HEAVENS

THE HEAVENS

Monthly Record of the Stars, Planets, and Astronomical Events

No. 1 LOS ANGELES, APRIL, 1916 $1.00 per Year

THE HEAVENS

Edited by
WILLIAM H. KNIGHT
621 Witmer St.

Published by
T. L. O'BRIEN
684 Kip St. 55191 and Bdwy. 8173

THE ASTRONOMICAL SOCIETY OF LOS ANGELES

Meets at the Los Angeles High School, North Hill Street, on the second and fourth Tuesdays evenings of each month, except July and August. Annual Dues $1.00.

FOREWORD

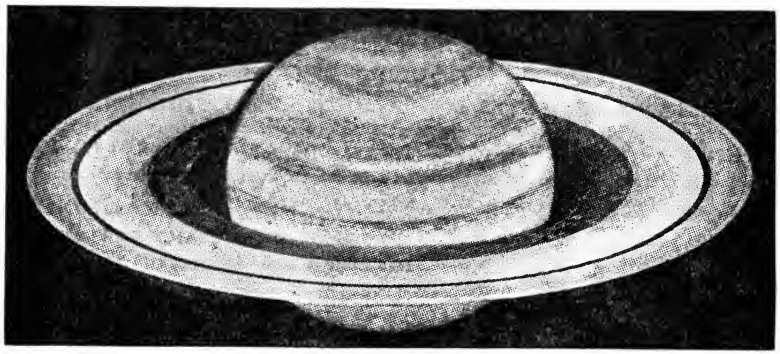
Great interest has been stimulated at the well-attended meetings of the Astronomical Society, now in the fourth year of its existence, in the noble science which deals with the heavenly bodies. As eager inquiries are constantly being made regarding current astronomical events and the work of the Society, it has been deemed best to publish a monthly Bulletin, giving in simple language for the comprehension of the intelligent but untechnical reader, an explanation of planetary phases and other information regarding the stars in our evening skies, and also announcing future events at our semi-monthly meetings and occasional astronomical excursions.

The Constellations for April

In this longitude, 119 degrees west of Greenwich, the Giant Hunter, Belted Orion, with a quadrilateral of bright stars in his shoulders and feet, and three stars of the second magnitude in his Belt, and the great Nebula of Orion in his flashing Sword, still holds the field in the early evening. To the northeast is the zodiacal constellation of Gemini with two bright stars, Castor and Pollux, locating the heads of the respective Twins. Castor is a fine double star, easily separated in a telescope of moderate power. The two components are large suns of unknown magnitude and revolve round their common center of gravity in a period of about 350 years. What is surprising is that each of these components is a spectroscopic double of very short period—a few days—thus making the great star Castor an interesting quadruple system.

Saturn and Its Wonderful Rings

To the west of Gemini and midway between it and the constellation Taurus is the great yellow planet Saturn, surrounded by its gem-like rings. Its distance from the sun is 886,000,000 miles and its time of revolution round that body is about 29½ years. It is 73,000 miles in diameter, being 760 times larger than the earth, and larger than all the other planets of the solar system together, excepting only Jupiter. The planet is believed to be still in a hot condition and enveloped in an atmosphere of vapor hundreds of miles in depth. It turns on its axis in 10½ hours, consequently its day is but a little more than five hours in length. This great planet is surrounded by two enormous rings, 27,000 miles in breadth and 60 miles in thickness. They are now in a very favorable position and shine like burnished gold. The rings are probably composed of small meteoric bodies, so close together that the rings seem to be solid, but each of these small bodies is moving in an independent orbit, and those nearest the planet are moving much faster



THE GREAT PLANET SATURN AND ITS RINGS

than those farthest away. Inside the nearest bright ring is a dark or "crepe ring," semi-transparent, and possibly disintegrating and gradually falling upon the surface of the planet.

Saturn's Many Satellites

Ten satellites, or moons, are circling round this great planet, thus giving it the character of a miniature solar system. The nearest, Mimas, completes its swift revolution round its primary in 23 hours. The largest, Titan, is 3,500 miles in diameter, (the largest satellite in the solar system), is 750,000 miles distant, three times the distance of our moon from the earth, but completes its journey in 16 days. The farthest, Phoebe, is very small, probably not over 100 miles in diameter and requires about two years to complete its long journey. Its motion is retrograde, or contrary to that of the other satellites and the planets. On account of their great distance from the earth only three or four of these satellites are visible in the Lowe telescope.

The Contellations Leo and Cancer

To the east of Gemini is the constellation Cancer within which is the beautiful star cluster, Praesepe, the central star of which is double. East of Cancer is Leo, containing the bright star Regulus which is at the end of the handle of the famous group known as the Sickle. The third star from Regulus is Gemma Leonis—a double star whose two components show in the telescope the complementary colors of blue and yellow.

The Red Planet Mars

Midway between Leo and Cancer is the planet named for the god of war. It presents a large round brownish disc in the telescope and shows one of the polar snowcaps to advantage. Its peculiar markings, sometimes denominated "canals," can only be discerned in large telescopes located in high altitudes. Mars is the next planet beyond the earth's orbit and is 141,000,000 miles from the sun. Its diurnal rotation is 24½ hours and its period of revolution round the sun is 687 days, or a little more than one year and ten months. Mars is attended by two very small satellites, not more than 15 or 20 miles in diameter. They can only be seen by the aid of very powerful telescopes. Some astronomers believe that Mars is inhabited by intelligent beings, and that the so-called canals are broad zones of verdure irrigated by watercourses connected with the melting snows of their polar regions.

Venus Now at Its Brightest

This brilliant evening star is now at the acme of its glory. Good eyes can see it in broad daylight. In March it presented the appearance of a half moon. It is now beginning

to assume the shape of a scescent. As it returns towards the sun the crescent will continually grow more slender till the planet disappears entirely from view. Venus is a sister planet nearly as large as the earth and when between us and the sun is only 26,000,000 miles distant. It is surrounded by a thick atmosphere of vapor so that the body of the planet can never be seen. It is 67,000,000 miles from the sun and its period of revolution round that body is 224 days, and it moves at the rate of 21 miles per second in its orbit.

HISTORY AND WORK OF THE ASTRONOMICAL SOCIETY

A little over three years ago two bright young men—Prof. Charles C. Kelso of the Los Angeles High School, formerly with Dr. Washington Gladden of Columbus, Ohio, and Mr. Thomas P. Smith, an enterprising business man of this city, both

LOWE OBSERVATORY

ardent students of astronomy, organized the "Astronomy Club" with Miss Clare Germain, a lady of culture and extensive foreign travel as president. A large class room with black-boards and electric current for lantern slides was kindly tendered for the use of the club by the high school management. The club grew and flourished and semi-monthly sessions have been held since its inception.

Lectures on astronomical and scientific topics have been given by Mr. B. R. Baumgardt, speaker of national fame; Dr. Frank P. Brackett, Director of the Pomona College Observatory; Prof. Melville Dozier, Deputy Superintendent of Public Schools; Mr. S. J. Keese, physicist of the Academy of Sciences; William H. Knight, Former President of the Academy of Sciences; Prof. Edgar L. Larkin, Director of the Lowe Observatory; Rev. Ralph B. Larkin, on Radio-Activity; Mr. W. Scott Lewis, student of astronomy; Mr. William A. Spalding, former President of the Academy of Sciences; Dr. Charles E. St. John, of the Mount Wilson Solar Observatory and Prof. D. S. Swan, of the Los Angeles High School.

From time to time astronomical excursions have been made to the Lowe Observatory, to the Mount Wilson Solar Observatory, to the Carnegie Laboratory of the Solar Observatory at Pasadena, and to Mount Hollywood at the summit of Griffith Park. Others are contemplated in the near future.

At the beginnig of the year the name of the organization was changed to its present title—"Astronomical Society of Los Angeles."

The Giant Sun Canopus

Almost directly south of Sirius, about six degrees above the southern horizon, is the remarkable star Canopus, which, next to Sirius, shines in the skies of the southern hemisphere with a splendor exceeding that of any other of the so-called fixed stars. It belongs to the constellation Argo Navis and is not visible in any of the observatories of Europe or America except those located in Southern California, and then only when Orion is near the Meridian. Its brightness, like that of the sun when near the horizon, is dimmed because we view it through a stratum of dense atmosphere. Its parallax has not been determined but it cannot be less than 500 light years distant, and in magnitude it may exceed the sun 50,000 times.

OFFICERS OF THE ASTRONOMICAL SOCIETY

William H. Knight ..... President
Miss Clare Germain ..... Past President
Mrs. Ita Dennison ..... Treasurer
Chas. C. Kelso ..... Chairman Finance Committee
Mars Baumgardt ..... Chairman Program Committee
Thomas P. Smith ..... Chairman Executive Committee
852 South Figueroa St.

T. L. O'Brien ..... Secretary
684 Kip St. Phones: 55191 and Broadway 8173

Tuesday, April 11th, 8 p. m.

Address by Mr. William A. Spalding, on "The Period of Sunspot Maxima Now Approaching—Are Suns and Planets Great Dynamos Mutually Influencing Each Other, and Affecting Climatic Conditions on the Earth?"

The Astronomical Society of Los Angeles meets at 8 p. m. on the second and fourth Tuesday of each month, at the L. A. High School. All meetings are open to the public.

ASTRONOMICAL EXCURSION BULLETIN

Direction of T. L. O'Brien, 684 Kip St.,
Phones Broadway 8173, Home 55191 LOS ANGELES

ASTRONOMICAL EXCURSION AND BASKET PICNIC TO MT. LOWE OBSERVATORY AND ALPINE TAVERN

SATURDAY, APRIL 22nd

The Excursion will leave the P. E. Station, Sixth and Main Streets, at 9 a. m. on Saturday, April 22nd, reaching Alpine Tavern at 11 a. m. The return trip will start at 5 p. m. from Alpine Tavern, stopping at the Lowe Observatory, view the Sun set in the Pacific Ocean, and then, gathering round the great telescope, observe the wonders of the Heavens. Prof. Edgar L. Larkin will preside.

Reduced Excursion fare for the round trip, $1.75, includes stop-over privilege of one day. (Tickets good going on any regular car same day.)

The party will arrive home about 9:45 p. m.

A special identification badge will be provided each member of the party to insure admission to the observatory.

Tickets are now on sale at Wells Fargo & Co. Express, 609-611 South Main Street, directly across the street from the Pacific Electric Station, or can be secured from T. L. O'Brien.

EASTER SUNRISE PARTY NOTICE

Several members of the Astronomical party will take advantage of the stop over privilege of their tickets and form an Easter Sunrise Party on the summit of Mt. Lowe which is over 6000 feet above sealevel.

Parties leaving on the 1:30 and 4:00 p. m| cars will arrive at the Lowe Observatory in time to join the homeward bound Astronomical Party and there view the Heavenly Bodies together and then complete the trip to Alpine Tavern where the stop is made for the night.

To insure hotel accommodations reservations should be made at the earliest possible date.

For further information see T. L. O'Brien.

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Thereon was figured earth and sky and sea,
The ever circling sun and full orbed moon,
And all the signs that crown the vault of heaven—
Pleiads and Hyads. and Orion's might,
And Arctos, called the Wain.
—Homer.

WHY STUDY ASTRONOMY?

By Harold Jacoby, Professor of Astronomy at Columbia University

The question is often asked: Why is it desirable to study astronomy? Would it not be better to devote our time to something less abstruse, less far away—in short. to something practical that we can use in our everyday life? There must exist a good answer to this question, just as there must be a reason why students of early human records accept the state of astronomical knowledge as a touchstone by which to test the intellectual development of ancient peoples.

What is there, then, about astronomy distinguishing that science among all branches of human learning? On the one hand it makes an appeal to the imagination, almost invariably irresistible; for no mind remains unaffected by the vastness inseparable from the heavens. This gives us a poetry of the stars, attractive above and beyond the science itself. Joined to this again is another characteristic still more important. The problems of astronomy are the most intricate known to the intellect of man, and yet they are the ones permitting the most exact solutions. Astronomy has been rightly called the "perfect science"; but its perfection does not consist in completeness of knowledge. It i not that our information is all gathered in, that no chance of further success tempts men on to new fields of research, but that the harvest we hope to gain in the future, like those garnered in the past, will be quite perfect of its kind.

It is a singular thing, then, that astronomy, though a leader among the more abstruse sciences, should, nevertheless, be one that comes nearest the people in their daily life. For it is to astronomy that we owe the possibility of regulating time and navigating ships. Without the results of observatory work we could neither guide vessels across the ocean nor adjust the time pieces used in our everyday affairs.

THE PLANETS FOR MAY

Mercury is now an evening star and will reach its greatest eastern elongation, 22 degrees from the sun, on May 12. It will then be in Taurus and will be visible for an hour and a

half after sunset. It is a reddish planet and euqal in brightness to a star of the first magnitude. The only prominent star near the sun.

Venus continues an evening star throughout the months of May and June. On April 23 it was at its greatest eastern elongation, 45 degrees from the sun. On May 23 it will be in conjunction with Saturn, in the constellation Gemini, but the two planets will be 3½ degrees apart. It will increase in brilliancy till May 27th, from which date it will begin to wane.

Mars, now in the constellation Gemini, will move eastward and enter Leo, passing the first magnitude star Regulus on May 24th. It will then be within one degree of that star and will be a fine sight.

Saturn will be visible during the months of May and June, advancing slowly eastward through Gemini towards Cancer.

Jupiter is now a bright morning star.

HISTORY OF THE LOWE OBSERVATORY

(From an article published in the Scientific American October 13, 1894)

Owing to advancing years and failing eyesight Dr. Swift resigned as director in 1902 and returned to the East, and in 1913 died at the home of his boyhood in Central New York at the ripe age of 92.

He was succeeded by the present learned and popular astronomer Prof. Edgar L. Larkin, to whom the stars have been a study of absorbing interest for forty years.

"A new astronomical observatory has been established in Southern California by Professor T. S. C. Lowe, the projector, builder, and president of the Mount Lowe Railway, an illustrated description of which was published in our issue of February 3, 1894. Its location is seven miles by rail north of Pasadena and sixteen miles northeast of Los Angeles, the rapidly growing metropolis of the Southwest.

"The new observatory is well euipped with the great 16 inch Clark refractor and other instruments, which have done notable work in the Warner Observatory at Rochester, under the directorship of the eminent astronomer Dr. Lewis Swift. The buildings consist of a central tower 32 feet in diameter, surmounted by a light dome, and two unequal wings—the smaller containing a dark room for photographic work and the larger furnished with cases for the extensive astronomical library of reference gathered by Dr. Swift in the course of his professional career. A large platform in front will have ample room to manipulate the comet seeker, and to accommodate the throngs of visitors who will claim his attention on stated occasions.

