178th Meeting
Acoustical Society of America

2019/12

OSUG
Observatoire des Sciences de l'Univers de Grenoble

Mesoscopic wave physics in fish shoals

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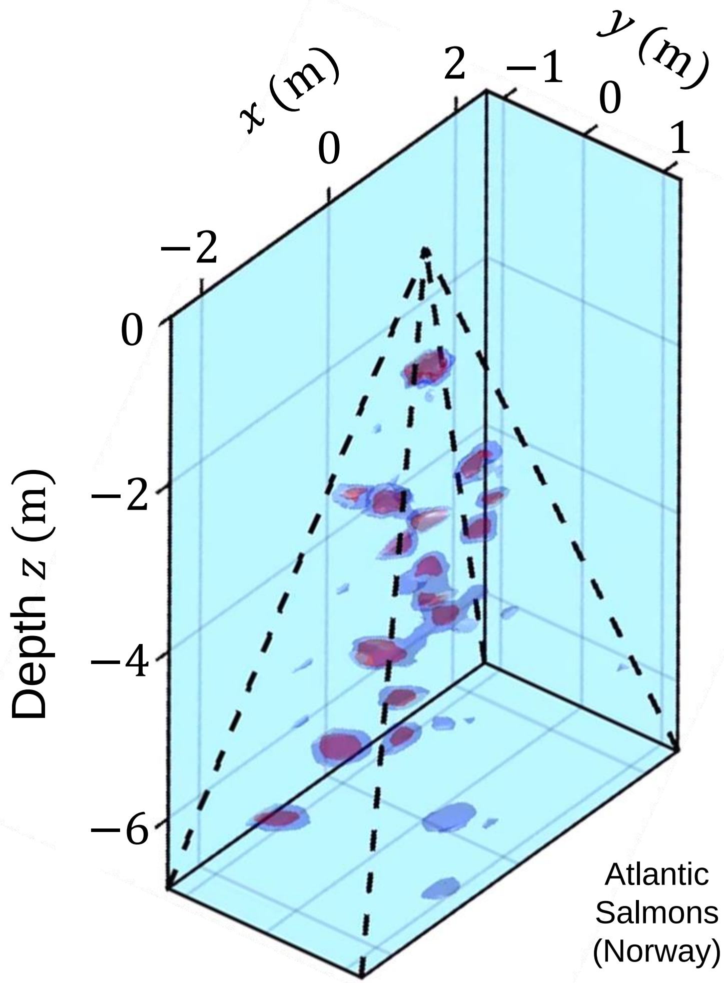
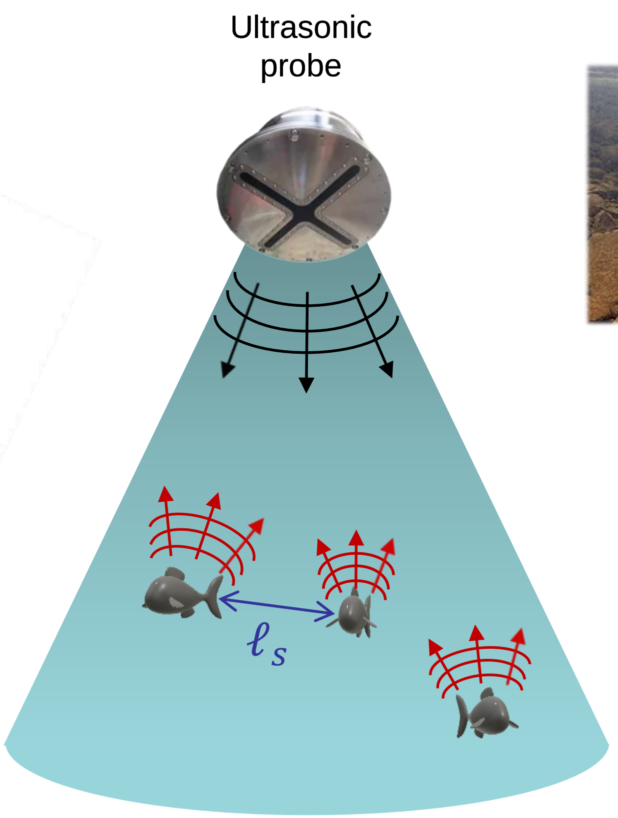
cnrs dépasser les frontières

