PHYSICS

Build Mental Model Stars To Simplify Stellar Problems

Physics Societies Learn of Vibration Danger to Airships, Communication and Acoustical Problems

MANY of the problems of astronomy are so big that they must be mentally simplified before astronomers can even start to try to solve them, declared Dr. Henry Norris Russell, Princeton University's professor of astronomy, at the meeting of the five founder societies of the American Institute of Physics. Prof. Russell delivered the noted Josiah Willard Gibbs lecture of the American Mathematical Society on "Model Stars" at this New York meeting.

Showing how astronomers go about simplifying their intricate stellar problems, Prof. Russell chose a typical example.

"What would happen," he asked, "to a large mass of matter left to itself in space?"

"If we could solve this completely, and work out the special case of our solar system in all detail, we would not have to bother with straw-votes or Presidential polls. To get something we can handle mathematically, we must take a single body, forget that it is rotating, and forget that the 90 different kinds of atoms of which it may consist may be present in different proportions in various parts—or, to be polite, assume that the material is 'thoroughly mixed.' The problem can then be solved for a 'cold body' which has lost into space all the heat that could possibly be got out of it.

White Stars

"For a small body of a cubic mile or less, this would be a lump of rock, ice, or solidified gas. For a very large body, as massive as the sun, the matter would be 'degenerate' and very dense. The atoms would be ionized, or deprived of their outer electrons, by the enormous internal pressure. The white dwarf stars, like the companion of Sirius (which is about 30,000 times as dense as water), represent an approach to being final condition.

"A completely cold body, whatever its mass, cannot be larger than a certain size. This has been calculated by the East Indian physicists, Kothari and Majumdar, as 25,000 miles in diameter, for a mass about one two-hundredth that of the sun.

"For a body which still contains internal heat, we do not yet have data enough for an exact solution of the problem. Various assumptions lead to different 'model stars,' all of which are probably like the real stars in some ways, and none of them exactly like them."

The source of the energy which stars are continually pouring into space as radiation, said Prof. Russell, is now generally agreed to be caused by transmutation of light hydrogen into heavier elements; with the possibility that the newly-discovered neutrons may also share in a similar building-up process.

"If only we knew in full," continued Prof. Russell, "the laws which govern this process—or set of processes—we could calculate what the stars ought to be like—if we knew what sort of atoms were present in them, and in what proportions. But we know neither of these things yet."

On many fronts, Prof. Russell indicated, astronomy which studies the gigantic things in the universe—the stars, nebulae, and super-galaxies—is therefore waiting, paradoxically with patience and hope, for the nuclear physicist to make discoveries of the most minute things in the universe—atoms, the cores of atoms, and electrons. Can neutrons exist in stellar interiors? Little hope is held of finding out with telescopes. The laboratory of the physicist is a much better place.

Vibration Prevention

Quelling dangerous and annoying vibration is a major contribution of the science of physics to industrial progress, declared Dr. J. P. Den Hartog, associate professor of applied mechanics at Harvard University.

The near-fatal flight of the Graf Zeppelin in 1929 when the shafts on four out of five of its motors snapped in a gale over France is the outstanding example of what may happen when vibration is not considered and guarded against, said the Harvard scientist.

In every form of transport using internal combustion engines, he pointed out, there is a terrific force on the motor shafts because the power is applied in a series of shocks by the explosions within the cylinders.

Referring to the Graf Zeppelin's hair-breadth escape, Dr. Hartog added:

"Upon inspection of the only surviving engine a large crack was found in its shaft which would have made its failure certain within an hour.

"The reason for this near-disaster was a 'coupling' between the engines and their propellers which made their calculation quite difficult, but the engines had been thoroughly tested and found in good order. Just before the fatal trip, however, the motors were overhauled and a few bolts were tightened up in the coupling to take out the 'play.' This changed the system sufficiently to cause the dreaded 'resonance,' with its inescapable result. It goes without saying that everybody concerned with these problems learned a valuable lesson from this case."

A new type of vibration damper developed only recently, Dr. Hartog disclosed, helps to combat this problem. A piece of metal is attached loosely to the motor shaft between two pins so that it can be moved about one-quarter of an inch when the shaft is at rest.

When the shaft is turning, the piece of metal, weighing several pounds, vibrates back and forth and gives shocks to the shaft. The apparatus is so designed that these intentional shocks just counterbalance the shocks coming from the cylinders so that the engine runs smoothly and safely even at the "critical speeds." Airplane engines were the first application and now other uses are being found for the novel technique.

Voice Sorter

How crystal filters sort out the hundreds of voice speeches traveling simultaneously over the new type coaxial telephone cables was described by Dr. O. E. Buckley, director of research for the Bell Telephone Laboratories.

