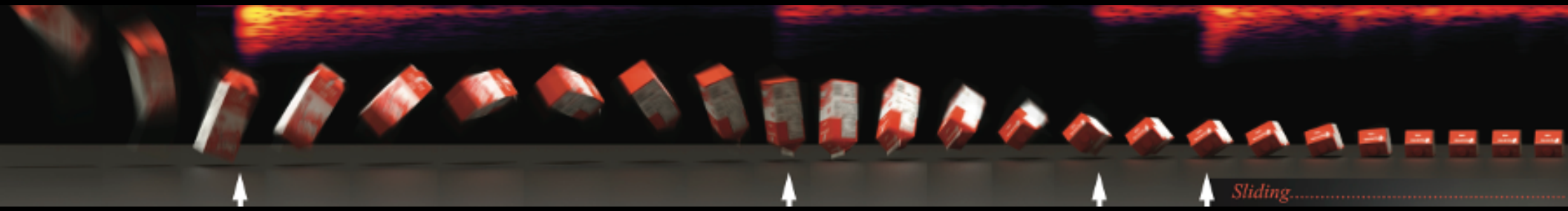
CS 448Z: Physically Based Animation and Sound



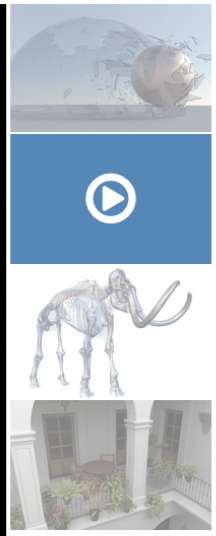
Prof. Doug James
Gates 362

Prof Doug = new Prof();

Doug James

- New Full Professor in Computer Science
  - 1997-2001 UBC, Applied Math, PhD
  - 2002-2006 Carnegie Mellon, CS/Robotics
  - 2006-2015 Cornell, CS
- **Area:** Computer Graphics & Animation
  - physics-based simulation, sound, haptics, geometry, + ???
- New to Stanford but not new to Graphics…

In This Section:



