comfortable living conditions can be provided almost anywhere.

Because of these developments, surveys can now be carried out that have as their purpose the location of the finest possible observatory sites, with much less attention given to accessibility than in the past. Then the problem of installing the best possible instruments on these sites and arranging for satisfactory living conditions becomes a technological one. It seems quite possible that this approach may furnish sites for future observatories far superior to any now in use on the earth's surface, and intermediate in quality between the best of existing observatory sites and those contemplated for future establishment on vehicles outside the earth's atmosphere.

And now, let us look for a few moments at some of the vistas in astronomical research itself. The safest predictions for the future are those in areas where breakthroughs in method have occurred recently—methods which have not yet been utilized, except in a preliminary fashion. I shall refer briefly to several instances of this kind.

1) A few years ago, Bengt Strömgren developed a method whereby, from precise measurements of a star's radiation within certain narrow, specially selected spectral regions, he was able not only to determine the true luminosity, or candle power, of a star but also to derive the stage in evolution of the star—and therefore, in principle, its age. This method of Strömgren's, as used by himself and by his pupil D. L. Crawford, now makes possible the determination of distances and ages of hundreds of thousands of stars, and this with the use of telescopes no larger than the completed 36-inch reflector of the Kitt Peak National Observatory.

And what problems can be solved by this kind of observation? Problems concerning the precise nature and location of the spiral arms of our galaxy and the arrangement in space of stars of varying ages and physical characteristics, and there is even the possibility —with the giant telescopes of Palomar and Mount Hamilton—of investigating the physical similarities and differences of stars in the galaxies nearest to our own.

2) One of the most active fields in present-day astronomy is the study of galaxies, or great clusterings of stars similar to the Milky Way system in which our sun and planets are located. Investigation by means of the spectroscope shows that some galaxies are composed principally of hot, blue stars and gas, while others are composed principally of cooler yellow and red stars, there being little evidence of large quantities of gas; intermediate between these two categories are galaxies having mixed characteristics, of hot and cooler stars together and intermediate amounts of gas.

Now a relationship exists between the forms of the galaxies and the stellar populations just described. The galaxies that contain the greatest proportion of extremely hot stars and gas turn out to be irregular in shape, with little concentration of their light toward their centers. On the other hand, galaxies composed principally of the cooler yellow-red stars are found to possess extremely luminous central regions and a generally symmetrical appearance. From an extension of these conclusions it becomes possible to make an approximate determination of the stellar and gaseous characteristics of galaxies from a simple inspection of their forms. And so, a method is furnished whereby the average stellar-population characteristics of galaxies can be determined over extended regions of the universe.

I could describe many other instances of exciting possibilities for astronomical research in the future; however, we must content ourselves here with the statement that at no time in the history of modern astronomy have there been so many golden pathways toward the expansion of our basic knowledge of the universe; never has there been such a rich range of possibilities for fruitful investigation by those now working, or by those expecting to enter the field of astronomical research.

Science in the News

Basic Research in the Defense Department: The Department's View

Final agreement on the $40 billion Defense budget was reached last week just before the congressional recess began. The appropriations include over $4 billion for RDT & E—research, development, test, and evaluation. A small proportion, roughly 3 percent, of this will be spent on basic research, but a small proportion of this huge sum makes up a very significant portion of the total amount of money the government spends for basic research.

The official budget lists $136 million, but together with other sums that properly should be considered basic research, the Defense Department will probably spend $150 million during the 1961 fiscal year, which began 1 July. This will be about one quarter of the total federal investment in basic research, and compares with a little over $100 million to be spent by the National Science Foundation, the government agency specifically created to support basic research.

Because Defense has a fairly good idea of where it wants to spend its money, its mechanism for giving grants is quite different from that of the NSF. The foundation picks out what seem to be the most promising proposals submitted. Defense identifies certain areas it wants to support and then uses a sort of talent-scout system to seek out people in the universities and foundations who can do some work in the area. Here are a few samples of the areas singled out by an advisory panel last year: physics—work with high magnetic fields; meteorology—wind fluctuations in the upper atmosphere; mechanics—theory of elasticity; mathematics—theory of numbers; geography—exploration and mapping of the polar regions; chemistry—preparation and properties

of ultra-pure materials; biology—genetics.

Defense officials cite as a particularly successful example the grants to Kusch and Lamb, of Columbia, which led to their discovery of the hyperfine structure of hydrogen. The thinking behind this and many other Defense basic research grants has been this: Defense was interested in microwave physics; it felt that almost any advance in this area might turn out to have important practical applications. Kusch and Lamb were not only working in the forefront of this area but they were recognized as outstandingly capable men, and experience has shown that it is as important to support the most promising men as to support the most promising projects. In this case both the men and the project were promising, and the results were a Nobel prize for Kusch and Lamb and the development of Maser extremely low noise amplifying tubes, with important applications in long-range radar, radio astronomy, missile and satellite instrumentation, and other areas.

