

Vacant Regions in the Milky Way

Herschel's "Windows of Heaven"

By Mary Proctor

THAT vacant regions of apparently absolute darkness prevail amid the luminous clouds of stars in the Milky Way has been shown by the photographs taken by Prof. E. E. Barnard of the Yerkes Observatory. In these marvelous galactic landscapes, bright, cloud-like masses furrowed by dark rifts and dusky lanes are revealed, indicating seemingly the eventual breaking up of the material forming the Milky Way into many small but independent nebulae. According to the theory of Sir William Herschel, these black openings amid the starry regions of the Galaxy denote the ravages of time and are among the most impressive of celestial phenomena. "Hier ist wahrhaftig ein Loch im Himmel" (Here, truly, is a hole in the sky), he is said to have remarked to his sister Caroline, when, after a long, awful silence, he concluded his examination of a black opening four degrees wide, in the constellation of the Scorpion. It was specially remarkable, as it bordered on the west of an exceedingly compact cluster (Messier's No. 80), possibly formed, he thought, by stars drawn from the adjacent vacancy. The chasm was to him one of the most impressive of celestial phenomena. Night after night, and year after year, he returned to the study of this strange dark abyss without ever clearing up the mystery of its origin.

Since the days of Herschel, we have become more familiar with the peculiarities of these vacant regions in the star depths, by means of the photographs obtained by Prof. Barnard. Yet we are not much nearer the solution of the problem concerning these gloomy deserts of the sky. Are they actual rifts amid dense layers of stars, the "Windows of Heaven," as Herschel termed them, giving us a glimpse of the immensity of space beyond; or are these dark spaces in the sky due to absorbing matter between us and the stars? According to the theory advanced by Prof. Barnard, such matter must, in many cases, be perfectly opaque, for in certain parts of the sky the stars are apparently blotted out. Elsewhere we see them dimly as through a veil, as though a vast nebulous mass drifted between us and the stars. "It is hard to believe in the existence of such matter on such a tremendous scale as is implied by the photographs. As to its nature, if it does exist," according to Prof. Barnard, "it must be in some way related to the nebulae, for we find them in most cases to be intimately

connected. Is it an ultimate condition of nebulous matter, or is it something wholly different from the ordinary nebulosity of the sky?" It is believed stars run through their various stages of brightness, until in the course of their career they fade from view, drifting like black cinders through space, undetected save where the spectroscope betrays their influence on glow-

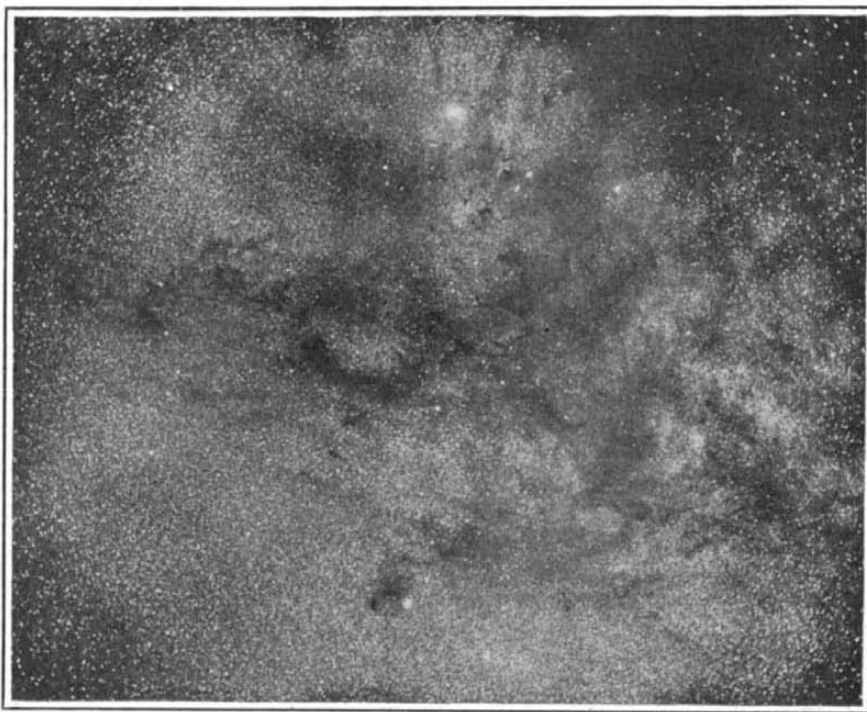
of clouds of stars interspersed with dark rifts, separated by luminous wisps and tendrils, as though a celestial breeze had wafted them apart. Pointed arches, intricate passages, and key-hole apertures enhanced the general effect, which was all the more remarkable, as feelers were observed which reached outward toward nebulae and clusters and intertwined themselves around outlying stars like tendrils clinging around a vine. Nevertheless, these visual records of barely perceptible details, in the Milky Way, cannot begin to compare in value with the elaborate wealth of detail shown in the photographs of this region obtained by Prof. Barnard.

