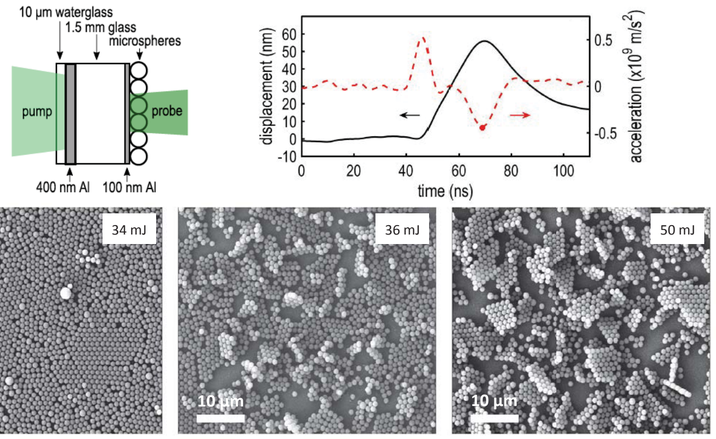
Dynamics of Microscale Granular Crystals (μGCs)

Designer dynamically responsive materials and new understanding of microscale granular media via ordered systems

Boechler Research Group
Wave-material interaction

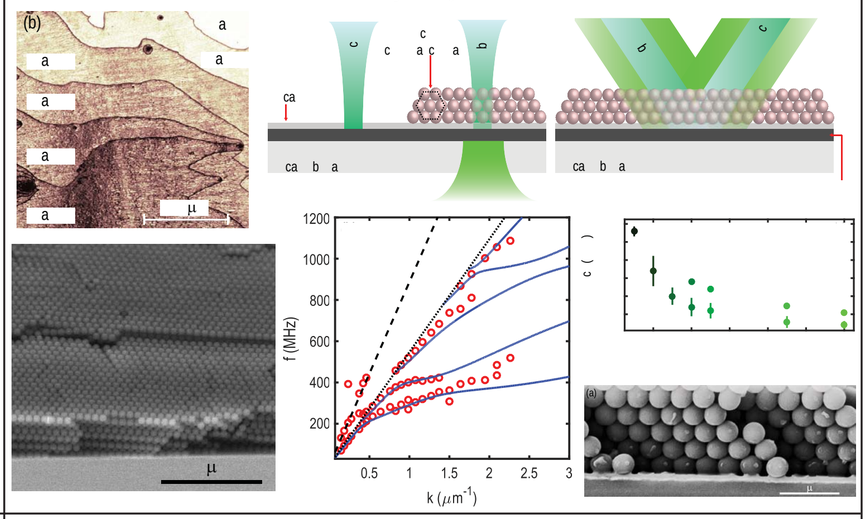
UNIVERSITY of WASHINGTON

Spallation of 2D μGCs

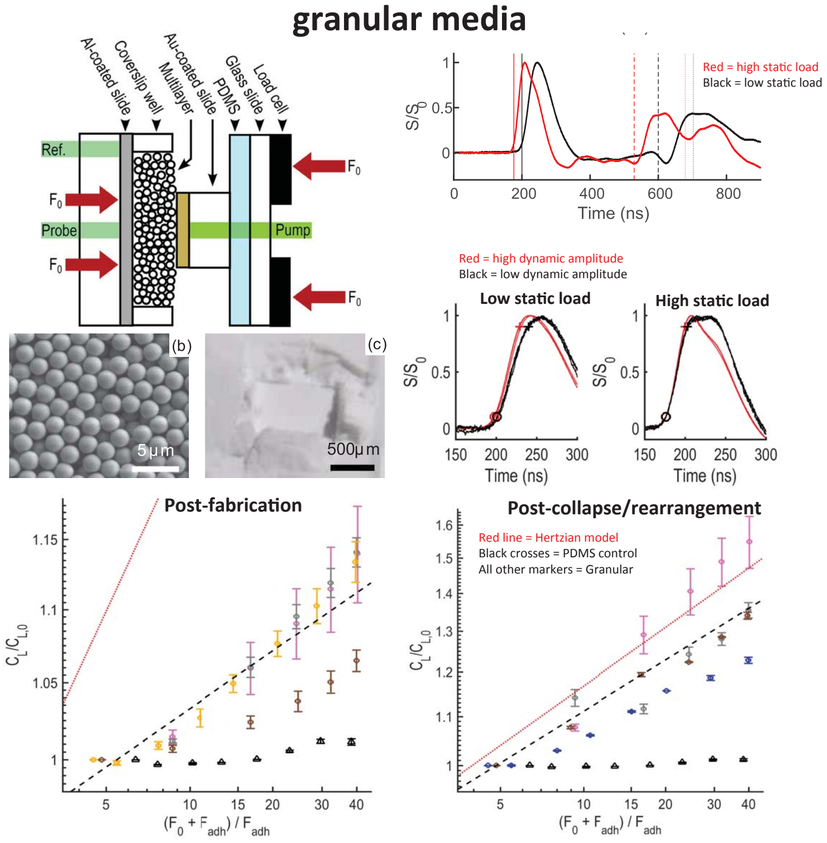


Hiraiwa, M., Stossel, M., Khanolkar, A., Wang, J., and Boechler, N. "Laser-induced spallation of microsphere monolayers" Langmuir, in press (2016)

