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Magnetic and thermodynamic properties of S=1 bond-alternating antiferromagnetic chains

Masayuki Hagiwara (Osaka University)

We report the experimental results of magnetic susceptibility, magnetization, ESR, inelastic neutron scattering (INS) measurements on some Ni bond-alternating (BA) chain compounds which are regarded as the S=1 BA antiferromagnetic chains. According to the Affleck-Haldanes' conjecture and subsequent numerical calculations, it is shown that the energy gap between the singlet ground state and the triplet excited one closes at a certain bond alternating ratio. For $Ni(C_9H_{24}N_4)_3(PF_6)$, abbreviated as NTEAP, we verify by experiment the existence of the gapless point by comparing the susceptibility and magnetization of NTEAP with the numerical ones calculated by Prof. Takahashi's group. We also observed one half magnetization plateau in some Ni bond-alternating chain compounds, which is the first experimental realization that meets the Oshikawa-Yamanaka-Affleck condition necessary for the emergence of magnetization plateaus in quantum spin systems.. In one of Ni BA compounds, $Ni(C_9H_{24}N_4)NO_2(ClO_4)$, alias NTENP, the magnetic specific heat along the chain direction is found to be proportional to temperature above a critical field at which the energy gap vanishes in a temperature region above that the long-range ordered state, which is the first observation in a gapped one-dimensional antiferromagnet. In comparison with the numerical calculation based on the c=1 conformal field theory, we have an evidence for a Tomonaga-Luttinger liquid. We also want to talk about the results of INS experiment on NTENP by showing the difference from spin excitation of one of the Haldane material $Ni_2(C_5H_{14}N_2)_2N_3(PF_6)$ (NDMAP). We have found the highest mode intensity of the triplet is extremely weak, which is caused by the location of two magnon continuum above the isolated one magnon mode (triplet).