Interactive Appearance Prediction for Cloudy Beverages

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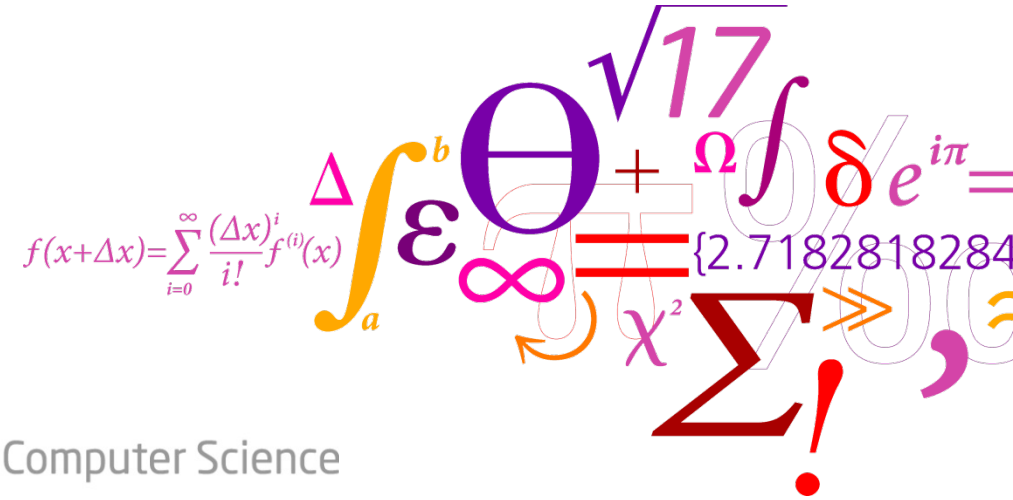

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Department of Applied Mathematics and Computer Science

Motivation

- *"The visual appearance of a cloudy drink is a decisive factor for consumer acceptance."* [Bev02]

Goals:

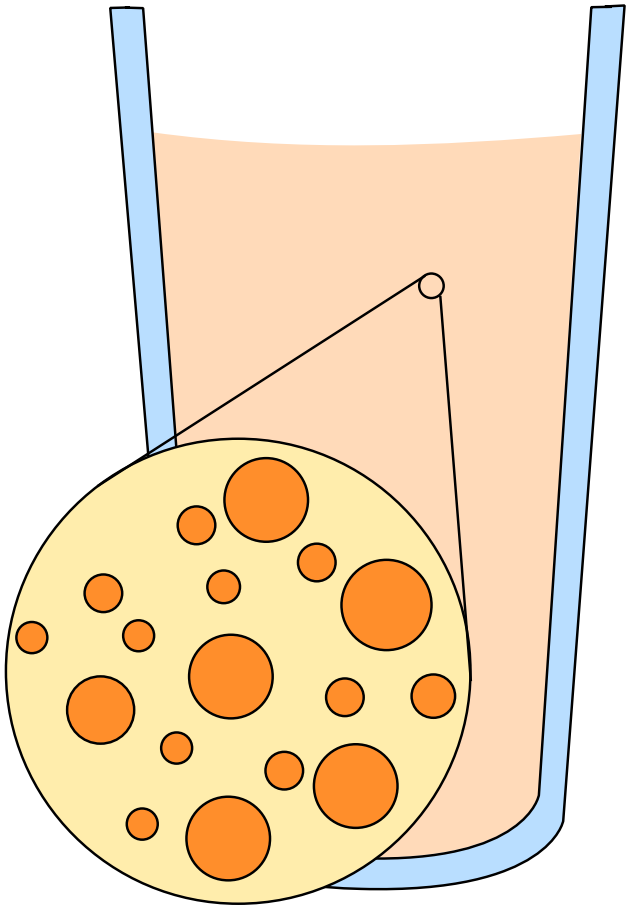
- Predict effect of modified production parameters
- Analyse the product with cameras
- Quickly test changes in production parameters

Appearance model

- Juice modelling: host liquid + particles

- Appearance is modeled as a complex index of refraction $n = n' + i\,n''$

- We can infer these parameters from production parameters:
  - Particle concentration
  - Handling of apples
  - Ambient (oxidative vs. non-oxidative)
  - …



