where l is the mean free path of the molecules of the gas divided by the radius of the sphere. It will be seen that the result involves an exponential term not given by the theoretical investigation of Cunningham or the experimental work of McKeehan, although the authors show that there is some indication of its effect even in the observations made by the latter.

A LECTURE, under the auspices of the Graham Lecture Fund was delivered on Tuesday, January 16, in the hall of the Technical College, Glasgow, by Prof. H. E. Armstrong, F.R.S. The lecture was arranged by the Royal Philosophical Society, and the subject selected was "Some Consequences of Graham's Work." The lecturer was dealing with a subject on which he was specially qualified to speak when he described the way in which Graham's work on diffusion had been developed in recent years. The effects produced by non-electrolytes, which are able to penetrate the membranes of living cells, and so to set going important physiological processes, are now recognised as factors of vital importance in the life and development of plants and animals; it was therefore a happy inspiration on the part of the trustees of the Graham Fund to secure from Prof. Armstrong himself a description of the experiments which have done so much to bring home to the physiologist, as well as to the chemist, the important results which have followed upon the pioneer work of Graham.

AN interesting study of the localisation and function of potassium in plants, by Dr. Th. Weevers, is contained in the *Recueil des Travaux botaniques Néerlandais* (vol. viii., p. 289), use being made of Macallum's very delicate microchemical test, based on the precipitation of potassium cobalt nitrite and subsequent conversion of this into black cobalt sulphide by treatment with ammonium sulphide. In a very large number of plant tissues tested, potassium was found always to be present, save in the Cyanophyceæ. In all cases the cell nucleus, however, contained no trace of this element, even in cases when the cytoplasm contained this element in abundance. Special experiments showed that this result was due neither to potash salts diffusing out of the nucleus under the treatment, nor to inability of the reagent to penetrate therein. The larger portion of the potassium is contained in the vacuoles of the cells, the chromatophores being free from it; chlorophyll also contains no potassium. In all cases tested the potassium was present in a form soluble in water, and can be extracted practically completely from the cell by water or 50 per cent. alcohol, but it seems to be insoluble in ether. In phanerogamous plants the potassium is most abundant in the parenchyma, especially in the growing points and reserve organs. In the secondary tissues potassium predominates in the living elements of the wood and bark, especially in the cambium and medullary rays; the latter seem to act as potash reserves for the growth of new shoots. In discussing the physiological significance of potassium in the plant, it is considered that this element plays little or no part in carbon assimilation, but probably is concerned more in building up protoplasm at growing points. In the leaf it probably functions in synthesis and degradation of the protein.

MESSRS. WITHERBY AND CO. are about to publish "The Game-birds of South Africa." The book is by Major Boyd Horsbrugh, and will be illustrated by nearly seventy coloured plates reproduced in facsimile from the drawings of Sergeant C. G. Davies. The work will be in small quarto, and will be issued in four quarterly parts.

OUR ASTRONOMICAL COLUMN.

SCHAUMASSE'S COMET, 1911*h*.—In the *Comptes rendus* for January 8 (No. 2) M. G. Fayet announces his tentative conclusion that the comet discovered by M. Schaumasse at Nice on November 30, 1911, is a periodic comet with a period of about seven years. A parabolic orbit first calculated showed such digressions from the observed places that an elliptic orbit was tried which gave satisfactory O–C differences for intermediate positions. The preliminary elements, determined from positions observed at Nice on December 1, 11, 16, and 21, 1911, are as follows:—

$$T = 1911 \text{ November } 12{\cdot}2440 \text{ M.T. Paris.}$$
$$\left.\begin{aligned} \pi &= 136^\circ\ 33'\ 37'' \\ \Omega &= 93^\circ\ 14'\ 32'' \\ i &= 17^\circ\ 40'\ 46'' \end{aligned}\right\} 1911{\cdot}0$$
$$\log q = 0{\cdot}084487$$
$$e = 0{\cdot}675480$$
$$\mu = 489{\cdot}938''$$

The data are, of course, too meagre for any certainty to be claimed for these elements, but it is worthy of notice that on December 28 the departure of the observed place from M. Fayet's ellipse was only 15″.

THE DISTRIBUTION OF BRIGHTNESS IN THE TAIL OF HALLEY'S COMET.—Some important results concerning the nature of the particles in the tail of Halley's comet, and of their illumination, are obtained by Drs. Schwarzschild and Kron in a paper of which a translation is printed in No. 5, vol. xxxiv., of *The Astrophysical Journal*. The material for the discussion was provided by plates secured by the Potsdam Observatory expedition to Teneriffe to observe the comet.

