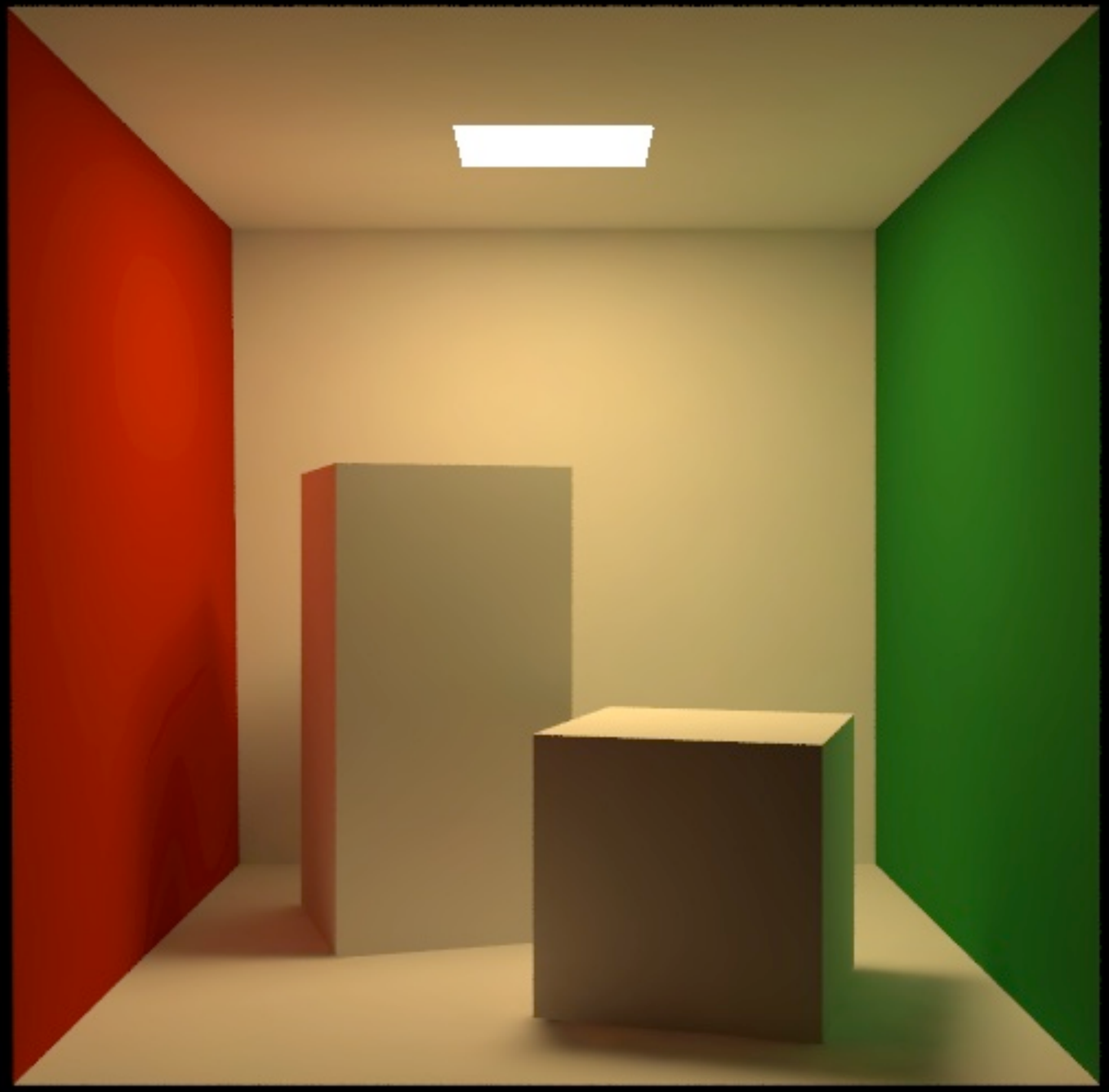
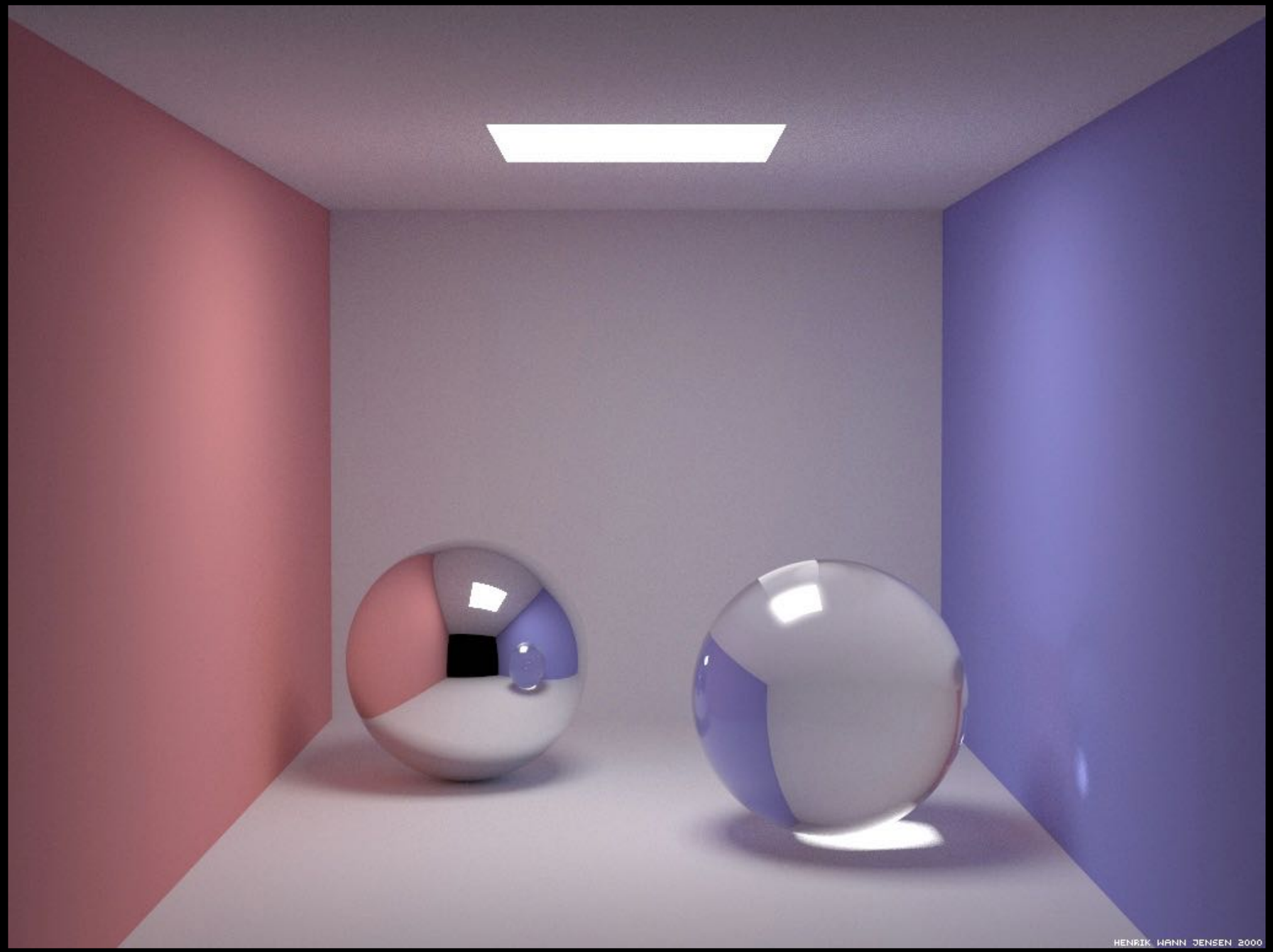
Wrap-up

CS4620 Lecture 27

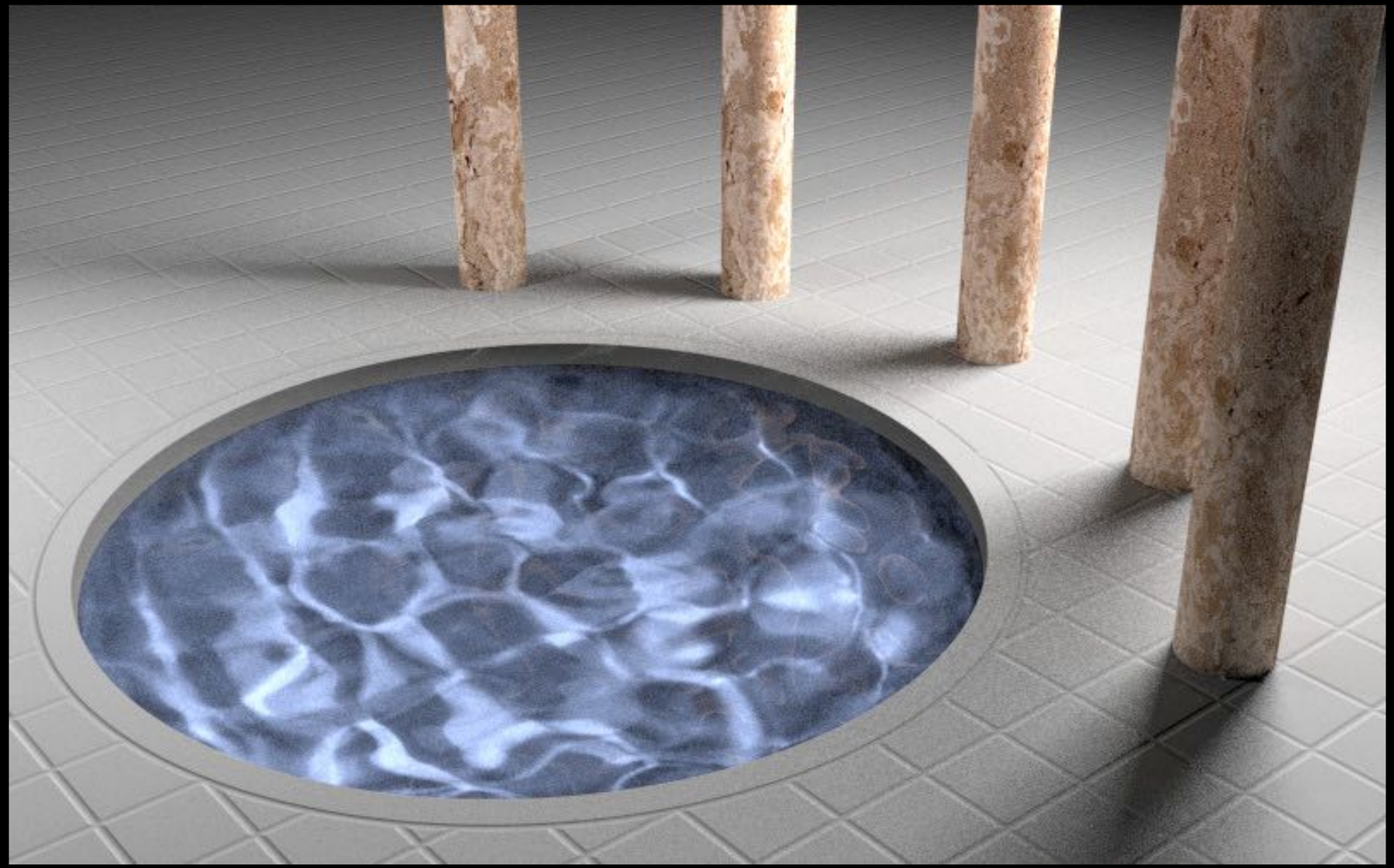
CS4620 Home Staff **Schedule** Assignments Exams About Office Hours Books Piazza

date	topic	reading	assignments
25 Jan	Introduction slides		
27 Jan	Triangle meshes slides		Meshes out
30 Jan	Triangle meshes	.obj files demo meshes	
1 Feb	Triangle meshes 2 slides	Sec. 12.1	
3 Feb	Ray tracing intersection slides	Chap. 4, Sec. 2.7	
6 Feb	Ray tracing shading slides		
8 Feb	Ray tracing textures slides	Sec 11.1–2 except 11.2.4	Meshes due
10 Feb	Ray tracing interpolation slides		Ray 1 out
13 Feb	Perspective slides		
15 Feb	Transformations slides	Chap. 6, Review 5.1–5.3	
17 Feb	Transformations		Ray 1 due
20 Feb	—February Break—		
22 Feb	History of CG		
24 Feb	Viewing: Orthographic slides	Sec. 7.0–7.1	Scene out
27 Feb	Viewing: Perspective demo	Sec. 7.2–7.5	
1 Mar	Hierarchies and scene graphs slides	Sec. 12.2	
3 Mar	Rasterization slides	Sec. 8–8.1	
6 Mar	Rasterization | Graphics Pipeline slides	Chap. 8	Shaders out
8 Mar	Graphics pipeline		
10 Mar	OpenGL and GLSL demo slides	Chap. 17	Scene due
13 Mar	Games with textures slides		
15 Mar	—Snow Day—		
17 Mar	Games with textures demo		
20 Mar	Textures | Splines slides	Sec. 15.0–15.3	
21 Mar	Midterm: 7:30pm, Olin Hall 155		
22 Mar	Splines	Sec. 15.4–15.6	Splines out
24 Mar	Splines		Shaders due
27 Mar	Subdivision surfaces slides		
29 Mar	Animation slides	Sec. 16.0–2	
31 Mar	Animation and 3D Rotations	Sec. 16.3–7 (just for interest)	Splines due
3 Apr	—Spring Break—		
5 Apr	—Spring Break—		
7 Apr	—Spring Break—		
10 Apr	Ray Tracing acceleration slides	Sec. 12.3	Animation out
12 Apr	Physics-based animation slides		
14 Apr	Reflection and Illumination slides		
17 Apr	Monte Carlo illumination slides		
19 Apr	Monte Carlo illumination		Animation due
21 Apr	Advanced ray tracing slides	Chap. 13	Ray 2 out
24 Apr	Advanced ray tracing		
26 Apr	Advanced ray tracing		
28 Apr	Images and Displays slides	Chap. 3	
1 May	Antialiasing and compositing slides	Sec. 3.4, 11.4	
3 May	Antialiasing and compositing		
5 May	Color science	Chap. 19	Ray 2 due
8 May	Color science		
10 May	Wrap-up		

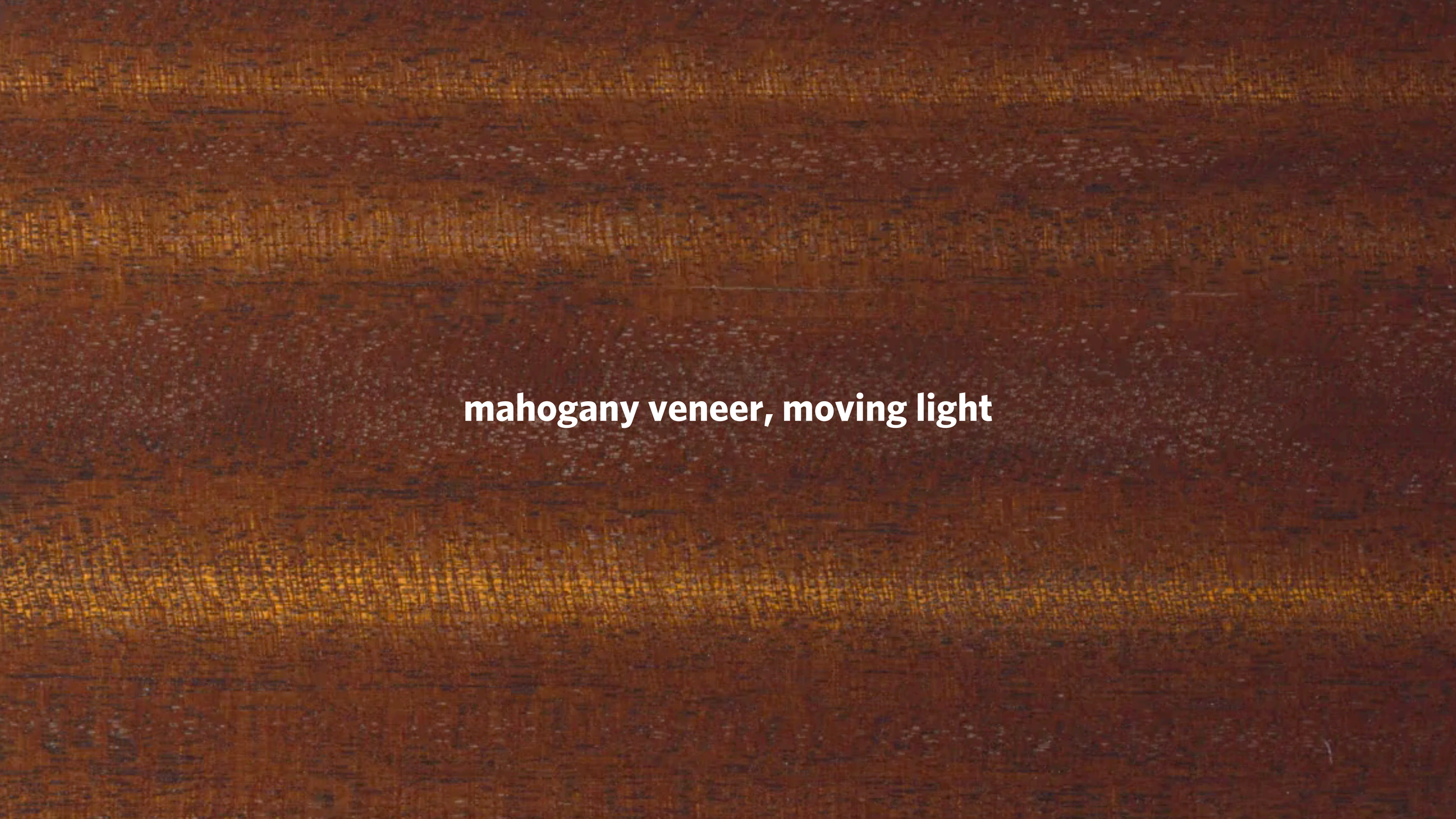


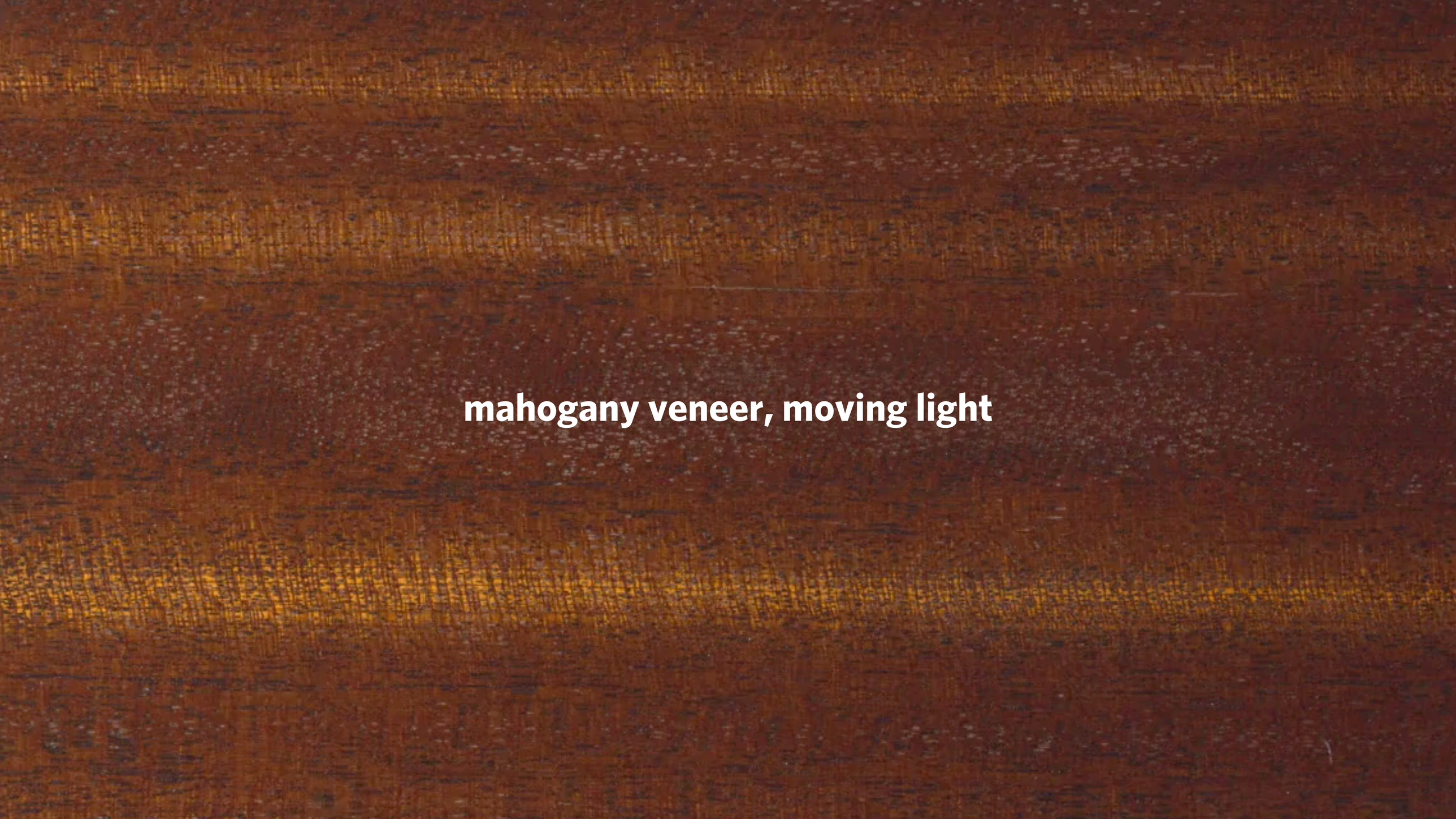

HENRIK WANN JENSEN 2000

Henrik Wann Jensen



[Jakob et al. SIGGRAPH 2014]


mahogany veneer, moving light


mahogany veneer, moving light


Valdese Weavers

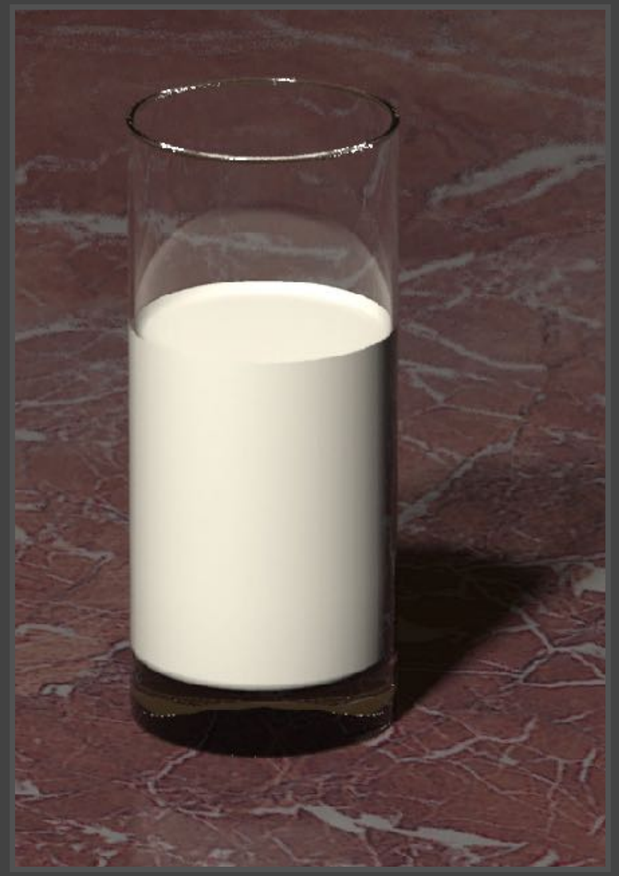

Wikimedia Commons | Pschemp

volume optics
light reflection from translucent materials

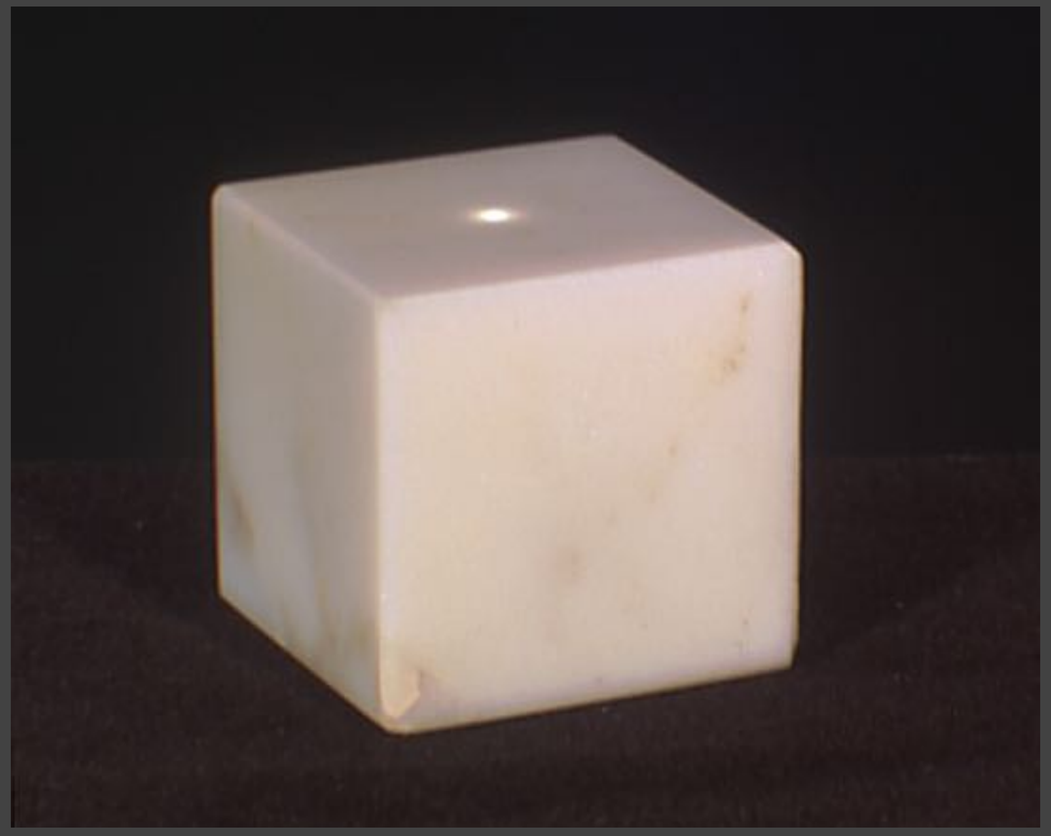
volume optics
light reflection from translucent materials

Henrik Wann Jensen, Stephen R. Marschner, Marc Levoy, and Pat Hanrahan.
"A Practical Model for Subsurface Light Transport." SIGGRAPH 2001.

