

oxygen and nitrogen which so largely predominate on the surface.\* We now know that the higher the clouds are the faster they move and *Ciel et Terre* says that the motion of cirrus clouds is on the average 60 feet a second in latitudes like our own and 45 feet within the tropics, while there are thus currents in the upper air to the violence of which nothing indicates the limits. The word violence I understand implies chiefly velocity and amplitude, for in highly rarefied air, the force of such currents must not be likened to what we should experience if there were at our level a constant gale of from 30 to 45 miles an hour. From mountains and balloons those who frequent high altitudes have often seen below them the upper surface of a layer of clouds, the existence of which surface depends upon a delicate adjustment of heat and gravity. They have described how huge billows will rise from the placid and shining cloud-layer and sometimes subside as quickly as they arose. *Balloons sondes* and high-flying kites have carried instruments which show that there are frequent horizontal strata in our atmosphere, and that the low barometer in one is seldom vertical to the low in another, so that the lowest reading at a height of ten thousand feet may be hundreds of miles distant from the lowest reading at the surface. And the characteristics of these layers are very different. Thus; the outer one, which we never shall reach, must shade off in temperature to the cold of space, dust and moisture never reach it and its inferior surface is the upper limit to the lightest possible cloud. Then comes the air of which the lower limit determines the snow-line on our mountains. Lastly we may place the shell in which we live, within which alone lightning flashes and rains fall, and there is enough moisture to interpose a blessed screen against the terrible cold of a very few miles above. We will not consider the terrestrial hydrosphere and lithosphere because there can be nothing analogous to them in the solar orb, to which we will now turn.

The first scientific conception I can find as to the physical nature of the sun is that of Anaxagoras, who is reported to have said it was a red-hot stone, as large as the Peloponnesus. A hundred years ago it was defined as a glowing solid mass, stationary in the heavens. Even Sir John Herschell in the early edition of his astronomy which I used when a school boy said "it is hardly possible to avoid associating our conceptions of an object of definite globular shape and of such enormous dimensions with some corresponding attribute of massiveness and material solidity." A theory that it was liquid fire prevailed for a time. But it seems to be regarded now as composed of incandescent gas, and I too believe that the sun is a great globe of such vapours or gases, of which the visible outer envelope is as tenuous as the smoke of a cigar.

No sooner had Galileo turned his *perspicillum* on the sun than he perceived its frequent spots, and it was his treatise *Delle macchie solari* which was the ostensible cause of his disfavour with the papacy. Milton, who as a youth visited him, has a half punning allusion to them:—

. . . . . "A spot like which, perhaps,  
Astronomer in the sun's lucent orb  
Through his glazed optic tube yet never saw."

Their nature was mysterious then, and the question as to their cause and nature is not yet surely answered. One plausible theory, which still holds a certain sway, is Wilson's, who thought they were depressions in the luminous solar envelope, through which the dark interior body of the sun became visible. But out of hundreds of drawings, made with the utmost care and minutely examined, less than one in three gives any countenance whatever to this view. Were it true there should be a regular shading off from the circumference of spots to their centre, whereas there are only two well marked distinctions, viz., the black looking umbra near the middle and the more lightly shaded penumbra irregularly surrounding it. The way spots are usually drawn in astronomical journals has become conventionalized; radiations from the centre towards the circumference or *vice versa* are rarely to be seen. Moreover, this hypothesis assumes the interior layers to be less luminous than the exterior, which, as they cannot well be cooler, is improbable. Another theory was that the spots are scum or slag, floating on the surface of molten matter, but if the visible surface be

\* M. G. Heinrichs, Comptes Rendus de l'Académie, August 20th, 1900.