Host medium

- Host medium is clarified apple juice
- Composed mostly of water and sugar

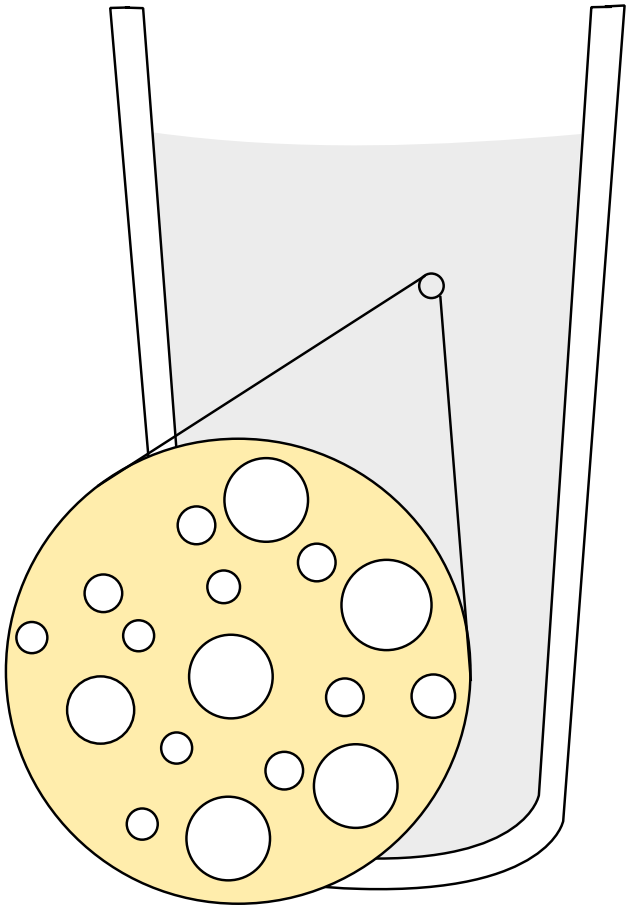
- IOR Real part [GL06]

Depends on concentration of soluble solids X:

$$n'_{host}(\lambda) = n'_{water}(\lambda) + 0.0016\,X$$

- IOR Imaginary part: [BFH86]

Absorption measurements of apple juice blended with water absorption



Particles

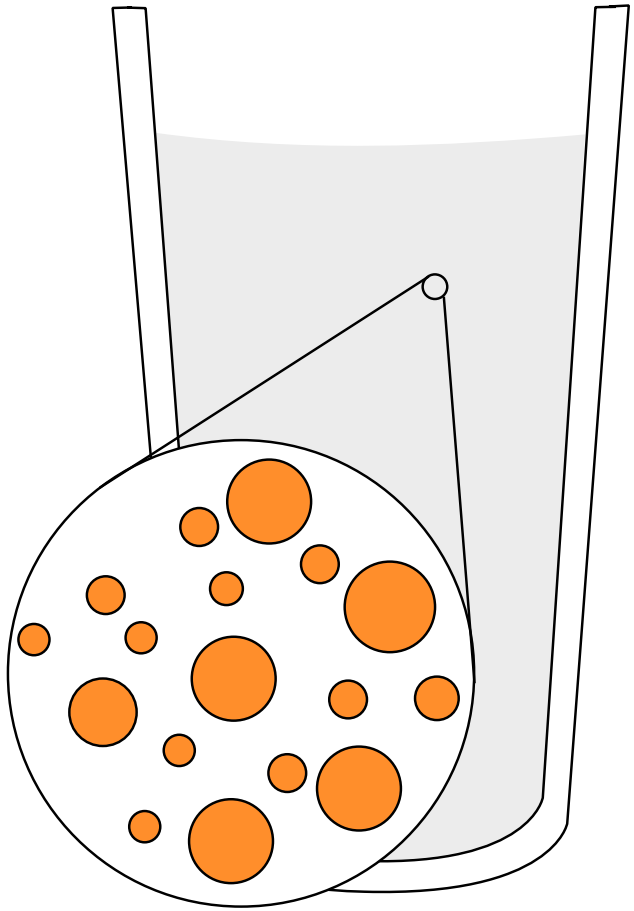
- Modeled as particles of browned apple flesh

- IOR Real part:

