Distorted Spectrum Reveals Star Speed

Astronomy

Some Turn 150 Times Faster Than The Earth

BECAUSE a spinning star is both moving toward you and away from you at the same time, astronomers can now measure their speed of rotation, and have found many that turn at 40 miles a second, 150 times the speed of the earth at the equator.

This seemingly paradoxical effect occurs merely because one side of a turning sphere approaches while the opposite side recedes. Stand in front of a phonograph and watch the turntable as it revolves. If you drop a bit of paper or some small object on the right side, it will be carried towards you, but if you drop something else on the left side, it will be carried away from you at the same time.

Light Waves Squeezed

Then, of course, the first thing will go from you and the second towards you. Only if you were directly above the turntable, or if the phonograph were tilted so that you were in line with the axis of rotation, would all parts of the table remain constantly at the same distance.

This is an example of the principle used by C. T. Elvey, astronomer at the Yerkes Observatory of the University of Chicago, to measure how fast a number of stars are turning. The method was developed by a Russian and a German astronomer, also at the Yerkes Observatory, Dr. G. Shajn and Dr. Otto Struve.

By a well known and often used effect, the spectroscope can be used to reveal the motion of a heavenly body. When a star rapidly approaches the earth, the light waves are squeezed together and made shorter. With light from a rapidly receding star the waves are spread out, and made longer. As it is the length of the wave that determines its color, or position in the spectrum, the light from an approaching star is bluer and from a receding one redder than if the star were standing still.

The spectroscope reveals a host of dark lines in the spectrum of a star, and by measuring the position of these as compared with the same lines in the spectrum of a light from an earthly source, the speed of the star can be determined. If the lines in the star spectrum are shifted to the red, it shows that the star is receding, but if they are shifted to the blue end, it shows an approach of the star. The amount of the shift indicates the speed.

Also Measures Sun's Rotation

This phenomen, called the Döppler-Fizeau effect, can also be used to measure rotation of such a body as the sun. By making spectrum photographs with the light from one side and then from the other side of the sun, the speeds of approach and recession of these sides can be measured and from them can be determined the rate of rotation.

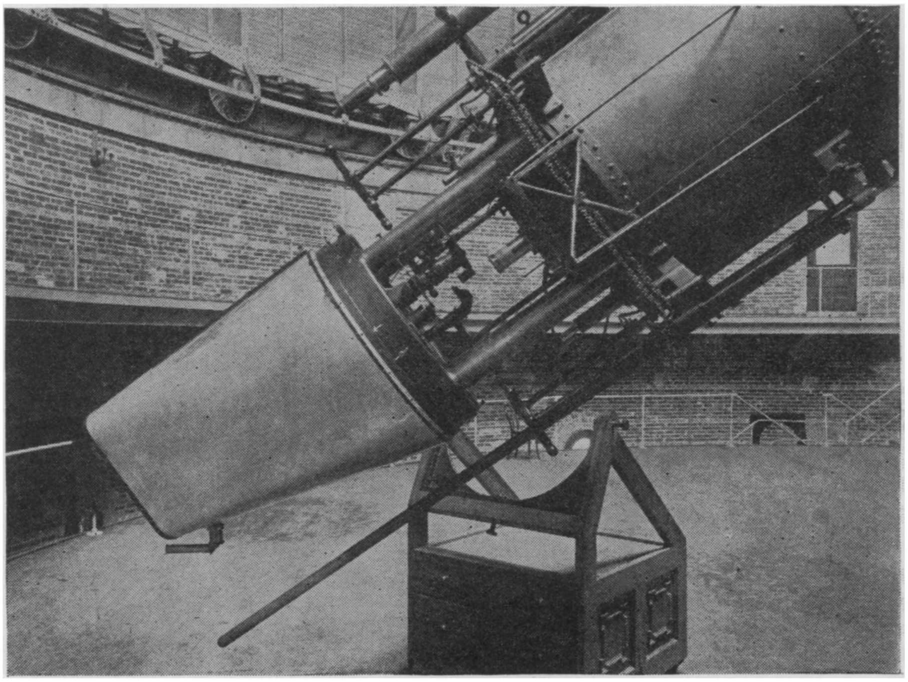
Though the stars are the same shape as the sun, they are all so far away that the closest present no appreciable disc, but seem like points of light, even with the largest telescopes. Consequently, it is impossible to isolate the light from one side by ordinary methods. Dr. Frank Schlesinger, now director of the Yale Observatory, but then at the Allegheny Observatory in Pittsburgh, found a way of doing it in 1909.

There is a certain class of stars called Algol variables, typified by the star Algol in the constellation of Perseus. These consist of two separate bodies, one bright and the other dark. In some, like Algol, the dark body periodically comes between us and the bright one, causing an eclipse and a diminution of light. Just before or just after the maximum eclipse, the light comes mainly from one side or the other of the bright body. Therefore, spectrum photographs made at these times show shifts of the lines, due to the rotation of the star.

Only a small proportion of the stars in the sky are Algol variables, and so this method is limited. But the method worked out by Drs. Shajn and Struve is applicable to any type of star, provided it is rotating with sufficient speed, and shows suitable spectral lines.

The light from a spinning star is made from a source that is both approaching and receding, and so the lines in the spectrum are really shifted both ways at once. The result is that a line which is dark and narrow in a stationary star would be fainter and wider in a turning one. Part of it would be displaced to one end of the spectrum and part to the other.

