Cosmic Nuclei

The primary cosmic radiation consists of atomic nuclei of the chemical elements. Some of these nuclei are endowed with energies many thousand times larger than the particle energies obtained even with large accelerators. Atomic nuclei of hydrogen, helium, carbon, oxygen, etc., up to elements as heavy as iron, have been detected with sensitive photographic plates, and of these the nuclei of hydrogen are most abundant.

For 10,000 hydrogen nuclei one observes about 2500 helium nuclei, 90 nuclei of carbon, nitrogen, and oxygen, 16 nuclei of magnesium and silicon, and 8 nuclei heavier than sulfur but not much heavier than iron. These abundance ratios are of great interest since they may be compared with the abundance ratios of chemical elements in stars and interstellar matter as determined by astrophysical methods. They certainly have some bearing on the still open question: Where do the cosmic rays come from? If the cosmic ray particles originate near the sun we would expect that the abundance ratios of nuclei in the cosmic radiation reflect the chemical composition of the solar atmosphere. If cosmic rays are filling the whole space, even the space between galaxies, we may expect that these ratios reflect the chemical composition of matter at an early stage of the evolution of the universe. If cosmic rays are produced and kept within our own galaxy by magnetic fields, another factor which may affect the relative abundances of various nuclei will certainly be important: namely, the smashup of cosmic ray nuclei in collisions with atomic nuclei of interstellar hydrogen gas. These collisions would result in the production of some light nuclei, such as nuclei of lithium, beryllium, or boron, which are exceedingly rare in the atmosphere of the sun. A search for these rare nuclei therefore may help to decide whether or not the cosmic rays we observe today have journeyed within our galaxy for some million years already. H.L.B.

The Heavy Nuclei of the Primary Cosmic Radiation. By H. L. Bradt and B. Peters. *Phys. Rev. 77:54, January 1, 1950.*

Ultrasonic Absorption

Classically, absorption of sound waves in liquids was attributed to viscosity and heat conduction, with heat conduction playing a minor role. However, many nonviscous, nonpolar liquids, notably carbon disulphide and benzene, show an absorption at least 1000 times greater than expected from their viscosity. Other structural features of the liquid must be effective in causing absorption. At present, the main point of interest is the transfer of the sound energy to internal degrees of freedom of the liquid molecules and the consequent absorption because of the slowness of the energy exchange.

The present investigation used the optical method of Debye and Sears to determine the effect of dissolving small amounts of polystyrene in benzene or toluene, thereby producing great increases in viscosity. The almost complete independence of absorption and viscosity found by the author (*less* absorption than viscosity would predict) can be explained qualitatively in terms of the ease of transfer of ultrasonic waves by associated liquids or molecular groups as pointed out by Kittel. A similar lack of absorption *change* was found between pairs of liquids differing only in symmetry or bonding—such as p-xylene, o-xylene, or tetrachloroethylene, tetrachloroethane. All of them absorb more than could be expected classically, so the coupling between external translational and external rotational degrees of freedom could well be the cause since symmetry or bonding has no observable effect.

Eventually ultrasonic absorption and velocity measurements over a wide range of frequencies ($\sim$ 1 to 1000 megacycles) can provide much information about the structure of liquids and aid in the development of an adequate theory of the liquid state. G.W.H.

Ultrasonic Absorption in Liquids. By G. W. Hazzard. *J. Acous. Soc. Am. 23:32, January, 1950.*

Alpha-Emission

The first successful application of quantum mechanics in relation to the atomic nucleus was the satisfactory explanation about 20 years ago of the dependence of the half-life for alpha-particle emission on the alpha-energy and the atomic number (and radius) of the nucleus. The answer to another important question, namely, the dependence of the alpha-particle energy (and therefore the half-life) on the mass number and atomic number, so that these radioactive properties could be understood and predicted for any nucleus Z^A, was also sought from the beginning but with only limited success. The main difficulty in such an endeavor has been the lack of data, since only about 24 alpha-particle emitters, all members of the three natural radioactive series, were known as recently as 10 years ago.

Today there are about 100 heavy alpha-decaying nuclear species known, the additional ones coming mainly from the artifically produced transuranium elements, the recently prepared neptunium ($4n + 1$) radioactive family which is missing in nature, and the several newly found series of alpha-emitters which are collateral to the four radioactive families. The data concerning these species has made it possible to add a great deal to our knowledge concerning the above mentioned questions, that is to our understanding of the systematics of alpha-radioactivity.

With regard to the correlation between half-life and energy, it is now clear that the nuclei of the "even-even" type (even number of neutrons and even number of protons) conform well with the existing alpha-decay theory, but all nuclear types with odd nucleons show prohibited decay. The new data make it clear that the reason for this prohibition is not to be found in spin