".The Sierra Madre Mountains, upon which the Lowe Observatory is located, have an east and west trend, and rise abruptly from the San Gabriel Valley on the south to an altitude exceeding 6,000 feet above sea level. The observatory is built upon a southern spur of these mountains, about 150 feet higher than the Echo Mountain House, reached by the Mount Lowe Railway, and half a mile west of it. Its altitude is about 3,600 feet above the sea and 2,000 feet above the foot hill mesa at the base of the base of the mountains, which are very steep at this point. While the crest of the range rises high above the observatory and shelters it on the north, leaving, however, the north star visible, the entire southern horizon is unobstructed, extending to the rim of a large segment of the Pacific Ocean, about 100 miles distant on the south and west. Astronomically it is nearly at the intersection of 34th parallel of north latitude with the 118th meridian of longitude west of Greenwich. This very low latitude combined with a high altitude, gives Dr. Swift a zone

of the celestial sphere ten degrees wide not visible from his Rochester Observatory, and his longitude enables him to observe celestial objects three hours after they are below the horizon at the Harvard Observatory.

"Besides the ten degrees of south latitude at the Lowe Observatory not commanded by Dr. Swift at Rochester, he now posseses other advantages which must be fruitful of important scientific results. The large proportion of clear nights will enable him to make continuous and uninterrupted observations. When a new discovery is made, whether a comet, an asteroid, a nebula, or a new star blazing forth from the depths of space, he will be able to follow it night after night with telescope and spectroscope and camera, and catch and hold the celestial object in all its varying phases and motions.

"But besides an unclouded sky, there is a peculiar clearness in the atmosphere.

"Three-fourths of a mile of the densest portion of the atmosphere, with its dust, fog, haze, and other impurities, is below the observatory and Dr. Swift is able to use much higher powers on his instruments at all times than he could under the most favorable conditions at Rochester, thus vastly increasing the efficiency of their use.

"Dr. Swift has been the recipient of many distinguished honors from eminent institutions in Americ and Europe. Three gold medals were awarded by the Imperal Academy of Science at Vienna for comet discoveries in 1877, 1878, and 1879. The Lalande prize, valued at 500 francs, and a silver medal were given by the French Academy of Sciences in recognition of the rapidity of his astronomical discoveries in 1881. The bronze medal of the Astronomical Society of the Pacific was awarded for the discovery of the famous many-tailed comet of 1892.

"But brilliant as are his achievements in the discovery of comets, they are almost insignificant when compared with the work accomplished in an entirely different field of investigation. Dr. Swift has discovered and catalogued more nebulae than any other living astronomer. The number of these faint, elusive, tantalizing, and highly interesting objects first detected and accurately described by him now reaches the surprising total of 960. Only the two Herschels, father and son, surpass this record. Sir William began his researches more than a century ago, and Sir John had the advantage of several years' residence in South Africa, thus placing the entire southern hemisphere under his scrutiny.

Wm. H. Knight.

"Los Angeles, August 28, 1894."

THE MOUNT WILSON SOLAR OBSERVATORY

From an interview with Dr. Walter S. Adams, Assistant Director of the Mount Wilson Observatory, we learn that the large circular building which is to house the great 100-inch reflector, is nearly finished, and the heaviest castings for the telescope, one of which weighs nine tons, are now in place. But the mirror will not be ready to be set in its elaobrate mounting till the early part of the year 1917. The delicate work of grinding and polishing the immense concave surface has been a very laborious task, bue is being successfully accomplished by Prof. G. W. Ritchey, who produced the flawless surface of the great 60-inch reflector, by means of which unrivalled research work has been accomplished during the past six years. What may be not expect when the 100-inch reflector is installed next year? Will it give us glimpses of other universes beyond the confines of the vast sidereal system which we have been studying?

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Miss Clare Germain .....Past President
Mrs. Ita Dennison .....Treasurer
Thomas P. Smith, 852 S. Figueroa St.....Chairman Executive Committee
Mars Baumgardt, 626 W. 30th St.....Chairman Program Committee
T. L. O'Brien, 684 Kip St. (Home 55191, Bdwy. 8173).....Secretary

MEETINGS OF THE ASTRONOMICAL SOCIETY

Tuesday, May 9—Mr. W. Scott Lewis will address the Society. His subject: "The Ice Age; Various Theories Regarding the Formation and Disappearance of the Great Polar Ice-cap Many Thousands of Years Ago." Los Angeles High School at 8 p. m. sharp.

Tuesday, May 16—Observation Night, Los Angeles High School.

Tuesday, May 23—Lecture by Mr. W. C. Schoelkopf. Subject: "Astronomical and Scientific Measures of Time; Referring to Siderial, Solar, and Standard Time, and Human Devices for Measuring Same." Meeting at the L. A. High School at 8 p. m. sharp.

Tuesday, May 30—Observation Night, Los Angeles High School.

Tuesday, June 13—Lecture by Dr. C. C. Kiess, Assistant Director of the Brackett Observatory at Pomona College. Subject: "Variable Stars; the Algol Eclipsing and Other Types." At the Los Angeles High School, at 8 p. m. sharp.

Tuesday, June 27—Lecture by Mr. Waddy, an English gentleman. Subject will be announced later.

A special meeting of the Astronomical Society will be held at the Auditorium of the Polytechnic High School, Wednesday, May 17th, at 8 p. m., and will be addressed by President Wm. H. Knight on the "Approaching Conjunction of Venus, the Brightest Star in the Heavens, and Saturn, the Ringed Planet." The public is cordially invited. Admission free.

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Reduced Excursion fare for the round trip, $1.75, includes stop-over privilege of one day. (Tickets good going on any regular car same day.)

The party will arrive home about 9:45 p. m.

A special identification badge will be provided, to insure admission to the observatory.

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VULCAN, THE HYPOTHETICAL PLANET

By Mars F. Baumgardt

An interesting chapter of astronomy is that which deals with Vulcan, the intra-Mercurial planet, supposedly discovered by Dr. Lescarbault, a Parisian banker and amateur astronomer.

It had not escaped the attention of astronomers that there were certain discrepencies in the orbit of Mercury, which, like those of Uranus, might be explained upon the theory of some unknown disturbing body in the solar system, but this time situated between Mercury and the sun. Among those whose attention was attracted to the subject was Leverrier, the Director of the Paris Observatory, a mathematical genius of the very highest order, who thirteen years earlier, jointly with John Couch Adams had by the inverse method discovered the planet Neptune.

Leverrier found that the discrepency in the case of Mercury amounted to 31° of arc in the perihelion motion, a disagreement between theory and observation which could be satisfied by postulating the existence of a disturbing body between Mercury and the sun. Applying Bode's Law, an empirical formula supposed to express the approximate distances of the planets from the sun by doubling the distances and adding four to the product, as we proceed in an outward direction, it was thought that the perturbing body should be about sixteen million miles from the sun. Then by the application of Kepler's Third Law, that the cubes of the average distances of the planets from the sun are ever proportional to the squares of their periodic times, an orbit of thirty-three days was given to the hypothetical planet, and a transit across the disk of the sun was predicted for March 22, 1877. At the appointed time from observatories located all over the world the surface of the sun was closely watched. No transit occurred. Theory and observation did not agree.

A new orbit was then calculated by Theodor von Oppolzer, another eminent mathematician, and once more a transit was prophesied. The results, however, were equally disappointing.

At the time when Leverrier made his first announcement, Dr. Lescarbault stated that he had actually seen the supposed planet pass across the sun as early as March 26, 1859. After this, from time to time, other amateur astronomers reported having observed the same phenomenon. Leverrier rejected all but six of these reported observations. From these he calculated his elements for the transit that did not take place. When the reported observations were more closely scrutinized it was found that they had been made by amateurs with but small instruments at their command. In many cases sunspots had been mistaken for Vulcan, the name by which the hypothetical planet was now known. Nevertheless, when every allowance had been made for error there remained some observations that it seemed could not be ex-

plained away. It was therefore necessary to try other methods.

During total eclipses, at the time of maximum darkness, small stars can be seen in the neighborhood of the sun. If Vulcan, accordingly, was of its calculated size, it should during the eclipse be a rather conspicuous object when in the proximity of the sun. The Lick Observatory took the matter up. Astronomers were sent all over the earth, accompanying eclipse expeditions for the express purpose of searching for the intra-mercurial planet. Specially constructed cameras were used for photographing the neighborhood of the sun in areas extending beyond the limits allowed Vulcan. This was repeated at so many eclipses that if the elusive planet really existed it should have made itself manifest on at least some of the plates. A careful examination, however, of the plates proved that every object around the sun at the time of eclipse could easily be identified with some known star. The negative results of these trials has recently been announced by Director Campbell of the Lick Observatory.

But what about the visual observations of Vulcan announced simultaneously by Watson of Ann Arbor and Lewis Swift, the one time Director of the Lowe Observatory? Both these sleuth-hounds of the heavens were certain that on the occasion of the Total Eclipse of the Sun July 29, 1878, they had actually seen two intra-mercurial planets in the neighborhood of the sun. The answer is that what they took to be planets was in reality the two stars Theta and Zeta in Cancer, an explanation with which Dr. Lewis Swift never agreed. To the very last he stoutly maintained that he had not been mistaken—that he had actually seen Vulcan.

As the matter stands today it seems that Vulcan has been eliminated from the family of planets surrounding our sun. The disturbances in the orbital journey of Mercury are attributed to other causes—to friction due to cloud-particles such as go to make up the Zodiacal light, to radiation and intense electrical disturbances emanating from the sun itself.

Thus closes what is probably the last chapter of a famous astronomical controversy which for fifty-seven years occupied the attention of some of our leading men of science.

MR. SPALDING'S LECTURE ON "SUNSPOTS"

The lecture on "Sunspot Phenomena" given before the Astronomical Society by Mr. W. A. Spalding at the meeting of April 11, was effectively illustrated, both on the screen and by blackboard drawings. The spots were first studied by Scheiner in 1610, but their existence was doubted and deplored by unscientific writers who insisted that the sun was a pure and unsullied body. The lecturer gave an interesting account of the discovery of the sunspot period of eleven years by the long and patient research of the amateur astronomer Heinrich Schwabe, of Dessau, Germany.

By means of sunspots we learn that the period of the sun's rotation on its axis is 25 days and five hours, giving the surface velocity at the solar equator at about 3,000 miles per hour. The spectropheliograph reveals the fact that the spots are vast whirling maelstroms in the solar photosphere. They appear in zones between latitudes from eight to thirty degrees either north or south of the sun's equator. The spectropheliograph also reveals the fact that the spots north of the equator whirl in an opposite direction. The lecturer compared these reverse motions to those of the cyclones in the earth's atmosphere on opposite sides of the terrestrial equator. Mr. Spalding believes that phenomenal outbursts of sunspots, when directed towards the earth, not infrequently affect the electrical condition

of the earth's atmosphere, and they are often attended with unusual displays of the Aurora Borealis. By means of a series of dates and curved lines on the blackboard there was an intimation that certain positions of the great planet Jupiter in its orbit were coincident with observed effects upon the sun. Mr. Spalding has long been a student of these phenomena and speaks with authority.

VENUS, MARS AND SATURN

Changeless Duration of the Constellations

By George C. Comstock, Director of Washburn Observatory

Have you watched the serene beauty of Venus as it crept modestly forth from the glare of sunset a few weeks ago, and has grown in brilliancy till it stands as a celestial beacon commanding even the most heedless eye, and stirring even the dullest churl to admiration of its splendor? A glorious spectacle and worthy to be followed in its declining course as, with diminishing brightness, the planet moves backward toward the sun, setting each night a little earlier until it is lost in the sun's radiance, only to reappear a little later in the morning sky, there to run another course.

And so may Mars and Saturn be followed and the paths marked out in which they move, a long stride towards the east, followed by a shorter one to the west, and again a long one to the east, in endless procession. Easy for us to understand who know the relations of the planets to the earth and the sun, but puzzling in the highest degree to remote generations of astronomers.

And the stars themselves, fixed stars, that, unlike the planets, abide ever in the same constellations, forming among themselves indissoluble groups and families that come and go, each at its appropriate season, with an unrivalled punctuality that regulates the clocks and watches of mankind today, as 5,000 years ago, the same stars, moving at the same unvarying pace, regulated the lives of men to whom clocks and watches were unimagined things. Are not these admirable for their well-ordered beauty and their changeless duration?

Orion and the Pleiades, Gemini and the Sickle, the Scorpion and that glorious celestial girdle of shimmering light that men call the Galaxy, or Milky Way—these have come to us unchanged from the days of Homer and David, of Job and the earliest civilization that grew up in the valley of the Nile. And what is there of such undoubted antiquity yet so accessible to modern eyes? Where else in art or nature shall we find the veritable objects about which twine more than fifty centuries of admiring myth and legend, of reverent worship and of patient scientific study? The immutable, the eternal, stand here as nowhere else, revealed in all their sublimity to the contemplative mind.

TWO PROCESSIONS OF STARS

It is with pleasure that we learn that Prof. J. C. Kapteyn, of the University of Groningen, Holland, is to resume his research work at the Mount Wilson Solar Observatory in a few weeks. It was his analytical mind that untangld the mazes of the sears' proper motions and set them marching, so to speak, in two orderly processions across the celetial sphere. In his account of the methods by which he reached his conclusions, in a lecture given before the assembled astronomers of the world at the solar Conference held on Mount Wilson, in September 1910, he thrilled his appreciative audience, and all felt that they had a new glimpse into the wonderful mysteries of the Universe.

OFFICERS OF THE ASTRONOMICAL SOCIETY

William H. Knight, 621 Witmer St. (Wilshire 354).....President
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MEETINGS OF THE ASTRONOMICAL SOCIETY

Tuesday, June 13—Lecture by Dr. C. C. Kiess, Assistant Director of the Brackett Observatory at Pomona College. Subject: "Variable Stars; the Algol Eclipsing and Other Types." At the Los Angeles High School, at 8 p. m. sharp.

Tuesday, June 20th—Observation Night, Los Angeles High School, 8 P. M.

Tuesday, June 27th—Lecture, Los Angeles High School, 8 P. M. Subject announced later.

VACATION EXCURSIONS

The Astronomical Society will take a vacation during the months of July and August, but two excursions have been planned for the Society during those months as follows:

On Saturday, July 22, the members of the Society and their friends spend the evening on Mount Hollywood, in Griffith Park. The summit is 1660 feet above sea level and commands a magnificent view of the surrounding country. Take the Hollywood Franklin Avenue trolley to Western avenue, arriving at 4 p. m. with lunch baskets and field glasses, and walk thence three miles to the summit.