Mr. Elvey has measured what is called the "contour" of a line with the instrument known as the recording microphotometer. In this instrument the spectrum plate is moved in front of a narrow slit



The Bruce Spectrograph of the Yerkes Observatory attached to the 40-inch telescope, as used by Mr. Elvey. It analyzes the light of spinning stars to tell how fast they turn.

through which a light shines. An electrical arrangement measures the amount of light which gets through and makes an automatic record by a moving spot of light on a strip of photographic paper. A single sharp narrow line makes a deep notch in the line on the paper after development. But if the spectrum line is broad and faint, it makes a flat "bay," broad and shallow. The "contour" of the line refers to its shape when recorded by the micro-photometer. As the spectrum line of wave length 4481 due to ionized magnesium is ordinarily sharp and narrow, it is well adapted to such studies and was the one used by Mr. Elvey.

Of 59 stars that he has studied, the average surface speed is 60 kilometers (37 miles) a second. The sun, at its equator, turns only about 2 kilometers a second. Therefore if these stars are the same diameter as the sun, which is of about average size, they turn about thirty times as fast, or about once in 24 hours. The sun is about 865,000 miles in diameter and turns once in about 28 days. At the equator of the earth the speed is only about 400 meters, or about a quarter of a mile, a second, because of its much smaller size.

These speeds for the stars are conservative, because Mr. Elvey has made no consideration of the effect of darkening at the limb of the star. Most of the star's light comes from the center as it faces us, the region which is not approaching or receding. This makes the broadening of the spectrum line less than if the light came with equal intensity from all parts of the star.

One star studied by Drs. Shajn and Struve is turning even faster. It is known as W Ursae Majoris, and is in the Great Bear. Though about three quarters as large as the sun, or 650,000 miles in diameter, it turns once in a third of a day.

Science News-Letter, August 16, 1930

Fish Die in Water for Want of Air

Physiology

FISH dying in an abundance of water, because they were not getting enough of the air that is traditionally supposed to be fatal to them, have been the subjects of study in two German laboratories during the past few months.

The researches were prompted by the fact that great numbers of fish died of suffocation under the thick ice produced by last winter, which was unusually severe in Europe; and scientists wanted to know, for both practical and theoretical purposes, just how much oxygen has to be dissolved in water in order to sustain fish life.

Goldfish and carp became distressed and finally died when the oxygen in the water fell to a concentration of from four one-hundredths to one-tenth of one per cent. Whiting, perch, and several other species of fish showed signs of distress at one tenth of a per cent., and died when the concentration fell below eight one-hundredths of one per cent.

The requirements of trout, earlier experiments showed, are higher. This active fish can get along on water containing from five-tenths to eight-tenths of one per cent of oxygen, finds one third that much insufficient, and dies if the oxygen falls below that. Carp can live easily where trout find it suffocating, can endure what kills a trout, but finally die at the low figure of five one-hundredths of one per cent.

Tenacity of life under ordinary hardships does not seem to have anything to do with ability to withstand low oxygen rations. Observers noted last winter that eels, one of the hardest-to-kill of all fish, were the first to suffocate when thick ice cut off the air supply from their water.

Science News-Letter August 16, 1930

Parks for England

THE preservation of natural beauty in England by the transfer of large parks, at present owned privately, to public ownership is advocated by S. K. Ratcliffe in a report to the Royal Society of Arts.

The expansion of cities, and the changing system of land ownership which is reducing the amount of land held by single individuals, is increasing the need for a national park policy in that country if any large stretches of country are to be preserved for the future in their present state. The American national parks were cited as models, but Mr. Ratcliffe proposed that the national parks in England should be barred to motor cars.

National Parks

Science News-Letter, August 16, 1930

Million Volt Globe

THE shiny metal globe which the front cover pictures was spun on a lathe from two flat sheets of copper one-eighth inch thick. It will be used with another by the Westinghouse Electric and Manufacturing Company to measure man-made lightning of 2,000,000 volts and greater.

When high potentials are measured by sphere spark gaps the distance between the spheres must not be greater than their diameters if the measurements are to be accurate, it has been found. One hundred centimeter, 39.3-inch diameter, spheres had been made to measure one million volts. This one is 150 centimeters, 59.16 inches, in diameter.

The old spheres were turned from cast brass and were heavy and expensive. The new one is simply made and weighs little more than 400 pounds. The flat metal was spun against a huge hemispherical wooden form. Two hemispheres of copper were made and soldered together. So accurate are they that their diameters differ by less than one-tenth inch.

Electrical Engineering

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Up from New Mexico

THE small town of Roswell, New Mexico, will soon be the scene of preparations for one of the most spectacular and also the most important scientific experiments ever performed. Prof. R. H. Goddard, of Clark University, famous authority on rockets as a means of exploring the upper atmosphere, has gone to Roswell and has announced that he will make his future experiments from that region. The favorable climate, the nature of the country and the clear air were the chief factors that induced him to select the site.

A grant from the Guggenheims recently made to Prof. Goddard, will permit him to continue his experiments on a much larger scale than in the past. Camp Devens, Mass., near Worcester, his home, had been selected before, but the New Mexico location will now be used instead. Prof. Goddard emphasized that the preliminaries would take considerable time, and that it is impossible at present to state when he will start shooting actual rockets into the air.

Astronautics

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