博士論文公聴会の公示（物理学専攻）

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論文題目:
Optical, Electrical and Magnetic Properties of Alkali Metals Loaded into Channel-Type Zeolite L
（チャンネル型ゼオライトLに導入したアルカリ金属の光学的電気的磁気的性質）
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場所：理学研究科H棟7階セミナー室 A（H701 号室）
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論文要旨:

Novel properties of s-electrons are observed in alkali metals loaded into periodic nanospaces of zeolite crystals. So far, alkali metals have been loaded into zeolites with cubic structures, such as simple cubic and diamond structures. These s-electrons exhibit exotic properties with a rich variety. In this work, zeolite L with main-channels of consecutive spheroidal cages along *c*-axis is employed as a host zeolite for alkali metals.

Potassium metal was loaded into K-form zeolite L at various loading densities, where the value *n* is defined as an average loading density of K atoms per unit cell. Optical, electrical and magnetic properties are investigated in detail at $0 \leq n \leq 9.6$. Optical resonant absorption/reflection band at ≈ 1.1 eV is observed in all K-loaded samples. A new reflection band at ≈ 1.8 eV appears together with the band at ≈ 1.1 eV at $n > 5$. These bands at 1.1 and 1.8 eV are assigned to the optical excitations of s-electrons confined in main-channels of zeolite L. A mid-IR absorption is found to increase in its intensity with *n* at $n \gtrsim 5$. A temperature independent term of spin susceptibility is observed in the ESR intensity at $n \gtrsim 5$ and is assigned to a Pauli paramagnetism of metal. Electrical resistivity decreases more than nine orders of magnitude with *n*. A metallic resistivity is observed only at $n \gtrsim 9$, but at $n \lesssim 9$ the resistivity displays an insulating behavior. We propose the model of one-dimensional metallic wires to explain the metallic properties at $n \gtrsim 5$, where the one-dimensional metallic state can not be observed in electrical properties because of random connections of powder particles. The metallic state at $n \gtrsim 9$ is assigned to the three-dimensional metallic state of the dense bundle of wires. A plausible model of 1s, 1p and 1d states in quantum cylinders with a finite confinement potential depth is proposed in order to explain optical, electrical and magnetic properties.

Rubidium metal was loaded into Rb-form zeolite L. The Rb-system resembles the K-system in optical, electrical and magnetic properties, but the decrease in the critical value of *n* is observed. The difference is ascribed to a lower ionization energy of Rb atoms compared with K atoms.