The Relationship between the Scaling parameter and relaxation time for non-exponential relaxation processes in disordered systems

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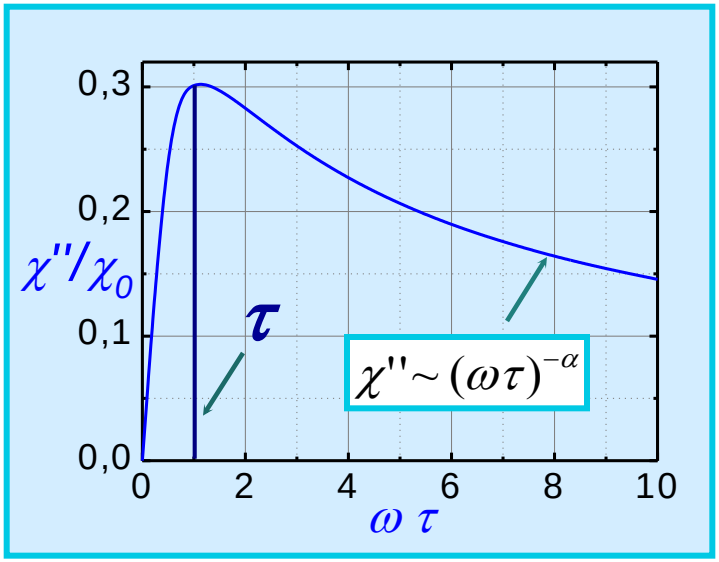
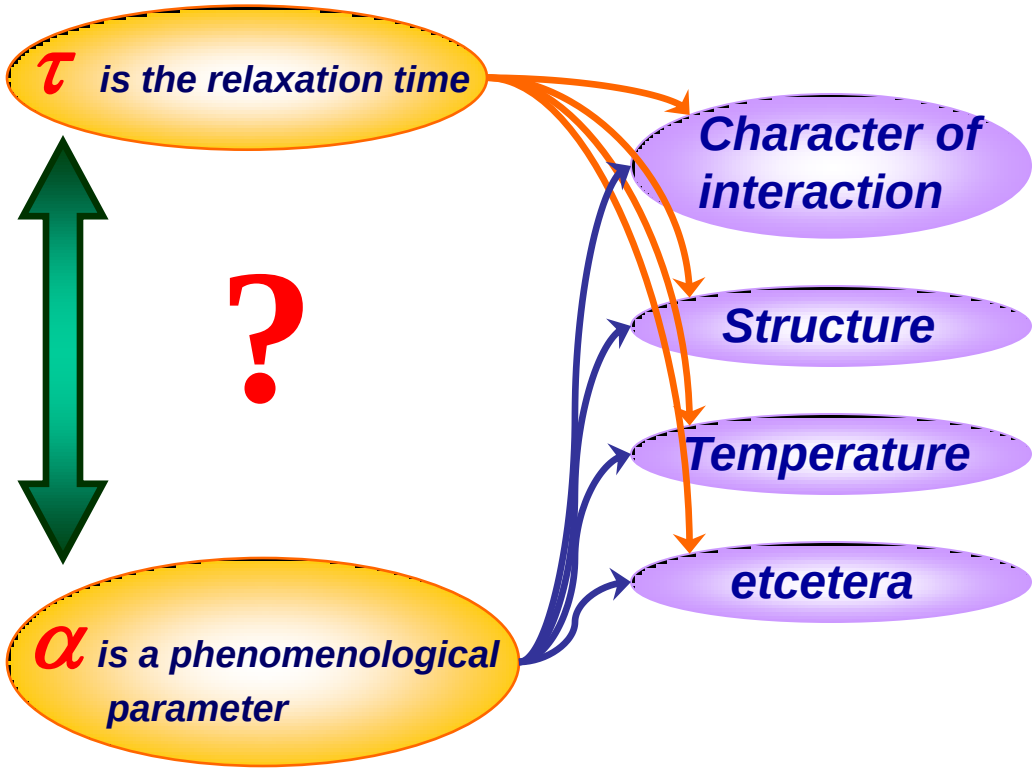
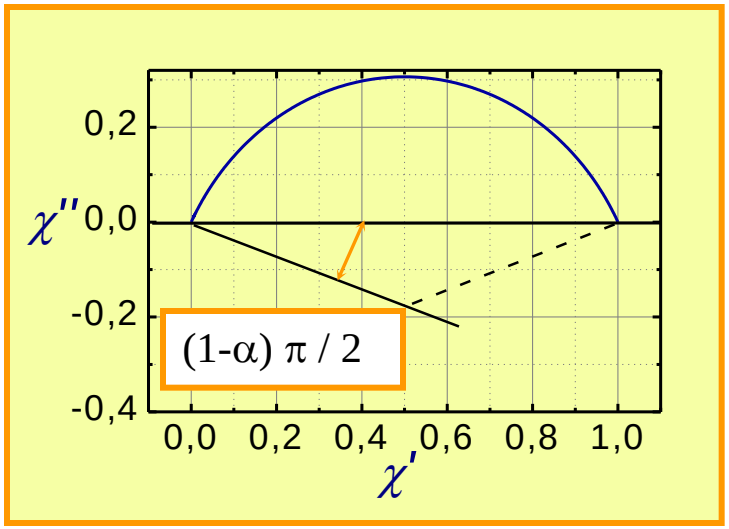
Non-exponential relaxation

