博士論文公聴会の公示（物理学専攻）

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論文題目:

Ferromagnetic properties of Na-K alloy clusters incorporated in zeolite low-silica X

（ゼオライト low-silica X 中の Na-K 合金クラスターにおける強磁性）

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場所 ： 理学研究科H棟 6 階セミナー室 B （H601 号室）

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論文要旨:

　　In zeolite low-silica X (LSX), β-cages and supercages are arrayed in a double diamond structure. The chemical formula of zeolite LSX used in the present study is given by $Na_xK_{12-x}Al_{12}Si_{12}O_{48}$ per β-cage (or supercage). By the loading of guest nK atoms into zeolite, Na-K alloy clusters are generated in these cages. In previous studies, ferrimagnetism and metallic properties have been observed for K-rich samples ($0 \leq x \leq 4.0$) at respective regions of n. The ferrimagnetism is explained by a model of non-equivalent magnetic sublattices, one of which forms an itinerant electron ferromagnetism in supercage cluster network and the other of which has localized magnetic moments in β-cages. These two sublattices have an antiferromagnetic interaction. Na-rich samples at $x = 7.8$, however, have shown nearly non-magnetic properties.

　　In the present studies, Na-rich samples at $x = 5.1$ and 7.3 have been newly prepared. For $x = 7.3$, nearly pure ferromagnetic properties are observed at $8.6 \leq n \leq 9.5$. A Curie constant in the ferromagnetic samples and the close relation to the change of the optical reflection spectra suggest that magnetic moments are formed by β-cage clusters. The electrical resistivity indicates insulating states in all of the samples. In order to explain the insulating ferromagnetic state, a model of ferromagnetic superexchange interaction between magnetic β-cage clusters via the sp^3 closed-shell state in supercage clusters is proposed.

　　For $x = 5.1$, ferrimagnetic properties are observed, but the n-dependences of the Curie constant and the optical reflection spectra are similar to $x = 7.3$. The electrical resistivity indicates insulating properties differently from K-rich samples at $x \leq 4.0$. Hence, a mixture of ferromagnetism and ferrimagnetism with a weak disorder is proposed for $x = 5.1$.

　　Finally, the x-dependence of the magnetic and electrical properties in Na-rich samples are discussed in terms of the strong electron-phonon coupling which is provided by the distribution of Na atoms.