

Title: Physics in Nature Presentation: Why Do Clothes, Paper, Wood & Soil Look Darker When They Are Wet?

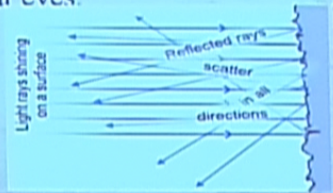
Date: Aug 19, 2011 12:00 PM

URL: <http://pirsa.org/11080099>

Abstract:

## Initial Analysis

- Absorbent surfaces look darker when they become wet. This phenomena would not that obvious if the surface was smooth and nonabsorbent.
- Surface looks darker because a smaller portion of light is diffused into our eyes.
- But why?



$$\frac{1}{\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$\langle \hat{r}_L | U_{H_1} | a_n \rangle \langle a_n | U_{H_1} | E_1 \rangle = C_n \quad U_{H_1} = e^{-iH(t-t_0)}$$

$$\langle U_{H_1}^\dagger | E_1 | a_n \rangle \langle a_n | U_{H_1} | E_1 \rangle = C_n$$

# Experiment

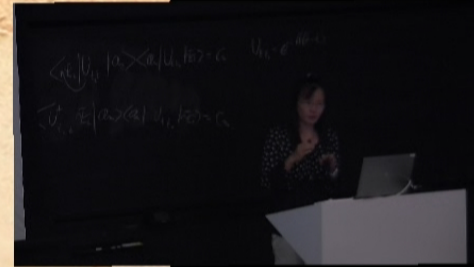


- A greater portion of light is transmitted through the wet paper.



# Explanation 1

- Water fills in spaces between fibres, but there are still thin air films remaining around fibres.
- Because air's refractive index(1.0) is less than water's (1.33), they form “optical fibres!”
- Through water, light penetrates to the deeper layer of materials and a smaller portion of light is diffused.





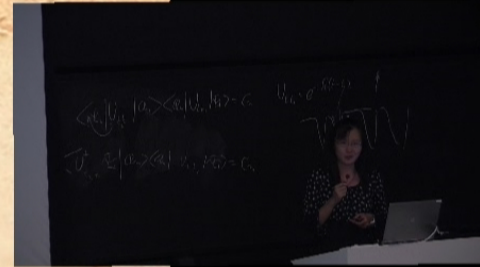
$$\langle \bar{\Psi}_2 | U_{t_2 t_1} | a_m \rangle \langle a_m | U_{t_1 t_0} | \bar{\Psi}_1 \rangle = C_m$$

$$\langle U_{t_2 t_1}^\dagger \bar{\Psi}_2 | a_m \rangle \langle a_m | U_{t_1 t_0} | \bar{\Psi}_1 \rangle = C_m$$

$$U_{t t_0} = e^{-i H(t-t_0)}$$



- **Sounds reasonable?**
- **Are you satisfied with this explanation?**

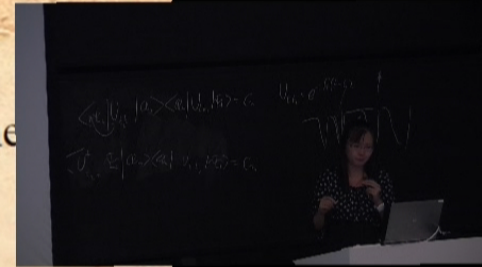
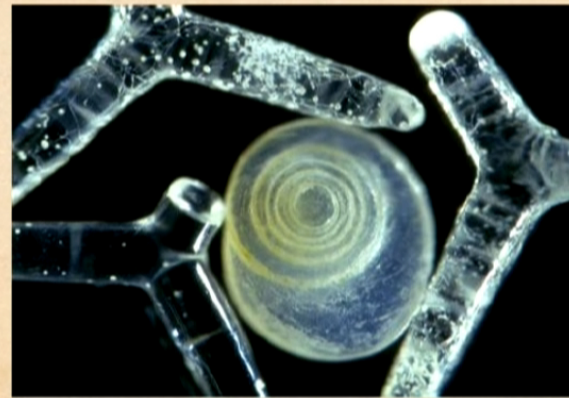




- If we consider tiny pieces of an opaque material, such as the grains in sand or the sub-fibres in wood, they can also refract a portion of light.



Sand grains zoomed in 250 times.

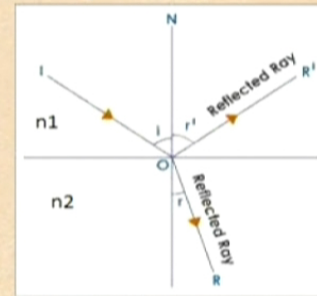




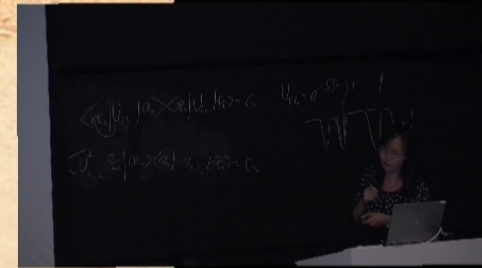
## Explanation 2

- The reflectivity (derived from the Fresnel equation)

$$R \propto \frac{(n_1 - n_2)^2}{(n_1 + n_2)^2}$$

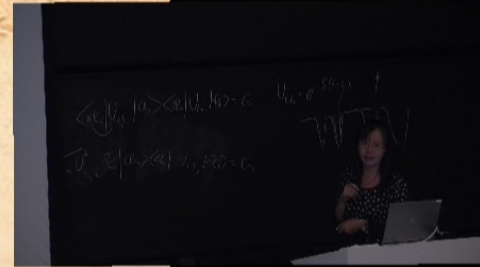


- Compared with air, water has a higher refractive index, thus the reflectivity between water and a material will be smaller than it is between air and the material.
- A greater portion of light refracts into the wet material and the diffuse reflection becomes weaker.



# Conclusion

The refractive index of water is higher than air's, which causes a greater portion of light to refract into the material and decay inside it, thus giving less diffuse reflection.





Thank you!

