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ASTRONOMY

Astronomers Told of Comet's Wandering

HOW SKJELLERUP'S COMET APPEARED through the telescope of the Lowell Observatory on December 16, 1927. *From a drawing by E. C. Slipher*

On this page James Stokley reports on the interesting papers presented at the meeting of the American Astronomical Society. This was held at Yale University, December 29 and 30.

People who expected the Skjellerup comet to be a bright object in the western evening sky will be disappointed. The comet has turned around and is moving back again to the southern sky. This is shown by observations made at the Wellesley College Observatory by Prof. John C. Duncan, and announced at the meeting.

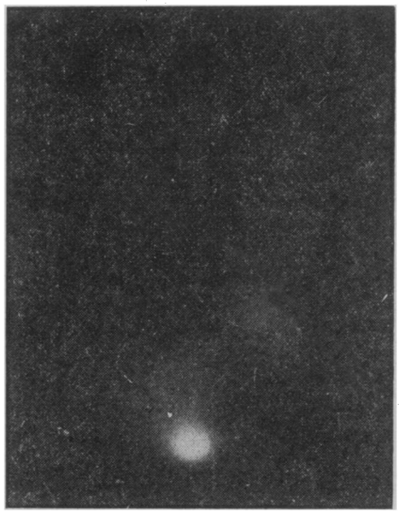
Professor Duncan had been observing the comet for several days with his telescope, and on Christmas he was surprised to find that it was south of the place where he had seen it on Thursday previous. According to the expectations of astronomers, it should have continued in its northerly motion. On Tuesday, December 27, he saw it again still farther south, confirming his Yuletide observation. Since the comet is rapidly getting fainter, it is unlikely that it will be observed with the naked eye again.

The astronomers saw what it looked like in a photograph made at the Lowell Observatory in Arizona. This, the first photograph to be made of this heavenly wanderer, was sent to the meeting by Dr. V. M. Slipher, director of the Arizona institution. Though only a white spot on a gray background, the photograph was received with applause because it had been made when the object was very close to the sun, which made pictures of it extremely difficult.

In the paper by Dr. Slipher details were given of observations of the comet by analyzing its light through the spectroscope. When first seen from there, on Friday, December 16, the spectrum revealed its light to be principally reflected sunlight, but in the next few days there appeared strong bands which indicated the presence of the element sodium, one of the two constituents of table salt. A peculiarity of these sodium bands was that they appeared not only in the light from the comet's nucleus, but also a long distance from it. These spectrum photographs also showed that it was moving away from the earth at a speed of nearly 60 miles a second.

Brilliant Fireball

Comets were but one of many papers presented to the meeting. Dr. C. P. Olivier, of the University of Virginia, told of a fireball that had been observed last summer in North Carolina. This is a very brilliant shooting star. As the result of observations made by a number of laymen and communicated to Dr. Olivier, he has found that this fireball was about 76 miles above the surface of the earth when first seen, that its path was about 116 miles long and that it vanished at a height of 18 miles traveling with a speed of 17 miles a second. As it appeared in such a position that it overtook the earth as it sped along in its own orbit, its real speed must have been considerably greater he said.



SKJELLERUP'S COMET photographed by E. C. Slipher of the Lowell Observatory on December 16, 1927. *Made when the comet was within five degrees of the sun, this represents one of the most difficult astronomcal photographs ever attempted*

Eclipse Coming

If you missed seeing the eclipse of the sun visible in New England on January 24, 1925, you only need wait until 1932 for another chance. What is better, you can combine it with your vacation for this eclipse will happen on August 31, 1932. The path of totality, in which the moon will completely cover the sun and the corona which surrounds it will flash out in all its glory, crosses the White Mountains of New Hampshire, Miss Caroline Furness, of Vassar College, stated.

The exact path of this eclipse, the next to be seen in the United States, has just been worked out by Dr. L. J. Comrie, of the British Nautical Almanac Office, in London. It was presented at the meeting of the American Astronomical Society. Pre-

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Astronomical Meeting

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vious determinations of the track, he stated, are much in error. The path in which the eclipse will be seen as total, as given in a famous work by Oppolzer, an Austrian astronomer, and known as the "Canon of Eclipses," is much farther north than it will actually be, said Dr. Comrie. A later determination by an American astronomer is also in error, it was stated. Dr. Comrie's more accurate figures were made possible by the recent "Tables of the Moon," by Prof. Ernest W. Brown, of Yale University.