Cole-Cole law

$$\frac{\chi(i\omega)}{\chi_0} = \frac{1}{1+(i\omega\tau)^{\alpha}}$$







The Memory function for Cole-Cole law

$$z f(z) - 1 = -\Omega M(z) f(z)$$

$$\frac{\chi(z)}{\chi_0} = 1 - z f(z)$$

the memory function

a fractional derivation

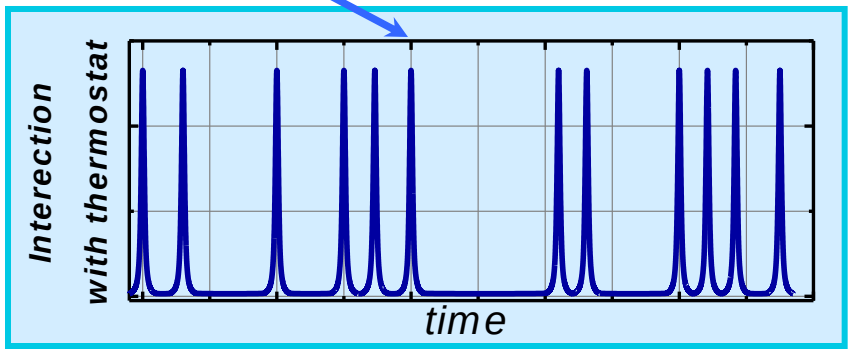
$$\frac{df}{dt} = -\tau_0^{-\alpha} D_0^{1-\alpha}[f(t)]$$

$$M(z) = z^{1-\alpha}$$

$$\tau = \Omega^{-\alpha}$$

Fractal set

$$\alpha = d_f$$



L. Nivanen, R. Nigmatullin, A. LeMehaute, *Le Temps Irrevesibible a Geometry Fractale,* (*Hermez, Paris, 1998*)

R.R. Nigmatullin, Ya.E. Ryabov, *Physics of the Solid State*, **39** (*1997*)