On Saturday, August 19, there will be an excursion to Mount Wilson. The summit is nearly 6000 feet in height and can be reached by foot by horseback, and by automobile.

ANCIENT ESTIMATES OF SUN'S DISTANCE

Aristarchus, born 267 B. C. was the first to reason that the earth moves round the sun, and estimated the distance of that body 3,000,000 miles.

Hipparchus, the father of astronomy, born 160 B. C., discovered the Procession of the Equinoxes and gave same estimate of sun's distance.

Ptolemy, born 140 A. D., inventor of the Ptolemaic theory of the celestial sphere, increased the sun's distance to 5,000,000 miles.

Kepler, the great German astronomer, born 1571, and contemporaneous with Copernicus and Galileo, increased the sun's distance to 14 million miles.

Cassini, French astronomer, born 1625, made first approximation to present accepted distance, 86,000,000 miles.

Euler, German astronomer, born 1707, gave an estimate of 92,900,000 miles which nearly coincides with present figures.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students. Saturday and Sunday of each week at the Mt. Lowe Observatory.

Edited by
WILLIAM H. KNIGHT
621 Witmer St.

Published by
T. L. O'BRIEN
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THE HEAVENS

Monthly Record of the Stars, Planets, and Astronomical Events

No. 4 LOS ANGELES, SEPTEMBER, 1916 $1.00 per Year

THE ASTRONOMICAL SOCIETY OF LOS ANGELES

Meets at the Los Angeles High School, North Hill street, on the second and fourth Tuesday evenings of each month, except July and August. Annual Dues $1.00.

MARVELS AND DELIGHTS OF THE SCIENCE OF ASTRONOMY

By William H. Knight

The development of the noble science of astronomy from the crude imaginings of the ancient seers to the present broad grasp of the laws governing the motions of the heavenly bodies, and an insight, however imperfect, of their physical and chemical constitution, is a subject of profound significance to the student of human thought.

At the very dawn of civilization, Hindu, Chaldean, Egyptian, Persian, Arabian, and Greek philosophers, were deeply interested in the problems suggested by the various aspects of the stars. With astonishing precision they observed and recorded in their crude way, minute and elusive details of star positions and constellated groups. They speculated with hazy thoughts about the sweep of an adamantine firmament across the mysterious vault of heaven. But what could they actually know, or even reasonably conjecture about the appalling distances, the vast magnitudes, or the complex motions of the heavenly bodies?

To them the earth was a wide-spreading plain, the chief object in the universe, and the stars, though out of reach, not very far off, ornamenting an ever rolling firmament, arranged for the exclusive benefit of mankind. Little by little a certain order was evolved from the scattered observations. Magnifying instruments gave discs to the planets and suggested that they are great worlds in space. Mathematical calculations demonstrated their distances. Chemistry, optics and spectrum analysis gave hint of their physical constitution and kinship with earth substances. These, together with the coordinating aid of other branches of science, have given the modern mind a more adequate conception of the profound truths of astronomy.

Some of us may be oblivious of the laws of astronomical science, but we are ever under their sway. We whirl with the earth's surface round its imaginary axis every twenty-four hours. At the equator this surface motion is at the rate of one thousand miles per hour. Here, on the 34th parallel, we are constantly rushed forward at the rate of 750 miles per hour. We fly in a vast orbit round the sun, 550,000,000 miles in length, with the unthinkable speed of eighteen and a half miles per second. Yet, how unconscious we are of both motions.

Nay, there is a third motion, of vast significance, by which our central sun, with its marvelous retinue of planets, satellites, asteroids and comets, numbering thousands of bodies, is performing a grand journey through the profound depths of space, directed towards a point in the constellation Lyra, in the neighborhood of the massive sun Vega, now shining serenely in the zenith of our summer skies. Twelve miles per second, more than a million miles per day, nearly 400,000,000 miles per year, marks the progress of this wonderful journey. And all of

us are passengers in this sublime flight through the mysterious depths of uncharted space. Some of us give no more thought to these tremendous facts than the spider swinging in its gossamer hammock, the bird caroling from the tree, or the wild beast hunting its prey.

Is it not worth while to enrich your experiences with some knowledge of these things? To know the stars is to love them; they become the children of your mind. They will be an unfailing source of intellectual pleasure as long as you live.

STARS AND PLANETS ARE DYNAMOS

(St. Louis Post Dispatch)

The results of observations and experiments at the Mount Wilson Observatory have led Director Hale to express the belief that the sun is a great magnet.

It has long been believed that there is a connection between the earth's rotation and its magnetism. There seems to be no reason to doubt that all the planets are magnets, and that they derive their magnetic power from their rotation.

This opens to the imagination a picture of the Universe as a huge dynamo, the various planets swinging round their suns, each wrapped about in its own magnetized and magnetizing coil, and the whole generating an all-pervading electric fluid.

Thus, the earth, Venus, Mars, Jupiter, Saturn and the rest of them, transforming force into the terms of electricity, find within themselves sources of energy, heat and light.

And this, repeated in thousands of other solar systems, each group consisting of a great sun, or perhaps two spectroscopic suns, and many planets revolving round them, makes of space a perpetual source of supply of that most mysterious thing in the world—electricity.

Just exactly what magnetic force really is, nobody is really sure. It was discovered that if one took a bar of soft iron and wrapped an insulated wire round it, and turned on an electric current, the bar became a magnet. But it lost its power when the current was turned off. This established beyond dispute that there is some connection between magnetism and electricity, but just what no one has been able to discover.

North of the Equator the compass needle points to the north, and the further north you go the deeper the dip, till finally it points towards the center of the earth. It is presumed that this behavior of the needle would be the same if transformed to other planets.

Sprinkle iron filings on a cardboard, hold a magnet under the board and tap it with your finger. The filings will arrange themselves in systematic curves. On the occurrence of the solar eclipse of May 28, 1900, a photograph of the sun's corona was taken. On this occasion the photograph exhibited whorls of light which bore a striking resemblance to curves set up in the iron filings. It was assumed that the two phenomena were due to the same general cause.

Spectograph pictures of the sun have shown that there are magnetic fields on its surface around the so-called sun spots.

ANTARES AND THE SCORPION

One of the finest objects in these skies is the splendid constellation known from time immemorial as the Scorpion. Indeed it is the only one in all the heavens that bears a striking resemblance to its name. We can imagine with what veneration the astronomers of Persia, Arabia and Egypt regarded this remarkable group of stars. Fiery Antares, a ruddy star of the first magnitude throbs at the heart of the monster; a row of bright stars farther west mark the head;

while a chain of brilliants extending downward and eastward, then curving up to two stars which form the sting, and it is not surprising that this prodigy of the southern skies should have held spell-bound the imagination of those ancient peoples.

To add greatly to the interest of modern astronomers, many of the stars expand into doubles, triples and quadruples under the telescope. And the naked eye perceives that the creature is whisking its tail among a multitude of small stars in the Milky Way. But note those two stars of the second magnitude to the west of the head; these were known in very ancient times as the two projecting Claws of the Scorpion. Previous to the time of Julius Caesar there were only eleven signs in the Zodiac, and Caesar felt that there should be twelve signs, corresponding to the twelve months of the year. Now as Scorpio was the largest of all the constellations, this reformer of the calendar amputated the Scorpion's claws and with some adjacent stars formed the new constellation of Libra—the scales of even-handed justice. It is the only constellation in the Zodiac not named for some animal.

One of the giant suns of the universe is the red star Antares in the heart of the Scorpion. It is so far away that its parallax has not yet been definitely determined, but it cannot be less than 300 light years distant, and that means that it cannot be less than 20,000, possibly 30,000 times larger and more massive than our sun. It is accompanied by a small green companion of the 10th magnitude, which, however, may not be physically connected with Antares, but may be either much nearer or far more distant in space than its apparent primary. As the immediate neighborhood of Antares is otherwise vacant of stars it has been conjectured that this powerful body may have absorbed into its own gigantic mass many of the nearer ones, and that it may be still devouring whatever vagrant material may be drawn to it by gravitation.

It may be well to state that the name of this star is derived from the Greek, "Anti Ares," or rival of Mars, referring to its color and brightness. The later Greeks called it Kardia Scorpion, and the Latins Cor Scorpii, both meaning the Scorpion's heart. The Arabians' Kalb al Akrab, meant the same thing. A Euphratean name was Dar Lugal, the God of lightning.

THE SUMMER CONSTELLATIONS

The September Constellations

The aspect of the stars is very beautiful on these clear autumnal evenings. The three chief brilliants are Vega, the steel white star near the zenith; Arcturus, the light orange star in Bootes, 50 degrees to the southwest, and Antares, the ruddy star at the heart of that striking constellation—the Scorpion. Observe that these three stars of the first magnitude form a great triangle whose sides are just fifty degrees in length. All three are giant suns, and each is moving swiftly through the universe.

Vega is the sparkling gem of the small but interesting constellation Lyra. The history of Lyra dates back to prehistoric times. Hercules, one of the heroes of the Trojan war, is immortalized by being placed in the heavens between Lyra and Bootes, but the stars are not conspicuous. He had a friend, Hermes, who one day found an empty tortoise shell on the beach, and conceived the idea of fastening strings across it with which he could produce harmonious sounds, and thus the first harp was invented. The achievement was so noteworthy that its emblem, the Lyre, was placed in the sky near Hercules.

Owing to the precession of the equinoxes the North Pole of the heavens is slowly shifting, and in

about 11,500 years it will be near the bright star Vega, which will then become our brilliant Pole Star.

Near Vega is a small star called Epsilon Lyrae. A small telescope shows it to be double, and a still more powerful instrument discloses the surprising fact that each of the components is a double. The two stars in each component are supposed to be revolving round a common center of gravity in a period of about 200 years. And furthermore, the two doubles are supposed to be swinging in an enormous orbit, also round a common center of gravity in a period of thousands of years.

LECTURES—SEASON OF 1916-1917

Tuesday evening, Sept. 12, 1916—Rev. Ralph B. Larkin of Ontario will address the Society on "The Marvelous Element—Radium." It will be illustrated by numerous diagrams on the blackboard.

Tuesday evening, Sept. 26, 1916—The noted lecturer of nation-wide fame, Mr. B. R. Baumgardt, will present his new lecture on Astronomy, illustrated with lantern views of exquisite beauty and perfection of detail recently received from the Yerkes and Harvard observatories, which he lately visited.

Tuesday evening, Oct. 10, 1916—Date open, to be filled.

Tuesday evening, Oct. 24, 1916—Mr. J. Wood Porter will address the Society on "Matter and Force—Their Relation to Astronomy."

THE PLANETS IN SEPTEMBER

Mercury will be a morning star.

Venus is an exceedingly brilliant morning star.

Mars is an evening star and at the beginning of the month it will be near the bright star Spica in the constellation Virgo.

Jupiter is a morning star in Aries.

Saturn is a morning star in Gemini.

Uranus is in Capricornus near Beta, and can be seen on any clear evening with an opera glass.

Neptune is in Cancer and is so far away that it can only be seen with a telescope.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

ASTRONOMICAL EXCURSION AND BASKET PICNIC TO MT. LOWE OBSERVATORY

Saturday, September 30th

The excursion will leave the P. E. station, Sixth and Main streets, at 1:30 p. m. Bring lunch and field glasses. Objects of special interest to be observed will be: the giant planet Jupiter, the sunset in the Pacific ocean, the double star Albireo at the foot of the Northern Cross, as well as other interesting bodies.

Reduced excursion fare for round trip, $1.25. For information and tickets write or telephone mornings to the Secretary.

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WILLIAM H. KNIGHT
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THE HEAVENS

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No. 5 LOS ANGELES, OCTOBER, 1916 $1.00 per Year

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JUPITER DOMINATES THE HEAVENS

That superb object, the giant planet Jupiter, now invites the attention of all astronomical students. Its position is most favorable for observation. While it is 484,000,000 miles from the sun, it is, at the present time, only about 400,000,000 miles from the earth, and presents a disc large enough to show considerable detail.

Jupiter is seen to be crossed by alternate white and colored belts. On the edge of one of them near the equator there is a large reddish spot, somewhat faint at present, but in some years very pronounced in form and color. This spot, which has been growing since it was first observed about forty years ago, is now about 30,000 miles in length by 7,000 in width. Its nature, which has been the subject of many ingenious conjectures, is still a profound mystery. One of these, which is regarded plausible, supposes that under the thick envelope of atmosphere saturated with vapor, there is a region of volcanic outbursts which give an unwonted glow to the clouds above. The subsidence and then renewal of the volcanic activity would account for the alternate brightening and paling of the great red spot.

Jupiter has a family of nine satellites, four of which are visible in small telescopes, and were first seen by Galileo in 1610. These little bodies, that were seen to be revolving round Jupiter, fortified the contention of Copernicus that small bodies revolve round larger ones. A fifth satellite was discovered by Barnard in 1892. It was the first notable discovery made with the great Lick telescope. It flies round its primary in a little less than 12 hours, and at a distance from its surface of about 70,000 miles. It is only some 20 miles in diameter and shows a very small disc as it glides across the Jovian sky.

The four larger satellites are Io, swiftly revolving round its primary in one day and 18 hours; Europa, in three days and a half; Ganymede in 7 days and 3 hours; and Callisto in 16 days and 16 hours. Ganymede is the largest satellite in the solar system, being 3,550 miles in diameter, and is 664,000 miles distant from Jupiter.

But Jupiter has four additional satellites—very small and very distant. The 6th and 7th have nearly the same period, about 8 months, their distance being about 7,000,000 miles. But the 8th and 9th are anomalies in the solar system, each having a retrograde motion, their exact distances and periods being as yet undetermined. The 9th is so small that it cannot be seen in any telescope—it is only caught on films of long exposure.

THE CONSTELLATIONS IN OCTOBER

Near the zenith is the fine constellation Cygnus, the Swan, containing that well known group of stars—the Northern Cross. It is located in the Milky Way at its northern division into two streams. With wings outspread, each marked by a bright star, it stretches its neck towards the south as if it were about to fly down the

Galaxy between those brilliants, Vega and Altair.

Alpha, the brightest star in Cygnus, is at the top of the cross, and is called Deneb, though in old charts it has the alternative name Arided. The three stars forming the transverse beam of the Cross are Epsilom at the left, Gamma, otherwise known as Sadr, in the center, and Delta on the right. Within the triangle formed by Alpha, Gamma, and Epsilon, is one of the vacant spaces in the Milky Way through which one seems to peer into the profound any mysterious depths of interstellar space. It has been called the Northern Coal Sack.

Six degrees northeast of Epsilon, quite near the Coal Sack, is a small star, just visible to the naked eye, but famous for being the nearest star in the northern heavens. It is known as 61 Cygni, and was the first star of which the parallax was measured. Bessel accomplished this in 1838 and found that 61 Cygni is just eight light years away. It is a double star, both components being of a golden yellow.