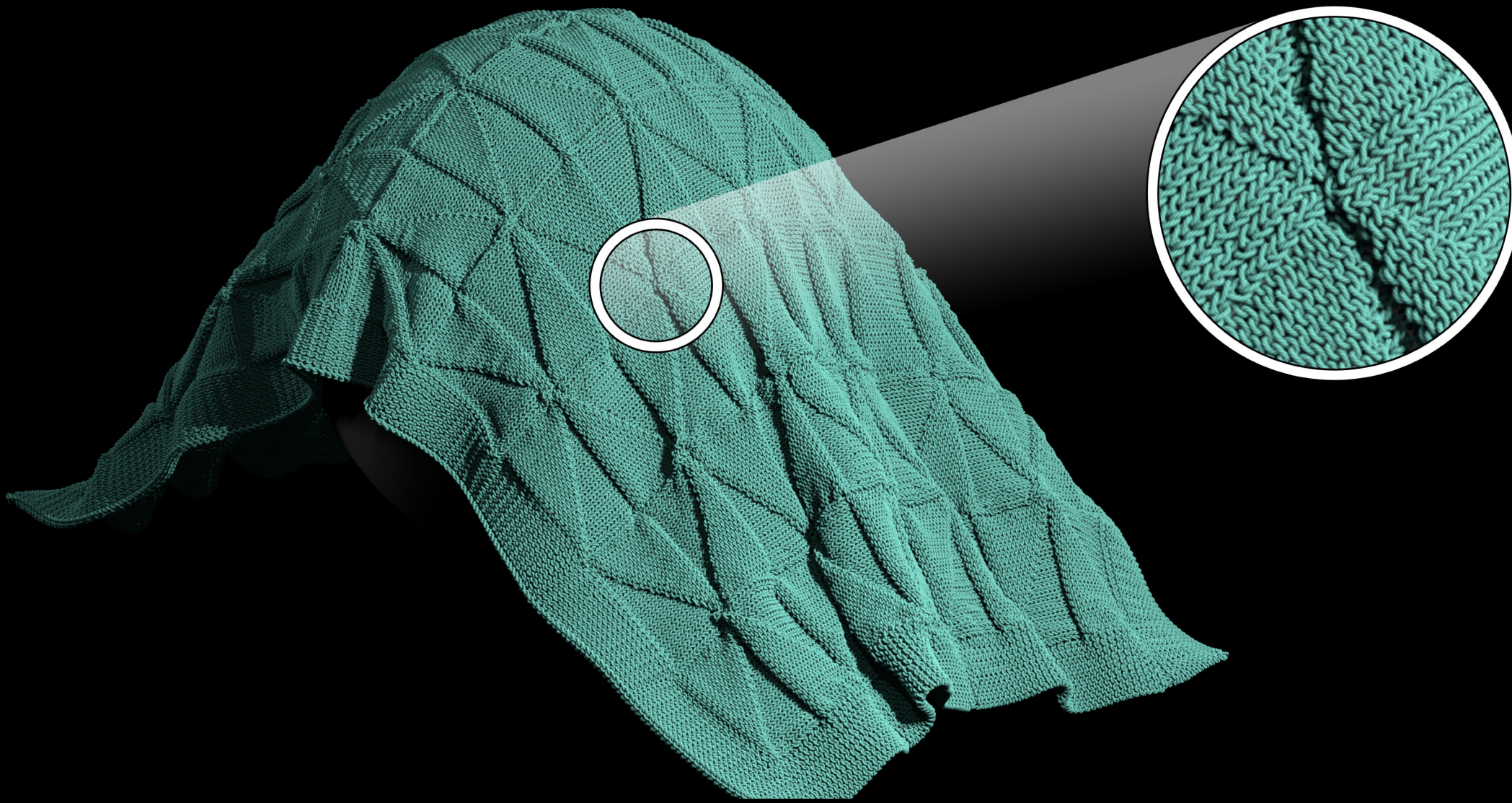
Technical Papers

Submission Deadline

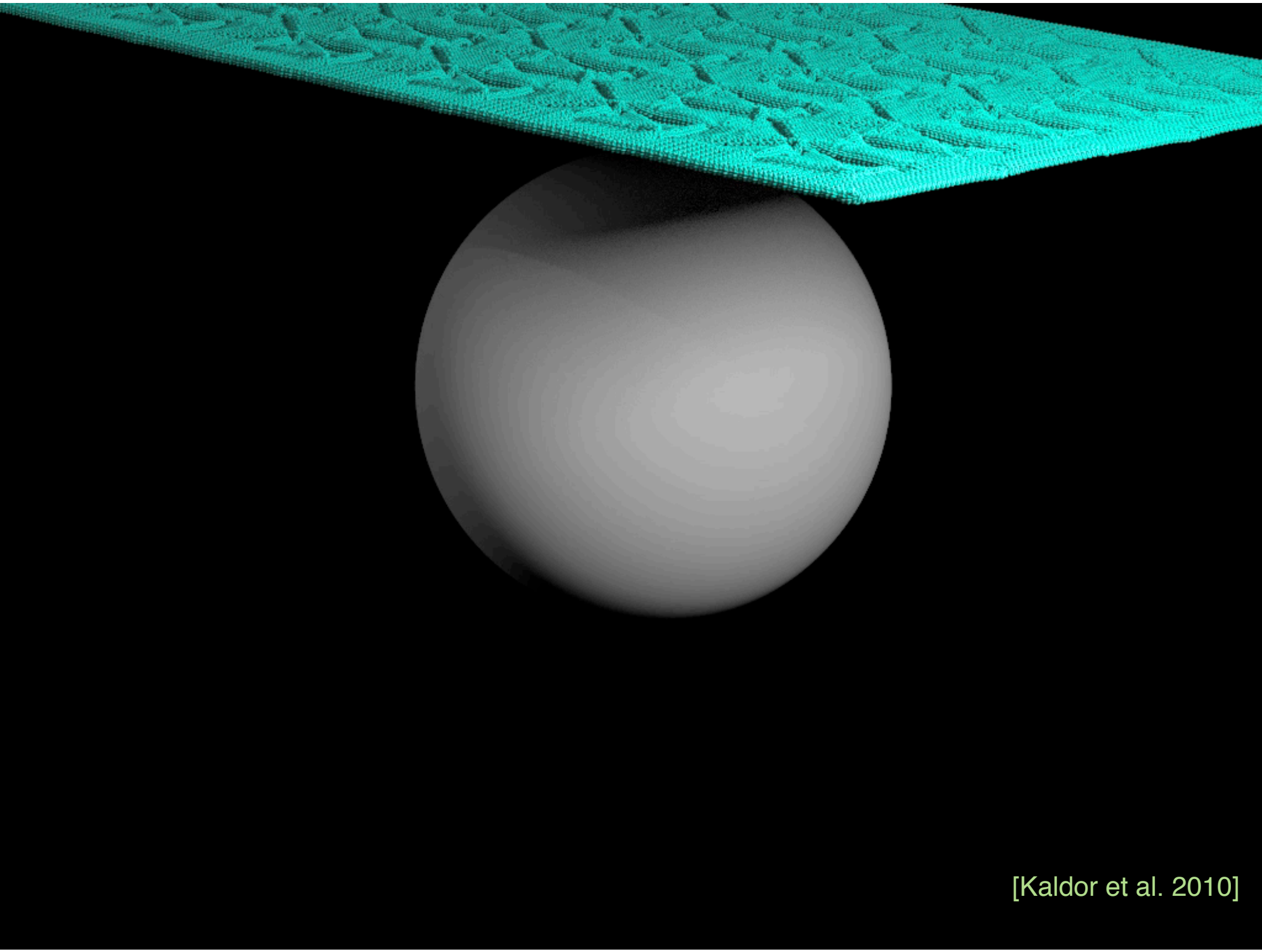
The SIGGRAPH Technical Papers program is the premier international forum for disseminating new scholarly work in computer graphics and interactive techniques. Submitted papers must adhere to the highest scientific standards. They cannot overlap substantially with any paper previously accepted for publication or under review by any