The photographs were secured in pairs, and photometric standards for comparing the density of the image were produced simultaneously; the photographs show that the apparent intensity of the tail diminishes continuously from the head outward. This diminution might be produced by two causes, first the decrease in density of the tail matter, secondly by a decrease in the actual luminosity of the individual particles; decrease in density would be produced by increase in cross-section of the tail as units further from the head were considered, and by the greater velocity of the particles through each section produced by the solar acceleration.

The density effect was very carefully calculated by the authors, and, to their surprise, was found to account, in the most part, for the decrease of brightness. It should be remembered, however, that several unknown quantities enter into the conditions discussed. This result, if legitimate, can be explained by assuming that the light of a comet's tail is a kind of fluorescent or resonant radiation excited by the solar radiation. On this basis they calculate the amount of matter passing through a unit section, and also the density, and find that, exposed for a whole day to the conditions obtaining at the time of its passage through the tail, the earth would not collect more than 250,000 kilograms of cometary matter, a relatively insignificant amount.

OBSERVATIONS OF PLANETS.—In No. 4548 of the *Astronomische Nachrichten* is published a telegram, received from Prof. Lowell on January 12, announcing that since the last presentation the canal Titan on Mars has doubled.

M. Jarry-Desloges reports that the south polar cap reappeared, as two distinct masses, on January 3, and that the abnormal white streak at the north pole going south between Propontis and Palus Mæotis, had completely disappeared on that date.

The latter also states that on December 29, 1911, at 23h. 30m., the south polar regions of Saturn were covered by a well-defined dark area having an equally well-defined greyish area at its centre; taking the equatorial diameter of the planet as unity, the respective diameters of these patches were 0·31 and 0·11. At 23h. 15m. the same evening the eastern anterior portion of the rings appeared very notably darkened, but the phenomenon did not endure more than twenty-four hours. The farther eastern section of the exterior ring, as compared with the Cassini division, was also darkened. At this time the inner transparent

ring was rather difficult, but on December 30 it was easily seen and its granular structure detected.

THE "ANNUAIRE" OF THE BUREAU DES LONGITUDES, 1912.—This year's issue of the "Annuaire" contains the usual astronomical information, ephemerides, and tables, and deals with chemistry and physics similarly. It also contains the complete list of minor planets, for 714 of which it gives the orbital elements. Among the "notes" there appear an interesting *résumé* of solar physics by M. Deslandres, a long discussion on the various calendars, an article by M. Bigourdan on seismology, a brief description of the physical constitution of the moon by M. Puiseux, and a discussion of the mean temperature in various parts of France by M. Bigourdan. All the times in this "Annuaire" are given in accordance with the new law of March last. The price of the "Annuaire" is 1.50 francs net.

THE RADIAL VELOCITIES AND SPECTRAL TYPES OF STARS.

ALTHOUGH the determination of radial velocities is, as a practical proposition, a development of comparatively recent years, the data already secured by the several observatories doing line-of-sight work promises to be of inestimable value in the study of cosmological problems. It is no longer merely a question of "approach" or "recede"—a far greater vista has been opened up as the work has proceeded. Combined with the researches of Kapteyn, Eddington, Dyson, and others on the streaming tendencies disclosed by the discussion of "proper motions," it promises a rich mine of as yet undisclosed facts concerning the evolution of enormous sidereal systems.

A glance through Prof. Campbell's second catalogue of spectroscopic binaries [1] tells of much work already accomplished, and the discussion discloses how much there is still to be done.

One outstanding result of this discussion of more than 300 binary systems, so far as it applied to the comparative few for which the periods of revolution and other orbital elements have been determined, was the fact that the motions of the stars are intimately related to the spectral types which may be taken as indices of stellar ages. Briefly, it appears that the older a binary system becomes the greater becomes the eccentricity of the orbit and the longer grows the period of revolution.