SAWs in multilayer μGCs on substrates

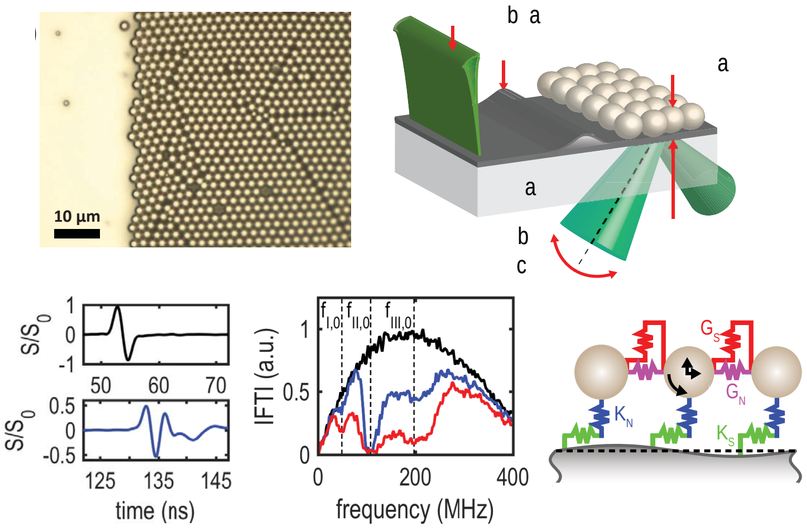


Nonlinear acoustics of 3D disordered microscale granular media

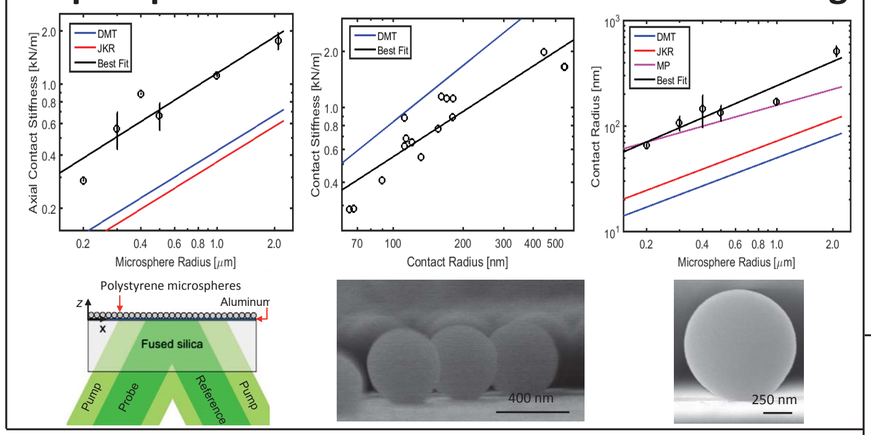


Hiraiwa, M., Wallen, S. P., and Boechler, N. "Acoustic wave propagation in disordered microscale granular media under compression" under review (2016)

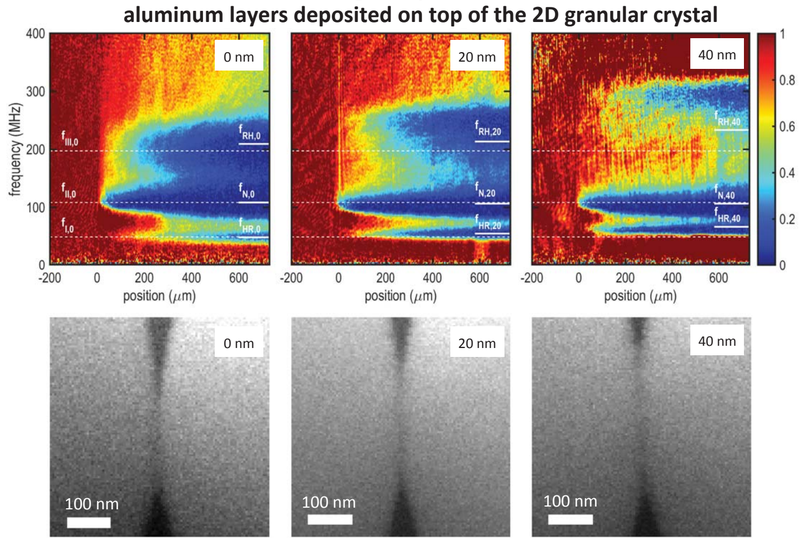
Resonant attenuation of SAWs reveal tunable, interparticle contact mediated modes in 2D μGCs