Scaling relations

$$d_f = \frac{\ln(N)}{\ln(\xi^{-1})}$$

$$\tau \sim R^{d_E}$$

$$\alpha = \frac{d_G}{d_E}\frac{\ln(\tau B)}{\ln(\tau / A)}$$

$$\xi = \frac{A}{\tau}$$

$$N \sim R^{d_G}$$

N, ξ are scaling parameters

d_E *is the Euclidean dimension*

d_G *is a geometrical fractal dimension*

$$B = G\,R_0^{d_G}$$

$$\tau_0 = A$$

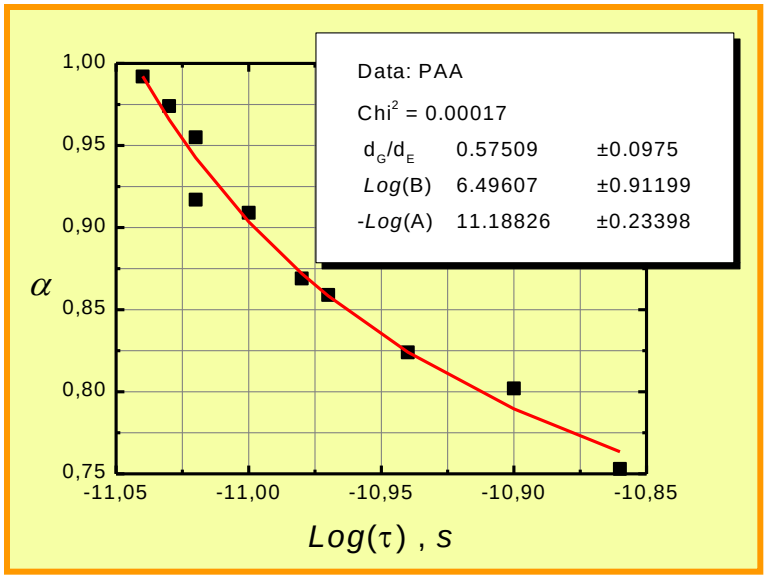
For the Seprinski gasket

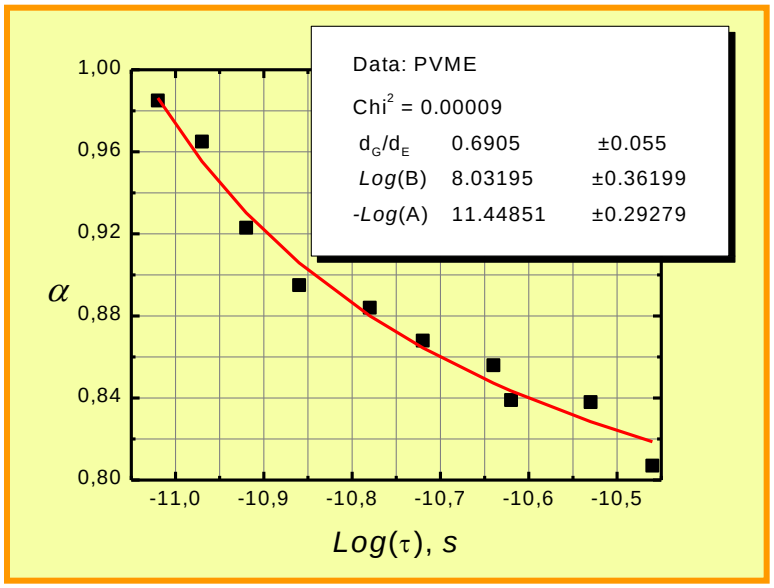
$$G = \sqrt{3}/4 = 0.433$$

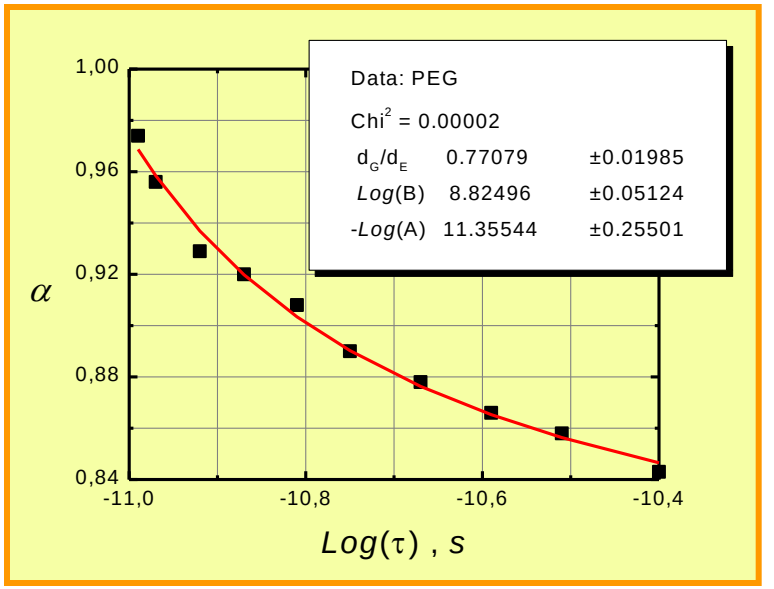
A and B^{-1} *parameters reflect the minimal and maximal self similarity scale of the system*