"Roughly speaking" says Dr. Comrie, "the eclipse occurs at 3:30 p. m., local time, lasts 100 seconds, the sun being 30 degrees high, and the track 100 miles wide. The central line runs from Pierreville, Quebec, to Biddeford, Maine. At points along this line the eclipse will have the longest duration. The southern limit of the area in which the eclipse will be seen as total runs from Montreal to Salem, Mass., and the northern limit from St. Jean des Chaillons, Quebec, to Richmond, Maine. The central line passes over the White Mountains, which will probably provide some good observing sites."

Three Rivers and Sherbrooke, Quebec; Portland, Maine, and Portsmouth, N. H., are all well within the path, and should have a good view of the eclipse. Montreal will be just on the edge, as was New York at the time of the eclipse in January, 1925, so that probably people in one part of the city will have a total eclipse, with the sun's corona flashing out for an instant. In the western part of the city, however, there will probably be seen the "diamond ring" effect, observed in lower New York in 1925, when a bit of the sun's edge constantly remained visible. Boston is sufficiently far away from the path that even this will probably be absent, and all they will see will be a very large partial eclipse, with a crescent of the sun constantly in view. At points farther away, a still smaller partial eclipse will be seen, with a larger crescent of sunlight remaining in view.

Can Count Atoms

Prof. Henry Norris Russell furnished one of the most important papers from a scientific viewpoint that had been presented to the meeting when he told of the recent work he has been doing at the Mt. Wilson Observatory. He is also a research associate of the Carnegie Institution, which operates it, and his work was done in cooperation with Dr. Walter S. Adams, the director.

The important effects of this work, stated Prof. Russell, are that it is now possible for astronomers to determine the relative number of atoms involved in causing the lines that appear in spectrum photographs of the sun and stars. These lines that appear when the light is passed through the prisms of a spectroscope, have long enabled astronomers to determine the chemical elements in the stars. Strong lines like the yellow one due to sodium and known as the D line, may require a hundred thousand times the number of atoms that give rise to the faintest lines observed, he stated.

With the great spectrograph attached to the 100-inch telescope of the Mt. Wilson Observatory, the largest in the world, these principles have been applied to the stars. This permits an actual confirmation of theories about the stars' atmosphere. He has found for instance, as previously suspected, that the number of atoms in the excited states in hot stars like the sun is greater than in cooler stars like Arcturus or Betelgeuse.

The third important result, he stated, is that the total quantity of material in the atmosphere of a star, that is in the part above the visible

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Astronomical Meeting

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surface, can be determined. In a star such as Betelgeuse the bright northern member of the Constellation of Orion, which now shines in the southeastern evening sky, there is two hundred times as much stuff as in the sun's atmosphere. And as this atmosphere is much less than that of the sun, it must be much deeper, perhaps many hundreds of thousands of miles. There is also evidence that the chromosphere, the outer layer of the star, is much more extensive in these giant stars than in the sun.

Einstein Substantiated

Another objection to the validity of Einstein's theory of relativity was effectually disposed of when Dr. Ross W. Marriott told of measurements made by him and Dr. John A. Miller of the moon's diameter during a total eclipse of the sun. Einstein predicted that light from a distant star, when passing close to the sun, would be bent slightly towards it. Stars near the sun can only be photographed when its brilliance is obscured by the moon coming in front of it, as in a total eclipse. Photographs made at various eclipses have shown that the stars near the sun actually were closer together than would have been expected.

A few years ago Dr. Charles Lane Poor, of Columbia University, made the suggestion that this was caused by the star's light entering the cool shadow of the moon in the atmosphere of the earth. He suggested that this could be checked by measuring the diameter of the moon during an eclipse as compared with its diameter at other times, if it was due to such a cause the moon would be similarly effected. After a long series of measurements, Drs. Marriott and Miller have found the moon's diameter during an eclipse to be precisely the same as at other times, thus substantiating Einstein.

Elected Honorary Member

One of the world's champion discoverers of comets and tiny planets was honored by the society when they elected Dr. Max Wolf, of Heidelberg, Germany, to honorary membership. Only foreign astronomers of great eminence are thus honored by the society.

