

space can expand, does not satisfy an inquiring amateur. If one believes, as this amateur does, that there are super-galaxies (galaxies of galaxies) and galaxies of super-galaxies to as many orders as you wish to count, the idea of an explosion, or of expanding space, becomes a mental nightmare.

Apparently there is nothing wrong with the spectra of these objects—the extraordinary shift toward the red is there—so something must happen to light in its long journey through the abyss of space. Maybe, as de Sitter suggests, light loses some of its energy in its long journey from its source, and is thus reddened by age. (Light becoming reddened in this way and the spectral shift toward the red end are the same phenomenon.) But how is it reddened? What happens to it? I do not know what gives the appearance or terrific recessional speed of distant spiral nebulae so I wonder if the scattering of the short rays of light—the zigzag drag—could produce it? That the red shift is due to something happening to light in its long journey seems plausible. The indicated stampede does not seem plausible.

A recent discovery is that of a galaxy in Boötis, two hundred million light years away, receding at 24,200 miles a second. Go far enough into space at the same accelerating rate and these objects would be receding faster than the speed of light—plausible only to a writer of "Amazing Stories."

The final solution of this question as well as the whole enigma of diffuse nebulae will take greater knowledge than we have at present. This ignorance, however, need not lessen our pleasure in viewing the Orion Nebula. The Orion is the "type" nebula of diffuse nebulae, but it is not the largest of its kind. The Looped Nebula in the Greater Magellanic Cloud is said to be more than two thousand times as great as the Orion Nebula, and the great dark nebula that splits the Milky Way from Cygnus to near the Southern Cross is so large—and its distance being unknown—that it is difficult to estimate its size.

San Francisco, California.

J. B. DURVEA.

## Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editors may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

### A Mechanical Explanation of Light and Related Phenomena

The generally accepted theory of light is that it is wave motion in a stationary medium called ether. There are many questions that are not answered by this theory and many phenomena that render it absurd. Some of the questions are the following:

(1) How can a medium be so rigid and elastic as to transmit an impulse through a distance of 186,300 miles in one second and yet so mobile and non-resistant as to allow free motion, even of a body consisting of the rarest gas, offering no more resistance to this than to a massive planet?

(2) Why do light waves travel in perfectly straight lines while sound waves, supposed to be similar, do not necessarily do so?

(3) If light and other related waves resemble sound waves in any sense whatever, what explanation is there for the following:

(a) The beam of light; (b) Polarization of light; (c) Refraction; (d) Aberration; (e) Diffraction; (f) The lateral nature of the wave motion discovered by recent investigation; (g) Interference of light from one source and non-interference from different sources; (h) The passage of these wave motions through certain forms of matter with little or no effect upon them; (i) Transformation of waves of one frequency into those of another frequency; (j) The quantum theorist's assertion that light waves come in bundles, resembling a bundle of darts, striking at different times, that is, waves in different phases but the same frequency?

Try to send a beam of sound through a room and leave that room in utter silence. A beam of light can be sent through a dark room leaving the room in utter darkness, yet that same beam, falling on a white surface in the next room, will illuminate that room. A beam of sunlight may pass through a lens of ice without melting it and may be made to melt metal on the other side of that ice lens.

The mechanics of light cannot be explained apart from rectilinear motion of propagation and motion of something beside the so-called wave, something, of course, that gives the effect of undulation or wave motion.

My theory is that all space is filled or permeated with particles extremely long with respect to their almost zero cross section (yet actually very short). These particles are moving at the velocity of light, 186,300 miles per second. They advance in perfectly straight lines without any deviation therefrom. Through every point in space these particles are passing in every one of the infinite directions, both ways. The lines undulate: they are in the shape of a wavy wire, so to speak. The waves travel only as the particles travel. The undulations may be any length (wave-length), from almost zero to the longest radio wave, or any combination of these wave-lengths at the same time. The undulations may be in any plane containing the moving line of particles.

These moving particles pass through matter without any hindrance to their velocity of travel, but the atoms of matter are capable of absorbing or transforming the wave-motion of the particles or imparting wave-motion to them, or of retarding somewhat the undulations.

Incidentally the atoms are elongated particles, revolving, when excited, about their central points, like a drum major's baton, in every conceivable direction.

With this mechanical set-up the various phenomena of light and the other kindred entities may be explained.

Rectilinear motion is of course obvious.

Transparency of certain substances to certain wave-lengths means that the atoms cannot absorb vibrations of those frequencies. The same substances may be able to absorb completely other wave-lengths; they are opaque to these.

Aberration is completely explained.

Polarization is inhibition of undulations in one general direction. Molecules of a crystal arranged in grill-like fashion would explain this. Nothing but undulations transverse to the line of advance could begin to explain polarization.

Reflection is the handing over of the undulations of particles moving in the direction of the angle of incidence to other particles moving from behind the reflecting surface at the angle of reflection. Refraction is a similar transfer of undulations. Neither is instantaneous but requires some part of the time of the passage of one wave. This is why the experiments of Michelson failed to detect the proper motion of the earth; the short beams (about 40 feet long) were reflected and refracted so many times that light interference was too large a scale to meas-

ure a fraction of a wave-length.

When light is diffracted, as in a beam passing through a narrow slit, vibrations are communicated laterally to other moving particles passing through the slit at the same time at small angles with the main beam, exciting these to the condition of light carriers. This is quite different from the common explanation that the waves spread as sound waves are known to do; sound waves spread through 180 degrees.

