Long period helimagnetism in the cubic B20 $Fe_xCo_{1-x}Si$ and$Co_xMn_{1-x}Si$ Alloys

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CoSi is diamagnetic, FeSi is paramagnetic

$Fe_xCo_{1-x}Si$ $0.3<x<0.9$ is ferromagnetic

When x =0.95

$Fe_{0.95}Co_{0.05}Si$ is paramagnetic

When x = 0.2

$Fe_{0.2}Co_{0.8}Si$ is diamagnetic

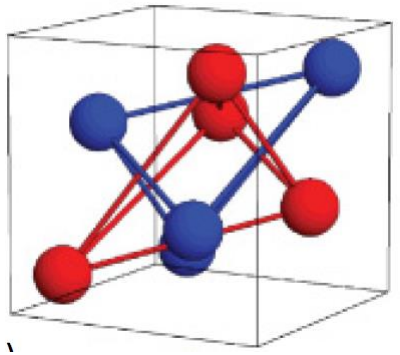
MnSi is ferromagnetic

$Co_xMn_{1-x}Si$ x=0.02, 0.04 and 0.06

When x = 0.08

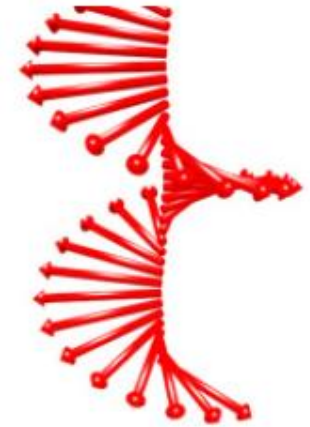
$Co_{0.08}Mn_{0.92}Si$ is diamagnetic

B20 cubic structure ($P2_13$)

