RESEARCH NOTES FROM THE HARVARD OBSERVATORY

New star in Sagittarius. In the constellation Sagittarius, the "home of galactic novae," a new star has recently been found by Miss Gill, on photographs made at Arequipa, Peru. It appeared suddenly at the eighth magnitude on June 22, 1924, and during the succeeding three months, in the ordinary course of the sky patrol, was unknowingly photographed seventeen times as its light steadily decreased beyond the range of the Arequipa telescopes. The star fails to appear on some fifty patrol photographs of the region made since September, 1924, and it is also completely absent from more than three hundred photographs of the region extending throughout the twenty-five years preceding its outburst.

Of the fifty or so galactic novae, nearly twenty have been discovered on Harvard plates of Sagittarius and the immediately surrounding constellations. The high concentration of catastrophes in one region is due, I believe, to the fact that these constellations lie in the direction of the center of the Galaxy and provide, therefore, a deep hunting ground for novae. An alternative explanation of the frequency of novae depends on the abundance of dark nebulous clouds that might contribute to the explosive unbalancing of involved stars; but such nebulosities are numerous in other parts of the sky where novae are rarely or never found.

Cosmic rays. The source of penetrating radiation is a problem that is exciting considerable attention of physicists and astronomers just now—perhaps too much attention, for in some quarters the actual existence of the highly exciting cosmic rays is yet doubted. The measures by Kohlhörster and others in Europe of the intensity of the radiation and of its variations from day to day and hour to hour are not in too good agreement with results by Millikan and collaborators in America. But granting the existence of this agent that discharges highly protected electrometers, it is of importance to seek its origin and particularly to study the probable cosmic effects.

Professor Gerasimovič has taken up at Harvard the theoretical study of cosmic rays, and one of his investigations, which is just published (H. B. 847), concerns the hypothesis of Corlin that the source of the cosmic radiation lies in the long period variable stars, such as Mira. There are hundreds of these stars, mostly faint, undergoing variations of several magnitudes in periods of a few hundred days. They afford, indeed, a plausible source of extremely short wave length radiation, because of their low atmospheric density (being very diffuse, red, gigantic stars) and also because hydrogen is an unduly conspicuous element in their spectra and therefore available for the hypothetical synthesis of chemical elements which might give rise to the extreme radiation-inciting energy changes. Corlin sought to correlate the observed variation in the intensity of penetrating radiation and the variation in the number and total brightness of long period variables above the horizon at corresponding times of the day.

The great number of current observations of long period variable stars, available through the work of the American Association of Variable Star Observers, permits a ready and definite calculation of the total brightness of the variables at any given time. In fact, Mr. Campbell's predictions, published bimonthly and annually from Harvard, permit this calculation for a year or so in the future. Carrying out the analysis, Gerasimovič finds no correlation between the stellar radiation and the cosmic rays. Moreover, he shows that the radiation of cosmic rays would need to be four times as intense as the black body radiation of the same stars to account quantitatively for the daily disturbance of penetrating radiation as recorded in Europe. If the diurnal variations exist, we conclude that they are not closely associated with the behavior of the variable stars.

Globular clusters. The investigations of globular clusters that I have carried out in the past years have been founded mainly on photographs with the large reflectors at Mount Wilson. Great telescopic power was necessary to separate and record adequately the exceedingly faint and concentrated individual stars. An important study of the clusters has, however, just been completed with two miniature Harvard telescopes of two inches aperture—a research that would be quite impossible for the large reflectors. This new work is the determination on a uniform basis of the total light of each of the globular clusters as a whole, and forms one of the steps in determining their relative distances and their uniformity in dimensions and brightness. For this work the individual stars of a cluster are not desired, as the integrated photographic effect can be most satisfactorily measured on plates made with such small telescopes that the images of the clusters are themselves starlike.

To determine the integrated magnitudes of the ninety-five recognized globular clusters, Miss Sawyer has handled hundreds of plates. The study shows some variety among globular clusters, and also indicates that most of the typical systems are much alike in total absolute or intrinsic luminosity. They average 13.4 magnitudes intrinsically brighter than our Sun, and therefore each one radiates about 10^{39} ergs per second.

