give us a further insight into the physical nature of these celestial vagrants.

Rating the light of the new comet at 1 at the time of its discovery, its progressive increase in brilliancy will be as follows:

July 2	17·8	July 26	146·3
" 10	32·3	Aug. 3	245·0
" 18	64·8	" 11	130·0

From the investigations of Secchi and Huggins upon Tempel's comet, it was found that the nucleus is partially self-luminous and composed of gas in a luminous condition, containing carbon. Nuclei, beside emitting their own light, reflect, with the coma and the stars, the light of the sun. Hence the latest theory is that the comets are composed of minute solid bodies, like a cloud of smoke or dust; and as the mass approaches the sun, the most easily fusible constituents become wholly or partially vaporized and in a condition of white heat, overtake the remaining solid particles, and surround the nucleus in a self-luminous cloud of glowing vapor. It should be remembered, however, that our positive knowledge on the subject is very limited, and that the above is merely a hypothesis which, to a certain degree, accounts for observed phenomena. Tyndall has put forward another theory of great ingenuity, founded on physical experiment, in which he regards the tails of comets as resulting from the formation of a species of actinic cloud by the action of the solar rays after their character has been altered during their passage through the comet's head. Zöllner considers that the small comets are masses of vapor consisting of water or perhaps of liquid hydrocarbons, an idea which is fortified by the character of certain nebulæ. He also believes that the electricity developed by the solar rays, either in the process of evaporation or by the molecular disturbances they produce, is amply sufficient to cause the luminosity and also to form the train.

The length of comets' tails is rarely less than 500,000 and often reaches 150,000,000 miles. The breadth of that of the comet of 1811 was 14,000,000 miles, and the comet of 1828 had a nucleus 528,000 miles in diameter.

PROTECTION FROM FIRE.

A recent amendment to the building laws of New York city provides that every dwelling occupied by more than one family above the first floor, including all hotels, lodging and boarding houses, shall be provided with fire escapes, doors, and alarms. Stores, warehouses, or other buildings, except dwelling houses, schools, and churches, shall be provided, above the first story, with fireproof shutters, capable of being opened and closed upon the outside. The occupant is required to close the shutters before leaving the premises at night.

We welcome all enactments like the foregoing, which make it inconvenient and vexatious for people to own or build inflammable structures. The tendency of such laws is to hasten the good time when nothing but fireproof materials will be permitted in the erection of buildings. This is the only sure and practical method of averting the dangers of general conflagrations, to which all of our towns and cities are now constantly exposed. We are confident that, if laws were passed to encourage the erection of dwellings and other buildings wholly fireproof, our architects and builders would soon invent the methods and means of accomplishing the work at costs not greatly exceeding those of the structures now commonly put up, in which wood is so largely a component.

Until a clean sweep out is made of everything of a combustible nature in our building materials, we must submit to be saddled with the expenses and annoyances of special laws, fire insurances, fire brigades, police, private watchmen, steam and hand engines, water tanks, chemical extinguishers, fire escape apparatus, and other paraphernalia.

The losses by fire in New York city in 1873 are put down at $2,650,000. The expenses for running the fire department of the city during the same period amounted to over $1,500,000, requiring the employment of 600 men and 150 horses, 40 steam engines, 18 hook and ladder machines, and 4 chemical engines. In addition to the foregoing, the indirect losses and expenditures due to the use of combustible building materials in New York city may be safely estimated at $2,000,000 per annum, making a grand annual total of $6,000,000.

SCIENCE READS AN ORACLE RELATING TO THE METALLURGY OF THE FUTURE.

One of the most interesting incidents of the visit of the American Society of Civil Engineers to the Stevens Institute of Technology, at Hoboken, suggested the above title for our article. After witnessing the beautiful experiments exhibited by President Morton, inspecting the multitude of interesting objects in the lecture room of the Department of Engineering, and spending a pleasant quarter of an hour with Dr. Mayer among the mysterious physical apparatus of his laboratory, the party crowded into the little lecture room of Professor Leeds. The professor had thrown upon the screen the images of several contorted and rather uninteresting looking specimens of mineral. These, he states, were pieces of a "fulgurite," or thunderbolt, as it is often called, sent him from North Carolina. When a heavy flash of lightning strikes the earth, it sometimes fuses the soil in its track, and, on solidification, it becomes a solid bar or rod, which may be, and often is, dug out of its bed. In this case, the lightning had penetrated a bed of pure white sand, melting the silex and forming a hollow shaft two or three inches in diameter and four feet long, filled within and surrounded without by the white sand of the locality. The shaft, however, was not white. Its color varied from a dark to a light pearly gray. Chemical analysis showed it to contain iron, and so accurate was the work that, on estimating it as usual, as oxide, the figures proved some error to have occurred. Estimating it as metallic iron, the figures were correct. Apparently, therefore, the fulgurite was discolored by finely divided metallic iron, and this deduction was confirmed by other and direct experiment. This would explain the peculiarity of color, since the oxide would have colored the silex green. But metallic iron does not exist in Nature on the earth's surface, and the chemist was compelled to seek some explanation of its existence here by an examination of the peculiar conditions under which it was produced.

