and dissipated, so we do not see the same tail of a comet all the time, because the matter which makes up the trail is constantly streaming outwards, and constantly being replaced by new vapor arising from the nucleus. The evaporation is, no doubt, due to the heat of the sun; for there can be no evaporation without heat, and the tails of comets increase enormously as they approach the sun. Altogether, a good idea of the operations going on in a comet will be obtained if we conceive the nucleus to be composed of water or other volatile fluid, which is boiling away under the heat of the sun, while the tail is a column of steam rising from it.

"We now meet a question to which science has not yet been able to return a conclusive answer,—'Why does the mass of vapor always fly away from the sun?' That the matter of the comet should be vaporized by the sun's rays, and that the nucleus should thus be enveloped in a cloud of vapor, is perfectly natural, and entirely in accord with the properties of matter which we observe around us; but, according to all known laws of matter, this vapor should remain around the head, except that the outer portions would be gradually detached, and thrown off into separate orbits. There is no known tendency of vapor, as seen on the earth, to recede from the sun, and no known reason why it should so recede in the celestial spaces."

The uniformity of nature justifies the inference that the tendency of highly tenuous matter to recede from the source of heat, here observed in the celestial spaces, will certainly be found in terrestrial matter when we reach the requisite conditions. The first supposition of Mr. Crookes, namely, that the rays of heat exerted a propelling force on the solid matter of the vanes in vacuum, has no analogy in the phenomena above described; but the hypothesis that the rays of heat exert this force on the residual gas in the bulb seems to be entirely in accord with what occurs in the celestial spaces. The cometary matter, having become extremely tenuous, is put in motion in a direction radiant from the sun, the source of heat. It was in the effort to find operative in terrestrial matter the force which causes the projection of a comet's tail, that my attention was attracted to the consideration of the cause of motion in the radiometer.

The tenuity of the matter in the bulb can be measured; and it would be interesting to know at what degree of tenuity the phenomenon will appear, when it reaches the maximum, and when, as perfect vacuum is approached, it disappears. It is evident that the phenomenon results from the tenuity, and not from the temperature, of the residual gas: for a radiometer immersed in melting ice and salt, and exposed to the sun, will revolve rapidly. Heat causes tenuity by expansion, and during this process heat is absorbed: but it seems from this determination, that, when a certain degree of tenuity is reached, matter begins to lose its capacity to absorb heat by further expansion, and then it develops the tendency to recede from the source of heat, the tendency increasing with increase of heat and tenuity. The work of pushing around the fly in the radiometer requires a momentum which is the product of the impetus and mass of the residual gas in the bulb; and, whether the motion be vibratory or tangential, it is possible to reduce the mass of gas in the bulb to so small a quantity that no possible impetus would put the fly in motion.

The phenomenon of incandescence also seems to indicate that matter reaches a condition of tenuity at which it begins to resist further expansion. In his beautiful description of the phenomena of combustion and incandescence in his "New Chemistry," Professor Josiah P. Cooke leaves no doubt that the incandescence incident to combustion results from the resistance of matter to heat-work. It is true that he does not refer to this as the cause of incandescence, but he shows most clearly that ordinary heat-work in matter is to produce chemical re-action or expansion, or both: and, when these are free and unrestricted, no incandescence appears; but when this work is resisted, incandescence results. Vibratory motion always results from two forces, that is, from force resisted; and, light being a form of vibratory motion more intense than that of heat, it is certainly not improbable that the light from combustion is the result of the resistance of matter to the less intense vibratory motion of heat. Assuming this to be true, we have a very simple explanation of the incandescence of highly tenuous matter. The Geissler tubes, Crookes's tubes, Tyndall's tubes, and many other phenomena, demonstrate that highly tenuous matter becomes incandescent from the application of heat at a temperature far below that required for incandescence in matter less tenuous; and the same thing seems to occur in a comet's tail, which shines with a light of its own, and in the *aurora borealis*.

If it be true that when matter reaches a certain degree of tenuity it begins to resist further expansion, we ought to expect it to become incandescent at low temperatures, the temperature at which the phenomenon would occur being determined by the degree of tenuity. Professor Tyndall was not looking for this law in his experiments, but they come very near demonstrating its existence.

The proposition that matter at a certain degree of tenuity resists further expansion, and for this reason, on the application of heat, is put in motion in a direction radiant from the source of heat, and becomes incandescent at low temperatures, does not involve a denial of the molecular theory of matter, nor of the kinetic theory of gases. The proposition is entirely consistent with the theory that matter is composed of molecules, and that in the gaseous form, or in any other form of matter, these molecules are in constant vibration. It simply requires us to admit, that, if there be molecules in vibration, the vibration, like every thing else in nature, can go so far, and no farther. It does require us to deny the deduction from the kinetic theory to the effect that the vibrations are infinite, and that if the molecules of gas "were in space, where no external force could act on them, they would fly apart and disappear in immensity." But this is a mere vagary without legitimate parentage either in reason or experiment, and ought to be discarded from physical science even if the proposition here presented is not established. A much more serious objection to the proposition will come from those who have accepted the motion of the radiometer as visible evidence of molecular vibration. There is something intensely enticing in the idea that we have a wheel revolved by these scientific elves, and the theory has taken deep root in the minds of scientists in this country and in Europe. But the proposition here presented, if it can be scientifically established, opens the way to determinations in respect to the constitution of nature of far greater importance than any here mentioned; and I earnestly hope that some competent scientist will take up the subject, and continue the experimental work until no doubt remains.

DANIEL S. TROY.

BOOK-REVIEWS.

Harvard Historical Monographs. Edited by ALBERT B. HART. No. 1. The Veto Power. By EDWARD C. MASON. Boston, Ginn. 8°. $1.

THE study of history is now carried on quite extensively in this country, and new works are constantly appearing; but we cannot say that many of them have a very high value, while not a few are almost unreadable. We are glad, therefore, to meet with a work of the kind that is somewhat superior to the mass, and such a work we have in this pamphlet by Mr. Mason. It has, indeed, no particular excellence of style, but it shows more thought and more political intelligence than is usually the case with such works. The author has not only studied his facts with great care and diligence, but discusses the principles involved, and often with much acuteness. He gives a brief chronological list of all the bills that the Presidents of the United States have vetoed, with an extended account of the more important ones. The body of the work is divided into chapters dealing with the different classes of vetoes, and showing their significance. The constitutional questions involved in the use of the veto power, and also its bearing on party politics, are carefully noted; and, though the author has confined himself to the national government, his work will be of interest and of real use both to students of history and to practical politicians. This series of historical monographs has been well begun, and we wish it good success; but we trust that the writers will not confine themselves to American history nor to the history of politics, but will treat the whole subject of the past life of humanity.