Why do these look wrong?



Marble sample

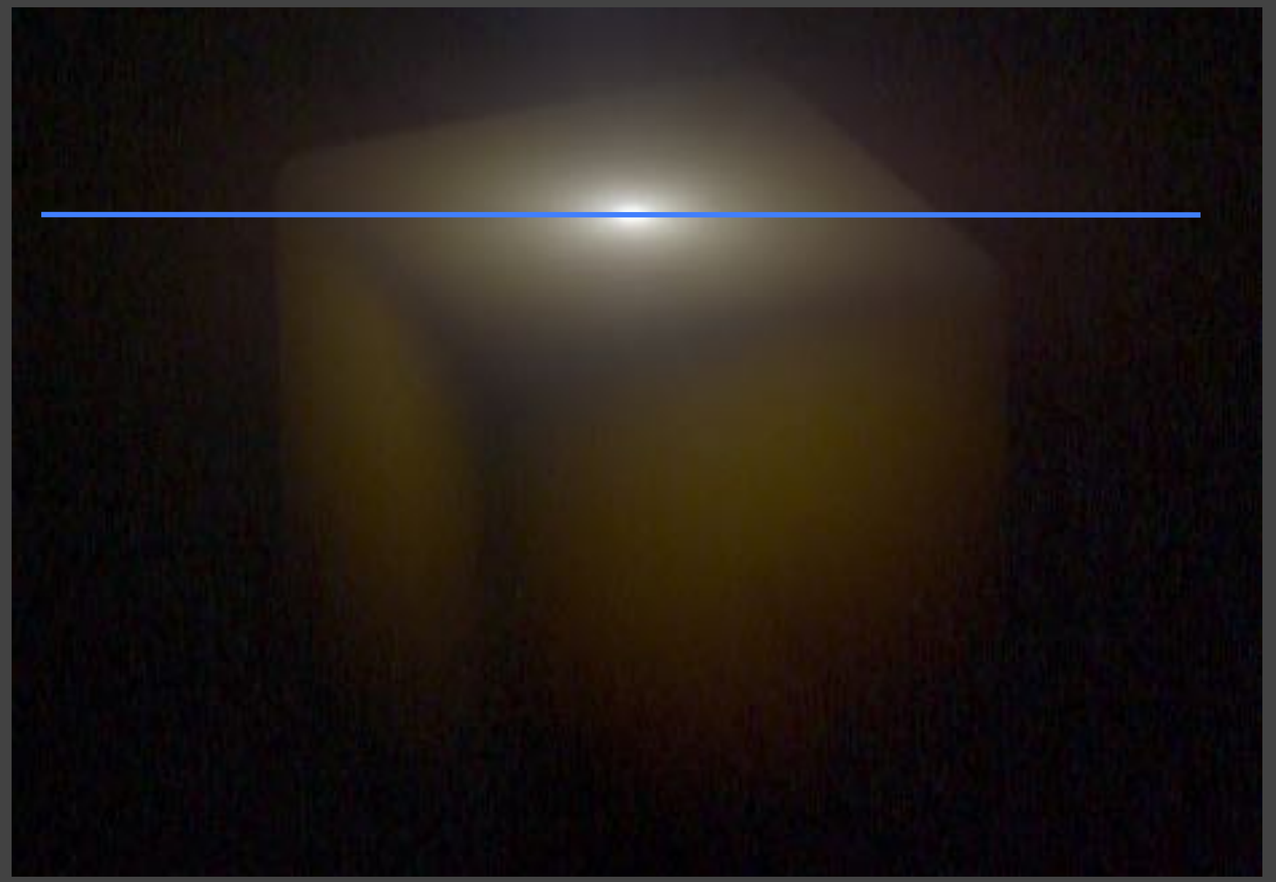


40mm cube of statuary marble

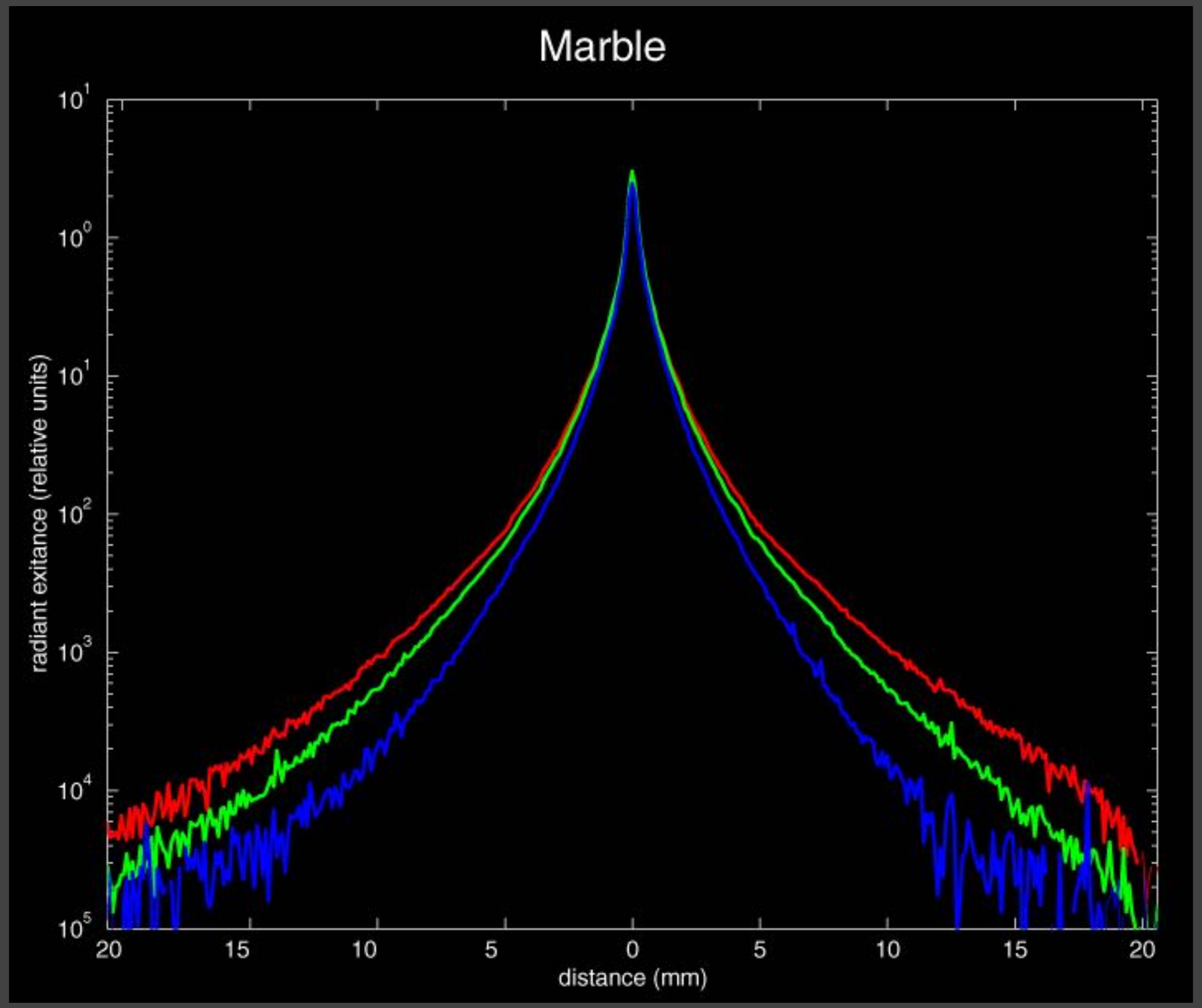
HDR photograph

(log scaled image)

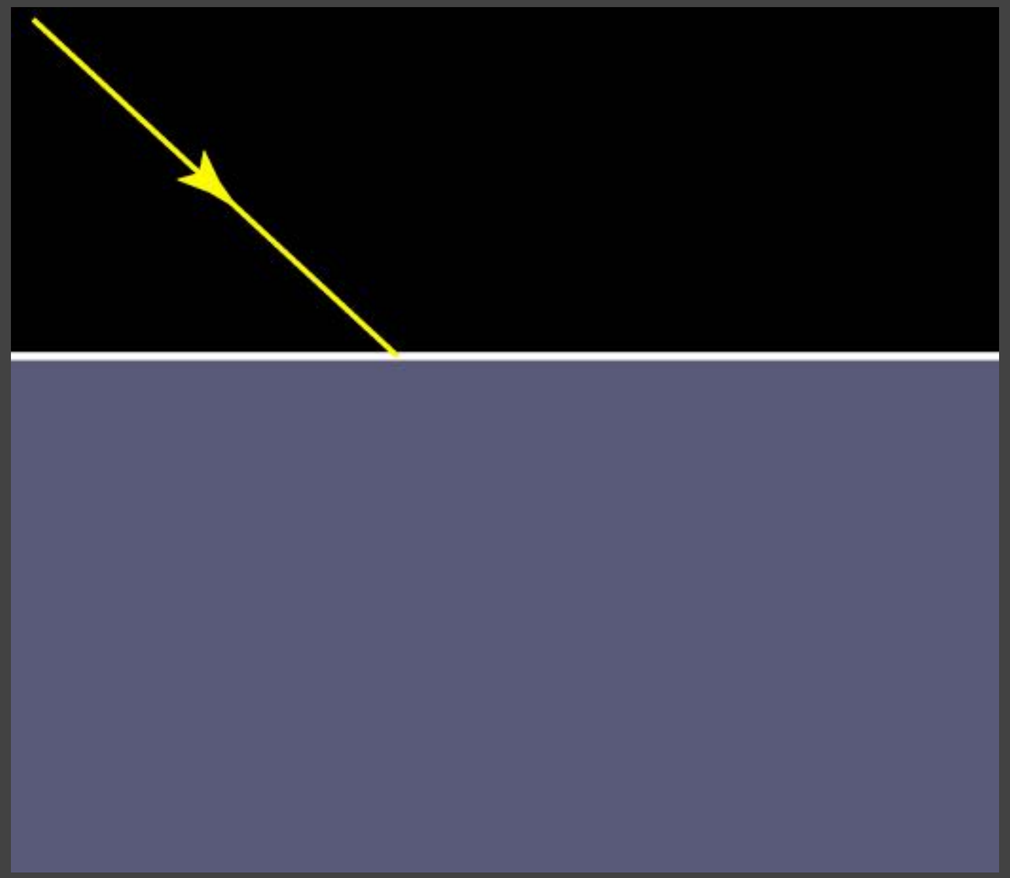
HDR photograph



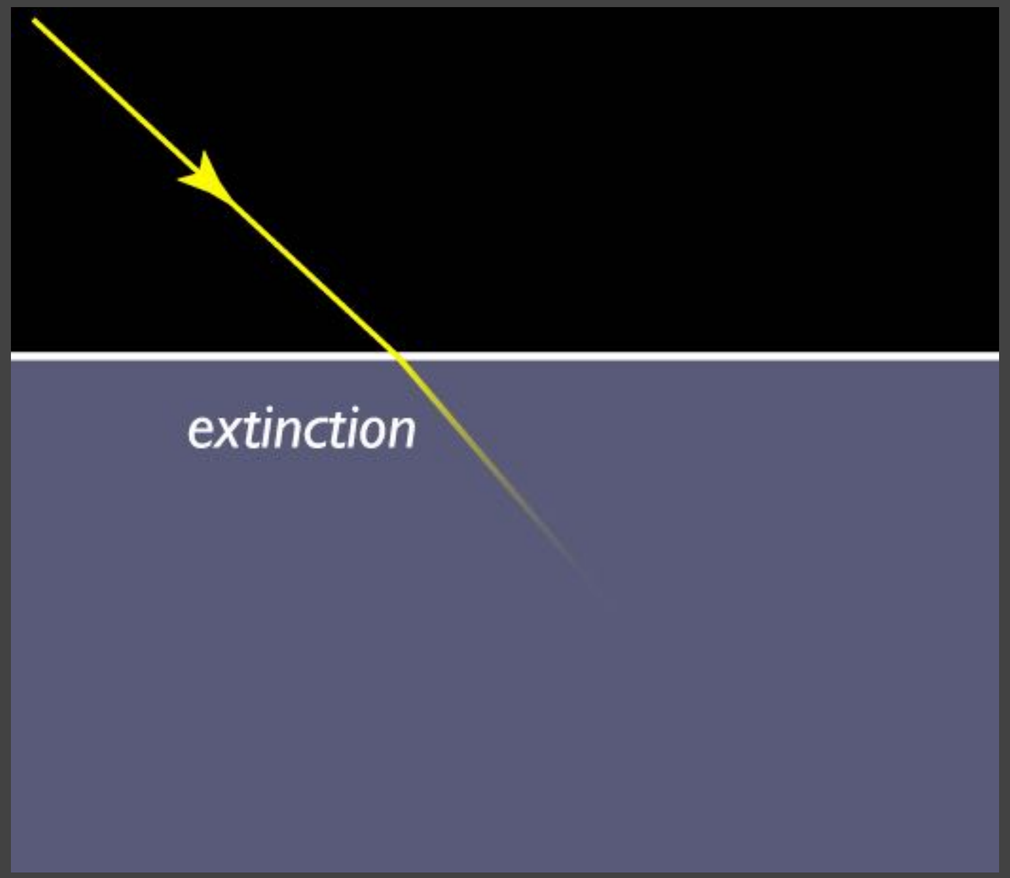
(log scaled image)


Marble
radiant exitance (relative units)
10^1
10^0
10^1
10^2
10^3
10^4
10^5
20
15
10
5
0
5
10
15
20
distance (mm)