Ultrasonic fish counting

Low fish density





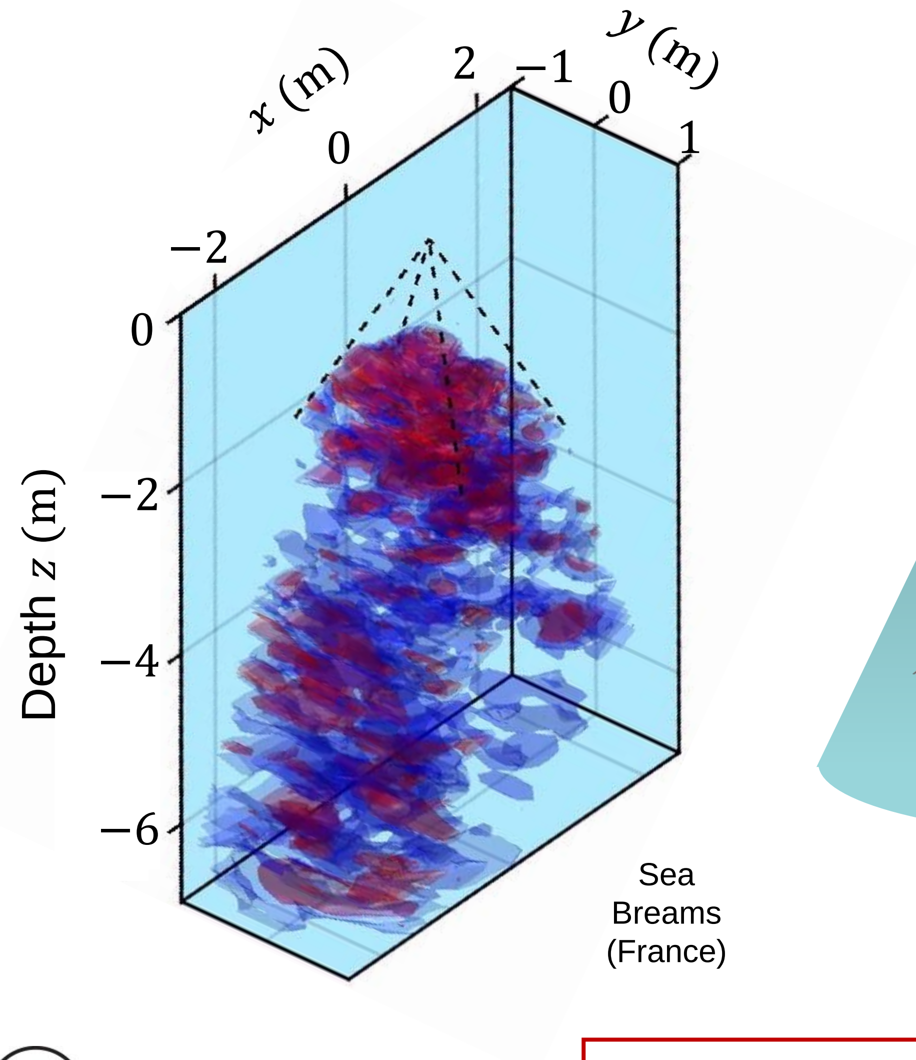
Atlantic Salmons
(*NOAA*)

