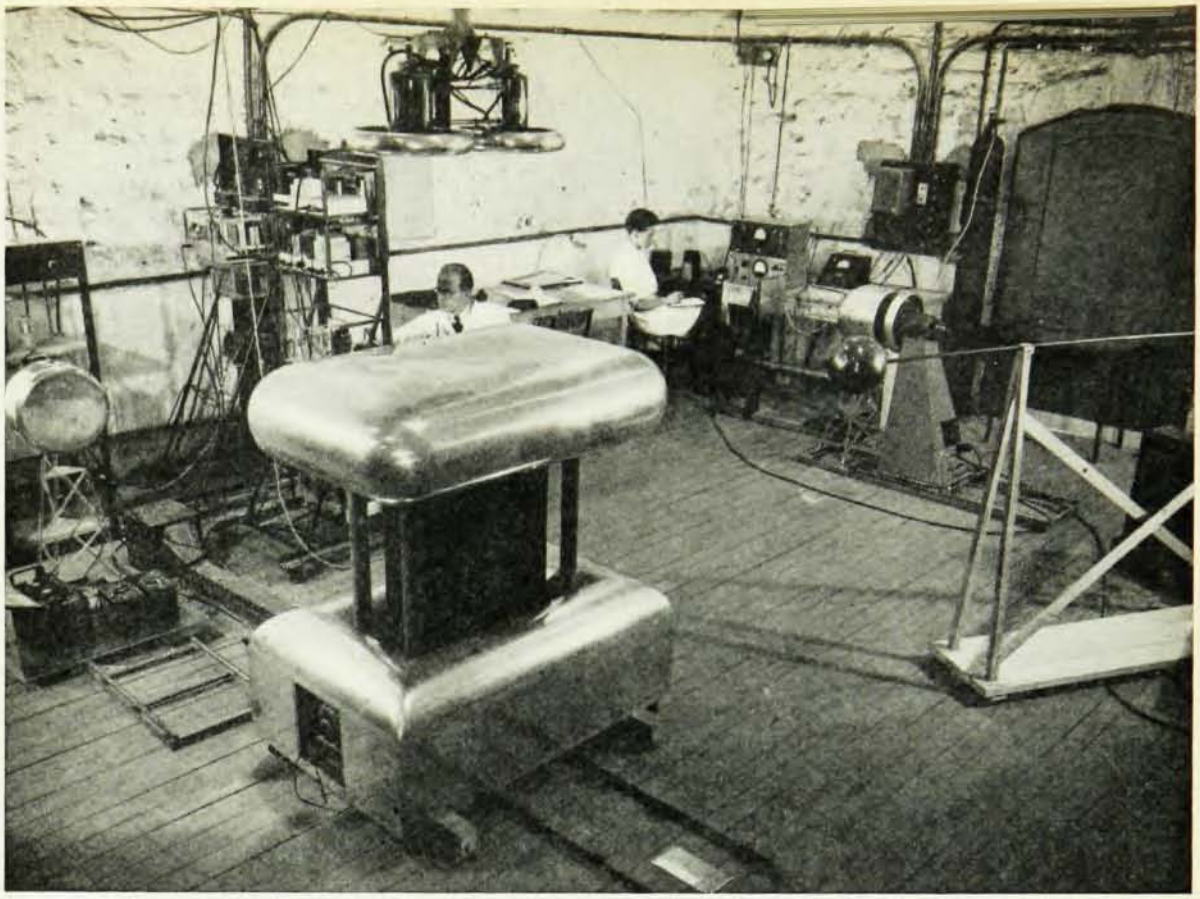
the pile is used to train personnel in such fields as nuclear engineering, pile operation, electronics, and mechanical engineering with emphasis on reactors. At present there are only some twenty people in Europe, all French, who can operate a pile. Third, the pile is used to study the physics of chain reactions, and reactor theory. It is surprising to see that practically no use is made of the neutrons produced by the pile, except for one or two neutron cross section experiments.

In addition to the pile, or rather in conjunction with it, research at Fort Chatillon includes measurements using fission chambers, beta ray coincidence counting experiments, short half-life measurements, and the study of various types of counters. A Van de Graaff accelerator is under construction and should be nearing completion about now. When I was there the first belt had just been installed, and a celebration was promptly declared, everyone drinking some very good white wine and trying to toast such an unprecedented thing as an electrostatic generator belt. We have better accelerators in this country, and France has the better celebrations; perhaps we can profitably exchange ideas on these subjects.

