ASTRONOMY

Spectral Lines Measured

Research helping to reveal composition of steel, stars and stockings reported to astronomers in Rome. Relative brightness of 30,000 spectral lines measured.

➤ THE COMPLETION of a research that will help reveal the composition of steel, stars and stockings, and will be of wide interest and high importance to the industrial manufacturer as well as to the academic astrophysicist, was reported by Dr. William F. Meggers, chairman of the International Commission on Standard Wave Lengths, at a meeting of the International Astronomical Union in Rome.

The relative brightness of 30,000 spectral lines in the spectra of 70 different chemical elements has been measured in the course of this work, in progress for 15 years. Dr. Meggers, in charge of the spectroscopic laboratories of the National Bureau of Standards in Washington, is one of the leading spectroscopists of the world.

In many industrial processes, it is important to know what impurities are present in a critical material and in what amounts. The impurities are frequently so minute that they cannot be detected or measured by ordinary chemical methods.

The spectroscope and the arc, however, are exceedingly sensitive. The slightest trace of an impurity is revealed by the appearance of characteristic lines in the spectrum, if the electrodes for the arc are made in part of the material under examination.

The spectrum differs conspicuously from element to element, because of the varied organization of the electrons in the outer part of the atoms. For example, sodium has one, chlorine, seven, etc.

With the aid of the new tables (soon to be published) of the intensities of spectrum lines, the composition of materials as well as the traces of impurities can be determined and the relative amounts accurately measured.

Astrophysicist Also Aided

The astrophysicist analyzing the planetary atmospheres or the gaseous composition of stars, nebulae and galaxies is similarly aided by the new work from the Bureau of Standards. Often spectral lines appear that have not yet been identified with any element.

Such lines in the spectrum of a star may indicate that the atomic composition is chemically unusual, or that the pressure and temperature conditions on the star's surface are peculiar. The way atoms of any element vibrate and radiate their spectrum lines depends on the pressure, temperature and abundance of those atoms.

Dr. Meggers' intensity measurements, all made by him personally on a uniform basis referred to a superposed line spectrum of copper, will also be of astrophysical use in determining for many spectra certain fundamental atomic constants known as "f values," and through them in contributing directly to basic theories of atomic structure. Heretofore, such values have been determined laboriously by other methods and for only a limited number of spectra.

The textile, chemical, metallurgical and pharmaceutical industries will be most benefited by the completion of the new tables of line intensities. In all such establishments, the spectroscope and spectrograph are important analytical tools.

The provision of standards of weights, lengths and material qualities for industry is one of the functions of the National Bureau of Standards and much basic research is a necessary part of the work.

The 70 elements studied by Dr. Meggers are all of those that show spectrum lines in the direct current arc that are suitable for intensity (brightness) measurement. The 28 elements omitted from the tabulation include the six new, artificially-created radioactive elements, like plutonium, that have atomic numbers greater than 92, the number for uranium.

Also omitted are the five halogens (chlorine, iodine, etc.), the six noble gases (neon, argon, etc.), and oxygen and nitrogen. But all the common metals, the alkalies and alkaline earths are in the list.

For some of the elements missing from the tables, the spectral lines do not occur in the interval of wavelength from 2,000 Angstroms to 9,000 Angstroms, where Dr. Meggers has worked and where industrial scientists and astrophysicists do most of their investigations. Less than half of the measured 30,000 lines fall in the visual range from violet to red.

The number of measurable lines varies greatly from element to element. Scarcely a dozen lines can be listed for elements of simple electronic structure like sodium and potassium. The "rare earths" elements, such as lanthanum and cerium, have each more than a thousand lines in the tables. Also iron, nickel and manganese are rich in measurable lines, and the now famous radioactive uranium has many thousands of

RIPPLE TANK—Oceanographer Wilbur Marks indicates the wave pattern created by a typical obstruction in the ripple tank, an instrument designed and constructed at New York University for the study of ocean surface waves. The effect of wave patterns on beach erosion is being investigated by the newly-formed department of meteorology and oceanography.

lines, a most confusing spectrum, from which Dr. Meggers has made selections of appropriately distributed wavelengths.