Measured by [BGL07] to be 1.487

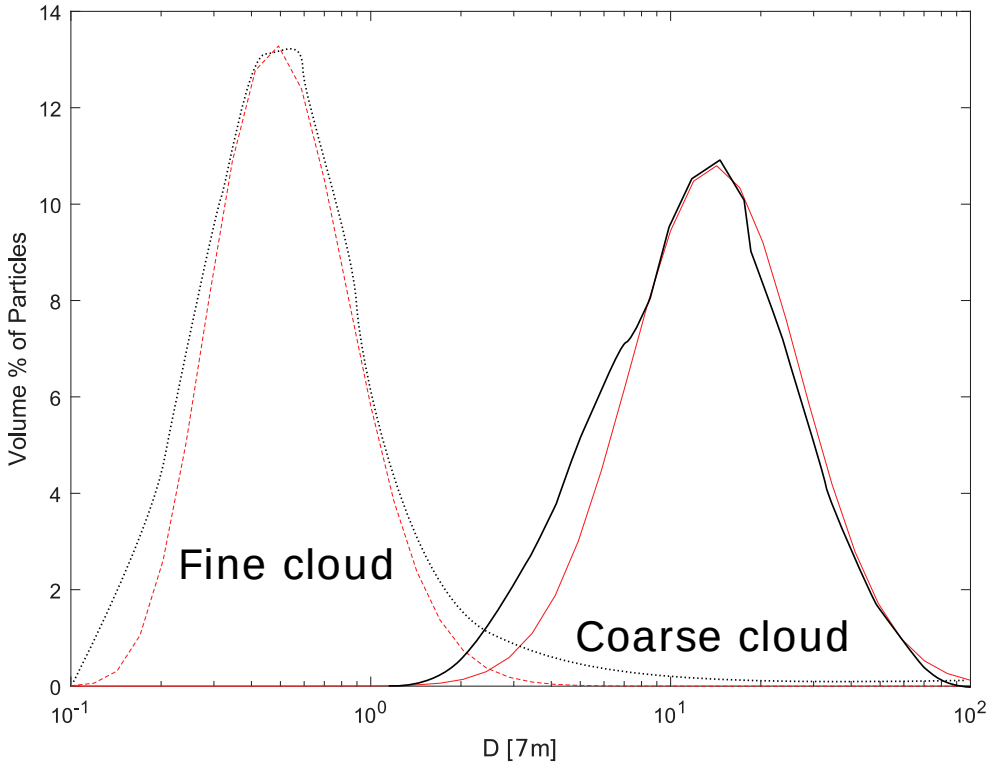
- IOR imaginary part:

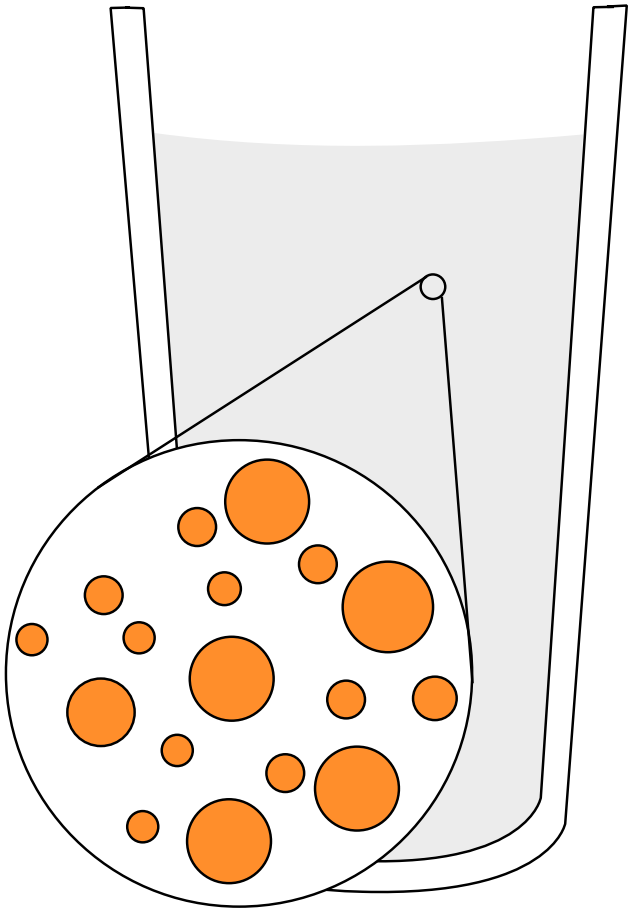
Combining absorption of apple flesh [SVRT*08] with bruised apple flesh (from 500 nm upwards) [LCHA10]