The crystal filter was chosen as an example by Dr. Buckley to typify the blending of different research achievements of many men over many years into a single piece of telephone equipment.

Initial physical discovery in the development of crystal filters was the observation of the piezo-electric effect first noted by the brothers J. and P. Curie in 1880. They found that when certain crystals were compressed opposite electric charges appeared at each end. It was not until vacuum tube amplification came into being that a practical use could be found for the phenomenon.

Submarine detectors were developed during the World War by Prof. Langevin in France and A. M. Nicholson in America which were the first practical application. Prof. Walter G. Cady of Wesleyan University recognized the value of quartz crystals, with their piezoelectric effect, as a source of constant frequency. Most good radio stations now use such crystal controls on their broadcasting transmitters.

Value of the crystals as sorters for myriads of telephone messages going over the same cable lies in the fact that by cutting the crystals to known dimensions and shapes they can be made separately sensitive to but a single frequency. Thus as many messages can be sent simultaneously as there are different frequencies going over the cable.

The crystal filter, which is a simple enough device, illustrates, said Dr. Buckley, the importance of "keeping at it" in industrial research and the importance too of cooperation between scientists.

Musicians Help Scientists

Probably without knowing all the reasons why, six professional musicians have been playing selections for scientists at the State University of Iowa to make possible research on the tones of violins.

This was revealed in the report to the meeting of the Acoustical Society of America by Dr. Paul C. Greene. The purpose of the study was to see if violinists, in unaccompanied performances, played typically in the natural or equally tempered musical scales.

Actually it was found that they played in neither one when their violin tones were turned into electrical currents and made visible on an oscillograph.

Musicians will wish to know "that compared with both natural and equally tempered intonation the violinists tended to expand their major seconds and thirds and perfect fourths tended to approximate the theoretical scale values for that interval."

Ear As a Loudspeaker

The human ear can act as a radio loudspeaker, converting the impulses coming in on an ordinary radio set into music, Dr. S. S. Stevens, of Harvard University's Psychological Laboratory, told the Acoustical Society of America. This sort of electrical hook-up is not likely to serve as a substitute for hearing, however, Dr. Stevens predicted. Although the music can be heard and popular tunes readily identified, the quality is not rich but rather like "tin-pan" music. Nevertheless, there is the advantage that radio advertising is eliminated; speech can be recognized as speech, but only occasional words can be understood.

In Dr. Stevens' experiments, ordinary alternating electric currents were introduced into the ear by means of an electrode placed in the ear when it was filled with a salt water solution. The alternating current was converted into sounds that could be heard. The theory that the basilar membrane of the ear carries a sufficient electric charge so that it is able to respond mechanically to an alternating electrical potential is regarded by Dr. Stevens as a reasonable explanation of this phenomenon.

"We know that the ear behaves as a condenser microphone in the sense that sound energy is transformed into electrical energy," he said. "The present hypothesis suggests merely that the ear, like all condenser microphones, is capable of the reverse process of converting electrical into mechanical energy."

Thus the ear can be both microphone and loudspeaker, transforming mechanical energy into electrical impulses and back again into sound.

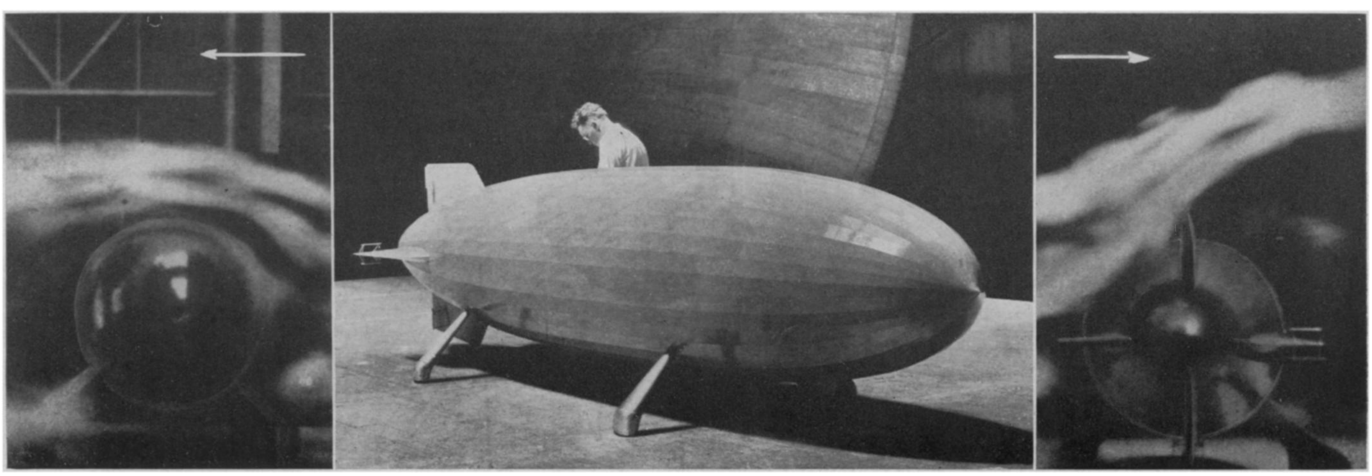
Judge Pitch Differences

It is possible for a person to listen to a tone and then to regulate the frequency of a second tone until it is just half the pitch of the first, the meeting learned from another report by Dr. Stevens in collaboration with Dr. J. Volkmann of Harvard and Dr. E. B. Newman of Swarthmore College.