Experiment

N. Shinyashiki, S. Yagihara, I. Arita, S. Mashimo, Journal of Physical Chemistry, B **102** *(1998) p. 3249*







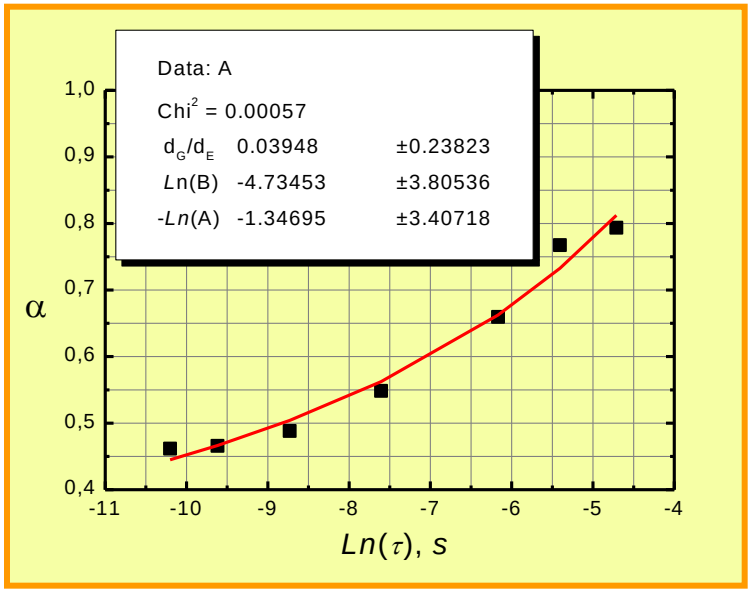
Experiment

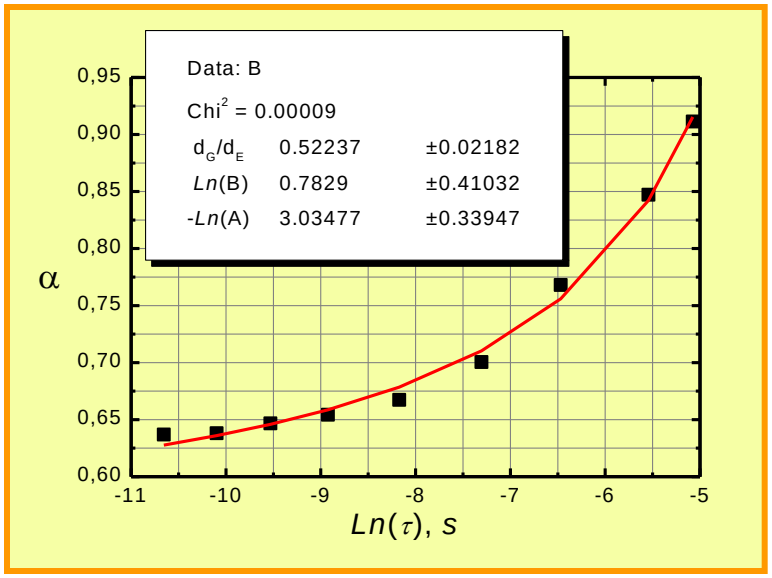
Havriliak-Negami law

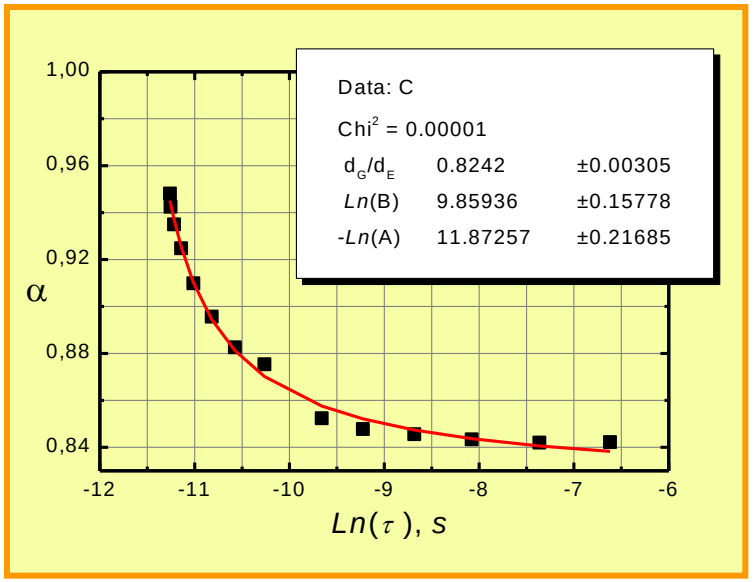
$$\frac{\chi(i\omega)}{\chi_0} = \frac{1}{\left(1+(i\omega\tau)^{\alpha}\right)^{\beta}}$$

?

A.Gutina, E. Axelrod, A. Puzenko, E. Rysiakiewicz-Pasek, N.Kozlovich and Yu.Feldman, *J. Non-Cryst. Solids*, (1998) Vol.**235/237**, pp.302.-307