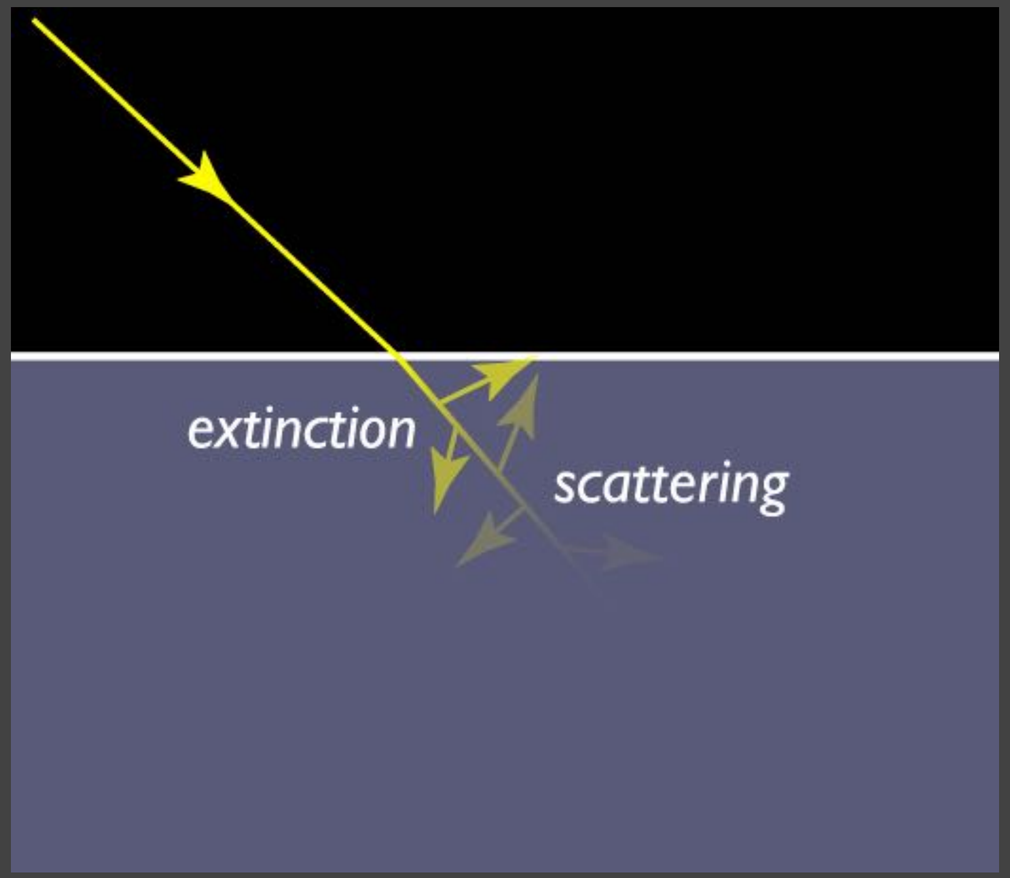
Subsurface volume scattering



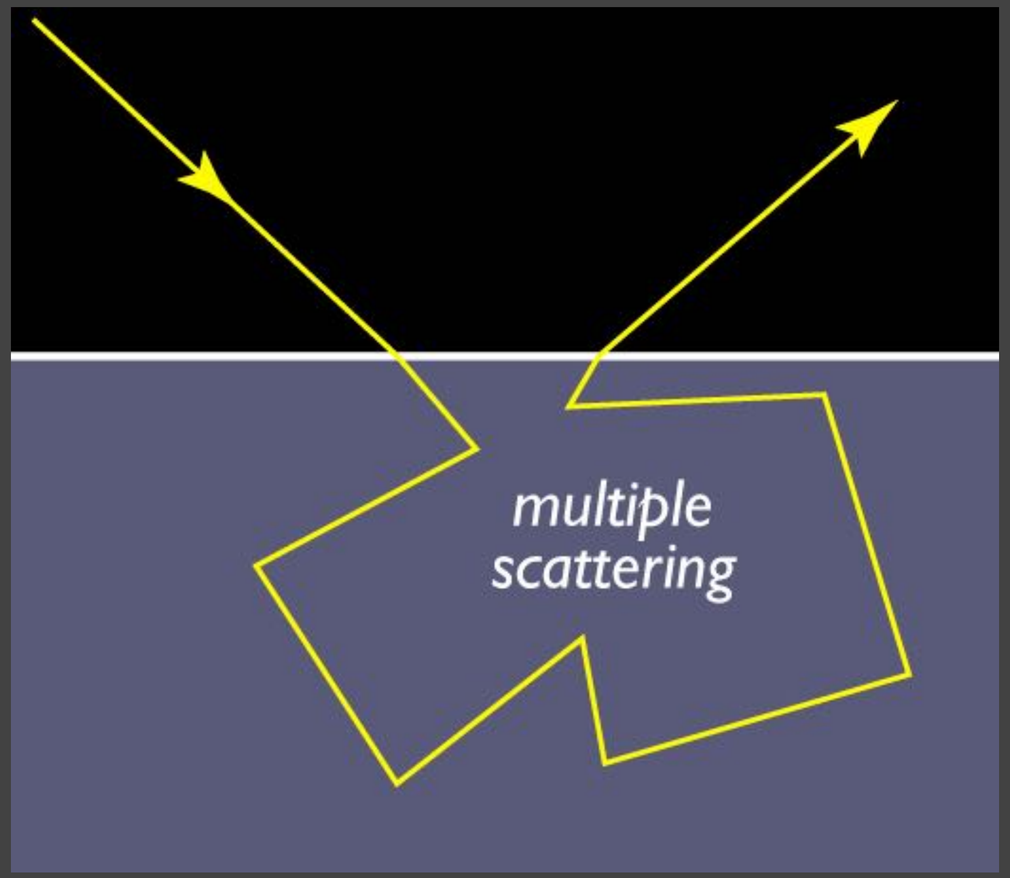
Subsurface volume scattering



Subsurface volume scattering

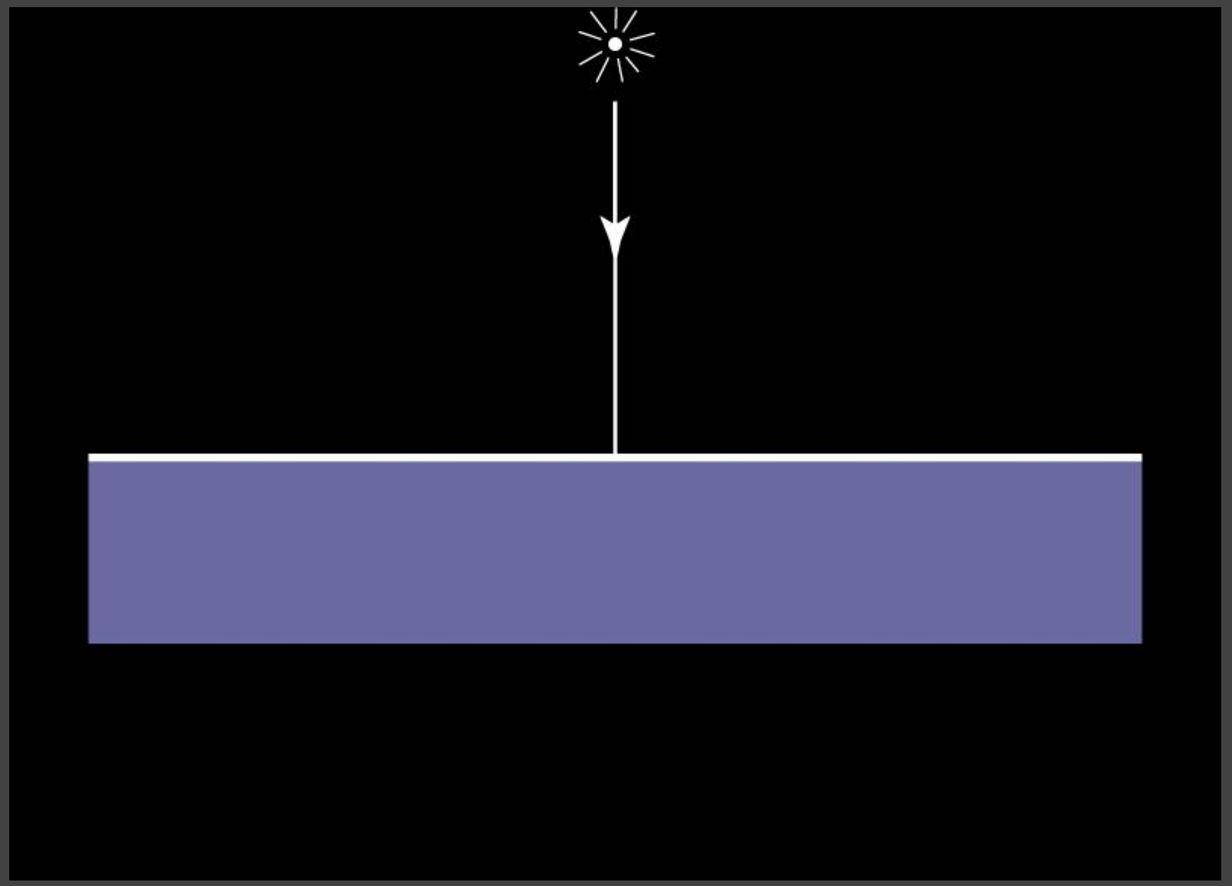


Subsurface volume scattering

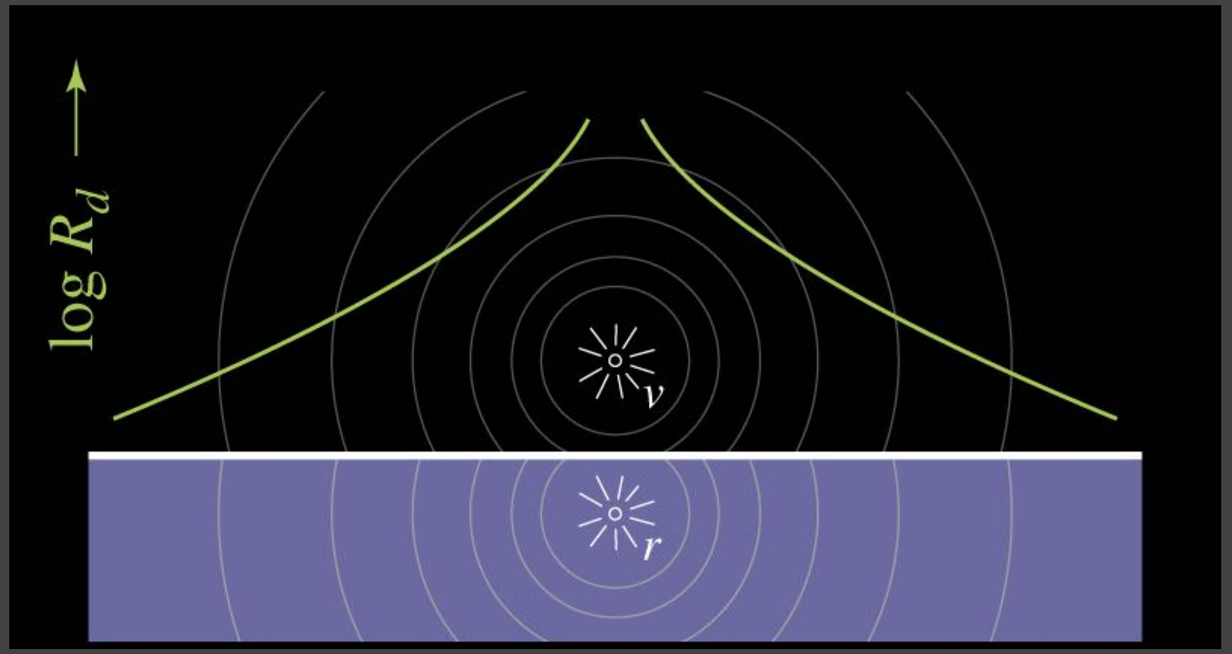


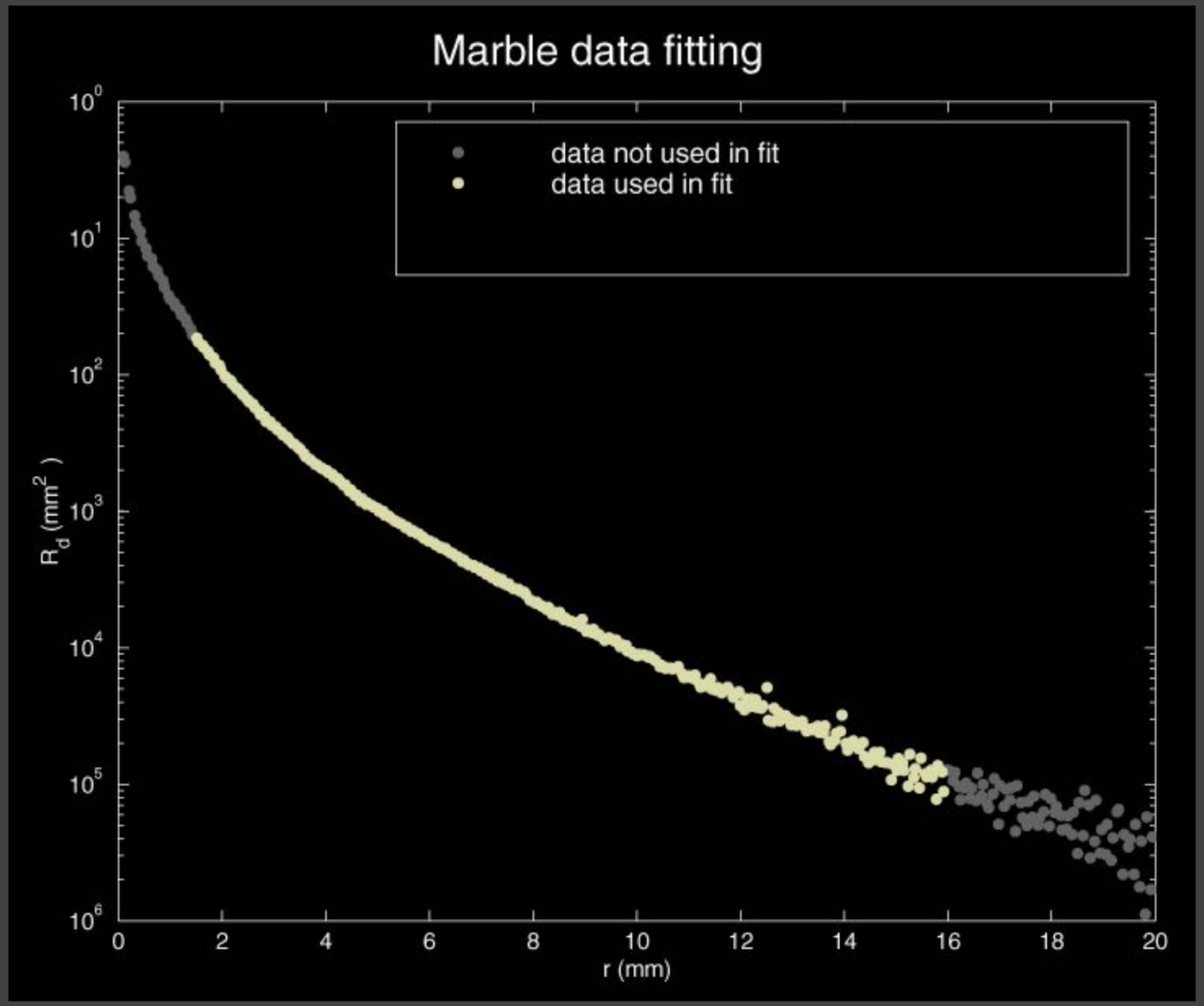
Light diffusion

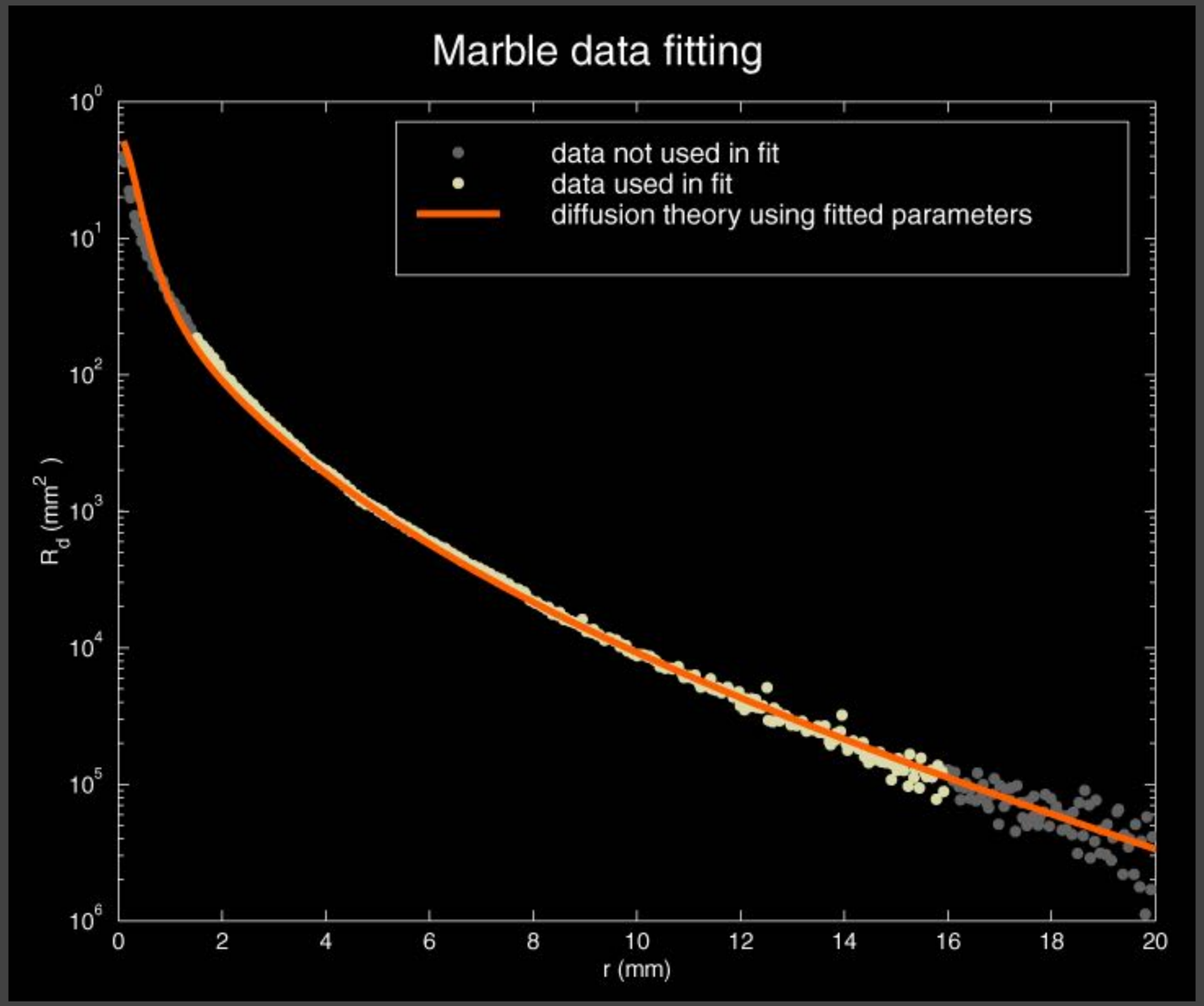
Diffusion approximation



Diffusion approximation



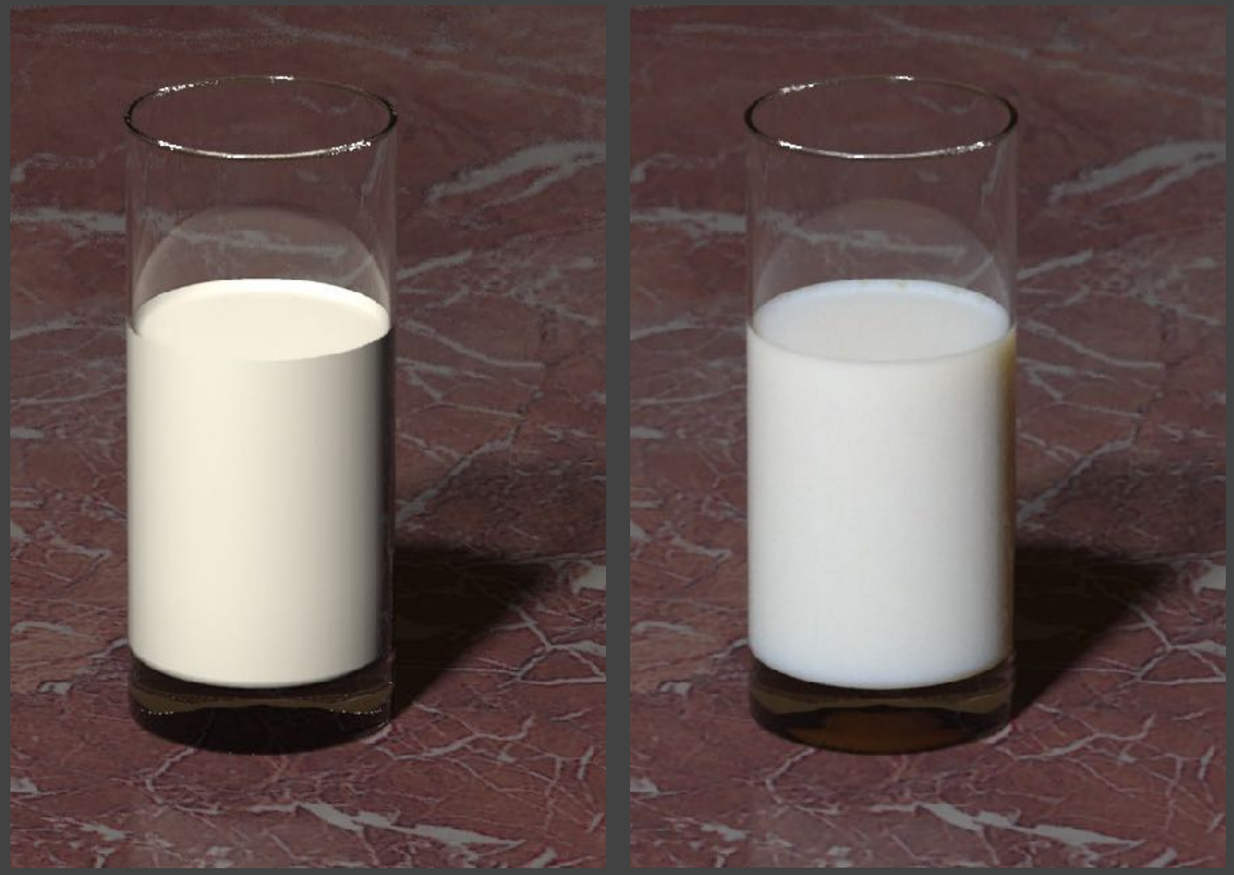

Marble data fitting
data not used in fit
data used in fit
10^0
10^1
10^2
10^3
10^4
10^5
10^6
R_d (mm^2)
0
2
4
6
8
10
12
14
16
18
20
r (mm)


Marble data fitting
data not used in fit
data used in fit
diffusion theory using fitted parameters
10^0
10^1
10^2
10^3
10^4
10^5
10^6
R_d (mm^2)
0
2
4
6
8
10
12
14
16
18
20
r (mm)

Results: milk

Diffuse “milk”

Results: milk



Diffuse “milk”

Skim milk

Results: milk

Diffuse “milk”

Skim milk

Whole milk

Results: skin

opaque skin

translucent skin

The Two Towers (2002)

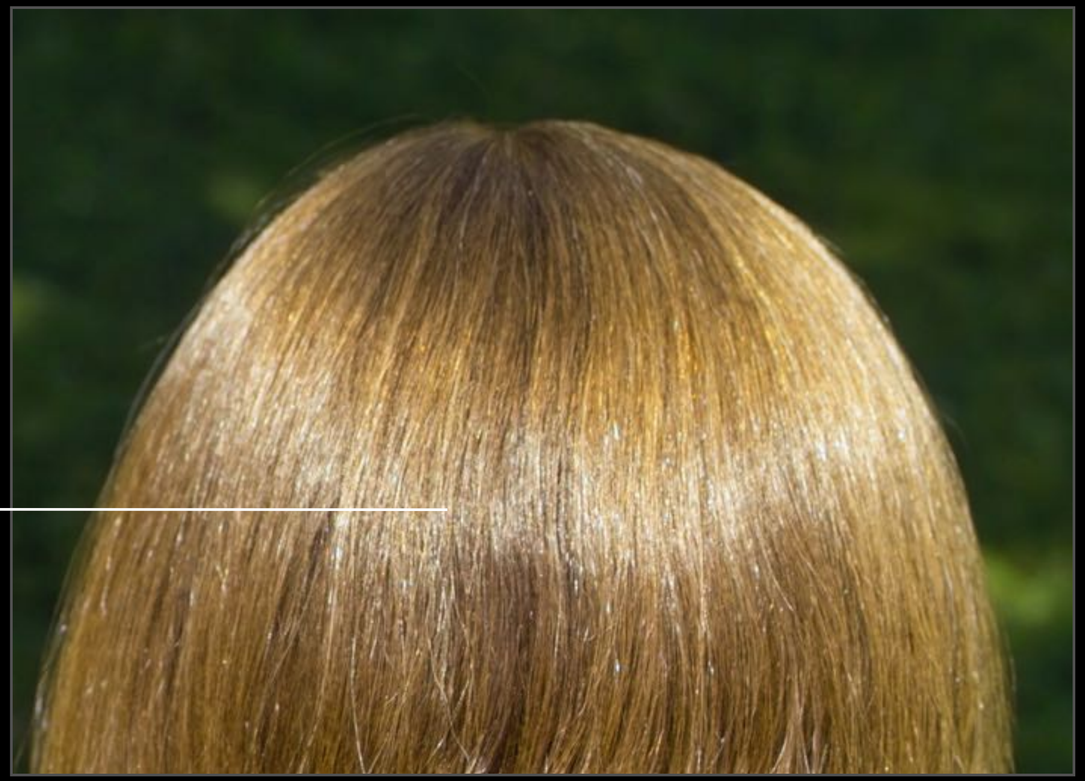
hair optics

scattering from human hair fibers

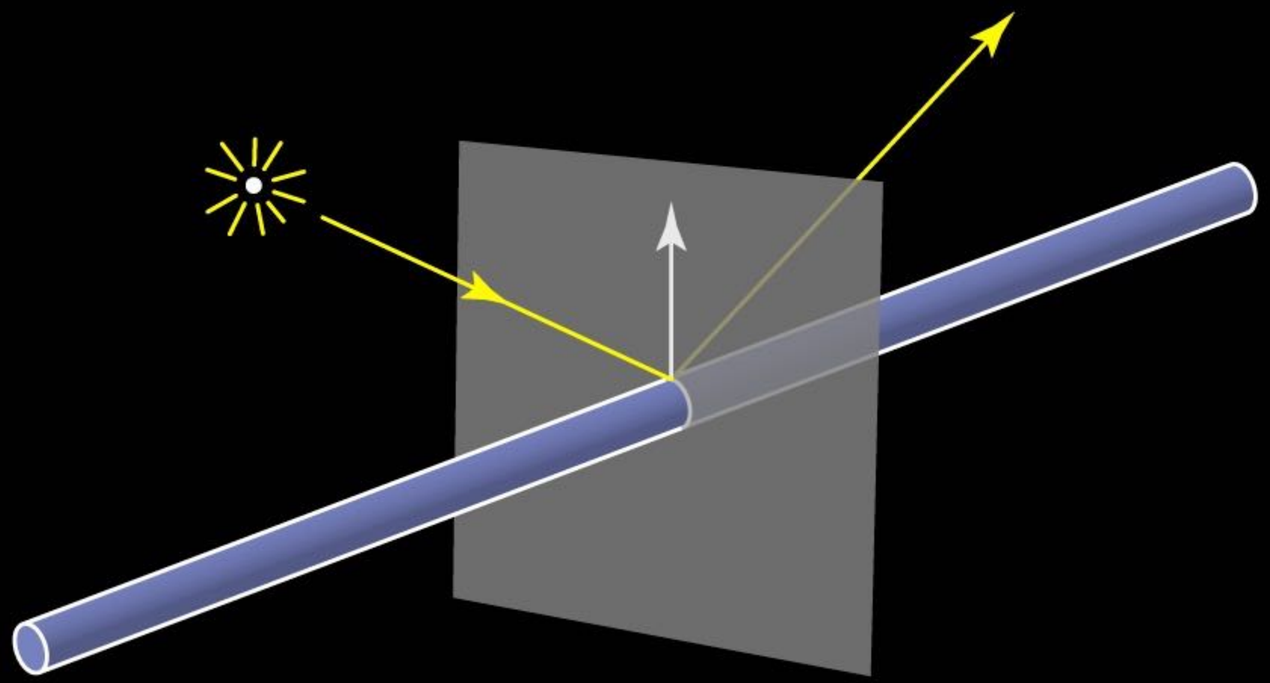
hair optics
scattering from human hair fibers

Stephen R. Marschner, Henrik Wann Jensen, Mike Cammarano, Steve Worley, and Pat Hanrahan. “Light Scattering from Human Hair Fibers.” SIGGRAPH 2003.

