points that he described in his letter must appear, and I thank him for using the words "luminosity-distance" which is what the distance actually is, and also the mistake that he pointed out in a formula on page 25.

I did not use the concepts of cosmological models and I did not intend to use them for good physical reasons. In his letter Professor McVittie failed to inform us of one important fact about the present status of cosmological theories; perhaps he is more enthusiastic about this present status than I am. *There does not yet exist any data to reveal to us that even a curvature exists in the structure of our universe.* From all galaxies observed, the most one can say is that there exists a linear relation such as I gave in my paper. Hence all familiar noncosmological concepts of distance, etc., may be used. Cosmological effects become noticeable when the red shift is large. For 3C273, the red shift is 0.16 and the relativistic correction in converting it to velocity, using a linear relation, is around 0.01, hardly significant. For 3C48, the red shift is 0.37 and the relativistic correction is 0.07, around 25 percent. These corrections are not significant, since Hubble's constant has fluctuated by more than a few decibels in the past few years. The same, however, cannot be said for quasars with a larger red shift.

I am not pessimistic about cosmological theories. It is well known that the ability of the 200″ telescope to resolve world models *by using galaxies* is limited to a distance of around 2 billion light years, where a poor physicist's concept of space and time (which he is used to) is still valid. With the high luminosity of quasars (100 times that of galaxies), the range of the 200″ telescope is extended *roughly* ten fold (the exact number depends on what cosmology one believes in). If good statistics and a knowledge about the structure of quasars can be obtained, there is a good hope that even the modest 200″ telescope we now have on earth may give cosmological theories an experimental boost, which they badly need.

After my article on gravitational collapse was published, I received a letter commenting on W. H. Jefferys' measurements on the motion of 3C273 (which were discussed on page 26 of the May issue). Dr. W. J. Luyten of the University of Minnesota, an expert in the measurement of proper motions of stars, remarked that the measurement that Jefferys made on old plates may contain larger errors than that quoted in his work. The Harvard plates have a scale of 180 seconds of arc to one millimeter, and to achieve the accuracy quoted by Jefferys one needs to measure the position of a star to an accuracy of 1/35 micron. During these years of storage, the Harvard plates may have suffered shrinkage, rendering such accuracy impossible.

Dr. Luyten has measured the proper motion of four quasars (3C48, 3C196, 3C273, 3C286) using different techniques. He found that their proper motions are not larger than their mean errors of measurement. His result was published in *Publ. of the Astron. Obs. of the Univ. of Minn.*, Vol. III, #13, July, 1963.

Hong-Yee Chiu
Institute for Space Studies
New York City

Teacher exchange

The COPFIC Report (*Physics Today*, May 1964, p. 36) was both gloomy and stimulating. In general, it should have a beneficial effect. It might be especially effective if reprints were put into the hands of administrators in the same way as the "Five Colleges" Report.

I wish to make two comments about recommendation (e) in the COPFIC report.

1. I have seen only two requests associated with the summer job Placement Service of AIP but both of these were requests for PhD's with considerable experience. If this is generally true, the service is of little help to the beginning teacher with the PhD or to any teacher with the master's degree only.

2. In a letter to Dr. Brode, Chairman of the Committee, dated October 9, 1963, I made a suggestion which I still believe would be useful. With very moderate NSF support, the summer job Placement Service could extend its service to the deliberate exchange of beginning teachers between colleges for the summer session. The only cost involved would be transportation and, perhaps, a small removal sum. The advantage to the teacher of limited experience would be the association with experienced teachers other than those of his home institution. Although it is recognized that there are other problems involved, it would still seem a relatively inexpensive method for a fairly rapid diffusion of innovations in teaching, student evaluation, demonstration techniques, etc., through the college physics community.

John A. Fynn
McMurry College
Abilene, Texas

General exam

With the increased interest in graduate study, it is surprising that the general examination (sometimes called the preliminary or qualifying examination) for the doctorate has received so little attention. The general examination may be described as ranging from superficial to sadistic. It appears that many graduate students are so exhausted when they pass the examination that they never regain their drive to do really creative work.

The writer has taken four such examinations, failing twice (University of Chicago) and passing twice (Northwestern University and Western Reserve University). In my opinion, there is an urgent need for reform with respect to the general examination. I should like to correspond with anyone who has specific criticisms of the examination or suggestions for its improvement.

