NEW EXPERIMENTAL RESULTS ON FOAM ACOUSTICS

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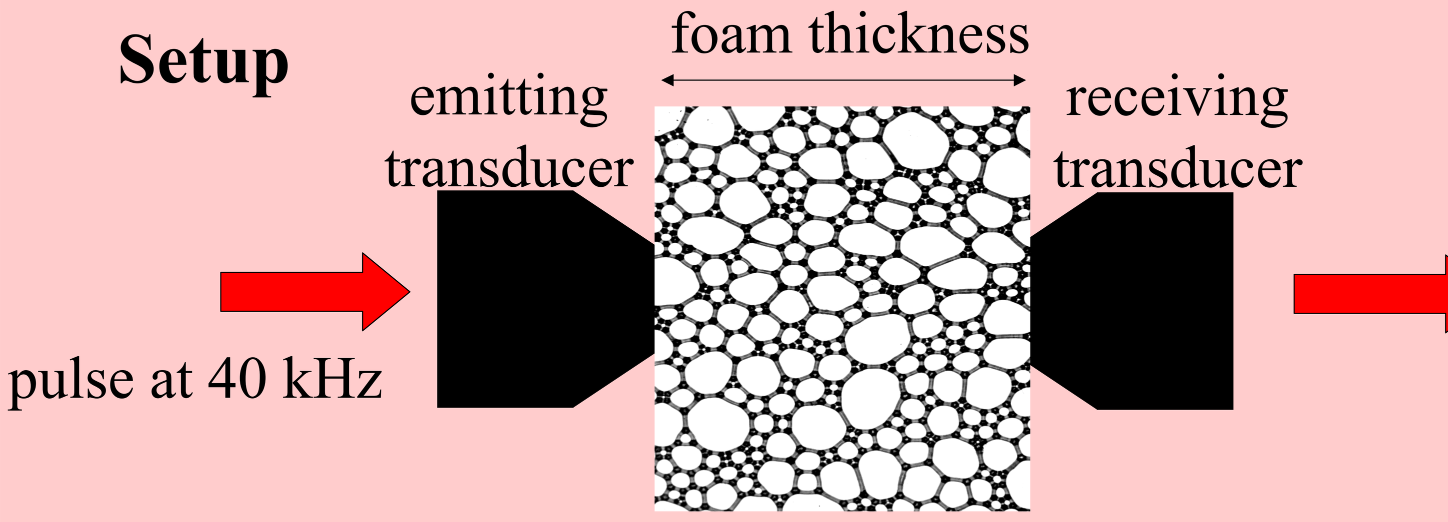
MOTIVATIONS: to better understand sound propagation and attenuation in foams

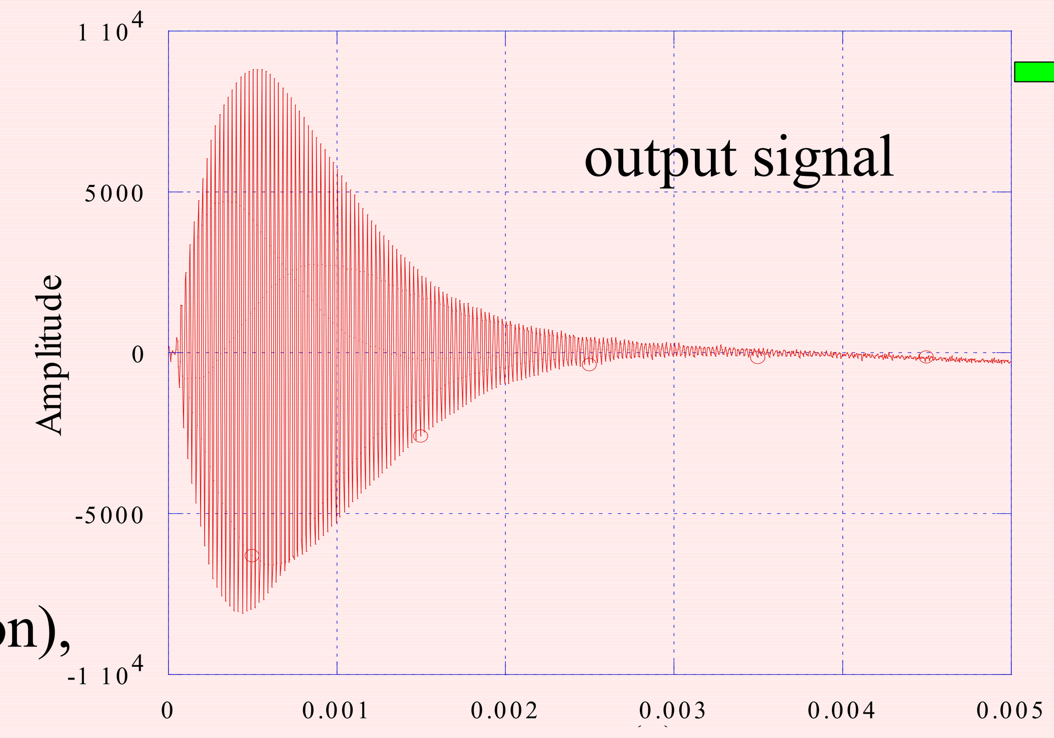
- **macroscopic measurements**: attenuation and sound velocity as functions of bubble size and liquid fraction ϕ_l
- **microscopic measurements**: acoustic-induced motions at the bubble scale

