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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