The "bundle of darts" idea is completely explained by this theory; each line of particles has its own phase. By the same token interference of light from one source (and not from different sources) is made clear; incident and reflected lines of particles have the same phase, therefore they can interfere.

Matter may absorb undulations of one frequency, and the absorbed undulations or vibrations may issue at the same time or later, as vibrations of other wave-lengths. This absorption and transformation is one of the most common of phenomena. It is probably due to the arrangement or composition or proper motion of the atoms or molecules.

Radioactive substances absorb waves of some length and transform the same into the vibrations that seem to emanate from such substances. The radioactive substances are certainly not the source of these vibrations nor of the energy the same represent, but merely transformers, so to speak. Possibly the waves absorbed are exceedingly short waves that science has not yet found the means to detect, and yet that flood all space.

Wave-lengths of the visible spectrum were the first to be recognized and measured, then infra-red and ultra-violet, later the X-ray, the cosmic ray, etc., and among the long ones, radio waves. The waves responsible for electricity and magnetism seem yet to be classified as to frequency.

The X-rays will penetrate certain thicknesses of matter but will be stopped by greater thicknesses. The cosmic ray will penetrate eleven feet of lead. It is doubtless stopped by greater thickness. Probably there are other rays, of shorter length than the cosmic ray, coming from distant space, that penetrate matter with great ease but still would be absorbed in matter of great thickness. It seems to be true that the larger the heavenly body (in the solar system at least) the higher its temperature, as for example the moon, the earth, Jupiter, and the sun.

In distant space there are vast expanses of nebulae, matter in exceedingly rare form but extremely active, excited to vibrations the frequency of which is almost infinite. In vast amounts these vibrations reach us through the medium of our moving particles as undulations that science cannot yet detect or measure. In a large, thick body of matter some of these undulations can be absorbed and transformed into internal heat.

The greater the size and mass of a heavenly body the greater its capacity to absorb this fugitive energy. Absorption would be as the cube of the diameter for equal density, but radiating surface is as the square of the diameter. As a rough and tentative calculation assume that the earth receives and radiates  $1\frac{1}{2}$  units of fugitive energy from space in a unit of time and that its temperature is  $200^{\circ}$  C, absolute. This is about the temperature at the poles, where the sun's heat and the kneading influence of the moon are practically zero. The sun would receive and radiate 330,000 times as much, or 495,000 units. By Newton's law of radiation (proportional to absolute temperature) the sun would radiate  $x/200$  times as much as the earth per unit of surface and  $900/8$ , squared, times this, by reason of relative surfaces, or  $63x$ ,  $x$  being the absolute temperature of the sun. Equating this to 495,000 gives about  $7100^{\circ}$  as the absolute temperature of the sun at the poles,

where Jupiter's kneading influence is nil. The temperature of Jupiter on the same basis is computed to be about  $820^{\circ}$ , absolute.

In my theory all energy and power has its source in these swiftly-moving, impinging, undulating particles. All space is dynamic, but only certain conditions serve to transform the power into usable form. The atomic power theory has no grounds for its assumptions in anything that goes on in the earth. To assert that the interior temperature of the sun is  $52,200,000^{\circ}$ , when it is known to have a surface temperature near  $10,000^{\circ}$ , is fantastic in the extreme. Why assert that action takes place in the stars that cannot in any degree be approached in the earth?

It has recently been asserted that gravitation acts with the speed of the velocity of light. In 1908 I published an article in which I set forth the theory of light here described and the theory that gravitation is the result of the impinging of the particles that carry light on the atoms of matter, driving them together. No doubt gravitation does act with the speed of light, but the only example where it would affect the motion of heavenly bodies is in a satellite of great eccentricity.

Space forbids discussion of gravitation or of electricity and magnetism and their purely local character.

EDWARD GODFREY.

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## General Notes

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**Maud Worcester Makemson** has recently been appointed chairman of the department of astronomy and director of the observatory at Vassar College, Poughkeepsie, New York, on the Alumnae Maria Mitchell Foundation.

**Mr. C. W. Elmer**, well known in astronomical circles as a capable and energetic amateur astronomer, recently elected secretary of the American Association of Variable Star Observers to succeed the late William Tyler Olcott, and Mr. R. S. Perkins have become associated with the William Moge and Sons Company in the manufacture of telescopes. The reorganized company has offices at 154 Nassau street, New York City, and factory at Plainfield, New Jersey.

**The Rittenhouse Astronomical Society**, of Philadelphia, held a meeting on Friday, November 13, in the Hall of The Franklin Institute, Twentieth Street and the Parkway. The program was "Siberia: Eclipse and Meteor Craters," illustrated with slides and motion pictures taken by the speaker, Dr. Clyde Fisher, Curator of the Hayden Planetarium of the American Museum of Natural History.

On Saturday afternoon, November 21, a visit of the members of the society to the Westinghouse plant at Lester, Delaware County, to inspect the work on the mounting of the 200-inch telescope was made.

A. CLYDE SCHOCK, *Secretary*.

**A Solar Halo.**—On June 23, this year, we observed a sun halo, which, when we first noticed it at 11:45, E.S.T., was complete and brilliantly colored. Holding thickly folded paper between our eyes and the sun, we watched the awe-inspiring sight at intervals for the three hours during which it was visible, after which, having lost none of its brilliance, it disappeared in the clouds that obscured the sun.

At one time an arc of a second more faintly colored ring was seen to the southwest at a distance of about  $22^{\circ}$  from the inner ring. The atmosphere between the halo and the sun was of a peculiarly luminous color; deeper than the