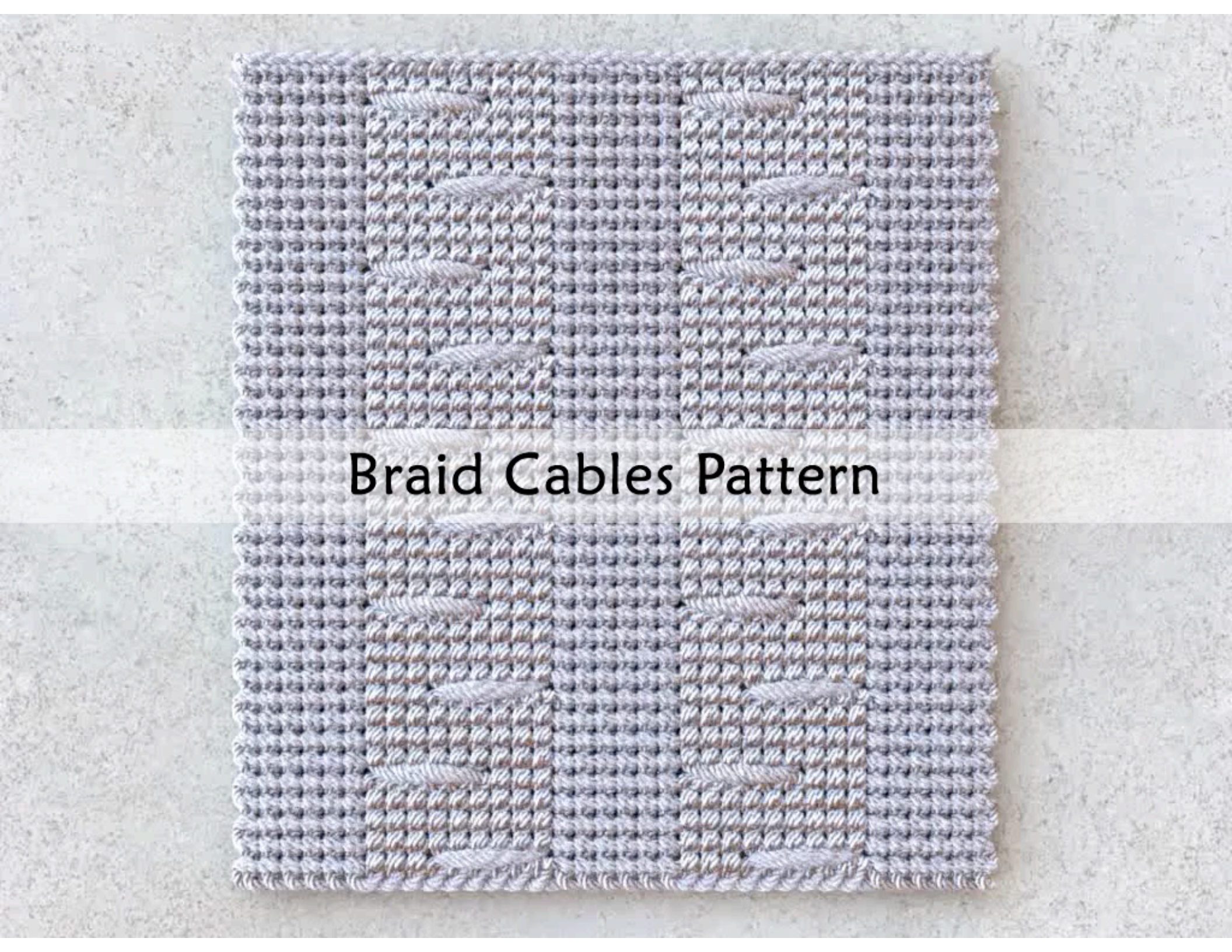
PHYSICS-BASED COMPUTING FOR THE SENSES

Visual Simulation



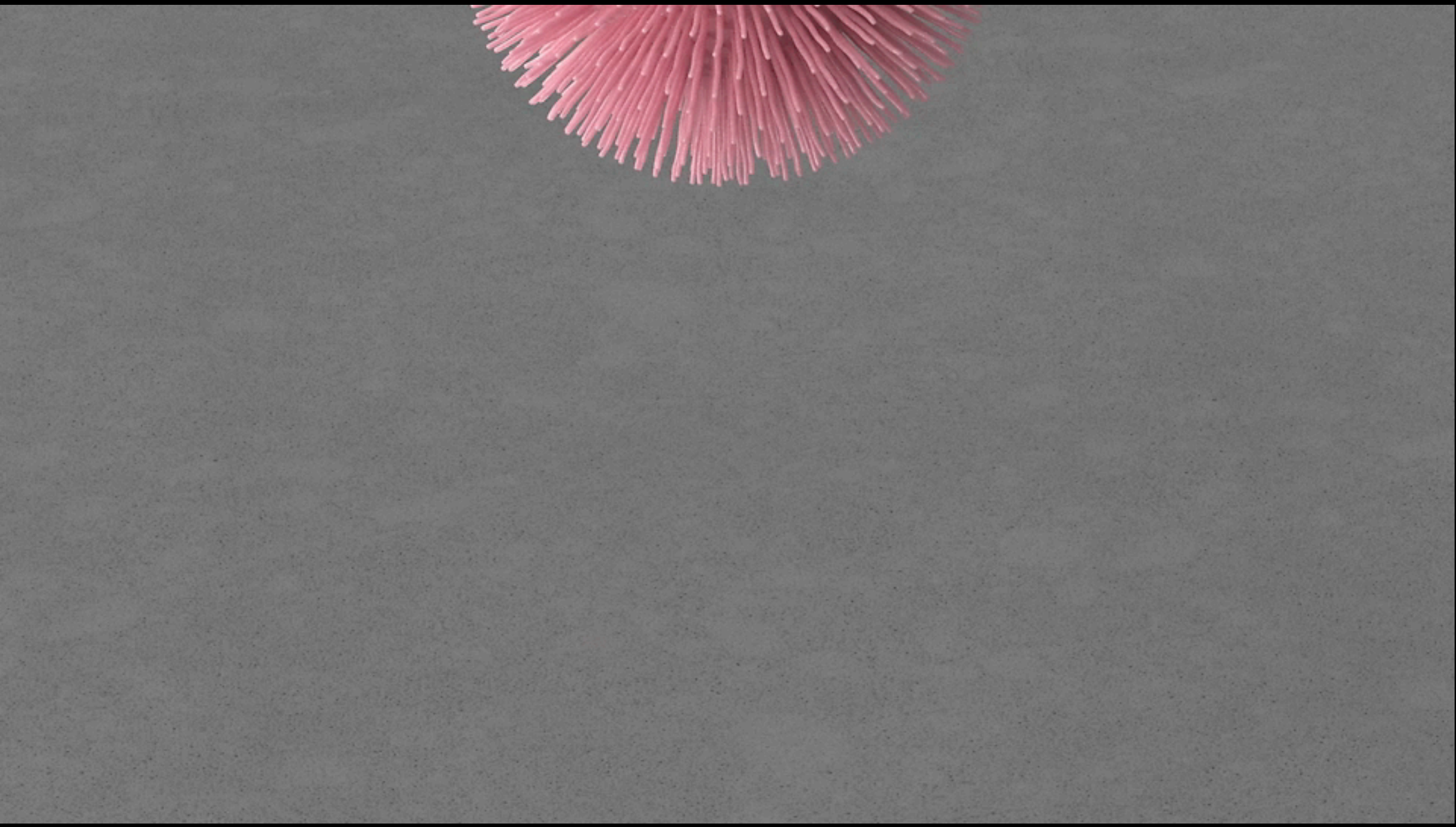
[Kaldor et al. 2010]


[Kaldor et al. 2010]