$z \sim \ell_s$

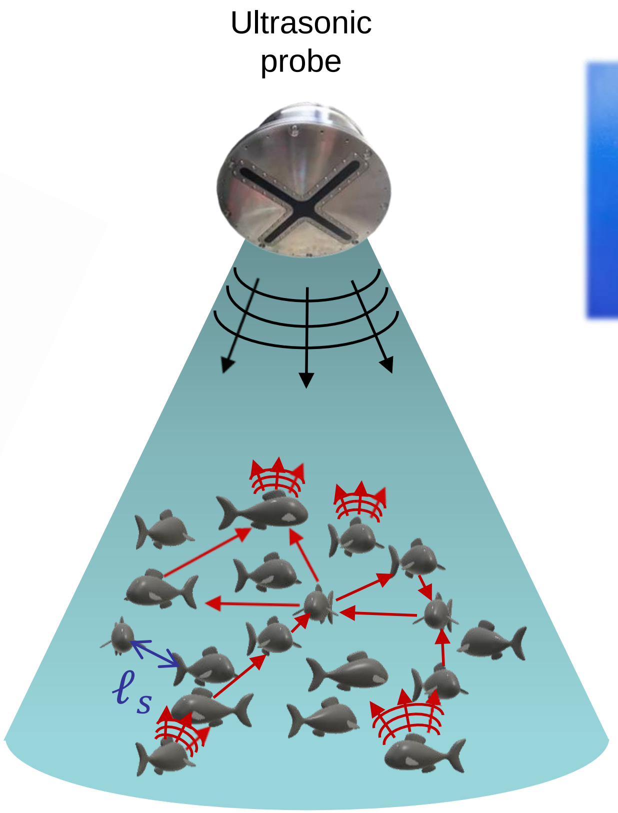
Single scattering regime

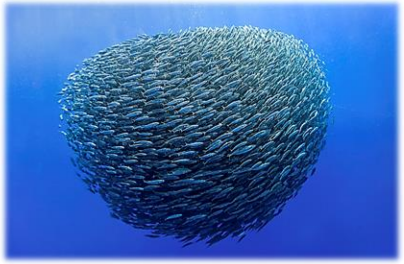
Ultrasonic fish counting

High fish density



Sea Breams (France)





Herring school (*Christopher Swann*)

$z \gg \ell_s$

Multiple scattering regime

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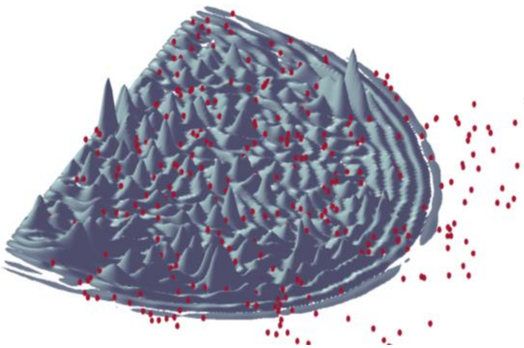
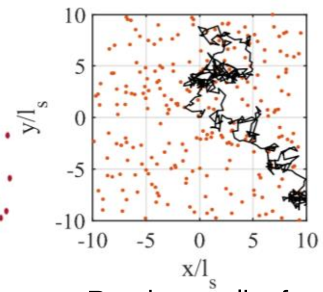
Mesoscopic physics

Microscopic description (scale $\sim \lambda$):

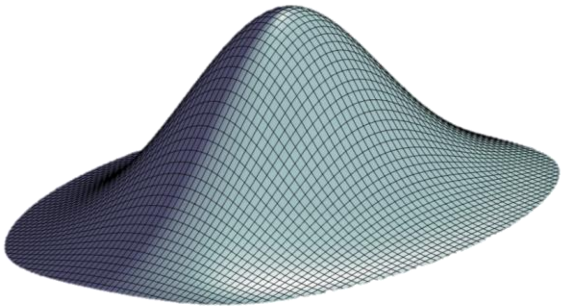
Macroscopic description (scale $\gg \lambda$):





Random walk of propagation direction

Random walk transport

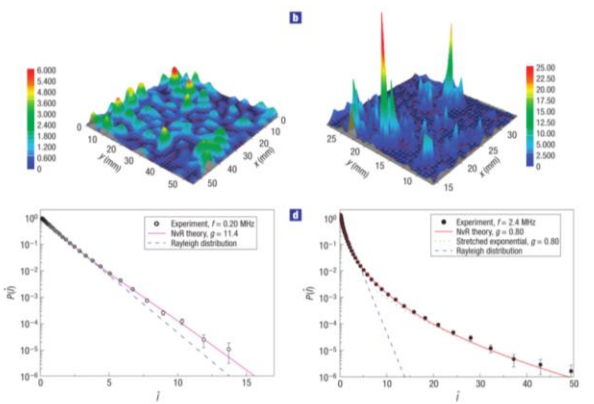


Rayleigh scattering (*NASA*)