The element copper has played a guiding role, a sort of motherly function, in all of this spectroscopic work at the Bureau of Standards. Copper is used as a reference standard for all the other 69 elements. Its spectrum is reasonably "clean" (that is, free from blends), and not too rich. The lines are nicely spread, from the shortest to the longest wavelengths. Also, copper works up easily into the electrodes for the direct-current arc.

In practice, the 69 elements are one at a time introduced as impurities into the otherwise pure copper electrodes. The amount of the impurification is accurately controlled—one atom to a thousand atoms of copper. This one-tenth of one percent is ample to give properly the combined spectrum of the "impurity" and of copper, and lead to the compilation of the 30,000 lines for the 70 kinds of atoms. The copper itself was standardized against silver of the purest quality possible.

Cooperating with the spectrographic work at the Bureau of Standards, and extremely important for the success of the enterprise, have been the chemical laboratories at the Bureau and at industrial and educational institutions. Some of the elements have been extremely difficult to get in suitable purity.

Science News Letter, September 20, 1952

ASTRONOMY

Helium Burned to Carbon For Older Stars' Energy

➤HELIUM IS being "burned" by transmutation into carbon in the extremely hot cores of some of the older stars in the universe to keep them stoked.

This possibility is substantiated by recent and still incomplete spectroscopic observations reported to the International Astronomical Union meeting in Rome by two Americans, Dr. Jesse L. Greenstein of California Institute of Technology, Pasadena, and Dr. Martin Schwarzschild of Princeton University Observatory. The temperatures rise by contraction to some 200,000,000 degrees in the center of these stars shining on helium energy.

More certain is transmutation of hydrogen into helium with release of energy in the cores of most normal stars.

The first definite hints regarding the conditions under which the stars were formed, from the very beginning of our Milky Way galaxy until now, are given by other studies of the light spectra from the stars. When the older stars, like the red giants Betelgeuse and Antares, were formed there seems to have been a lack of interstellar dust, which contains heavier chemical elements. Younger stars, like our sun, Vega and Sirius, have a relatively high abundance of heavy elements, and dust evidently was important in their formation.

Science News Letter, September 20, 1952

PHYSICS

Problems of Space Travel

Meteors, air-friction heat and weightlessness among the many perplexing problems that must be solved before travel in space will be possible.

➤SCIENTISTS WILL have to find answers to many perplexing questions before you can jump into a sleek rocket ship with a round-trip ticket to the moon.

Heinz Haber, associate physicist at the University of California, Los Angeles, told the American Society of Mechanical Engineers meeting at the Centennial of Engineering in Chicago that space travel poses numerous physical and psychological problems requiring more study.

Moderately large meteors could puncture the hull of a high-flying ship easily, he said. That could result in an immediate "explosive decompression of the crew."

Present-day airplanes are not troubled by meteors, because most of the particles from space vaporize at great altitudes as they whiz into the earth's atmosphere, wasting away completely by the time they have fallen to a 60-mile altitude. But at 90 miles, a rocket ship would run the same risk of being meteor-struck as when it is in interplanetary space, except for the protection offered by the earth, he said.

The heat generated by air friction, by the sun and by the men inside the ship creates another problem. If the rocket ship's cooling system failed, the inside heat would rise rapidly. Men would collapse in an hour at a temperature of 185 degrees Fahrenheit. It would take only three minutes if the temperature swiftly rose to 500 degrees.

Mr. Haber said cosmic rays would be a health hazard at 13 to 23 miles. Estimates show a cosmic ray concentration great enough to be considered harmful to body tissues.

A blanket of ozone surrounding the earth between nine and 25 miles high normally protects earthmen from excessive quantities of ultraviolet light. When the rocket ship passed that blanket, ultraviolet rays would become harmful to skin and eyes unless protective measures were taken.

The ozone itself could be toxic if too much of it got into the cabin air. But just as special window materials can screen out ultraviolet light, so special filters can keep ozone from entering the rocket ship.

Weightlessness would occur when the rocket ship reached an altitude of 50 or 60 miles. Experiments have shown, however, that weightlessness merely creates slight disturbances in circulation and breathing. Its most pronounced effect would be felt when passengers started to walk around, to pick up things or to coordinate body movements with their sense of touch.

Mr. Haber said little definite knowledge exists of the psycho-physical consequences of weightlessness. He said this offers one of the biggest challenges in space-medical research.

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