Particles

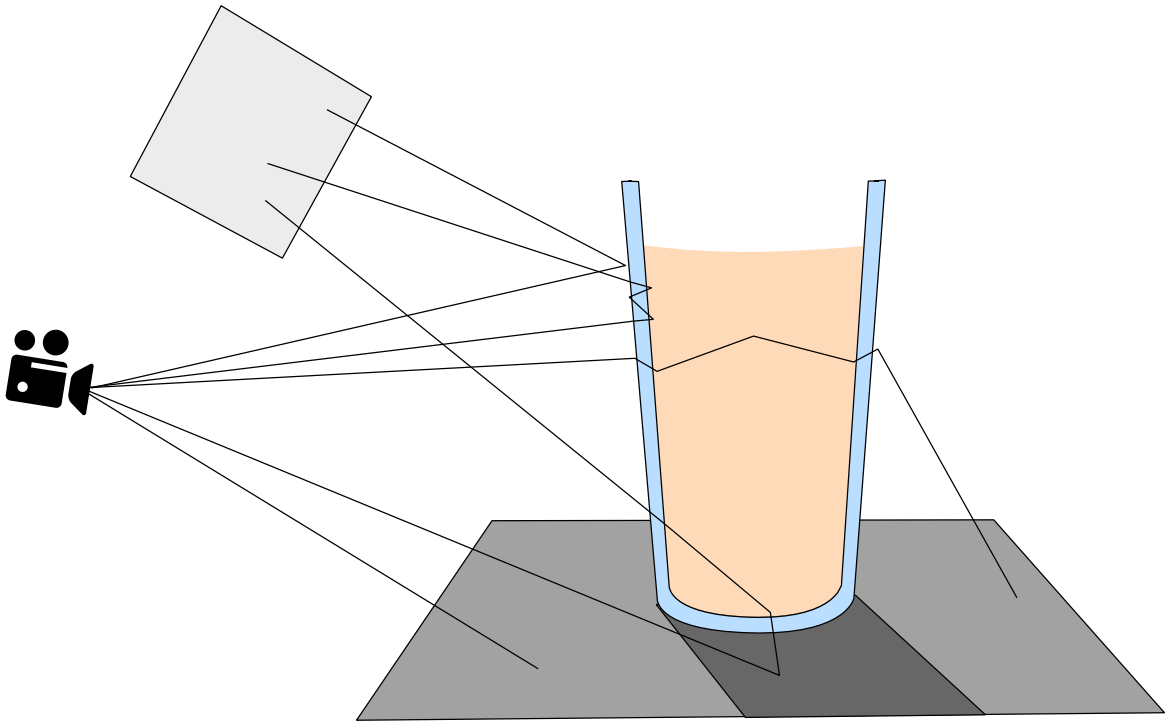
- We use a bimodal particle size distribution from [ZPDG94]





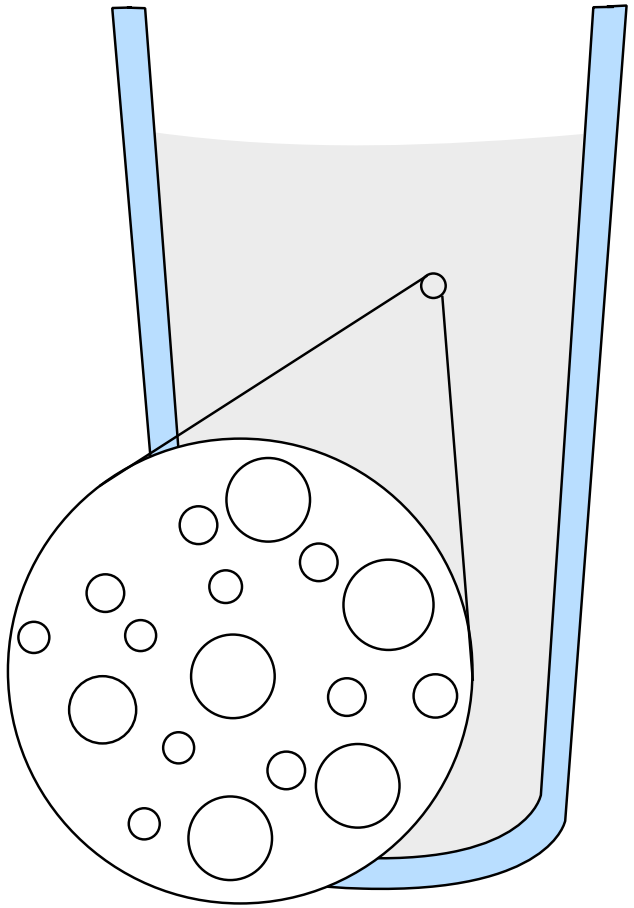
Rendering

- We can neither use single scattering nor subsurface scattering techniques
- Progressive full volume unidirectional path tracing [Rus88]
- Accounting for IORs using different interfaces



