American Physical Society Division of Fluid Dynamics

Webcast Media Briefing

Nov. 19, 2012

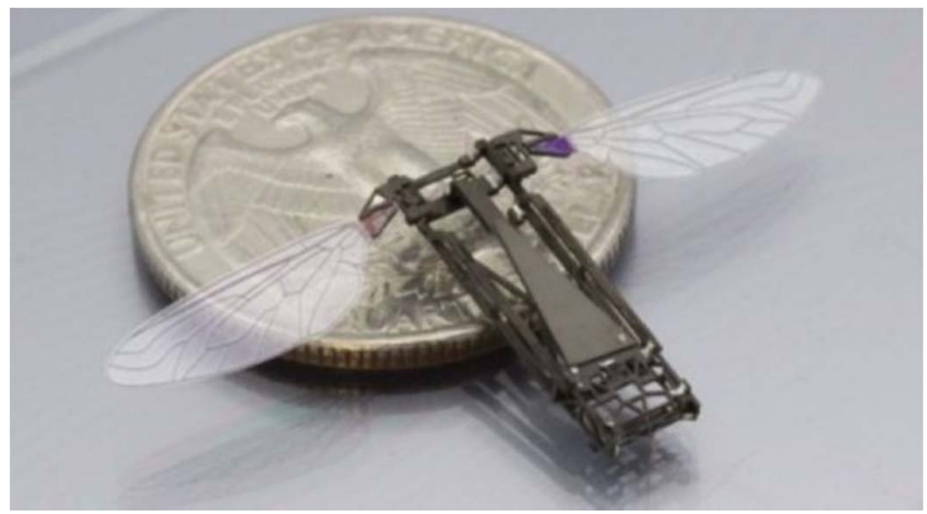
7 a.m. PST / 10 a.m. EST

Mosquito Flight Failure in Heavy Fog

Andrew Dickerson and David Hu
School of Mechanical Engineering
Georgia Institute of Technology

When subjected to very dense fog, mosquitoes tumble uncontrollably, causing them to plummet to the ground.

Insecticide fogging to fight malaria
(Falcon fogger)

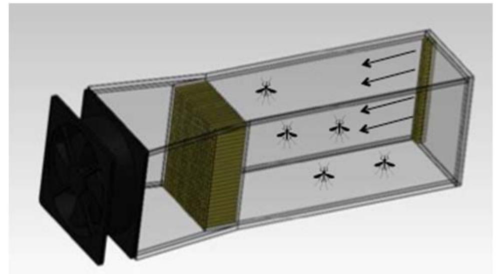


Micro-aerial vehicle
(Robert Wood, Harvard)

Methods


Consumer grade humidifier

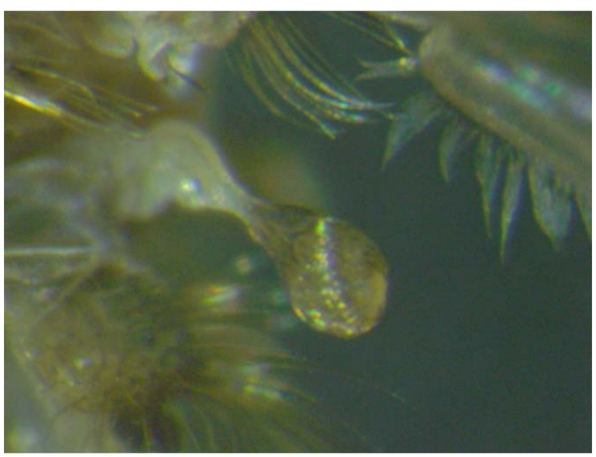

Phantom high-speed camera


Custom, miniature wind tunnel

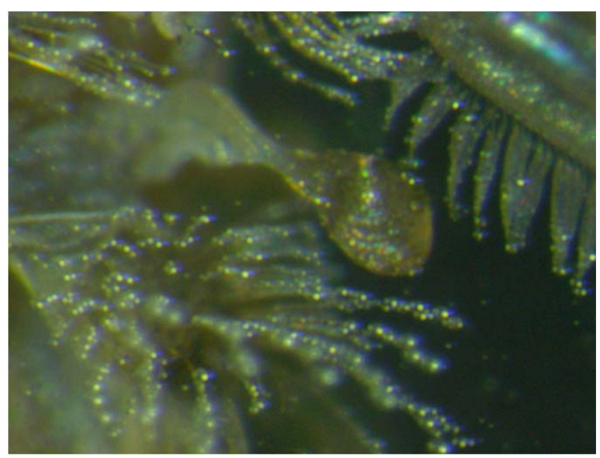
- fog drop diameter = 5 microns
- filmed at 8000 fps

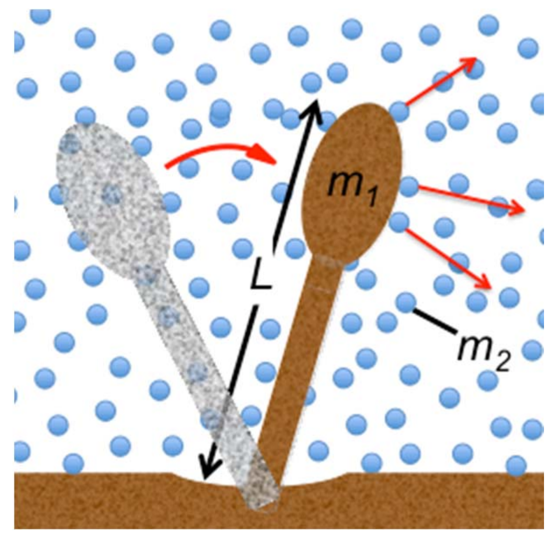
Results

- knob-like halteres provide gyroscopic feedback in flight
- halteres strike 5 – 10 fog particles per stroke
- strokes occur 400-700 cycles per second
- fog causes halteres to flap asymmetrically and slower
- disturbance of haltere motion upsets sensing of body orientation



fog exposure





Conclusion

Fog grounds us too!