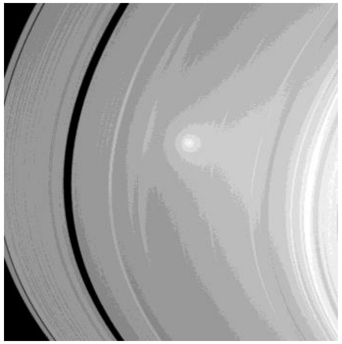
Diffusive transport

Mesoscopic physics ($\lambda < \ell_s$):

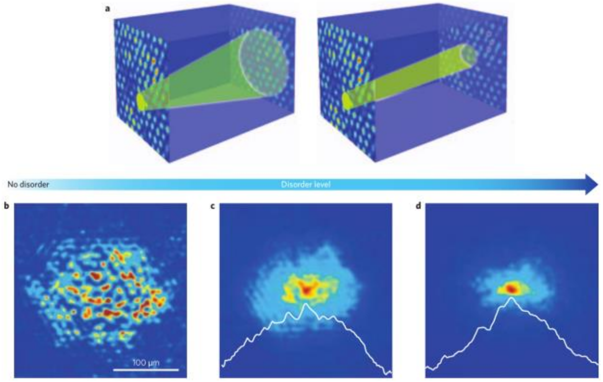
impact of microscopic interferences of the macroscopic description



Non Rayleigh distribution of ultrasonic speckle (H. Hu *et al.*, *Nat. Phys.* **4**, 2008)



Coherent backscattering of light on Saturn's rings (*JPL, Caltech*)



2D Anderson localization of light (M. Segev *et al.*, *Nat. Photon.* **7**, 2013)

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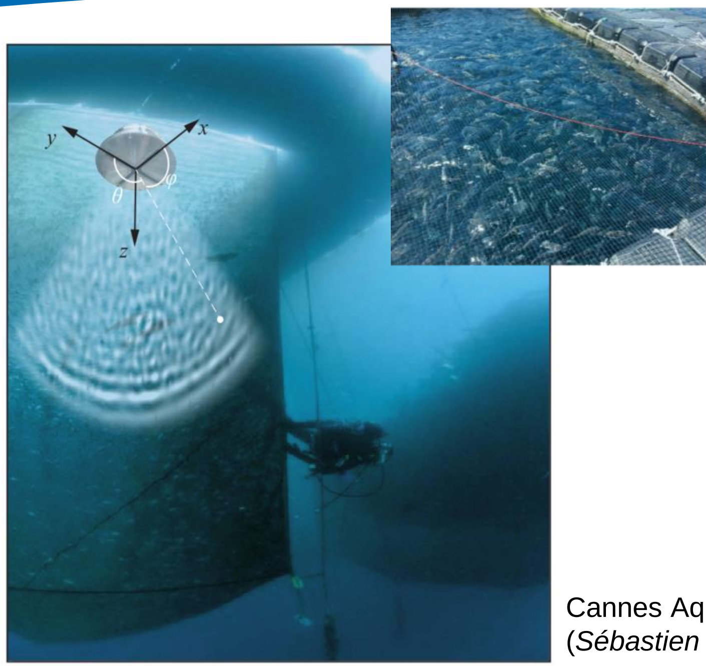
Mesoscopic physics for biomass assessment



Cannes Aquaculture
(*Sébastien Pasta*)

Organic certified farm:

- Fish raised under conditions close to their natural environment (selected species, densities, size…).
- Necessity of developing non-invasive monitoring methods.

"Invasive" fish counting method
(*Email Gourmand*)

	N	W	η (kg/m^3)	V (m^3)
C1 (sea breams, fry)	75,000	10	6	125
C3 (sea breams, adults)	10,080	284	23	125
C4 (sea breams, adults)	6,000	320	15	125
C5 (croakers, adults)	13,900	886	24	512