Hair appearance

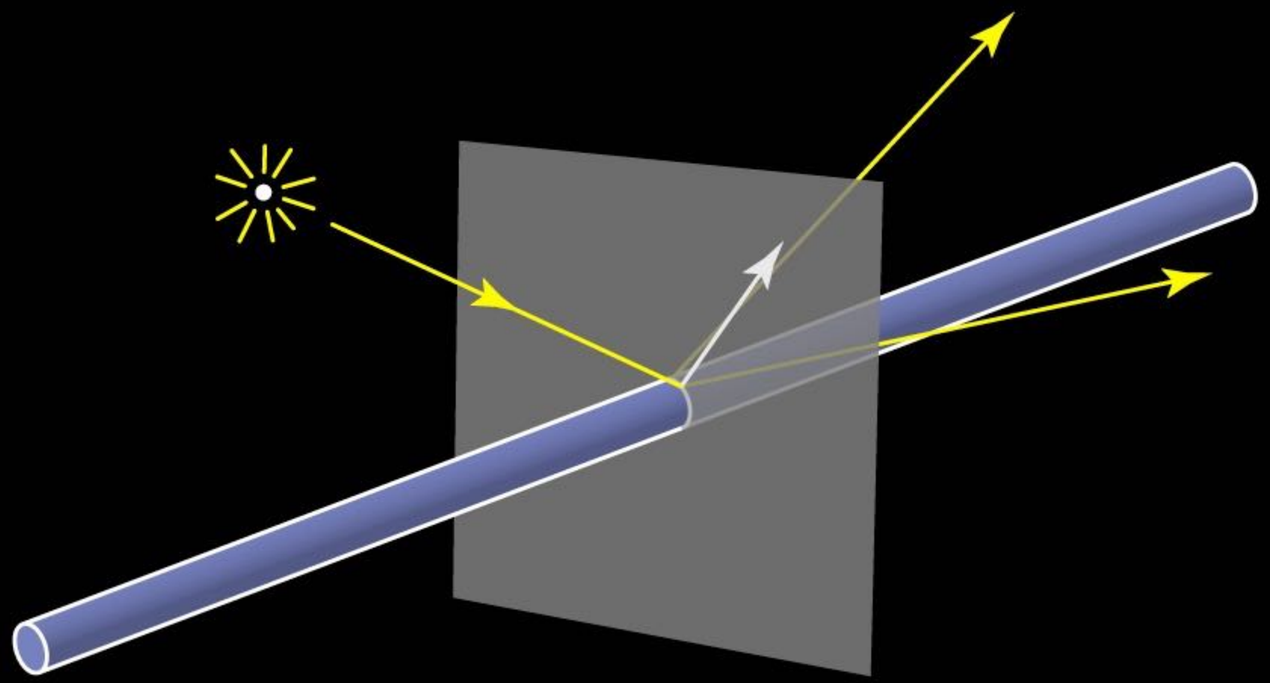


Classic hair reflection model



predicts a single, white highlight

Classic hair reflection model



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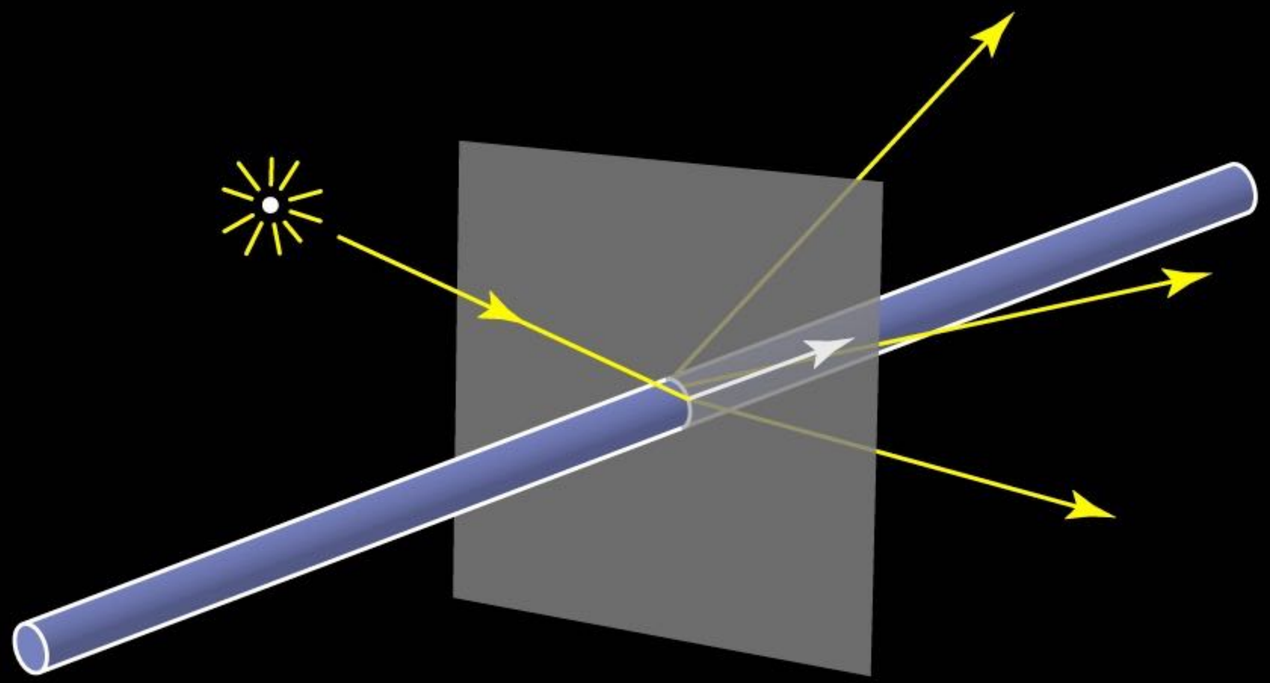

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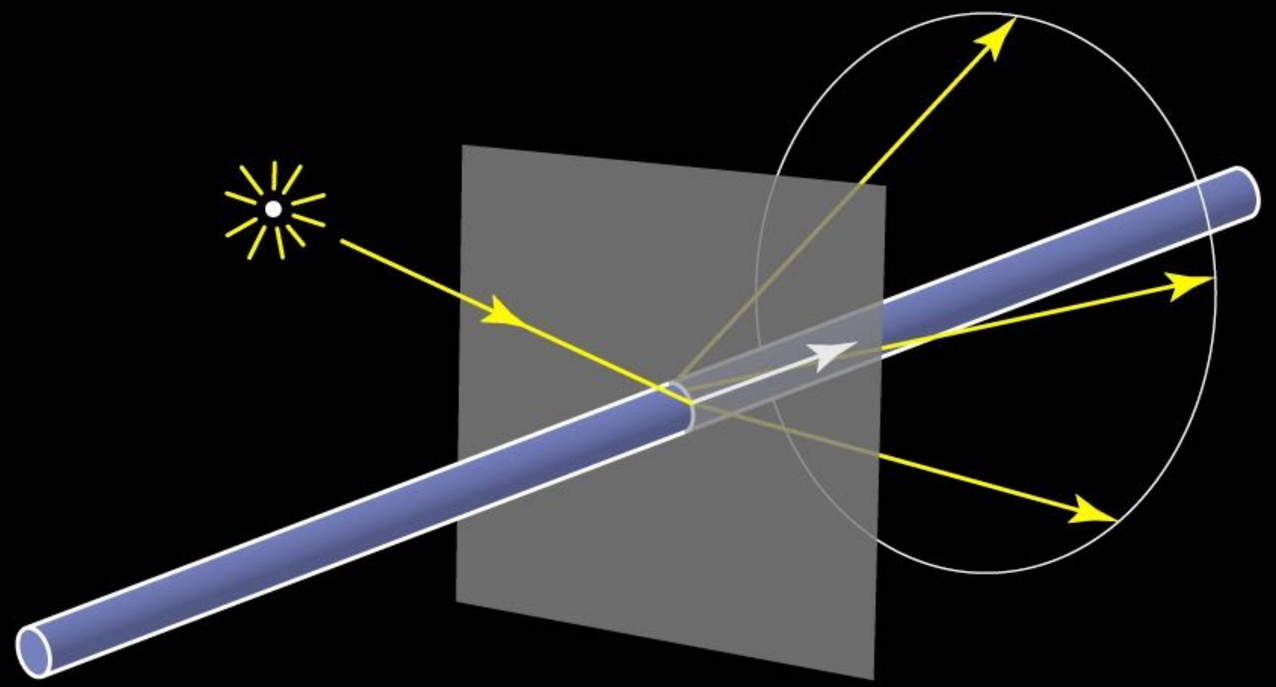

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Hair appearance

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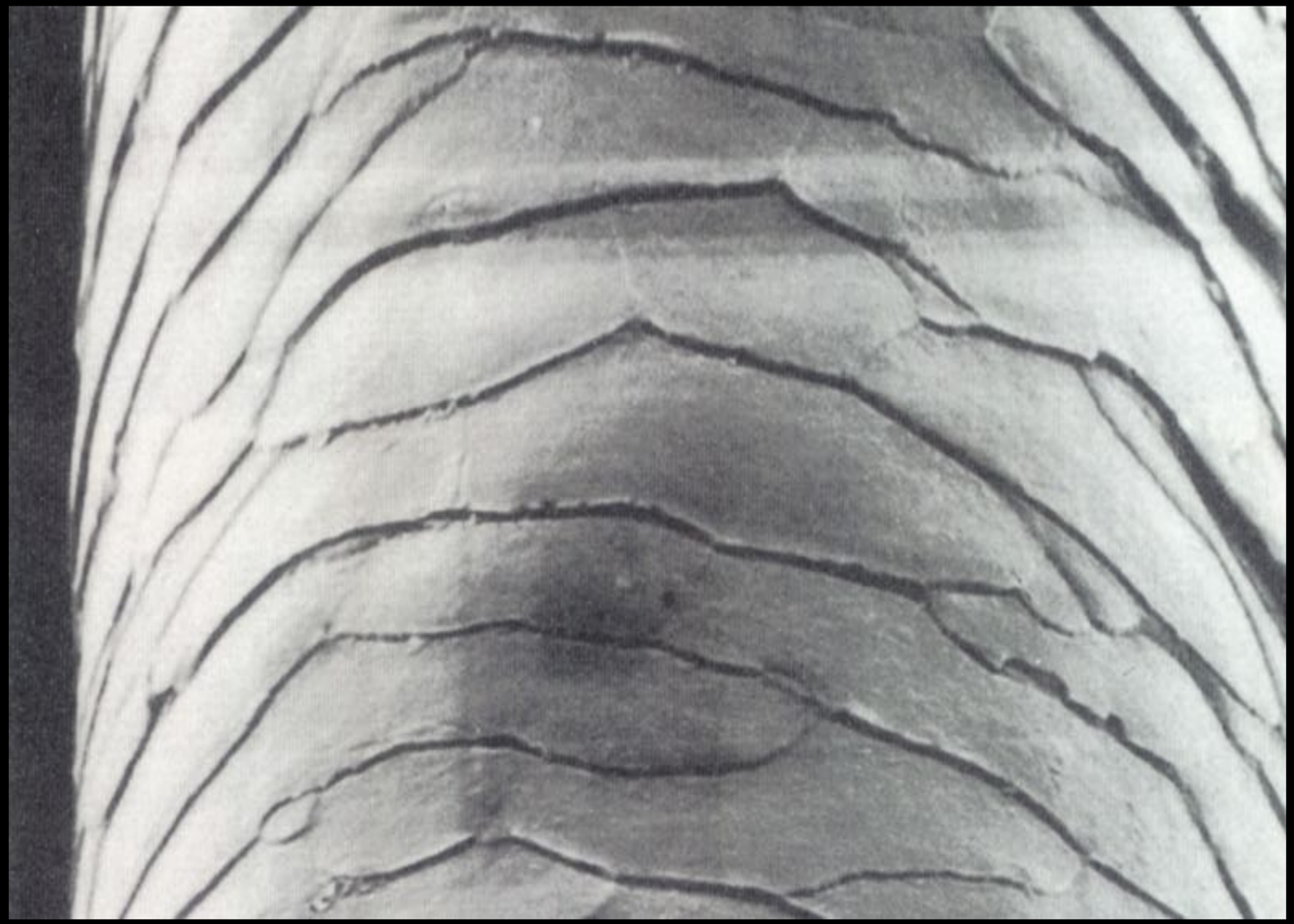
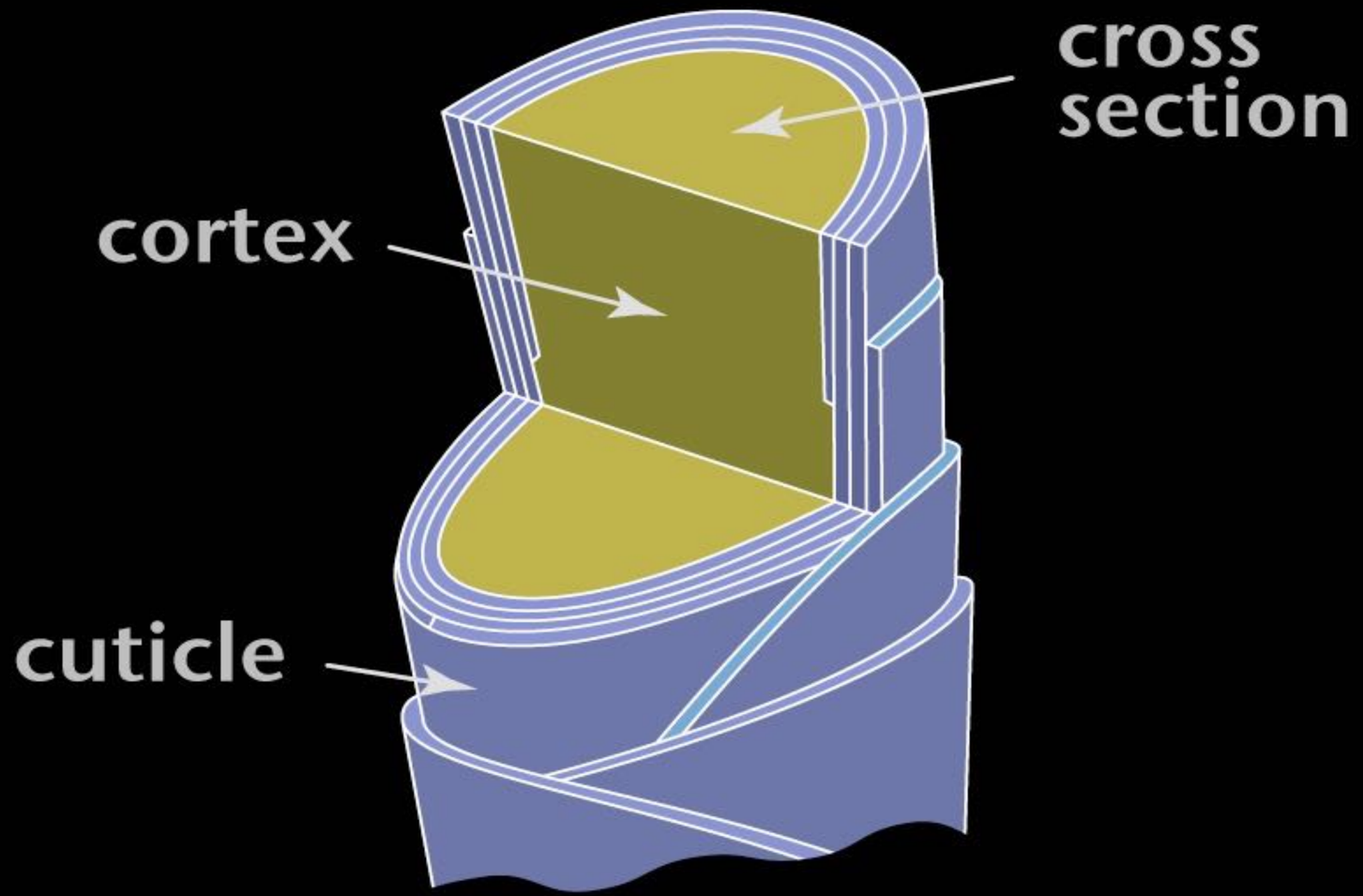
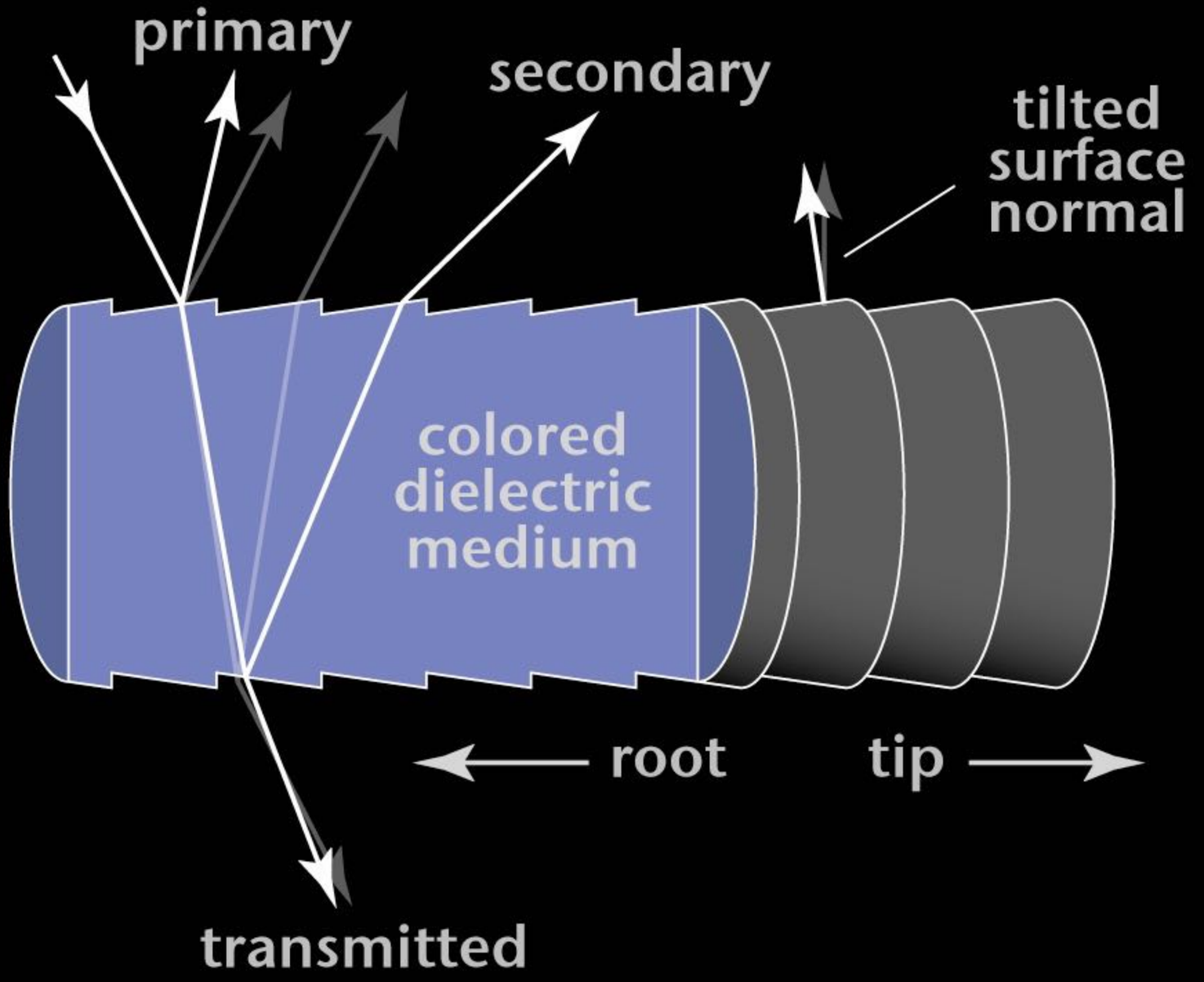
Hair appearance



[Robbins 1994]



(after [Robbins 1994])


primary
secondary
tilted
surface
normal
colored
dielectric
medium
root
tip
transmitted

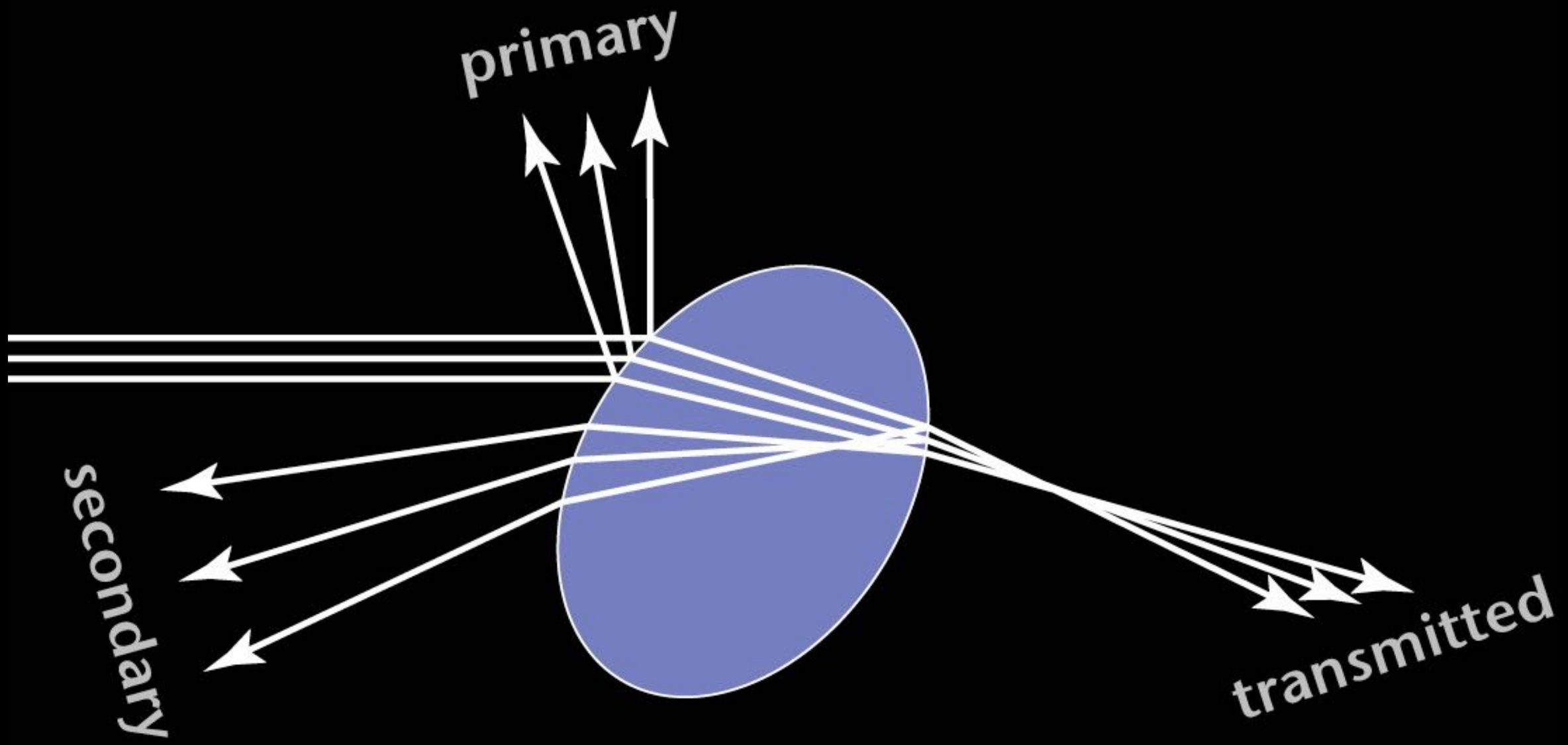
secondary

primary

secondary

primary

glints
(secondary)


primary
secondary
transmitted

King Kong (2005) | visual effects: Weta Digital

A Practical and Controllable Hair and Fur Model for Production Path Tracing
Matt Jen-Yuan Chiang, Benedikt Bitterli, Chuck Tappan, Brent Burley
Eurographics Symposium on Rendering, 2016

wood optics
reflection from finished wood surfaces

wood optics
reflection from finished wood surfaces

Stephen R. Marschner, Stephen H. Westin, Adam Arbree, and Jonathan T. Moon.
"Measuring and Modeling the Appearance of Finished Wood." SIGGRAPH 2005.

What causes the distinctive “depth” of finished wood?

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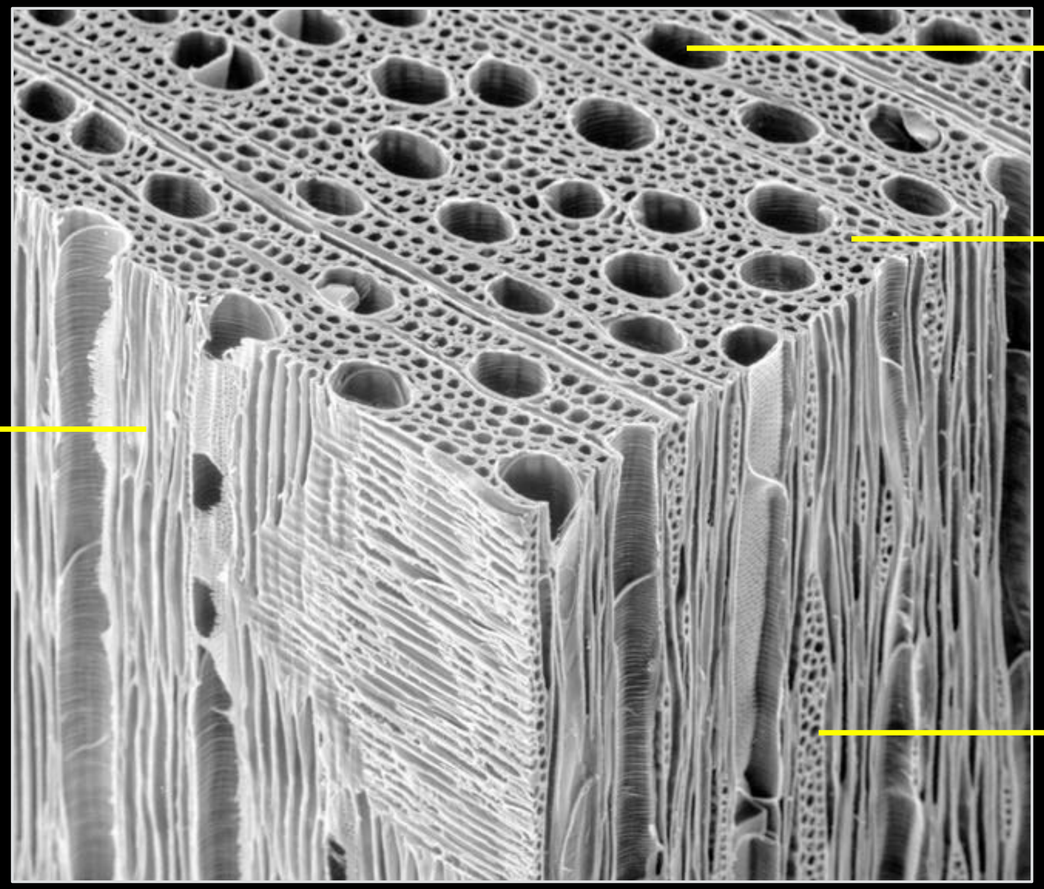


N.C. Brown Ctr. Ultrastructure Studies, Syracuse Univ.