Braid Cables Pattern

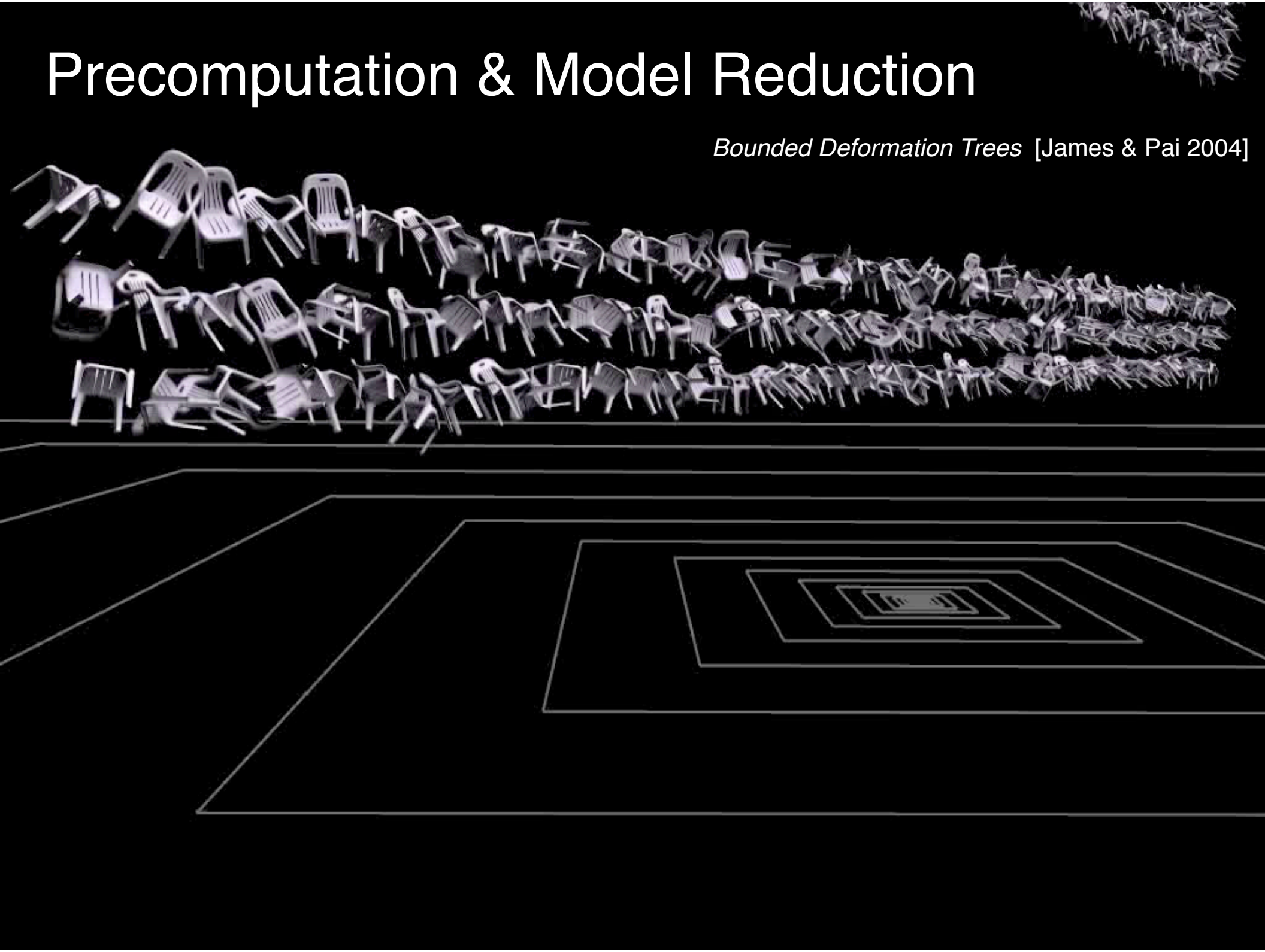
Collision Processing

Energy-based Self-Collision Culling [Zheng & James 2012]

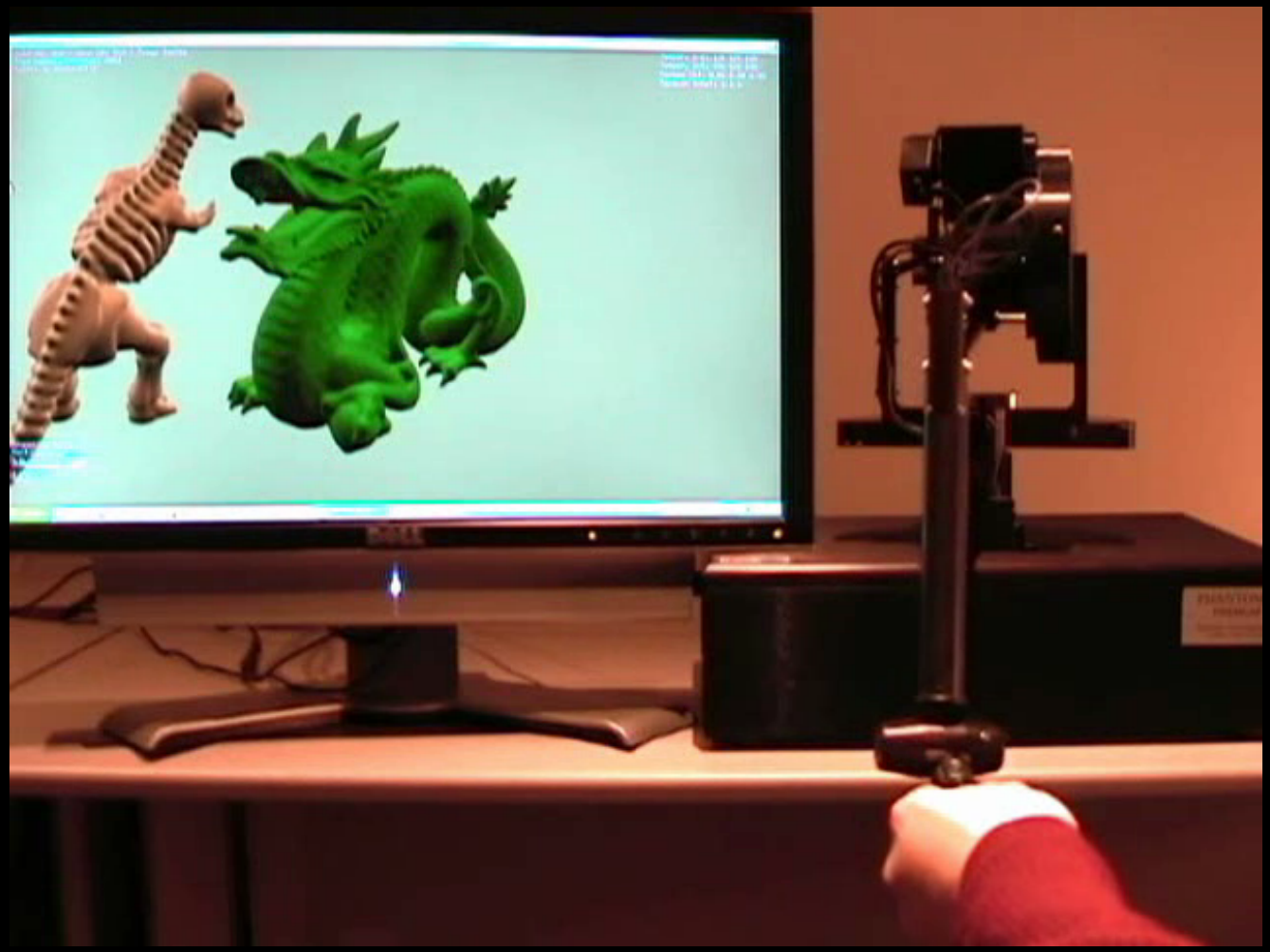


Precomputation & Model Reduction

Bounded Deformation Trees [James & Pai 2004]



