evolution to that which is taking place in double stars; the latter appear to be separating from a single original mass and the former condensing into one.

*Colours and Spectra of Stars,—*The brighter stars show a marked variety of colour in their light, and with the aid of a telescope a still greater diversity is noticeable. It is, however, only the red stars that form a clearly marked class by themselves. For purposes of precise scientific investiga­tion the study of spectra is generally more suitable than the vague and unsatisfactory estimates of colour, which differ with different observers. Of the first magnitude red stars Antares is the most deeply coloured, Betelgeux, Aldebaran and Arcturus being successively less conspicuously red. Systematic study of red stars dates from the publication in 1866 of Schjellerup’s *Catalogue*, containing a list of 280 of them.

The two components of double stars often exhibit complementary colours. As a rule contrasted colours arc shown by pairs having a bright and a faint component which are relatively wide apart; brilliant white stars frequently have a blue attendant—this is instanced in the case of Regulus and Rigel. That the effect is due to a real difference in the character of the light from the two components has been shown by spectrum analysis, but it is probably exaggerated by contrast.

The occurrence of change, either periodic or irregular, in the colour of individual stars, has been suspected by many observers; but such a colour-variability is necessarily very difficult to establish. A possible change of colour in the case of Sirius is noteworthy. In modern times Sirius has always been a typical white or bluish-white star, but a number of classical writers refer to it as red or fiery. There is perhaps room for doubt as to the precise significance of the words used; but the fact that Ptolemy classes Sirius with Antares, Alde­baran, Arcturus, Betelgeux and Procyon as “ fiery red ” (*ὑπόκιῤῤοι*) as compared with all the other bright stars which are “ yellow ” (*ξάνθοι*) seems almost conclusive that Sirius was then a redstar.

When examined with the spectroscope the light of the stars is found to resemble generally that of the sun. The spectrum consists of a continuous band of light crossed by a greater or less number of dark absorption lines or bands. As in the case of the sun, this indicates an incandescent body which might be solid, liquid, or a not too rare gas, surrounded by and seen through an atmosphere of somewhat cooler gases and vapours; it is this cooler envelope whose nature the spectroscope reveals to us, and in it the presence of many terrestrial elements has been detected by identifying in the spectrum their characteristic absorption lines. Stellar spectroscopy dates from 1862, when Sir William Huggins (with a small slit-spectroscope attached to an 8-iπ. telescope) measured the positions of the chief lines in the spectra of about forty stars. In 1876 he successfully applied photography to the study of the ultra-violet region of stellar spectra. Various schemes of classification of spectra have been used. The earliest is that due to A. Secchi (1863-1867) who distinguished four “ types subsequent research, whilst slightly modifying, has in the main confirmed this classification. Secchi’s Type I. or “ Sirian ” type includes most of the bright white stars, such as Sirius, Vega, Rigel, &c.; it is characterized by strong broad hydrogen lines, which are often the only absorption lines visible. Type II. includes the “Solar” stars, as Capella, Arcturus, Procyon, Aldebaran, their spectra are similar to that of the sun, being crossed by very numerous fine lines, mostly due to vapours of metals. The great majority of the visible stars belong to these first two types. Type 111. or “ Antarian ” stars are of a reddish colour, such as Antares, Betelgeux, Mira, and many of the long-period variables. The spectrum, which closely resembles that of a sunspot, is marked by flutings or bands of lines sharply bounded on the violet side and fading off towards the red. It has been shown by A. Fowler that these flutings are due to titanium oxide; this probably indicates a relatively low temperature, for at a high temperature all compounds- would be dissociated. Type IV. also consists of red stars with banded spectra, but the bands differ in arrangement and appearance from those in the third type, and are sharply bounded on the red side. These stars are also believed to have a comparatively low surface temperature, and the bands are attributed to the presence of compounds of carbon. About 250 Type IV. stars are known, but none conspicuous; 19 Piscium, the brightest, is of magnitude 5∙5.

Other classifications which are extensively used are those respectively of K. H. Vogel, T. N. Lockyer and the Draper Catalogue. the divergences depend mainly on the different views taken by their authors as to the order of stellar evolu­tion. Apart from these considerations, the chief modification in the classification introduced by more recent investigators has been to separate Seechi's Type I. into two divisions, called *helium* and *hydrogen* stars respectively. The former are often called “ Orion ” stars, as all the brighter stars in that constellation with the exception of Betelgeux belong to the helium type. Helium stars are generally considered to be the hottest and most luminous (in proportion to size) of all the stars. Type 11. is now subdivided into “ Procyon,” “ Solar ” and “ Arcturian" stars. The “ Procyon ” or *calcium* stars form a transition between Type I. and Type II. proper, and show the lines of calcium besides those of hydrogen. An important variety of Type 111. spectra has been recognized, in which, as well as the usual absorption bands, bright emission lines of hydrogen appear ; stars having this particular spectrum are always variable. Finally, a fifth type has been added, the Wolf-Rayet stars; these show a spectrum crossed by the usual dark lines and bands, but showing also bright emission bands of blue and yellow light. About 100 Wolf-Rayet stars are known, of which γ Velorum is the brightest ; they are confined to the region of the Milky Way and the Magellanic Clouds. (See Planet.)