A commonality between airplane and mosquito flight: hindered sensory capability

Mosquito can fly in wind & rain, but not fog.

Loss of flight control in dense fog:

- not caused by changes in aerodynamics
- caused by interactions between sensory systems (halteres) and fog

06/13/2012

A cloak of invisibility against ocean waves

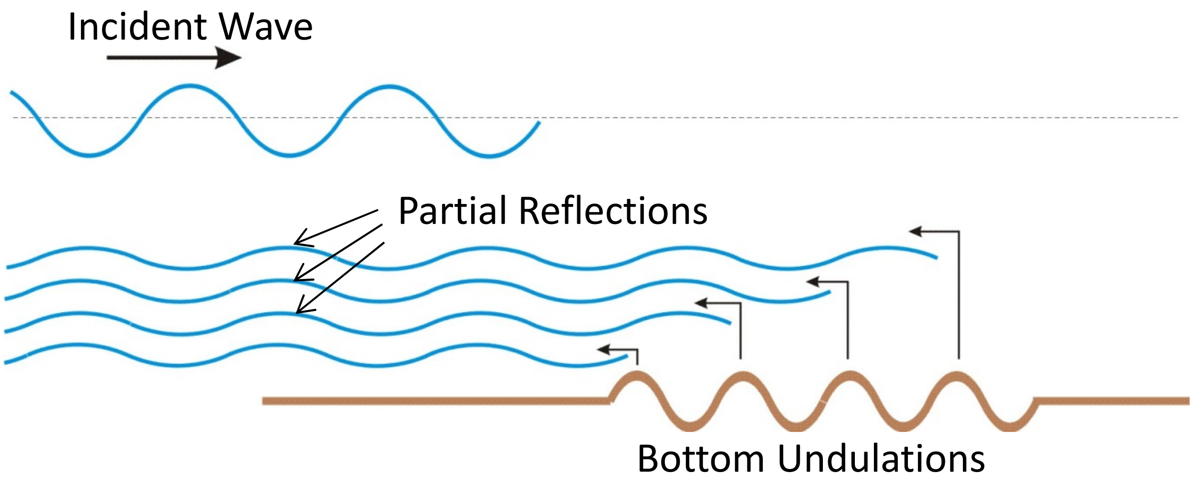
M.-Reza Alam

Mech. E., U.C. Berkelery

reza.alam@berkeley.edu

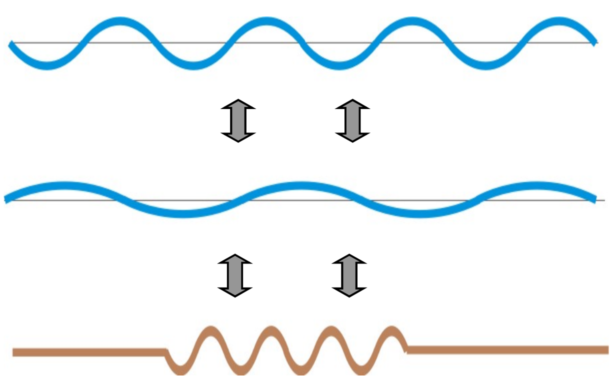
Bragg Resonance of Water Waves

Northwestern Danish Coast (Liu & Cho 1993)

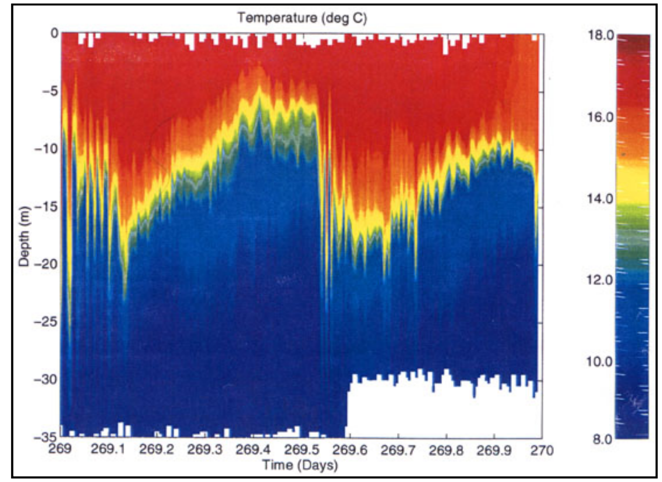


Davies (1982), Mei (1985), Liu & Yue, (1998), Hancock et al (2008).

