THE HEAVENS IN JANUARY.

BY HENRY NORRIS RUSSELL, PH.D.

Though the bright planets which have added so much to the evening skies for the past few months are now disappearing early in the west, the winter heavens still present a spectacle of great magnificence. In identifying the constellations which we can now see, let us begin with Orion, which is nearly due south at 9 o'clock in the evening during the middle of the month. This splendid constellation is familiar to almost everyone, and need not be described here. The line of Orion's belt, continued downward and to the left, points to Sirius, which can be recognized by its great brightness, three times that of any other star that we ever see. Below it is the rest of Canis Major, with several bright second-magnitude stars that would be conspicuous if they were not so low.

Some distance to the left, and higher up, is Procyon the other dog-star, and farther on in the same direction is Gemini, with its twin stars Castor and Pollux.

A line from Betelgeuse—the bright red star in Orion—through Procyon, continued about half as far again, points out the head of Hydra, a small but fairly conspicuous group. Farther north and lower down is Regulus, at the end of the sickle of Leo. Cancer, which lies between Leo and Gemini, has nothing of interest except the star-cluster known as Praesepe, which is easily visible on a moonless night as a small patch of milky light, while separate components are disclosed by a field glass.

Directly below Orion, and level with Sirius, is the small constellation Lepus. Still lower is Columba, with one fairly bright star, which lies about as far from Sirius on one side as Procyon does on the other. The large region to the right of these groups is occupied by the inconspicuous constellation Eridanus.

Orion's belt, continued upward, points to Aldebaran, and beyond nearly to the Pleiades. Above these, and very nearly overhead, is Auriga, whose principal star, Capella, is the brightest, next to Sirius, that we can now see.

Aries is almost due west of the zenith, at an altitude of about 50 deg. south, and west of it is Cetus, which fills most of the southwestern sky.

The great square of Pegasus stands on one corner low down in the west, and the line of stars which extends from it through Andromeda and Perseus to Capella is nearly vertical. Cygnus is just setting in the northwest, but its brightest star is still visible.

Of the circumpolar constellations, Cassiopeia is high on the left of the pole, Cepheus lower down, Draco and Ursa Minor right below the pole, and Ursa Major coming up on the right.

One of the most interesting pieces of recent astronomical news comes from the Lick Observatory, and relates to the new stars that have attracted so much attention by their sudden appearance at various times in the past few years. Though these stars have all long since disappeared to the naked eye, the brighter ones are still telescopically visible, though very faint.

With the aid of the great Crossley reflector of the Lick Observatory, and a specially constructed spectrograph, a number of photographs of the spectra of these faint objects have been obtained by Mr. Perrine and others. In order to appreciate their results, let us recall some of the facts previously known concerning the spectra of new stars.

At maximum, and for some time after, these bodies show a remarkable and typical spectrum, crossed by both bright and dark lines, which are broadened and displaced in a way which, though not yet satisfactorily explained, seems to show that a large part of the star's light comes from gases in a condition of very violent disturbance. As the star fades, these lines, as well as the continuous spectrum upon which they lie, decrease in brightness, some of them vanish, and new lines appear, until finally, when the transformation is complete, the spectrum is exactly like that of a gaseous nebula.

This is as far as the changes had previously been followed, and it has been pretty generally supposed the new stars had actually turned into nebulæ. But the recent Lick photographs tell another story. As the star grows still fainter, the bright lines gradually become proportionately weaker, compared with the continuous spectrum, and at last disappear. This is well shown by comparing the spectra of new stars of different age since their outburst. Nova Geminorum, which blazed up last spring, has now fully developed the nebular type of spectrum. In Nova Persei, which appeared in 1901, the intensities of the nebular lines have much diminished, and one or two have disappeared.

Nova Aurigæ (1891) has lost many of its bright lines, a decided change having occurred since 1901. Finally, Nova Cygni (1876) has lost all its bright lines, and shows only a continuous spectrum, which is just what any ordinary star of the same brightness would do in the same instrument.