Fort Chatillon serves yet another purpose in French physics. It is the only producer of nuclear instruments, such as power supplies, scaling circuits, amplifiers, counters, etc. French industry has apparently not yet ventured into this field which has proved to be quite lucrative in the United States. The shops of Fort Chatillon thus supply nearly all physics laboratories in France with standard equipment. This is a very important service, and it is doing much to lighten the burden of the working physicist in the field. A rather striking prospecting counter has also been developed at Fort Chatillon; the complete counter and power supply are contained in an aluminum cylinder about 10 inches long and one inch in diameter. The counter weighs only one pound, and seems to be at least as compact as anything we have in this country.

Political Physics

Much attention has been drawn to the question of communism and physics. Frédéric Joliot, unques-



French experimental model of Van de Graaff generator. All photographs courtesy L. Kowarski.

tionably France's foremost experimental physicist, is a member of the party. This is not an article on the faults of communism, but it seems to me that a physics laboratory is not the right place for political meetings. This is just what is happening. At Joliot's laboratory in the Collège de France there is a communist cell meeting every week. Physicists waste more time and energy in their communist activities than they spend on their research. It appears that laboratories in Paris are known by their political affiliations rather than by the work they do. Thus we have clerical laboratories, communist laboratories, socialist laboratories, instead of cosmic ray laboratories, spectroscopy laboratories, and nuclear physics laboratories. This is an unfortunate situation inasmuch as it generates bitterness and personal antagonism in what is supposed to be a high-minded, unprejudiced group of people.

Physics has always been an international science; a free exchange of information between countries has been vital to its progress. The best way to learn about physics in France would be to send students there, and in return accept French students at American universities. In this way we would get a much more significant interchange of ideas than can be gotten from a few international conferences. The American student, however, faces a problem if he wishes to study under a man like Joliot. To be sure, Joliot is a first-rate physicist, but he is also a communist, and if his student were seeking a position in the United States most government sponsored jobs would be closed to him, and many universities would consider working for Joliot a handicap rather than a good recommendation.

It occurred to me that France would be a good place to find out how the Russians defend their scientific policies, in particular their vituperative condemnation of Mendel-Morgan genetics. In my talk with another well known French physicist I asked what was the official Soviet attitude toward science. The reply was that in a communist society the state has the right to encourage that scientific theory which could bring greater immediate economic benefits to the people, regardless whether the theory was true or false. A rather startling attitude for a scientist of this person's stature, all the more surprising since "encourage" and "discourage" can mean pretty serious things.

Outside of Paris there is at least one outstanding physics center in France. That is at Grenoble, where Professor Néel, a world authority on magnetism, has his laboratory. At Lyon there is Professor Thi-

bault, now being groomed by some as Joliot's successor on the French Atomic Energy Commission.

Italian Research Facilities

On crossing the border from France to Italy one outstanding fact becomes apparent: Italy is a far poorer country. This is reflected in the physics laboratories, and becomes even more evident when one considers the physicists themselves. Italian universities offer the only jobs a physicist can hope to get, and there are always more applicants than openings. Salaries are extremely low; beginning at less than one hundred dollars a month, except in a few cases, and never getting much higher. One must bear in mind that the cost of living in Italy is practically the same as in the United States. Whereas in America the average physicist is comfortably well off and can change his job if he finds that he does not like it, the Italian physicist is poor, and unless he is really outstanding must remain in his position for fear that he may not get another one.

Geographically, physics in Italy resembles our conditions more than the French. Laboratories are scattered throughout the country, with the outstanding centers at Rome, Milan, Padua, and Turin. Financially the laboratories are almost entirely dependent on the government, which seems to have no money either. All scientific research in Italy is supported by the Government Research Council whose yearly budget is $500,000. This is split up among all the sciences, and among all the universities, so that not much money gets to any one laboratory. The physics laboratory at the University of Rome is the pride of Italy. It is in a modern building with a great deal of room for research. Some of the world's greatest contributions to modern physics have come out of it. Consequently the Research Council magnanimously awards it $15,000 annually, to which the University adds $2,500 and the students another $2,500, so that the laboratory operates on a yearly budget of $20,000, a sum that would appear ridiculous to any comparable American university.

The Italian physicist, then, has to choose his field of research according to the money he can save, rather than from the point of view of general or personal interest. Cosmic rays are cheap, and this explains why Italian physics has lately been so concerned with research in that field. At Rome one finds work on a fast high pressure ion chamber for the detection of stars produced by ionizing and non-ionizing particles. Also there is Professor Amaldi's apparatus for the measurement of scattering cross sections for μ-mesons. Delays in extensive air showers are being investigated, and a variety of cosmic ray apparatus is under construction. The only other research carried on there is in the field of thermal diffusion. A ten-meter Clusius and Dickel column has been set up for the separation of the neon isotopes. In conjunction with this work Dr. Boato has built a 60° mass spectrometer, apparently the only one in Italy. With it he hopes to measure speeds of reactions as well as diffusion constants of gases.