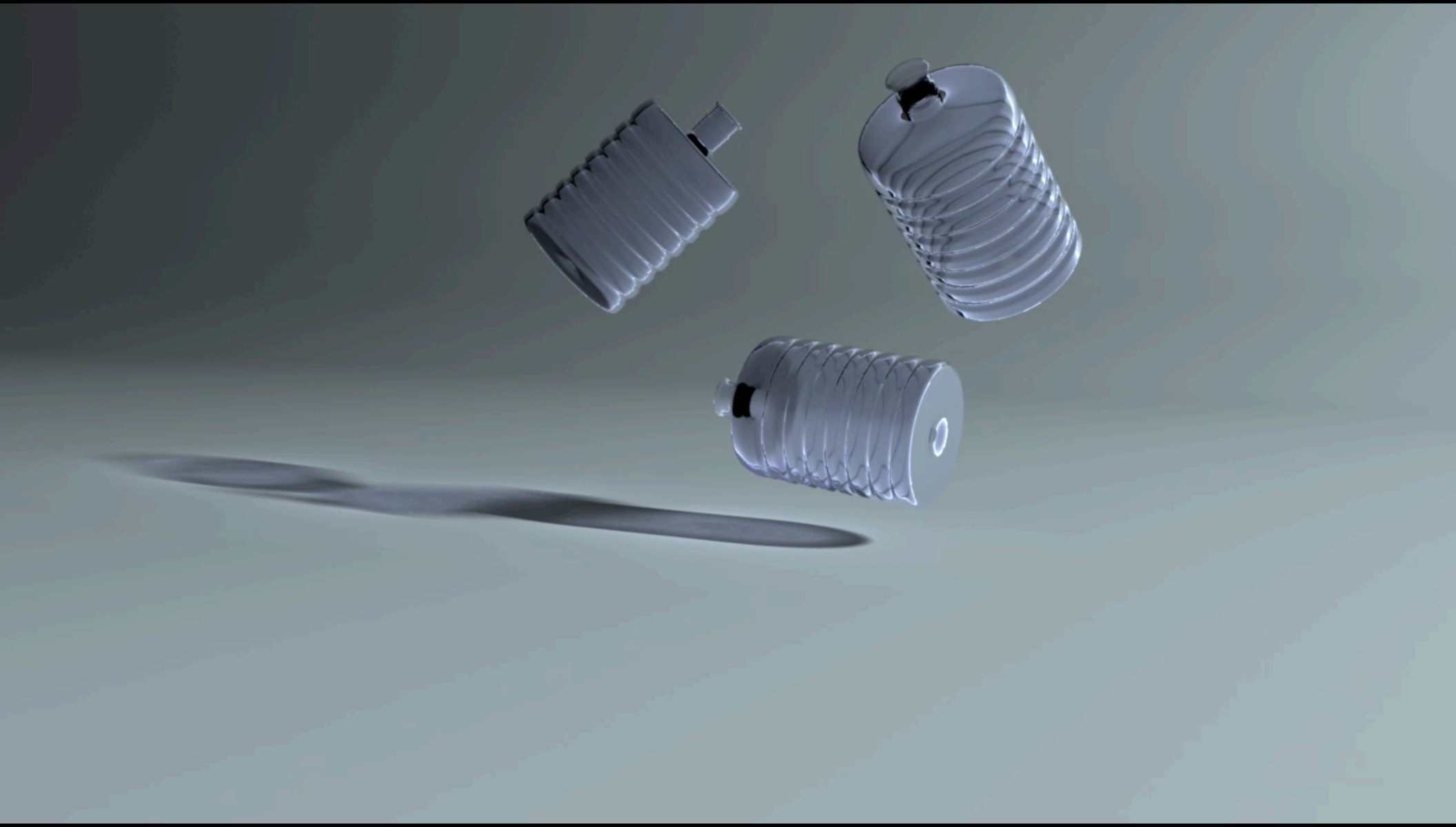
Touch



[Barbic and James 2008]

PHYSICS-BASED COMPUTING FOR THE SENSES

Sound



[Chadwick et al. 2009]

Silent Algorithms

Silent Algorithms

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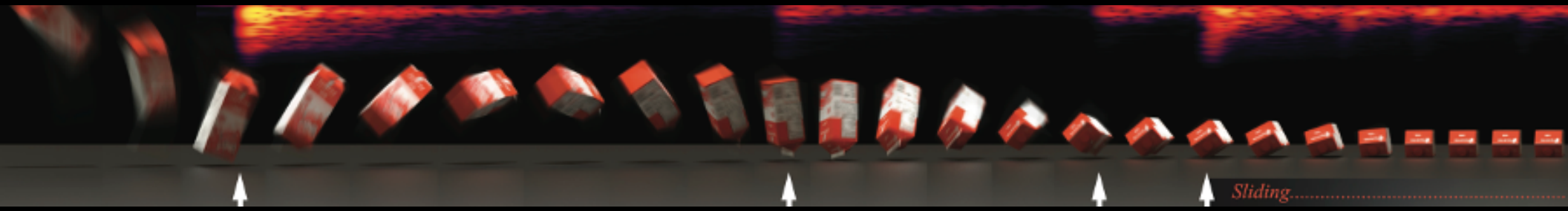

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Description

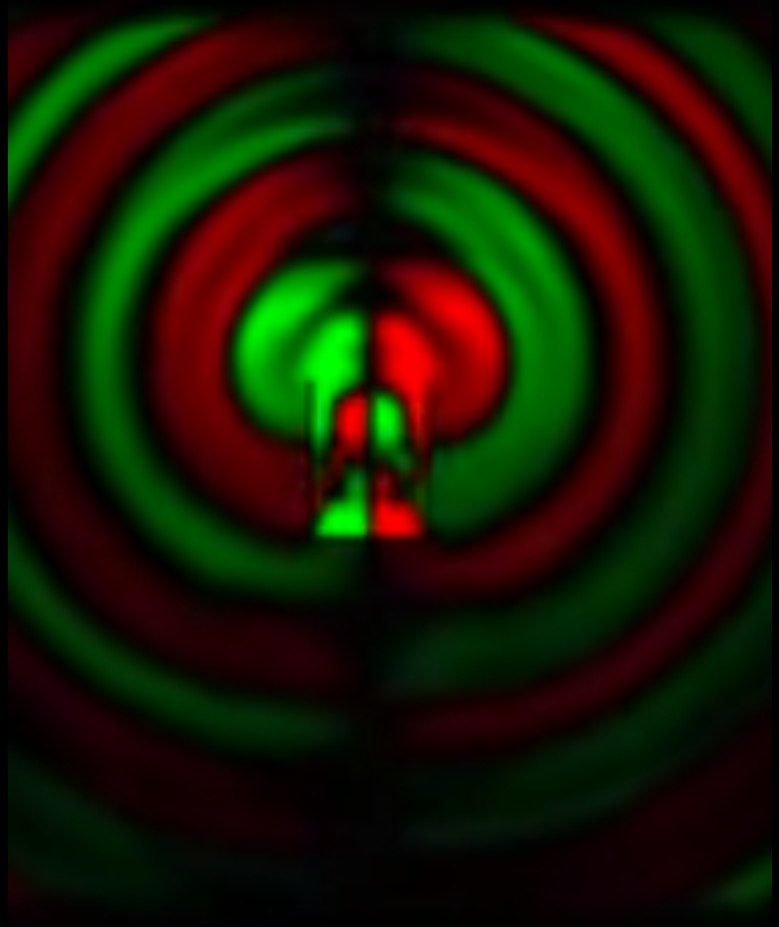
Intermediate level, emphasizing physically based simulation techniques for computer animation and synchronized sound synthesis. Topics vary from year to year, but include integrated approaches to visual and auditory simulation of rigid bodies, deformable solids, collision detection and contact resolution, fracture, fluids and gases, and virtual characters. Written assignments and programming projects.