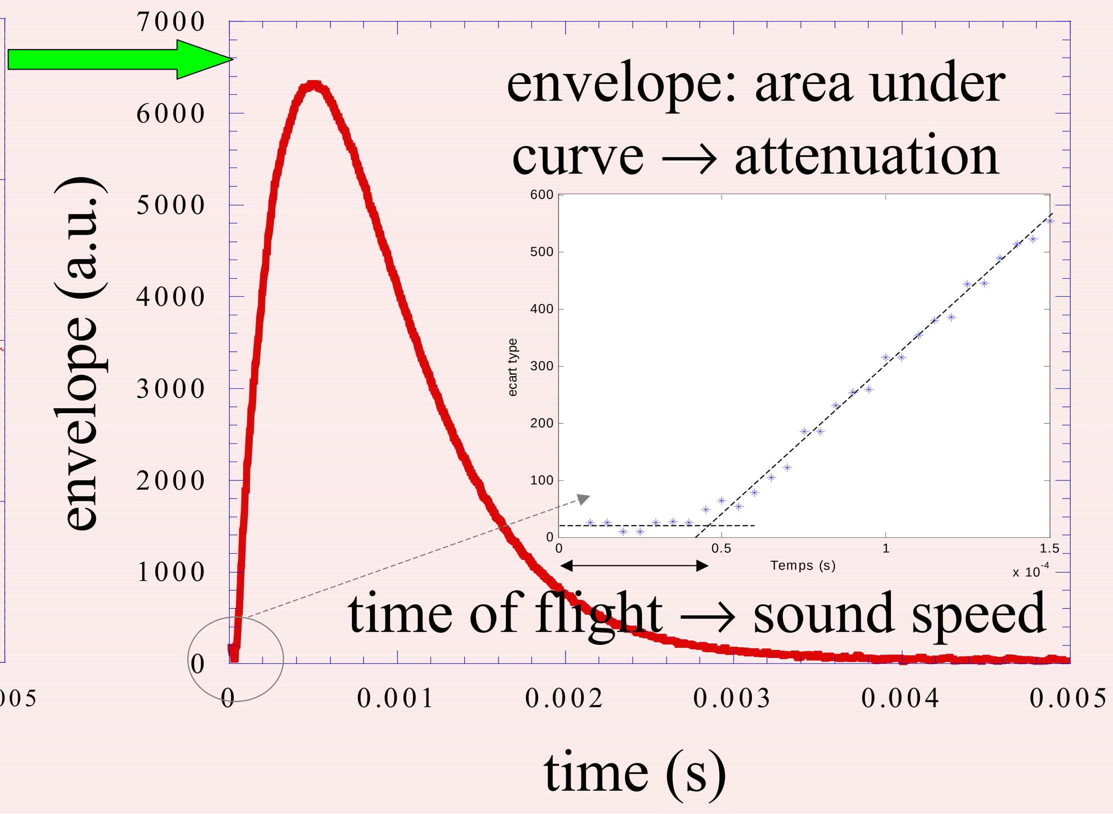
MACROSCOPIC MEASUREMENTS: attenuation and sound velocity