House Bought with Comets

How the "greatest astronomical observer of his generation," as the late Edward Emerson Barnard is con-

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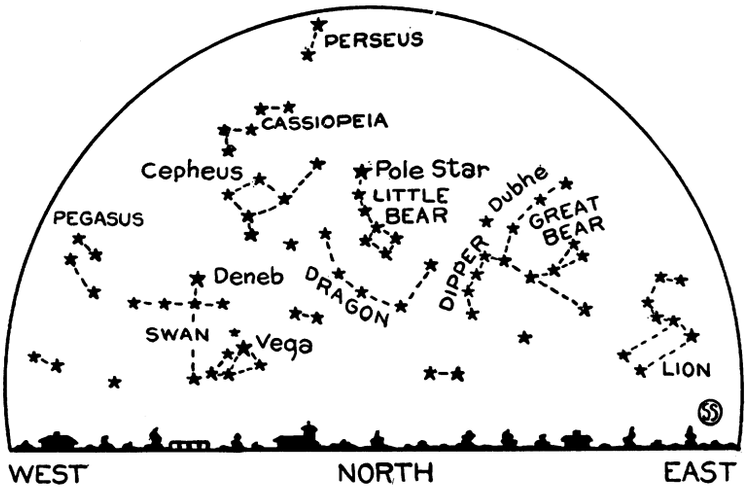
Dog Star Has Many Claims to Fame



By James Stokley

The nearest naked eye star ordinarily seen from the United States; the brightest of all the stars, except the sun; a star with a close satellite made of the densest known stuff in the universe; the star which to the ancient Egyptians foretold the annual inundation of the Nile and the star which has provided important evidence in favor of the validity of the theory of relativity—any one of these things would seem to make a star of some interest.

But it happens that all this is true of one star, and a star that is now with us in the evening sky. Go outside tonight, if it is clear, and look over to the southeast. The brightest star there is Sirius, the "dog star," that has all these claims to fame.

Is Nearest Star

There are two other stars which rise above the horizon for people in the United States, and which are nearer than Sirius, but they are too faint to be seen except with a telescope. One of these is called Lalande 21185, after its number in Lalande's star catalog. It is in the constellation of Leo Minor. The other, known as Barnard's proper motion star, because of its extremely great speed across the heavens, is in the constellation of Ophiuchus, the Serpent Bearer. Perhaps there are one or two other faint stars as close, which have not yet been identified.

However, at present we are concerned with Sirius. Measured in the popular measuring stick of the astronomer, it is 8.67 light years from us.

It is principally on account of its closeness that Sirius appears so bright to us, for it would appear only 26 times as brilliant as the sun, if both could be viewed from the same distance.

In recent years, the so-called "companion of Sirius" has claimed a large amount of attention in the astronomical world, even though it

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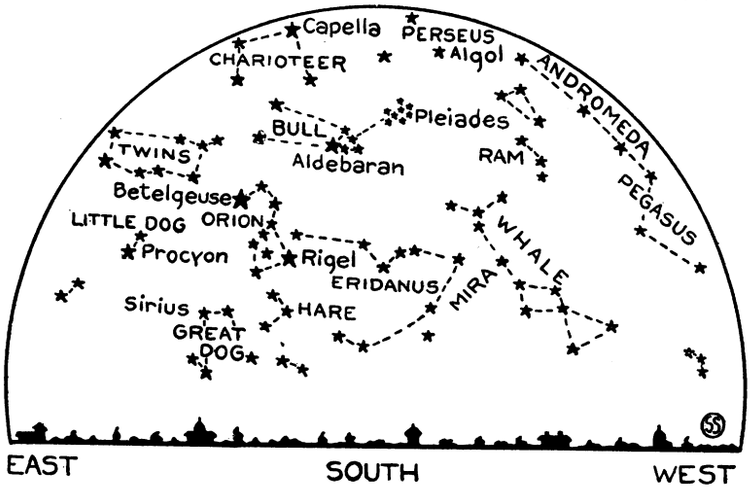

HOLD THESE MAPS in front of you and they portray the northern or southern evening sky in January

Dog Star Has Claims to Fame

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is so faint that a large telescope is required to reveal it. It was over 75 years ago that the presence of such a companion was found though not for some years later was it actually seen.

Influenced by Gravity

When two heavenly bodies, no matter how far distant, revolve around each other, they do so under the same influence of gravitation that pulls a stone to the earth. And just as the military engineer, for example, can calculate the exact way in which gravitation affects the projectile from a big gun, the astronomer can calculate the influence of gravitation between these two stars, far out in space. He can see the paths they take. From this he can figure out the mass of each. And when he does, he finds the curious fact that though the faint companion of Sirius is only 1/10,000 as bright as its big brother, it is two-fifths as massive.

One of the latest chapters in the history of the companion of Sirius has been written within the past few years. It seemed, theoretically, as if the companion should be exceedingly dense, far more than lead or mercury or other dense terrestrial elements. The density of a substance depends on its mass and volume—the mass was known, but with a body as small and as distant as this, there is little hope for measuring the diameter, and hence the volume.