Rendering - glass

- Glass modeled as a transparent material with absorption and roughness
  - Transparent: Russian roulette on Fresnel reflectance R
  - Absorption: Killing path with probability $T_r = e^{-\sigma_{a,glass}\, s}$
  - Roughness: Small diffuse term (with $\rho_d = 0.1$)
- Parameters from Schott N-K5 crown glass



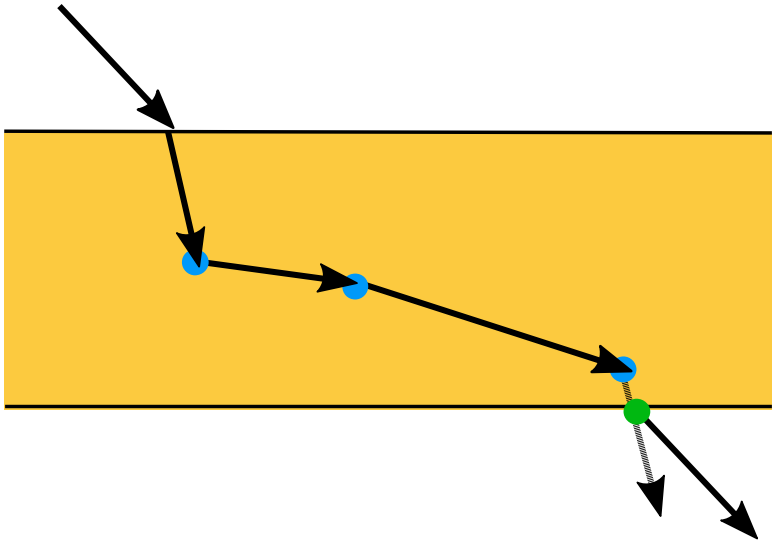
Rendering - juice

- Specular material with scattering

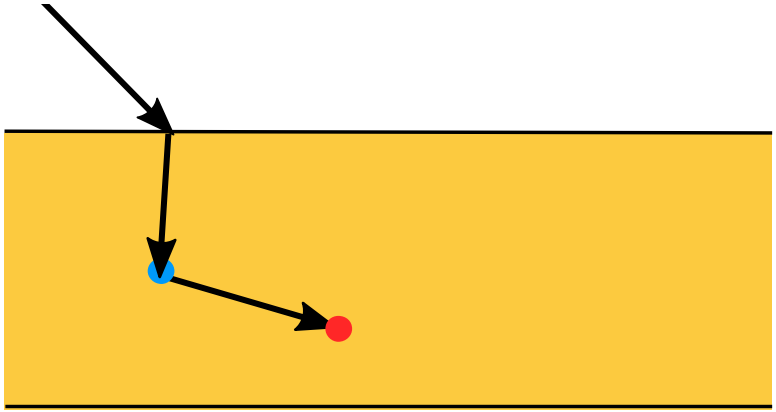
- From parameters and Lorenz-Mie we estimate scattering properties (σ_t, σ_s and g)

- Volumetric scattering process (stochastic walk). At each step either:
  - Absorb the path with probability σ_s/σ_t and discard the walk
  - Exit the material
  - Create a new step
    - New step distance: exponential on extinction σ_t
    - New step direction: sampling Henyey-Greenstein phase function