Setup

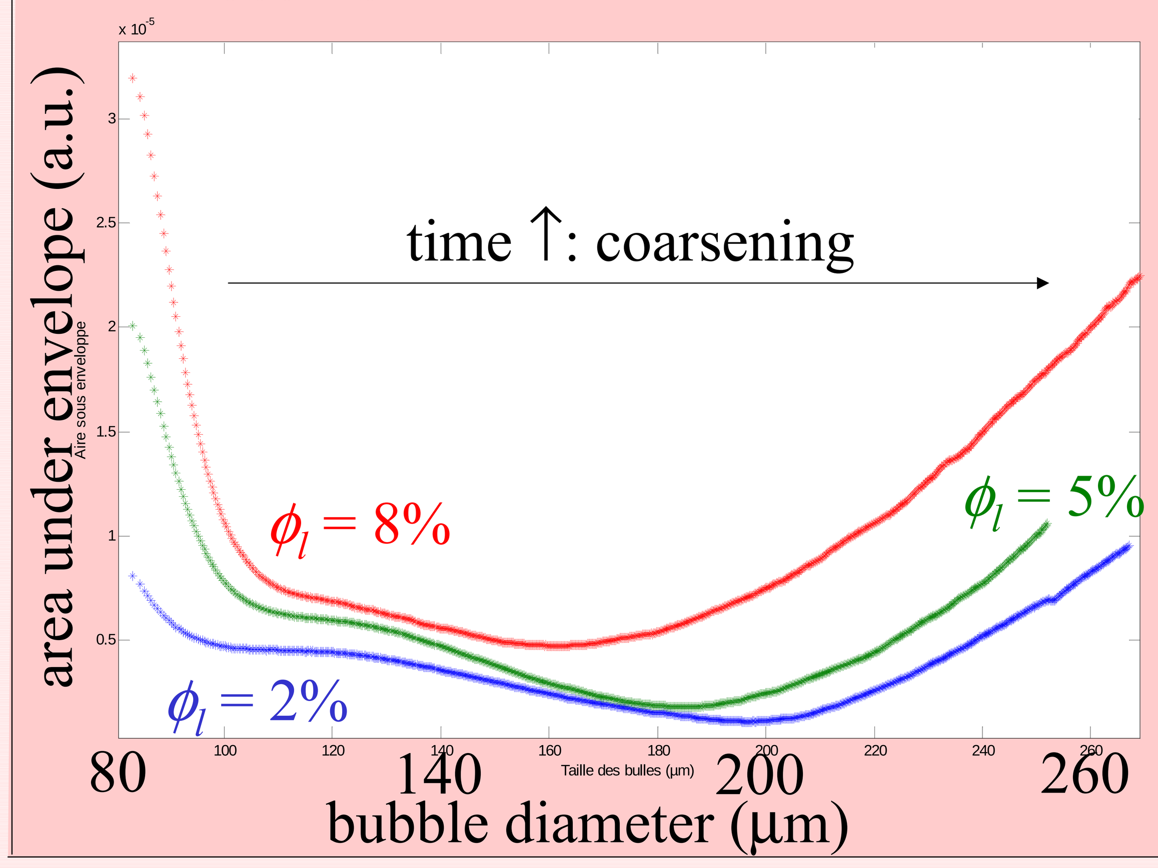


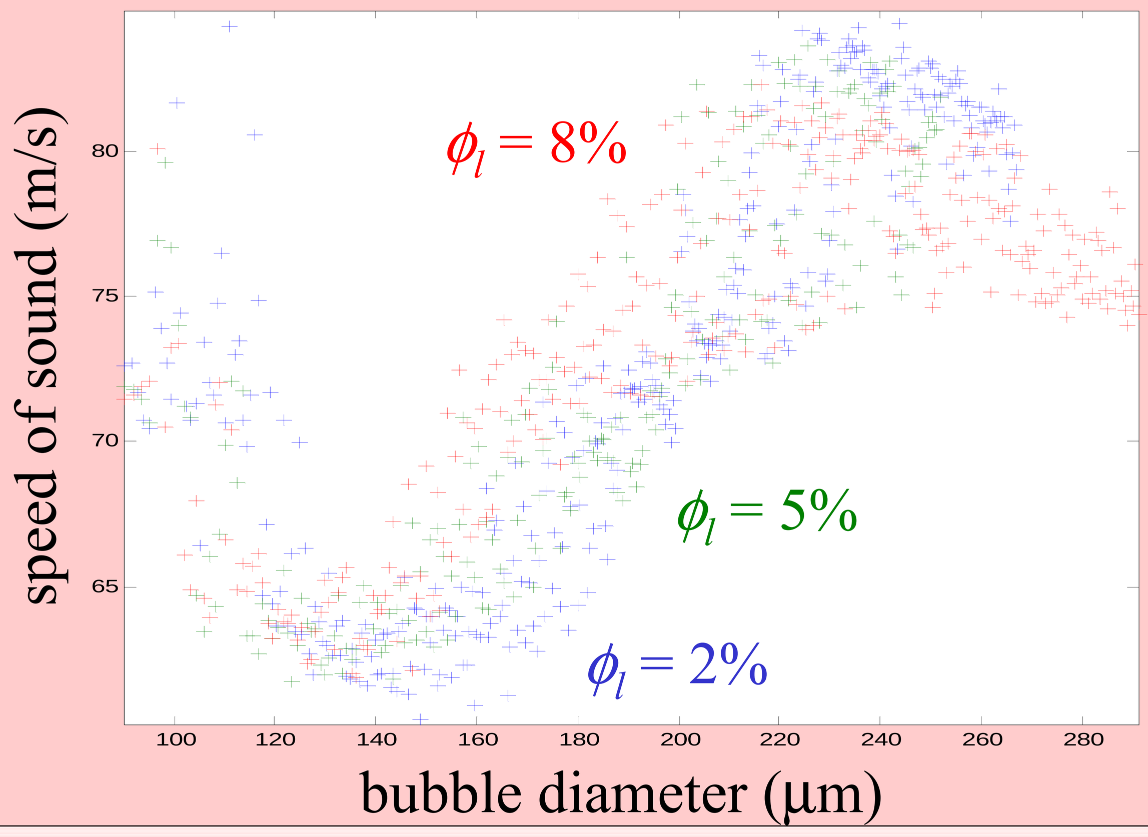
Laponite foam + C_2F_6: no drainage (controlled liquid fraction), slow coarsening [1]





Results



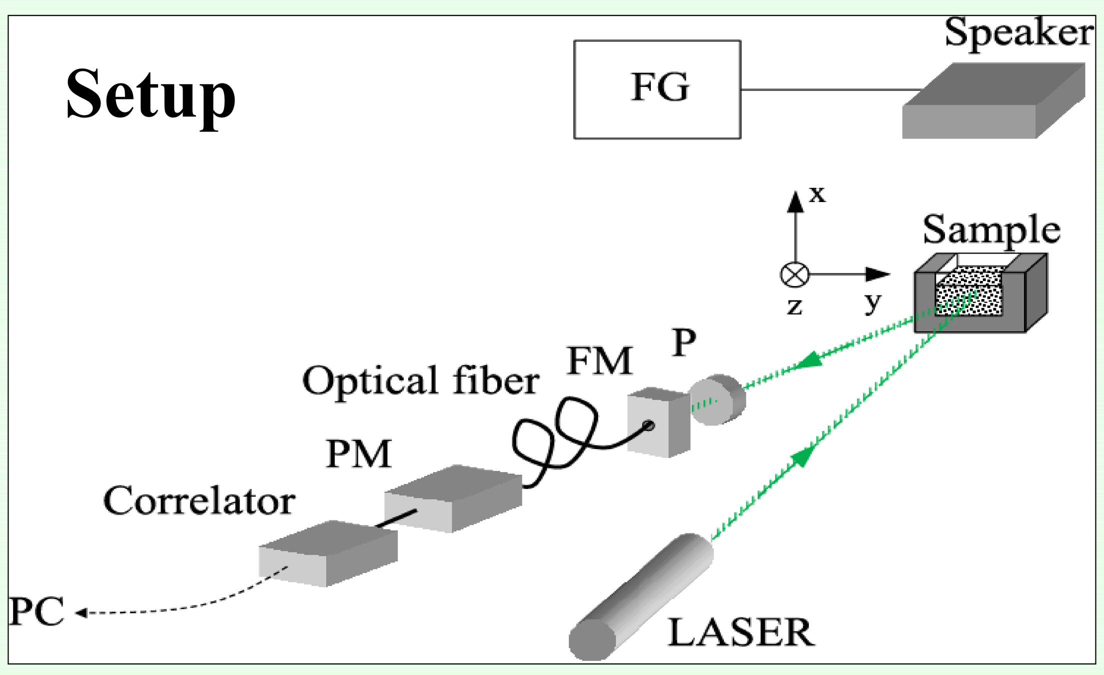


- **attenuation**: for all ϕ_l, nonmonotonic behavior in bubble diameter, maximum at ~ 150 µm
  → extends previous measurements [2]
  → acoustic resonant diameter: alike a single bubble in water at 40 kHz!

