High pressure $\mu$SR study on cobalt oxide spinel

Y. Ikedo$^1$, J. Sugiyama$^1$, H. Nozaki$^1$, K. Mukai$^1$, H. Itahara$^1$, P. L. Russo$^2$, D. Andreica$^{3,4}$, and A. Amato$^4$

$^1$Toyota Central R&D Labs. Inc., Nagakute, Aich 480-1192, Japan
$^2$TRIUMF, Vancouver, BC V6T 2A3, Canada
$^3$Faculty of Physics, Babes-Bolyai University, RO-3400 Cluj-Napoca, Romania
$^4$Laboratory for Muon-Spin Spectroscopy, PSI, 5232 Villigen PSI, Switzerland

The magnetic nature of the Co$_3$O$_4$ spinel has been studied under pressure up to 13.4 kbar by means of zero field (ZF) and weak transversal field (wTF) $\mu$SR using a polycrystalline sample. At ambient pressure, Co$_3$O$_4$ enters into an antiferromagnetic (AF) phase below 30 K, as evidenced by two distinct spontaneous muon-spin precessions in its ZF spectrum [1]. Figure 1 shows the temperature dependences of normalized initial wTF asymmetry ($A_{TF}$) for Co$_3$O$_4$ under pressures of 1.0, 6.7 and 13.4 kbar. As $T$ decreases from 40 K, $A_{TF}(T)$ curve exhibits step-like decrease down to zero under all applied pressures, indicating that Co$_3$O$_4$ undergoes the AF transition with $T_N$ of 30 K at 1.0 kbar, 31.5 K at 6.7 kbar and 33 K at 13.4 kbar, respectively. On the other hand, ZF measurements show that the frequency of spontaneous muon-spin precession is almost independent of pressure. Since only the Co$^{2+}$ ions at the tetrahedral site in the Co$_3$O$_4$ spinel lattice are magnetic, the increase in $T_N$ by pressure indicates that the AF interaction between the Co$^{2+}$ ions at the tetrahedral site is enhanced by pressure through the decrease in the distance between the adjacent Co$^{2+}$ ions.

Fig. 1: $T$ dependences of $A_{TF}$ for Co$_3$O$_4$ under three different pressures.