Until 1957, there was some tendency for top-level officials to play down the need for basic research. But there now seems to be little support in the Department or in Congress for former Secretary of Defense Charles Wilson's "who cares why the grass grows green" school.

Projects such as those of Kusch and Lamb make it an easily demonstrable fact that the military departments have derived tremendous benefits from the basic research they have sponsored. Transistors, which make possible the miniaturized electronic devices that control the latest weapons, were developed by Bell Laboratories on the basis of studies in solid-state physics sponsored by Defense during the early post-war years. Studies in hydrodynamics sponsored by the Office of Naval Research supplied information which later turned out to be necessary for the development of the Polaris guided missile. This weapon, fired from a submerged submarine, is regarded as possibly the most potent in the Defense Department's arsenal. Klystron-tube technology sponsored at Stanford for use in high-energy electron accelerators for studies of subatomic particles led to the missile warning system and the monitoring of air activity deep inside Russia; the Klystrons are a type of super-powered radio amplifying tubes, and they made possible the high-power radar used in the missile warning and long-distance monitoring systems.

Defense research officials, backed by their committees of outside advisers, say the results produced from investments in basic research are so impressive that Defense ought to be doing a great deal more of this work, perhaps double or more the present level. A report prepared by the Department's Advisory Panel on General Sciences and endorsed by the Defense Science Board suggested that it is unwise to set a level of support in terms of dollars. They said that "support . . . should be determined by the availability of competent scientists rather than the availability of funds." But the research program has actually been lagging considerably behind the recommendation of the advisory panels. The totals have been climbing every year since Sputnik, but the total percentage increase for basic research, about 50 percent, has not matched the percentage increase for over-all R & D.

Getting Support

Defense officials dealing with basic research point to several reasons why support is not as great as they would like it to be. According to their view the problem is partly one of budgeting, partly the over-all concept of Defense research and development. They say it is difficult to get a department operating within budget restrictions to set aside money for things which may turn out to be valuable at some unforeseen time in the future when the department feels a strong and immediate need to spend all the money it has for things it can buy this year. The problem is not peculiar to the Defense Department. The difficulty in getting an adequate program in oceanography [*Science* **131**, 1592 (27 May 1960)] stemmed from the fact that although the field was recognized as important to the nation, it was fragmented among a dozen or so agencies none of which was inclined to give it much consideration in comparison with the other programs the agencies had to pay for within their budgets —programs which had a more direct short-range importance.

The problem is made more difficult, Defense research officials say, by the "systems" concept of R & D. There is nothing wrong with the concept, the officials say; indeed it works very well. It applies, or at least attempts to apply, the idea of the assembly line to R & D; that is, it is hoped that the over-all project will develop in such a way that each component of the system will be ready when it is needed. This works well enough for applied research, where it is at least comparatively easy to estimate how long it will take to get something done, but it leaves little room for basic research. It is almost impossible to guess when a basic breakthrough will take place, or even to guess what the exact nature of the breakthrough will be or where the information developed can be put to practical use. This means that, for the most part, the big development projects are based on fundamental research that has already been done. It leads to a tendency to merely assume the existence of basic information and to forget that much of it would not exist except for basic research sponsored in earlier years.

But despite such difficulties there are certain advantages in having a great deal of basic research sponsored by operating agencies like Defense rather than in placing it all under a single outside agency such as the National Science Foundation or the often proposed Department of Science.

Defense officials argue that people who are close to the applied programs necessarily develop an awareness of the areas where research is going to be most valuable; they point out that no change in organization could relieve the Defense Department of the responsibility for seeing to it that basic research is pushed in areas that are vital to national security. To assign all basic research to an independent agency would merely separate assigned authority from inescapable responsibility. It would add another layer of organization to a government which already appears to be so big that it has a sometimes embarrassing difficulty in coordinating its activities and making decisions.

The Defense officials claim that even the occasional criticism that money is wasted on projects that are not very promising is really a further argument for keeping the research within the Department, where it will be close to people involved in applied R & D. They say that it is and should be the policy of the department to occasionally gamble on projects that may appear risky, but which may lead to a major breakthrough. The Defense Department spends billions every year on R & D; it is thus a matter of common sense that it should be willing to gamble a few hundred thousand dollars on a research project that may develop infor-

mation that could save hundreds of millions later on. Officials view it as part of the function of the Defense basic research program to support these risky projects which an agency like the NSF, not so closely aware of potential practical applications, is likely to be unwilling to support. There seems to be substantially less of the "that's been tried before and it isn't going to work" attitude in Defense than in NSF, and the Defense officials argue that that is precisely the way it should be.

