The Laplace transform of a function $f(t)$ is defined as

$$\mathcal{L}\{f\}(s) = \int_0^\infty f(t)e^{-st}dt$$

where, in general, the transformed function denoted as $\bar{f}(s)$ is a complex-valued function of the complex variable s. In an NMR T_2 relaxation experiment, the signal intensity of a signal with time constant T_2 decays as $I_0(t)e^{-t/T_2}$. In a sample with multiple peaks, each with its own relaxation behaviour, the total integrated signal decays as

$$I(t) = \sum_n I_{0n}e^{-t/T_{2n}}$$

sampled at discrete time points $\{t_m\}$. This resembles a discrete version of the Laplace transform with $T_2 = 1/s$, where both the original and transformed functions are real-valued functions of real variables. The amplitudes of the relaxation components that exist in the signal, $\{I_{0n}\}$, can be extracted by inverting the Laplace transform.

Unlike the Fourier transform, however, the Laplace transform is not unitary and the inverse cannot be easily calculated [1]. Writing the expression above in matrix form with the following redefinitions

$$\mathbf{b} = \left[I(t_0)\ I_(t_1)\dots I(t_m)\right]^\intercal$$
$$\mathbf{x} = [I_{01}\ I_{02}\dots I_{0n}]^\intercal$$
$$\mathbf{A} = \begin{bmatrix} e^{-t_1 s_1} & \dots & e^{-t_1 s_n} \\ \vdots & \ddots & \vdots \\ e^{-t_m s_1} & \dots & e^{-t_m s_n} \end{bmatrix}$$

we have a system of linear equations

$$\mathbf{Ax} - \mathbf{b} = 0$$

which can be solved as an optimisation problem with constraints $x_i \geq 0$. The same approach can be used for T_1 recovery experiments by changing the functional form of the elements of the transformation matrix **A** to recovery curves.

[1] Numerical algorithms to compute the inverse exist (`https://link.springer.com/article/10.1007/s11075-012-9625-3`), but generally require the function to be sampled at a large number of arbitrary points, which is not compatible with experimentally acquired datasets.