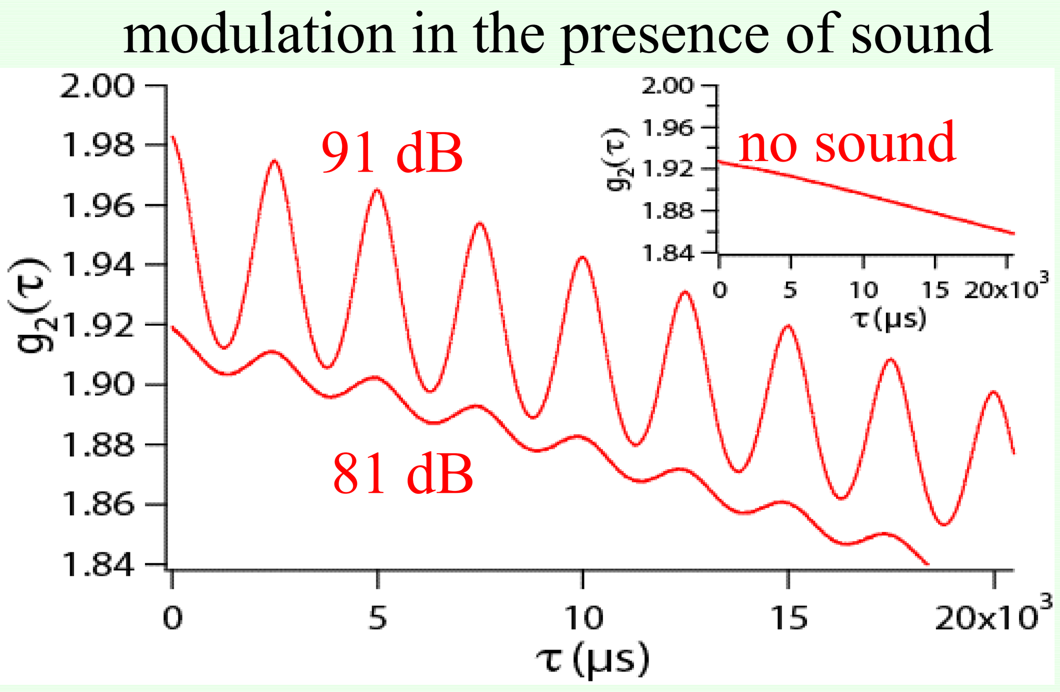
- **speed of sound**: trend in qualitative agreement with bubbly liquids [3]

MICROSCOPIC MEASUREMENTS: bubble motion detected by DWS [4]

