Luminescence-Z-scan
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Z-scan is the most popular technique for characterization of nonlinear optical materials. In this work we demonstrated an extension of this technique to investigate nonlinear materials that exhibit fluorescence due to an excited state population and the total fluorescence is monitored along the Z-scan. We'll consider the simplest case where the excited state population is proportional to \( s/(1+s) \), where \( s = I_o/I_s \) is the saturation parameter with \( I_s = h\nu/\sigma_{abs}\tau \), where \( \sigma_{abs} \) is the absorption cross-section and \( \tau \) is the excited state lifetime. Considering the Gaussian shape of the laser beam, the integrated luminescence is proportional to:

\[
y = \frac{(1 + x^2)}{s} \ln \left( 1 + \frac{s}{(1 + x^2)} \right)
\]

where \( x = z/z_c \), \( z_c \) is the Rayleigh length, \( I_o = 2P/\lambda z_c \) is on-axis intensity of the Gaussian beam and \( P \) is the excitation power. The above expression predicts a decrease of the integrated luminescence due to saturation at the focus position \((z = 0)\) due to absorption saturation. The measurement were performed solid state laser materials with lifetimes \( \tau \approx \) milliseconds using an Ar+ cw laser with the time-resolved Z-scan technique [1,2].

The saturation intensity is obtained as a fitting parameter from the fit of experimental curve described by Eq.(1). Our preliminary results are \( I_s = 2.6KW/cm^2 \) for Ruby at \( \lambda = 515 \) nm, \( I_s = 12.9KW/cm^2 \) for Cr:YAG at \( \lambda = 457nm \) and \( I_s = 42KW/cm^2 \) for CaF\(_2\) : 2Tb\(^{3+}\) at \( \lambda = 488nm \).