Description

- Prerequisites: None. However, prior exposure to computer graphics (CS 148 and CS 248), and/or scientific computing (CS 205), is recommended. Exposure to computer music and/or sound synthesis is helpful.
- Textbook: None; lecture notes and research papers assigned as readings will be posted here.
- Communication:
  - Class mailing list (for occasional announcements)
  - Piazza (for questions and discussion)
- Requirements: Students are expected to attend the lectures and participate in class discussions, and read the supplemental materials.
- Assignments: There will be programming assignments, and a final project based on a student-selected topic.
- Exams: None.

Sound waves and radiation modeling

Sound pressure; acoustic wave equation; Helmholtz equation; boundary conditions for one-way coupling.

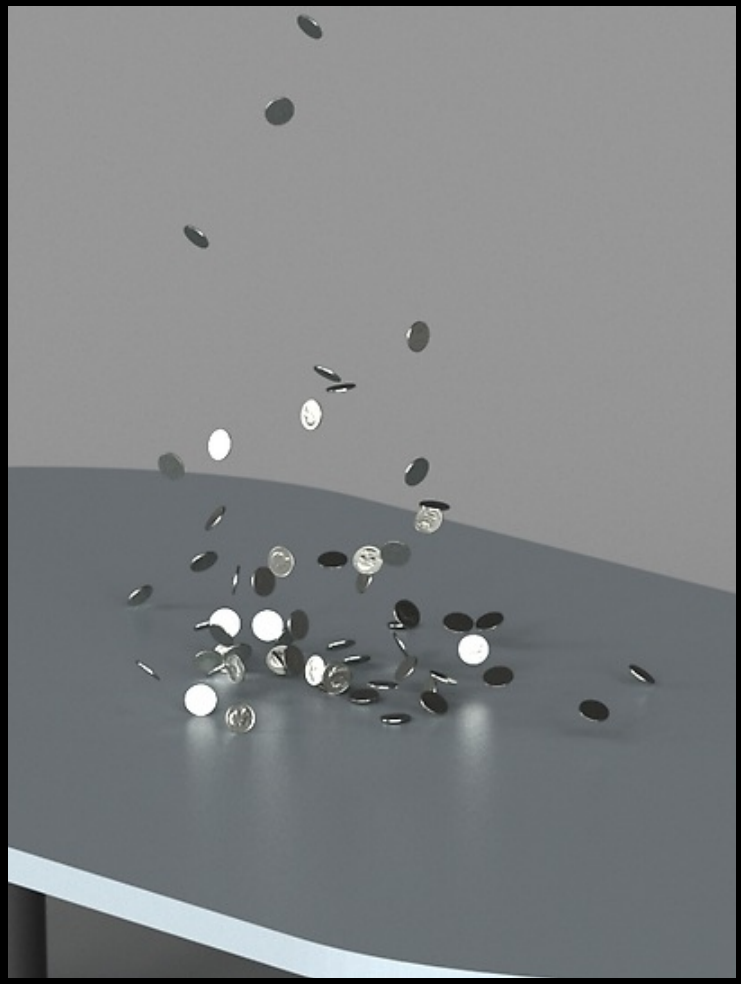


Rigid-body dynamics & contact modeling

Animation background; equations of motion; discrete-time integration; collision detection; contact resolution strategies; friction.

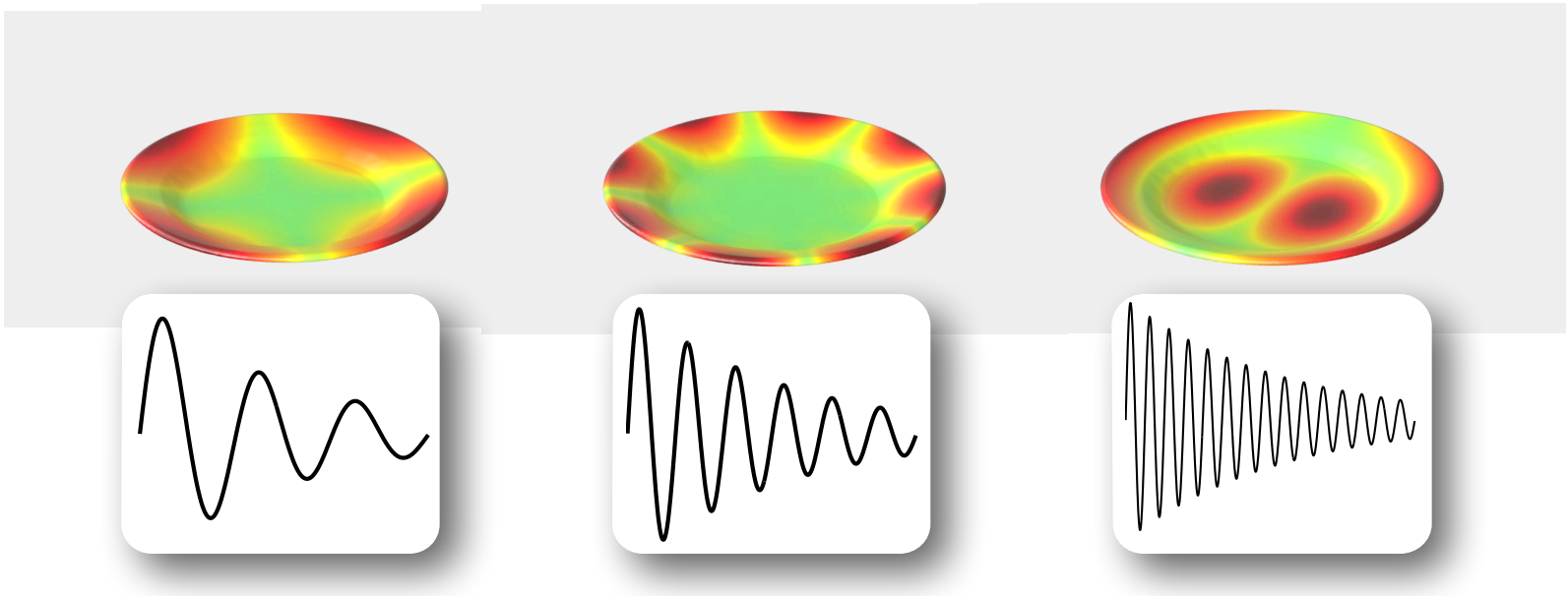
Acceleration noise for rigid-body impacts

Rigid-body acceleration; Hertz contact and impact time scale; acceleration noise pulses; precomputation; rendering details.



