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Developments of analysis functions for μSR time spectra which show intermediate shapes between Gaussian and Lorentzian

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How to choose analysis functions is a key matter to deduce the information in physics from the muSR results. For instance, local magnetic fields at the muon site in the paramagnetic state are well known to be coming from surrounding nuclear dipole moments. In this case, the field distribution at the muon site becomes to be the Gaussian distribution [1]. This Gaussian distribution typically occurs when there are independent contributions from many magnetic sources with similar amount of contribution. On the other hand, in case that, one magnetic spin, which is located nearest to the muon, tends to give a dominant contribution, the local field due becomes random and a different field distribution appears at the muon site. For the dilute limit (effectively for concentrations less than 3~5 %), the field distribution becomes to be Lorentzian [2].
In our presentation, we described the crossover field in terms of a convoluted function of Gaussian and Lorentzian. We derived the equation of the three-dimensional (3D) convolution in two ways. The first derivation uses the convolution integral starting directly in the 3D space. The other derivation starts from that of the one-dimensional (1D) convolution and make it to be converted to the 3D form. From the latter, we showed that the equation can be decomposed to a sum of three known convolutions. By applying the Fourier transform to this equation, we achieved the correct relaxation function for the zero-field condition, which was found to be given by a simple analytical equation. In addition, we tried to describe the intermediate analysis function under applied magnetic fields and under dynamic fluctuations based on the development of the zero-field intermediate analysis function. Finally, we applied our developed analysis function to some μSR results to make sure its validity [3].

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