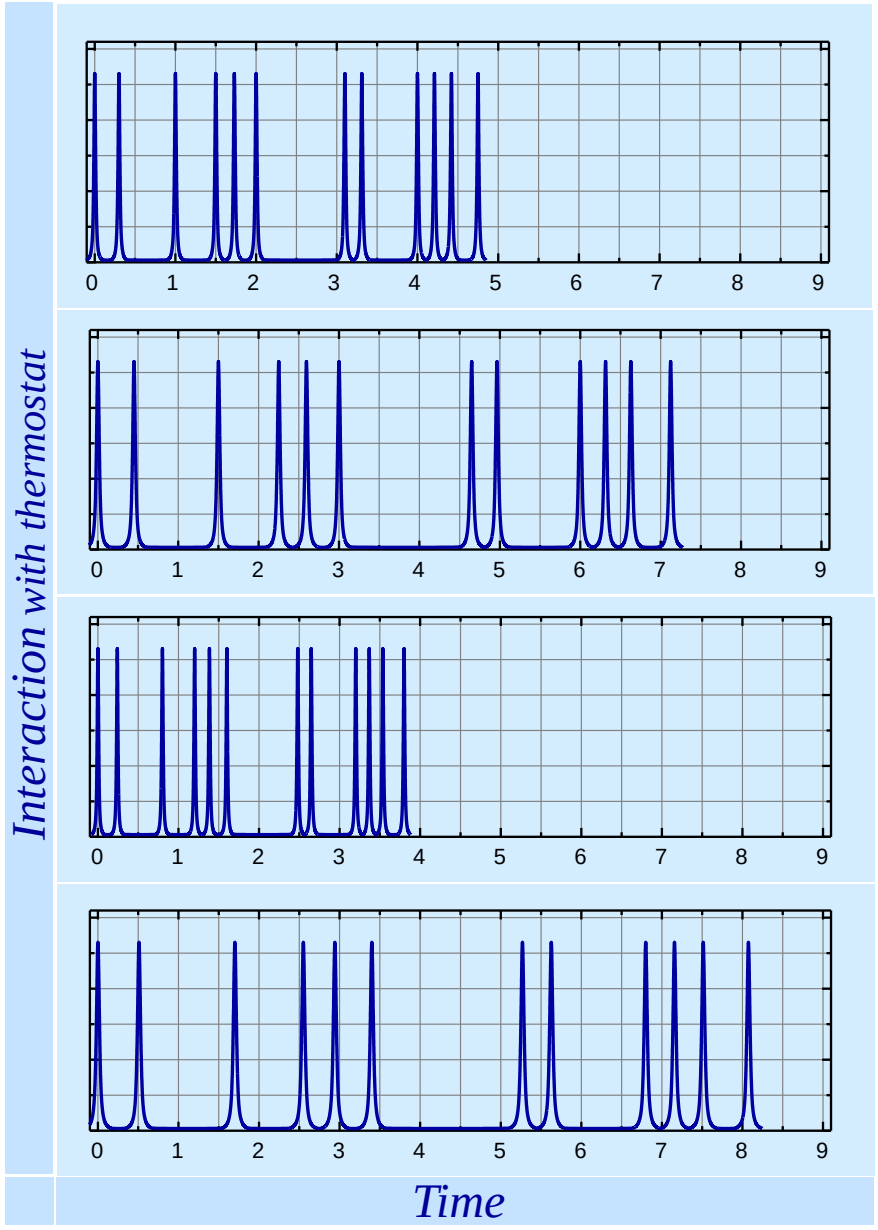
Conclusions

I *The Cole-Cole scaling parameter depends on the features of interaction between the system and the thermostat.*

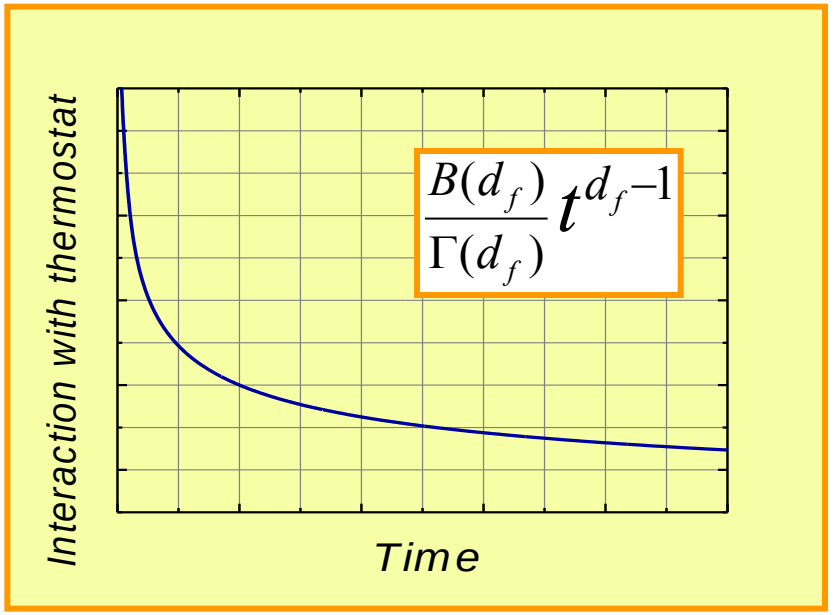
II *The Cole-Cole scaling parameter and the relaxation time are directly connected to each other.*

III *From the dependence of the α parameter on the relaxation time, the structural parameters can be defined.*

The Fractal set



Averaging with measure conservation



$$B(d_f) = \left(\frac{K-1}{1-\xi}\right)^{-d_f} K^{-\frac{1+d_f}{2}}$$

d_f — *Fractal dimension*

K, ξ - *scaling parameters*

L. Nivanen, R. Nigmatullin, A. LeMehaute, *Le Temps Irrevesibible a Geometry Fractale,* (*Hermez, Paris, 1998*)