

Why does time reversal break down in granular media?

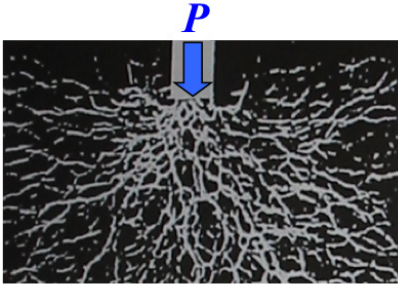
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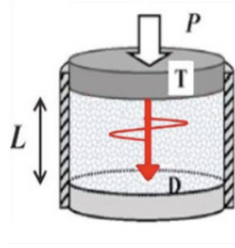
Experiments

Contact force network



Dantu (1957)

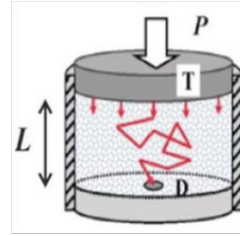
Coherent wave



$$\lambda > 10d$$

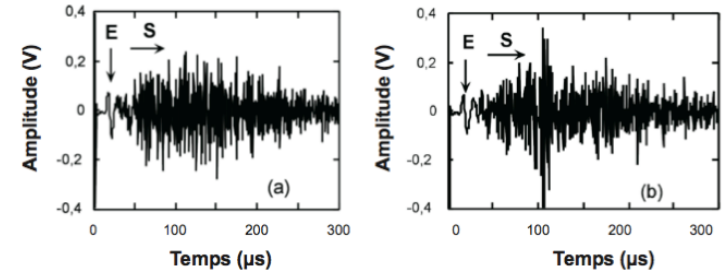
Jia (1999)

Scattered wave



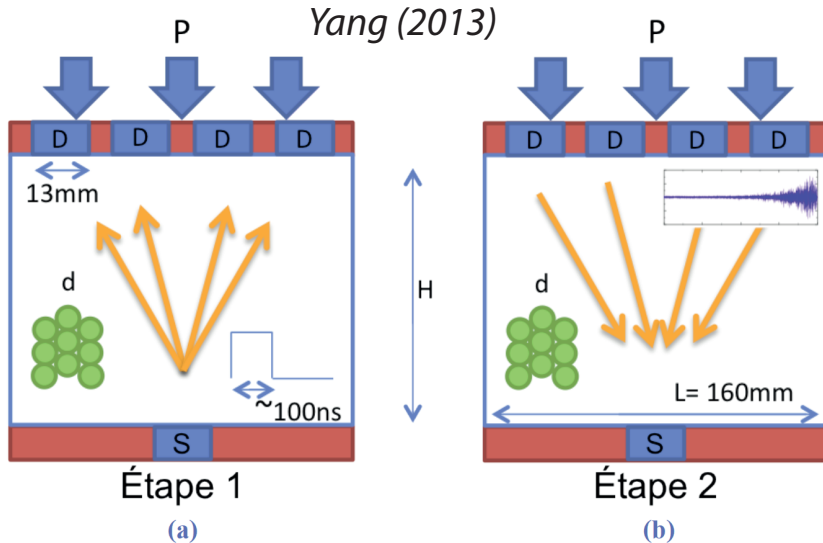
$$\lambda \sim d$$

Typical acoustic signal



Jia (1999)

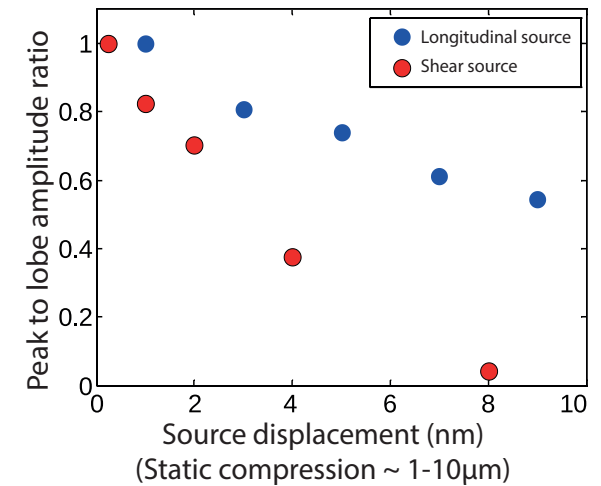
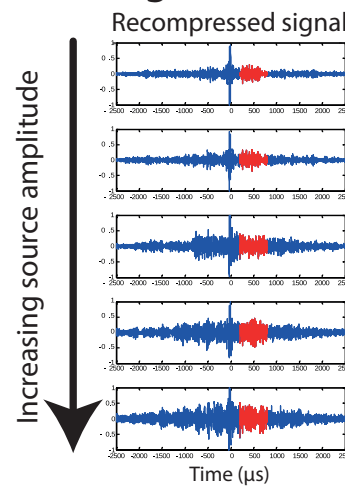
Time reversal



Yang (2013)