Einstein's Answer

Here the theory of relativity appears in the picture. If light waves start from a body in which gravitation is very strong, because of great density, they should be slowed a little by the pull in leaving. If the light from such a dense glowing body is broken up into the colored spectrum by a spectroscope, the lines which cross it should be a bit nearer the red end than in the light from a similar glowing body on the earth. Such a shift, though very small, was found in the light from the sun. In a very dense star, such as the companion appeared to be, it should be perhaps twenty or thirty times as great.

With the 100 inch Mt. Wilson telescope, the largest in the world, Dr. Walter S. Adams succeeded in photographing the spectrum of the companion, in itself a difficult procedure. In these photographs the shift was very close to that predicted by Einstein's theory. It showed the diameter of the star to be about a thirtieth that of the sun, or about 30,000 miles. Thus was furnished at the same time strong evidence in favor of the relativity theory, as well as in favor of the theory of the stars. In other words, as has been said, it was a case of killing two birds with Einstein.

Densest in Universe

Its diameter so small, and its mass so great, the density of the companion is inconceivably great. A pint of water weighs about a pound, according to the old proverb; a pint of lead about eleven and a half pounds, a pint of mercury about 14 pounds, but a pint of the stuff of which the companion is made, if we could obtain it, would weigh about 25 tons!

Professor A. S. Eddington, of Cambridge University, has shown how this can be possible. According to his ideas, the atoms in the star are broken up. Ordinary atoms are supposed to consist of a structure similar to the solar system, with a "proton" taking the place of the sun, and electrons of the planets which revolve around it. Thus there is a limit to the closeness with which they can be crowded together, and the density of ordinary matter. But in the companion of Sirius the atoms are undoubtedly greatly ionized, which means that most of the outer planets of the atomic system are loose, and floating around freely. The remaining central part is so much smaller than the original atom that far more can be crowded together, and such great densities can be attained. But as yet there seems to be no way of imitating this process on the earth, and we cannot hope to have paper weights made of the stuff.

Other Stars

So when you see Sirius tonight blazing in the southern sky, remember that there is more to it than appears to the naked eye. Above Sirius and to the east is its neighbor, Procyon, in the Little Dog, and which is also accompanied by a dense companion. The constellation of Orion shines to the west of Sirius, while overhead is Capella. The heavenly twins, Castor and Pollux, appear below to the southeast. Over in the east is Regulus, at the bottom of the handle of the sickle, part of Leo, the lion. No planets are visible in the evening sky this month, though Venus is still in the eastern sky before sunrise.

Bought House with Comets

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sidered, once bought a house in Nashville by discovering comets was described by Dr. R. G. Aitken. Dr. Aitken, who is in charge of the Lick Observatory of the University af California, delivered an address as retiring vice-president of the astronomical section of the American Association.

Taking Dr. Barnard, who was a native of Nashville, and whose astronomical career largely began at the previous meetings of the Association at Nashville in 1877, as the subject of his address, Dr. Aitken related many personal reminiscences.

"On September 17, 1881, he found a comet," said Dr. Aitken, "and he sent word of the discovery to Lewis Swift, and through him to astronomers generally. This comet was therefore carefully observed and is known, in the annals, as Comet 1881 VI. This discovery had important consequences quite other than its bearing upon his reputation as an observer. Mr. H. H. Warner of Rochester, New York, had offered a prize of $200 for each unexpected comet discovered by an American observer. This prize came to Barnard for the discovery of Comet 1881 VI; Mrs. Barnard felt that the money must be used for some definite purpose, and with her encouragement, and faith that later payments would be met 'somehow,' and that they would 'manage,' it was accordingly used as the first payment for a house. Faith backed by hard work had its due reward, for Mr. Warner's offer was continued for several years, and Barnard actually won enough prizes for cometary discoveries to pay for the 'Comet House,' as it is still known here in Nashville and to all astronomers."

Upon the founding of the Lick Observatory in 1887 Barnard, then at the age of 30, joined its staff. Later he went to the Yerkes Observatory, in Wisconsin. Among the many important discoveries which he made, said Dr. Aitken, were those of the fastest moving known star, and also the second closest, the first moon of Jupiter to be found since 1610, the "Gegenschein" or faint glow of light that appears in the sky opposite the sun, as well as numerous comets and double stars. As a great astronomer, concluded Dr. Aitken, Barnard was "honored by astronomers throughout the world. Barnard, the modest, simple-minded, unselfish, kindly man was loved by everyone who knew him."