II. Effect of Density Stratification and Internal Waves

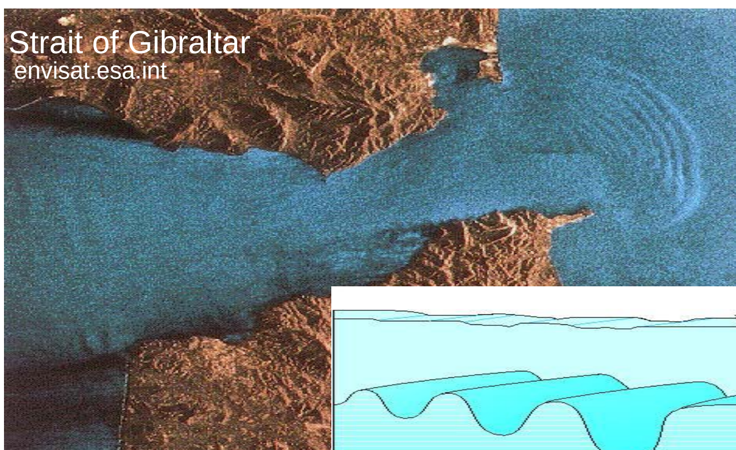


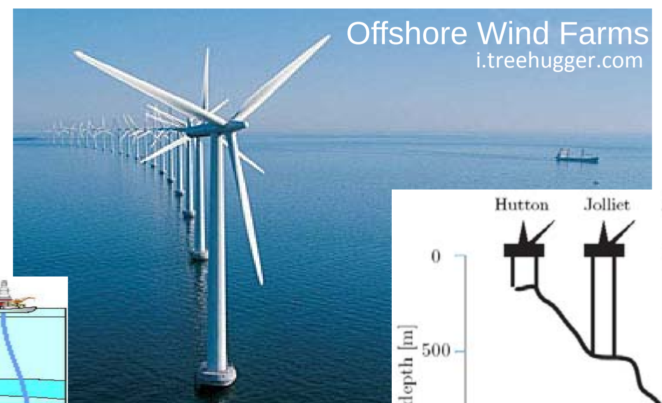
Ocean Density Stratification & Internal Waves



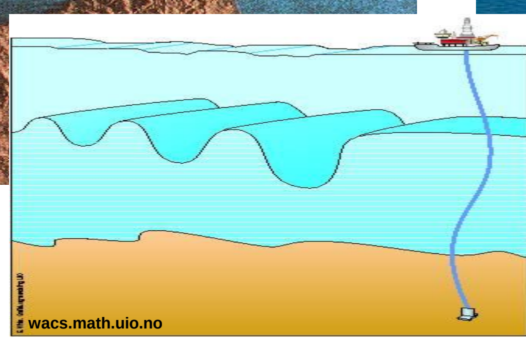
Depth of isotherms as a function of time

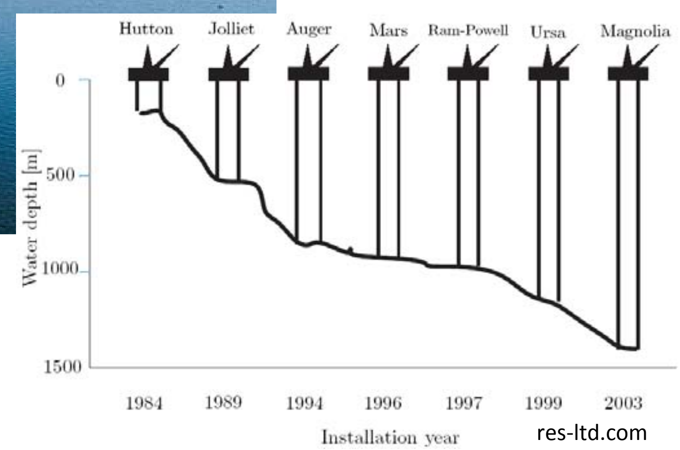
From NOAA, USDC





Dead-water phenomena →





res-ltd.com

Ekman 1904; Ball 1964; Wen 1995; Hill & Foda 1998; Garret & Munk 1975; Yeung & Nguyen 1999; Barranco & Marcus 2005; Marcus, Kundu, & Lee 2000;

Bragg Resonance in a 2-Layer Density Stratified Fluid

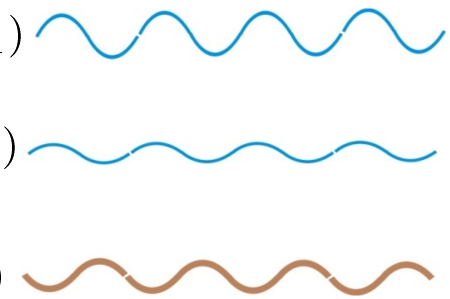
Resonance Condition:

$$k_1 + k_b = k_3$$
$$\omega_1 = \omega_3$$
$$\mathcal{D}(k_3, \omega_3) = 0$$

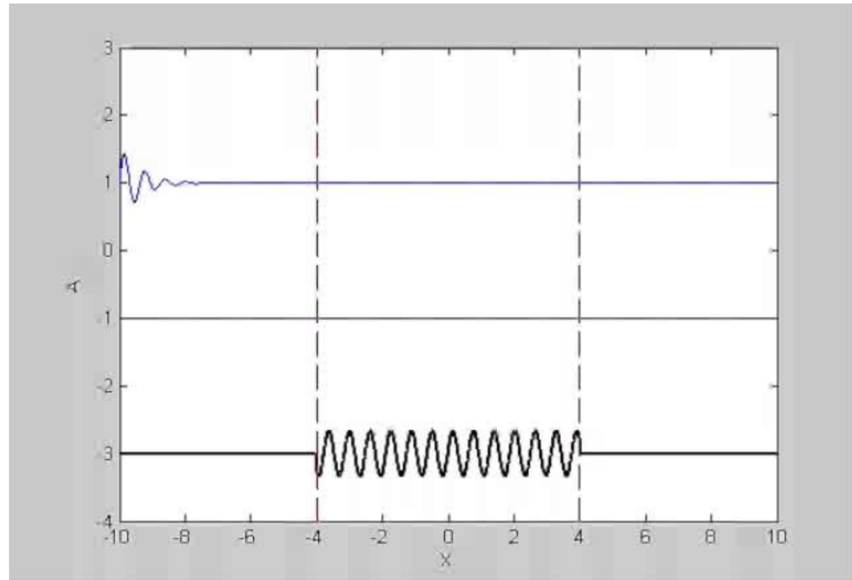
(k_1, ω_1)