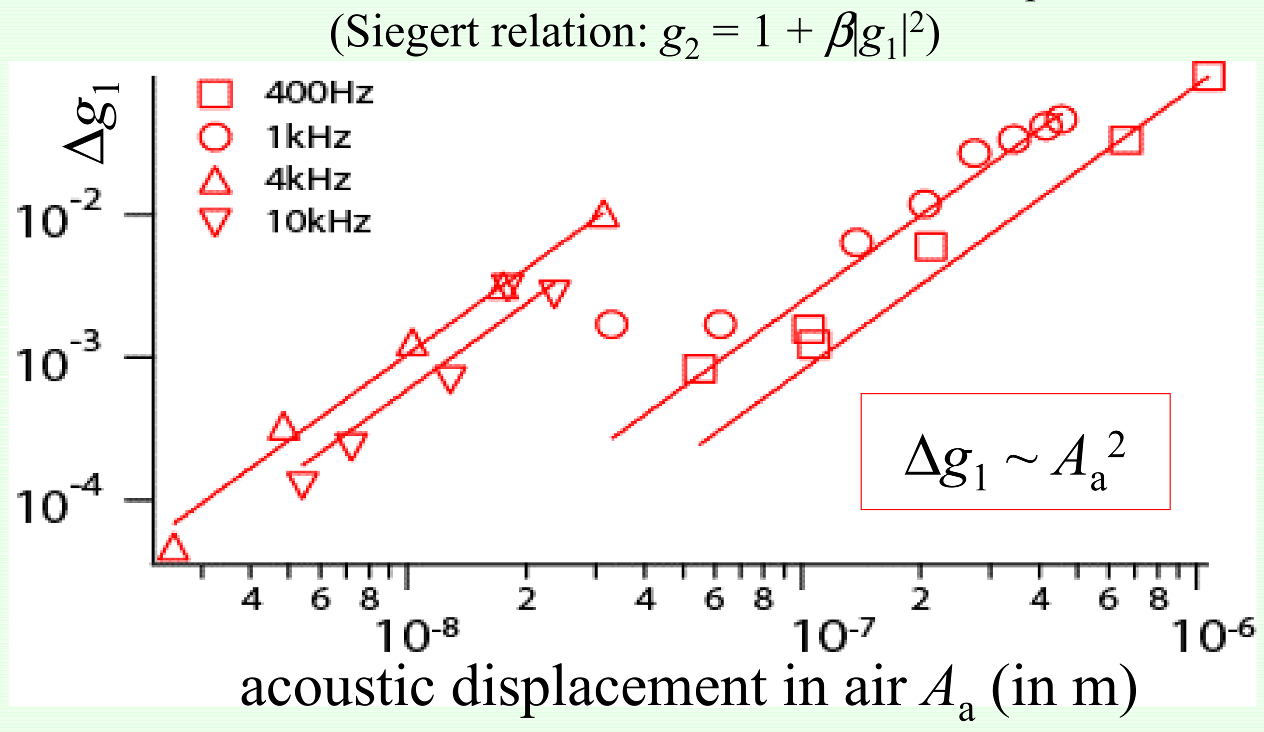
Setup



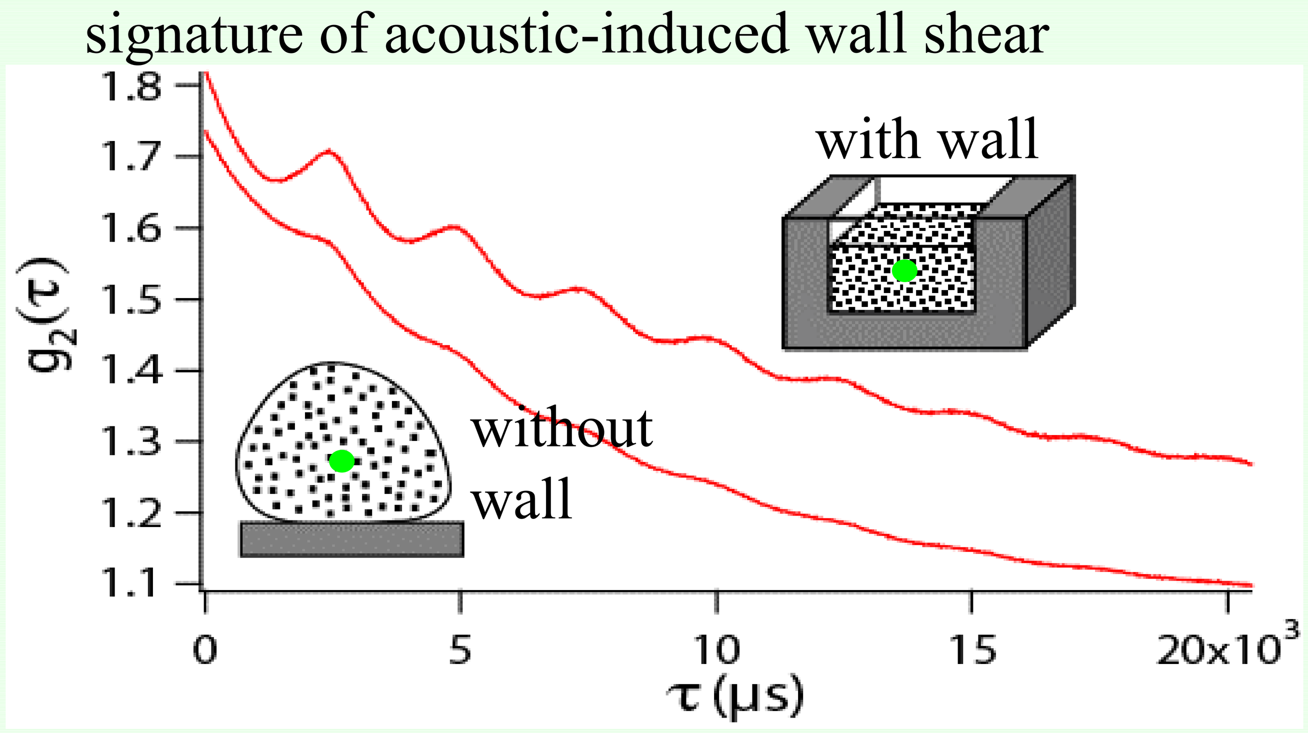
correlation function of the intensity: modulation in the presence of sound