In a paper read before the Astronomical and Physical Society, December, 1905, entitled "Vacant Regions of the Sky," he gave the following account of a small star cloud in Sagittarius which can be readily seen with the naked eye: "The photographs show this cloud to be specially remarkable for two black holes in its upper part. The east side of the larger hole is very sharply defined, the cutting off of the stars and the apparently feeble nebulous light is remarkably abrupt, as if someone had drawn its outline with a brush and black paint. The west side of the hole shoals slowly and is not abrupt. So definite is this spot that several astronomers have thought that it may not really be a hole, and that it is perhaps an opaque mass of some sort that cuts off the light from this part of the Milky Way, against which it is seen in black relief. My own opinion is that it is a true hole through which we look out into space beyond

where there are no more stars. In the hole is a conspicuous star which has a small attendant preceding. There are one or two other minute stars in the hole."

Another photograph taken of a "long, dull vacancy" visible to the naked eye, in a region near Theta Ophiuchi, resolves itself by means of the camera, into an irregular rift almost encircling the bright mass within which the star is placed. Furrowing lanes for itself through the nebulous star mist north of Theta, and straggling westward to the edge of the photographic plate, it finally connects with vacant regions of the sky in the neighborhood of Rho Ophiuchi. This is a fine but wide double star, and in speaking of it, Sir John Herschel describes it as being on "an intensely black background in a great blank space." The latter

(Continued on page 511)



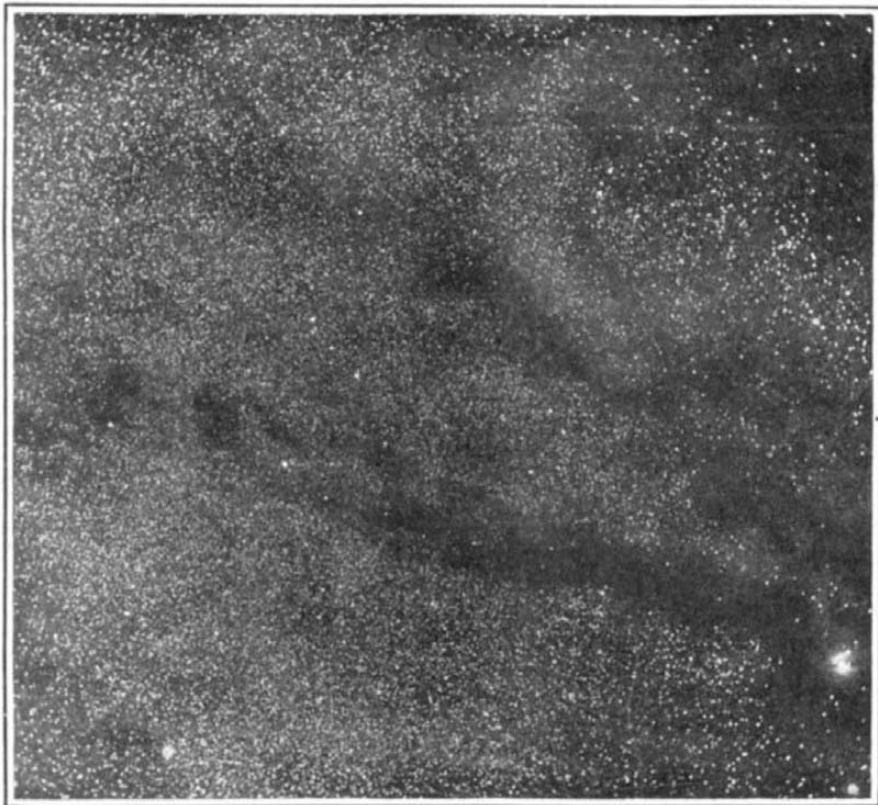
Photographed by Prof. E. E. Barnard.

The remarkable dark vacancies north of the star Theta Ophiuchi.

This photograph was made with the 10-inch Bruce telescope of Yerkes Observatory on May 8th, 1905. The plate was exposed three hours and thirty minutes.

ing suns. In like manner the nebulae may run their course during vast æons of time, drifting like derelicts along the Silver River of Heaven, as the Milky Way has been fancifully termed by the Japanese. "The dying out of nebulae," says Prof. Barnard, "is a probability fully as warranted as the belief and certainty that the stars must die."