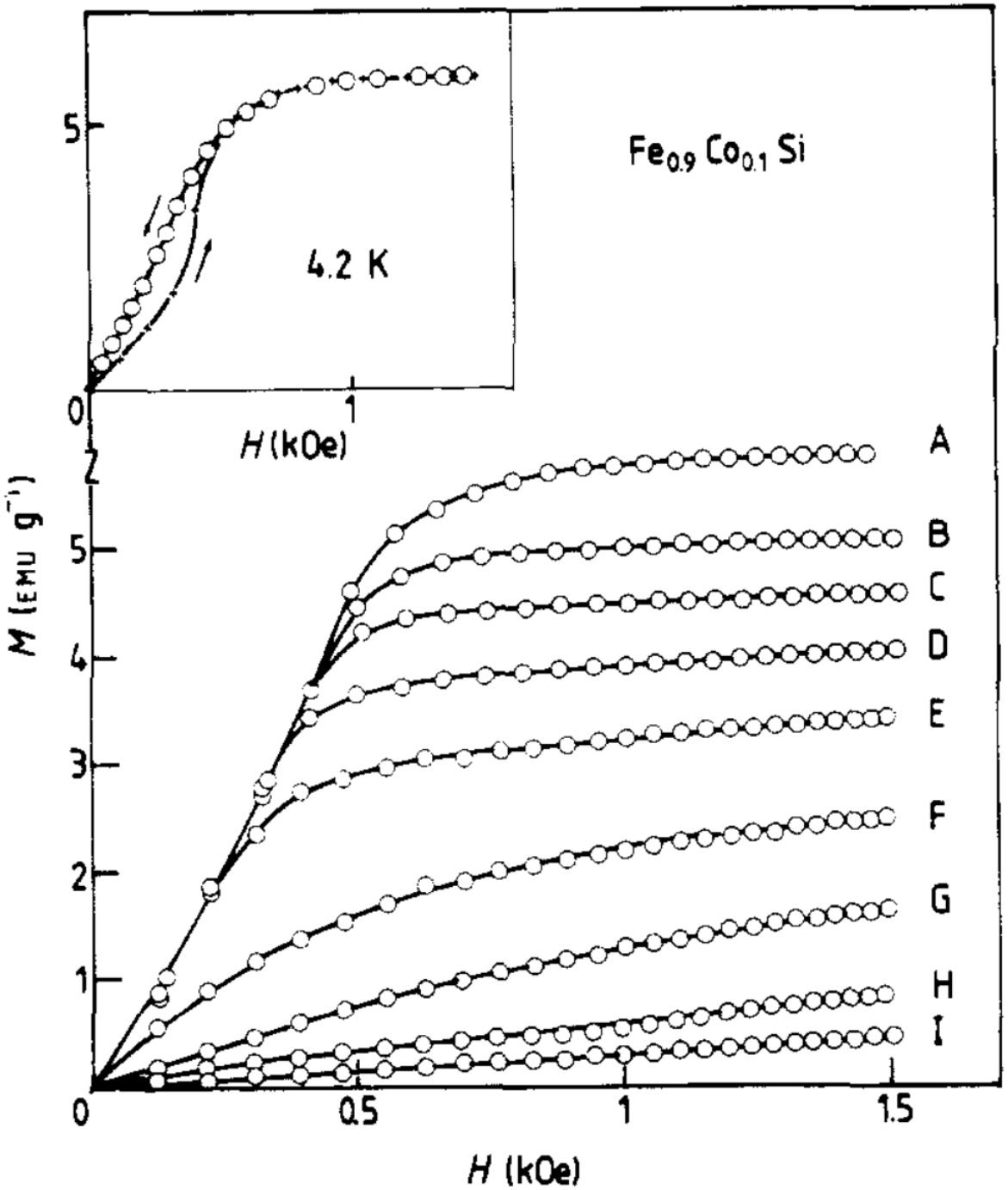


Red balls correspond to Co, Fe and Mn

Blue balls correspond to Si

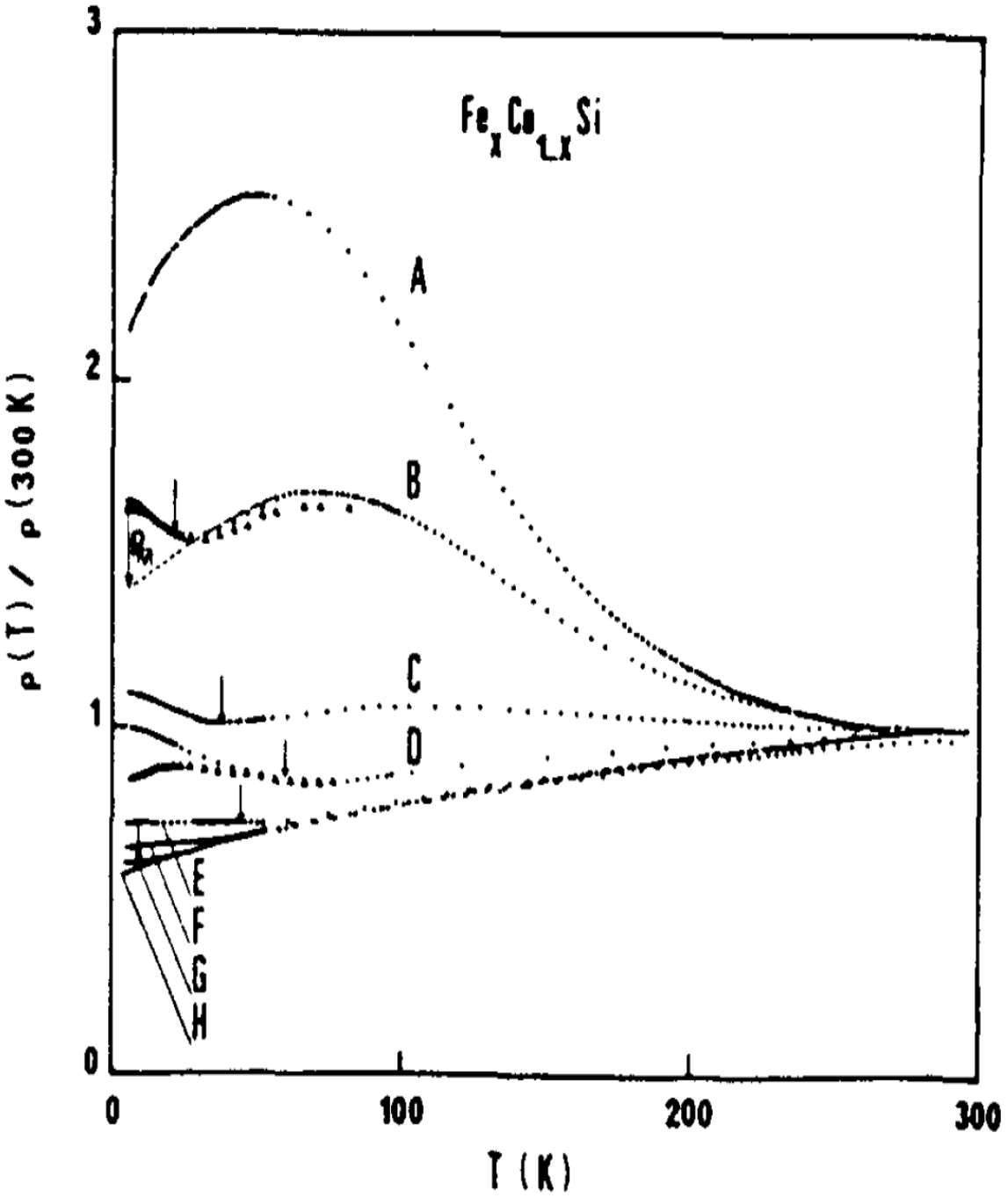


Spin structure of B20 magnet



Magnetisation M against field H for the $Fe_{0.9}Co_{0.1}Si$ alloy:
A:4.2 K B: 9.9 K C:12.1 K
D:14.3 K E:16.3 K F:18.2 K