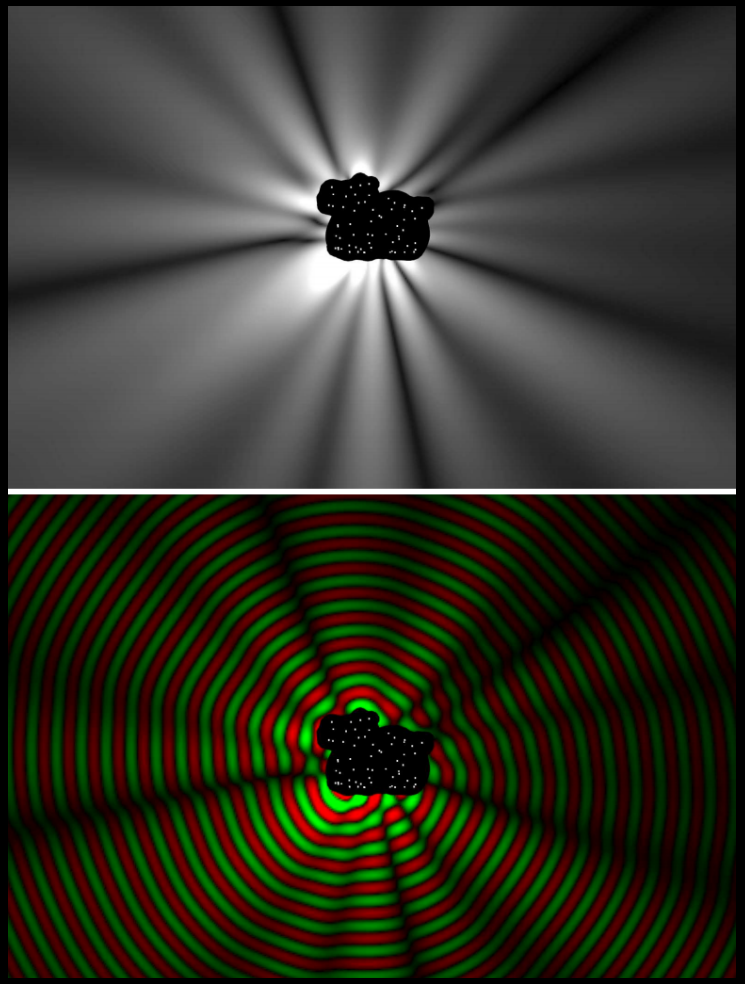
Modal vibration analysis & synthesis

Simple harmonic oscillator, mass-spring systems; modal vibration of 3D solids; mass and stiffness matrices; meshing and discretization; generalized eigenvalue problem; eigenfrequencies and eigenmodes; eigensolvers for large systems; damping models; time-stepping modal vibrations; integration with rigid-body dynamics engines.



Acoustic transfer for modal vibrations

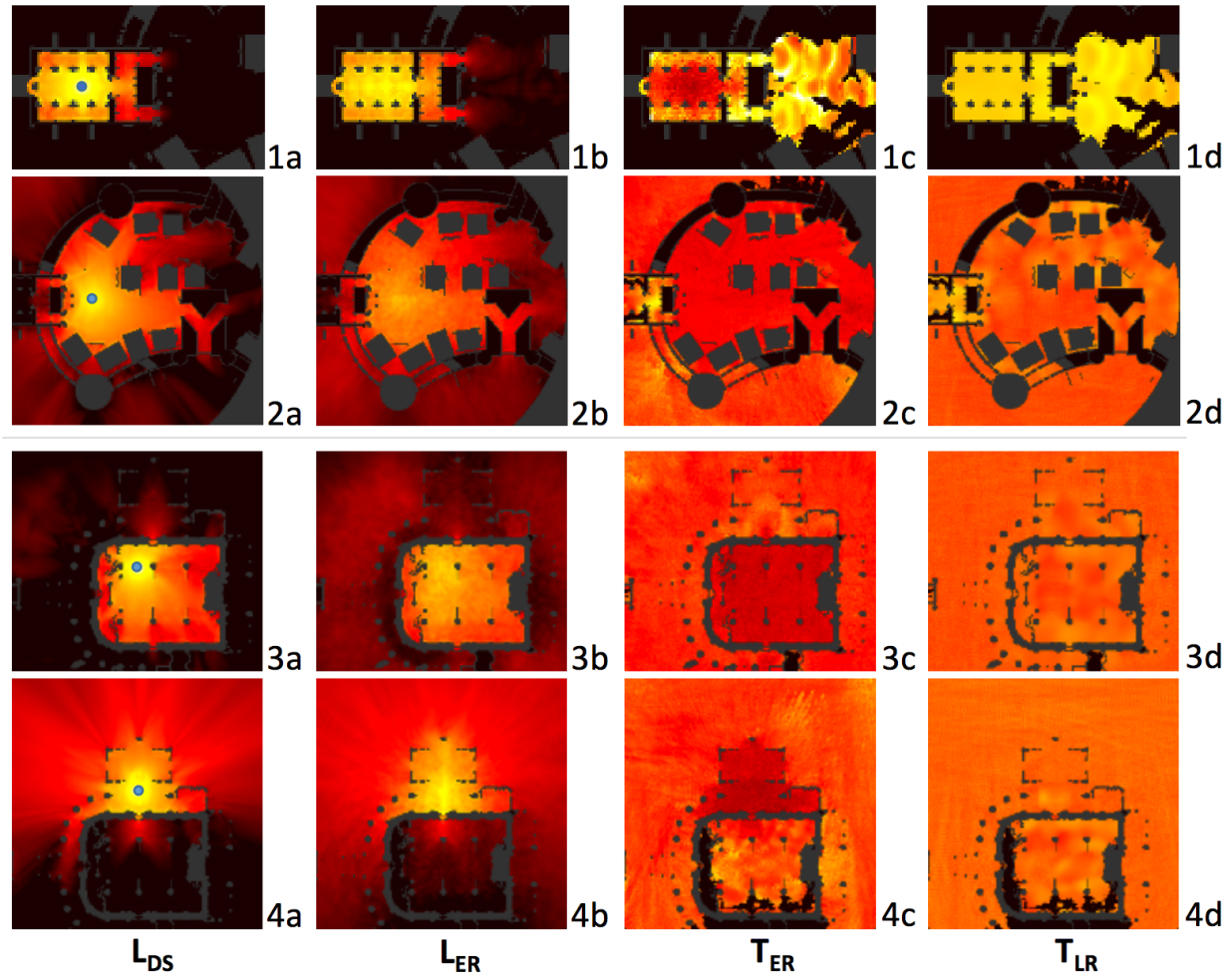
Transfer function definition; multipole expansions; solvers and precomputation; fast evaluation; rendering details.