Although several (*Turn to page* 302)

TEST LANDING FORCES

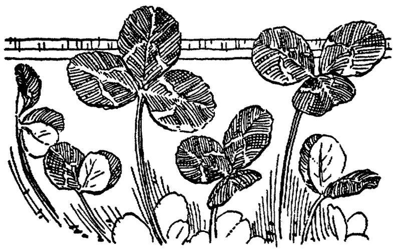
With their giant full-scale wind tunnel, air streams up to 100 miles an hour and liberal supplies of smoke, scientists at the government laboratories of the National Advisory Committee for Aeronautics have now investigated the amazingly large air forces occurring when some giant airship like the Hindenburg or the ill-fated Akron or Macon is landing. Shown below (center) is a model of the late S. S. Akron in one-fortieth actual size. In the background can be seen part of the giant wind tunnel, large enough to hold full-sized Army and Navy combat airplanes for study. The large platform, bigger than many a night club ballroom floor, simulated the ground of the landing field for the airship wind tunnel tests. At left the airship model is shown head on with smoke curling over it to make visible the airflow during the recent tests. At the right is the tail of the Akron model showing the different shape of the air currents. It was found that in an airship the size of the Hindenburg or Akron the landing forces in a 20-mile-an-hour wind may be as large as 25,000 pounds in lift and 60,000 pounds in lateral force.



SOIL SCIENCE

NATURE RAMBLINGS

by Frank Thone



The Endowment of Roots

PLANTS are workers, earners, creators of real wealth, all their lives. They take the low-value minerals of the soil, the almost valueless carbon dioxide of the air, the unpriced yet priceless water, and finally the intangible gold of sunlight, and weave it all into food and framework tissue. Some the plant is permitted to use for itself, some is appropriated by hungry humans, animals, fungi, bacteria—uncreating exploiters, all of us.

That the dead plant returns to the dust from whence it came is a commonplace. The least observant, least scientific of us realizes that. We see the dead leaves on the ground, the crop of clover or cowpeas plowed under by the farmer. We realize, at least in a vague general way, what it is all about.

But probably few of us ever take time to notice the role of the roots that are left in the soil when the top of the plant dies. These, no less than the overground parts, were created out of the same raw materials, contain much the same finished products, are capable of enriching the soil in the same way.

Indeed, they are already in place to do their best work of soil enrichment—they do not even need to be plowed under, or to be carried down by the combined activities of decay organisms and rain, as do the decaying leaves and stems. They can be acted on right where they are, and when the fungi and bacteria and small nameless animals have done their work, the final product, humus, is exactly where it is needed by the next generation of roots that send their living finger-feeders down through the soil.

It is a significant thing that the topsoil which conservationists are nowadays so anxiously talking about, and working about, is in most places practically identical with the depth to which the great mass of roots penetrates. "Thin" soils are found in places of shallow root penetration, "deep" soils where plants found conditions favorable, through long ages, and sent their roots down farther. The dark "A horizon," that is the really valuable part of a soil, is marked out by the roots, and partly made by them.

This dark zone on top of the soil is what makes human life possible on the millions-scale known to civilization, because it makes large-scale production of food possible. Our very lives are the endowment of the roots.

Science News Letter, November 7, 1936

From Page 295

of those taking part in the experiment declared that the feat was impossible, they all found that they were able to make this judgment of a tone just half as high as another and a numerical scale of psychological pitch was made up in this way. Further experiments indicated that the apparent size of just perceptible increases in pitch remains constant regardless of their location on the scale. This is just the reverse of the way sound intensities are heard. The smallest loudness difference that can be perceived depends upon the intensity of the first sound heard.

It would seem that pitch and intensity are not perceived by the same type of physiological mechanism, the investigators concluded. Loudness appears to depend upon the total number of fibers stimulated in the auditory nerve. Pitch depends upon the location of that stimulation on the basilar membrane, they hold.

When a person picks out a tone he feels is just half as high in pitch as another, he picks one that stimulates a portion of the membrane just halfway between that stimulated by the first tone and the end of the membrane.

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