the equator, now occur most frequently at the poles. The faculæ are brighter and are more widely distributed, and the chromosphere is richer in lines. The spots at this period occupy broad zones with mean latitudes of about 18° N. and 18° S. There are no spots near the poles and none near the equator ; but large spots, indicating a state of violent agitation, surrounded by gigantic faculæ, follow each other in these zones. Each of these indicators of solar activity is accompanied by a prominence. At this time also we note the greatest velocities of down-rush in the vapours which form the spots and of up-rush in those which form the prominences. These changes are accom­panied by corresponding changes in the corona ; and, fortunately, we have photographic records for two periods of maximum,—1871 and 1882. In these the streamers, instead of being limited to the equator or to mid-latitudes, exist in all latitudes, so that they practically extend to every part of the sun. Their directions, which may be called lines of force, are very varied, some being straight and some curved ; but it is difficult to unravel the appear­ances, because what we see are only projections of the actual things, and this is especially the case when the sun’s pole is tipped towards or away from the earth to the greatest extent. In the eclipse of 1882 the corona in­dicated a more equal distribution of action than that of 1871, but the general result was the same.

After the maximum period there is a gradual falling off of all the various energies, the mean latitudes of the spots decreasing until they reach 8° N. and 8° S. ; then another series of spots breaks out about 35° N. and 35° S. lat., and the cycle begins anew.

*General Theory.*

It has been very generally accepted for some time that sun-spots are depressions in the photosphere, produced by downfalls of cool material. The following sketch shows how, if we accept this view and also the hypothesis that the chemical elements are dissociated in the lower parts of the solar atmosphere, many of the more important solar phenomena may be explained and correlated.

We know that small meteorites in our own cold atmo­sphere are heated to incandescence by friction, that is, by the conversion of their kinetic energy into heat, and it is therefore not difficult to imagine that enormous masses, falling with great velocities through the sun’s highly heated atmosphere, would be competent to give rise to such dis­turbances as those with which we are familiar on the sun’s surface. This cool material is produced by the condensa­tion, in the upper cool regions of the sun’s atmosphere, of the hot ascending vapours produced at the lower levels, and this is probably the main source of supply of spot- producing material. The faculæ and other disturbances of the general surface do not precede but follow the formation of a spot, so that a spot may be considered as the initial disturbance of the photosphere in the region where it is observed. Large spots almost invariably appear first as little dots, frequently in groups, and then suddenly grow large. The little dots, according to the view of spot forma­tion now under discussion, are formed by small masses which precede the main fall. The heat produced by friction with the atmosphere and the arrested motion causes up- rushes of heated vapours, which eventually cool and con­dense, and afterwards fall to the photosphere and produce fresh disturbances. Down-rushes of cool material must take place all over the sun’s surface, and, although the most violent results of such falls are restricted to certain regions, minor disturbances are distributed over the whole surface. These generally distributed phenomena are well known to be merely different degrees of the same kind of energies that operate in producing the more restricted ones.

We will now review the several phenomena in turn, beginning with the most widely distributed.

Besides the general darkening near the edge of the sun’s disk, the surface is seen to he strangely mottled near the poles, near the equator, and in fact universally. Moreover, small black specks, called *granulations* or *pores,* are everywhere visible, and spectro­scopic examination shows that every one of these is a true spot, The fine mottlings frequently indicate the existence of powerful currents in that they take definite directions, sometimes in straight lines, sometimes in lines suggesting cyclonic swirls. In addition to the pores spots of a smudgy kind, called *veiled spots,* are some­times seen, and it is probable that in such cases the force of the down-rush is insufficient to depress the photosphere to an extent competent to give rise to the ordinary dark spots. Some spots appear as large pores, that is, they consist of nothing but umbra ; others appear as Well-developed veiled spots, consisting almost en­tirely of penumbra. The obvious large spots consisting of umbra and penumbra follow next in order of intensity, and, as has been previously pointed out, their appearance is confined to definite spot zones. Minute observation, therefore, shows that the whole of the sun’s surface is traversed by down-rashes of varying intensities, from almost infinitesimal dimensions to the most powerful that we can conceive. Some of the ordinary spots do not appear to be in any violent state of agitation : the penumbra and umbra are well de­fined, and the ridge of faculæ round such a spot does not indicate any disturbance by either lateral or convexion currents. Other spots, however, indicate very violent commotion, the penumbra and umbra being tremendously contorted and mixed up. In this kind of spot the disturbance often affects enormous areas of the sun’s surface ; one spot in 1851 was 140,000 miles across, and the commotions were so great that they could be detected by eye ob­servation with the telescope. It appears as if the material carried in the first instance below the level of the photosphere produces a disturbance in the interior regions, which exhibits itself at the surface by an increase in the quantity and brilliancy of the sur­rounding faculæ. As a spot dies away it is replaced by faculæ, and these remain long after the spot has closed up. It often happens that new spots break out in the places occupied by pre­vious spots. The spot-producing material in its descent is dis­sociated either before or when it reaches the photosphere, and the rapidity and energy of the dissociation depend upon the velocity with which it travels. Gravitation is of course the main factor operating in the production of a down-rush. The velocity produced by gravitation in matter falling from great heights above the photosphere must be very great, and in consequence the kinetic energy of the moving mass must also be great. The motion is impeded by friction with the gases in the sun’s atmosphere, and some or perhaps all the kinetic energy becomes heat. The heat thus developed must produce sudden expansions, and the initial down-rash is surrounded by up-rashes along the lines of least resistance. The effects of such down-rashes vary in degree accord­ing to the quantity of matter falling and the height from which it falls.

Equally too there are observed different degrees of the effects of up-rushes. All over the sun’s surface are seen domes of faculæ, either separate or in groups, and there is indication that they are hotter than the rest of the surface, for the bright lines of hydrogen are seen to surmount them. It is probably owing to this that the chromosphere exhibits a billowy outline when under con­ditions of little disturbance. The next condition of increased action exhibits itself in the growing complexity of the chemical nature and of the form of the chromosphere. Occasionally the whole level of the chromosphere over a large region seems to be quietly raised, and observation proves this to be due to the intrusion of other vapours. There is either a gradual evaporation from the photosphere or a gradual vaporization or expansion of slowly fall­ing material over large regions, raising the level of the sea of hydro­gen. The chromosphere then appears to contain different layers, and the lower we descend towards the photosphere the less we know about the substances that exist there. The next degree of disturb­ance is seen in what are called the *quiet prominences,* which very frequently occur in regions where the beginning of a disturbance has been previously indicated by the appearance of domes and metallic strata. As a rale the quiet prominences are not very high—not higher than 40,000 miles—and many of them resemble trees. They are almost entirely composed of hydrogen, or at least of a substance which gives some of the lines observed in the spectrum of hydrogen. Such a prominence grows upwards from the photosphere, being first of a small height, then getting higher and often broader, and finally a kind of condensation cloud may form at the top. The upward velocity of the gases forming these prominences is seldom very great. When a prominence disappears it does not follow that tl∣e substances of which it was composed have also disappeared, and there is evidence to show that the apparent disappearance is due to a reduction of temperature. The most intense degree of action of an up-rash is exhibited by the metallic prominences, which