Harold F. Mathis
2905 Halstead Road
Columbus, Ohio 43221

Underdeveloped countries

Two articles in recent months have discussed research in underdeveloped countries. In the first (*Physics Today*, August 1963) David Tabor criticizes the efforts of some underdeveloped countries to undertake fundamental research on the grounds that such activities are not in line with the state of technological development in these countries and that the primary purpose of such research is national

The excellence of the Half-Meter Ebert Spectrometer

plus vacuum ultraviolet capabilities

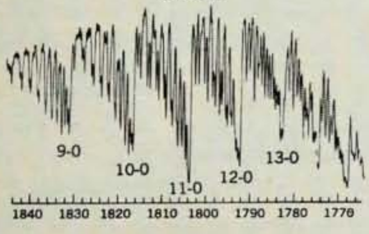
plus screw accuracy of ±1 micron over the entire wavelength range

THE JARRELL-ASH HALF-METER VACUUM EBERT SPECTROMETER

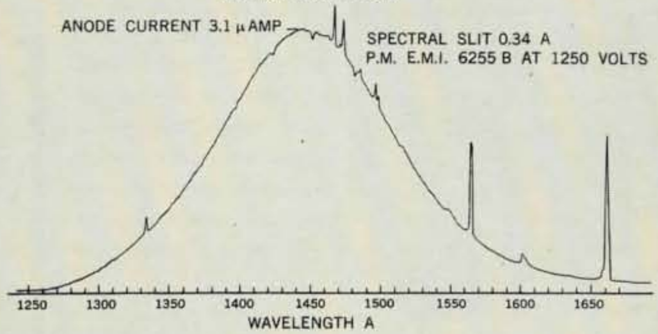
Wavelength Range	1200A — 1.6 microns, 1180 g/mm grating
Resolution	0.2A first order, 0.1A second order
High Energy Source	Rare gas sources produce background continua from 1200—2000 A
Vacuum System	Ion pump — no oil contamination
Gratings	5 available for up to 25.6 microns. Kinematic mount makes them easy to change in less than 10 minutes.
Related Jarrell-Ash Instrumentation	Also available as double-beam automatic recording spectrophotometer

Write for information on Model 84-110

SCHUMANN-RUNGE ABSORPTION SYSTEM
OXYGEN



KRYPTON CONTINUUM



Jarrell Ash

ANALYTICAL INSTRUMENTATION · SPECTROSCOPY · GAS CHROMATOGRAPHY · X-RAY DIFFRACTION

JARRELL-ASH COMPANY • 540 Lincoln Street, Waltham, Massachusetts 02154
JARRELL-ASH (Europe) S. A., Rue de la Jacuse 6, Le Locle, Switzerland
NIPPON JARRELL-ASH CO., LTD., Kiyamachi-Sanjyo-Sagaru, Nakagyoku, Kyoto, Japan

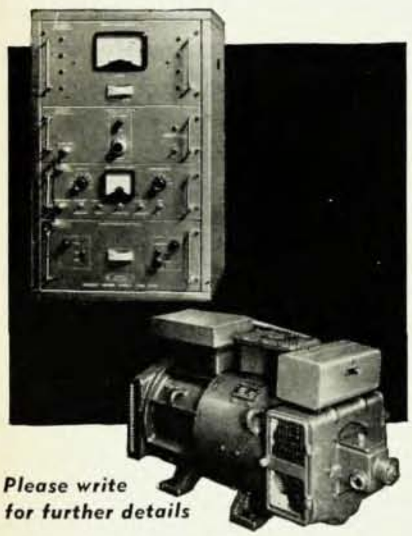
IS THERE A PROJECT IN YOUR LAB AWAITING A SPEX OPTICAL SCANNING SPECTROMETER?

- wl range 1100A to 22 microns
- accuracy to 1A
- resolution to .03A
- speed f/6.8
- quick-change gratings
- air path or evacuable models
- enhancing SPEX-cessories include:
  1—continuously variable scanning drive with wl marker
  2—straight-through optics
  3—detector systems
  4—standard and Polaroid cameras

Write, phone or visit us for full specifications and prices on these instruments as well as our Grazing Incidence Spectrometer-Monochromators.

SPEX INDUSTRIES, INC. · 3880 PARK AVENUE · METUCHEN, N. J.,08841 · ☎ 201-549-7144

LABORATORY MAGNET POWER SUPPLIES



MAGNET POWER SUPPLY TYPE C

Current-stabilized for use with the Newport range of laboratory Electromagnets, and incorporating specially-designed motor-generator sets to give improved isolation against fast mains transients.

Please write for further details

Also available:

1½ in. Electromagnet Type C	Magnetometer Type G (0-500 G)
4 in. Electromagnet Type A	Magnetometer Type H (0-20 kG)
Slow Sweep Unit Type A	Magnetometer Type P (2-15 kG)
Calibrating Solenoid Mk II	Magnetometer Type J (0-150 kG)

NEWPORT INSTRUMENTS

NEWPORT INSTRUMENTS (Scientific & Mobile) LIMITED

Newport Pagnell, Buckinghamshire, England

U. S. Distributors—Cryotronics, Inc., West Main St., High Bridge, N. J.

PHYSICIST or NUCLEAR CHEMIST

PARTICLE ACCELERATOR, Sponsored by the AEC Operated by Princeton Univ. & The Univ. of Pennsylvania; located at Princeton Univ.

This new research tool now in full operation, offers stimulating work in a university program of basic research.

OPPORTUNITY: in Radiation Research

EDUCATION: Ph.D. in physics or nuclear chemistry with experience in nuclear spectroscopy.