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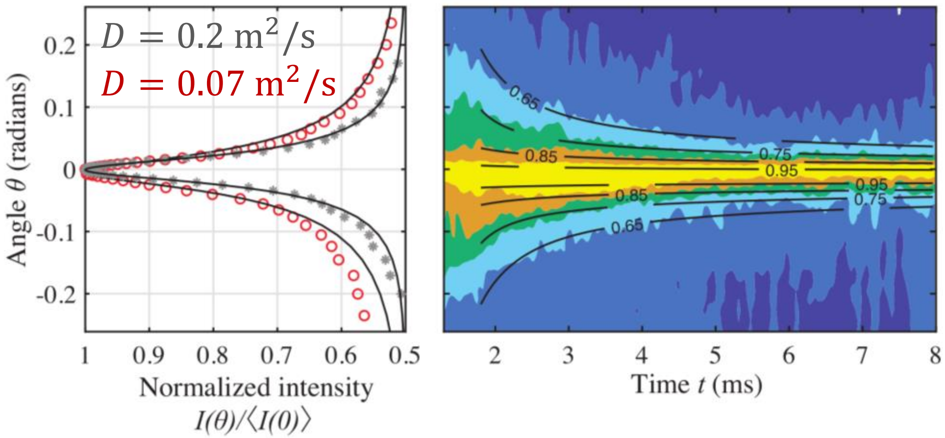
Mesoscopic physics for biomass assessment

For high fish densities ⇒ mesoscopic phenomena

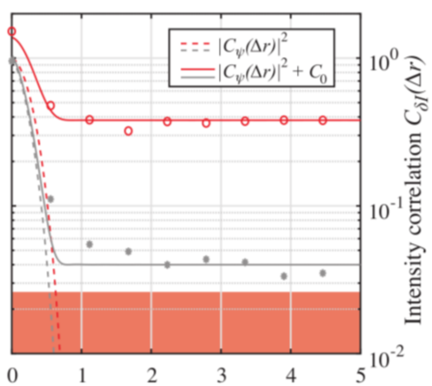
Coherent backscattering effect



	$W\ (g)$	$\eta\ (kg/m^3)$
C1	10	6
C3	284	23
C4	320	15
C5	886	24

Measurement of the
"fish school diffusivity"

Correlations of the speckle pattern

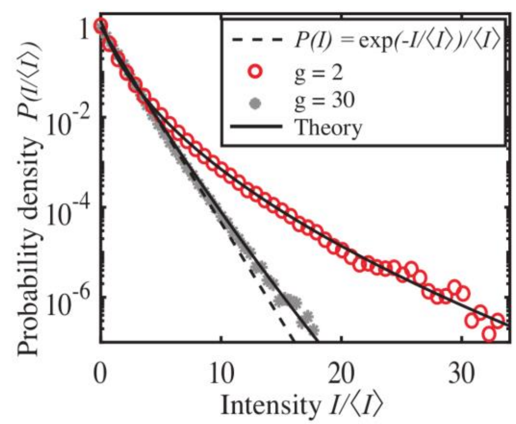


$C_0 = 0.04$

$C_0 = 0.4$

Long range correlations of
the backscattered field

Non Rayleigh distribution of the speckle pattern



$g = 30$

$g = 2$

Measurement of the
"fish school conductance"

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New "mesoscopic tools" for biomass assessment

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l'Europe s'engage en France avec le FEAMP

Thank you

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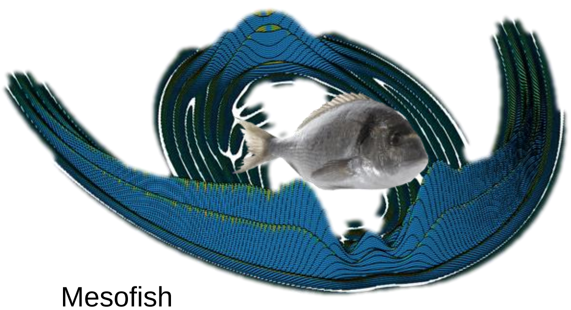
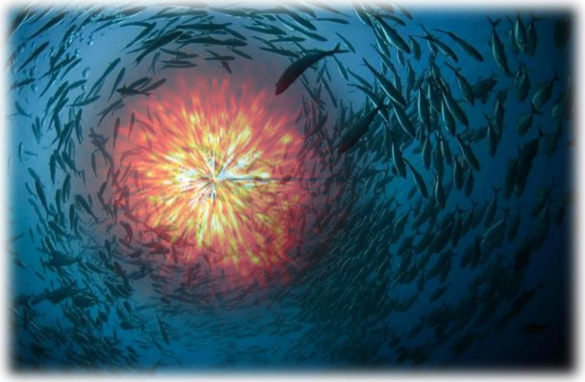


Mesofish



Mesoshoal

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Coherent diffusion of ultrasound in fish shoals
Phys. Rev. Lett. (under review)