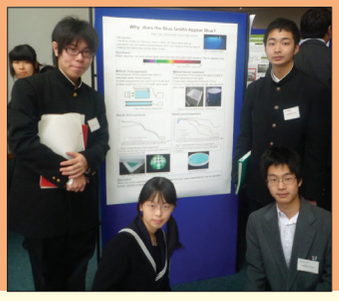
Why does the Blue Grotto appear blue?



Yuki Hara, Yuki Matsuoka, Ken Ohashi, Shuji Yamada[1]

Ichinomiya Senior High School, [1]Kariya Senior High School, Japan. E-mail: brilliancefield@yahoo.co.jp

DOI: 10.4103/0974-6102.107618

ABSTRACT

This team of young Japanese scientists were interested in why the Blue Grotto in Italy was blue and thought it may be to do with the light transmissivity properties of water. They, therefore, carried out several experiments modeling the water in the grotto as water in boxes. They found that percentage of light absorbance was dependent on the dimensions of the container and the reflective properties of the container wall. In all cases, red light was absorbed the most and this was especially significant across large depths of water. They concluded that this was why the Blue Grotto appears blue and hope to establish a relationship between transmissivity and volume.

Introduction

Why do Blue Grottos, such as the one in Capri, Italy, appear blue? This question is interesting as it concerns why water appears blue so I will study this by calculating its transmissivity.

Experiments

The experiment to calculate transmissivity of water

Equipment

A foam polystyrene box (35 × 20 × 20 cm^3) and a black wooden box (180 × 20 × 20 cm^3) were used. A halogen lamp, when the foam polystyrene box was used, and a fluorescent light, when the wooden box was used, were used as the light source.

Method

The light inside each container was analyzed and the transmissivity was calculated.

The experiment to check the water absorbs all red light

Equipment

Three foam polystyrene cubes (5, 10, and 20 cm on each side) and a drum whose inner part was covered with foam polystyrene were used. A halogen lamp, in the experiment of the foam polystyrene boxes, and sun light, in the experiment of the drum, were used as the light source.

Method

The lights inside each container was analyzed and the transmissivity was calculated.

Results and Discussion

Figures 1 and 2 show the percentage transmittance against wavelength. As Figure 1 shows, water absorbs a lot of red light and little green and blue lights regardless of container or light source. As Figure 2 shows, transmissivity can be almost zero, if

Figure 1: The Blue Grotto in Capri, Italy. Available from: http://en.wikipedia.org/wiki/File: Grotta_azzurra.jpg

you have a large amount of water as a drum. Larger volumes may absorb a larger spectrum of light.

Conclusion

Water absorbs red light and has potential of making blue similar to the Blue Grotto. In the future, to clarify the relationship between transmissivity and volume, I'll experiment with higher precision.

Since the 1st Anglo-Japanese Science Conference, we have further explored this area. Below is a summary of our further work in order to achieve greater precision: We believe that $F(\lambda) = s(\lambda)*a(\lambda)^d$ holds.

λ: Wavelength. Unit is usually nm.

F(λ): Strength of light whose wavelength is equal to λ. Various units such as W/cm ^2 are used.

s(λ): Strength of light used as a light source whose wavelength is equal to λ.

Various units such as W/cm ^2 are used.

a(λ): Transmissivity of light whose wavelength is

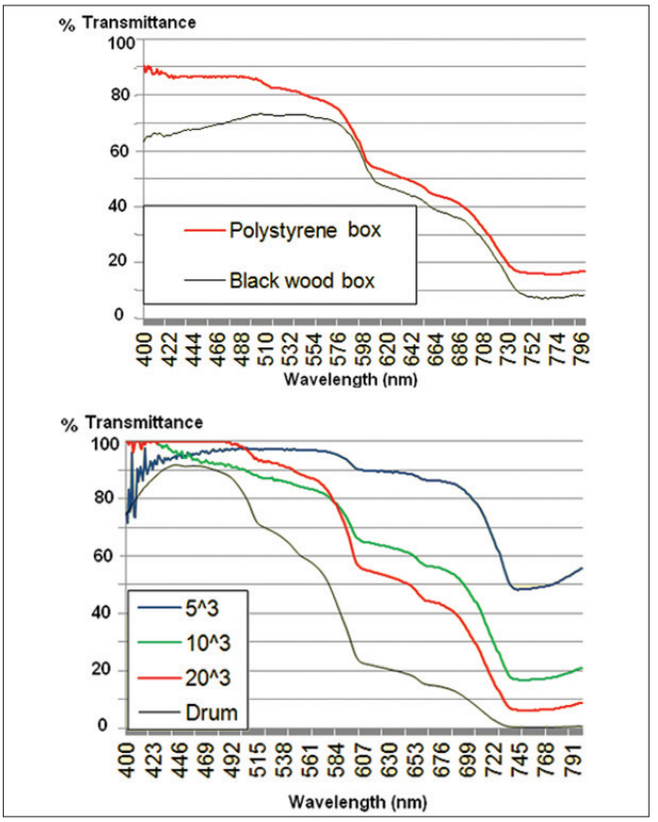


Figure 2: How transmittance varies across wavelengths for each dimension of the boxes (above) and cubes (below)

equal to λ.

d: Distance light goes through water. Unit is usually meter.

After identifying transmissivity (a(λ)), we can calculate the water's colour (F(λ)) only by deciding the distance between our eyes and the light sources (d) and what to use as the light source (s(λ)).

Therefore, by calculating with a computer, we can analyze the light of the Blue Grotto only if we measure its spectrum. However, we have not yet had a chance to measure it in Italy!

About the Authors

Yuki Hara was born in Aichi, Japan in 1996. He has studied about the Blue Grotto for two years since he succeeded to his predecessors and in 2012 he received some awards and joined the science conference at St.Paul's School. He is very interested in economics and his ambition is to be a greater entrepreneur than Mark Elliot Zuckerberg, the president of Facebook.

Yuki Matsuoka, Ken Ohashi and Shuji Yamada also attended the science conference at St.Paul's School.