

# RELATIONSHIP BETWEEN THE MAGNETOTAXIS OF PARAMECIA AND MAGNETIC FIELD STRENGTH

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## INTRODUCTION

Paramecia have magnetotaxis. Magnetotaxis is an electrophoretic properties of the microorganism when exposed to a magnetic field. Studies about the magnetotaxis of paramecium had been done, and the they reveal the relationship between magnetic direction and moving direction.

People who studied them examine the movements of paramecium by taking a video and the trail in the magnetic field.

However, the degree of the movement of the paramecium depending on the magnetic field strength has not been studied.

So, we decided to examine about this in our study.

## PURPOSE

1. To analyze the data by a new method.
2. To clarify “degree of reaction” to a magnetic field.

## METHOD

In the study, we defined degree of reaction for magnetic field indepently. First we projected the image of a paramecium on to a smartphone’s screen. On that screen, we set the coordinate axis with the lower left point as the coordinate origin. Let the coordinate of the point the paramecium enters be  $(x_1, y_1)$  and the coordinate of the other point the paramecium leaves be  $(x_2, y_2)$ .

Finally, we calculate the difference of each x,y coordinate  $(x_{dif}, y_{dif})$ . This data treatment shows the paramecium’s movements in the horizontal and vertical direction. Ex.)



$x_1$	$y_1$	$x_2$	$y_2$	$x_{dif}$	$y_{dif}$
0	3	8	2	-8	1
6	6	5	0	1	6

We repeat this operation and calculate the average. We think it’s possible to know the paramecium’s movements from a mathematical point. However, this time, the paramecium doesn’t have an external factor and the paramecium moves at random. (In reality, the microscope reverses top and bottom, right and left so the operation is done in opposite ways.)