At the University of Milan the situation is similar. Only cosmic ray research is going on, and the laboratory's equipment consists of a cloud chamber, some counter filling apparatus, and an electronics laboratory. Here, as elsewhere in Italy, the physicist must build his own electronic circuits; he cannot buy them as he can in France, nor does he have electronics technicians who can do the work for him. At Turin Professor Wataghin directs a cosmic ray group, and at Padua Professor Rostagni has constructed a cyclotron. There is another cyclotron at the Health Institute in Rome, used chiefly for biophysics.

Physics Without Money

This about completes the research facilities in Italian universities. They are all greatly hampered by lack of money for research and low salaries for physicists. It is then all the more surprising to see how much good work can be gotten for so little money. Apparently the amount of good physics produced is not proportional to the money invested; there are, as a matter of fact, those who think that too much money is a handicap in that it channels the physicist into a line of research in which all the money can be invested. Italy is a good proving ground; can physics without money compete, in the long run, with such wealthly physics as we have in the United States today? Another fact hampers the Italian physicist and that is the lack of graduate students in the universities. A physicist goes to the university for about five years at the end of which he is awarded a Doctor's degree. During that time he has not had much time to do any original research, nor has he been able to learn much about it. Consequently he is not equipped for research work when he gets his degree, and later he has no graduate students to help him in the more routine aspects of his work.

There is in Milan a rather unique establishment called CISE. Roughly translated the letters stand for Information and Experimental Studies Center.

Actually it is a nuclear physics laboratory, supported by industry and headed by Professor Bolla of the University of Milan. This is perhaps the most dynamic laboratory in Italy. It occupies only two floors of an apartment building, but it is the Italian equivalent of our Atomic Energy program. From such small beginnings Italian industry hopes some day to obtain enough information to build a nuclear reactor and perhaps utilize atomic energy for its further development. The work at CISE is mainly in the field of neutron physics, such as measuring neutron cross sections, $n - \alpha$ reactions, and initial experiments on proportional BF_3 counters. Their progress is much hampered by the fact that they have to use a radium-beryllium neutron source, rather than a pile. Still, this laboratory is an auspicious start; it is the more encouraging since it shows that industry in Italy is interested in fundamental research, and has finally realized that spending money on such a seemingly impractical laboratory will eventually benefit Italian industry, Italian physics, and, perhaps most important, the Italian people. Professor Bolla, who is the director of CISE, was quite outspoken on the state of physics in Italy. Briefly he claims that physics is in a terrible condition: there is no body of experimental work, the standard of research is very low, and the universities produce "disgusting" physicists. The reason for this, Professor Bolla goes on, is that to the Italian a scientist is a second class intellectual. First come the humanists, the philosophers, historians, and artists; then come the scientists. Gifted young people naturally turn away from science, which promises them neither prestige nor financial rewards, only hard work that is looked down upon by their fellow academicians. In this sort of atmosphere it is difficult for physics to prosper and for physicists to lead decent lives.

When confronted with the important contributions Italian physicists have made since Galileo, Professor Bolla deprecates their worth, and as for Fermi he says, "Fermi belongs to the world, it is just an accident that he was born in Italy". For all their modesty I think the Italians are very proud of Fermi, and I don't believe that their opinion of Italian physics is so low as they pretend.

An International Laboratory?

It has been proposed that Europeans ought to pool their resources and, with perhaps some help from the United States, build a European nuclear energy center. Such a center would provide facilities for research which no university can now afford, and would at the same time present an excellent place for the exchange of ideas and a more internationalized physics. Surprisingly this suggestion has had a cool reception in French and Italian laboratories. Many physicists claim that they could not work both at such an institute and in their university laboratories, and they prefer to stick to their own research. Mme. Joliot, in her usual blunt manner, said that it was useless for France to take part in such an enterprise since the two leading French physicists (M. and Mme. Joliot) would be barred on political grounds. The Italian physicists were wary because they feared that the French would dominate such a laboratory, and that Italians would be regarded as poor relations. The spirit of nationalism has not yet died in European physics.

There is, perhaps, another reason why an inter-European laboratory might not be very successful, and it lies in the training and attitude of the European physicist. Research in nuclear physics requires teamwork; in our laboratories the concept of a "group" working on a problem has found widespread acceptance. In an integrated program such as can be found in any of our larger nuclear centers it is impossible for one man to work alone. Also it is important that he have people working with him rather than under him. It is precisely this aspect which is difficult to understand for the tradition ridden and bureaucratically educated European. He is a very good scientist working alone. He may even be good working under someone, but working in a group of physicists, all of the same rank, he is lost. The age old feeling of master and subject is too deeply ingrained to be swept away in a generation or so. The lack of research groups is evident in all the laboratories of France and Italy.

American physics is held in very high esteem in France and Italy. I have been received most hospitably in all the laboratories I visited, and by all physicists regardless of their political beliefs or personal opinions.