Optically: parallel air tubes in dielectric

curly maple

video

rendering

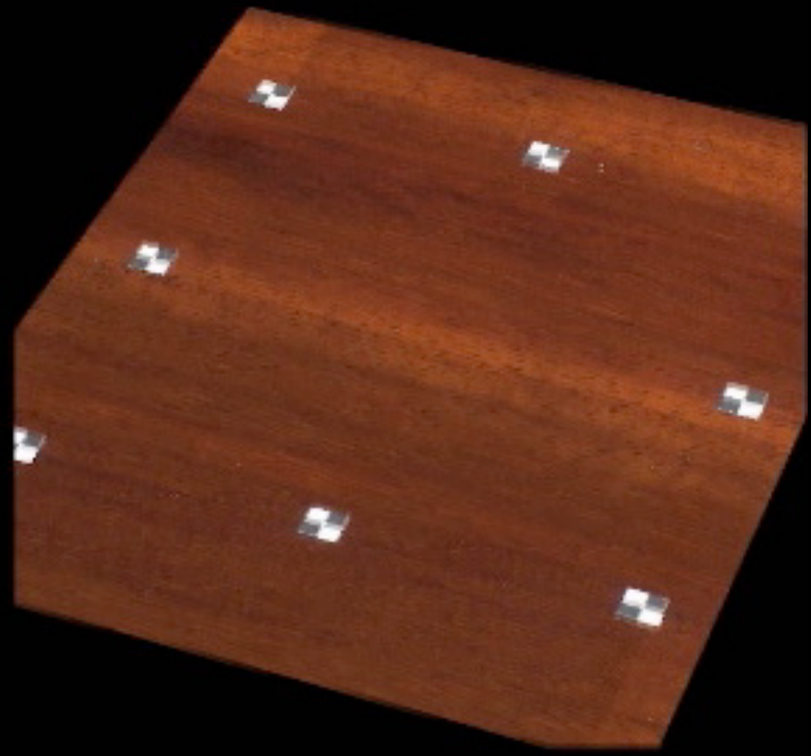
curly maple

video

rendering

padauk

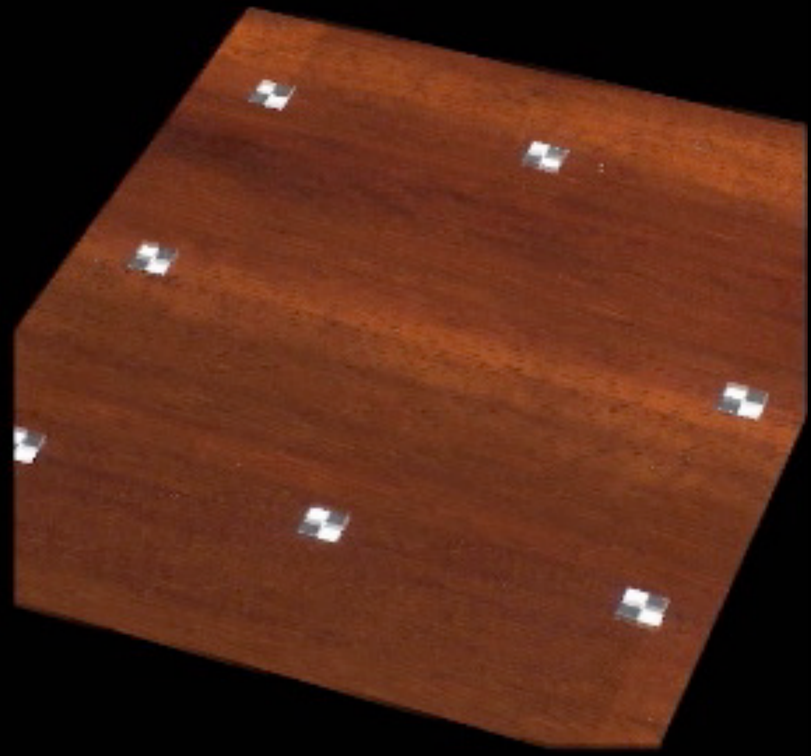
video



rendering

padauk

video



rendering

cloth mechanics
yarn-based cloth modeling

cloth mechanics
yarn-based cloth modeling

Jonathan Kaldor, Doug James, and Steve Marschner. “Simulating Knitted Cloth at the Yarn Level.” SIGGRAPH 2008

Jonathan Kaldor, Doug James, and Steve Marschner. “Efficient Yarn-based Cloth with Adaptive Contact Linearization.” SIGGRAPH 2010

Cem Yuksel, Jonathan Kaldor, Doug James, and Steve Marschner. “Stitch Meshes for Modeling Knitted Clothing with Yarn-level Detail.” SIGGRAPH 2012

Why Yarns Are Important

- Cloth is not a continuum
  - Discrete yarn behavior drives overall cloth behavior
- Particularly evident in knit fabrics

http://toveb.typepad.com/

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Structure-Dependent Behavior

Garter Stockinette Rib

Yarn Properties

- Thin, flexible rods, with many degrees of freedom

- Strongly resist stretching
- Weakly resist bending
- Can compress laterally
- Friction between yarns

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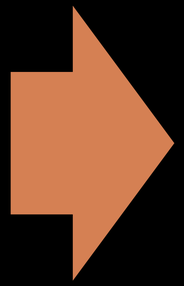

- Constrained Lagrangian dynamics

$$\mathbf{M}\ddot{\mathbf{q}} = \mathbf{f} - \nabla\mathbf{E} - \nabla\mathbf{D}$$

$$\mathbf{C}(\mathbf{q}) = \mathbf{0}$$

- Inextensibility constraints
- Bending, twisting energies
- Collision energy
- Velocity filter for damping

Modeling Dissipation

- Damp yarn-yarn contacts
- Damp non-rigid motion
  - [Müller et al. 2006]
    [Rivers and James 2007]
- Small regions: stabilizing collisions
- Large regions: damp cloth-level motion

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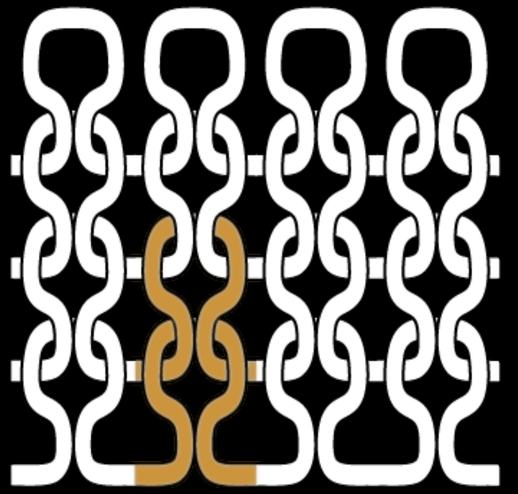
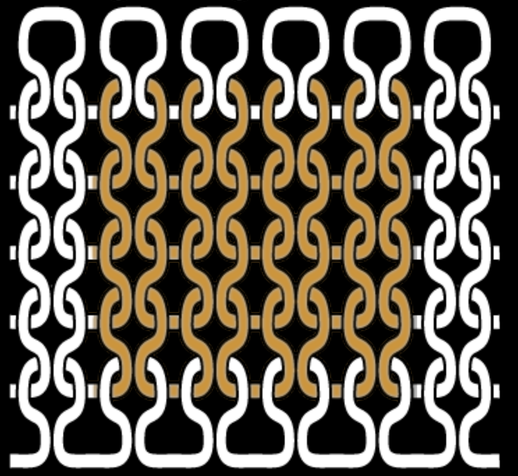


Small regions

Large regions

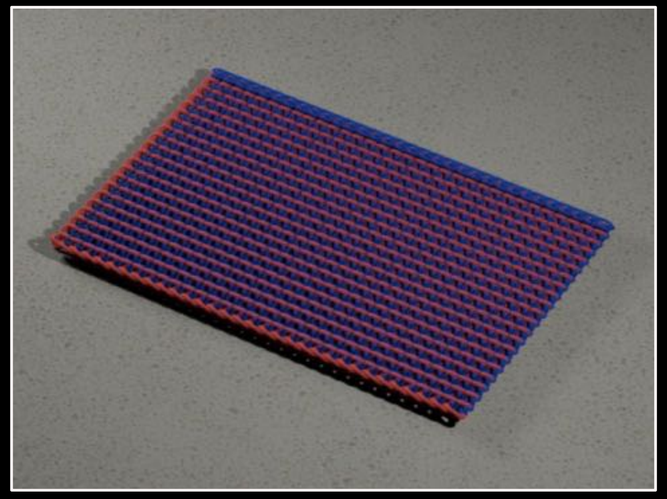


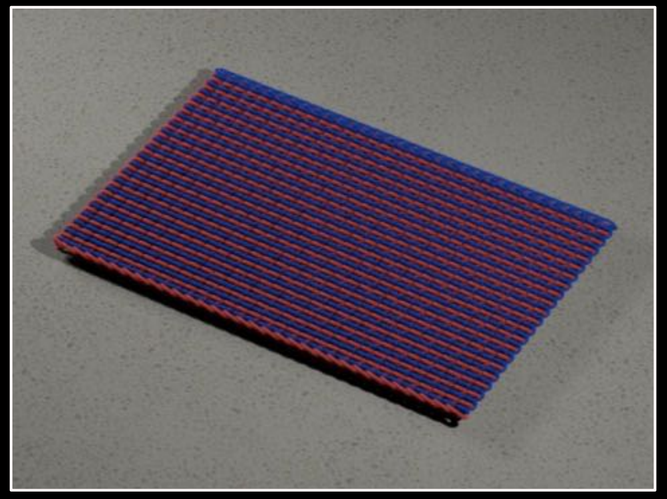
Relaxed Models

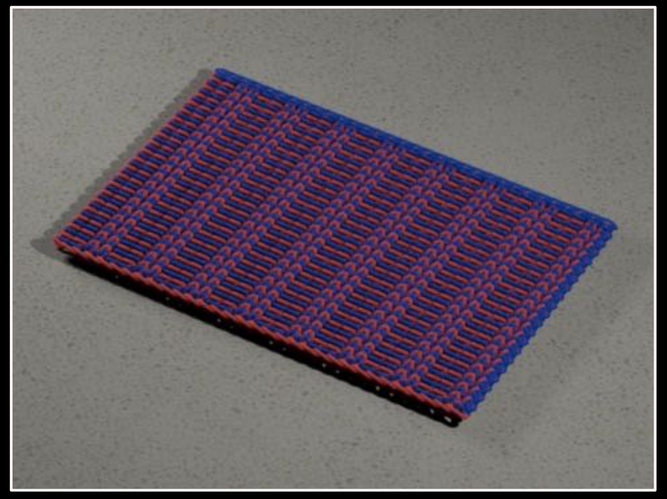
Garter

Stockinette

Rib







Relaxed Models

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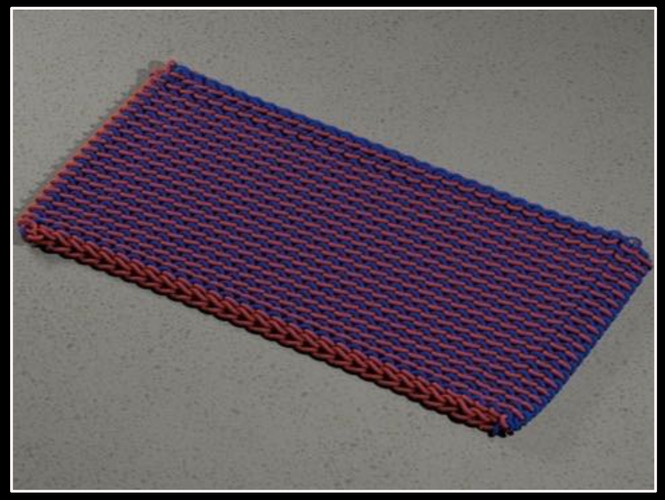
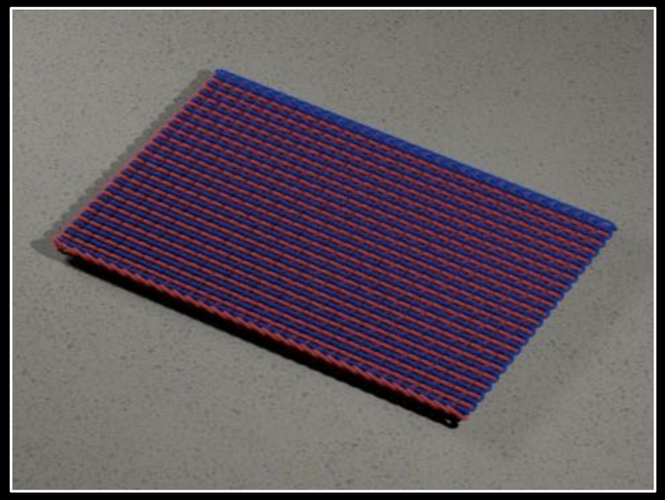
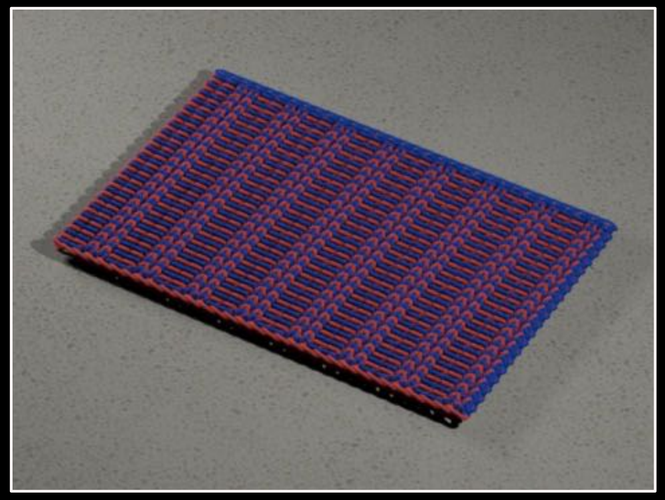