POSITION: perform and evaluate measurements leading to a picture of energy transfer from radiation field to matter. This will involve the measurement of neutron scattering, cross-sections (elastic, inelastics, and differential) as well as multiple body break ups due to high energy neutron and proton interactions.

Develop the necessary instrumentation for the above work.

Other positions for engineers and physicists are also available.

Please write for further details.

Work in suburban Princeton area. Salary comparable to industry. Unusual benefits include 4 weeks vacation & generous retirement plan.

Write to: A. C. Allen, include salary requirements

ACCELERATOR

P.O. Box 682, Princeton, N.J.

An equal opportunity employer

prestige. He points out that the high cost of research makes it feasible only in a few highly developed countries such as the United States or the USSR, and that smaller and poorer nations will experience a "drain" on their scientific manpower. He further states, "The current pattern of frontline fundamental research in underdeveloped countries tends to produce a class of scientists whose activities are oriented toward world science. In general this means a divorce from the economic and industrial needs of their own country. . . ." In a later issue (*Physics Today*, January 1964), M. J. Moravcsik takes issue with some of Dr. Tabor's conclusions, but I feel that subject needs further discussion.

Whether or not the establishment of basic research is in line with the state of technological development, it is a necessity for any country striving for growth and independence. In the initial stages of a country's development, an important purpose of research is to keep the country and its universities abreast of the latest advances in science throughout the world. A team of highly trained individuals are capable of this only if they are actively engaged in research. Otherwise their initial training and experience will soon become inadequate. This phenomenon is evident in a number of universities in some underdeveloped countries with which the author is familiar. There, certain professors who obtained their training in Europe some forty years ago still teach the outdated material of those times. Lack of sufficient research activity in these universities is certainly the main reason for this phenomenon.

A further and equally important reason for supporting research in these countries is the need for worldwide cooperation on many scientific problems. Programs such as the International Geophysical Year are rapidly increasing in number and it is likely that more and more research projects in the future will require cooperation among scientists of many countries. Such international scientific programs can be carried out more effectively if research facilities exist in all parts of the world. Consider the following example. Let us suppose that in connection with a geophysical research project a measurement of the earth's magnetic field need be taken in some part of Africa. With the present state of affairs it may take months of preparation and negotiations with local authorities to send equipment and personnel to construct a station for this measurement. Even scientific stations operated by foreign personnel are looked upon with suspicion by local people in many of these underdeveloped countries as some recent examples have demonstrated in connection with satellite tracking stations in parts of Africa. It may, therefore, be to the advantage of the more advanced countries to help in the development of scientific competence in the underdeveloped areas.

The problem of the "brain drain" and cost of research can be solved at least partially in a number of ways. Several scientific cooperatives have already been established in Europe with the purpose of sharing the cost of expensive research. These efforts have been successful and have perhaps slowed down the "brain drain" considerably. Shortages of funds and personnel may be relieved if the underdeveloped countries follow this example. There are already movements in the direction of cooperation among many underdeveloped nations. There has been talk of unity in Africa, Latin America, the Middle East, and elsewhere. Europe has already made advances in this direction. Such movements toward unification have economic and political roots, but are greatly enhanced by the rapidly developing communications facilities among peoples of various nations. Admittedly, such movements in Africa, Latin America, and the Middle East are still in the very primitive stages, but their eventual success does not seem too far fetched. Scientific cooperation among underdeveloped countries may be bolstered by these political movements.

The objection raised by Dr. Tabor that the fundamental research in underdeveloped countries will be divorced from the economic and industrial needs of these countries may be only partially true. In general, fundamental research does not follow the pattern of technology in any particular country and its subject matter is independent of the national boundaries. It is natural, therefore, that those engaged in this type of research would belong to a sort of world community. The fundamental researcher, however, need not be divorced from the needs of his country. He may participate and direct the training of engineers and applied researchers, and may himself take part in this type of research which is directly connected to the needs of his country.

Jamshid Naghizadeh
University of California
La Jolla, California

Fundamental vs. applied

In his article on fundamental research in the underdeveloped countries, Professor Moravcsik makes the statements: ". . . the fundamental science of today will become the applied science of tomorrow . . ." and "The training and experience of a person working in fundamental research tends to be more thorough and broader. . . ." These beliefs are widely held in the western scientific community, but they are really no more than myths. Neither the history of scientific ideas nor any sociological study of the situation in modern technology will justify such sweeping claims. As a single example, the areas of agronomy, ground-water engineering, heat flow in structures, and related topics are now showing and will increasingly show a tremendous development through the marriage of finite difference and matrix methods and digital computation. Furthermore, these are critical areas in engineering and applied physics in underdeveloped lands. Often this type of analysis requires little more than algebra plus considerable ingenuity in duplicating the real world by a system of hundreds of simple equations. No fundamental mathematician would have the slightest interest in this crucial field. Furthermore, its development has fallen primarily to engineers and computer programming specialists and is studiously ignored (and quite properly) at the more rarefied levels of modern mathematics. It would be wholly irresponsible for a small and impoverished country to permit its students to engage in abstract investigations in modern mathe-