

Neutron Scattering Group

Academic Staff

Professor	Yasuo Endoh
Associate Professor	Masahumi Kohgi
Research Physicists	Michihiro Furusaka*) Kazuyoshi Yamada

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Technical Staffs	Mitsugi Onodera Michirou Suzuki
Secretary	Kayoko Abe
Graduate Students	Hiroyuki Fujimoto (D3) Shinichi Itoh (D1) Kenji Ohyama, Eisuke Kudo and Jun'ichi Suzuki (M2) Masayuki Ito and Masaaki Matsuda (M1)
Guest research Fellows	Yasuhisa Noda and Shigefumi Onodera (Sendai Radio Technical College)

\*) On leave of absence, present address : Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX, U.K.

Research Activities

(I) DENSE KONDO AND VALENCE FLUCTUATING SYSTEMS

- a. Magnetic excitations in dilute Kondo system  $\text{La}_{0.5}\text{Ce}_{0.5}\text{Cu}_6$   
(Y.Endoh, K.Yamada, E.Kudo and H.Suzuki)

Neutron inelastic scattering from the dilute Kondo system  $\text{La}_{0.5}\text{Ce}_{0.5}\text{Cu}_6$  has been studied with the triple axis spectrometer TUNS at JAERI. No distinct magnetic response has been observed at the temperature down to 0.5K in the magnetic fields up to 5T. It is in contrast to the case of dense Kondo alloy  $\text{CeCu}_6$  where the antiferromagnetic correlation is observed at the low temperatures.

- b. Magnetic excitations of ferromagnetic Kondo system  $\text{CeSi}_{1.8}$   
(M.Kohgi, F.Hippert, L.P.Regnault, J.Rossat-Mignod, B.Hennion,

F.L.Chui and T.Satoh)

Low energy magnetic excitations of  $\text{CeSi}_{1.8}$  have been studied by neutron inelastic scattering at Grenoble and Saclay. Spin-wave-like excitations were observed below  $T_C$ , however, their widths were found to be abnormally large. It indicates that the associated 4f levels are unstable at the low temperatures. This work was supported by the Japan-France collaboration on magnetism.

c. Magnetic structure of  $\text{Ce}_2\text{Bi}$  and  $\text{Ce}_2\text{Sb}$

(S.Onodera, M.Kohgi, A.Isobe and T.Suzuki)

The antiferromagnetic structures of the new dense Kondo systems  $\text{Ce}_2\text{Bi}$  and  $\text{Ce}_2\text{Sb}$  have been studied with powder diffraction spectrometers MRP and HRP at KEKS. The incommensurate spin structure was found for  $\text{Ce}_2\text{Bi}$ .

d. Magnetic structure of  $\text{CeGa}_2$  and  $\text{Mn}_{1/4}\text{NbSe}_2$  intermetallic compounds

(H.Tanaka, M.Kohgi, Y.Endoh and T.Satoh)

Successive magnetic phase transitions of  $\text{CeGa}_2$  near 10K have been studied by neutron scattering at TUNS and magnetization measurement. It is found that the spin structure of upper two antiferromagnetic phases are cycloid ones whose spins rotate within c-plane and the ferromagnetic phase below 8K is not a simple one but probably of a fan structure. The cycloid spin structure was also found for  $\text{Mn}_{1/4}\text{NbSe}_2$  which has the same crystal structure with respect to the magnetic ion as  $\text{CeGa}_2$ .

## II. 3d ITINERANT MAGNETISM

a. Spin waves in  $\text{MnP}$  and  $\text{CoTiO}_3$

(Y.Todate, K.Yamada, H.Tanaka, E.Kudo and Y.Endoh)

Spin waves in  $\text{MnP}$  (ferromagnetic) and  $\text{CoTiO}_3$  (antiferromagnetic) have been measured up to the transfer energy of 40 meV with TUNS at JAERI and multi crystal analyzer spectrometer MAX at KENS. In both systems, anisotropic dispersion relations have been obtained.

b. Paramagnetic spin fluctuations of  $\text{MnP}$

(K.Yamada, Y.Todate, Y.Endoh, P.Boni and G.Shirane)

Paramagnetic scattering of neutrons from  $\text{MnP}$  has been studied by means of polarized neutron polarization analysis method at

Brookhaven. An anisotropic  $q$ -dependence of widths of the paramagnetic fluctuations near  $T_C$  was found. This work was supported by the Japan-US collaboration program of neutron scattering.

### III. SPIN GLASS

- a. Study of 're-entrant' spin glass system Fe-29.5at%Al  
(J.Suzuki, M.Furusaka, Y.Endoh, M.Arai and H.Yoshizawa)

Spin wave scattering as well as elastic small angle scattering from the 're-entrant' spin glass system Fe-29.5at%Al has been studied with the small angle neutron scattering instrument SAN at KENS. The spin wave scattering has also been studied by triple axis spectrometer TUNS. The inelastic scattering components were observed for the small angle scattering not only in the ferromagnetic state but also in the so-called re-entrant spin glass state.

### IV. POLARIZED NEUTRON WORKS

- a. Polarized cold neutron study of ferro-fluid  
(S.Itoh and Y.Endoh)

Structures of Co and Magnetite ferro-fluids have been studied with the polarized cold neutron spectrometer TOP at KENS. The polarization analysis of the transmitted neutrons through the frozen samples under magnetic field suggests that there exist some kinds of ordering of the ferromagnetic particles.