G:19.7 K H:21.9 K I: 25.7 K

inset: 4.2K curve and the following one at decreasing field



Normalized resistivity R(T)/R(300 K) as a function of temperature for the $Fe_xCo_{1-x}Si$ alloys field H of 8 kOe

(A)x = 0.95

(B)x =0.9

(C) x = 0.8

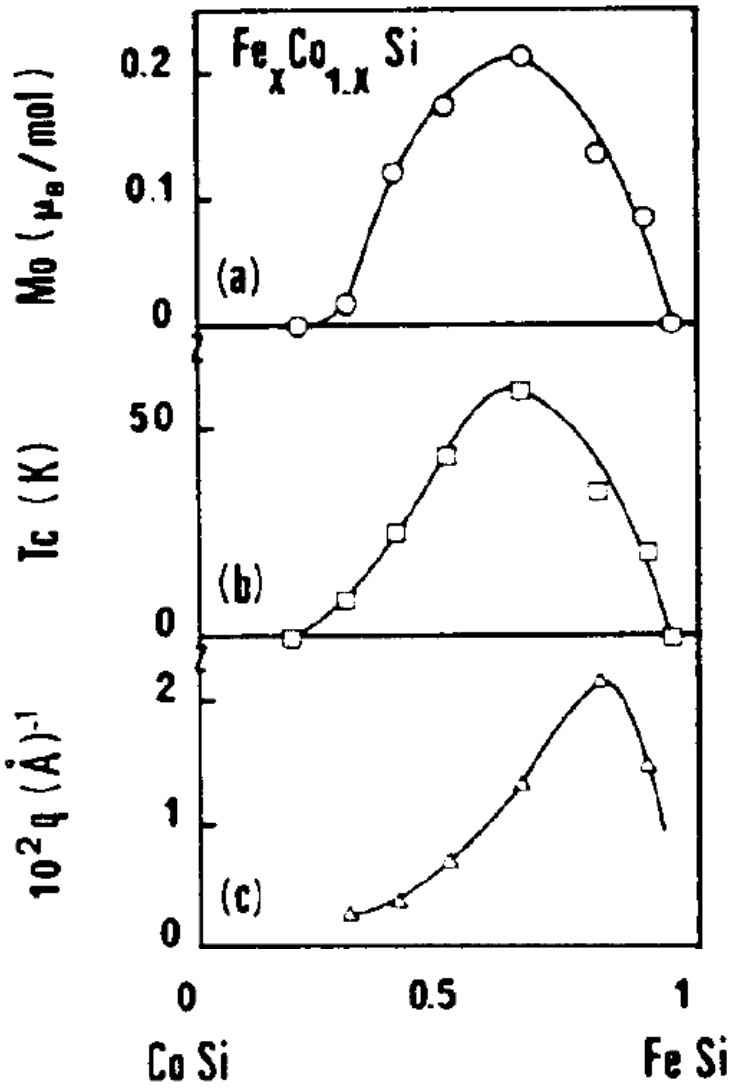
(D) x = 0.65;

