# Non linear thermo-elastic response in experiments of extreme ultraviolet transient grating


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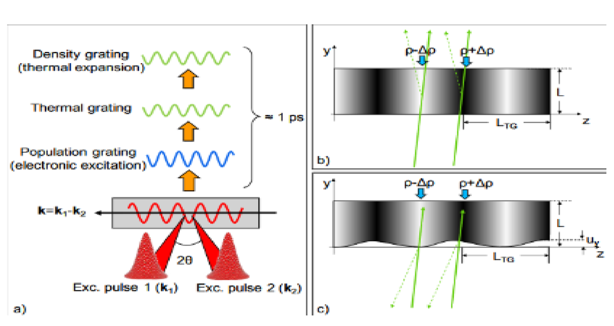
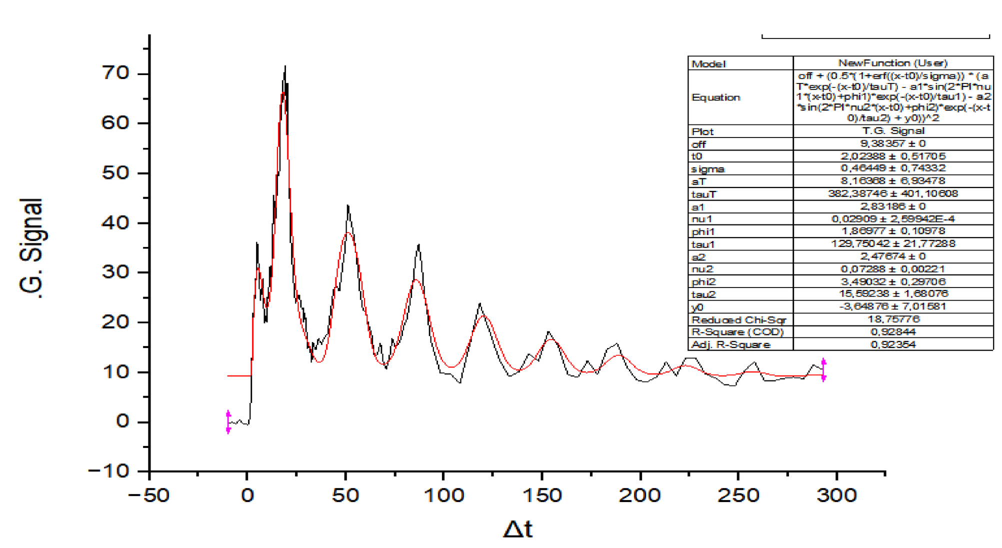
## Introduction

It has been investigated an anomalous behavior of the thermoelastic dynamics, observed in extreme ultraviolet transient grating (EUV TG) experiments and consisting in an irregular oscillation pattern, lasting only a few acoustic cycles. These dynamics cannot be accounted for by the conventional approach used for describing the thermoelastic response in optical TG experiments.Available data suggest that this behavior may be a general aspect of TG, related to either the large amplitude of the thermal grating (Λ_TG) and/or to the ratio between the attenuation length and the TG period (L abs /L TG).
Furthermore it has been tried to implement a new theoretical description of the process, with the aim to describe correctly the decays over the time of the thermoelastic response.Our approach consisted in adding a time dependence on the temperature, considering two different parameters τR *(which describes the rice up of the function) and τ*η (which describes the modulation decay of the function).This approximation leads to a new PDE for the acoustic wave equation whose solution is a correct explanation of the decaying behavior of the thermoelastic response.




## Thermoelastic response, anomalous behavior and possible solution

Here is an example of one Scan registered at the FEL in Trieste, on the sample Zr_65 Cu_27.5 Al_7.5.
Comparing this behavior with the one theoretically predicted by Keith A. Nelson in "Laser induced phonons: A probe of intermolecular interactions in molecular solids", can be seen an incongruence.




To fit this incongruence we have introduced a time dependence inside the temperature, so that the acoustic wave equation to be solved now is $\frac{\partial^2 v_z}{\partial t^2} = \frac{c_{11}^2}{\rho_0}\frac{\partial^2 v_z}{\partial z^2} + (c_{11}+2c_{12})\alpha T \frac{\pi}{\Lambda} e^{-\frac{t}{\tau}} \sin\left(\frac{2\pi z}{\Lambda}\right) \exp\left[-t\left(\frac{1}{\tau_R}+\frac{1}{\tau}\right)\right]\left(\frac{1}{\tau_R}+\frac{1}{\tau}\right)$

The T.G. signal is proportional a part for numerical constant to the solution of this equation. This latter has been found numerically and it is, for $c_{11} = 15,\ \tau_R = 0.1,\ \tau = 3,\ \rho = 1,\ c_{12} = 1,\ \Lambda = 50,\ \alpha = 1,\ T = 500.$