(k_3, ω_3)

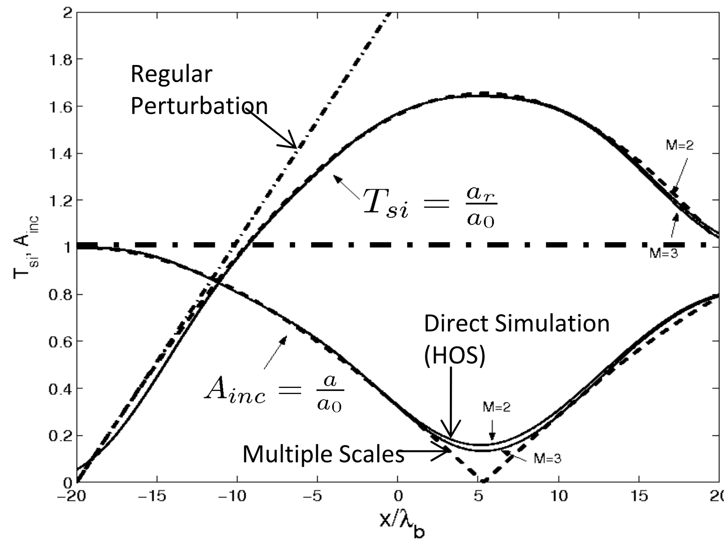
$(k_b, 0)$

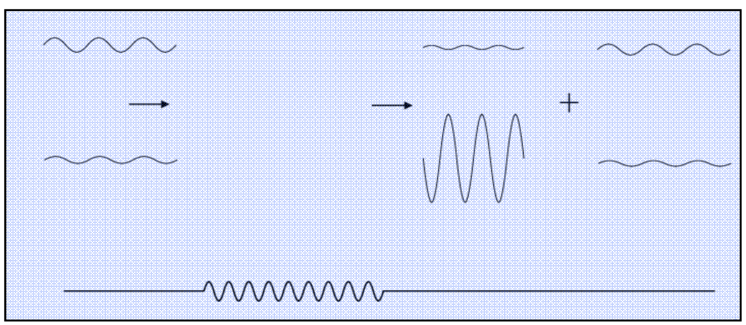


$$\eta_b = d \sin(k_b x)$$



Artist rendering of Bragg resonance

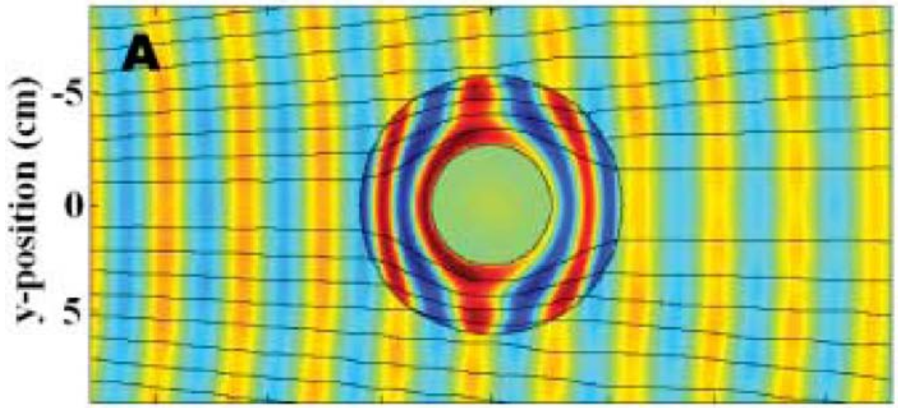




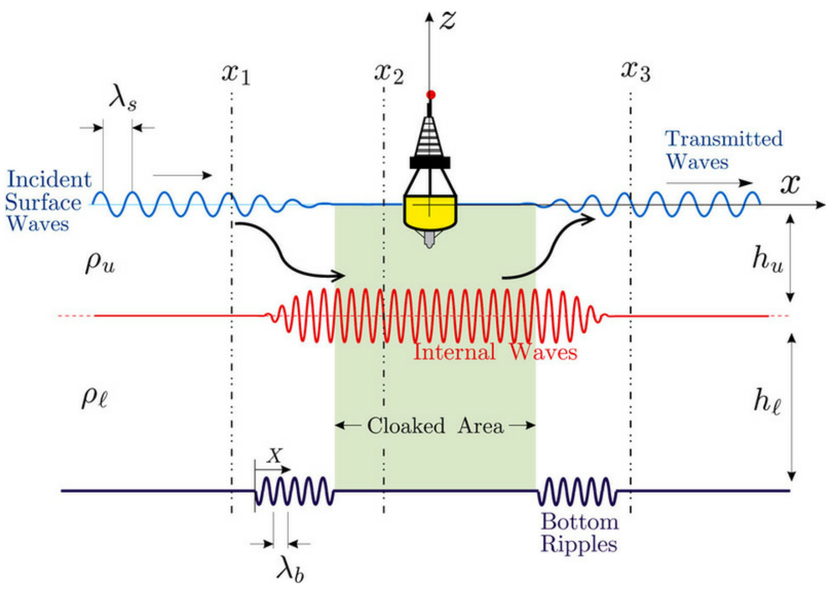
Alam, Liu & Yue, JFM 624, 2009a
Alam, Liu & Yue, JFM 624, 2009b