amplitude of the modulation of g_1
(Siegert relation: $g_2 = 1 + \beta|g_1|^2$)



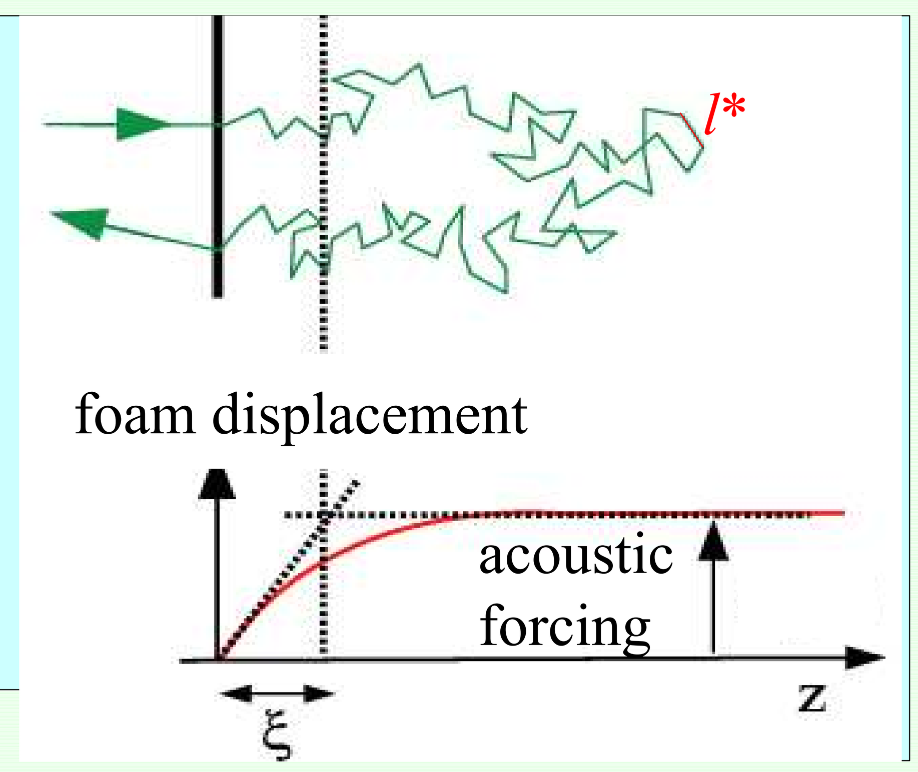
modulation only in the presence of a wall: signature of acoustic-induced wall shear



Data interpretation

1) **Light scattering model**
- photons propagate as a randow walk of step l^*
- $\Delta g_1 \sim A_a^2$: penetration length > shear length ξ

2) **Mechanical model**: wall friction + viscoelastic foam [5] + inertia + acoustic forcing
- predicts $\xi \sim \omega^{3/4}$ in qualitative agreement with Δg_1 data
- justifies no-slip condition, hence wall shear



[1] Guillermic et al., *Soft Matter* **5**, 4975 (2009).
[2] Mujica & Fauve, *Phys. Rev. E* **66**, 021404 (2002).
[3] Commander & Prosperetti, *J. Acoust. Soc. Am.* **85**, 732 (1989).
[4] Erpelding et al., *Phys. Rev. E.* (2010)
[5] Gopal & Durian, *Phys. Rev. Lett.* **91**, 188303 (2003).