It seems therefore almost certain that these new stars have not permanently become nebulæ, but that they will finally settle down as ordinary stars, the nebular spectrum marking one stage in the process.

The most remarkable thing about this is the rapidity with which the changes take place. They seem to run their whole course, from invisibility, or extreme faintness, through great brightness to faintness again, in fifteen or twenty years at most. This is an excessively small fraction of the life of a star (which is probably many millions of years), so that the whole outburst is but a momentary episode in its history. It is quite conceivable that many stars that are now quite orderly members of the stellar system have had such affairs in their past; but we are getting into the region of speculation, and had better stop.

THE PLANETS.

Mercury is evening star until the 17th, when he passes through inferior conjunction and becomes a morning star. He is only visible during the first and last days of January, and even then with difficulty.

Venus is morning star in Scorpio and Sagittarius, and is still very bright, though she is so far south that she is less conspicuous than she was. On the 1st she rises at about 3:45 A. M., and on the 31st at about 4:30. On the 28th she is in conjunction with Uranus, being about 1¾ degrees north of him.

Mars is evening star in Capricornus and Aquarius, and can be seen shortly after sunset, as he does not set till about half-past seven.

Jupiter is evening star in Pisces. He is past quadrature, and is well down in the west by dark. He sets at about 9:30 P. M. on the 15th.

Saturn is evening star in Capricornus, and may still be seen during the first few days of the month, when he sets two hours after the sun. He is approaching conjunction with the sun, and soon disappears from view.

Uranus is morning star in Sagittarius, and is not favorably placed for observation.

Neptune, on the other hand, is well placed, being about a month past opposition. He is in Gemini, his exact place on the 14th being R. A. 6h. 17m. 30s., Dec. 22 deg. 18 min. 22 sec. north. He can be found with an equatorial telescope, but does not repay the search very well, as no detail can be seen on his disk, even with the largest telescopes.

THE MOON.

Full moon occurs at 1 A. M. on the 3d, last quarter at 4 P. M. on the 9th, new moon at 11 A. M. on the 17th, and first quarter at 3 P. M. on the 28th.

The moon is nearest us on the 4th, and farthest off on the 19th. She is in conjunction with Neptune on the 2d, Venus on the 13th, Uranus on the 15th, Mercury on the 17th, Saturn on the 18th, Mars on the 20th, Jupiter on the 22d, and Neptune again on the 29th. The conjunction with Jupiter is the closest, but even then the moon and planet are nearly two degrees apart.

Cambridge Observatory.

Radium and Its Mysteries.

BY SIR WILLIAM RAMSAY.

The story of the discovery of radium is full of interest, and my readers may pardon me even if it is again told; for it forms the first chapter in a volume of which many have still to be written.

M. Henri Becquerel, prompted by a hint from the celebrated mathematician, M. Poincaré, discovered that the compounds of uranium, a somewhat rare metal, as well as the metal itself, were capable of impressing a photographic plate wrapped up in black paper, or otherwise protected from light. It was also found that such salts, placed near a charged electroscope, discharged it, the gold leaves falling together. An electroscope, it may be explained, is a metal box with glass sides; through a hole in the lid a wire passes. The stopper which closes the hole and supports the wire is made of sulphur, or sealing wax, or some other material which does not conduct electricity. From the end of the wire are suspended two pieces of gold leaf, hanging down so as to be visible through the glass sides of the box.

If a piece of sealing wax is rubbed, so as to excite it electrically, and if the projecting end of the wire is touched with the rubbed sealing wax, a small charge of electricity is given to the wire, and through it to the gold leaves, so that they repel each other, and fly apart, making a figure like an inverted V. If the wire be touched with the finger the electric charge is conducted away through the body, and the leaves swing back into their original position.

This effect of discharging was found to be produced when a salt or mineral containing uranium was placed inside the box. Mme. Curie, a Polish lady, living in Paris, noticed that the rate at which the gold leaves fell together was more rapid with certain uranium minerals (specimens of pitchblende) than could be accounted for by the uranium oxide in the mineral; she therefore separated the mineral into its groups of constituents—uranium, iron, lead, barium, bismuth, etc. (for the mineral contains all these and many other elements), and tested each group as to its power of discharge. At first she thought that she had traced the discharging power to the bismuth group, and attributed it to an element which she named "polonium," after her native country.