The final conclusion seemed necessarily to be that, at the immensely high temperature at which silica melts (the extreme limit attainable with the oxyhydrogen blowpipe), iron "dissociates" from oxygen, and that here, dissociation having occurred, the metallic iron, transported by the electric flash from some subterranean deposit, became encased in molten sand, and was preserved unoxidized within the fulgurite. The melting of that immensely refractory material, silex, the dissociation of iron from oxygen, and the transportation of such an amount by electrical action, were circumstances at once remarkable and interesting. After describing this interesting research, Professor Leeds called upon his colleague, Professor Thurston, whose frequent contributions to the SCIENTIFIC AMERICAN have made his name familiar to our readers; and that gentleman then gave his fellow members of the society and of his profession an outline of the possible bearing of this curious instance of natural metallurgy upon the future of the art. He stated that, while it could hardly yet be considered as probable, it certainly did not appear impossible that at some future time the processes of art might imitate what was here seen accomplished by Nature, and that this interesting phenomenon might be a strong intimation of the direction in which metallurgical changes might lead. Could a material be obtained of which to build furnaces which should be capable of resisting the temperature at which silex melts, and could such a temperature be attained in the furnace, we need but throw our ore upon the bed of the furnace and allow it to reach the temperature of dissociation, when the oxygen would pass off up the chimney, without the use of carbon or other deoxidizing agent, and the metal would flow down upon the hearth. The requirement of a new refractory material may not improbably be fulfilled. Equally remarkable discoveries are frequently made. The attainment of so high a temperature necessitates probably the invention of a method of preventing the dissociation of oxygen and hydrogen by high temperature. As we also have stated, in an editorial article in our last issue, the limit of combination of these gases, or their temperature of dissociation, is stated by Deville at about 4,500° Fah., and this is, therefore, the limit of temperature attainable by their combustion. Oxygen and carbon dissociate at a lower temperature.

The speaker referred to the possibility that this elevation of the limit may be attainable by carrying on combustion under pressure, as already proposed by Bessemer, and as probably illustrated in some slight degree by the elevation of pressure within the converter, and the extraordinary temperatures there observed. This interesting subject and the novel ideas suggested by it were evidently looked upon as important as well as entertaining by the visitors, one of whom expressed the idea which is embodied in the title which we have assumed for our article, and nearly all of whom forgot professional dignity so far as to applaud heartily. Many of our readers, by the character of their pursuits, are also interested in this subject. We hope that some may be so fortunate as to be able to aid in securing the benefit here indicated as possibly attainable.

THE ASTOR LIBRARY.

By the munificent endowment of the late John Jacob Astor and of his son William B. Astor, the splendid institution known as the Astor Library was founded in this city. Its doors are open free of charge to all comers, and here the reader may call for any books on the catalogue and spend as long a time in their study in the alcoves of the library as he desires. There are 147,640 books and pamphlets now upon the shelves, which, with the building, have cost something over $700,000. The twenty-fifth annual report shows that during the past year 116,694 volumes were given out to readers, of which about one half were books relating to the department of Science and Art; and of the twenty divisions of this department, by far the largest number of books called for by alcove readers were those relating to patents. This is an instructive fact, showing the useful influence of our patent laws in leading people to study up the recorded knowledge of subjects which have specially engaged their minds.

PHILOSOPHERS ON SOUND.

The phenomena of sound and light are, as every student knows, closely analogous.

In media of uniform density, luminous impulses travel in straight lines. In media of various or varying density, the lines are broken or curved. A rod wholly in water or wholly in air appears straight; if partly immersed, it seems to be broken at the surface of the water. The rays of the rising and setting sun come to us through miles of atmosphere increasing in density, and are so curved in their passage that we see the sun when it is really below the horizon.

As sonorous impulses are refracted according to substantially the same laws, similar acoustic phenomena must occur under corresponding conditions: in other words, sound waves passing through atmospheric strata or other media of different densities will be bent from a straight course, rising or falling, or swerving to right or left, as the conditions may determine.