Rendering – volume scattering

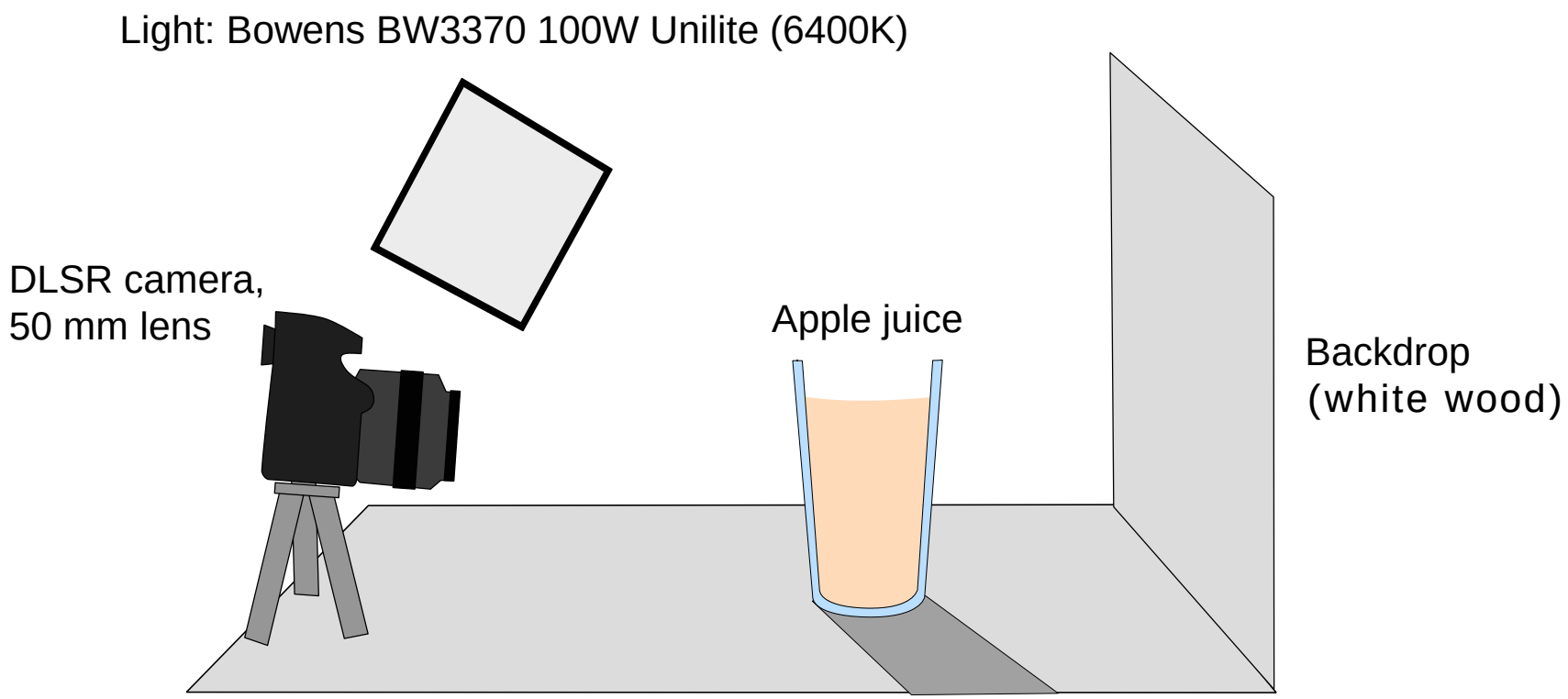


Scattering path exiting the material



Scattering path being absorbed

Scene


Light: Bowens BW3370 100W Unilite (6400K)
DLSR camera,
50 mm lens
Apple juice
Backdrop
(white wood)