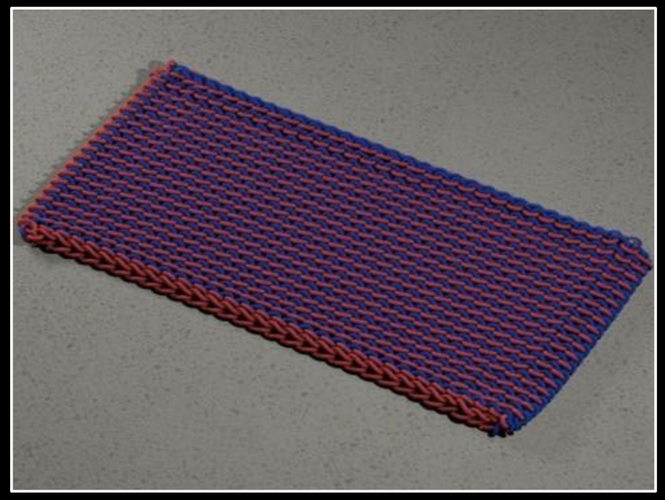


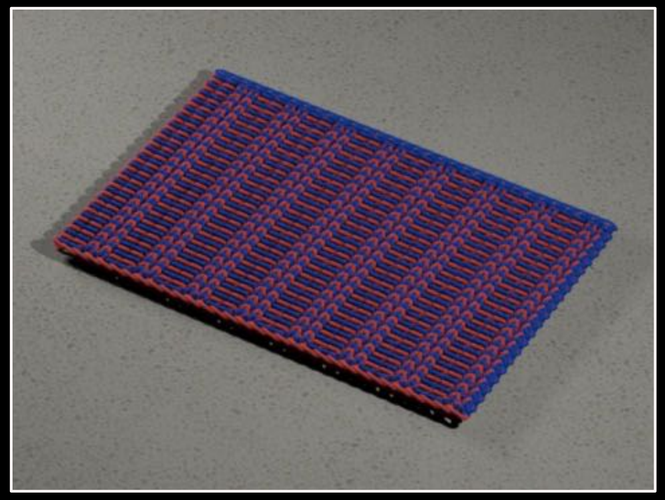
Relaxed Models

Garter

Stockinette

Rib



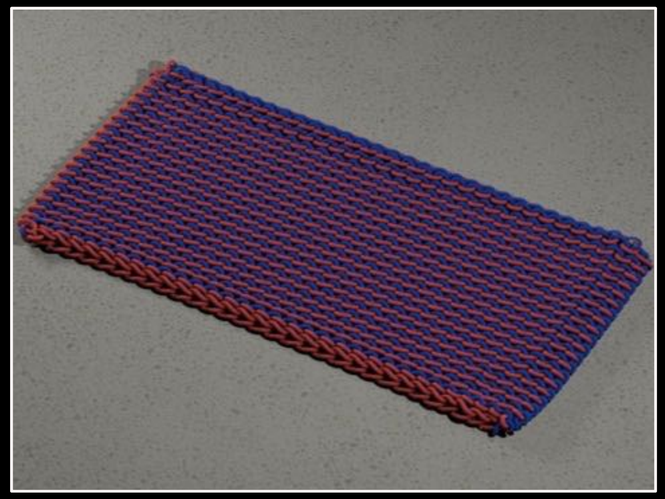


Relaxed Models

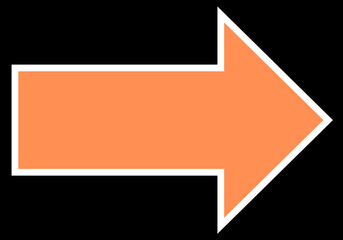
Garter

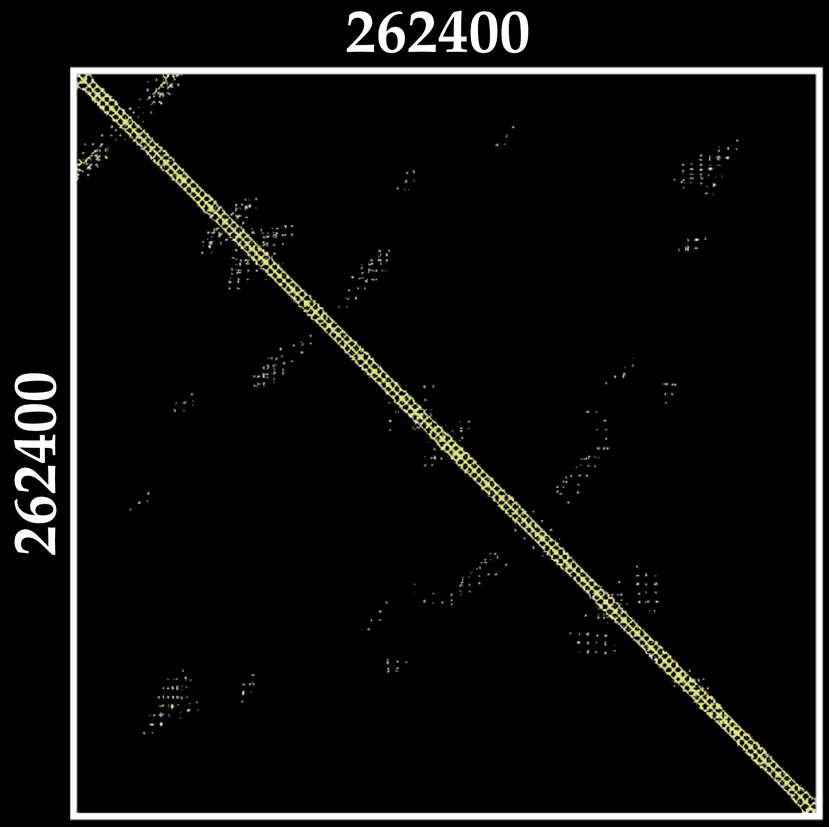
Stockinette

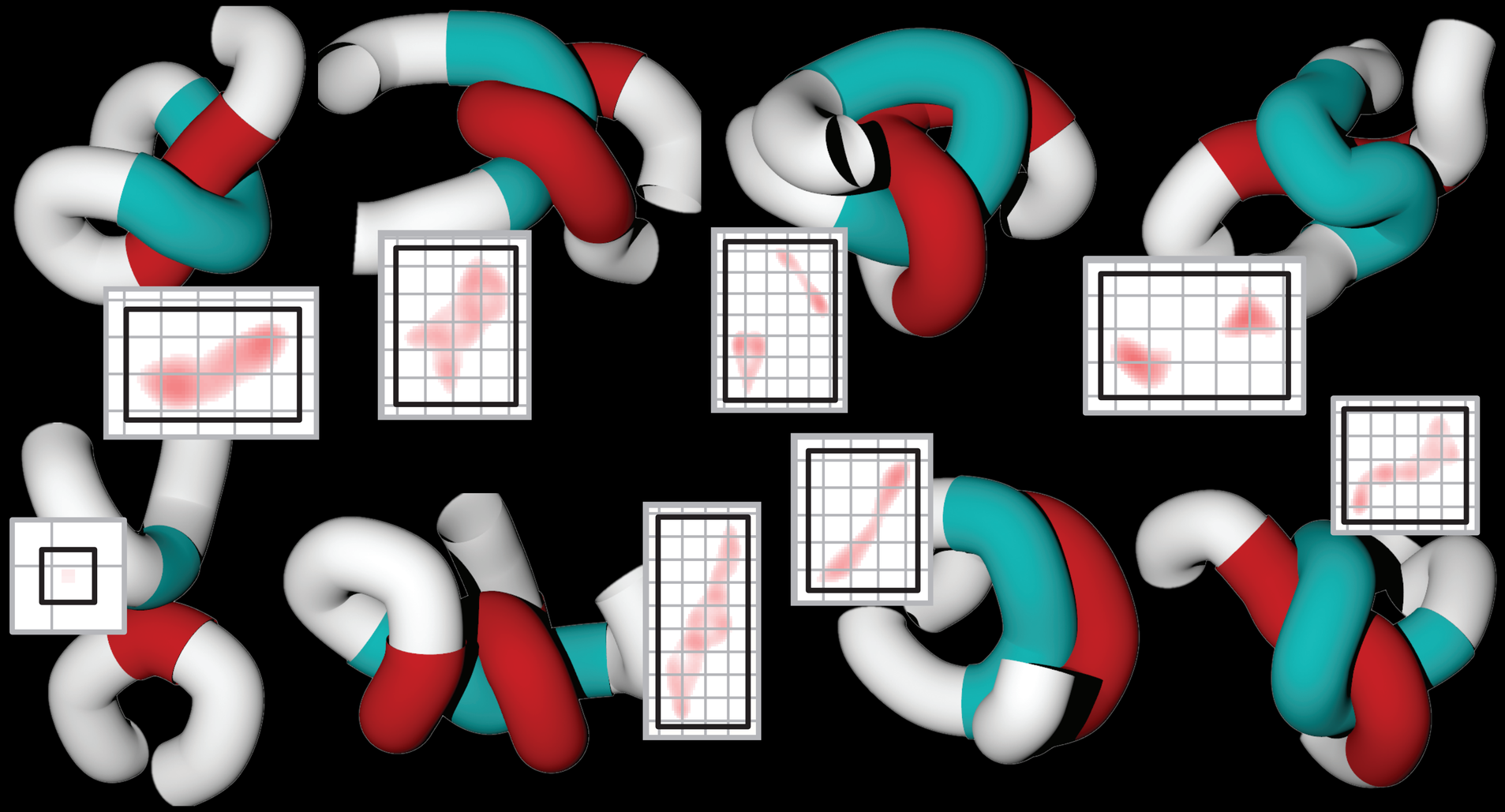
Rib

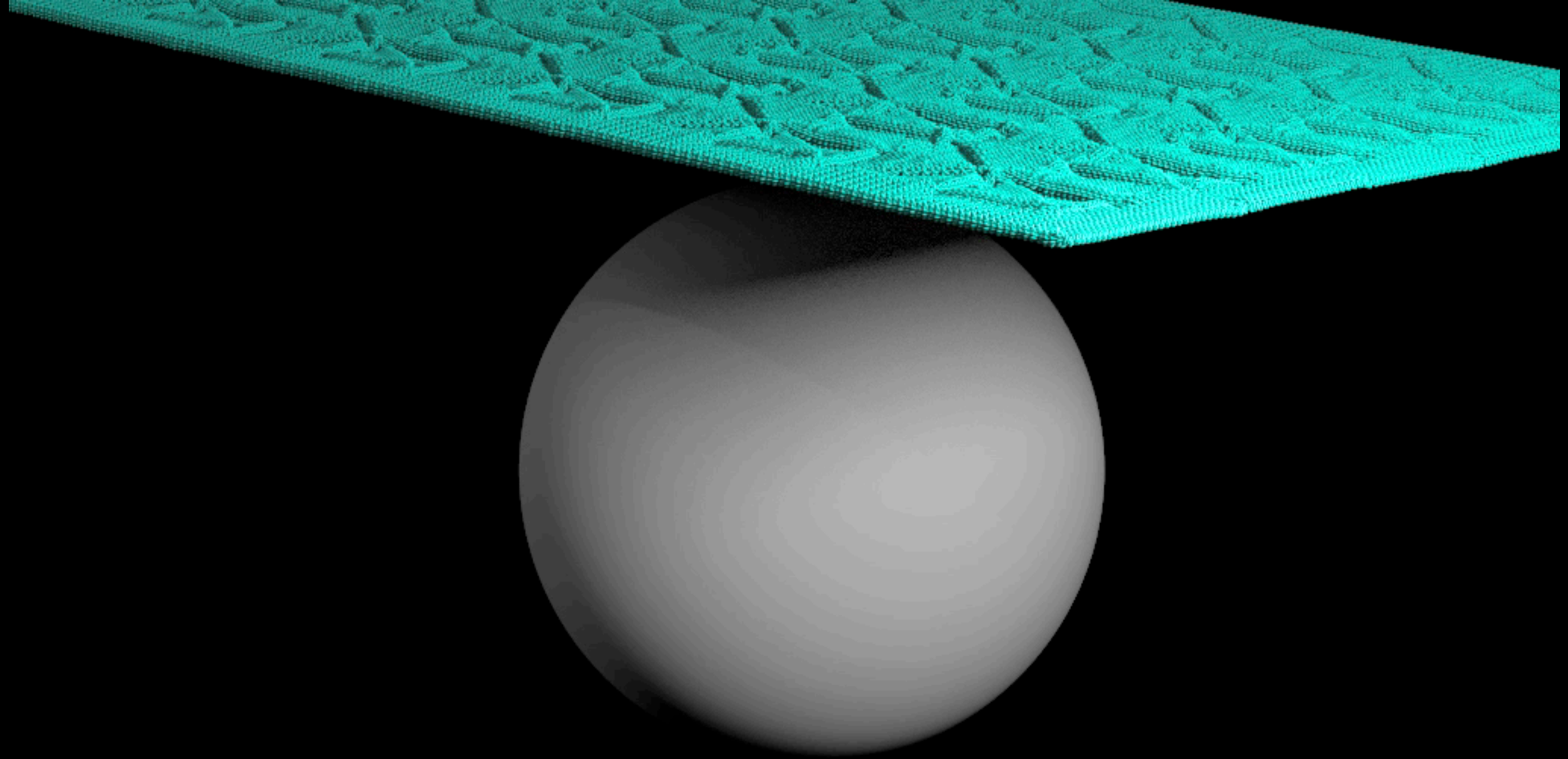


Contact Matrix



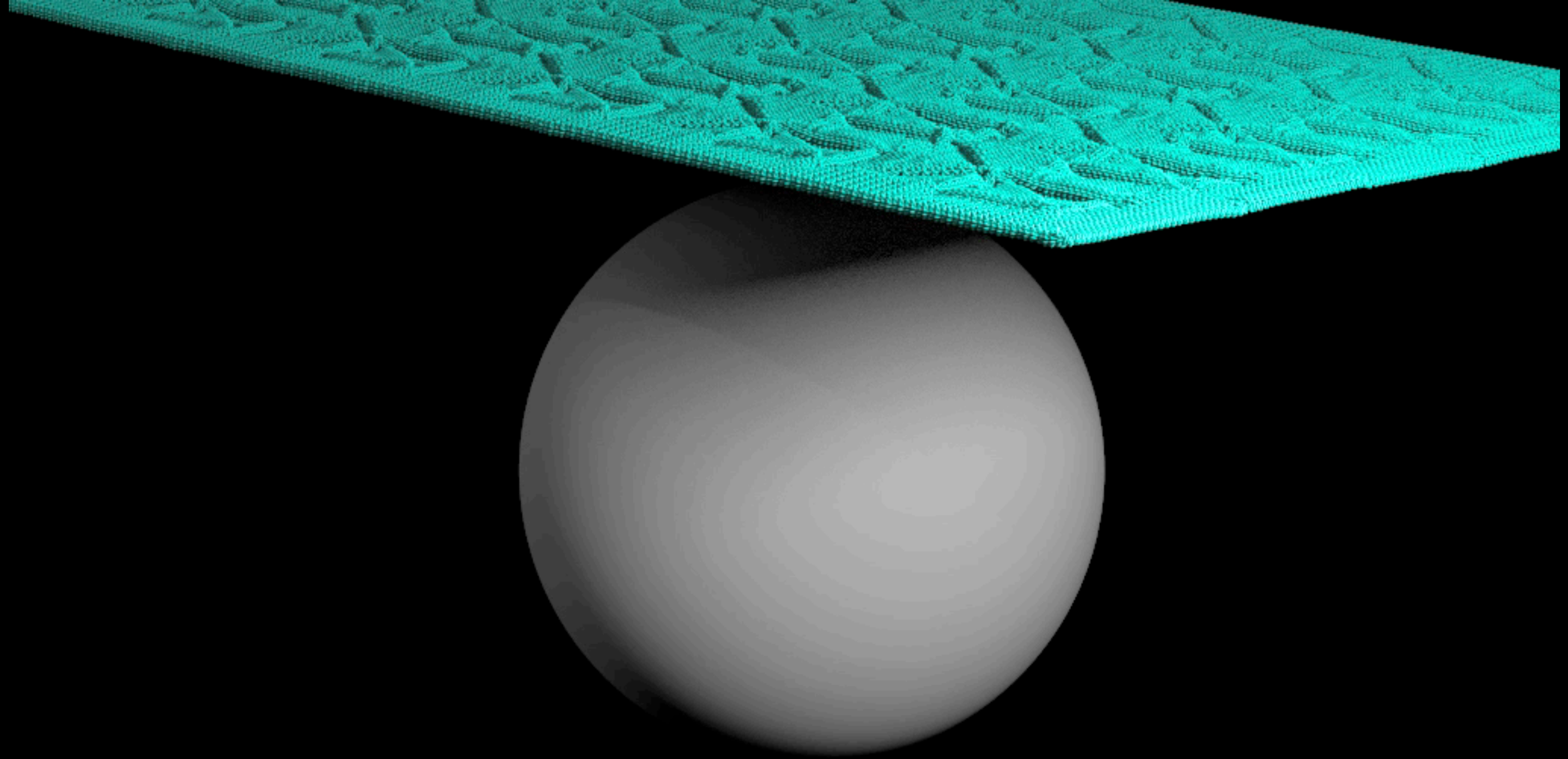






54,340 knit loops, ~365K contact sets
6.7X contact force speedup, 4.2X overall
10.5m per 1/30s frame

⅓ speed



54,340 knit loops, ~365K contact sets
6.7X contact force speedup, 4.2X overall
10.5m per 1/30s frame

⅓ speed

45,960 knit loops, ~295K contact sets
9.1X contact force speedup, 5.0X overall
8m per 1/30s frame

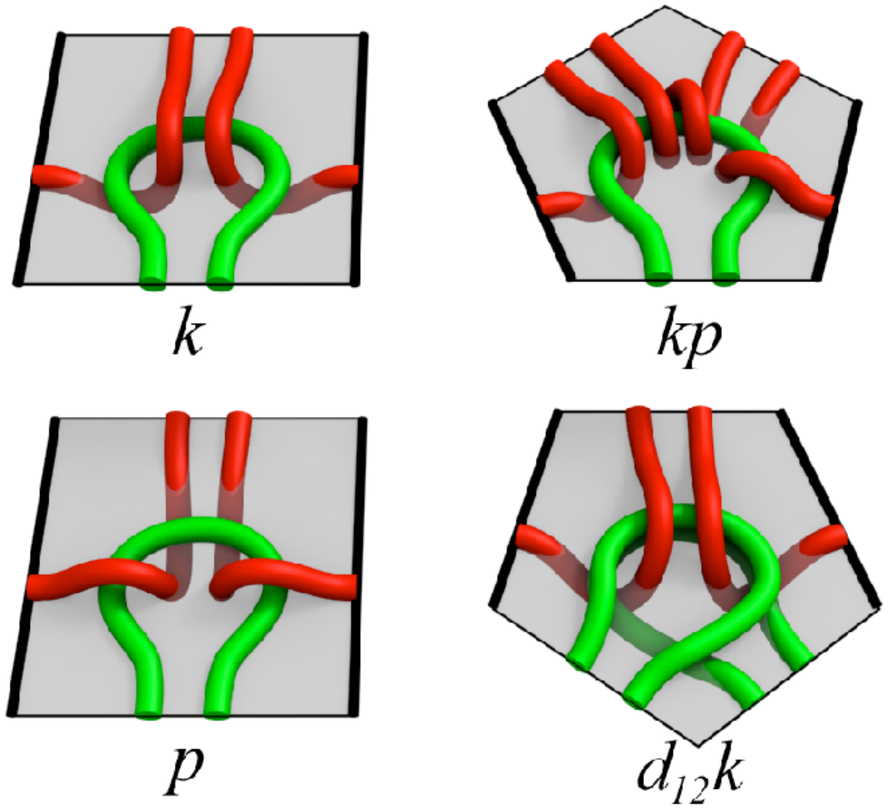
½ speed

45,960 knit loops, ~295K contact sets
9.1X contact force speedup, 5.0X overall
8m per 1/30s frame

½ speed

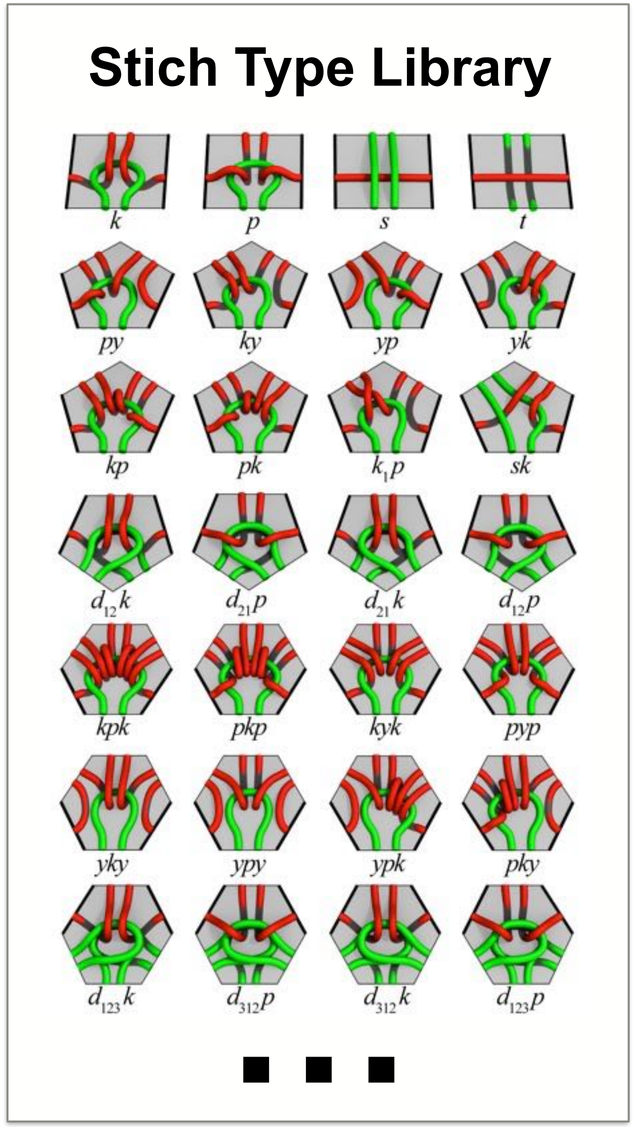
Stitch Meshes

Stitch Mesh



Stitch Mesh Faces

Stitch Type Library



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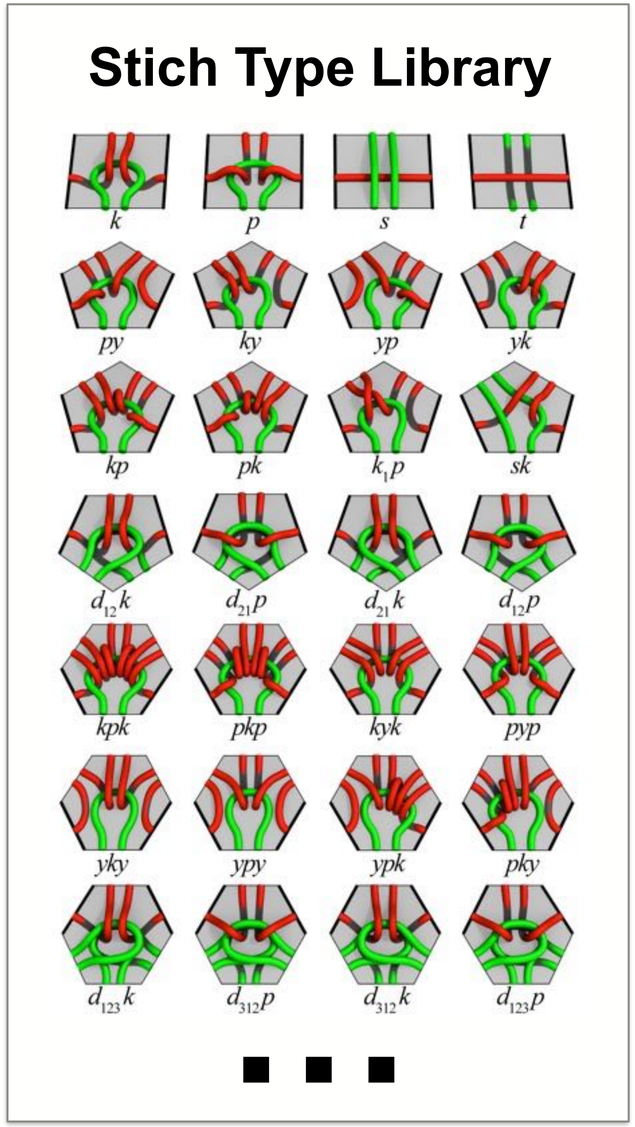
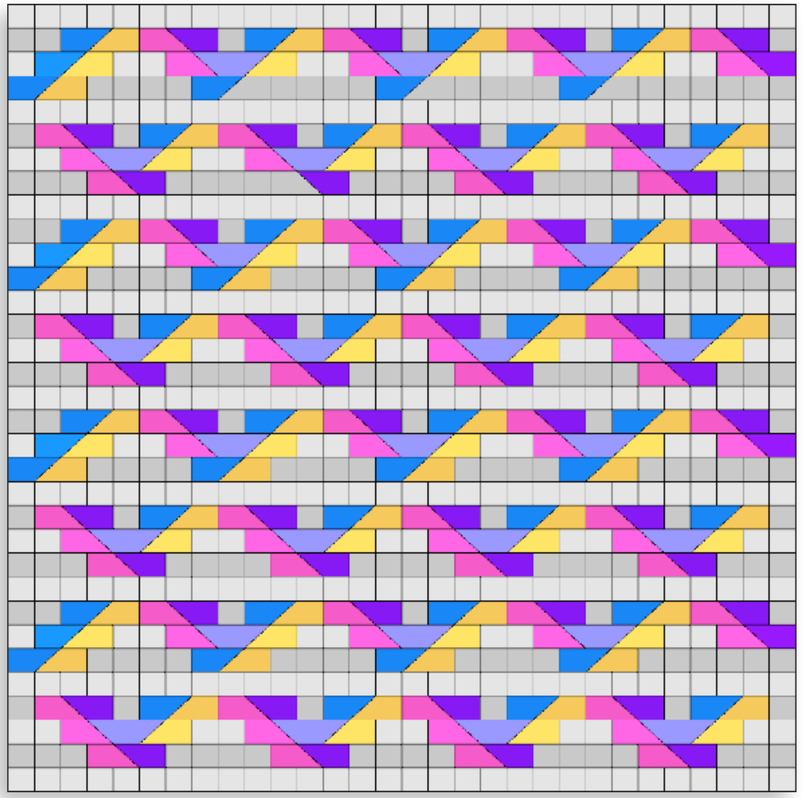
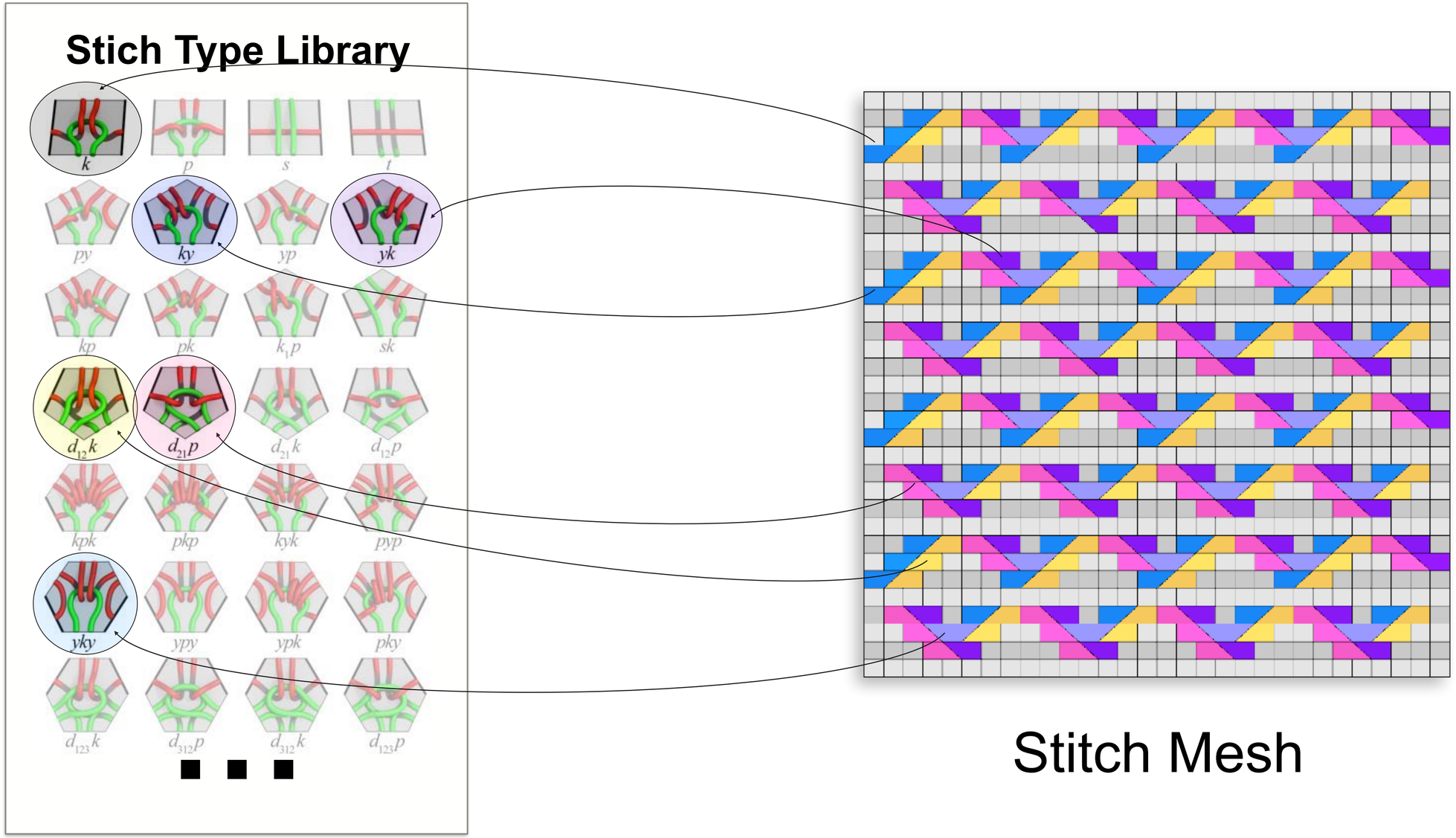
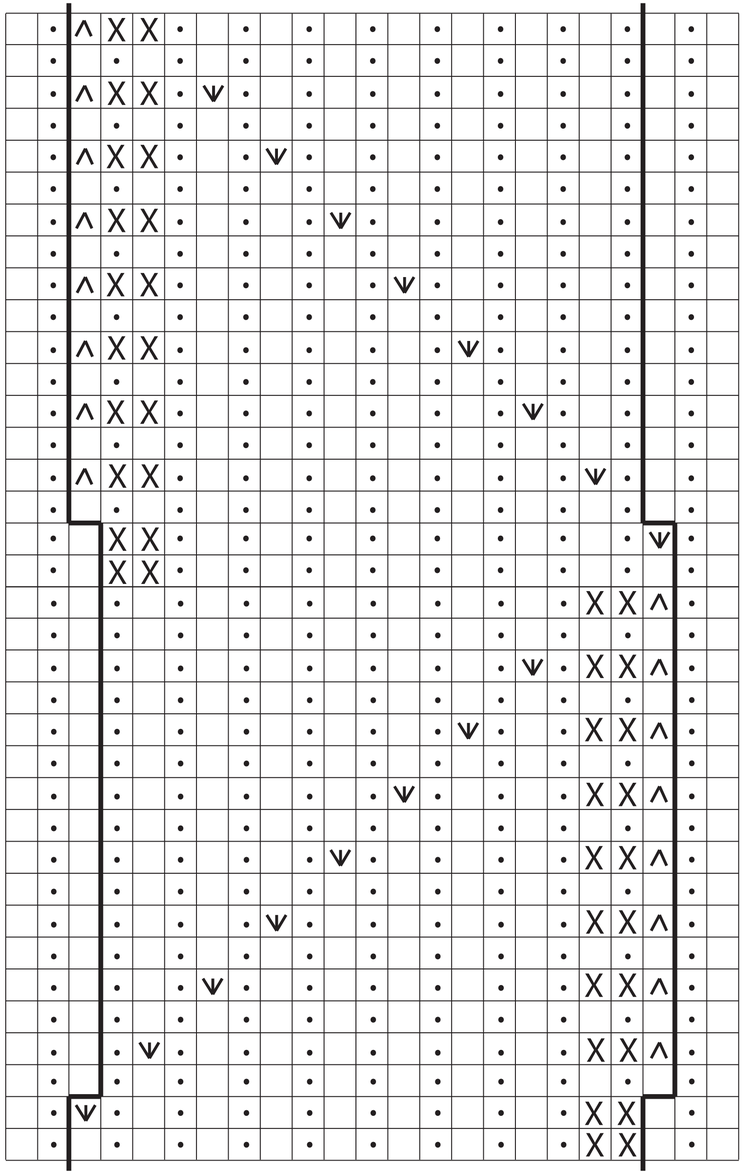


