Long-range magnetic order in Mn_2GaC films studied by NMR

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Mn_2GaC films belong to the MAX phase family and present an atomically laminated structure stacked along the hexagonal c-axis, where the Mn-C-Mn stacks are interleaved with the atomic layers of gallium. This compound is magnetically ordered below 507 K and is the only MAX phase containing a single M element that has been successfully synthesized up to now. At around 214 K this compound undergoes a first-order phase transition, but the magnetic structure below this transition point is not well understood. It has been shown that each Mn-C-Mn trilayer can be considered as a supe-rmoment with collinear spin configurations having parallel spin directions, but the exchange interaction across the Ga layer between the respective super-moments is a matter of controversy. Previous zero-field NMR investigations carried out on ^{69}Ga, ^{71}Ga, and ^{55}Mn nuclei suggested a non-collinear arrangement of manganese super-moments across a gallium layer. The present study gives further details on the low-temperature spin arrangement, provided by the in-field ^{55}Mn NMR experiments. ^{55}Mn NMR spectra have been recorded at 4.2K in presence of the external field up to 1T applied in the film plane

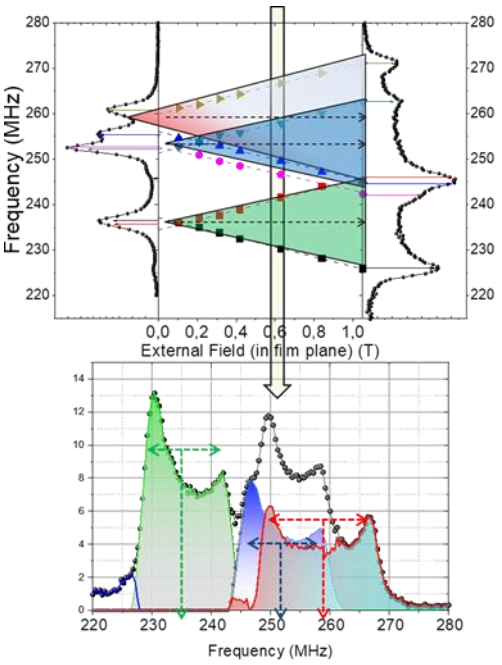

Fig.1 ^{55}Mn NMR data taken at 4.2K from the 100 nm thick Mn_2GaC/ MgO(111) film

top: signal frequency position of the characteristic peaks in the ^{55}Mn NMR spectra vs. the in-plane external field.

bottom: decomposition of the ^{55}Mn NMR spectrum recorded at B_{ext}=0.6T into three components taking as a reference the intensity distribution of the well-resolved low frequency line (225-245 MHz).

The above presentation illustrates clearly that the observed peaks can be grouped into three bifurcated NMR lines, with all the frequency branches linearly increasing/decreasing with a slope equal to the Mn gyromagnetic ratio: Υ = 10.5 MHz / T.

Considering the crystal structure of this MAX phase compound the above data indicate that the plausible magnetic structure justifying such distribution consists in a spin spiral extending along the film normal (i.e. along the crystal c-axis). Such a spiral spin structure can be formed as a result of the competing exchange interactions between the first nearest neighbor and the second nearest neighbors exchange interactions.

This work has been supported in part by a grant from the National Science Center, Poland (UMO-2019/35/B/ST3/03676)