One of the chief objects of astronomical interest in Cygnus is Beta Cygni, a beautiful double star at the foot of the Cross, popularly known as Albireo. One of the suns composing this double is of a golden hue, the other a contrasting blue, and a view of them in a telescope of moderate size never fails to charm the beholder.

There are so many other deeply colored orange and red stars in Cygnus, that it has been called the Red Region of the sky. But this constellation is unusually rich in multiple stars. Espin gives a list of 100 stars in Cygnus, that are double, triple, or multiple.

Midway between Sadr and Albireo is a remarkable variable, Chi Cygni. It varies from the 4th to the 13th magnitude in 406 days. But sometimes when it arrives at its maximum it is only of the 6th magnitude, thus presenting an interesting problem in astrophysics.

In no other constellation are there so many visual and telescopic stars as in Cygnus. Herschel counted 331,000 in a space of five degrees. Perhaps this may be accounted for on the theory that the solar system, which seems to be situated far within the zone of stars forming the Galaxy, is, according to recent estimates, about 2000 light years nearer that portion in which Cygnus is involved than to the opposite portion in the southern celestial hemisphere.

Aquila, the Eagle, is another bird which, like the Swan, the ancients placed among the constellations. It is also in the Milky Way and its one first magnitude star, Altair, is on the eastern edge of the Galaxy. It is figured on a Euphratean stone dated about 1200 B. C.

In Greece the Eagle was the bird of Zeus, the chief god of mythology. According to another story Jupiter assumed the form of an Eagle and is represented as carrying off Ganymede, a beautiful youth, which was figured in a group of stars below Aquila, but which the Romans subsequently named Antinous, who gave his life for one of the Emperors, and his heroic deed was thus emblazoned in the sky. Two third magnitude stars a few degrees below Altair—one southeast in the right arm and the other southwest, in the left arm of Antinous, form a triangle with that bright star. Two other stars—one near the hand and the other in the foot, form a larger triangle with Altair.

Below Antinous is Sagittarius, the Archer, one of the zodiacal constellations. It is immediately east of Scorpio, but has no very conspicuous stars. But if you have a small telescope you will be able to see the planet Uranus which was discovered by Herschel in 1781 and produced a great sensation in the astronomical and scientific world at the time. Uranus is 1,782,000 miles from the sun, and is 32,000 miles in diameter—one of the giant planets. It is attended by four satellites of retrograde motion.

RADIUM, THE WONDER ELEMENT

By Ralph B. Larkin

The study of radium is a study of the infinitessimal. It may be regarded as no less staggering to the imagination than the study of the infinite.

Radium is not merely a matter of curious interest. It also serves as a key to unlock some of the greatest mysteries of the universe. It is a heavy metal, but has not yet been isolated in its elemental state. It is the salts of radium which are used in the investigations, as the bromide or chloride. These resemble common salt in appearance and are in no wise remarkable save for the fact that the radium atoms in them are constantly breaking up, expelling particles with great velocities. These particles are of two general types. The smaller is infinitessimally minute even in comparison with the atom. It is the electron, the ultimate particle of which all matter is built up. In some cases electrons are expelled with a velocity of over 100,000 miles per second. The mass of the other type of particle is probably as much as 1700 times as great as the first, and has been proven to be an atom of helium. Here we behold the wonder of one element being born out of another, to the amazement of modern chemistry.

The streams of particles are called rays. There is a third type of ray which is not a stream of particles but of pulsations or waves. This type is exceedingly penetrating, being able to pass through one foot of iron and affect a photographic plate on the other side.

The impact of the particles produces heat. In view of the fact that there are great quantities of helium in the sun, it may be that the mystery of accounting for the sun's heat is near its solution. The helium may argue a great release of energy through radio-activity.

It may also be that the earth is not now continuing to cool. The crust thirty to fifty miles thick is a very poor conductor of heat. There may be enough radioactive material in the interior to more than offset the radiation. In that case, the interior is getting hotter and ultimately the crust will melt again. The cycles of melting and cooling may have been repeated many times for aught we know.

The tiny electrons are the building bricks of the universe. They are driven off from the millions of great suns in the universe by the pressure of light, and are carried in never-ceasing streams to the confines of the universe to form new atoms and new nebulae and new suns and new solar systems. Thus, if the universe is constantly disintegrating, it is also being constantly born anew. This equilibrium will go on, being maintained until—well, why should it ever come to an end?

THE BRIGHT STAR CAPELLA

Almost directly north of Orion is the fine constellation Auriga. Its chief brilliant is the first magnitude star Capella. Note that it forms a triangle with Betelgeuze in Orion and the Pleiades in Taurus. Dr. Furuhjelm of the Helsingfors Observatory finds that a faint star of the 11th magnitude, 12 minutes of arc from Capella, is physically connected with it, having the same proper motion, both in direction and amount.

As Capella is itself a spectroscopic binary, the discovery of the distant companion is of great interest. Accepting Elkin's value for the parallax of Capella, its distance from our system is about 41 light years, and the faint companion is about one-seventh of a light year from its primary—something over 8,000,000,000 miles. Remembering that Neptune, the outermost planet of the solar system, is only 2,800,000,000 miles from the sun, we are able to form some faint conception of the enormous range of the Capella system. This companion shining by its own light, is probably

half as large as the monarch of our own system. Our sun, placed at that distance, would shine only as a star of the 6th magnitude.

The binary character of Capella was discovered by Dr. Campbell of the Lick Observatory. It had been seen elongated in the 28-inch refractor at Greenwich. The two components revolve round a common center of gravity in a period of 104 days. They are nearly equal in mass and their united mass is about 18 times that of the sun. Their united lustre is 128 times that of the sun. Their distance apart is 52,000,000 miles, equal to a little more than half the distance between the earth and the sun. They do not shine with the same quality of light; one gives a pure solar spectrum, and the other shows a prismatic affinity with Procyon. Later we shall speak of the remarkable spectroscopic binary, Beta Auriga, a star of the second magnitude, four degrees east of Capella.

ASTRONOMICAL EXCURSION AND BASKET PICNIC TO ALPINE TAVERN AND MT. LOWE OBSERVATORY

Saturday, October 28th

The excursion will leave the P. E. station, Sixth and Main streets, at 9 a. m. Bring lunch and field glasses. Objects of special interest to be observed will be: the giant planet Jupiter, the sunset in the Pacific ocean, the double star Albireo at the foot of the Northern Cross, as well as other interesting bodies.

LECTURES—SEASON OF 1916-1917

Tuesday evening, Oct. 10, 1916—Prof. Melville Dozier, on "The Importance of Adopting the Decimal System in Business Transactions."

Tuesday evening, Oct. 24, 1916—Mr. J. Wood Porter will address the Society on "Matter and Force—Their Relation to Astronomy."

THE PLANETS FOR OCTOBER

Mercury will be a morning star during the latter part of the month.

Venus is a bright morning star, but hastening towards the sun with diminishing splendor. On the 1st it will be in Leo near Regulus.

Mars is still too near the sun to be seen to advantage. It is in the constellation Libra.

Jupiter will be the brighest object in the evening sky. Being nearly in opposition, it will be most favorably situated for observation at 9 p. m. Its four larger moons are visible in small telescopes ,and one or two may be descried in a good field glass.

Saturn is near Castor and Pollux in the western morning sky.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

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THE HEAVENS

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No. 6 LOS ANGELES, NOVEMBER, 1916 $1.00 per Year

Recent Progress in Astronomical Research

By William H. Knight

Probably the most important department of work in astronomical research thus far in the twentieth century is embodied in certain discoveries and the conclusions arrived at concerning the nature and motions of those numerous, diffuse and distant objects known as nebulae. Within this brief period we have learned that nebulae are moving with great velocity in various directions across the celestial sphere, and also toward and from our solar system in the line of sight.

But equally important is the fact that internal movements have been detected, as spectroscopic investigation shows that in some of the great nebulae axial rotation actually exists. In other words, those mighty fields of hazy light, often ten thousands of millions of miles in extent, are revolving around central axes of their own. This is highly suggestive of a process of world formation, going on before our eyes, such as was imagined by Laplace in his ingenious theory of the origin of the solar system.

Other Universes

We can scarcely doubt that some of the well-defined nebulae—like that of Andromeda and others which have distinct spiral convolutions and apparent centers of concentration, but whose blended light cannot be dissolved into starry systems on account of their almost infinite distance—we cannot doubt that some of these wonderful aggregations of worlds are independent universes, in magnitude and diversity not unlike our own visible sidereal system.

To the intelligent and instructed peoples in some of their habitable worlds, our great and complex sidereal system, with its myriad girdling stars in the Milky Way, its giant suns, Arcturus, Canopus, Rigel and Antares, gleaming among its otherwise confluent streams of hazy light—to them our system, distant and faint though it may be, must present a spectacle as suggestive to the minds of trained observers as many of the spiral nebulae are to the terrestrial astronomers of today.

Collision of Worlds

It was in February, 1901, that Nova Persel suddenly blazed forth from the depths of space, forming a conspicuous object in our sidereal universe, where, twenty-four hours previous, no star was visible. As its brightness dwindled during the next few weeks, the photographic film of long exposure recorded its expansion into a characteristic field of nebulosity, vastly greater than that of our entire solar system.

A reasonable conjecture attributed the phenomenon to the collision of two great worlds. The impact of these bodies, brought together with stellar velocities by their mutual attraction, instantly generated a temperature that reduced them to a molten and even a gaseous state, so that the materials of which they were composed, as varied perhaps as those which compose the crust of the earth, were driven by convective currents, and with great velocity, far out into surrounding space—the whole mass self-luminous for the time being, or

illuminated by the blazing central mass, of unknown distance from us—perhaps several hundred light years.

In the course of time the nebula thus produced, having an initial rotation started by an impact that would not, in a million chances to one, be absolutely square and direct, there would, as the rotatory motion was set up, in the course of astronomical ages, be centers of condensation, produced by gravitational attraction in the denser portions of the nebulous cloud, and sidereal or planetary worlds would be formed. And observers closer than ourselves to this great destructive and recuperative exhibition of cosmic transformations would witness on a grand scale what Laplace in imagination witnessed when the matter now forming the orderly solar system was a field of nebulosity extending a thousand million miles beyond our outermost known planet.

Spectroscopic Binaries

Within the last quarter of a century we have become cognizant of a multitude of spectroscopic binaries, where two mighty suns, too close to be separated by the most powerful telescopes, are known to be revolving around a common center of gravity with enormous velocity, and in the very nature of the case producing great tidal prolongations or tongues of flames pointed toward each other. Though these majestic phenomena are not visible to the physical eye, even when supplemented by the most skillful optical agencies, yet the trained intellect of man, with its creative imagination, clearly perceives these mighty suns, blazing with unquenchable fires, pursuing their undeviating course, even as with his physical eye he nightly watches bright Jupiter climbing the cerulean heights of the celestial sphere. Two notable spectroscopic binaries are Mizar in Ursa Major and Beta Aurigae, above the constellation of Orion.

Within the present century we have found that Phoebe, the most distant satellite of Saturn, and also two of the recently-discovered outermost satellites of Jupiter, have retrograde motions, compelling a modification in some degree of Laplace's nebular theory, though not necessarily conflicting with its larger conceptions. We do not know but these very small, telescopic objects may once have been comets or other vagrant bodies wandering through space, and captured by the powerful attraction of these giant planets. The same theory may account for the existence of Barnard's fifth satellite of Jupiter and also for the two tiny satellites of Mars.

Radium and Astronomy

When Mme. Curie discovered the new element radium, in the last year of the nineteenth century, no one suspected it would have any cosmic significance, but this remarkable element impinges upon astronomical research in two aspects. Its disintegration results in the production of helium. That previously unknown element was detected in the corona of the sun in the early 90's by Sir Norman Lockyer. It was subsequently obtained from certain earthy minerals, in which it was occluded by Sir William Ramsay. Still later Sir J. J. Thomson found that radium is constantly projecting into surrounding space ions of helium, and that this process is attended with the production of heat. Not only so, but radium is itself a product of the slow disintegration of uranium.

Now what bearing do these facts have upon astrophysical astronomy? Why, it is found that the spectrum of the Sirian type of stars—the brightest in the heavens—shows the presence of helium in a marked degree. It is thence inferred that there is perhaps an immense basic supply of uranium in those bodies, the disintegration of which produces an incessant and unlimited supply of radium, and furthermore that the activity of radium in

circlet of six small stars which mark the location of the Western Fish in the zodiacal constellation Pisces. There are two groups of small stars, the one to the west of Scheat, and the other to the west of Markab, which belong to Pegasus.

Andromeda, the Chained Lady

This splendid constellation is now in a favorable position for observation. Its principal star, Alpheratz, is also, as stated above, the northeastern star of the Great Square. It is a spectroscopic binary whose two components revolve round a common center in 97 days, and the system is approaching the solar system with a velocity of about 8 miles per second.

Andromeda was the beautiful daughter of Cepheus and Cassiopeia, and was freed from her chains by Perseus. All these mythological persons are represented by neighboring groups of stars. Olcott remarks: "The constellation Andromeda presents a beautiful appearance rising in the eastern sky in the early evening during the months of autumn. Low over the hills twinkle her chain of stars, sweeping down in a long graceful curve from the Great Square of Pegasus, like tiny lamps swinging from an invisible wire—a chain with which Perseus holds in check his winged steed."

Astronomically, the most interesting feature is the great Nebula of Andromeda. As far back as the year 900 a Persian astronomer called it the "Little Cloud," for this and the great Nebula of Orion are the only ones visible to the naked eye. It is probably an enormous aggregation of stars, perhaps yet enveloped in the nebulous cloud from which the stars are being condensed, and lying far out in space at an enormous distance beyond the confines of our sidereal system, and possibly itself an immense sidereal system in the making.

Perhaps the most interesting star is Almach (2d magnitude) in the foot of Andromeda. In 1778 it was found to be a double star—the primary being of a golden color, and its companion a contrasting blue, but in 1842 Struve discovered that the companion itself was a close double. Thus Almach is shown to be a beautiful triple system. The celebrated Bielid meteors have their radiant point near this star. Between Alpheratz and Almach is Mirach in the girdle, also of the second magnitude.

A NEW OBSERVATORY IN LOS ANGELES

The members of the Astronomical Society will be interested in the announcement that a private observatory has been established on the beautiful grounds of Mr. W. A. Clark, jr., on rising ground in the western part of the city, fronting on West Adams street, near Cimarron. The structure consists of a substantial brick tower, perhaps forty feet in height, surmounted by a shuttered dome on rollers and easily moved by hand. The tower is in three vertical sections. You rise to the second section by means of internal winding stairs, and enter a room large enough to accommodate 12 or 15 persons. From this level you ascend the third section, or telescope room. Here a fine modern refracting telescope is installed with all the accessories required for making and recording observations.