The existence of the relation between radial velocities and stellar types was also brought out in a later paper [2] dealing with some peculiarities in the motions of the stars, where the following table was given, the spectral types being given under the Harvard designations :—

Spectral types	No. of stars	Average radial velocities
O and B	141	8·99 km.
A	133	9·94 ,,
F	159	13·90 ,,
G and K	529	15·15 ,,
M	72	16·55 ,,

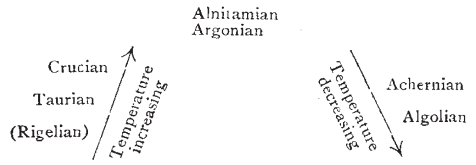
In the general discussion it was found that the B-type ("helium") stars called for special treatment, and Prof. Campbell discussed the motions of the brighter stars of this type in a further paper.[3]

The main conclusion to which we wish to direct attention here is that "An error, of obscure source, causes the radial velocities of Class B stars to be observed too great by a quantity, K, amounting to several kilometres. For stars of Class $B-B_5$ the value of this error is approximately $K = +4{\cdot}7$ km. per second. The value obtained for Class $B-B_9$ stars is $+4{\cdot}1$ km. It is therefore probable that K is less than $+4$ km. for stars of Class B_8-B_9."

The result was based on the consideration of 225 Class B stars, K being an assumed, unavoidable, but systematic error inherent to the observed velocities, and disclosed in calculating from these the velocity of the solar system in space. This systematic difference, peculiar to the B-type stars, has led to some very interesting and important suggestions as to the characteristics of the stars themselves; Prof. Campbell makes several tentative suggestions as to its source. Of these, we would direct attention to that in which it is suggested that in these stars the absorption takes place in the lower layers of the atmospheres, and therefore under greater pressure, thus modifying the effective wave-length and producing the error when the measures of wave-length are compared with terrestrial standards. Another suggestion points out that the helium lines frequently used in the measures are double, with the red component, in the laboratory, much the fainter. If the conditions in the star increase the relative intensity of these red components, the wave-length of the centre of gravity of the whole line would be shifted, and the observed difference be thus produced.

A most interesting contribution to the discussion of the motions of this type of star is published by Dr. Ludendorff [4] in the form of some remarks on the classification of helium stars. He takes from Campbell's list of 224 stars all those which have an absolute radial velocity, V_2, $\geqq 8{\cdot}0$ km., and shows that there is a distinct differentiation of their velocities if they are arranged according to Lockyer's classification [5] of the helium stars.

As is generally known, this classification is unique in that it aims at arranging the classes of stars in an evolutional order, difference in the chemical characteristics, accompanying differences in age and temperature, being the criterion. It also essentially takes into account the idea that stars probably increase before decreasing in temperature, and on these lines arranges the helium stars at the top of the temperature curve thus :—



In the Lockyer classification the Rigelian class is not given as essentially a helium class, although helium is mentioned as one of the prominent elements; for this latter reason Dr. Ludendorff includes it in his discussion.

Of the sixty-three stars selected from Campbell's list, he finds eighteen classified in the South Kensington catalogue, and tabulates them as follows, the velocities being given in round numbers :—

Ascending branch of Curve			Descending branch of Curve		
Star	Type	V_2	Star	Type	V_2
		km.			km.
ζ Persei	Crucian	+ 9	π Andromedæ	Algolian	+ 8
η Orionis	,,	+14	ν ,,	Achernian	−24
β Canis Maj.	,,	+10	19 Tauri	Algolian	−10
o^2 ,,	Taurian	+25	γ Corvi	,,	−13
η ,,	,,	+17	ι Aquilæ	Achernian	−14
δ Crucis	Crucian	+13	ε Delphini	,,	−10
χ Centauri	,,	+ 8	α ,,	Algolian	−10
ε Lupi	,,	+12	o Andromedæ	Achernian	−10
υ Scorpii	,,	+21			
67 Ophiuchi	Rigelian	+10			

From this table evolves the striking fact that, without exception, those stars placed by Lockyer on the ascending arm of the temperature curve all have + velocities, and, with one exception, those on the descending side have − absolute radial velocities. It would appear extremely unlikely that this remarkable division is due to chance; but Dr. Ludendorff seeks further evidence by taking from Campbell's catalogue all (seventy-one) those stars classified at South Kensington as helium stars—including the Rigelian class—and arranges them as follows, giving the mean absolute radial velocities V_2^0 of each class :—

[1] Lick Observatory Bulletins, No. 181. [2] *Ibid.*, No. 196. [3] *Ibid.*, No. 195.

[4] *Astronomische Nachrichten*, No. 4547, vol. cxc., p. 193.

[5] Catalogue of 470 of the Brighter Stars Classified according to their Chemistry.