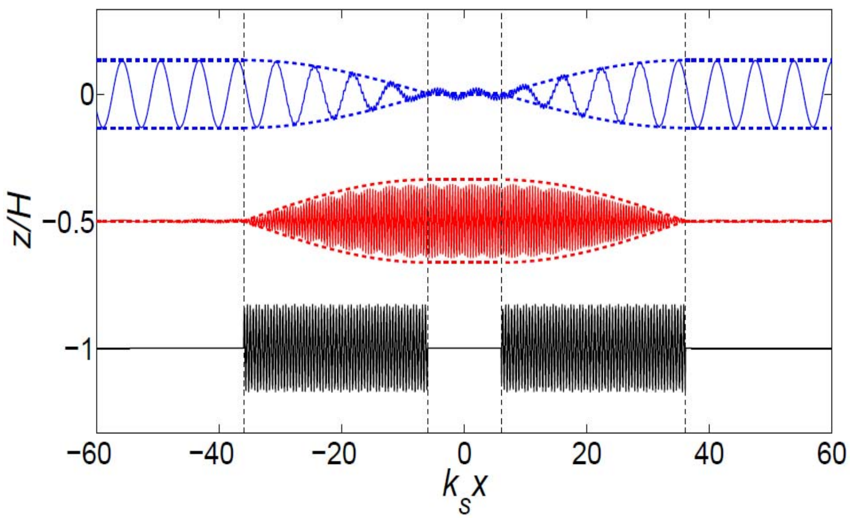
Cloaking of Floating Structures in Stratified Seas

The invisible man (Hollow Man 2000)



Schurig et al, Science, 2006
Zhang et al, 2008, 2009





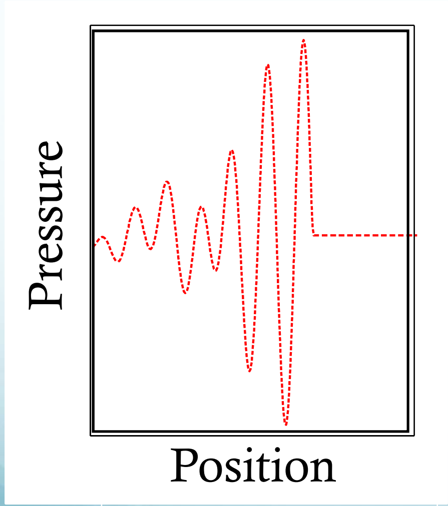
Numerical simulation for making a 2D buffer zone

Sound Bullets in Water

Carly Donahue, Paul Anzel,
Thomas Keller, Chiara Daraio

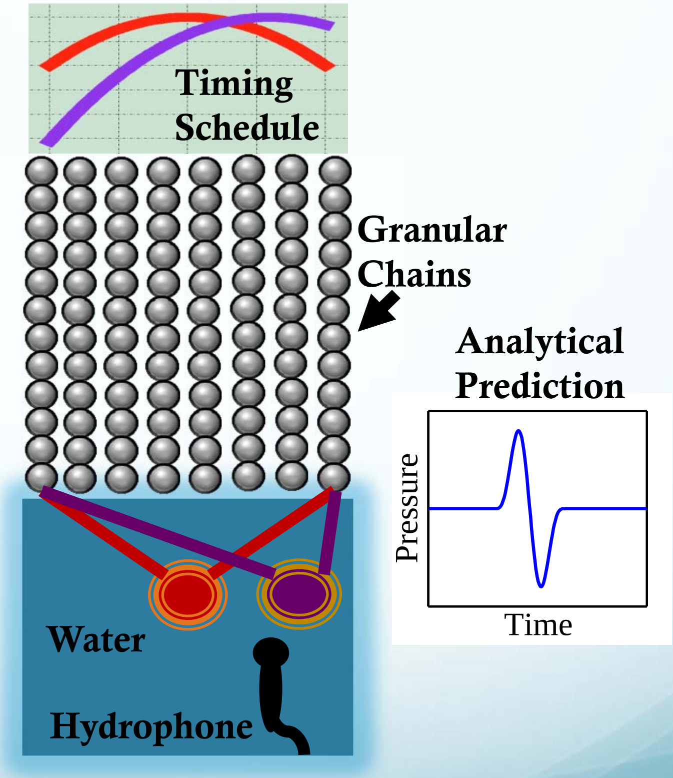
Current Applications Using Acoustic Waves:

- Underwater Imaging
- Ultrasound
- Lithotripsy

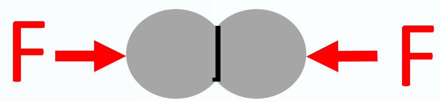


Non-oscillatory, More Compact, Higher Amplitude Pulses

Nonlinear Acoustic Lens

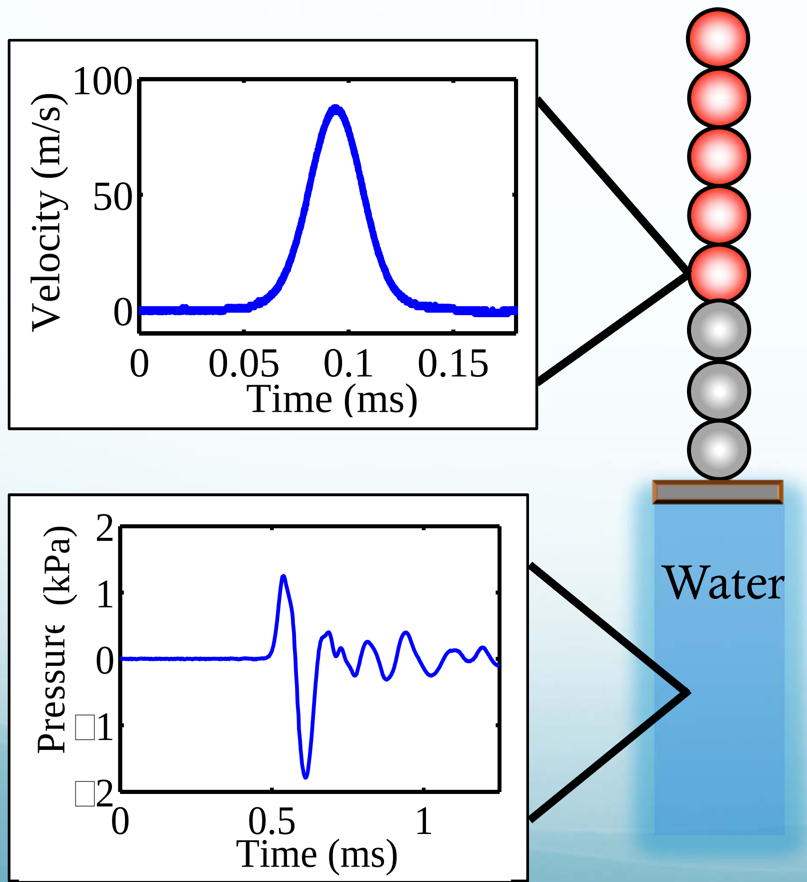


Methodology and Results

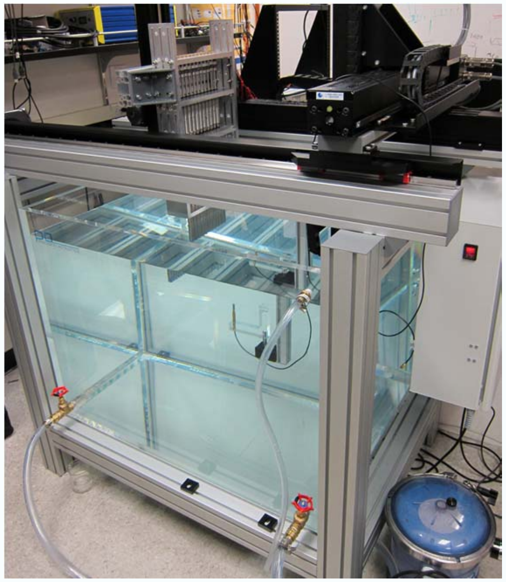


$$F = A\delta^{3/2}$$

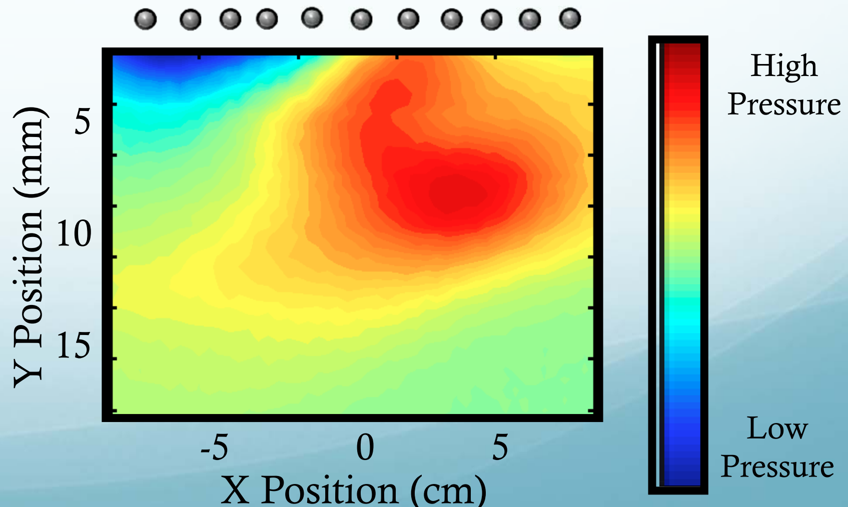
The nonlinear interaction between particles allows for solitary waves of finite size.