The tube, equatorial mounting, and clockwork for keeping the object centered in the field, was manufactured by the well-known firm of Warner & Swasey of Pittsburg, and the fine six-inch object glass, with powers ranging from 150 to 600, came from the optical works of John A. Brashear in Pittsburg. It brings out the belts of Jupiter very clearly and shows the four Galilean satellites to great advantage. When turned upon the double star Albireo at the foot of the Northern Cross, it separates the two components and exhibits their beau-

tiful complementary colors. We might enumerate many celestial objects that are brought out in a very attractive manner. It is hoped that persons interested in astronomy will have opportunity from time to time to view the planets, star clusters and nebulae that are beyond the reach of unaided vision. When the next comet makes its appearance we shall hope to make a study of the strange phenomena it will present.

ARTIFICIAL CONSTELLATIONS

At the last meeting of the Astronomical Society Mr. Mars Baumgardt gave a novel exhibition of a method of showing the constellations with scintillating stars by means of black perforated cards which when held up to an electric light exhibit various groups of stars in their true relations to each other, and also showing accurately a range of five magnitudes from the first to the fifth, inclusive. The stars in the constellation of Orion were a brilliant and realistic reproduction of that beautiful group in the heavens. Mr. Baumgardt's invention will at a later date be available for public and private use.

Look, how the floor of heaven
Is thick inlaid with patines of bright gold;
There's not the smallest orb which thou behold'st,
But in his motion like an angel sings.
—Merchant of Venice.

THE PLANETS IN NOVEMBER

Jupiter is the chief object of interest, and is now at its brightest, a very conspicuous object in the evening sky.

Venus is morning star, and is gradually diminishing in brightness.

NOVEMBER ANNOUNCEMENTS

Tuesday Evening, Nov. 14.—Dr. Arthur S. King, superintendent of the Physical Laboratory of the Mt. Wilson Solar Observatory, will address the Astronomical Society. Subject: "A Review of Recent Astronomical and Physical Investigations at the Mt. Wilson Solar Observatory."

Tuesday Evening, Nov. 28.—Mr. Mars Baumgardt will give a lecture on "The Scientific Theory of Colors and Their Mode of Combination in the Formation of White Light." It will be illustrated with brilliant experiments.

Information regarding class or private instruction in astronomy can be had by consulting the officers of the Astronomical Society.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

Roll on, ye stars, exult in youthful prime;
Mark with bright curves the printless steps of time.
—Erasmus Darwin.

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Strange Behavior of Encke's Comet

By William H. Knight

A press dispatch is headed "Old Encke Comet Ahead of Time." But that is misleading. The comet is not "ahead of time," but it is discovered on its expected return earlier than usual, owing to the vigilance of that veteran astronomer, Max Wolf, at Heidelberg, and his faithful camera. Knowing just where to point his telescope, his sensitive film caught the faint object when at a greater distance from the sun than ever before.

Encke's is one of the dozen or more short period Jovian comets that go out about as far as the orbit of Jupiter and then return to the neighborhood of the sun, in periods varying from five to nine years. But Encke's has the shortest period of any comet known. While its perihelion is just within the orbit of Mercury, its aphelion is considerably within the orbit of Jupiter.

Johann Franz Encke, for whom the comet was named, became an astronomer because he was a born mathematician. He was sent to Gottingen and placed under Gauss. But geometers are men, and he took up arms in the Hanseatic legion and marched and fought till Napoleon was exiled at St. Helena. In the course of his campaigning he met Lindenau, director of the Seeberg Observatory, and was appointed assistant under him, and became his successor in 1822. Thence he went to Berlin in 1825 and superintended the building of a new observatory, and remained at its head till 1864, the year before his death.

In 1818 Pons of Marseilles discovered an inconspicuous comet, and Encke calculated its elements. He brought out the surprising fact that it had a period of only three and a quarter years. He did more; he detected its identity with a comet seen by Mechain in 1876, and another seen by Caroline Herschel in 1795, and still another seen by Pons in 1805. Encke predicted its return in 1822, and it was seen in the Southern Hemisphere by Brisbane, near the place indicated by Encke.

It was the second time that a comet had returned as predicted since Halley made his successful prophecy, and it made the name of Encke famous. Its period is considerably shorter than that of any other known comet. Kepler's remark that comets are consumed by their own emissions undoubtedly has a measure of truth in it. Though extremely tenuous, the matter streaming out into the tail must ultimately affect the character of the comet. The impact of the sun's rays upon the exceedingly fine particles of which the comet is partially composed is undoubtedly the despoiler, and therefore frequent visits to the neighborhood of the sun gradually wear them out, or, rather, deprive them of that portion of refined matter which is subject to the influence of the sun's rays.

Thus Encke's and some of the other short period comets are almost shorn of their tails.

Encke found that the revolutions of his comet were subject to some influence besides that of gravity. After every possible allowance had been made for the pulls, now backward, now forward, exerted upon it by the several planets, there was still a sur-

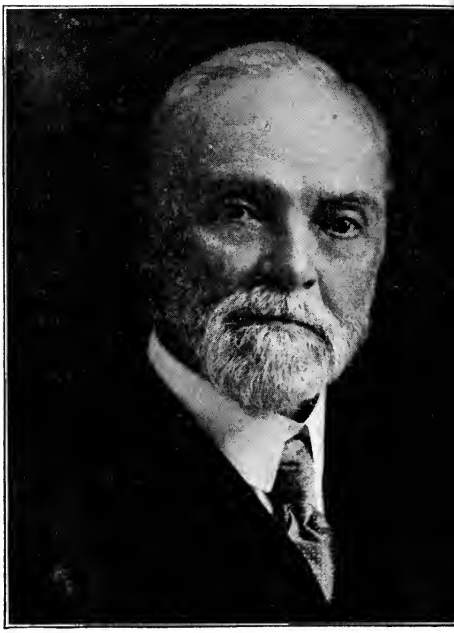
plus of acceleration left unaccounted for. Each return to perihelion took place about two and a half hours sooner than received theories warranted. Encke, and also Olbers, explained it as due to the presence in space of some such subtle matter as was long ago invoked by Euler to be the agent of eventual destruction for the fair scheme of planetary creation. It was considered that any check to the motion of bodies revolving round a center of attraction causes them to draw closer to it, thus shortening their periods and quickening their circulation.

If space were filled with a resisting medium capable of impeding, even to a slight degree, the swift course of the planets, their orbits would necessarily be, not ellipses, but very close elliptical spirals, along which they would slowly, but inevitably, descend into the sun. But when Encke's comet returned in 1863 its acceleration was diminished nearly one-half.

The visible change of volume in Encke's comet has been extraordinary. On October 28, 1828, it was 135,000,000 miles from the sun and its diameter was 312,000 miles—more than one-third that of the sun. On December 24, about two months later, its distance was 50,000,000 miles and its diameter only 14,000 miles. But while at perihelion passage on December 17, at a distance of 32,000,000 miles, its diameter was only 3000 miles.

It has since been a characteristic of Encke's comet that when it first comes into sight, at a distance of about 130,000,000 miles, it has a diameter of about 300,000 miles, and when it is near perihelion, at a distance from the sun of only about 33,000,000 miles, its diameter shrinks to 12,000 or 14,000 miles. But as it recedes it expands and resumes its original dimensions. Some other comets show a similar though less striking change.

The density of a comet must be exceedingly small. If a comet 40,000 miles in diameter has a mass equal to only 1-250,000th of the earth's mass, its mean density would be a little less than 1-9000th that of the air at the earth's surface—much lower than that of an airpump vacuum. This density is borne out by the fact that small stars can be seen through the head of a comet 100,000 miles in diameter.



WILLIAM H. KNIGHT

President Astronomical Society of Los Angeles; Vice-President Los Angeles Chautauqua Association; Former President Southern California Academy of Sciences.

But though the quantity of matter in a cubic mile of a comet is small, the density of the constituent particles need not necessarily be so. The comet may be composed of small, heavy bodies, widely separated. The head of a comet may be a swarm of meteoric stones, some of them several inches in diameter, others only small pebbles, and still others like grains of dust. And these meteoric substances may carry with them a certain quantity of enveloping gas.

But how shall we account for the reduction in the visible size of a comet

before Christ, it was the first sign of the Zodiac, and is engraved as such on Persian and Mithraic gems. The Hyades is a group that forms the letter V, with the red star Aldebaran at the top of the left hand stem. Aldebaran is the angry eye of the Bull. In the modern pronunciation of this star the accent is on the second syllable, but Mrs. Sigourney, as was common a century ago, placed it on the third syllable.

"Go forth at night,
And talk with Aldebaran, where he flames
In the cold forehead of the wintry sky."

The name, like that of other stars beginning with Al, is of Arabic origin, and was written Al Debaran, meaning the follower, that is, it follows the Pleiades.

The Wonderful Pleiades Cluster

The Pleiades is a storied group, about which hang many ancient legends. The keen-eyed shepherds of Mesopotamia, who watched their flocks by night under those clear skies, counted seven stars, and wove a legend about the Seven Sisters. In the more humid atmosphere of Greece only six stars were visible, so their poets invented another legend about the lost Pleiad. But sharp-eyed people today see seven stars on clear evenings under our California skies.

When Galileo pointed his two-inch telescope to this cluster in 1610, he was astonished to find forty stars in the field of his crude instrument. The six-inch object glass at the Clark Observatory in this city reveals many hundreds of stars in this wonderful group. But the brothers Henry, at the Paris Observatory, with a photographic plate of four hours exposure, were able to count 2326 stars in this miniature universe.

The brightest star, Alcyone, is of the third magnitude. The other five stars ordinarily visible are Electra, Atlas, Maia, Merope and Taygeta. Celaeno, the seventh or concealed star, is slightly below the sixth magnitude.

"The sister stars that once were seven
Mourn for their missing mate in heaven."

—Alfred Austin.

The Pleiades cluster is enveloped in a nebulous haze which is revealed in photographs of long exposure. Dr. Barnard, of the Yerkes Observatory, has detected wisps of the nebula extending far out beyond the limits of the group, implying that many of the worlds in the cluster are still unfinished suns, into which the surrounding nebulous matter has not as yet all been condensed.

What is the distance of that cluster from our solar system? Thus far this has been an insoluble problem. Estimates have been made ranging from 300 to 700 light years. Even if the latter estimate were correct, the group would be much nearer to us than the stream of stars whose blended light forms the Milky Way. But, although no parallax has been obtained, a small proper motion has been detected, showing that the cluster is moving in a southerly direction.

Thus far the positions of the individual stars seem fixed with reference to each other, but there is a notable exception to this rule. Six stars, apparently within the group, seem to be moving in a northerly direction through it, while two other stars are moving through it in a southerly direction. The supposition is that the six stars mentioned are outside of and far beyond the group, but visible through it; while the other two are much nearer than the cluster but at present in the same line of sight.

CLASSIFYING THE STARS

According to Dr. George E. Hale, we find that more than 100,000 spectra photographed at the Harvard Observatory belong to the following classes: White stars, in which the lines of helium are conspicuous; stars, also

as it approaches the sun? When at the aphelion of its orbit, the enveloping gases may be frozen in the zero temperature which prevails in distant space, in which case the solid particles would reflect the sun's rays and become visible. But on approaching the sun many of those frozen particles might melt and be restored to the gaseous state, thus becoming transparent and invisible.

But let us follow Encke's comet on its visitation in 1888.

Aphelion distance, 4.097 times the distance of the earth from the sun, that is, about 372,000,000 miles, or more than 100,000,000 miles within the orbit of Jupiter.

Perihelion distance, 0.343, or about 32,000,000 miles. Now, the orbit of Mercury is so eccentric that its distance from the sun varies from 28,500,000 miles at perihelion to 43,500,000 at aphelion—its mean distance being about 36,000,000 miles. Theerfore, as the comet crosses the orbit of Mercury twice at each perihelion passage, there is a possibility that on some future occasion it may come in collision with the planet, in which case the planet might go unharmed, but the comet would probably be strung out into a meteoric stream and become invisible. The comet of 1866 had formerly approached so near the earth as to become partially disintegrated, and a portion of its meteoric constituents entered our atmosphere, forming the brilliant November meteoric displays of 1799, 1833, 1866 and 1899, and these will be again repeated in November, 1933—the period of that comet being about thirty-three and one-fourth years.

Astronomers will watch the Encke comet with great interest as it approaches the sun with constantly accelerating velocity, and will note the precise moment of perihelion, to ascertain whether its calculated period of revolution has again been shortened as on former visitations. Encke and other astronomers conjectured that it might encounter a resisting medium, possibly the ether of space, in which case the perihelion velocity would be diminished, and this diminished momentum would fail to carry the comet out to its normal aphelion distance, and the resulting tendency would be towards a more circular orbit.

Another conjecture was that the comet might encounter meteor swarms when in the neighborhood of the sun, and thus have its speed retarded. But as this retarding effect has not been noticed in the case of other periodical comets, there is doubt about its being the true cause of Encke's shortened period.

Following are the elements of Encke's Comet for the year 1888:

Perihelion passage	June 27
Aphelion distance	4.097
Perihelion distance	0.343
Eccentricity of orbit	0.845
Inclination of orbit	13 degrees
Period of revolution	3.308 years

TAURUS AND ITS SPLENDID STAR GROUPS

The important constellation Taurus, the Bull, now comes upon the scene in these early winter evenings. With lowering head and fiery eye he is about to attack the valiant Hunter Orion, who holds the lion skin aloft for a shield. The Bull's horns are terminated by the bright stars Beta and Zeta above the head of Orion.

There are two beautiful star clusters in Taurus—the Hyades and Pleiades. The three bright stars in the Belt of Orion point in one direction to these two groups and in the opposite direction to the splendid star Sirius, thus furnishing a ready means of identifying the leading features of three constellations—Canis Major, Orion, and Taurus.

This constellation derives additional importance from the fact that in the ancient chronology of the Babylonians and Egyptians, many centuries

white, in which hydrogen plays the leading role, while traces of the metals begin to appear; yellowish stars, like the sun, in which the hydrogen lines, less conspicuous than before, have thousands of lines due to metallic vapors; orange or red stars, in which still fainter hydrogen lines, and stronger metallic lines, have bands of titanium oxide.

Variable stars of the Cepheid class undergo a regular variation in spectral type in a few hours, showing at the same time a corresponding fluctuation in brightness and in temperature.

The spectrum of a sunspot resembles that of a red star, which is essentially a cooler sun.