Sound propagation modeling and auralization

Citadel

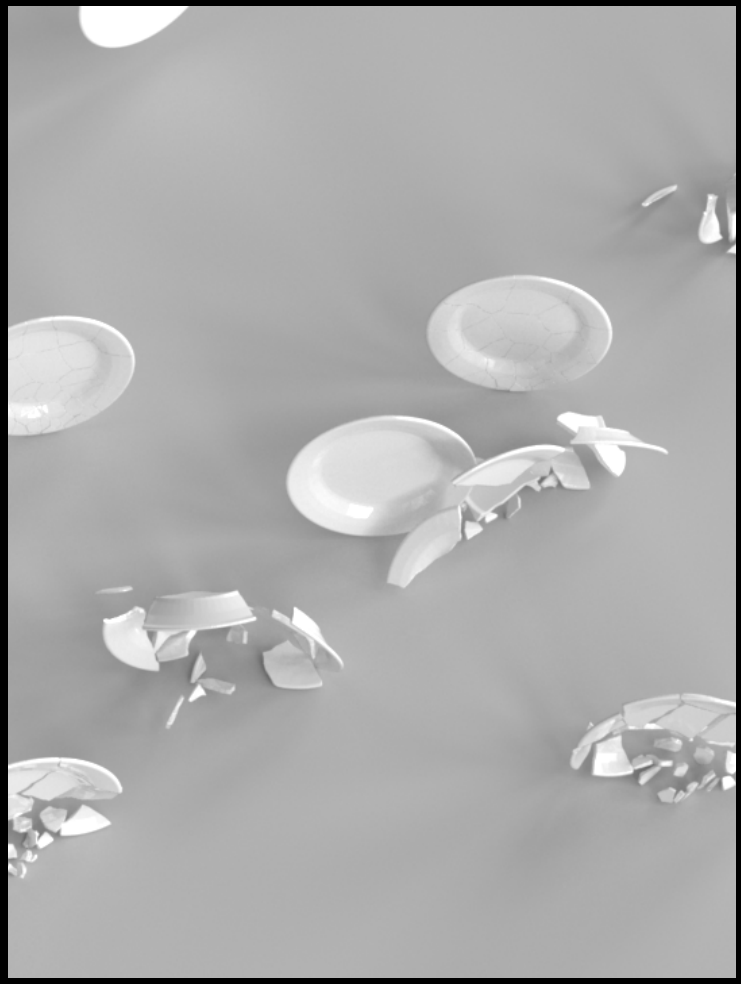
Sanctuary



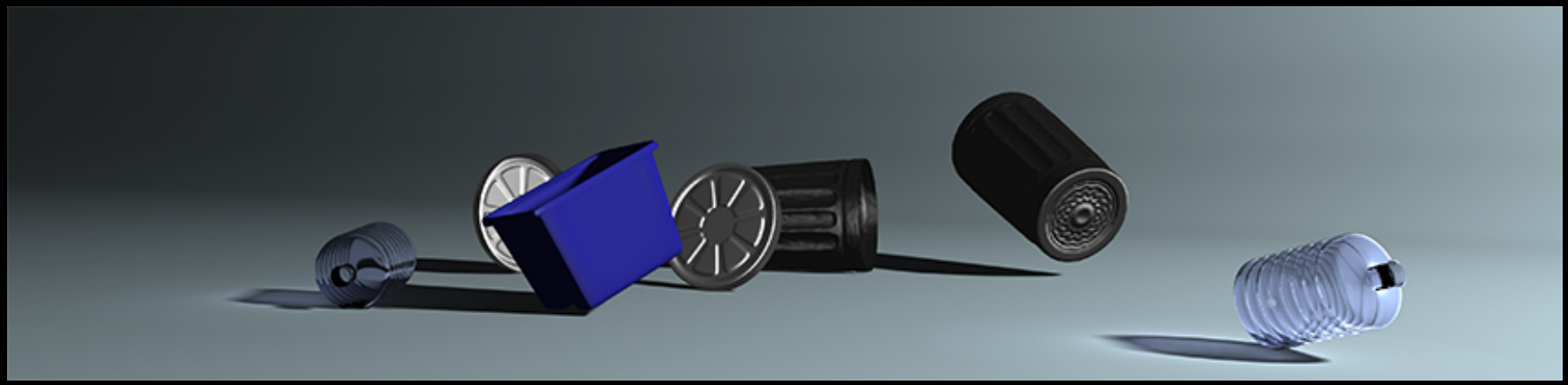
[N. Raghuvanshi et al. 2014]

Fracture

Animation background; rigid-body sound approximation; fracture impulses; ellipsoidal sound proxies; simplified implementation using pre-scored fracture.



Reduced-order dynamics modeling; Application to thin shells



Animation background; rigid-body sound approximation; fracture impulses; ellipsoidal sound proxies; simplified implementation using pre-scored fracture.

Liquids

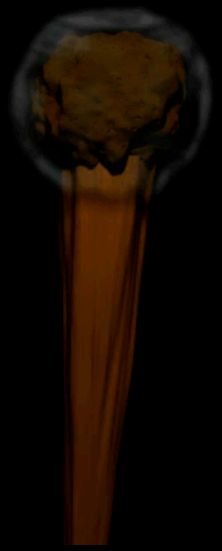
Animation background; acoustic bubble models; particle-based bubble simulation; acoustic transfer; speed-accuracy trade-offs; simplified implementation.

Turbulence & aeroacoustics

Modeling background; turbulence; Curle's model; precomputation techniques.

[Dobashi et al. 2003]

Fire



Animation background; combustion noise; low-frequency approximation; sound texture synthesis.

Cloth

Animation background; integration techniques; sound modeling of frictional contact and crumpling events.

Finally…

- Open problems in animation sound
- Selected topics (based on student interest)

Project Focus

1. Warm-up!: Acoustic particle system using openFrameworks
2. Real-time acceleration noise
3. Real-time rigid-body sound (Part I): Modal sound + rigid-body dynamics
4. Real-time rigid-body sound (Part II): Acoustic transfer modeling
5. Final project (Your choice)

Questions & Survey