The frequency of the black openings in the Milky Way, dimly seen with the naked eye in some cases, constitutes one of the most important facts, confirming their appearance as tested by the camera. An admirable delineation of a doubly perforated star-cloud, which forms part of the vivid scenery of the Milky Way in Sagittarius, was completed at Parsonstown in 1889, by Dr. Otto Boeddicker, after five years of labor. The result was a drawing showing a curious blending



The vacant lanes between Rho and Theta Ophiuchi.

This photograph was made on June 3rd, 1905, and plate was exposed exactly four hours. The instrument used was the 10-inch Bruce telescope of the Yerkes Observatory.



The great nebula of Rho Ophiuchi and the vacant lanes.

This picture was made on April 5th, 1905, with the 10-inch Bruce telescope of Yerkes Observatory. The exposure was four hours and thirty minutes.

HOLES IN THE SKY

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Vacant Regions of the Milky Way

(Continued from page 499.)

part of this description is true enough, according to Prof. Barnard, for this star is in one of the most remarkable of the blank regions of the Milky Way. Little, however, did Sir John dream when he spoke of the "intensely black ground" that Rho Ophiuchi was really the central point of a strong condensation of one of the most remarkable nebulae in the entire heavens.

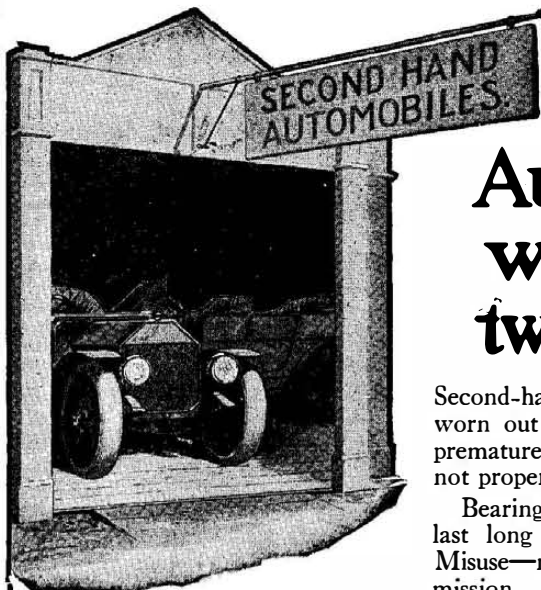
For many years this part of the sky attracted the attention of Prof. Barnard, until a photograph made by him, at the Lick Observatory on March 23rd, 1895, showed a vast and magnificent nebula in this region of the Milky Way. It was intricate in form, and apparently connected with many of the bright stars of that region, including Antares and Sigma Scorpii. The entire nebula occupies a vast vacancy among the stars here, from which lanes, absolutely devoid of stars, run eastward for ten or twenty degrees. From its dimensions, its individual peculiarities, and its occupation of a region almost devoid of stars, this nebula has scarcely an equal for interest in the entire heavens. To all appearances, the great nebula is located in a hole in a very dense part of the Milky Way.

The most singular feature, however, of the chasms visible in the Milky Way, is the presence within them of two gradations of obscurity, resembling the apparent blackness within the marginal umbrae of sun spots. The conviction is thus enforced that the Milky Way in the neighborhood of Rho Ophiuchi rests upon a far-reaching stratum of nebulous matter. Yet in regions thick with stars, such as are found in Ophiuchus and Scorpio, vacancies can be found within vacancies. "These regions," to quote Prof. Barnard, "seem veiled over with some sort of material in which occur blacker spaces, as if all this part of the sky were involved in a thin, faint, nebulous sub-stratum which partly veils the blackness of space beyond. In this, apparently, occur rifts and openings giving us a clear view of space."

It is, undoubtedly, by careful study of photographs of star-denuded regions, such as those taken by Prof. Barnard at the Lick Observatory and in the clear skies of Mount Wilson, California, that we can obtain some idea of their peculiarities which have an important bearing on the structure of the universe. These vacant regions are not merely curiosities of the sky, but actualities of the utmost interest, and as well worthy of study as the nebulae with which they seem in many instances so intimately connected.