- b. Polarized neutron study of Fe-Ni alloy fine particles and Fe-Zr amorphous alloy (H.Fujimoto, K.Ohyama, S.Onodera and M.Kohgi)  
Fine particles of Fe-Ni alloy near Invar region and ferromagnetic Fe-9at%Zr amorphous alloy have been studied with the polarized epithermal neutron spectrometer PEN at KENS. The amount of magnetic moment per atom and its distribution in the alloys are investigated by utilizing the time-of-flight method for diffraction of polarized white neutrons produced by the dynamically polarized proton filter of PEN. The analysis of data is under way.

### V. HIGH $T_C$ SUPERCONDUCTOR

- a. Antiferromagnetism and oxygen deficiencies in  $\text{La}_2\text{CuO}_{4-x}$   
(K.Yamada, E.Kudo and Y.Endoh)

$\text{La}_2\text{CuO}_{4-x}$ , one of the base material of the high  $T_C$  superconductors, has been studied by neutron diffraction with TUNS.

It is revealed that all samples show antiferromagnetism and their sublattice moments and Neel temperatures are strongly correlated with the oxygen deficiencies.

## VI. OTHERS

- a. Epi-thermal neutron scattering from Sm compounds  
(H.Fujimoto, K.Ohyama, M.Kohgi, B.Liu, A.Ochiai, M.Kasuya and T.Suzuki)

The neutron diffraction from the Sm compounds  $\text{SmSn}_3$  and  $\text{Sm}_4\text{As}_3$  have been studied by using the neutron energy of 0.5 to 2eV with the PEN spectrometer at KENS. The coherent neutron scattering length  $b$  of natural Sm was determined at the above neutron energy region. No magnetic Bragg scattering was observed for both samples below their magnetic transition temperatures within the experimental errors, suggesting that the magnetic moments of Sm atoms in these compounds are very small compared to the free ion value.

- b. Study of phase separation process in Al-Li alloys  
(M.Furusaka, S.Fujikawa, M.Sakauchi and K.Hirano)

The phase separation process in Al-9.5 and 11.4 at% Li alloys has been studied with the small angle neutron scattering instrument SAN at KENS. At very early stage of aging process at 423K, scattering function at the high  $q$  side is not only proportional to  $q^{-2}$ ,  $q^{-4}$  and  $q^{-6}$ , but it obeys non-integer power of  $q$  which changes continuously in very short time. This results can not be explained satisfactorily by the existing theories.

## VII. INSTRUMENTATION

- a. Construction of chopper type spectrometer at KENS  
(M.Kohgi, Y.Endoh, M.Arai, S.Ikeda and N.Watanabe)

Construction of the chopper type inelastic scattering spectrometer INC at KENS has been started. In this period the design and manufacture of the vacuum scattering chamber and its shield was completed.

- b. Operation of dilution refrigerator  
(K.Yamada, E.Kudo, H.Suzuki, M.Suzuki and Y.Endoh)

Oxford dilution refrigerator for neutron scattering experiments has been operated with loading large crystals. The lowest

temperature of about 40mK was recorded.

#### Publications

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- 3) G.Aeppli, H.Yoshizawa, Y.Endoh, E.Bucher, J.Hufnagl, Y.Onuki and T.Komatsubara  
Wave vector and Magnetic Field Dependent spin Fluctuations in the Heavy Fermion System  $\text{CeCu}_6$   
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- 4) Y.Endoh  
Physics of Spallation Neutrons  
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- 5) T.Shinjo, N.Nakayama, I.Moritani and Y.Endoh  
Monolayer of ferromagnetic MnSb  
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- 7) Y.Masuda, S.Hiramatsu, S.Isagawa, M.Ishida, Y.Ishikawa, S.Ishimoto, M.Kohgi, A.Masaike, K.Morimoto and T.Nakajima  
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- 10) K.Tajima, P.Boni, G.Shirane, Y.Ishikawa and M.Kohgi  
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- 11) K.Yamada, A.Matsumoto, N.Niimura, T.Fukunaga, N.Hayashi and N.Watanabe  
 Short Range Structural analysis of Lead Silicate Glasses by Pulsed Neutron Total Scattering  
 J.Phys.Soc.Jpn. 55 (1986) 831.
- 12) T.Kajitani, T.Kawase, K.Yamada and M.Hirabayashi  
 Site Occupation and Local vibration of Hydrogen Isotopes in Hydrogen Ti<sub>5</sub>Si<sub>3</sub>H(D)<sub>1-x</sub>  
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- 13) Y.Todate, K.Yamada, Y.Endoh and Y.Ishikawa  
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- 14) Y.Ishikawa, M.Furusaka, N.Niimura, M.Arai and K.Hasegawa  
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- 16) Y.Ishikawa  
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- 20)  $\text{CsCoCl}_3$ の相転移の中性子散乱  
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Master Thesis (March 1987)

- 1) Study of structure of Ferro-fluids by Polarized Cold Neutrons  
(Shinich Itoh)
- 2) Study of Phase Transition of Ce compounds by Neutron Scattering  
and Magnetization Measurement (Hideyuki Tanaka)