Temperature, then, is the main source of observed differences in stellar spectra. The white helium stars attain temperatures of perhaps 20,000 degrees, Centigrade. The white hydrogen stars may exceed 10,000 degrees. The yellowish stars like our sun measure about 6000 degrees. The red stars range from 2000 to 3000 degrees, thus falling within the limits attained by our electric arcs and furnaces.

Thoughts From Frank Crane's Meditations

We can gaze at the splendid pageant of the skies and let a little of its infinite feeling penetrate into our souls.

How many of us are companions of the imperial night? How many open up their mortal spirits once in twenty-four hours for the inrush of sidereal calm?

There be dwellers by the seashore that think of nothing but fish and driftwood; some live in the templed woods and have no thoughts but of cordwood and game; and in the lofty mountains are habitants whose ideas never rise above goats and cows. But all of us live beneath that outspread wonder-sky and get how little of its spiritual call, its message of immensity.

There are schoolboys and girls who are getting an education, yet have no acquaintance with the angelic globes of light. Night unto night uttereth speech, but it is strange to them. They follow not Orion in his martial strides, and know not Arcturus and the Seven Sisters.

Every night the mighty planet Jupiter hangs in the evening sky, under the starry sign of the Great Square of Pegasus, mounting slowly toward the meridian with the progress of the hours, and at midnight glowing in the center of heaven like a lamp for the gods.

Death of Dr. Lowell

In our November issue we gave a brief sketch of Dr. Lowell's work in elucidating the mystery connected with the markings on the planet Mars. A few days later, despatches from Flagstaff informed us of his sudden death at the age of 61. His demise is a great loss to the astronomical world. Whether we agree with his conclusions that Mars is an inhabited world, or place a different construction on the outcome of his labors, all must admit that his researches have added largely to our knowledge of Martian conditions, and that his work has been useful and his writings illuminating. We trust that the great observatory which he founded and established at Flagstaff will continue its splendid research work, for which it is so well fitted, not only on Mars, but also on the other planets, and on those mysterious objects, the nebulae in distant space.

Address of George E. Hale at Dearborn University

In the contraction of a nebula into a star, heat energy is developed in conformity with the principle of the conservation of energy. Helmholtz applied this principle to the contraction of suns in the 1860s, and his work was followed by that of Kelvin, Lane, and Ritter. It shows that if our sun has no other important source of heat, it

cannot have supplied the earth with heat for more than about twenty million years, and will not give the earth heat more than about ten million years in the future.

But physicists have found that some atoms break up into their constituent parts, in which process an enormous amount of energy is liberated. Possibly the sub-atomic energies are important sources for maintaining the heat of the sun and stars. Therefore the sun and earth may be much older and may last much longer than in the above estimate.

DECEMBER ANNOUNCEMENT

Tuesday Evening, Dec. 12—Mr. Francis G. Pease, Astronomer of the Mount Wilson Solar Observatory, will address the Astronomical Society. Subject: "The Research Work of the Great Sixty-Inch Refractor; What It Has Revealed Regarding the Motions and Structure of Nebulaet." The lecturer will also give an account of the present condition of the new 100-inch refractor, and state what it is expected to accomplish in astronomical investigations. The lecture will be richly illustrated with new photographic views.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

Information regarding class or private instruction in astronomy can be had by consulting the officers of the Astronomical Society.

ASTRONOMICAL EXCURSION AND BASKET PICNIC TO MT. LOWE OBSERVATORY

Saturday, December 30th

The excursion will leave the P. E. Station, Sixth and Main Streets, at 1:30 P. M., arriving at the observatory at 3 P. M.

There are numerous large sunspots now visible and can be seen with a magnified image before sunset.

The giant planet Jupiter is now in mid-heaven and in the best position for observation that it will be for the next ten years. Its colored belts and four larger satellites will be shown to advantage in the big telescope at the Lowe Observatory.

Dr. Albert Shiels, Superintendent of City Schools, will be a guest of the Astronomical Society. The teachers of the city schools are cordially invited to join the excursion.

The excursion fare will be $1.25 for the round trip. Will leave on the return trip about 8:30 P. M.

Tickets and information can be secured of Secretary T. L. O'Brien, 684 Kip Street. Telephones — 55191; Broadway 8173.

THE PLANETS IN DECEMBER

Mercury is an evening star far south in Sagittarius.

Venus is a morning star in Scorpio. She is moving towards superior conjunction.

Mars is an evening star in Sagittarius.

Jupiter is the most brilliant evening star. It is in Pisces.

Saturn is an evening star in Gemini.

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THE FINE CONSTELLATION AURIGA

On account of its two brilliant stars, Capella and Menkalina, this constellation is very conspicuous in the northeastern sky in the early evening. Midway between Capella and Betelgueze in the shoulder of Orion, is the bright star Beta Tauri, being in the foot of Auriga, the Charioteer, and at the same time at the end of the upper horn of Taurus, the Bull. Auriga holds a kid (Capella) in his left hand and the constellation was known to the shepherds of the Euphrates valley many thousands of years ago.

Capella is the nearest first magnitude star to the North Pole. In India it was sacred as Brahma Ridaya, the heart of Brahma. The early Arabs called it Al Rakakib, the Driver. Capella is a magnificent spectroscopic binary, about 41 light years distant from our system, and the two great suns of which it is composed together emit about 250 times as much light as our own sun. If the latter were placed at that distance it would shine as a small star of the sixth magnitude.

The two components of Capella, which shine as a single star in the most powerful telescopes, are about 52,000,000 miles apart, and revolve about a common center of gravity in a period of 104 days. There is a small companion, of the 10th magnitude some 8,000,000,000 miles distant from its double primary, or nearly three times as far away as Neptune is from the sun. What a splendid triple star system thus pictured to the imagination.

Ten degrees east of Capella is the bright star Menkalina, also known as Beta Auriga. This star is also another fine example of a spectroscopic binary, the two magnificent suns, only 7,000,000 miles apart, being obliged to revolve with a velocity of 150 miles per second, completing their revolution around common center of gravity in three days and 23 hours. Their combined mass is about twenty times that of our own sun, and their combined brightness exceeds it in splendor many times. Menkalina is flying away from our system with a velocity of 17 miles per second, but it will continue to be a second magnitude star for thousands of years to come. Of such vast proportions are the distances and magnitudes of the stars in our sidereal universe.

WONDERFUL STELLAR FORCES

The most conspicuous object in the evening sky at present is the giant planet Jupiter, the greatest world in the solar system. Jupiter is pulling upon the earth with a force, due to the attraction of gravitation, which is equivalent to about 198 million million tons. What prevents the earth from leaving its orbit and flying to Jupiter? It is swayed sensibly from the true curve of its orbit round the sun, and astronomers have been able to measure the amount of its perturbation. But the sun pulls with such an enormous force, 3,600,000 millions of millions of tons, that the earth cannot be diverted from its allegiance to the great central luminary.

"One cannot grasp the meaning of such a force expressed in figures," says Garrett Serviss. "Let us then try to illustrate what it means. A bar of steel one foot square would sustain a pull of 8,640 tons. If the bar were one mile square, it would sustain a

pull of 240,000,000,000 tons. Now it would take 15,000,000 such bars to resist the pull of the sun upon the earth. Forces of a like nature are acting upon the earth from all directions. Every planet and every star is pulling it with a force depending upon its distance and its mass. The moon would run away from the earth if the latter did not restrain it with a force amounting to 21,000 million million tons, which is equivalent to the strength of 87,500 bars of steel, each one mile thick. The nearest star in the sky, Alpha Centauri, pulls upon the earth with a force of 90,000,000 tons, while the force exerted between that star and the sun amounts to five million million tons. It is amazing to think of the cobweb of forces in the midst of which we live."

IS THE UNIVERSE LIMITLESS?

Carl Snyder says: "Nature is simple, and therefore understandable. That the universe is unthinkably vast does not imply that it is without limit. That it is composed of an unthinkably great number of suns does not imply that this number is uncountable. If it is limited in extent and in bulk, the mind of man will find a way to measure and weigh it. That its parts are unthinkably small does not imply that the process of division may be carried on indefinitely. There is probably a material substratum, either grannlar or continuous, and, if such an underlying material exists, all of its properties and actions will one day be known. At the present time there is nothing to indicate that an infinite universe exists. If it does not, if cosmos is finite, the day will come when we shall know all about it that there is to be known.

The evidence of the spectroscope seems fairly conclusive that the material of the universe is the same, and this material seems dominated by the same forces and the same laws. If, therefore, the stellar universe consists of several hundred or several thousand million suns, it is possible there are millions of other planets upon which life exists. It is conceivable, then, that hundreds of thousands are undergoing an evolution identical with that of our earth, both in character and time; in a word, that in far away places other worlds like ours are just emerging from an animal existence, from infantile superstitions, and beginning the study of natural phenomena. So far as we can see, life is simply a stage of planetary evolution. Planets, suns, and systems, come and go, wax and wane."

WHY IS SKY BLUE?

Sunlight, which we call white, is composed of light rays of different colors—red, orange, yellow, green, blue, indigo and violet. It can be broken up into its constituent colors in various ways. If it passes through a transparent prism (like the crystals that hang from a chandelier) or if it falls on a surface which has almost invisibly minute irregularities (like mother-of-pearl or the wing of a butterfly) we see the rays into which sunlight has been separated. These phenomena are observed when light is not absorbed, says Popular Science Monthly.

Hold a piece of red glass in front of flame and we see only red. Rays of all other colors have been absorbed. The natural colors of the objects we see about us, leaves, flowers, books and chairs, depend upon absorption. A green leaf throws back chiefly green rays; the rest are absorbed. So, the natural color of everything in nature is the unabsorbed residue from full white light. There is no such thing as color by itself.

A swarm of minute particles, scattered in the path of white light, will break it up, like the surface of mother-of-pearl. If the particles happen to be of just the right isze and the spaces between them just the right distance,

they will absorb rays of one color only and throw off the rest. The atmosphere is filled with countless dust particles, and their size and spacing is such that they scatter rays which we call sky blue. Nearer the horizon, larger particles turn the blue into white; this happens above a dusty town and when mists or clouds hang above us. All that is left of white sunlight, after passing through many miles of blue-scattering air, appears in the hues of sunset. The size and spacing of dust particles as well as the angle at which sunlight strikes them determines the color of the sky.

VERSATILE FEATURES OF ASTRONOMY

The science of astronomy, like all other great departments of science, has been largely specialized, and corps of astronomers are engaged in pursuing their investigations in many different fields. If we take up any special branch and diligently study it we find that we are entering an ever widening field of investigation, always opening up new realms of thought and speculation, and the whole domain of discovery ever broadens to the view, so that we gradually obtain, juster conceptions of the grand universe we are exploring.

Among the principal departments of astronomical research are the nature and constitution of the sun, the planetary system, the moon and its influence on the tides, the origin of the belt of asteroids, the strange features connected with Saturn's rings, the vagaries and ultimate destiny of comets, the sidereal universe, double and multiple stars, the fascinating speculations regarding variable stars, the myriad suns fo the Milky Way, the ever increasing and unfathomable mysteries of nebulae—perhaps island universes in the profound depths of space far exterior to our own sidereal universe.

Volumes can be written about either of the above departments of astronomical science without exhausting the subjects. We stand on this little speck of the universe which we call the earth, but our minds, equipped with the wings of imagination, and guided by sober mathematical formulae, reach out toward the infinite spaces, and behold magnificent flashing worlds flying with unthinkable velocity, but under the perfect control of inexorable law, through realms of supernal splendor. These unfettered minds are truly sparks of the divine, over ruling, all-pervading Essence of Being.

—W. H. K.

PROF. DOZIER'S LECTURE ON THE TIDES

A thoroughly scientific explanation of the phenomena of the tides was listened to with close attention by an audience which tested the capacity of the hall. Two forces—the moon comparatively near, astronomically speaking, and the sun, a mighty mass—act upon the fluid bodies which cover three-fourth's of the earth's surface. As the oceans, in the daily rotation of the earth, pass beneath these two heavenly bodies, their waters are lifted by the force of the attraction of gravitation slightly above their normal level from two to ten feet, according to the depth of the waters and the topography of the coasts. When they act together, on the same or opposite sides of the earth, a high tide is produced, but when they pull at right angles to each other we have a low tide. When there is a long narrow bay with a wide mouth, like the Bay of Fundy, the tide rushes in with great force and piles up the waters much higher than normal. The sweep and direction of the tides over the Pacific and Atlantic oceans was finely illustrated on the blackboard. Prof. Melville Dozier was formerly Assistant Superintendent of City Schools and Professor of Mathematics and Astronomy in the State Normal School.

Spiders and the Stars

Spiders as an aid to astronomy are recognized to such an extent that certain species are cultivated solely for the fine threads they weave. No substitute for the spider's thread has yet been found for bisecting the screw of the micrometer used for determining the positions and motions of the stars. Not only because of the remarkable fineness of the thread are they valuable, but because of their durable qualities. The threads of certain spiders raised for astronomical purposes withstand changes in temperature, so that often in measuring sun spots they are uninjured when the heat is so great that the lenses of the micrometer eyepieces are cracked. These spider lins are only one-fifth to one-seventh of a thousandth of an inch in diamter, compared with which the threads of the silkworm are large and clumsy.

THE PLANETS IN JANUARY

The giant planet Jupiter is still the brightest object in the heavens, being a little past the meridian at 9 o'clock. It is in the constellation Pisces.

Saturn is conspicuous in the eastern sky, in the constellation Cancer. Its rings still show to good advantage. It will continue to be the evening star for several months.

Venus is still the bright morning star, but gradually approaching the sun. It rises about an hour before sunrise, and can be seen throughout the dawn.

Mercury is an evening star, so near the sun that it will soon be invisible.

LECTURE ANNOUNCEMENTS

Tuesday evening, Jan. 9—The Society will be addressed by Mr. Wm. A. Spalding, former president of the Southern California Academy of Sciences. Subject: "Long Range Forecasts," touching upon meteorological, seismic, and cosmic phenomena. Illustrated by maps, diagrams, and blackboard sketches. Meetings at the Los Angeles High school, and open to the public.

Tuesday evening, Jan. 23—Regular meeting of the Society. Open for general discussion. Members are requested to suggest topics for the occasion. Remarkable comets of the 19th century will be referred to by the President.

Tuesday evening, Feb. 13 — Prof. Homer Martin will address the Society on the "Poetry of Astronomy," giving citations from the ancient and modern poets on this inspiring theme. It will be a classical and scholarly production.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

Information regarding class or private instruction in astronomy can be had by consulting the officers of the Astronomical Society.

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No. 9 LOS ANGELES, FEBRUARY, 1917 $1.00 per Year

Is a Great Comet Now Due?

By William H. Knight

Some of the brilliant Celestial Visitors of the Nineteenth Century.

