THE DIGNITY OF MATTER

BY WILLIAM ALPHONSO MURRILL

IN the olden days, anything *material* was spurned like the dirt beneath one's feet, and only force and spirit were esteemed worthy of attention. Matter was then considered inert, formless, and degrading; but the brilliant discoveries of modern science have lifted it up from its low position and placed it upon a pedestal. Matter as formerly conceived has vanished and energy has taken its place.

Consider the atom, which in days gone by could neither be divided nor analyzed. Every atom is now known to be a little system in itself, with definite elements definitely arranged, and most of them moving at terrific speed. In an atom of hydrogen, for example, there are two tiny particles; a nucleus, or proton, at the center and an electron moving around it at the rate of 1300 miles per second. Although the nucleus is 2000 times smaller than the electron, the mysterious attraction between the two holds the latter in its orbit as the earth is held by the sun. If the electrons were three inches in diameter, the diameter of its orbit would be 7200 feet, which is another way of saying that by far the greater part of the atom is space.

There are ninety-two elements, all built up from hydrogen, which is the simplest. In the hotter stars, extreme temperatures prevent combination, so they are all pure hydrogen; but upon cooling the hydrogen atoms gradually unite to form the other elements in succession. Four hydrogen atoms, for example, unite to form a helium atom, which has four protons packed together in its nucleus and two electrons revolving about it in distinct, fixed orbits. Next comes the element lithium, with three electrons; beryllium, with four; boron, with five; carbon, with six; nitrogen, with seven; oxygen, with eight; and so on up to uranium, with ninety-two electrons moving with a speed of 125,000 miles per second about a single nucleus composed of protons.

Not quite all of the ninety-two elements have been discovered—numbers 85 and 87 are still missing—but chemists know where to look for them and something of their properties, just as astronomers have located and described unknown heavenly bodies in the past. After the discovery of argon and terrestrial helium, toward the close of the last century, Ramsay obtained neon, xenon, and krypton from liquid air; celium was discovered by Urbain a few years ago; and two additional elements were reported by Noddack in 1925. The following year was a notable one for America because of the discovery of illinium at the University of Illinois after five years of patient research. The new element was named for the university and the state.

By analyzing the light of the various stars with the spectroscope, it is possible to determine the presence of carbon, calcium, and other elements as they are formed. The yellow light of our sun is said to be due to the presence of sodium. The various elements differ greatly in their properties. Helium gas, for example, is much more valuable for balloons than hydrogen because it is inert, like nitrogen, and cannot be set on fire with explosive bullets. Argon is another inert element, with its bonds of attraction satisfactorily balanced among themselves; while potassium, with one more electron, is exceedingly active. One inert element in a compound may readily wreck it: this is the basis of explosives.

The attraction of matter for matter is a remarkable thing. In the heavens, we call it gravitation; between two surfaces, adhesion; among the molecules of a solid, cohesion; and in the atom, the electrical attraction between positive and negative particles. What a power there must be in the tiny hydrogen proton to hold an electron two thousand times its size rotating a considerable distance away at the rate of thirteen hundred miles a second! Atoms combine into molecules because of their mutual attractions, and some of these combinations are so complicated as to be almost beyond human comprehension.

When we pass beyond the sphere of chemical reaction, there are other forces that determine the state of matter, whether solid, liquid, or gaseous. Suppose these three conditions of matter were impossible, or even one was lacking, what would become of the earth—and the universe? If air could only exist as a liquid; if water could only be solid; if a nebula must always remain an attenated gas!

The sun is not only the mother of the earth but, like a true mother, is continually giving of itself to supply the light and heat—without which life on the earth's surface would be impossible. Four million tons of the sun's substance is being poured out into space every second in the form of electromagnetic waves; and the same thing is true of countless myriads of other stars; some of which, at least, will entirely disappear in this way. What becomes of all this energy? Perhaps these waves are changing back to atoms somewhere to form new nebulous masses for the production of new star systems. These waves of energy proceed from the nuclei of atoms in the interior of the stars, where the temperature may reach thirty million degrees on the Centigrade scale!

Another way in which new nebulous masses may be produced is by collision among the stars. When such an event occurs, the pressure at the center of two colliding stars as they strike and flatten is a billion tons to the square inch, or, enough to vaporize a star as large as our sun one hundred thousand times over. If the heavenly bodies can thus disappear and reappear in cycles of countless ages—eon upon eon—, then matter must be regarded as practically eternal.

The immense size of the universe, also, challenges our greatest admiration and taxes our comprehension to the utmost. Our largest telescope penetrates space to a distance of 840 million million million miles without reaching a boundary. Our own stellar system, with its ten billion suns, is 300 thousand light-years in diameter; and there are two million other known systems similar to ours with their countless hosts of suns. So far as it is possible to estimate, the known universe is twenty million light-years in diameter; a light-year being the distance light travels in a year, speeding at the rate of 186,000 miles a second!

It is not my intention to exalt matter unduly, nor to claim that the chasm between non-living matter and living matter may be lightly bridged. However wonderful the stars; however beautiful the snowflake and the crystal; the tiniest living creature, whether plant or animal, is far more remarkable. It is composed of matter, to be sure, but possesses individuality and irritability as well; has birth, the power to grow and reproduce its kind, and death; is able to vary in form both throughout life and in its heredity; and to give rise to new types of life through segregation and selection.

But we have seen how remarkably well organized are the elements of matter in the atom, the molecule, the mass, the star, and the universe; and it seems to me that this very beauty of form and organization eminently fits the material elements to be closely associated with and to take orders from the immaterial forces resident in living beings. Of all things existing in Nature, nothing is unworthy—except, perhaps, the man who does not appreciate and live up to his opportunities.