Experimental Setup

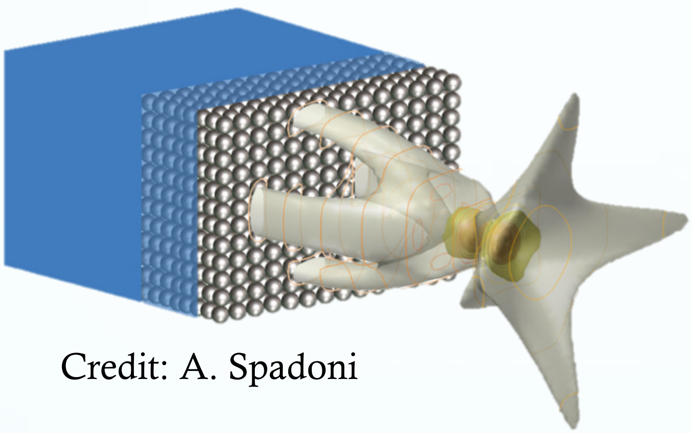


Sound Bullet



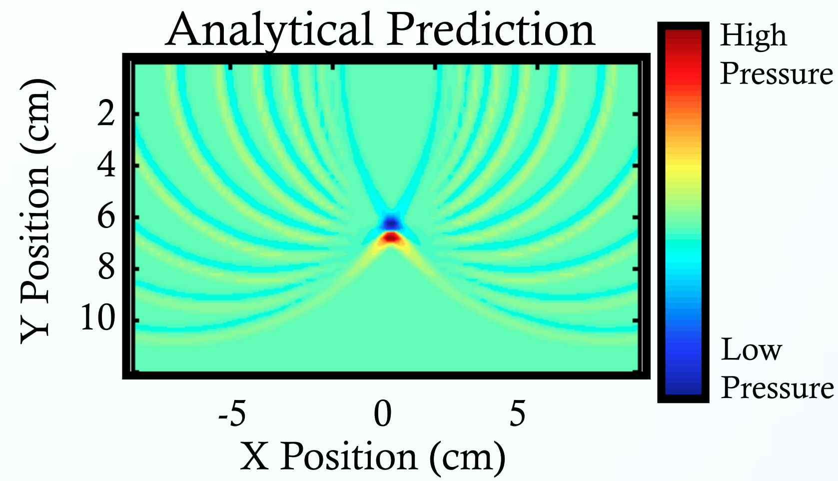
Future Outlook

Arrange chains in a 3D packing ➔ 3D control

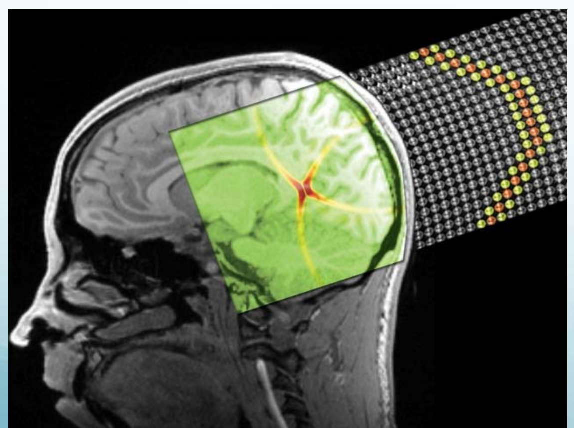


Credit: A. Spadoni

Miniaturize the system ➔ shorter wavelengths

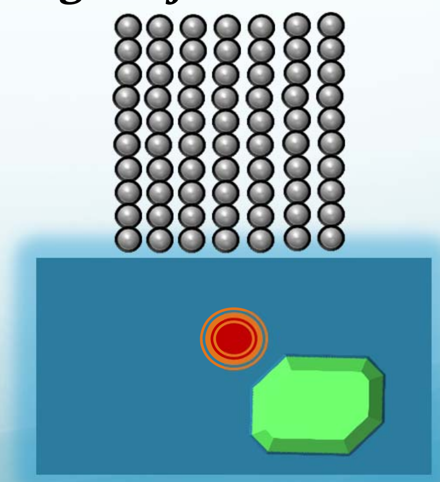


Nonlinear media as target



Credit: M. Tyszka

Image objects underwater



Poroelastic Trailing Edge Noise and the Silent Flight of the Owl

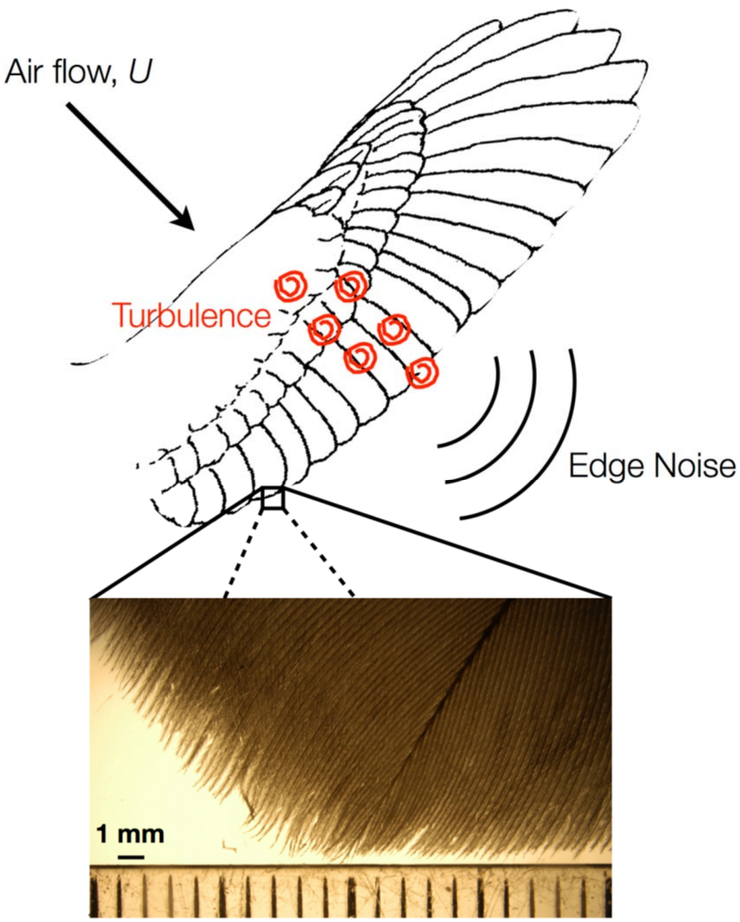
Justin W. Jaworski and Nigel Peake

Models of owl-inspired wings predict noise reduction for conventional aircraft

UNIVERSITY OF CAMBRIDGE

NSF

Edge Noise and the Owl



Siberian Eagle Owl

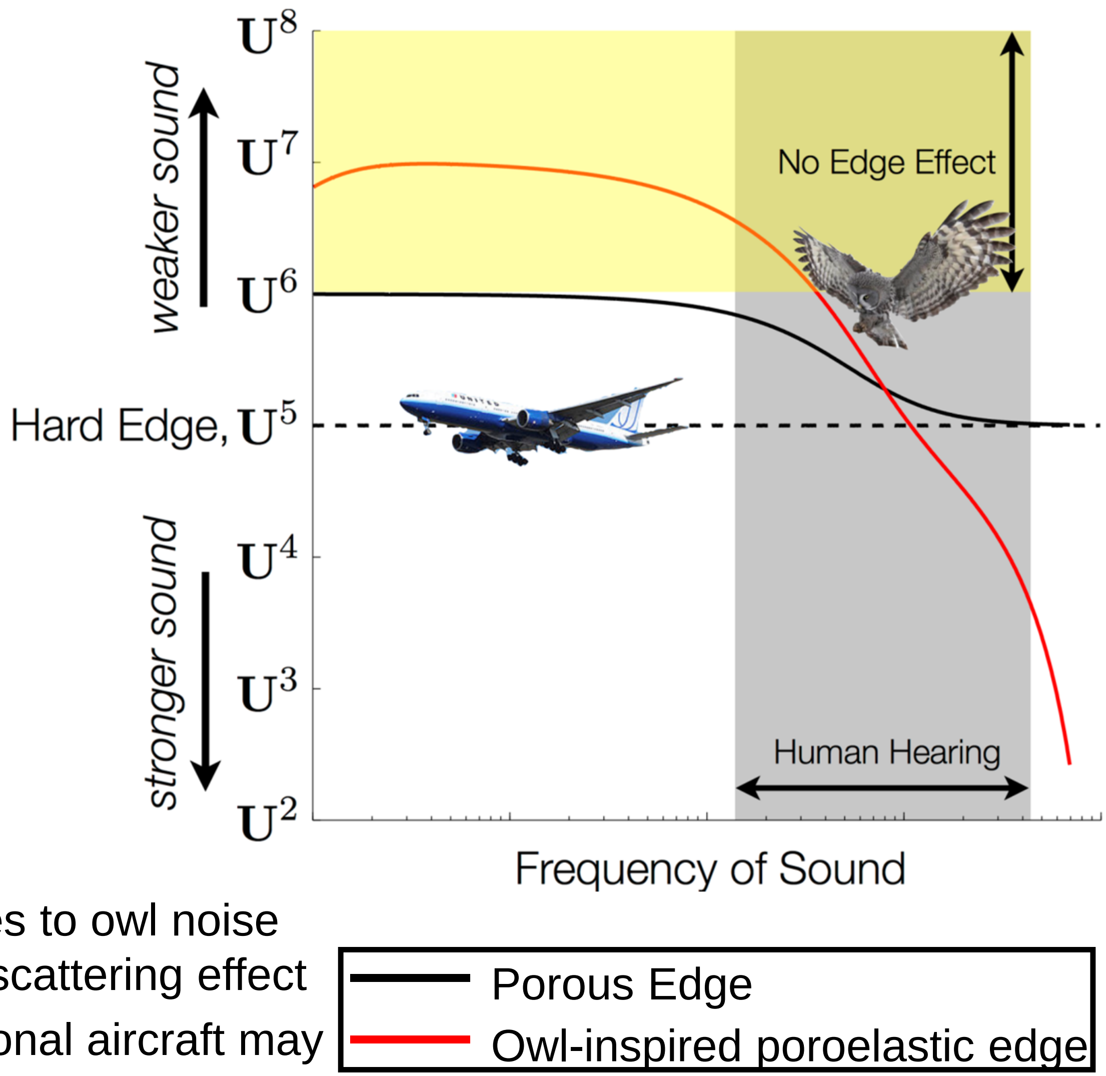
- All wings passing through the air create turbulent eddies, which produce sound when they hit the trailing edge
  - Main source of airplane wing noise
- Owls need to get rid of wing noise to be able to hear and sneak up on prey
- Compared to the rigid wings of conventional aircraft, the owl trailing edge is compliant and porous
  - Softer trailing edge is one of at least three physical features unique to owls that might eliminate their aerodynamic noise

<u>Our Approach</u>

➡Model the generation of sound by turbulence and determine how loud an owl-inspired edge would be relative to an ordinary wing

Results and Remarks

- Dependence of edge noise on flight speed, *U*, indicates the strength of sound
  - Ordinary aircraft are U^5
  - U^6 or weaker means <u>sound is produced as if there were no edge at all</u>
- Porous and elastic properties may effectively eliminate the edge noise mechanism
  - Noise signature influenced by weaker sources such as wing surface roughness



<u>Broader Impact</u>

➡Soft trailing edge likely contributes to owl noise reduction by removing the edge scattering effect

➡Trailing edges, flaps on conventional aircraft may be tailored to mitigate the dominant noise source