"Nuclear cooling" technique developed at UCSD

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FIRST SUCCESSFUL USE OF MAGNETIC NUCLEI AS A COOLANT TRIGGERS NEW LOW TEMPERATURE RESEARCH AT UCSD

Experimental research in a previously inaccessible range of temperatures is beginning at the University of California, San Diego with the first successful use of magnetic nuclei as a coolant. The "nuclear cooling" technique is the latest development in a long sequence of steps toward lower temperatures which began in the last century with the first liquefaction of gases. Helium, the last to be liquified, allowed temperatures of the order of 10K (-272.160c) to be reached with relative ease.

In the 1930's a technique known as "adiabatic demagnetization" was developed which in recent years has produced temperatures as low as .002K. At that time it was recognized that another form of adiabatic demagnetization, which uses the magnetism of atomic nuclei rather than electrons, could be used to reach temperatures as low as 10-6K. Experiments at Oxford in the 1950's indicated that indeed the atomic nuclei could be cooled to such temperatures but it remained to be seen whether they could actually be used as a coolant in order to perform experiments on other materials in that range.

In order to do this the material containing the nuclei must be precooled to at least 10-2K in a very large magnetic field (60 K gauss is currently available with superconducting magnets) and then isolated such that stray heat imputs are reduced to the order of /erg/min (1.7 x 10-9 watts).

These conditions have been met and the first results are reported in the February 1966 issue of "Cryogenics." Since those results were obtained some improvements have led to a temperature of .003K starting from a temperature of .013K and a field of 57 K gauss. The cooling substance was commercial copper wire.

Although this is not a record low temperature it represents only the first crude effort with the technique. The older adiabatic demagnetization techniques can not produce temperatures much below those presently obtained, but lower starting temperatures, different materials and smaller heat leaks allow for much lower temperatures with nuclear cooling.

Of primary importance in this new temperature range is the continuing investigation of the fascinating quantum mechanical processes which lead to electrical "superconductivity" in metals and "superfluidity" in liquid He 4. Currently at UCSD the properties of the light isotope of helium, He 3, are being studied for this purpose.

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