Nine remarkable comets shone in our nocturnal skies during the 19th century, being an average of one bright comet every eleven years. Of course the number of faint and telescopic comets was very much greater, averaging about five per annum since 1870, during which period there has been a large increase in the number and equipment of astronomical observatories.

With the exception of Halley's comet, which visited us in 1910 on a return voyage from distant space, we have had no great spectacular comet since the bright one which appeared on well remembered October mornings in the year 1882, a third of a century ago.

What we are now looking for and may reasonably expect in the next few years, is a great flaming monster like some of those which have startled and alarmed the generations of the past.

It shall glare down upon us with a fiery nucleus as bright as Sirius and be surrounded by a coma as large as the planet Jupiter. Its flaming tail will extend along 40 degrees of the celestial sphere, and measure 100,000,000 miles in length. Coming from the far depths of interstellar space, it will bear down upon our little family of worlds in the neighborhood of the sun with the unthinkable velocity of 50, 100, or even 200 miles per second.

The fortunate discoverer of this hypothetical visitor will be sweeping the heavens with a comet-seeker some starry night in the near future and his attention will be suddenly arrested by a faint, nebulous object floating into the field of his telescope. He hurriedly leaves his eyepiece, rushes to his library, and nervously scans the pages of Dreyer's catalogue of Nebulae. The object he has been examining is not in the list. It is then a hitherto uncatalogued nebula, or a comet, with a high probability that it is the latter, in which case its motion will soon be detected.

The astronomer eagerly resumes his observations; and after an almost agonizing watch of several hours, at length assures himself that it is approaching one of the adjacent stars, and is receding from the opposite one. Yes, this tiny patch of cloud, so faint that only the sharp eye of an astronomer can detect it, actually moves, it is, a veritable comet.

He instantly telegraphs the discovery, if in America to the Harvard Observatory, or if in Europe to Berlin; and from these centers the news is transmitted to every observatory in the world and in less than 24 hours it is published in all the newspapers in both continents, every telescope is turned upon the approaching stranger, and it is welcomed into our solar family with a right royal welcome, for there is a possibility that it may have a brilliant career and become one of the famous comets of the age.

The first business of the astronomer is to note the exact position of the comet in three successive observations, taken several days apart. From these data, and from abstruse calculations based upon them covering hundreds of pages, a probable orbit will be deduced, and he will be able to determine the future course of the stranger; whether it will approach the vicinity of the earth, or is headed for some far distant point; whether it is pursuing a closed elliptical orbit, in which case it will return to us again at some future time, or is coming down to the sun with such tremendous velocity that after wheeling round that orb it will rush off again into distant space along the curve of a parabola, and finally leave the dominion of the sun and after a journey covering aeons of ages, plunge with equal impetuosity into the heart of some other stellar system—that of Alpha Centauri, or Sirius, or Procyon, or Capella, or Aldebaran.

Of the great comets that flashed into our skies during the 19th cen

tury, the first very conspicuous one was that of 1811. It was a magnificent object, with a flaming appendage 25 degrees in length, about the distance between Sirius and Procyon, and of the extraordinary breadth of six degrees. The two outer stars of Orion's Belt are three degrees apart. This comet was visible to the naked eye for many months and was followed by the telescope for a year and a half. It will not return to us again until it has accomplished a journey that will take it out into space 40,000,000,000 miles, a distance of fourteen times farther than the orbit of the outer planet Neptune, and that will consume a period of 3065 years.

How much space on the page of history will be occupied by the presidents of our republic, the premiers of Great Britain, the Kaisers of Germany, the authors and philosophers and commercial magnates of the present age, when the great comet of 1811 again flashes into our skies?

A long period of 24 years elapsed before the next notable comet—that of 1835—appeared. It was Halley's periodic comet, and its advent had been predicted. It exhibited a tail 47 degrees in length, or half the distance from the horizon to the zenith. Its period is 75 years and it visited us again in 1910, as all present will remember. It was a brilliant object in the early mornings of the month of May in that year. At perihelion it came midway between Mercury and Venus, moving with a velocity of 30 miles per second. It will reach its aphelion, 3,000,000 miles beyond the orbit of Neptune, about the middle of this century, and will then be moving at a snail pace of only three miles per second. How many persons in this city will live to see its return in 1986? Astronomers have traced its previous appearances from historic allusions presumably referring to it as far back as the year 11 B. C.

The next comet to attract universal attention was the brilliant object which startled the world in February, 1843, eight years after Halley's had disappeared. It came up from below and unheralded, and with a velocity of 266 miles per second swung across the face of the sun and so close to its surface that it must have grazed the corona, the pearly emanation seen in total eclipses. It came within 77,000 miles of the sun's surface and it seems marvelous that the mighty attraction of that body did not arrest its progress and absorb the tenuous object in its fiery bosom. But the swift comet escaped and projected a tail of pure white light at an estimated distance of 200,000,000 miles into space, more than twice the distance of the earth from the sun. As I saw it at the age of seven this wonderful band of light extended from the horizon to the zenith, and it made a clear and indelible impression on my mind.

As the Comet of 1843 moved in a parabolic orbit it is believed that the velocity with which it flew away from the sun was sufficient to carry it beyond the control of that body. Might it not then pass across the border line into the sphere of influence exerted by the nearest stellar world—Alpha Centauri, four and a third light years distant. Then, rushing with unabated energy through that brilliant system it would, perhaps, speed next in the direction of the blazing double suns Sirius and his companion, eight and a half light years distant, and so, in restless wanderings, it would visit star after star, exciting the wonder and admiration of inhabited worlds, till eventually, after the lapse of millions of aeons in tireless flight, it would at last get tangled up and lost amid the mazes of the 2300 worlds which compose the miniature universe known to us as the Pleiades. What a journey of infinite surprises it would be if we could take passage on board such a comet! But there would be interminably long waits between stations.

Fifteen years after the brilliant apparition of 1843 the splendid comet discovered by Donati illumined the midnight skv. It was at its brightest in October, 1858, and is well remembered by many persons now living as one of the finest celestial objects they ever witnessed. It threw out a tail 45,000,000 miles in length, and at one time the bright star Arcturus shone through this shimmering appendage with undimmed splendor. The tail was gracefully curved like a scimitar brandished by a celestial giant, due, it was claimed, to the rapid sweep sweep round the perihelion curve—a great contrast to the sluggish motion of less than one-fourth of a mile per second while traversing its aphelion eleven hundred years ago, at a distance of 15,000,000,000 miles from the sun.

The generations living towards the end of the 39th century will anticipate with eager interest the return of this

wonderful stranger. Its motions, behavior, constituent elements, and vagaries, will be studied with the marvellous agencies and instruments of that advanced age of achievement, and by astronomers and physicists of transcendent genius, who will con the meager data vouchsafed by the records of 1858, and will add their rich store of observations, deductions and conclusions, to be handed down to their successors of the 60th century, even as Seneca preserved and recorded his notes of the great comet 2000 years ago, for the grandeur and value of a phenomenon then uncomprehended, was thus snatched from unmerited oblivion.

As in the case of Encke's comet the diameter of the nucleus of Donati's comet continually diminished as it approached the sun. On July 19 it was 5600 miles in diameter, about two-thirds the diameter of the earth; on August 30 it was 1000 miles less in diameter; on September 23 it was only 1280 miles; and on October 5 was reduced to the comparatively insignificant figure of 400 miles.

What is the explanation of this strange diminution of the nucleus? When the comet is at the zero temperature of distant space its gases are frozen into solid particles and are thus capable of reflecting the rays of the sun. But when the comet draws nearer the sun and is subjected to the increasing heat of his rays, the outer layers of frozen particles are melted and become transparent, and only the inner core of solid meteoritic material reflects the sun's rays.

And it is these melted gases, continually agitated by convection currents, like the boiling water of a tea kettle, that doubtless projects those luminous envelopes towards the sun while the impact of the sun's rays projects fine luminous particles from the comet out into space in a direction opposite the sun.

A bunch of comets made their appearance suddenly and unexpectedly in the years 1860, 1861, and 1862, respectively. That of 1861 was the most notable from the fact that on June 30 of that year the earth passed through its tail, which was a trifle of 24,000,000 miles in length. But the only visible evidence of being enveloped in that extremely tenuous substance was a singular yellowish phosphorescent glare pervading the overhead atmosphere, something like a diffused aurora borealis. Fifty years later, in 1910, the earth passed through the tail of Halley's comet and it likewise proved to be entirely harmless.

Just a dozen years now elapsed before the advent of Coggia's great comet of 1874. On July 3 its tail was 25,000,000 miles long, and on July 21 the comet was only 26,000,000 miles from the earth and in a good position for observation. Remarkable changes occurred in the gaseous envelopes of the nucleus. Successive layers were projected forwards and then trailed back into the tail, which at one time was 43 degrees in length. Coggia's comet requires a period of 57 centuries to make an entire revolution in its highly elongated orbit; consequently it was last previously seen about the time Jacob's Ladder formed a highway between earth and heaven. Perhaps our brilliant comet was the angelic light he saw at the top.

It was only eight years after Coggia's comet vanished from our sight in 1874 when one of the most remarkable comets of the century adorned the morning skies of September, 1882. Its nucleus was greatly elongated and it divided while under observation into four bead-like nuclei, as if a process of disruption were going on, caused either by the intense heat of the sun, or by the unequal attraction of that body on the different parts of the great non-cohesive bulk of the comet. Some of the orbital elements approximated those of the great comet of 1843, and also of two comets known as those of 1880 and 1887 which shone only in the southern hemisphere. These four comets, namely, 1843, 1880, 1882 and 1887, all passed quite near the sun at their respective perihelions, and were called the "four sun-grazers." It has been intimated that they had a common origin, or came from a common source in distant space. It is, as yet, an insolvable mystery.

It is now 35 years since the great comet of 1882 was the subject of careful observation and keen speculation, and it is high time that a new one with striking features and huge proportions should grace our celestial scenery. Many improvements have been made in astronomical equipment during the third of a century which has elapsed, and we shall study the new stranger, not only telescopically, but photographically and spectroscopically as well. We bid hearty welcome to the approaching but as yet unseen guest.

CASSIOPEIA, THE BEAUTIFUL

This interesting constellation is generally recognized by the group of stars known as Cassiopeia's Chair. But one of the chair stars is rather faint, and the remainder of them forms the well known irregular letter "W," which, once traced, is never forgotten. Alpha, at the left foot of the chair, sometimes known as Schedar, was formerly the brightest, but at present Beta, at the right foot of the chair, slightly excels Alpha in luster. Polaris lies midway between these stars and the Dipper.

Cassiopeia was the wife of King Cepheus and the mother of beautiful Andromeda who was chained to a rock, but was rescued from a sea monster by the gallant Prince Perseus. It was near the faint star of the chair that the famous nova of 1572 suddenly burst forth and shone for a short time brighter than Venus. It was the first of the novas to attract scientific attention, and led Tycho Brahe henceforth to devote himself to astronomical research.

AT LOWE OBSERVATORY

A trip to Southern California is not complete without including Mt. Lowe and the Lowe Observatory, where the great 16-inch refractor is open to visitors Saturday and Sunday evenings. Prof. Edgar L. Larkin, the noted scientist and astronomer, is in charge.

LECTURE ANNOUNCEMENTS

Tuesday evening, Feb. 13 — Prof. Homer Martin will address the Society on the "Poetry of Astronomy," giving citations from the ancient and modern poets on this inspiring theme. It will be a classical and scholarly production.

Tuesday evening, Feb. 27.—Prof. Melville Dozier will address the Society on the Seven Solar and Lunar Eclipses of the Year 1917. An orrery and blackboard diagrams will illustrate the lecture.

SPECTROSCOPIC BINARY

I have a Bulletin (No. 288) from the Lick Observatory, covering six large quarto pages, detailing the result of three years' observations of the binary h4 Centauri. This star belongs to the spectral class B5, which is included in the group called Orion or helium stars. The period of this binary is nearly 7 days—to be exact, 6.927 days. The combined masses exceed that of the sun several times, but their ratio to each other is problematical because the inclination of their orbit is not known, but is suspected to be about 44° to the angle of vision. In that case A, the larger one, would be about four times the size of B, the smaller one.

The parallax of this binary is too small to be definitely assigned, but as an approximate result of 3 measurements, is hypothetically fixed at 0.007, which would mean a distance of about 460 light years. As it is nearly of the 4th magnitude, a star at that distance must necessarily be a gigantic sun.

Address of Forest Ray Moulton on Mathematical Astronomy, at Semi-Centennial of Dearborn University

The one central law on which all discussion of celestial evolution is based is the law of gravitation. That law, as it was expressed by Newton in 1688, is correct to a degree of approximation that has not been attained in any other branch of science.

The great Frenchman Poincaré, whose brilliant genius has dazzled the whole world, produced a work on the problem of three bodies which owed its inspiration to George W. Hill, of Washington, who, in a brilliant series of papers in 1877, inaugurated a new epoch in the Lunar Theory. Hill was highly original, but Poincaré added to originality and the highest order of genius a perfect command of all the resources of modern mathematics. Unquestionably his work will stand out for centuries like that of Newton and Laplace.

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A New Spiral Nebula

Evidence of Its Astounding Internal and Radial Velocities

By William H. Knight

In his interesting lecture before the Astronomical Society a few weeks ago Astronomer Francis G. Pease of the Mount Wilson Solar Observatory, manipulator of the great 60-inch reflector, spoke of a spiral nebula whose remarkable motions have recently been noted, both at Mount Wilson by Mr. Pease, and at the Lowell Observatory by Mr. Slipher.

A photograph of the nebula shows it to be a spiral, seen almost edge on. The nebula is crossed by a dark streak which appears to absorb or obstruct the light. This streak seems to lie at the periphery, being possibly an outer ring of cooler material, or perhaps the unilluminated edge of the thin disk of nebulous matter surrounding the brilliant nucleus.

The radial velocity of the nebula away from the observer is 1180 kilometers (731 miles) per second according to Pease, and a few miles less according to Slipher. An equally surprising rotation velocity is also detected. At a point two seconds of arc from the center of the nucleus the apparently tenuous substance of the nebula seems to be whirling with a speed of 330 kilometers (204 miles) per second.

This high velocity of rotation is opposed to our conceptions of the stability even of a solid body. It is still more inconceivable that a nebulous object should rotate with such an enormous velocity without throwing off large masses of its content at its outer edge.