(E) x = 0.5

(F) x = 0.4

(G) x = 0.3

(H) x = 0.2



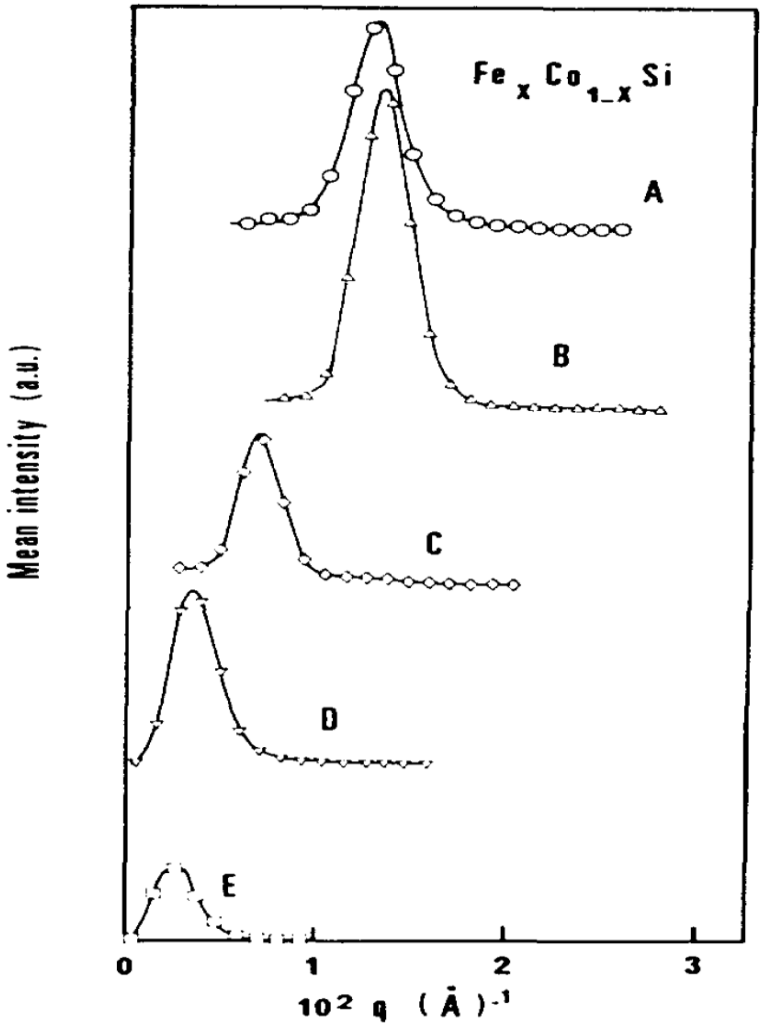
Using small angle neutron diffraction to determine the magnetic property