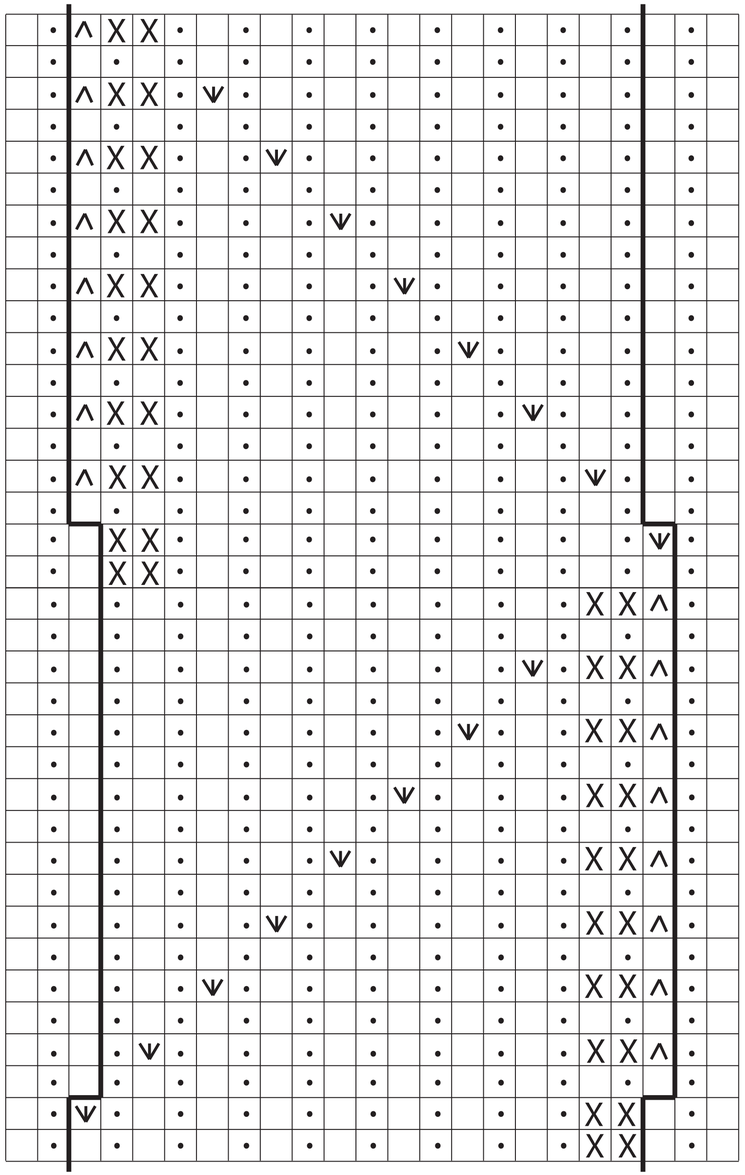


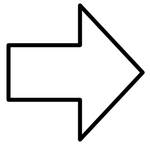
Stitch Mesh

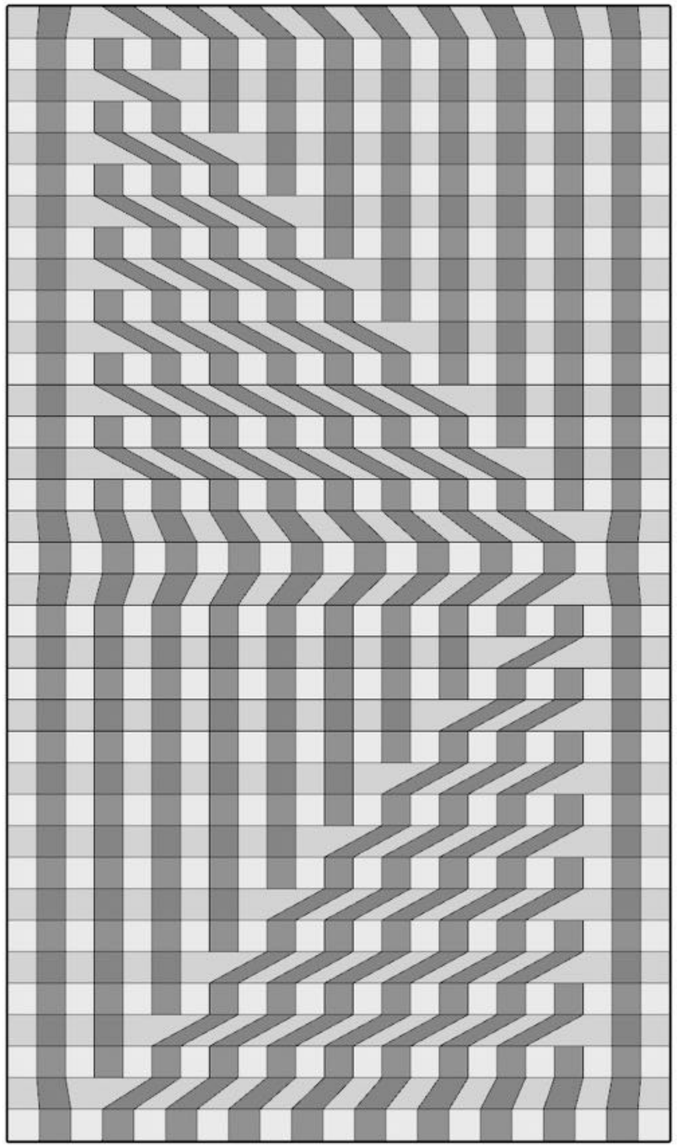
Stitch Type Library

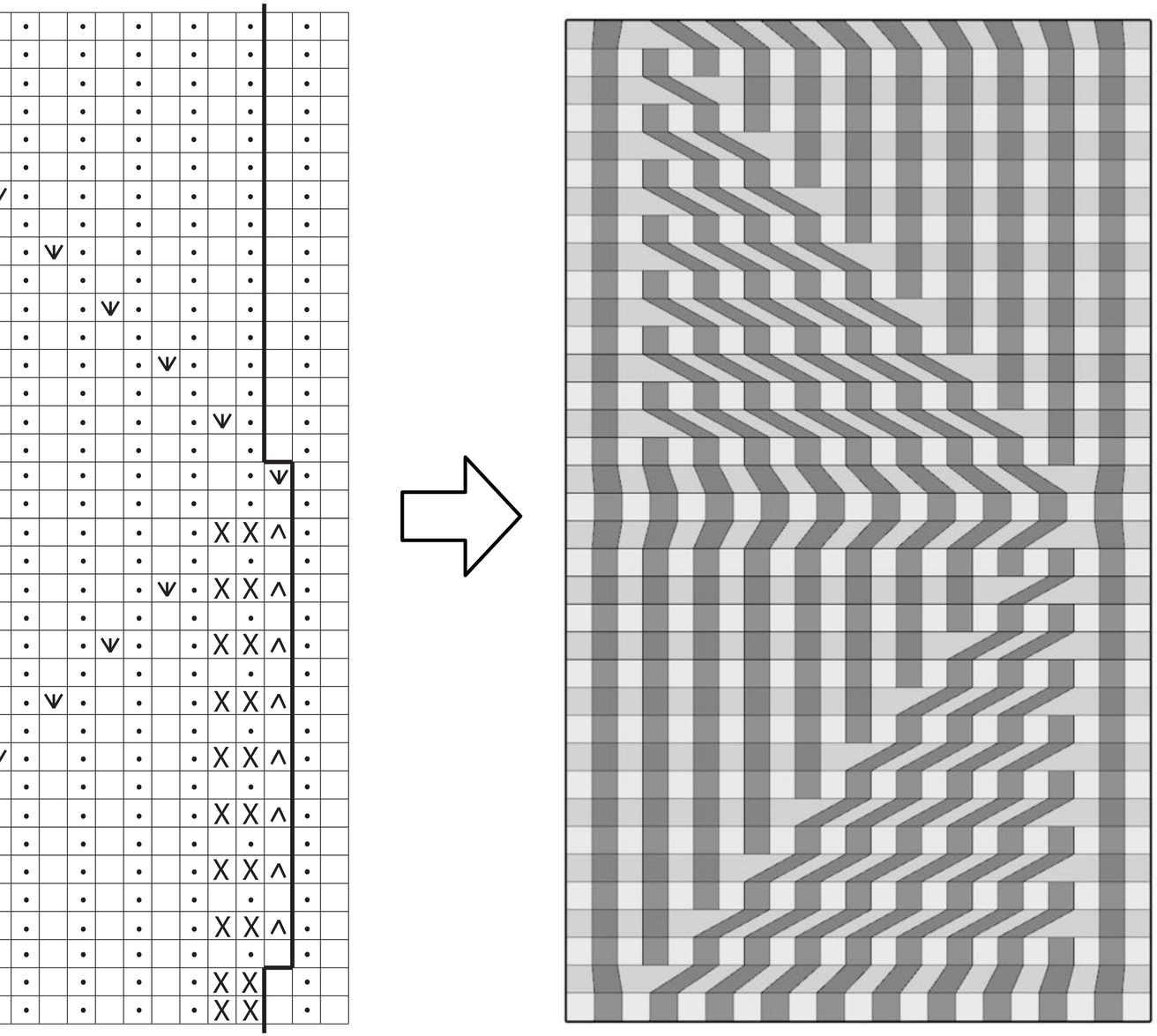


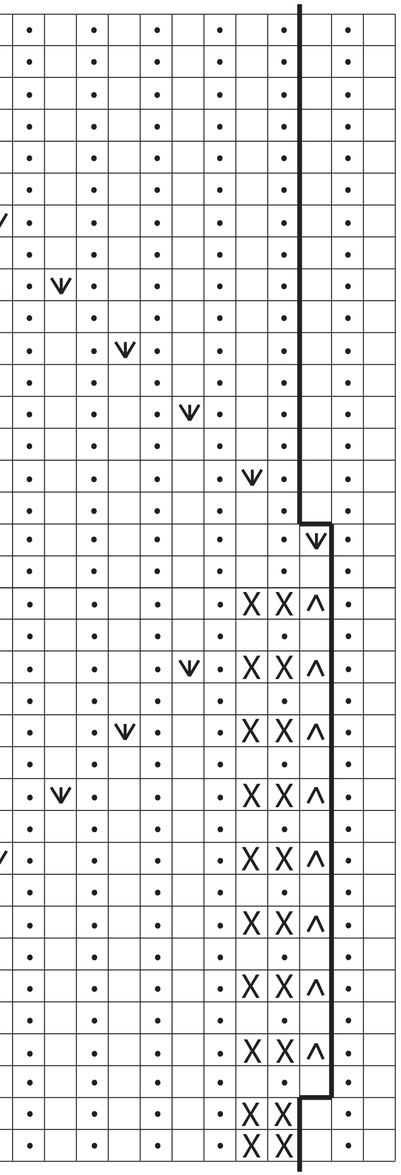


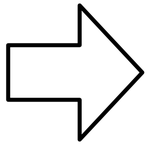


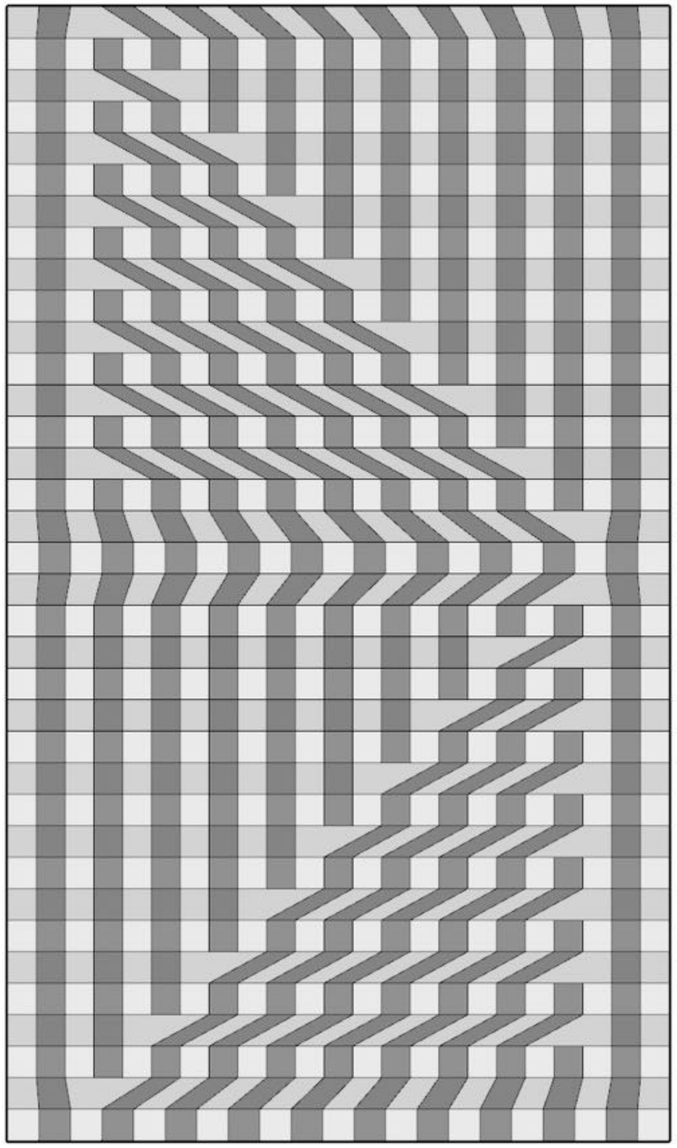


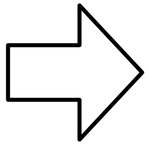


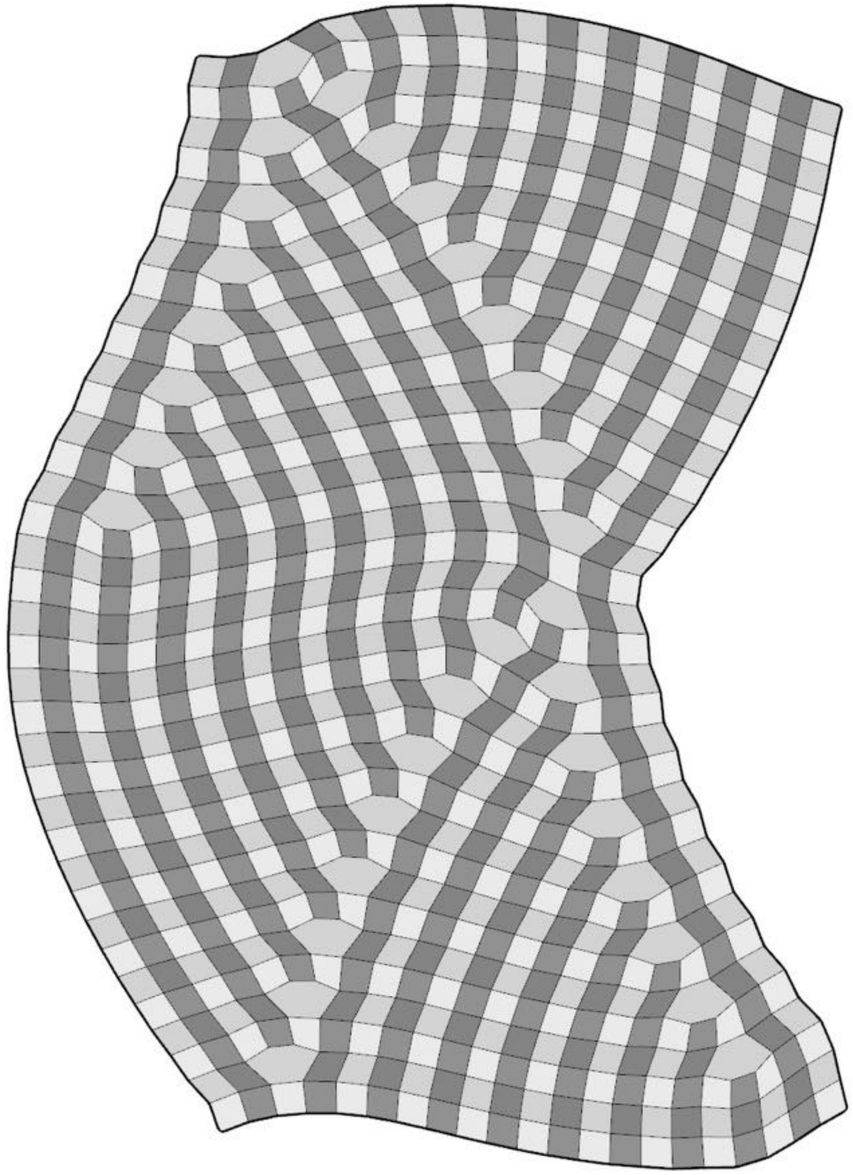


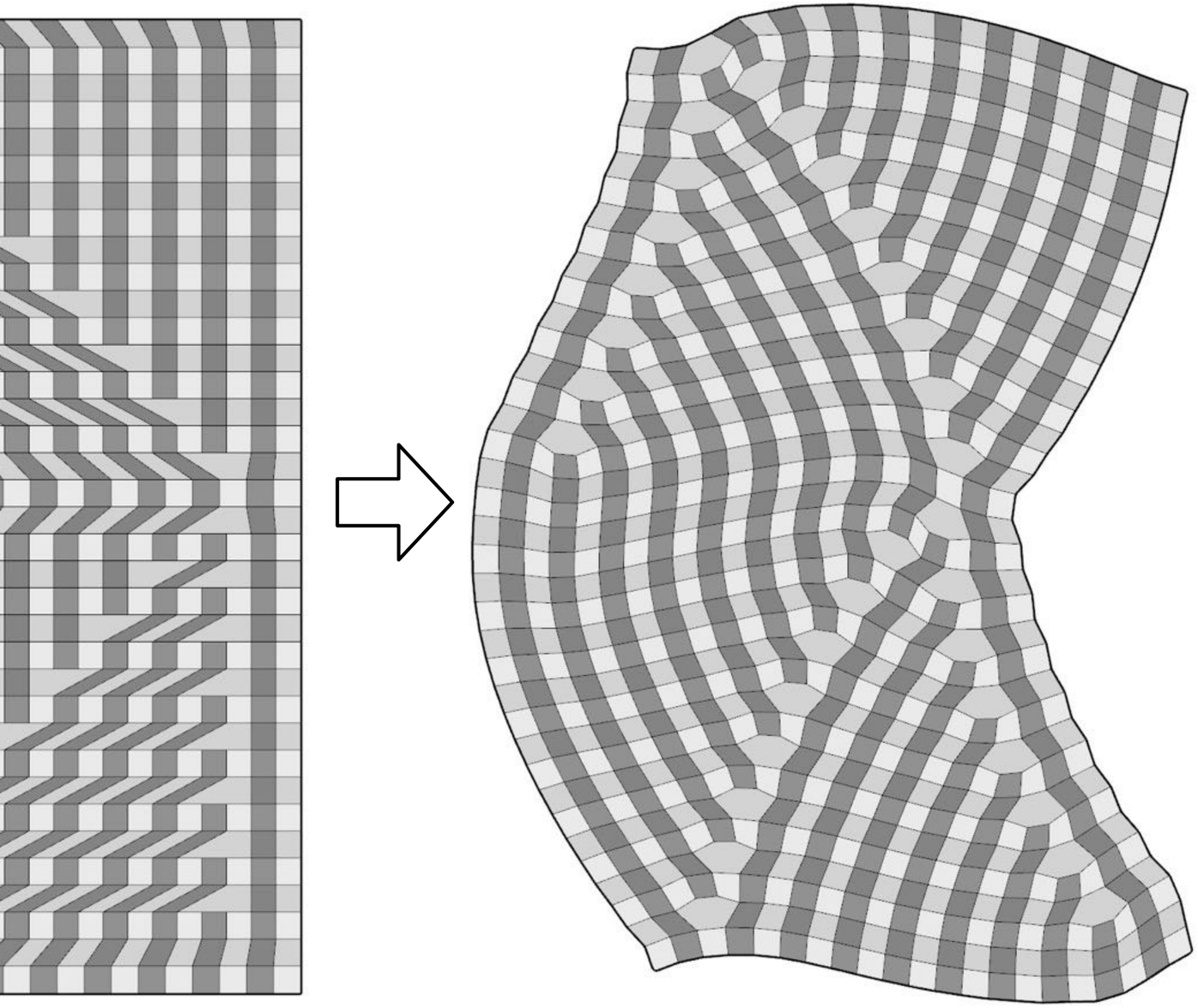


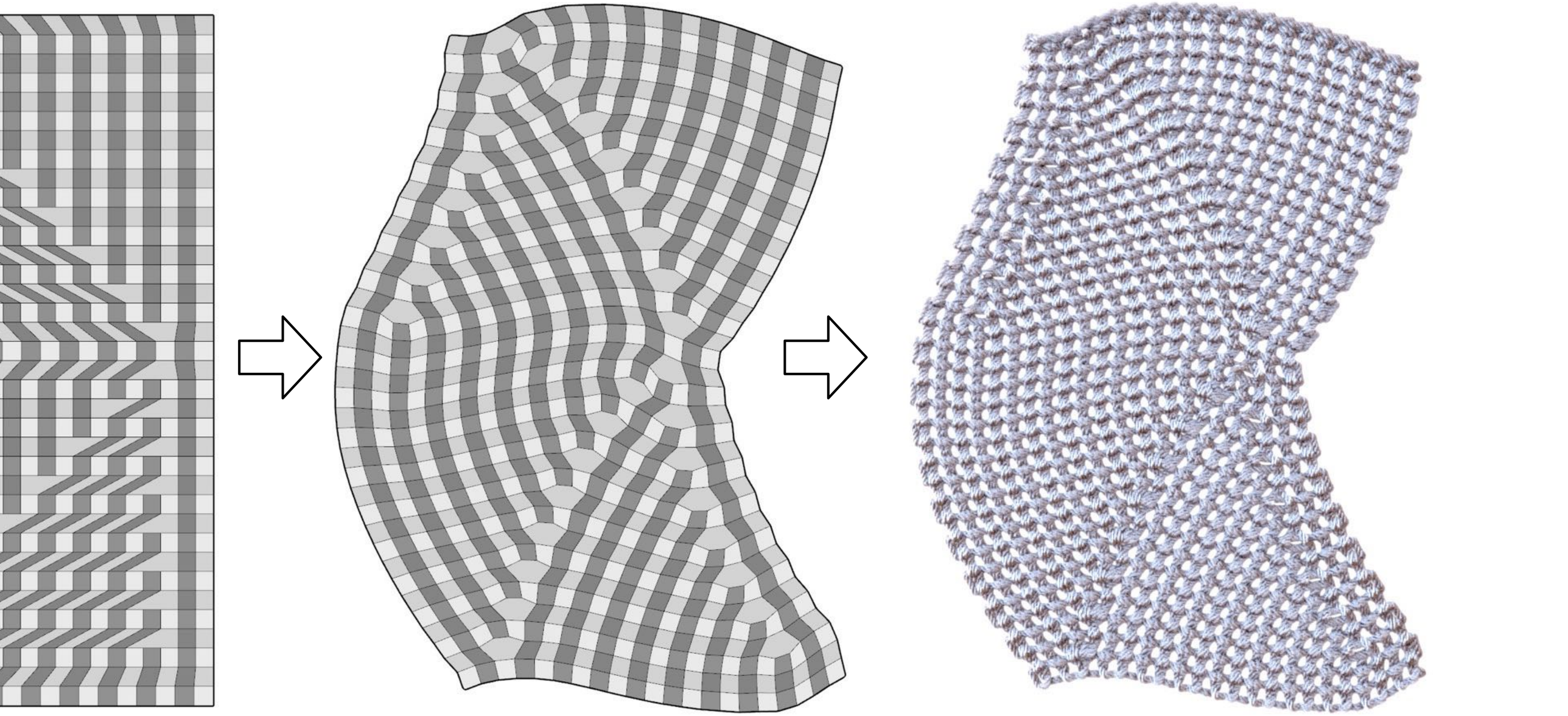


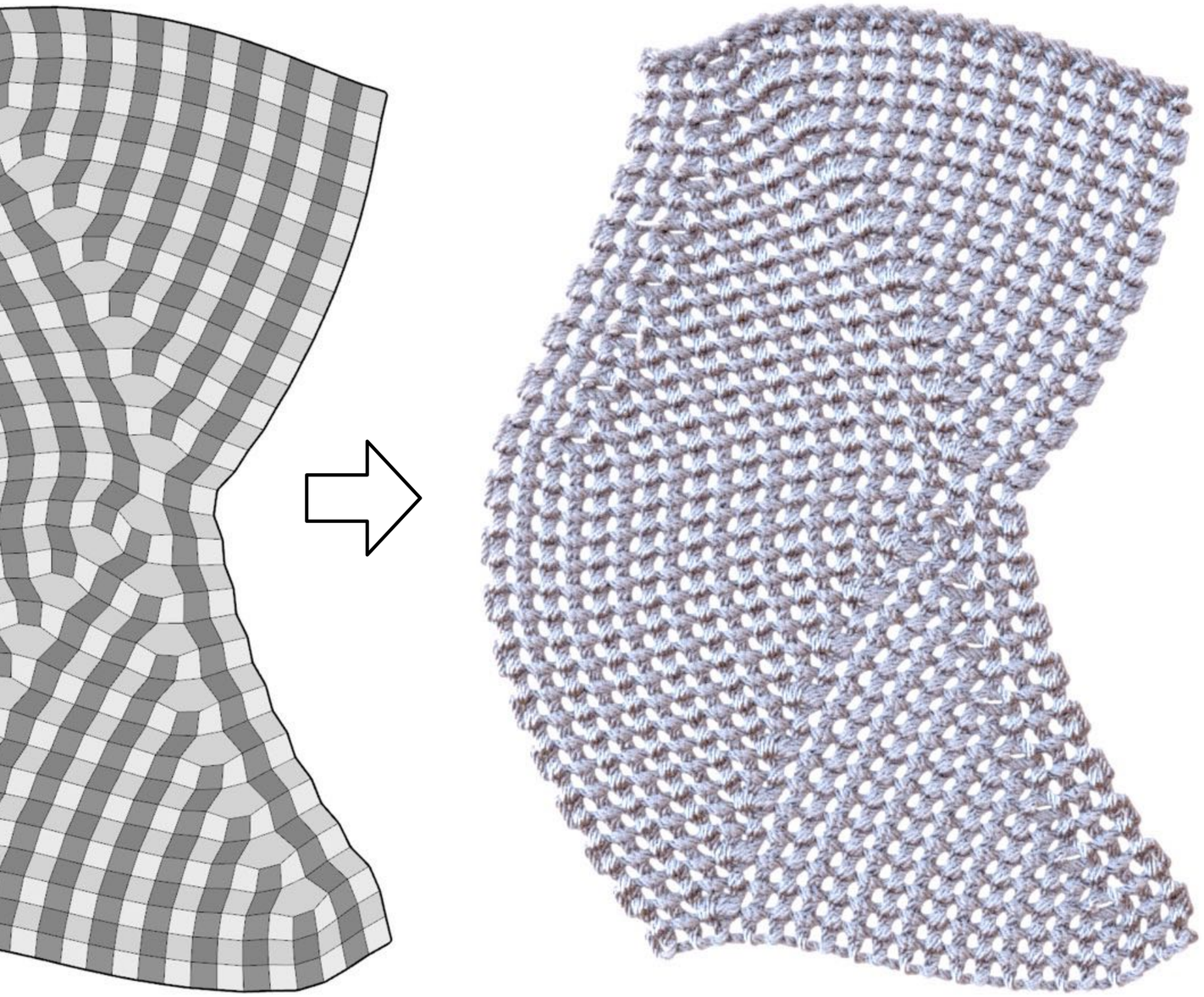


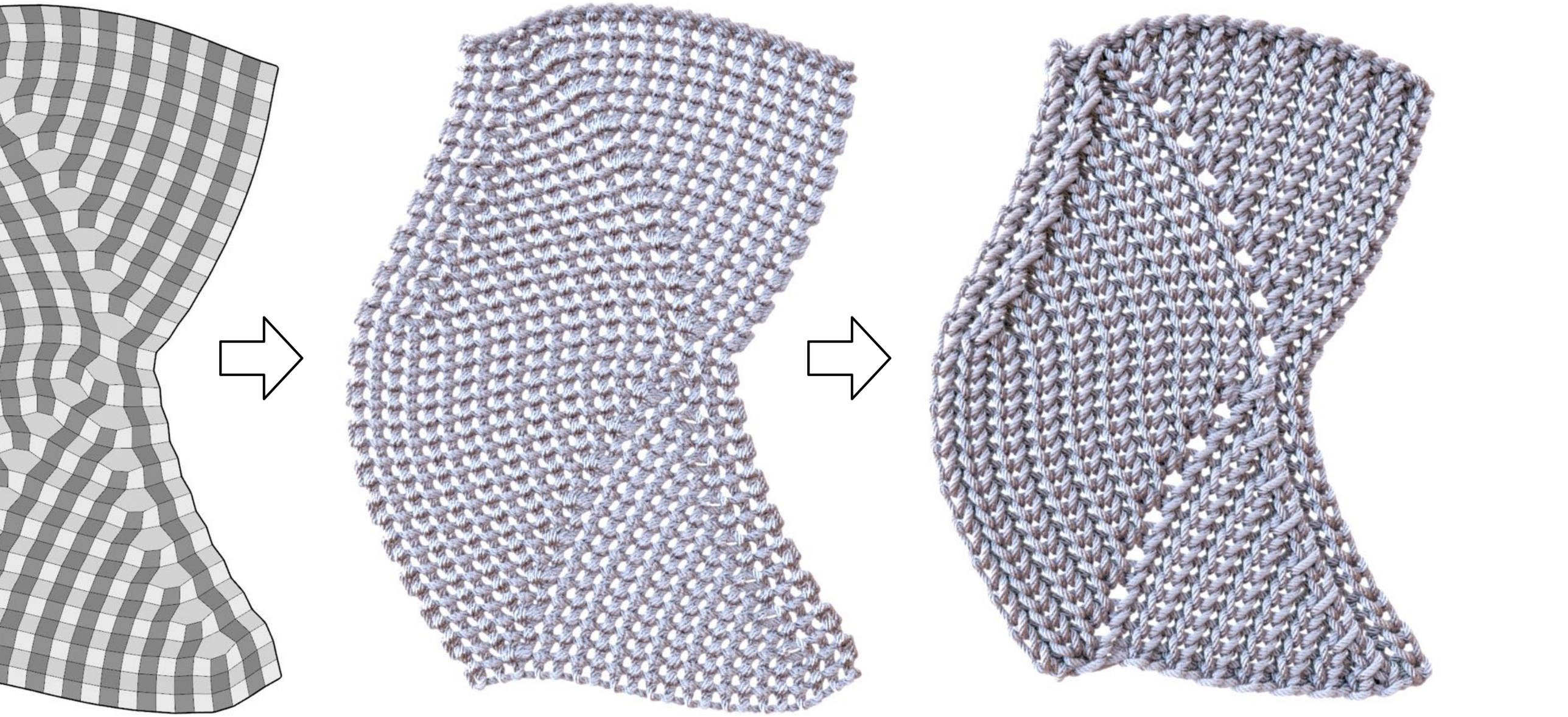


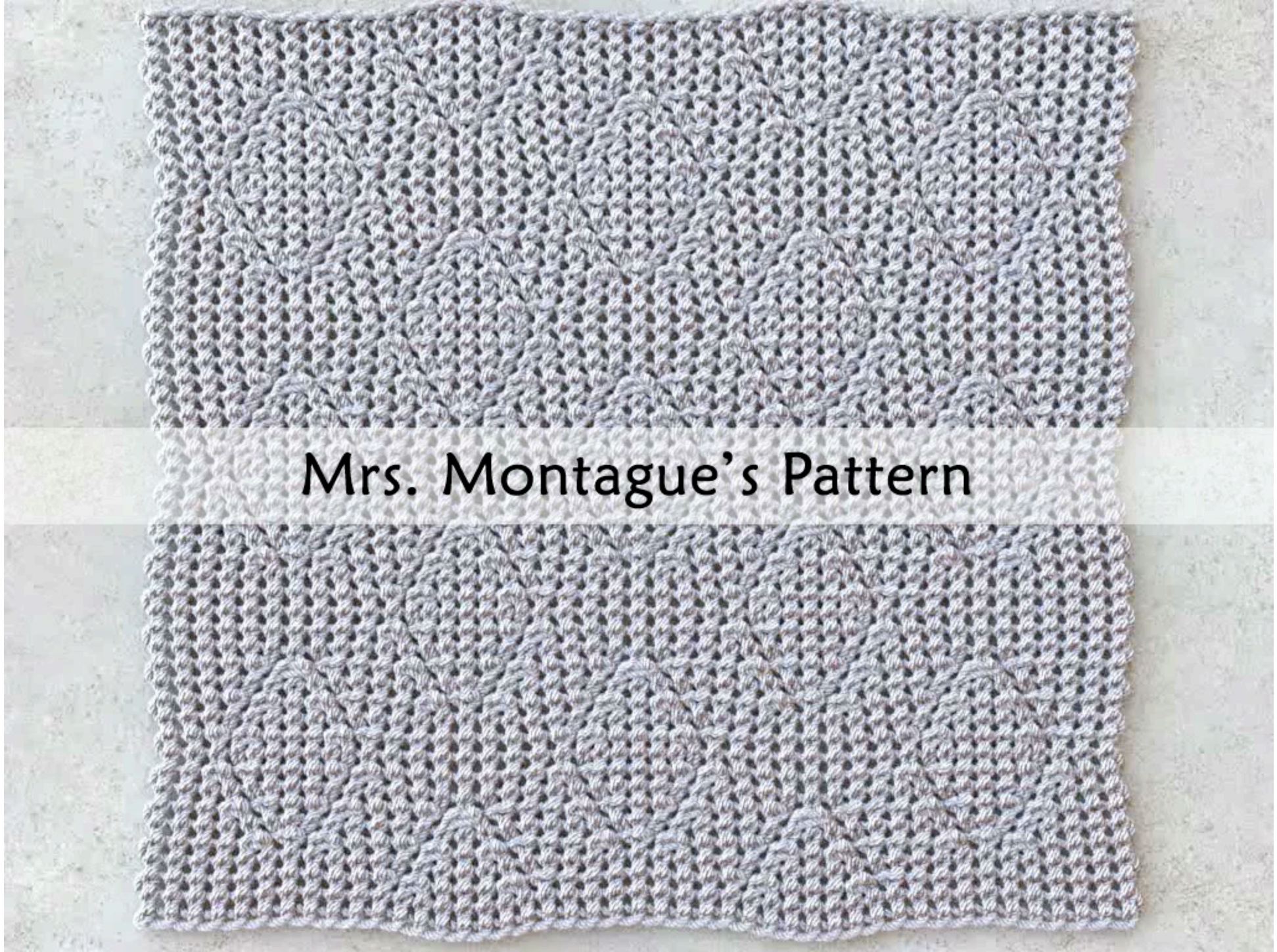


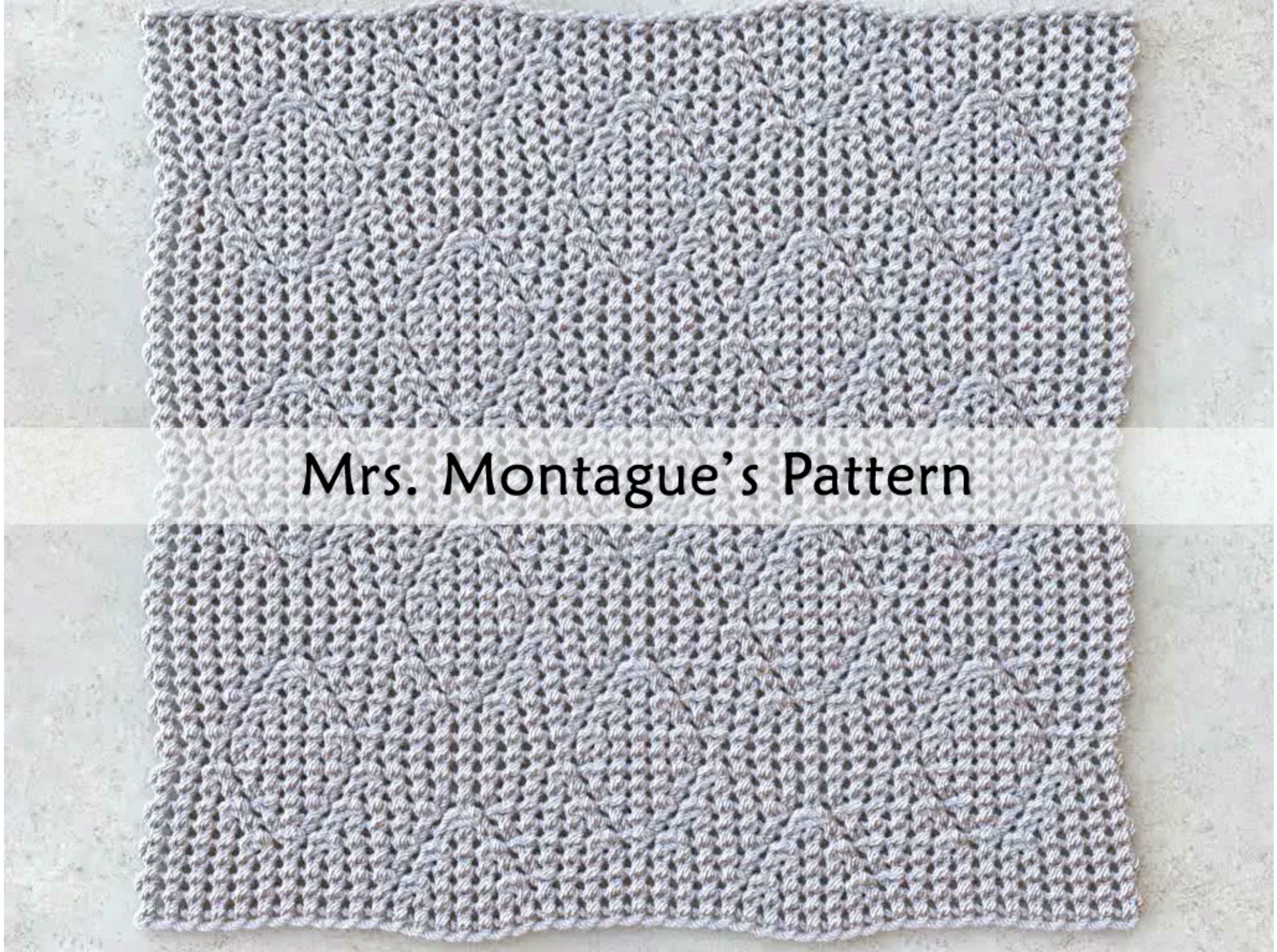