When we reflect that Mercury, the swiftest of our planets, flies in its orbit near the sun only at the rate of 30 miles per second, and that the phenomenal comet of 1843, almost grazed the photosphere of the sun with a computed velocity of 266 miles per second—the swiftest motion of any heavenly body hitherto recorded, what then must we think of a vast body, perhaps exterior to our own sidereal universe, darting away from the mighty aggregate attractions of all the vast congeries of mighty suns in our own universe with the unthinkable velocity of 730 miles per second? We cannot help wondering if the observations of two reputable astronomers, each provided with powerful instruments, are accurate and dependable, and their conclusions reliable. On what a magnificent scale are the phenomena of world systems being carried on in the profound depths of space beyond the exterior boundaries of our own sidereal universe.

WHAT A NOVA DISASTER MAY MEAN

The telescope and the camera disclose the existence of about 500,000,000 stars down to the 19th magnitude, and all these stars are suns—many of them doubtless dispensing light and heat to surrounding planets. That these blazing suns are in rapid motion was one of the discoveries made by Edmond Halley, whose name is identified with the great comet of 1910. The stars in this maze of worlds are moving with varying velocities, from two miles per second to the enormous

speed of more than 100 miles per second in some instances. Moreover they seem to be moving in every conceivable direction, some of them across the line of sight, and others towards or away from, our solar system.

But there is reason to believe that there are even more dark worlds, planets or extinct suns, than of those which are shining by their own light.

Now, when a star like 1830 Groombridge is rushing to its unknown goal with the tremendous velocity of 150 miles per second, 200 times faster than a shot leaves the cannon's mouth, what is to prevent this celestial derelict from plunging into some one of the thickly strewn worlds of the visible universe that may be lying near its path.

Here let us give play to our imagination and behold a massive dark world, ten times the size of Jupiter in dimensions, coming from infinite space, and headed towards the solar system. What would be the consequence? When it had reached a distance six times that of Neptune, say 17,000,000,000 miles, it would become telescopically visible, shining by the reflected light of the sun. It would require 34 years to traverse the space which would bring it to the orbit of Neptune, when it would shine like a star of the fifth magnitude. Meantime its precise course would be accurately determined by astronomers.

They would find, perhaps, that it would safely pass down through our maze of planets, satellites, asteroids and comets, without colliding with any of these bodies, but they might not be quite certain whether it would clear the great central sun in its wild course. In less than three years from the time it passed Neptune's orbit it would glide with fearful velocity past the earth—a huge ball of light, 43 times the diameter of the moon. By this time the astronomers would know that in 19 days, on a bright June morning, at 5 a. m., the vagrant world would crash into the eastern limb of the sun, and the result could be fairly well forecasted. Both worlds would be almost instantaneously shattered. The heat generated would melt and vaporize the most intractable substances known.

The mutual explosions of the two bodies would send myriads of fragments far out into surrounding space, and some of them would presently go whizzing towards and past the earth. But the most terrifying effect for dwellers upon the earth would be the emission of overwhelming masses of fiery mist with its tongues of many colored flames which would be shot out so far as quickly to envelope the earth and other planets, till they reached a distance far, far beyond the orbit of Neptune.

And astronomers in other starry systems would observe a grand Nova shining out with phenomenal splendor in this part of the sidereal universe, and presently they would note a new nebula of dull luminosity spreading over an immense field in this region of their sky.

For years before the impending catastrophe dwellers on the earth would be haunted with a vague fear of a terrible doom that the most skillful engineers and scientists would be unable to avert. The rich and the poor, monarchs and peasants, the powerful and the weak, masters of ruthless corporations and the humblest workmen, would alike be involved in the overwhelming catastrophe. Everything combustible would be consumed in a few hours after the fierce outburst of flames had reached the earth and thenceforth it would roll a blackened planet, its mighty cities, its vast forests, its proud warehouses, its thundering railway trains, its majestic steamships, its orchards, vineyards, and smiling fields of grain, and every living creature, all, all, buried in one holocaust of oblivion.

Why do I invoke your imagination to contemplate such a scene of ruthless devastation? Within historic times, and since Hipparchus had his attention drawn to a star shining with unaccustomed brightness, in the year 120 B. C., 29 novae, or new stars have been recorded up to the present time. None of them so far as we know were less than 100 light years away, and therefore they must have been intrinsically great suns.

If only one out of ten of those suns had inhabited planets revolving round them, then at least three worlds, possibly comparable with our earth in the evolution of living beings, would be involved in a catastrophe similar to the one I have pictured to your minds.

Then again, it must not be forgotten that our solar system, the mighty sun and all its circling planets and lesser worlds, is moving with a speed of twelve and a quarter miles per second, more than a million miles per day, or approximately four hundred million miles per year, and at present in a direction towards the bright star Vega, almost on the border of that wonderful star stream—the Milky Way.

We know not what strange, vagrant worlds, as yet unseen and undreamed of, our sun may encounter in its undeviating path towards those shimmering worlds in the Galaxy. But we do know that for some millions of years in the remote past, humanly speaking, while the earth life has been evolving from protozoa to intelligent man, no such catastrophe has overtaken us.

We know furthermore, that among the 500,000,000 suns of which our camera takes note, there have been only 29 recorded cases of probable world collisions in the last 2000 years. Therefore the chances for harm from such a source are reduced to an almost infinitesimal minimum, and we have the strongest reasons for indulging in perfect optimism. My object has been to give you a realistic picture of what may have happened in one of those burning worlds in distant space that have occasionally blazed forth with unwonted splendor and challenged the attention of thoughtful minds. —W. H. K.

FOUR GIANT PLANETS

There now shine in the evening skies the two largest planets in the solar system. The giant planet Jupiter is a little west of the meridian in the constellation Pisces—the Fishes. Below the western fish is the bright star Fomalhaut in the Southern Fish.

The other giant planet, Saturn, the most wonderful object known to us in the heavens, has for several months been nearly in a line with the Twin stars Castor and Pollux, and is now extending easterly from the latter towards Cancer, the Crab. The latter constellation is not marked by any bright stars, but within an irregular quadrilateral of small stars is a very interesting cluster known as Presepe, the Bee Hive. It shows very well in an opera glass.

You will remember that a year ago Saturn was in Gemini, but since that time it has moved half a zodiacal sign to the east. It takes Saturn 29½ years to complete the circuit of the celestial sphere, thus moving over a little less than half a sign each year. The great planet is still very favorably situated for observation in telescopes. It is nearly in opposition, and its rings are tilted at an angle that gives them a very beautiful and picturesque appearance.

Ancient astronomers only knew five planets—Mercury, Venus, Mars, Jupiter, and Saturn, for the earth, far from being a planet, was supposed to be the center of the universe. The periods of revolution of the planets named were well known, and the ancient astronomers rightfully inferred that Saturn was the most distant.

In the eighth edition of an astronomy published by Joseph Harris in

1757, 160 years ago, the distance of the earth from the sun was set down as 81,000,000 miles. We now know it to be about 93,000,000 miles. The whole scheme of the solar system was at that date correspondingly reduced. Accordingly the distance of Saturn was given as 777,000,000 miles. We now know it to be 886,000,000 miles. It was then regarded as the outer planet and the farthest limit of the system.

But a quarter of a century later—in 1781—Sir William Herschel discovered the planet Uranus, 1,782,000,000 miles distant, twice the distance of Saturn, and this important discovery enormously extended the limits of the solar system. No wonder it gave Herschel immediate and lasting fame. Six years later he discovered two of its four satellites. And it was by the perturbations of the planet Uranus in its orbit that Leverrier was enabled to demonstrate the existence of still another planet beyond Uranus, which he did in 1846.

But Uranus and Neptune are respectively 32,000 and 34,000 miles in diameter, and although they are giants as compared with the earth, both together are not equal to the dimensions of Saturn, which is 72,000 miles in diameter—more than nine times that of the earth, and 760 times its bulk.

The astronomer of 1757 said that Saturn has no less than five satellites. We now know that it has no less than ten, and that the two outer ones move in a contrary direction—retrograde. In that year, 1757, Herschel was nineteen years old and emigrated from Germany to London, where he became a leader of a military band. Years afterwards, becoming interested in astronomy, he constructed his own telescope with which he made notable discoveries besides that of Uranus.

In mythology Saturn was originally the Greek god Cronus, which name was changed to Saturn in ancient Italy. Cronus was the youngest of the Titans—the children of Sky (Uranus) and Gaea, the earth. Cronus (Saturn) swallowed all his children except the youngest, Zeus, whose name was changed in Italy to Jupiter, and who became the chief deity. All the planets and their satellites have received mythological names, those known in ancient times having received their Greek names as early as the fourth century B. C.

Of the ten satellites of Saturn, the largest, Titan, is upwards of 3,000 miles in diameter, being a third greater than that of our moon, and surpassing the planet Mercury in size. Its distance from Saturn is 771,000 miles, or nearly three times that of the moon from the earth, but the powerful attraction of its primary compels it to perform its great revolution round that body in sixteen days, or but little more than half the time our moon completes its very much smaller journey round the earth.

The nearest satellite, Mimas, only 117,000 miles from Saturn, flies round its orbit in the brief time of a trifle more than 22½ hours, while the farthest one, little Phoebe, distance uncertain but about 6,000,000 miles, requires about one and a half years to complete its long journey. It is so small that it can be detected only in the most powerful telescopes, and it has a retrograde motion. It has been surmised that at some very remote period of its history it was a comet coursing from distant space down towards our sun, but its path chancing to be near the great planet Saturn, that powerful body captured the wandering comet and annexed it forever to its numerous satellite family.

LEO AND THE SICKLE

One of the fine constellations now advancing in the eastern sky is Leo, the zodiacal Lion. Its well-known group of stars forming the Sickle is one of the most striking objects in the heavens. Regulus, at the end of the handle, is a first magnitude star with a parallax that gives it a distance of

35 light years, consequently the rays which excited our optic nerve last evening, left that giant sun more than a third of a century ago, in the year 1882. Children born that year are now engaged in doing the world's work in business, professional, and other departments of life.

If you should draw a line from the North Star through the pointers of the Dipper, and continue it to Leo, it would nearly impinge upon Regulus, which is almost exactly on the ecliptic. About 25 degrees east of Regulus is the bright second magnitude star Denebula, in the Lion's tail. The blade of the Sickle forms the shoulder of the Lion, and Regulus marks the heart, from which fact it is sometimes called "Cor Leonis"—the heart of the lion. The point from which the Leonid meteors radiate, producing brilliant meteoric showers three times during each century, lies within the curved blade of the Sickle. The next great Leonid showers will be due about the middle of November in the year 1934.

The second star from Regulus is the beautiful double, Gamma Leonis, sometimes called Algeiba. A telescope of moderate power reveals two stars with complementary colors. A more powerful telescope shows Regulus to have a small distant companion which is characterized by a deep blue color.

Prof. Edgar L. Larkin, the noted astronomer and scientist, will be at home to his many friends and astronomical students, Saturday and Sunday of each week, at the Mt. Lowe observatory.

LECTURE ANNOUNCEMENTS OF THE ASTRONOMICAL SOCIETY

Tuesday Evening, March 13—The Society will be addressed by Willett L. Hardin, Ph. D., consulting chemist, investigator of new processes. Subject: "Radio-Activity; in the Laboratory and from a Cosmic Point of View." How is radium related to the permanent temperature of the earth and also of the sun?

Tuesday Evening, March 27—Prof. H. LaV. Twining, of the Polytechnic High school, will give his views of "The Constitution of Matter." He will elucidate his theory of ether, electrons, ions, chemical elements, and their interaction. Illustrated by lantern views.

Tuesday Evening, April 10—Prof. D. S. Swan, of the Los Angeles High school, will talk on an astronomical topic to be announced later.

Tuesday Evening, April 24—Prof. Arthur W. Nye, Department of Physics, University of Southern California, will address the Society. Subject: "The Laws of Light," with beautiful lantern views showing the formation of wave fronts and their interference, reflection, refraction, etc.

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THE ASTRONOMICAL SOCIETY OF LOS ANGELES

Meets at the Los Angeles High School, North Hill street, on the second and fourth Tuesday evenings of each month, except July and August. Annual Dues $1.00.

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Grand Easter Ceremonial

on Mount Lowe, April 8th, 1917

Easter will be celebrated at sunrise with music, addresses, and other appropriate exercises on a spur of Mount Lowe above Alpine Tavern at an altitude of 5,500 feet—more than a mile above the sea—on Easter morning.

Guests at the hotel and adjacent cottages will be summoned at 5 A. M. and will proceed in a body up the romantic winding road to a picturesque group of rocks above Inspiration Point, to witness the first streaks of dawn, and the sun bursting forth into day above the distant mountain tops. This pinnacle was dedicated as Easter Rock a year ago and will henceforth be devoted to annual Easter services.

This year a fine double quartette of trained voices will render selections suited to the occasion, and a grand chorus of jubilant singers will make the welkin ring as the sun rises in glory above the horizon and sheds his beams of living light over the far-stretching landscape and distant sea.

There will be nothing comparable with this magnificent occasion anywhere else on the habitable globe. It will be an event ever to be held in the memory of all who may be present.

PART OF THE PROGRAM

5:10—Grand March from Alpine Tavern to Easter Rock.
5:25—"Salutation of the Dawn," Double Quartette. Organ accompaniment by Mrs. Hammond.
5:30—Invocation, by Chaplain Orville J. Nave.
5:35—Hymn, "The Morning Light Is Breaking." (Will be sung by the assembled throng.)
5:40—Brief passages from the Bible, Chaplain Nave.
5:45—Poem, "God of the Open Air," from Henry Vandyke. (Reading by Dr. J. A. Baber.)
5:50—"Palm Branches," Male Quartette.
5:55—Address, Dr. Merle Smith, Pastor First M. E. Church, Pasadena.
6:00—Hymn, "All Hail the Power of Jesus' Name." (By the congregation.)
6:05—Short Poem "On the Mountainside."
6:10—Short Poem, "The Gates of Morning."
6:15—"Hallelujah, Christ is Risen," Double Quartette.
6:20—"The Soul Shall Rise Again," Vivid Sketch.
6:25—Hymn, "Joy to the World, the Lord is Come." (By the congregation.)
6:30—Benediction, Chaplain Nave.

Fare, round trip, $2.00. Cars will leave P. E. Station on April 7th at 9 and 10 A. M., and at 1:30, 4, 9, and 12 P. M.

Grand Astronomical Excursion

to the Lowe Observatory, April 7th, 1917

Members of the Astronomical Society and their friends, and all others interested, will join an astronomical excursion to the Lowe Observatory to view Saturn and its rings and satellites, and other objects of great interest, through the large 16-inch telescope presided over by Professor Edgar Lucien Larkin. To many this opportunity will be the event of a lifetime. Special rates for the excursion have been arranged for by Secretary T. L. O'Brien of the Astronomical Society. Address, 684 Kip street. Phones 55191 and Broadway 8173.

Both of these notable events can be enjoyed on one railroad fare.