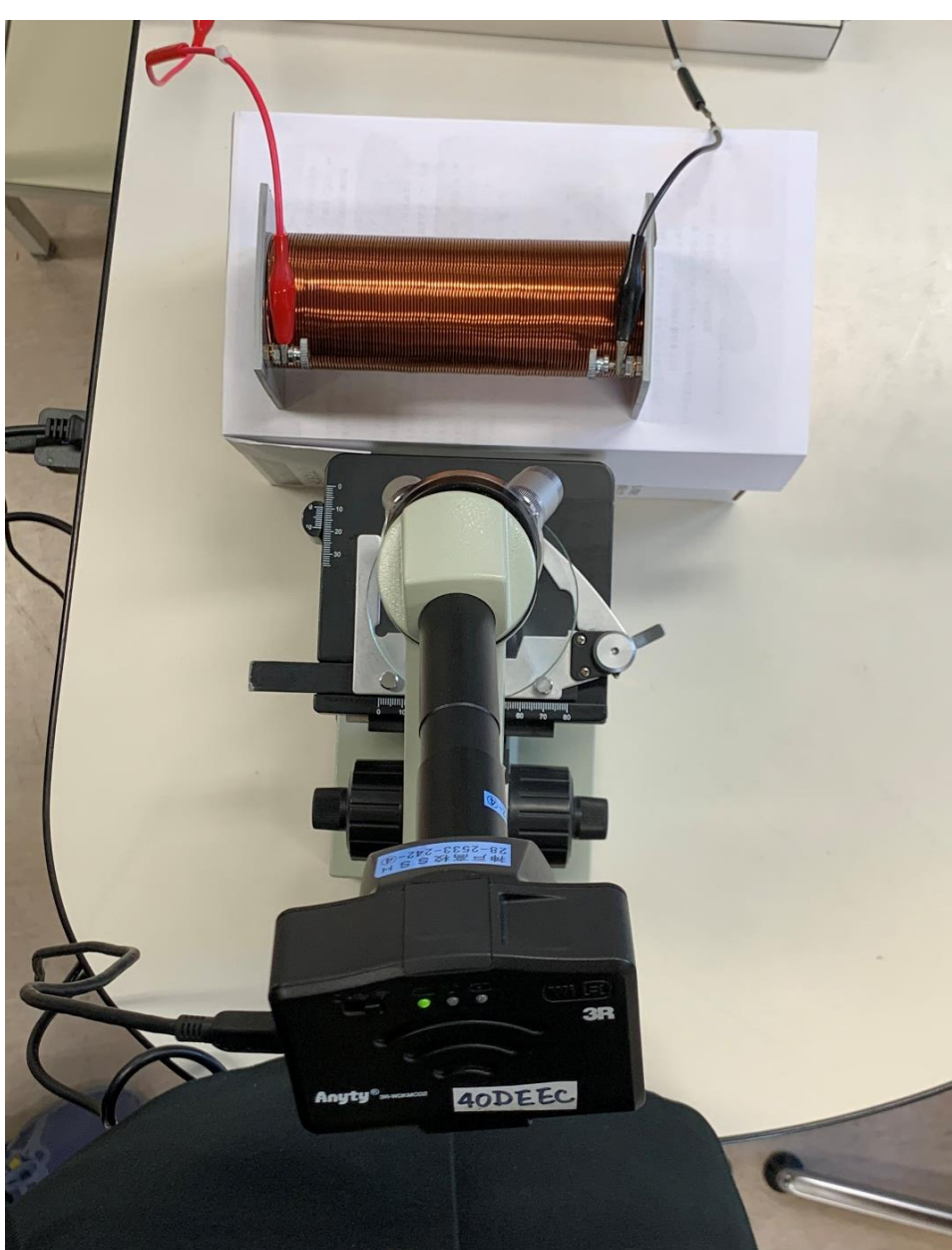


Figure 1

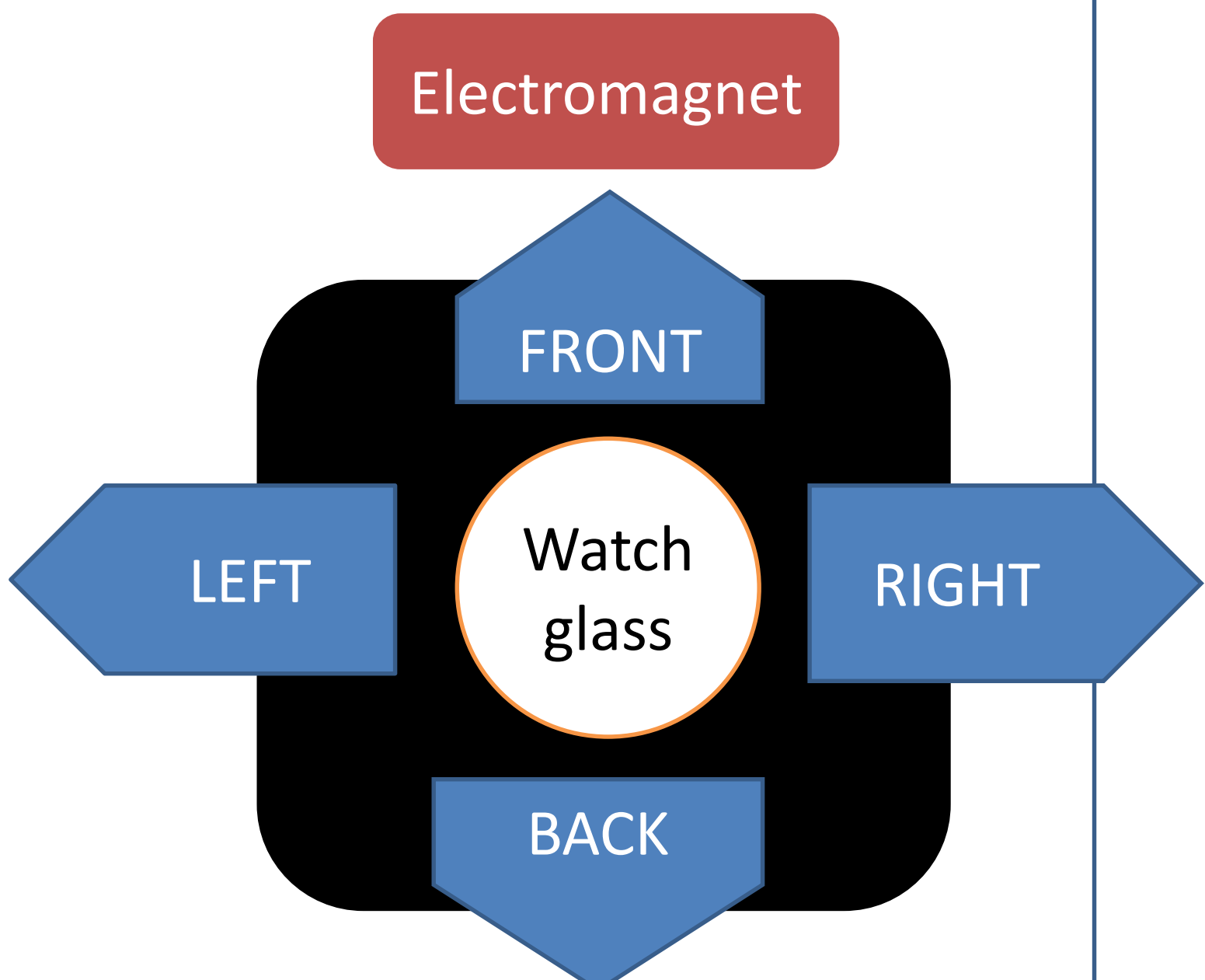


Figure 2

### Experimental process

- 1.Connect Wi-Fi camera to lens barrel and set 4 × objective lens.
- 2.Superimpose clear film written coordinate on the display projected video that is taken by the camera.
- 3.Take data about moving paramecia.
- 4.Continue this research while changing conditions.



Figure 3



Figure 4

## Results and Consideration

### Experiment 1

GRAPH 1

(BASE) ONLY GEOMAGNETISM	$x_{dif}$	$y_{dif}$
AVERAGE	-0.345	0.043
MEDIAN	0	0
POSITIVE	0.426	0.436
NEGATIVE	0.488	0.432

GRAPH 2

1.33A LEFT→RIGHT	$x_{dif}$	$y_{dif}$
AVERAGE	-0.416	-0.194
MEDIAN	-1	0
POSITIVE	0.412	0.456
NEGATIVE	0.548	0.488
DIF TO BASE	-0.071	-0.237

GRAPH 3

0.667A LEFT→RIGHT	$x_{dif}$	$y_{dif}$
AVERAGE	-0.578	-0.206
MEDIAN	-1	0
POSITIVE	0.416	0.456
NEGATIVE	0.536	0.492
DIF TO BASE	-0.233	-0.249

GRAPH 4

0.333A LEFT→RIGHT	$x_{dif}$	$y_{dif}$
AVERAGE	-2.07	-0.092
MEDIAN	-3	0.25
POSITIVE	0.332	0.500
NEGATIVE	0.636	0.444
DIF TO BASE	-1.725	0.049

GRAPH 5

0.250A LEFT→RIGHT	$x_{dif}$	$y_{dif}$
AVERAGE	-1.20	-0.0333
MEDIAN	-1	0
POSITIVE	0.413	0.480
NEGATIVE	0.553	0.427
DIF TO BASE	-0.858	-0.0097

