Stern-Gerlach Experiments of One-Dimensional Metal-Benzene Sandwich Clusters: $M_n(C_6H_6)_m$ (M = Al, Sc, Ti and V)

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A molecular beam of multilayer metal-benzene organometallic clusters $M_n(C_6H_6)_m$ (M = Al, Sc, Ti, and V) was produced by a laser vaporization synthesis method, and their magnetic deflections were measured. Multidecker sandwich clusters of transition metal atoms and benzene $Sc_n(C_6H_6)_{n+1}$ (n = 1-2) and $V_n(C_6H_6)_{n+1}$ (n = 1-4) possess magnetic moments that increase monotonously with n.[1-4] The ferromagnetic spin ordering of the $V_n(C_6H_6)_{n+1}$ clusters can be reproduced by theoretical calculations.[5] The magnetic moments of $Al(C_6H_6)$, $Sc_n(C_6H_6)_{n+1}$ and $V_n(C_6H_6)_{n+1}$ are smaller than that of their spin-only values as a result of intra-cluster spin relaxation, an effect that depends on the orbital angular momenta and bonding characters of the orbitals containing electron spin. While $Ti(C_6H_6)_2$ was found to be non-magnetic, $Ti_n(C_6H_6)_{n+1}$ (n = 2, 3) possess magnetic moments.[6] The mechanism of ferromagnetic spin ordering in $M_2(C_6H_6)_3$ (M=Sc, Ti, V) is discussed qualitatively in terms of molecular orbital analysis. These sandwich species represent a new class of one-dimensional molecular magnets in which the transition metal atoms are formally zerovalent.

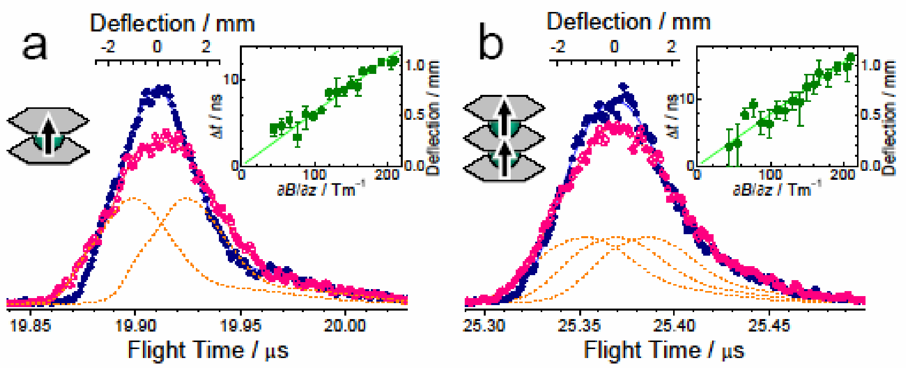

Figure 1. Broadening of TOF peaks of $V(C_6H_6)_2$ and $V_2(C_6H_6)_3$ by the magnetic field gradient at $T = 154$ K. (Filled circle: $\partial B/\partial z = 0$, open circle: $\partial B/\partial z = 205$ Tm^{-1}) Solid lines indicate modeled TOF profiles for zero-field profile and simulated broadened profile. Beamlets are shown by dashed lines. Inserts show the deflection magnitude of the outmost beamlet obtained by the 'beamlet' model.

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