Results

Rendering

Photograph

Results

- Varying concentration

0.0 g/L 0.1 g/L 0.2 g/L 0.5 g/L 1.0 g/L 2.0 g/L

Results

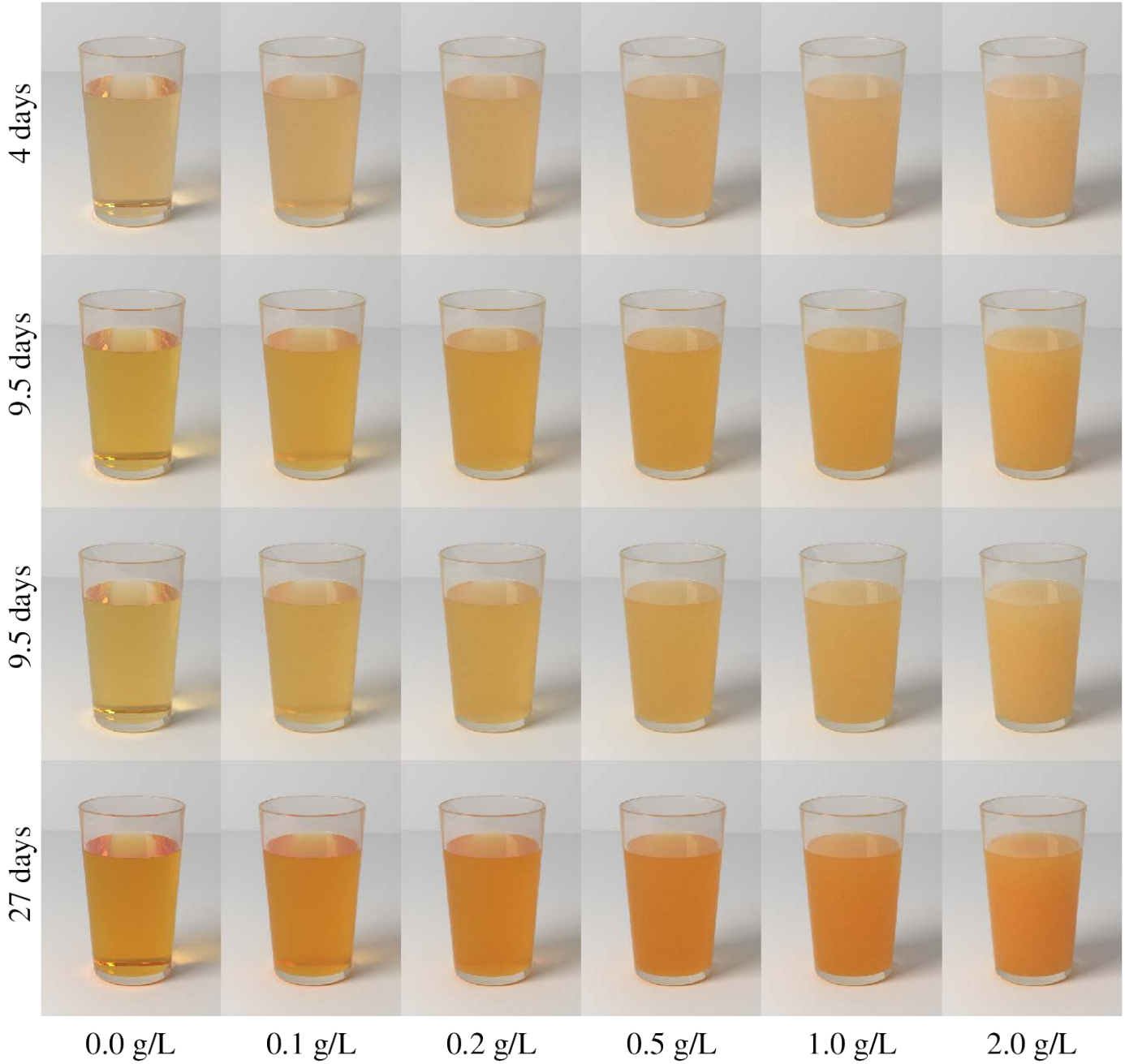
- Using different storage spectra (0.2 g/L)

