more than 35° N. or S. of it, and at 45° are practically unknown. Their occurrence within these zones follows statisti­cally a uniform law (see Aurora). Other information about the spots is given below, in connexion with their spectra. It may be said that nothing definite has been established as to what they are. The statement known as A. Wilson’s theory (1774), that they are hollows in the photosphere, long supposed to be proved by perspective effects as the spot approached the limb, is discredited by F. Howlett’s careful drawings, which, however, do not establish the contrary. To draw a trustworthy conclusion it is necessary that the spot should be quiescent, show a well-developed and fairly symmetrical penumbra, and be observed near the limb and also near the centre, and these conditions are satisfied in so few cases as to withdraw all statistical force from the conclusion. Figs. 5, 6, 7, 8 (plate) are reproductions of the Greenwich photographs of the sun from the 30th of January to the 8th of February 1905. The first, taken alone, might seem to bear out Wilson’s theory, but the others show that the penumbra is really very unsymmetrical and much broader on the side towards the limb, apart from anything which perspective may have to say. The photosphere does not rotate in one piece, lower latitudes outrunning higher. This was discovered by R. C. Carrington from observations of the spots, extending from 1853 *Relation of* to 1861, from which he determined also the position of the sun’s axis. But conclusions from the spots are full of anomalies. E. W. Maunder and Mrs Maunder found that different spots in the same zone differ more than do the means for different zones, while a long-lived spot settles down to give more consistent results than are furnished by spots of one apparition. In the span of two complete sun­spot periods no evidence was found of periodic or other change with lapse of time. The problem still awaits complete discussion. The irregularities incidental to use of the spots are escaped by comparing the relative Doppler displacements of the same spectral line as given by the receding and advancing limbs of the sun. The observation is a delicate one, and was first success­fully handled by N. C. Dunér in 1890. But his determinations, repeated recently *(Acta upsal.* IV. vol. i., 1907) as well as those of J. Halm at Edinburgh *(Ast. Nach.* vol. 173, 1907), are super­seded by a photographic treatment of the problem by W. S. Adams *(Astrophys. Journ.,* xxvi., 1907).

The diagram (fig. 9) shows Adams’s value for the angular velocity £ for different latitudes *φ,* the dots representing the actual observa­tions. Fig. 10 shows the consequent distortion of a set of meridians after one revolution (at lat. 30°). An important feature added to the discussion by Adams is the different behaviour of spectral lines which are believed to originate at different levels. The data given above refer to the mean reversing layer. Lines of lanthanum and carbon which are believed to belong to a low level showed system­atically smaller angular velocity than the average. This promises to be a fertile field for future inquiry. Pending more conclusive evidence from the spectroscope, the interpretation of the peculiar surface rotation of the sun appears to be that the central parts of the body are rotating faster than those outside them; for if such were the case the observed phenomenon would arise. For consider first a frictionless fluid. The equations of surfaces of equal angular motion would be of the form r = R (1— (cos2*θ*), where ε is proportional to the square of the angular motion, supposed small, and R increases as ε diminishes. Consider the traces these surfaces cut on any sphere *r=a∙.* we have *dε/dθ* =2εsin θcosθ∕{cos2θ- αR-2dR∕dε}, which is positive and has a maximum in the middle latitudes; so that, proceeding from the pole to the equator along any meridian, the angular velocity would continually in­crease, at a rate which was greatest in the middle latitudes. This is exactly what the ob­servations show. Now if this state be supposed established in a frictionless fluid, the con­sideration of internal friction would simply extend the char­acteristics found at any spot to the neighbourhood, and there­fore if the boundary were a sphere and so for a frictionless fluid an exception, it would cease to be an exception when we allow for viscosity. But this theory gives no clue to the results relating to hydrogen, which belongs to a high level, and which Adams has shown to move with an angular velocity decidedly greater than the equatorial angular velocity below it, and not to show any sign of falling off towards the poles.

It is useful to form a conception of the mechanical state within the sun’s body. Its temperature must be dominated directly or indirectly by the surface radiation, and since the matter is gaseous and so open to redistribution, the same is true of density and pressure. It is true that within the body radiations must be stifled within a short distance of their source; none the less, they will determine a temperature gradient, falling from the centre to the borders, though for the most part falling very slowly, and we may ask what relative temperatures in different parts would maintain themselves if once established. Stefan’s law of radiation ac­cording to the fourth power of the temperature is too difficult to pursue, but if we are content with cognate results we can follow them out mathematically in a hypothetical law of the first power. We then find that the density would increase as we go outwards, at first slowly, but finally with extreme rapidity, the last tenth of the radius comprising half the mass. The radiation from such a body would be practically nil, no matter how hot the centre was. Of course such a state would be statically unstable. It would never get established because currents would arise to exchange the positions of the hotter, less dense, inner parts and the cooler, more dense, outer ones. By this interchange the inner parts would be opened out and the total radiation raised. Since the only cause for these convection currents is the statical instability produced by radiation, and the rapid Stifling of radiations within the body produces there a temperature gradient falling very slowly, they would be for the most part extremely slight. Only near the surface would they become violent, and only there would there be a rapid fall of temperature and density. Through the main body these would remain nearly constant. Indeed it seems that, in the final distribution of density throughout the part which is not subject to violent convection currents, it must increase slightly from the centre outwards, since the currents would cease altogether as soon as a uniform state was restored. In the outer strata a different state must prevail. Rapidly falling temperature must (and visibly does) produce furious motions which wholly outrun mere restoration of statical balance. Portions change places so rapidly and so continually, that we may take it, where any average is reached, the energy is so distributed that there is neither gain nor loss when such a change occurs. This is the law of convective equilibrium. But in the sun’s atmosphere gravitation alone is a misleading guide. Convective equilibrium, which depends upon it, gives far too steep a temperature gradient, for it yields a temperature of 6ooo° only 200 m. within the free surface, whereas the chromosphere is of an average thickness of 5000 m., and attains that temperature only at its base. Probably the factor which thus diminishes the effective