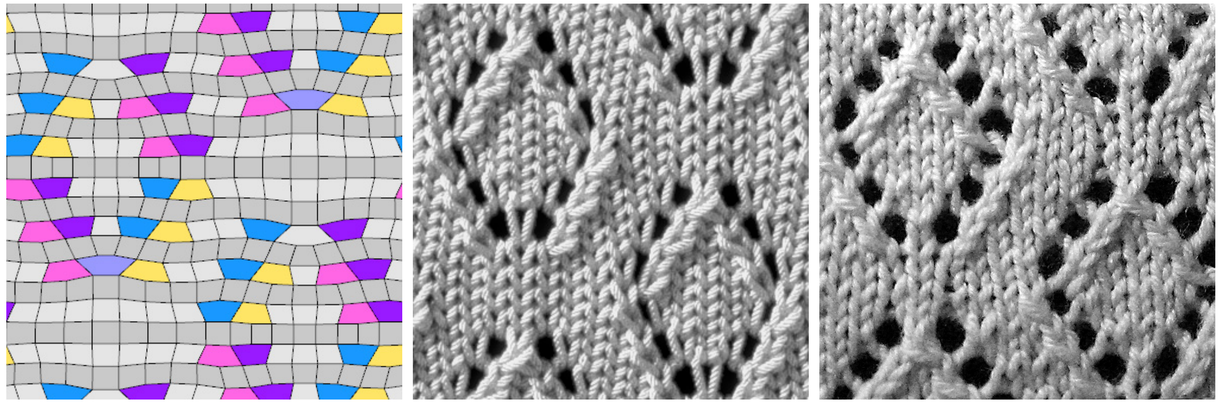




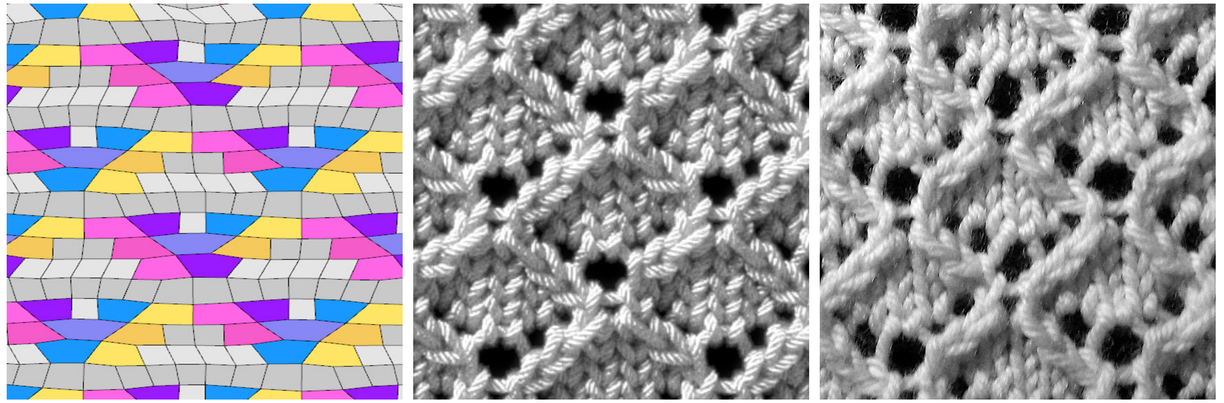



Mrs. Montague's Pattern

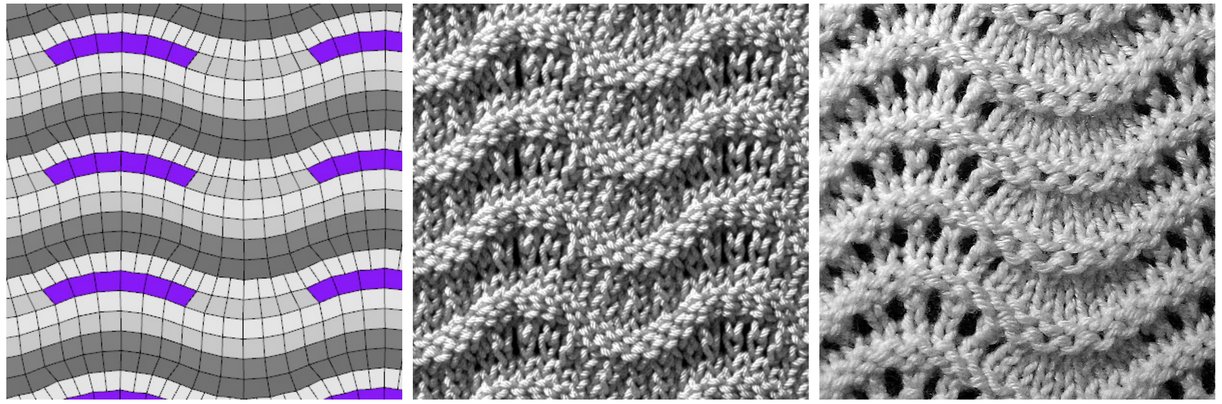

Mrs. Montague's Pattern



Mrs. Montague's Pattern [Matthews 1984]



Openwork Trellis Pattern [Matthews 1984]



Ridged Feather Pattern [Matthews 1984]

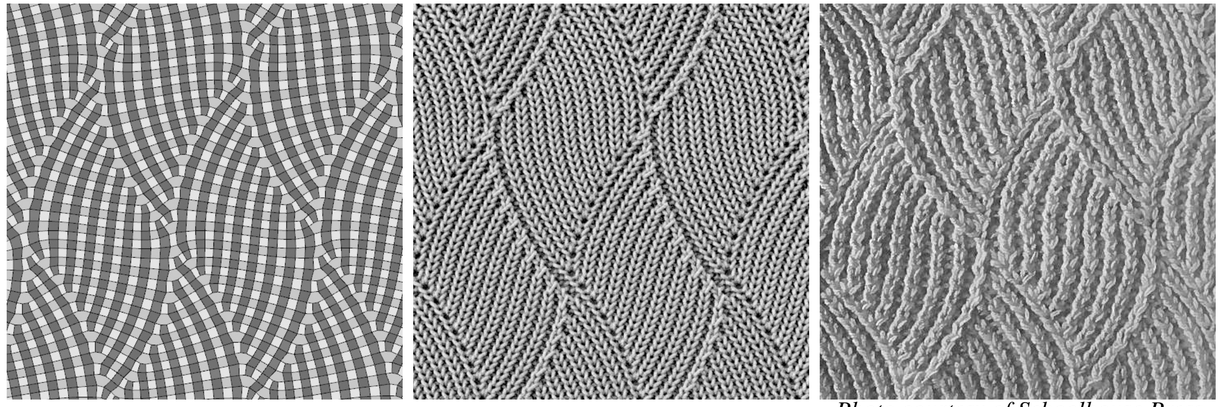
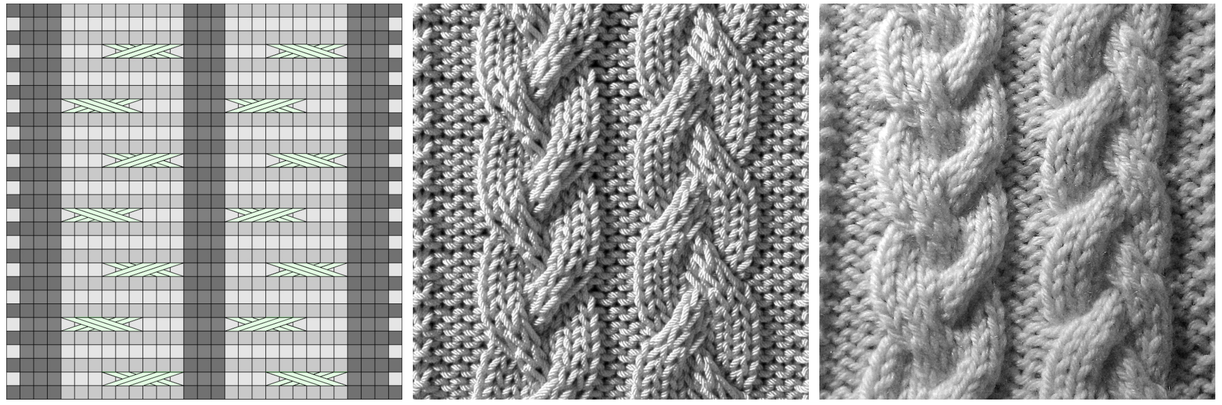


Photo courtesy of Schoolhouse Press

Flame Ribbing Pattern [Walker 2001]



Braid Cables Pattern [Allen et al. 2008]

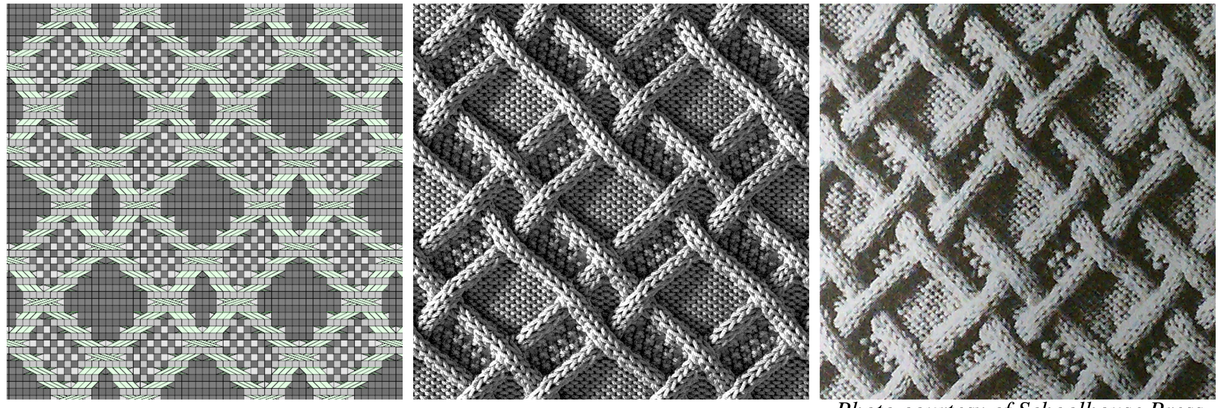


Photo courtesy of Schoolhouse Press

Cable Work Pattern [Walker 2001]



https://www.youtube.com/watch?v=5YvIHREdVX4