The brightest of the clusters are, of course, the nearest ones—ω Centauri and ξ Tucanae. They are easy naked eye objects and are about ten magnitudes brighter photographically than the faintest. These two leaders are far south; in fact, eighty per cent. of the globular clusters are in the southern hemisphere, as are most good things (astronomically speaking). This simply means that the solar system is inconveniently located pretty far to the north of the center of the Galaxy.

Iron and stone meteorites. There are on record fifteen times as many falls of meteoric stones as of meteoric irons or stony irons, according to a recent compilation by Miss Mussells, but the total weight of the irons is 2.5 times the total weight of the stones. This ratio of 2.5 may be taken as a measure, or at least as an intimation, of the relative frequency of iron and silicates in inter-planetary and interstellar space; it can be compared with the ratio of iron to stone in the Earth, which Dr. Fisher estimates at 4.5. Only the actual "falls" of meteorites are used in determining the ratio, for, once on the Earth's surface, irons persist but stones rapidly disintegrate, making estimates based on "finds" of meteorites of no significance for this computation.

The total number of recorded falls during the last four centuries, up to the year 1923, is 438. The total number of finds, where the actual fall was not observed, is 411. The total weight of all known falls and finds is some two hundred and fifty tons, a ridiculously small figure compared with the mass of the Earth, which is about 6×10^{21} tons.

New class O stars. There is a particular interest and usefulness in finding and investigating the superlatives—the hottest or smallest or most distant or most something-or-other. It gives us an idea of the extremes of nature and of the scope of our problems. Likewise we seek to add new members to any rare or unusual class of objects in order to provide sounder data for statistical examinations.

The Class O spectrum appears to be a peculiar stage in the life history of very massive stars. Emission and absorption lines are there variously presented, and conditions of high excitation are indicated. The O's have been placed at the top of the temperature scale—perhaps erroneously—and the spectroscopists are not yet in altogether happy accord in matters relating to their classification and to their joining up with the B-A-F, etc., series of more normal and numerously represented spectral classes. We shall have more luck with more data in hand.

To the 140 already known, Miss Payne, in a current publication, adds ten new stars of Class O, two of which are naked eye objects. All are in the southern hemisphere, and of course they lie close along the galactic circle, as do practically all stars of high intrinsic luminosity. These new members of the class have already brought up the question as to the proper limits between the late O stars and the early B's.

Beta Doradus. The discovery of a naked eye variable star with a large amplitude of light variation is certainly unexpected at the present time, for the sky has been studied thoroughly for decades by variable star observers and has been photographed hundreds of times. The far southern star β Doradus, however, not only varies in a ten-day period throughout more than a magnitude, but its variation is of the Cepheid type, for which the light is never constant. A fourth magnitude Cepheid, such as this, is important because of the scarcity of bright Cepheids and also because these variables in general are the most useful stars in the sky. They afford a powerful means of measuring great distances, and since their variations are not restricted to light alone, but affect color, velocity, spectrum and size, they bear on evolutionary problems. The Cepheids are exceedingly large—supergiants, we call them. And this one is a thousand times as bright as the Sun.

The discovery and measurement by Shapley and Miss Walton of the variability of β Doradus on Harvard plates was brought about by reports on spectroscopic researches at the Lick Observatory, most recently by Miss Applegate.

The Lick Observatory, using plates made in Chile, showed that in spectroscopic behavior the star is allied to the Cepheids; the Harvard observers, using plates made in Peru, showed that the star is itself a Cepheid. The photographs that best show the variability are a special series of short exposures on the near-by Nova Pictoris. The brightness of β Doradus had helped to conceal its variation heretofore, for on the usual photographs its images are overdone and so smeared that magnitude estimates are unreliable.

Now that the variability has been found and its period is known, we turn to the old star catalogues and find that the early visual observations had hidden in them the proof of the variability. The conservative astronomers of the past, however, had taken the blame on themselves for the large deviations shown by their measures, instead of mistrusting the star.

Only two or three Cepheids are brighter than β Doradus. The type star of the class, δ Cephei, is one; and the North Pole star is another, but its variation is less than a tenth the amplitude of that of our new southern Cepheid.