4 days

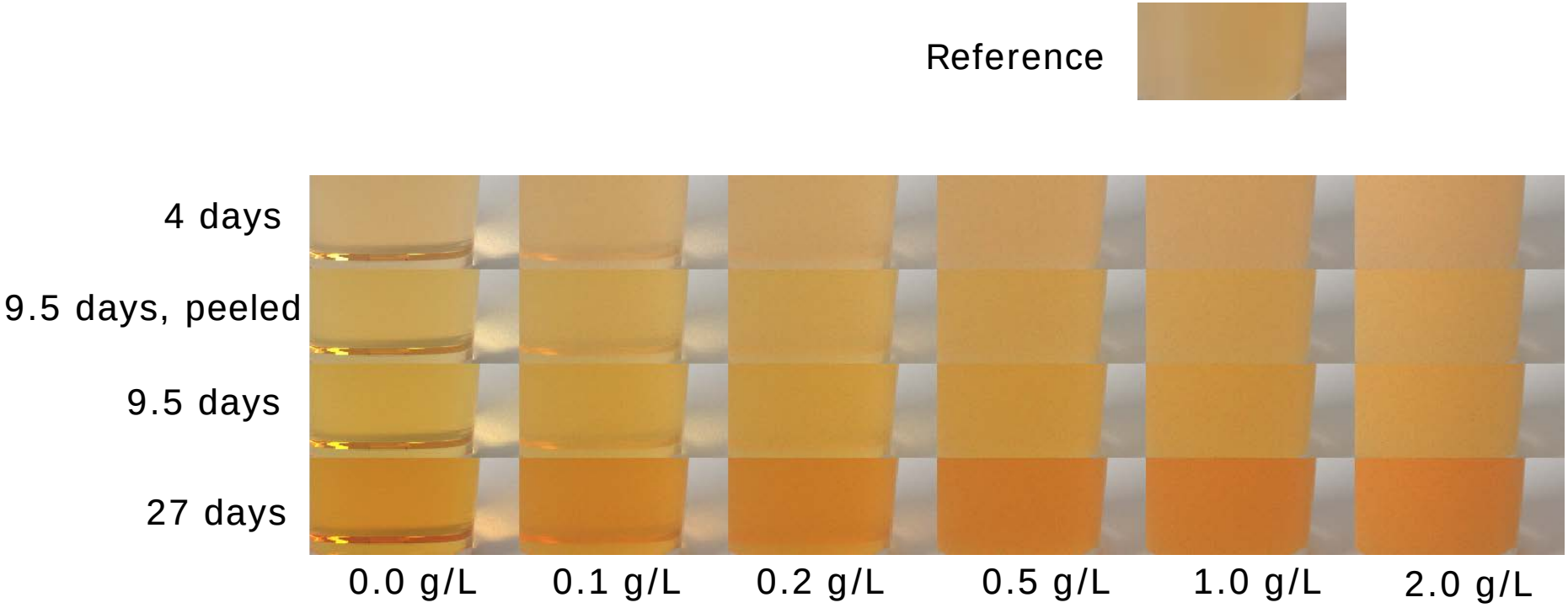
9.5 days,
peeled and cored

9.5 days

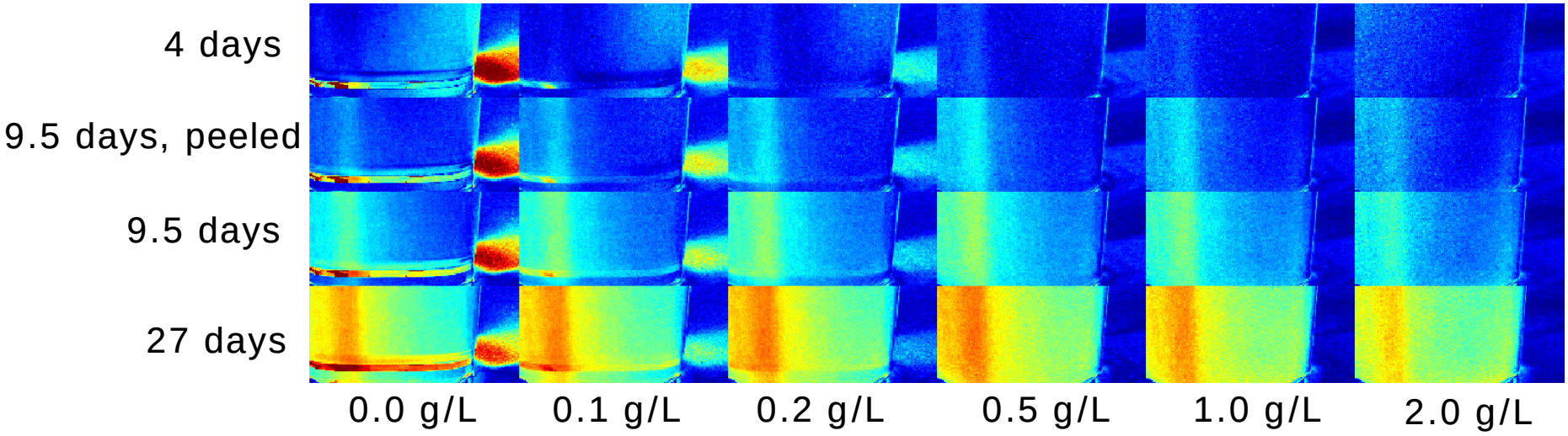
27 days


4 days
9.5 days
9.5 days
27 days
0.0 g/L
0.1 g/L
0.2 g/L
0.5 g/L
1.0 g/L
2.0 g/L

Results


Reference
4 days
9.5 days, peeled
9.5 days
27 days
0.0 g/L
0.1 g/L
0.2 g/L
0.5 g/L
1.0 g/L
2.0 g/L

Results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1.0 g/L
2.0 g/L

Future work

- Carefully measuring scene parameters
  - Geometry acquisition
  - Radiometric acquisition
  - Different setup
- Defining metrics for comparisons
  - Perceptually based metrics
- Dynamics

References

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