In fact, the connection of nebulae with vacancies, and the apparent blending of the outer portion of the nebulae with the darkness of the sky beyond as if that darkness were something really tangible, is an extremely important feature. Prof. Barnard is of the opinion that it may some day develop facts of the greatest importance in explaining the real structure of the heavens. For this reason, he is endeavoring to locate all these vacant regions of the sky, and to make long exposure photographs of them. In addition to the extraordinary regions of Ophiuchus, Scorpio, and Sagittarius already mentioned, he has succeeded in securing a photograph of an extraordinary region in Taurus. Narrow, vacant lanes tunneling a nebulous groundwork, seem to actually exist in this region independent of the stars. Besides the lanes, the photographs show a large nebula apparently in a hole almost devoid of stars, from which one of the lanes extends several degrees to the southeast.

Only a small part of the nebula is bright, the rest being feebly luminous like the dying embers of a fire. Possibly the hole and dark lanes may be the major portion of the nebula now dead or non-luminous. The picture conveys the idea that this non-luminous portion of the nebula "actually causes the apparent vacancy by cutting out the light from the stars." At any rate, this is what the picture suggested to Prof. Barnard, though he remarks, in an article published in the *Astrophysical Journal* for April, 1907: "I have been slow in accepting the idea of an obscuring body to account for these vacancies, yet this particular case almost forces the idea upon one as a fact. It almost seems to me that we are here brought face to face



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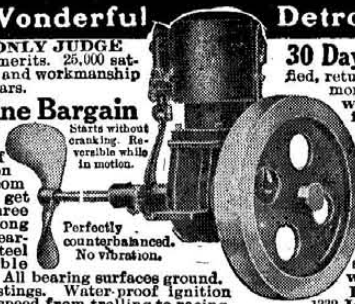
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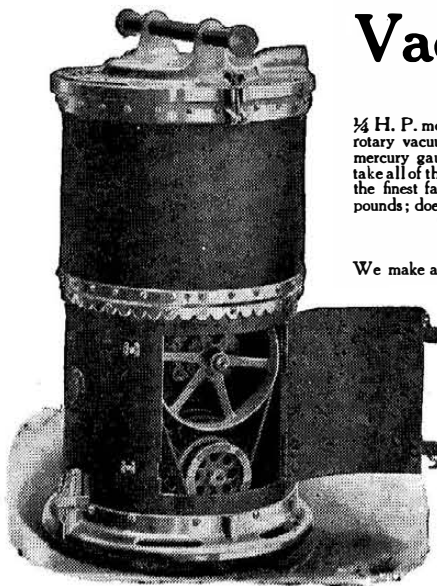
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with a phenomenon that may not be explained with our present ideas of the general make-up of the heavens."

A Great Obelisk

(Continued from page 500.)

where it stood upon the "Spina." It is said to be the only monument in Rome never overthrown. It had been a Herculean job to get it there, but now, believing that it might be utilized to support a great cross as an impressive symbol of Christianity in a move against the paganistic relics of Rome, Pope Sixtus V. had it removed from its foundations in the Circus Nero to be set up in the great piazza in front of St. Peter's, under the direction of Domenico Fontana, and this master-workman was threatened with death should he fail to carry out his plans!

The transference of the tremendous block of stone was accompanied by some remarkable ceremonies, and an interest that was full of dramatic, almost tragic, intensity. It was placed on great rollers that had been carefully prepared and tested. Fontana superintended every detail in the lowering of the shaft, that was much more easily accomplished than the raising of it, as you shall presently see. And well might the task prove strenuous to Fontana, for was not there the penalty of his head should he fail? Eight hundred men and one hundred and fifty horses were employed in the transportation, and thousands of people watched every moment of its progress. All the preparations for hoisting the shaft, when it finally arrived on the piazza, were made with great care, and completed with much solemnity. Every possible expediency seemed to have been considered; and indeed, so far had everything been provided for, that the Pope issued an edict threatening death to man, woman or child who should utter a single word or manifest any excitement while the stone was being lifted into place, so fearful was he lest the slightest diverting of attention from the work, or annoying agitation by those surrounding it, might cause a fatal blunder.

Forty-six huge cranes had been put in place, at various points reckoned with skill and ingenuity. When all was ready the great square was covered at all sides, sufficiently beyond the working space, by a vast concourse of people. The neighboring housetops were also occupied, and Pope Sixtus and his officers of state and government held a commanding position.

Never had a greater crowd assembled in Rome. The silence of it was so awesome that there seemed to be something portentous and ominous to a degree of terror. Finally there appeared to be a concerted movement among the workmen, and the great hempen cables of the cranes were seen to tighten and then to move—and then the stone monster began slowly to rise. Everything seemed to proceed so victoriously that at last there appeared to be but a few inches to overcome when the shaft would find its absolute perpendicularity and settle on its new base—when the hoisting suddenly stopped! It was seen that the ropes were yielding! Fontana had neglected to allow for their tension. A feeling of personal dismay ran through the mind of every one. The situation was strained to a tragic intensity, but suddenly, in that deathly, silent suspense, a voice rang out:

"Acqua alle funi!"