Eclipse of the Moon. The lunar eclipse of June 15

was probably the best observed eclipse of the Moon in the history of science. It also brought about the highest degree yet attained in the cooperation of state, church, commerce and science in a single scientific problem. The Canadian and the United States Weather Services, the United States Army Signal Corps, the Roman Catholic Eskimo Mission, the fur traders and trappers along the Arctic Circle, the Royal Canadian Mounted Police, the powerful radio broadcasting stations of the Westinghouse Company, the astronomers of the observatories in western and southwestern America, the newspapers and Science Service, and the amateur astronomical observers over a large part of the United States were all involved in various phases of the meteorological and astronomical observations of this eclipse.

It will be many months before all reports come out of Alaska and from the Canadian Arctic giving information concerning the character of the atmosphere where the grazing solar rays passed and were refracted into the Earth's shadow cone to illuminate faintly, and discolor, the eclipsed Moon.

The general plans for the eclipse observations were developed by Dr. W. J. Fisher, of the Harvard staff, who has specialized in phenomena associated with lunar eclipses; the Canadian work was organized through the efficient cooperation of Dr. R. M. Stewart, director of the Dominion Observatory at Ottawa.

Nova in Magellanic Cloud. A nova in one of the Clouds of Magellan is of more than passing interest. In the first place, such an object has not heretofore been found in either of the Magellanic Clouds, notwithstanding the presence there of practically all other known types of high luminosity stars. In the second place, the distance of the Clouds are known, and therefore the actual luminosities of novae in such places can be computed, which is far from being the case for the nearer novae in our own Milky Way.

While comparing two photographs of the Large Cloud, in a study of stellar motions, Dr. Luyten recently noticed on a plate taken last September a star that was wholly absent from all of the many earlier plates. A search showed its images on eight other plates taken between September 28 and November 6. Just after this last plate was taken the Arequipa telescopes were dismantled for transfer to the new station in South Africa, and the further behavior of the star is unknown.

A cablegram to the South African observatories has resulted in some special photographs being made at the Union Observatory, Johannesburg, but the nova has apparently already disappeared. At maximum brightness the star was difficult enough, being photographically of the twelfth magnitude. But actually, if it is a member of the Magellanic Cloud, it was, when brightest, some ten thousand times as bright as the Sun; the distance accounts for the apparent faintness. And while we are speaking of actualities we should add that it was only the terrestrial recording of a nova that occurred last September—the actual disaster happened nearly a thousand centuries ago.

HARLOW SHAPLEY

SPECIAL ARTICLES

FURTHER STUDIES ON THE ANTIRACHITIC ACTIVATION OF SUBSTANCES BY CATHODE RAYS[1]

IN a previous preliminary report[2] it was shown that, with the exposures used, high-voltage cathode rays[3] applied directly were not effective in healing rickets in rats. On the other hand, it was shown that cholesterol could be endowed with antirachitic potency by exposure to the cathode rays. In our earlier attempt cholesterol was exposed to the cathode rays in a rather thick film and had to be added to the diet in amounts of 0.2 per cent. or more to bring about within two weeks complete healing of rickets in rats, which were rendered antirachitic by the Steenbock rachitic diet No. 2965.[4]

We have since found that, with the film of the substance about a millimeter or less, just as active products are formed by exposure to cathode rays as with ultraviolet irradiation and moreover the time interval is much shorter. In Tables I and II are summarized some of the recent experiments carried out. The cathode ray exposure was in all cases at a distance of 1 inch from the window of the tube and a current of 1 milliampere and 200,000 volts used. The substances were exposed in air and in one instance in an atmosphere of nitrogen. The cholesterol used in these experiments was a commercially pure product. In the experiments with cholesterol purified by the dibromide method, it was first brominated, then debrominated, brominated a second time, again debrominated and finally recrystallized three times from hot alcohol.

From an examination of Table I it is seen that cholesterol exposed to cathode rays for 30 seconds is ef-

[1] From the Laboratory of Biological Chemistry, Albany Medical College, and Research Laboratory, General Electric Company, Schenectady, N. Y. The writer is greatly indebted to Dr. W. D. Coolidge for his valuable advice and assistance, and for the technical assistance of F. S. Randles and H. E. Tanis, Jr.

[2] Knudson, Arthur, and Coolidge, W. D., *Proc. Soc. Exp. Biol. and Med.*, 1927, XXIV, 363.

[3] Coolidge, W. D., *Jour. Franklin Institute*, 1926, ccii, 693.

[4] Steenbock, H., and Black, A., *Jour. Biol. Chem.*, 1925, lxiv, 263.