$2d\sin\theta = n\lambda$

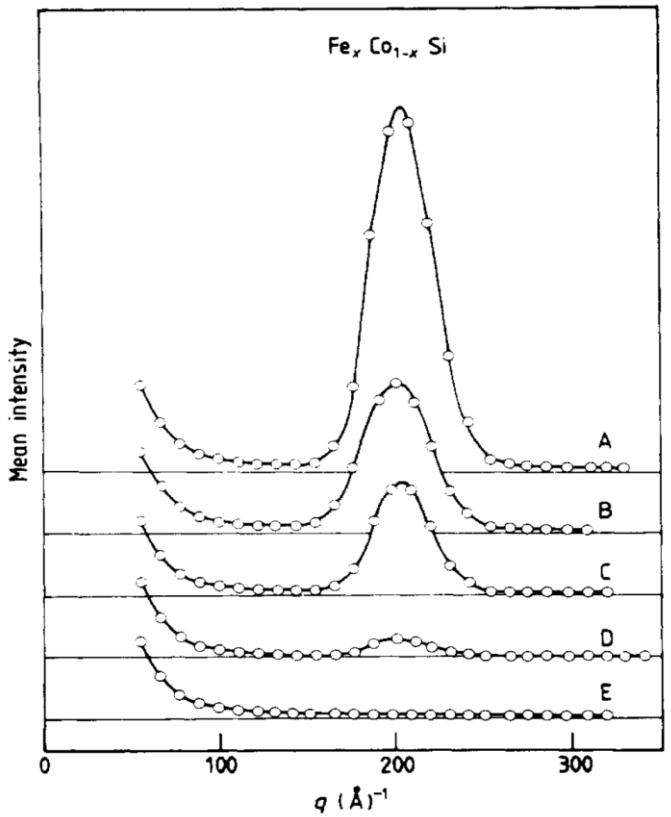
Θ is small, measure a big d-spacing

propagation vector $q = 2\pi/d$

Concentration dependence of the spontaneous magnetization M_0, transition temperature Tc, propagation vector q

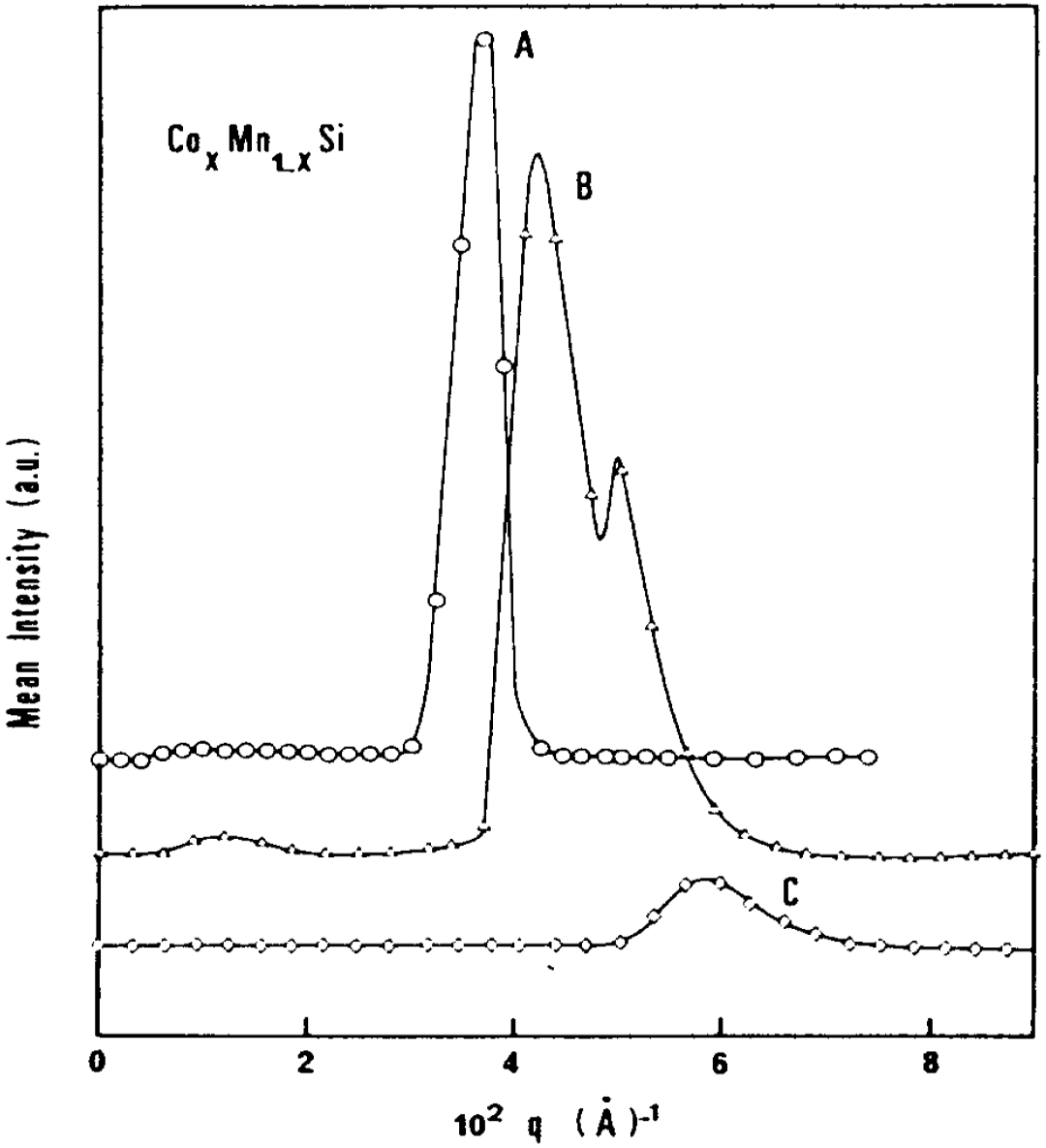


From the position of the satellite we have determined the helix period for
x = 0.9 (430 A), x = 0.65 (471 A),x = 0.5 (900 A), x = 0.4 (1740A) and x = 0.3 (2300 A).

