change in the visually estimated intensities of the super-lattice lines in the two cases and the parameter changes are presumably due to differences in the degree of order. No evidence was obtained of decomposition or the precipitation of a second phase at the lower temperature.

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Note added in proof. Cu$_2$MnAl has recently been shown[4] to partially disorder to a CsCl structure at high temperatures.

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Superconducting Alloys of the Nb$_3$Sn$_x$M$_{1-x}$ Type

IN a report prepared in this Laboratory some of the empirical observations concerning superconductivity which have been proposed in recent years were evaluated and modified using data obtained from the literature[1]. This work suggested that the initial materials to be examined should have the β-tungsten structure, contain an element which itself was a good superconductor, and have an average valence electron-per-atom ratio of approximately 4·75. Since Nb$_3$Sn, which has the highest superconducting transition temperature reported, meets the foregoing criteria, the many alloys which can be prepared by partial or total substitution for tin by elements with the same or nearly the same number of valence electrons as tin also will meet these criteria providing they retain the β-tungsten structure. As a consequence, an attempt was made to prepare and examine alloys with the general formula Nb$_3$Sn$_x$M$_{1-x}$, where M is germanium, silicon, aluminium or antimony, and is in the same group or neighbouring group of the Periodic Table as tin.

In the preparation of all the alloys, powders of the elements of 99 per cent purity were mixed in the desired stoichiometric amounts and ball-milled dry for 0·5 h. The powders then were pressed into pellet form and heated under the following conditions. Alloys in which germanium or silicon was substituted for tin in Nb$_3$Sn were heated at 1,750° C for 5·5 h under argon, and those containing antimony or aluminium were sealed first in evacuated silica capsules before heating them to 1,100° C for four days.

Small amounts of the samples were ground and powder X-ray photographs were taken using a 57·3 mm radius Philips X-ray powder camera and high-intensity copper Kα-radiation with settings of 50 kV and 40 m.amp for 3 h. The X-ray patterns were read, indexed, and the cell sizes determined by extrapolation of a_0 versus 1/2 (cos$^2θ$/sinθ + cos$^2θ/θ$) to θ = 90° (ref. 2).

The transition temperatures of the alloys prepared with the general formula Nb$_3$Sn$_x$Ge$_{1-x}$ were found to vary approximately linearly with composition, falling between the transition temperatures of Nb$_3$Sn and Nb$_3$Ge (6° K). Since germanium lies in the same group of the periodic table as tin, these alloys all had the same electron-per-atom ratio. When antimony was substituted for tin in Nb$_3$Sn, however, the electron-per-atom ratio increased from 4·75 to 5, and the transition temperature of these alloys showed a rapid drop with increasing amounts of substitution.

The substitution of aluminium for tin lowered the electron-per-atom ratio and lowered the transition temperature which, unlike antimony alloys, then reached a maximum with total substitution of aluminium, Nb$_3$Al (17·5° K) (ref. 3), indicating that there may be another ideal electron-per-atom ratio for the β-tungsten structure at 4·5 as well as 4·75. While this communication was in preparation, it was learned that Dr. T. Reed of the Lincoln Laboratories has also examined systems which involved the substitution of germanium, aluminium and antimony for tin in Nb$_3$Sn (ref. 4), so it was decided to present only the general trends that we had found.

As an extension of our work, the Nb$_3$Sn$_x$Si$_{1-x}$ system was also investigated. It is interesting to note that Nb$_3$Si does not adopt the β-tungsten structure as the other Nb$_3$M compounds in this work but instead was found to have the ordered Cu$_3$Au structure[5]. The largest amount of silicon which could be substituted for tin with retention of the β-tungsten structure is ~50 atomic per cent. Table 1 presents the compositions, cell sizes, and transition temperatures of the phases prepared.

Table 1. DATA FOR Nb$_3$Sn$_x$Si$_{1-x}$ ALLOYS

Alloy	Structure	Cell size (Å)	T_c ° K
Nb$_3$Sn	β-tungsten	5·292	17·8
Nb$_3$Sn$_{0·94}$Si$_{0·06}$	β-tungsten	5·285	17·8
Nb$_3$Sn$_{0·75}$Si$_{0·25}$	β-tungsten	5·263	16·4
Nb$_3$Sn$_{0·73}$Si$_{0·27}$	β-tungsten	5·261	13·9
Nb$_3$Sn$_{0·53}$Si$_{0·47}$	β-tungsten	5·239	8·3
Nb$_3$Sn$_{0·50}$Si$_{0·50}$	β-tungsten	5·235	7·0
Nb$_3$Si	ordered Cu$_3$Au	4·22	1·5

Since Nb$_3$Si and Nb$_3$Sn have the same electron-per-atom ratio of 4·75, the drop in transition temperature with increasing amounts of substituted silicon cannot be attributed to a deviation from this favourable ratio for the β-tungsten structure. Instead it may be that substitution of small silicon atoms for much larger tin atoms may decrease the stability of the chain of niobium atoms which runs through the β-tungsten structure until at 50 per cent substitution the structure is no longer retained.

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RADIATION CHEMISTRY

Electron Spin Resonance Investigations of Irradiated Carbohydrates

DURING an examination of the radiation chemistry of cellulose, electron spin resonance measurements were performed on a series of irradiated sugars. Certain novel features of the results which were observed are summarized here. Various carbohydrates have been examined previously by electron spin resonance[1-5], but no detailed investigation of a series has been reported using comparable conditions of irradiation and measurement.

Irradiations were carried out in a cobalt-60 source at dose rates of 1·25 × 10^6 rads/h in both vacuum and air to total doses of 10^7 and 10^8 rads. For vacuum irradiations samples were vacuum-dried to constant pressure before being sealed off in ampoules at less than 10^{-3} mm mer-