These are elementary principles, taught and illustrated in every textbook of physics, though the phenomena are less studied in the case of sounds than in the sister department of optics. It happens, too, in our ordinary thinking, that we seldom take them into account, probably because the sounds we have to do with rarely come to us through media greatly varying in density; or if they do, the precise direction of the sounding body is seldom a matter of serious importance. The ear measures angles very rudely, and usually a rough approximation to a correct estimate of the course of a sound wave is quite sufficient for our needs.

This fact is of little moment in itself; but in view of the conflict of opinion between Professor Tyndall and Professor Osborne Reynolds, as to the proper explanation of the irregularities observed in the transmission of sounds under varying conditions of the atmosphere, it rises to some degree of dignity. At least it serves as a striking illustration of the tendency of philosophers to overlook simple and familiar laws in seeking the causes of unfamiliar phenomena.

The reader will remember that Professor Tyndall lately investigated the variable sonorous power of fog horns, whistles, artillery, and other sound producers, and arrived at the conclusion that the unequal range of the sound of a given instrument on different occasions must be owing to the greater or less "acoustic transparency" of the atmosphere, due to the presence or absence of streaks of vapor or unequally rarefied air. At night and during cloudy, rainy, or foggy days, the atmosphere is to a great degree homogeneous; consequently, sound travels freely and reaches its maximum distance. On the contrary, on clear days the sun rays produce unequal effects on different substances, giving rise to columns of vapor or heated air, and the sound is quenched, Professor Tyndall asserts, by reflections and partial echoes from their surfaces.

The theory is a pretty one, but unfortunately it does not tally with fact. The sound waves, which Professor Tyndall assumed to be quenched, are shown by the observations of Professor Osborne Reynolds to have been simply deflected upward and carried over the listener's head. Thus, in one instance the sound of a bell, which was inaudible thirty yards distant on the ground, could be plainly heard at seventy yards when the observer stood up. At one hundred and sixty yards, the deflection was so great that the bell could not be heard at an elevation of thirty feet, though it was distinctly audible a few feet higher.

Professor Tyndall's columnar reflectors would therefore seem to be only figuratively "in the air." Such things might cause the stoppage of sounds, but the evidence is rather that they do not: and Professor Tyndall is fairly convicted of unscientific haste in coming to his very decided conclusions.

On the other hand, Professor Reynolds appears to have overlooked the familiar laws of refraction. According to his mode of accounting for the facts, the lifting of sound is due to the increasing velocity of air currents as the elevation increases, and is in direct proportion to the upward diminution of the temperature. The reasoning by which this position is supported, however, seems to be rather the consequence than the antecedent of the conclusion. Undoubtedly both wind and temperature are modifying elements, Professor Tyndall's reflecting columns sometimes entering the problem in like manner; still the effects of these conditions are accidental, and probably small in comparison with the refracting influence of atmospheric columns of varying density, and more especially the diminishing density of the atmosphere upward. One of Professor Reynolds' observations suggests a course of experiment which students may find attractive. We quote his fifth general conclusion:

"In all cases where the sound was lifted, there was evidence of diverging rays. Thus, although on one occasion the full intensity was lost when standing up at 40 yards, the sound could be faintly and discontinuously heard up to 70 yards. And on raising the head, sound did not at once strike the ear with its full intensity nor yet increase quite gradually, but by a series of stops and fluctuations in which the different notes of sound were variously represented, showing that the diverging sound proceeds in rays separated by rays of interference."

Trusting to Professor Tyndall's somewhat "treacherous imagination," we should interpret the facts very differently, accounting for the observed fluctuations by difference of refrangibility between high notes and low notes rather than by "interference," the conditions of which do not seem to be present. As a matter of prudence, however, we prefer merely to suggest that the matter be tested by experiment.

Recurring to the analogy of light, and remembering that the refrangibility of light rays increases with their rate of motion—red rays, for example, being less refracted than the more rapid green and blue rays—and bearing in mind the fact that sound notes differ, as colors do, simply in speed of vibration, we should naturally expect a corresponding difference in their refrangibility, producing under suitable conditions the effects observed by Professor Reynolds. It would be an easy matter to test this conclusion by means of a prism of gas, after the fashion of the gaseous lenses sometimes used in acoustic experiments. The analysis of sounds is no new thing; but its prismatic analysis has not, to our knowledge, been attempted. The experiment would therefore be novel, and, we think, sufficiently interesting to repay the trouble involved.

QUICKSILVER has been discovered in the mountains back of Boralitos, Santa Cruz county, Cal. Claims have been located and a company has been formed to work one of them.