Congressional Recess: Some Matters Left Undecided until August

There has been a great deal of speculation over the exact reason for the Congressional recess and even more over what the postconvention session will accomplish. The only precedent is the 1948 session Harry Truman called in order to dramatize his charges about the "do-nothing" 80th Congress. That session accomplished nothing of significance, since the Republicans who controlled it understandably had no intention of carrying out Truman's program. This time the situation is very different: the session is being called on the initiative of the party that controls the Congress, and the Democrats will necessarily be making a determined effort to make at least a start toward carrying out the program of their newly adopted platform.

During the closing hours before the recess, both houses adopted the conference report on Independent Agency appropriations (*Science*, 1 July 1960). This included $175.8 million for the National Science Foundation and $915 million for the Space Agency. Both houses also cleared the "Health for Peace" proposal. Action was put off until August on the HEW appropriation with its big proposed increase in funds for medical research, and on the Antarctic treaty, which in effect internationalizes the Antarctic, outlawing the establishment of military bases there and opening the entire continent to the scientific expeditions of all nations.

One thing that is certain is that federal support of scientific research and development will reach a new high in the fiscal year that began 1 July. It will run close to $9 billion, substantially more than the total of all nonfederal support for R & D and triple the pre-sputnik level prevailing before fiscal 1958—H.M.

News Notes

Eugenics in New Guinea

A plan to introduce a eugenic policy, apparently without precedent anywhere, has just been announced by the administration of the Territory of New Guinea [*South Pacific Post* (24 May 1960)]. This measure affects the tribe of Fore, some 30,000 strong, which inhabits an area of about 884 square miles in the Eastern Highlands. Almost half of the women and one-tenth of the men of the Fore tribe die of a hereditary disease known as kuru. This is a grave neuropathological disturbance for which no cure is known and which leads to death, usually within a few months from the appearance of the first symptoms.

As shown by studies conducted in the Fore area by a group of investigators from the University of Adelaide (South Australia), kuru is transmitted by a gene which behaves apparently as a Mendelian dominant in females and a recessive in males. The presumed homozygotes of both sexes die in childhood, usually before adolescence; heterozygous females die later, after most of them have produced children. The extremely high incidence of kuru in the Fore tribe and its absence in neighboring tribes except as introduced by migrants from the Fore area remain unexplained. The heterozygous carriers of the gene for kuru probably possesss some considerable adaptive advantage, both the males who survive and perhaps also the females who die after having completed at least a part of their reproductive lives. The nature of this advantage is, however, completely unknown.

In part because of the ravages of kuru, some portions of the Fore tribe have great excesses of males over females (as much as 2.5 males per female). Fore men tend to move into neighboring tribes, and some of them, like members of tribes in which kuru is unknown, come as contract laborers to work on plantations in other parts of New Guinea. Since many of them are heterozygous carriers of the gene for kuru, it is feared that the disease may spread and afflict the populations of other districts.

To counteract this danger, the administration's plan is to quarantine the Fore tribe, by prohibiting the emigration of its members from the tribal area. All Fore men who have been recruited as laborers from the area will be returned there. This is obviously a severe restriction to be imposed on a whole tribe. Realizing this, the administration is considering ways and means of developing the Fore area to provide work for its people and to make emigration unnecessary. The study of the disease is to be continued, in the hope of finding a remedy for kuru victims and a way of identifying the carriers of the kuru gene in heterozygous condition before the appearance of the disease symptoms.

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Documentation Center Opened

A Scandinavian Documentation Center (SCANDOC) was opened recently in Washington, D.C., to further the exchange of scientific and technical information and documentation among the Scandinavian countries, the United States, and Canada. SCANDOC, a nonprofit organization offering free service, is financed and directed by the research councils and scientific academies of the four Scandinavian countries through their common Scandinavian Council for Applied Research.

The center will procure nonclassified and nonconfidential documents and information not readily available and will channel this information to the interested countries through information offices organized under the research councils and academies of the countries concerned. Arne Sverdrup, former head of the Laboratory for Steroid Research of the Norsk Hydro's Institute for Cancer Research, Oslo, will head SCANDOC. Sverdrup is also science attaché at the Norwegian Embassy.

Dedication of NIH Building

The Division of Biologics Standards Building of the National Institutes of Health, Bethesda, Md., was dedicated on 30 June. Roderick Murray, director of the division, delivered the principal address, which commemorated the fifth anniversary of the creation of the division as a separate unit of NIH.

The $3.5 million structure was designed to house the scientific and ad-