*Evolution of Stars.—*The absence of the distinctive lines of an element in the spectrum does not by any means signify that that element is wanting or scarce in the star. The spectroscope only yields information about the thin outer envelope of the star; and even here elements may be present which do not reveal themselves, for the spectrum shown depends very greatly on the temperature and pressure. Stars of the different types are therefore not neces­sarily of different chemical constitution, but rather are in different physical conditions, and it is generally believed that every star in the course of its existence passes through stages corresponding to all (or most of) the different types. The stars are known to be continually losing enormous quantities of energy by radiating their heat into space.. Ordinary solid or liquid masses would cool very rapidly from this cause and would soon cease to shine. But a globe of gaseous matter under similar conditions will continually contract in volume, and in so doing transforms potential energy into heat. It was shown by Homer Lane that a mass of gas held in equilibrium by the mutual gravitation of its parts actually grows *hotter* through radiating heat; the heat gained by the resulting contraction more than counterbalances that lost by radiation. Thus in the first stage of a star’s history we find it gradually condensing from a highly diffused gaseous state, and growing hotter as it does so. But this cannot continue indefinitely; when the density is too great the matter ceases to behave as a true gas, and the contraction is insufficient to maintain the heat. Thus in the second stage the star is still contracting, but its temperature is decreasing. The greatest temperature attained is not the same for all stars, but depends on the mass of the star. It is, however, important to bear in mind that Lane’s theory is concerned with the temperature of the body of the star; the temperature of the photosphere and absorbing layers, with which we arc chiefly concerned, does not necessarily follow the same law. It depends on the rapidity with which convection currents can supply heat from the interior to replace that radiated, and on a number of other nicely balanced circumstances which cannot well be calculated.

Conflicting opinions are held as to the various steps in the process of evolution and the order in which the various types succeed one another, but the following perhaps represents in the main the most generally accepted view. Starting from a widely diffused nebula, more or less uniform, we find that, in consequence of gravitational instability, it will tend to condense about a number of nuclei. Jeans has even estimated theoretically the average distances apart of these nuclei, and has shown that it agrees in order of magnitude with the observed distances of the stars from one another *(Astro- physical Journal,* vol. xxii.). As the first condensation takes place, the resulting development of heat causes the hydrogen, helium and light gases to be expelled. This may explain the existence of gaseous nebulae, which are often found intimately associated with star-clusters, a good example being the nebulosity surrounding the Pleiades. As the nuclei grow by the attraction of matter they begin to be capable of retaining the lighter gases, and atmospheres of hydro­gen and helium are formed. The temperature of the photosphere at this stage has reached a maximum, and the star is now of the helium type. Then follows a gradual absorption of first the helium and then the hydrogen, the photosphere grows continually cooler, and the star passes successively through the stages exemplified by Sirius, Procyon, the Sun, Arcturus and Antares. Some authori­ties, however, consider the Antarian (Type 111.) stars to be in a very early stage of development and to precede the helium stars in the order of evolution; in that case they arc in the stage when the temperature is still rising. Type IV. (carbon) stars are placed last in the series by all authorities; they seem, however, to follow more directly the solar stars than the Antarian. If the latter are considered to be in an early state this presents no difficulty; but if both Antarian and carbon stars are held to be evolved from solar stars, we may consider them to be, not successive, but parallel stages of development, the chemical constitution of the star deciding whether it shall pass into the third or fourth type. The Wolf- Rayet stars must probably be assigned to the earliest period of evolution; they are perhaps semi-nebulous. In this connexion it may be noted that the spectrum of Nova Persei, after passing through a stage in which it resembled that of a planetary nebula, has now become of the Wolf-Rayet type.

*Density of Stars.*—Interesting light is thrown on the question of the physical state of the stars by some evidence which we possess as to their densities. The mean density of the sun is about 11/3 times that of water; but many of the stars, especially the brighter ones, have much lower densities and must be in a very diffused state. We have necessarily to turn to binary systems for our data. When