This discovery has been disproved, but it appears that the amount of polonium obtainable is exceedingly small, and difficult to separate from bismuth. Subsequently Mme. Curie discovered another element of the barium group, possessing enormous powers of discharge, and to this element, which occurs in relatively greater amount, she gave the name "radium."

It is an undoubted element in the sense in which that term is generally used; its salts resemble closely those of barium, and its spectrum has been observed by M. Démarçay, Prof. Runge, and Sir William Crookes. Its atomic weight has been determined by Mme. Curie as 225; the atomic weight of uranium is the highest known—240; and there is some evidence from its spectrum that radium may have even a higher atomic weight—over 250—and that the sample analyzed by Mme. Curie may not have been quite free from barium, of which the atomic weight is only 137.

While these researches were in progress M. Curie and Dr. Schmidt discovered simultaneously that another element, thorium, of which the atomic weight is 232, also possesses the power of discharging an electroscope, and, moreover, that if air be led over salts of thorium, the air acquires and retains for a short time discharging power.

FURTHER DISCOVERIES.

The subject was taken up by Prof. Rutherford, of Montreal, and by Mr. Frederic Soddy, who then worked in his laboratory; and they found that if the "active" air were cooled by passing it through a tube cooled with liquid air it lost its "activity," the active portion remaining in the cold tube. On warming the tube the active portion was carried forward, and with it the discharging power. They also found that a similar "emanation," or gas, was evolved from salts of radium, possessing a much more permanent discharging power. While the "emanation" from thorium salts "decayed" in a few minutes, that from radium salts lasted a month. It, too, was condensible when cooled; it was luminous, and imparted temporary luminosity to objects which it touched ("excited activity").

The fact that a radium salt is always hotter than its surroundings, discovered by the Curies, implies that radium is continually losing energy; and if the radium salt be dissolved in water some of this energy is expended in decomposing a portion of the water into oxygen and hydrogen gases. Prof. Rutherford and H. T. Barnes have recently shown that "more than two-thirds of the heating effect is not due to the radium at all, but to the radio-active emanation which it produces from itself." In November, 1902, Messrs. Rutherford and Soddy concluded from their experiments on the emanations from radium and thorium that they are "inert gases, analogous in nature to the members of the argon family," and also they threw out the surmise, "whether the presence of helium in minerals and its invariable association with uranium and thorium may not be connected with the radio-activity."

Now, I had the good fortune to discover helium in 1895; it is one of the argon gases, and is contained in certain minerals, and when Mr. Soddy came to work with me in the early summer of 1903 we tested the truth of this surmise, and we were rewarded by success. The fresh emanation from radium does not show the spectrum of helium, but as it "decays," helium is produced in minute but ever-increasing quantity.

We can help ourselves by an analogy. Very complicated compounds of carbon and hydrogen can be produced; one containing 30 atoms of carbon and 62 atoms of hydrogen is known. But one of, say, 200 atoms of carbon and 402 of hydrogen would almost certainly fall to bits; it would split up and give out heat. The supposition appears reasonable that just as there is a limit to the possible number of atoms in such compounds (for the molecules or groups of atoms fall apart by their own weight), so there may be a limit to the atomic weight of an element.

Those elements with high atomic weight, such as thorium, uranium, and radium, are apparently decomposing into elements with low atomic weight; in doing so they give off heat, and also possess the curious property of radio-activity. What these elements are is unknown, except in one case; one of the products of the decomposition of the emanation from radium is helium.

Can the process be reversed? No one knows. But as gold is an element of high atomic weight, it may b confidently stated that if it is changing, it is mu more likely that it is being converted into silver a copper than it is being formed from them. At stage, however, speculation is futile. It is certain further experiment will lead to more positive k edge of the nature of the elements and of the formations which at least some of them are going.—London Mail.