It was a desperate cry from one of the multitude to throw water on the ropes. As quick as a flash the workmen seized upon the vital meaning of these words that hurtled like an arrow across the open space. The man that shouted them had no fear of the penalty—gave no thought to Sixtus—he was a sailor who knew his ropes and saw the only way out of an impending catastrophe.

Without an instant's delay bucket after bucket was carried from a nearby fountain and dashed upon the cordage. As the strands shrank under the inspired baptism they drew the obelisk into place.

The sailor's name was Bresca, and when Sixtus demanded at once his presence, he declared that as a reward, in spite of his threat, he and his family should have the privilege of providing the palms to be used at St. Peter's on

Palm Sunday, so long as his family should last. And to this day in the old town of San Remo, where the Bresca people lived—on the Italian shore of the beautiful Mediterranean Sea, on the celebrated "Riviera"—most of the palms used in Rome and many other places in the Catholic world are gathered.

A Wonderful Dinosaur Mummy

(Continued from page 505.)

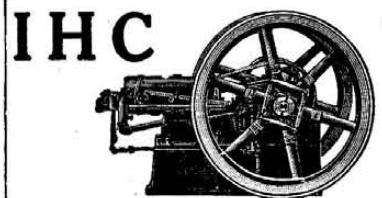
abdominal surfaces the epidermis was certainly drawn within the body cavity; while it was thrown into creases and folds along the sides of the body, owing to the shrinkage of the tissues within. At the termination of a low-water season, during which these processes of desiccation took place, the "mummy" may have been caught in a sudden flood, carried down the stream, and rapidly buried in a bed of fine river sand intermingled with sufficient elements of clay to take a perfect cast or mold of all epidermal markings before any of the epidermal tissues had time to soften under the solvent action of the water. In this way the markings were indicated with absolute distinctness. The outer covering or skin of the trachodons was of a thin character and made up, according to Prof. Osborn, of large and small size tubercles which varied in size and arrangement in different species. Associated with this varied epidermal pattern there was probably a many-colored surface design. The theory of a color pattern is based chiefly upon the fact that the larger tubercles concentrate and become more numerous on all those portions of the body exposed to the sun, that is, on the outer surfaces of the fore and hind limbs, and appear to increase also along the sides of the body and to be more concentrated on the back. On the less exposed areas, the under side of the body and the inner sides of the limbs, the smaller tubercles are more numerous, the larger tubercles being reduced to small, irregularly arranged patches. From analogy with existing lizards and snakes it is supposed, therefore, that the trachodons presented a darker appearance when seen from the back and a lighter appearance when seen from the front. The jaws of the large head were provided with a marvelous grinding apparatus composed of more than two thousand separate teeth, the most highly specialized known. The long, powerful, and compressed tail was used principally as an organ for swimming, acting as a propeller, and also served to balance the body when the animal assumed a standing posture. The trachodons had no protecting armament, and when pursued by the contemporaneous agile tyrannosaurus, king of the flesh-eating dinosaurs, found safety only in swimming far out into deep water. The "mummy trachodon" will be mounted in a glass case, when the visitor will be able by the use of a hand glass to study the finer details of the skin pattern. Of course, the actual skin itself has entirely disappeared.

Deviation of Bore Holes

(Continued from page 500.)

triangle whose base is the diameter of the ridges and whose vertical angle is the angle of deviation. But while the acid solution will enable the amount of deviation to be determined, it will not reveal the direction of it. When the tube has come out there is no record of how much it has turned on its axis, so that we are still somewhat in the dark. We know that the hole is bent, but which way—to due north, northeast, or to the west? In the same metal tube which contained the glass vessel etching liquid, a magnetic compass was placed and so arranged that a stop watch also included in the tube would fix its position at any predetermined time. It will now be understood that this arrangement would furnish a means of determining the orientation at the time of testing. The combined data would enable a very exact idea to be gotten of the course of the bore hole at the test point.

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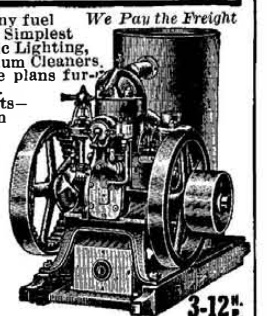
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