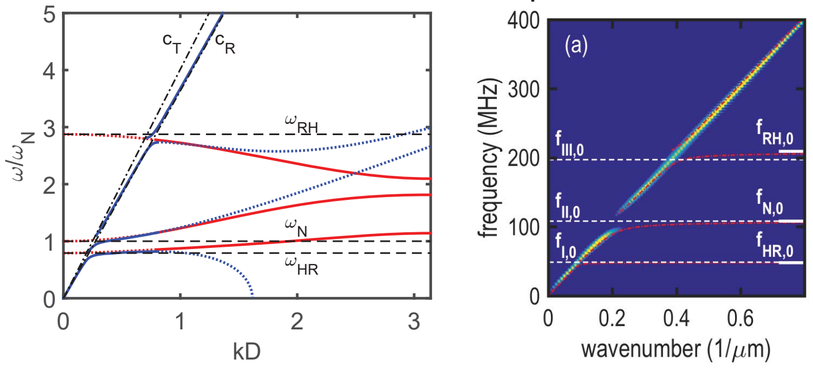
2D μGC particle-substrate contact stiffness scaling



Resonances shift with increasing interparticle contact stiffness via nanoscale aluminum layers deposited on top of the 2D granular crystal



Predicted and measured dispersion



Contact resonances vary with interparticle and particle-substrate contact stiffnesses

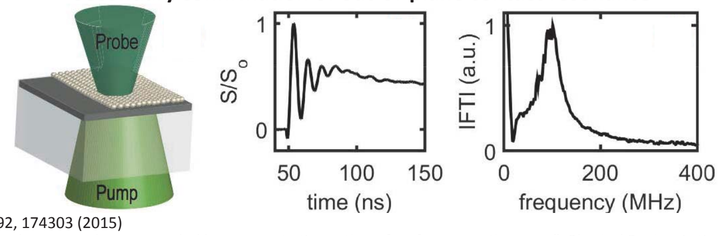
$$\omega_N = \left[\frac{K_N}{m}\right]^{1/2}$$

$$\omega_{RH} = \left[\left(\frac{K_S}{4m}\right)\left(20\gamma + 7 + \sqrt{400\gamma^2 + 120\gamma + 49}\right)\right]^{1/2}$$

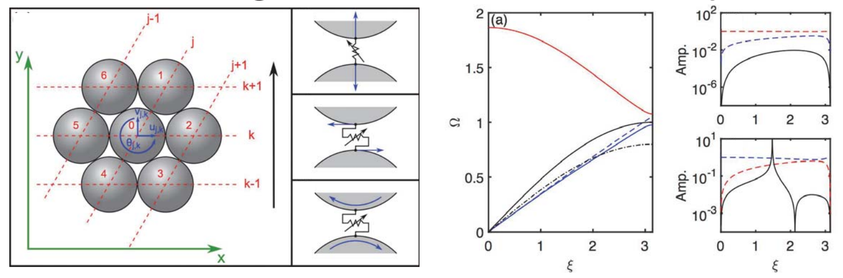
$$\omega_{HR} = \left[\left(\frac{K_S}{4m}\right)\left(20\gamma + 7 - \sqrt{400\gamma^2 + 120\gamma + 49}\right)\right]^{1/2}$$

$$\gamma = G_S/K_S$$

Secondary confirmation of out-of-plane contact resonance

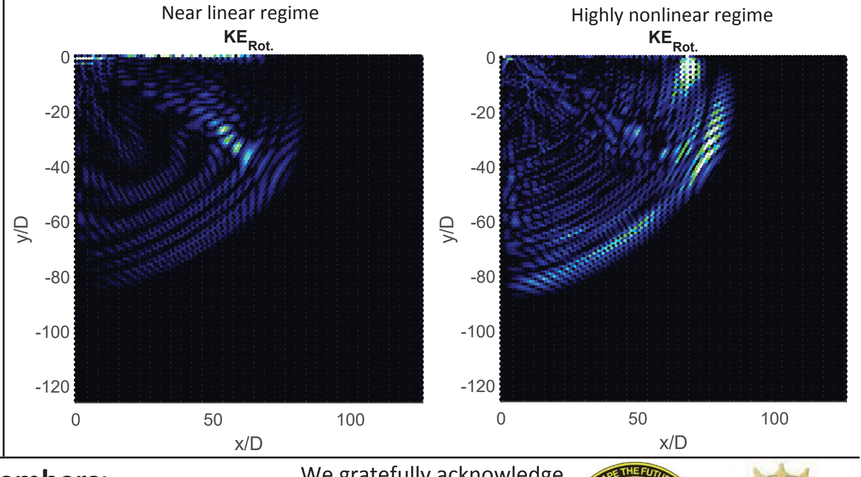


Shear to longitudinal mode conversion in μGCs



Wallen, S. P. and Boechler, N. "Shear to longitudinal mode conversion via second harmonic generation in a two-dimensional microscale granular crystal" (under review) (2016)

Amplitude dependence of impulse response in μGCs (DEM simulation including shear interactions and particle rotation)



- Wallen, S., Maznev, A. A., and Boechler, N., "Dynamics of a Monolayer of Microspheres on an Elastic Substrate" Physical Review B, 92, 174303 (2015)
- Hiraiwa, M., Abi Ghanem, M., Wallen, S., Khanolkar, A., Maznev, A. A., and Boechler, N., "Complex contact-based dynamics of microsphere monolayers revealed by resonant attenuation of surface acoustic waves", Physical Review Letters, 111, 198001 (2016)

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