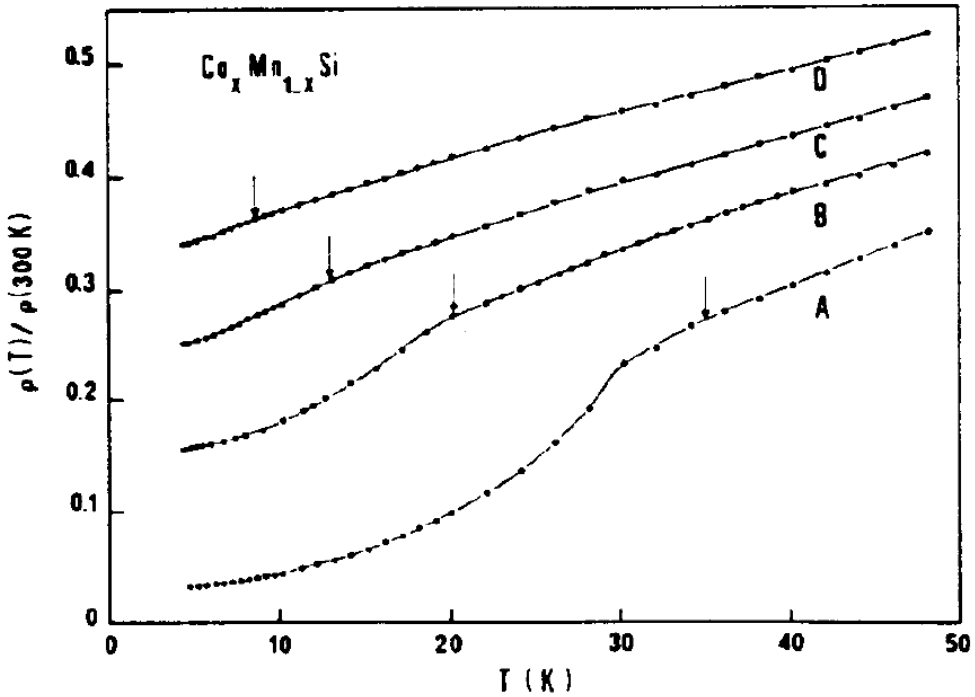


Scattered neutrons mean intensity corrected from the intensity of the central peak for the $Fe_xCo_{1-x}Si$ alloys: (A) x = 0.9 ; (B) x = 0.65; (C) x = 0.5 ; (D) x = 0.4 and (E) x = 0.3.

Scattered neutrons mean intensity under different magnetic fields for the
$Fe_{0.8}Co_{0.2}Si$ alloy: (A): H = 0 (B): H = 950Oe (C): H = 1420Oe (D): H = 1600Oe (E): H = 2000 Oe



Scattered neutron mean intensity corrected from the intensity of the central peak for the $Co_xMn_{1-x}Si$ alloys: (A) MnSi; (B) x = 0.02 and (C) x = 0.04.



Normalized resistivity R(T)/R(300 K) as a function of temperature for the $Co_xMn_{1-x}Si$ alloys: (A) MnSi; (B) x = 0.02; (C) x = 0.04 and (D) x = 0.06. Arrows indicate the transition temperature T_c.

The mean value of the helix period is
172A for x = 0,
143A for x = 0.02
106A for x = 0.04.

Conclusion

$Fe_xCo_{1-x}Si$ and $Co_xMn_{1-x}Si$ is found to be ferromagnetic

$Fe_xCo_{1-x}Si$ and $Co_xMn_{1-x}Si$ has a helical spin structure with a long period

Both compound has low transition temperature and low magnetic field, need to be further investigate.