Failure of TR focusing at high amplitude

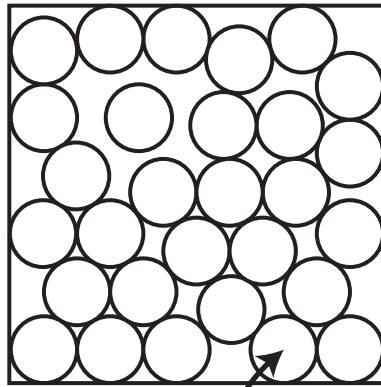
TR focusing at the source



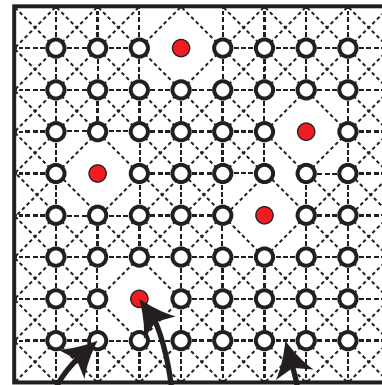
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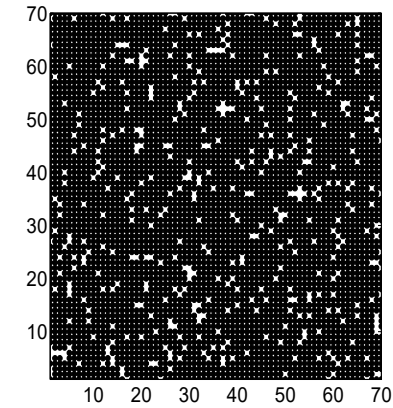
Simulations



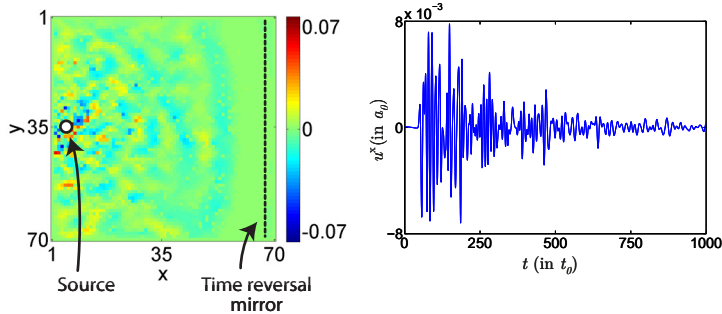
Mass



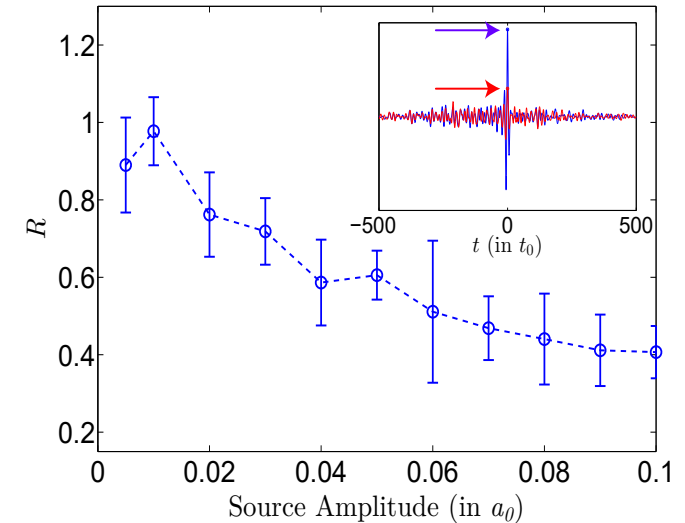
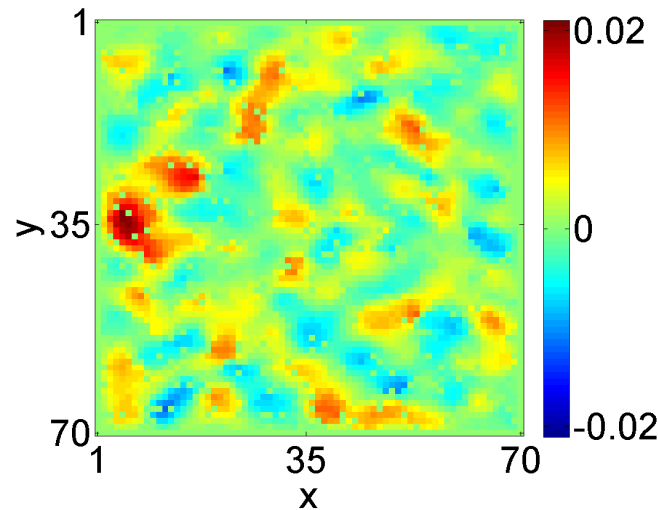
Mass Missing mass Linear spring with random stiffness



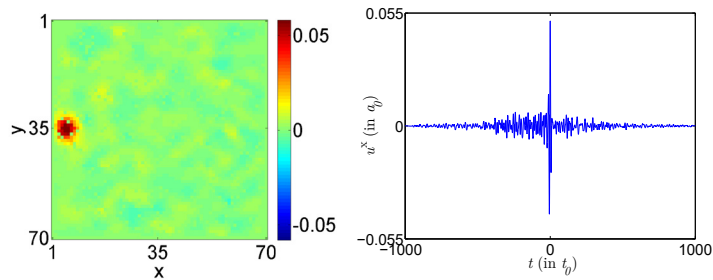
Transmission



Non-linear time reversal



Linear time reversal



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