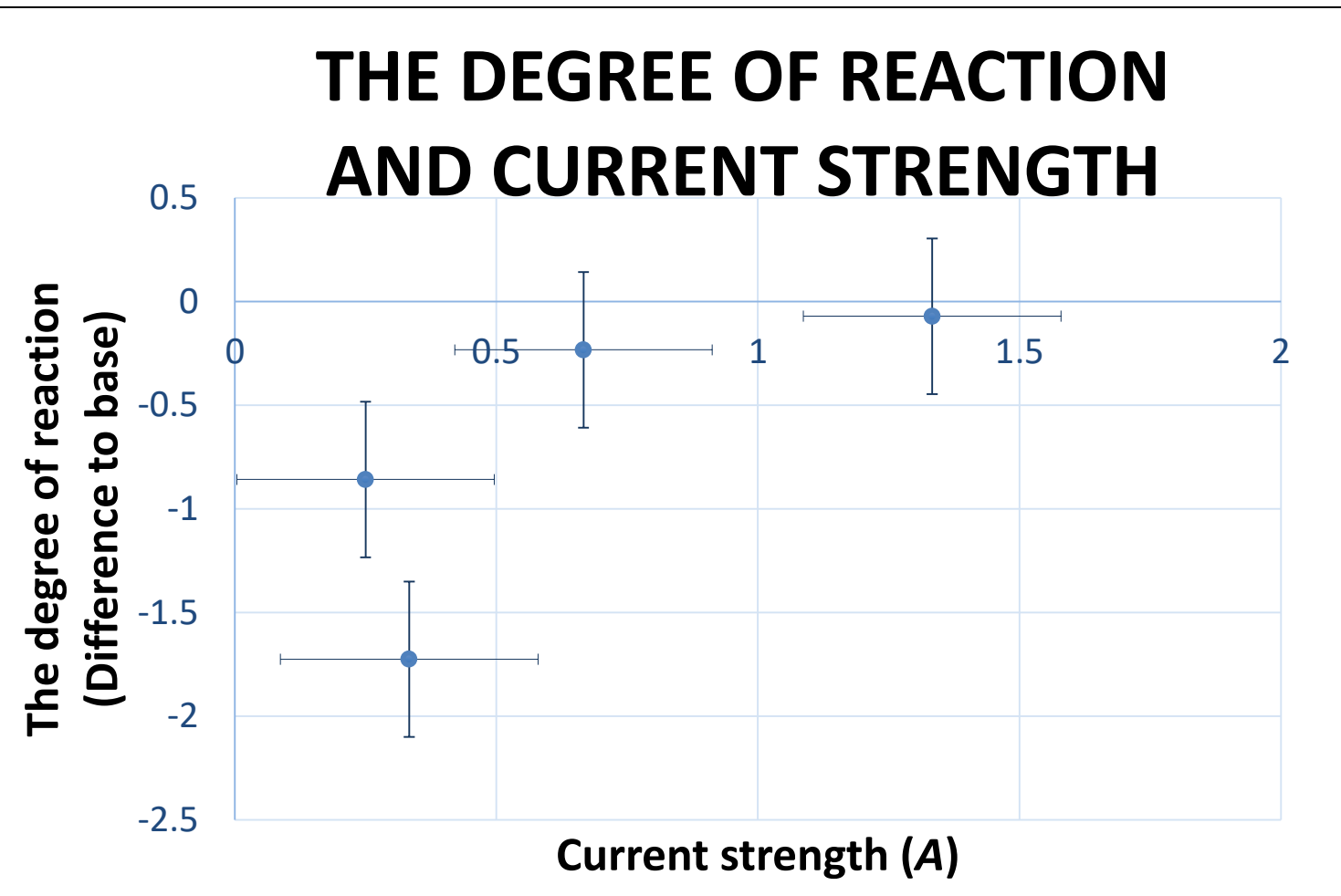


Figure 5

We found two things from Figure 5.

1. Paramecium moved along the lines of magnetic force.
2. The degree of reaction didn’t have a positive correlation with magnetic field strength.

At first, we constructed a hypothesis that the degree of reaction of the paramecia is proportional to the strength of the magnetic field. We conducted procedures where only the magnetic field is changed. The strength of the electric field depends on the strength of the electric field on the electromagnet, but the degree of reaction of paramecia does not getty large when the volume of electric is gets large.

As a result of this study, we can understand the positive correlation between lapse and degree of reaction with a neodymium magnet.

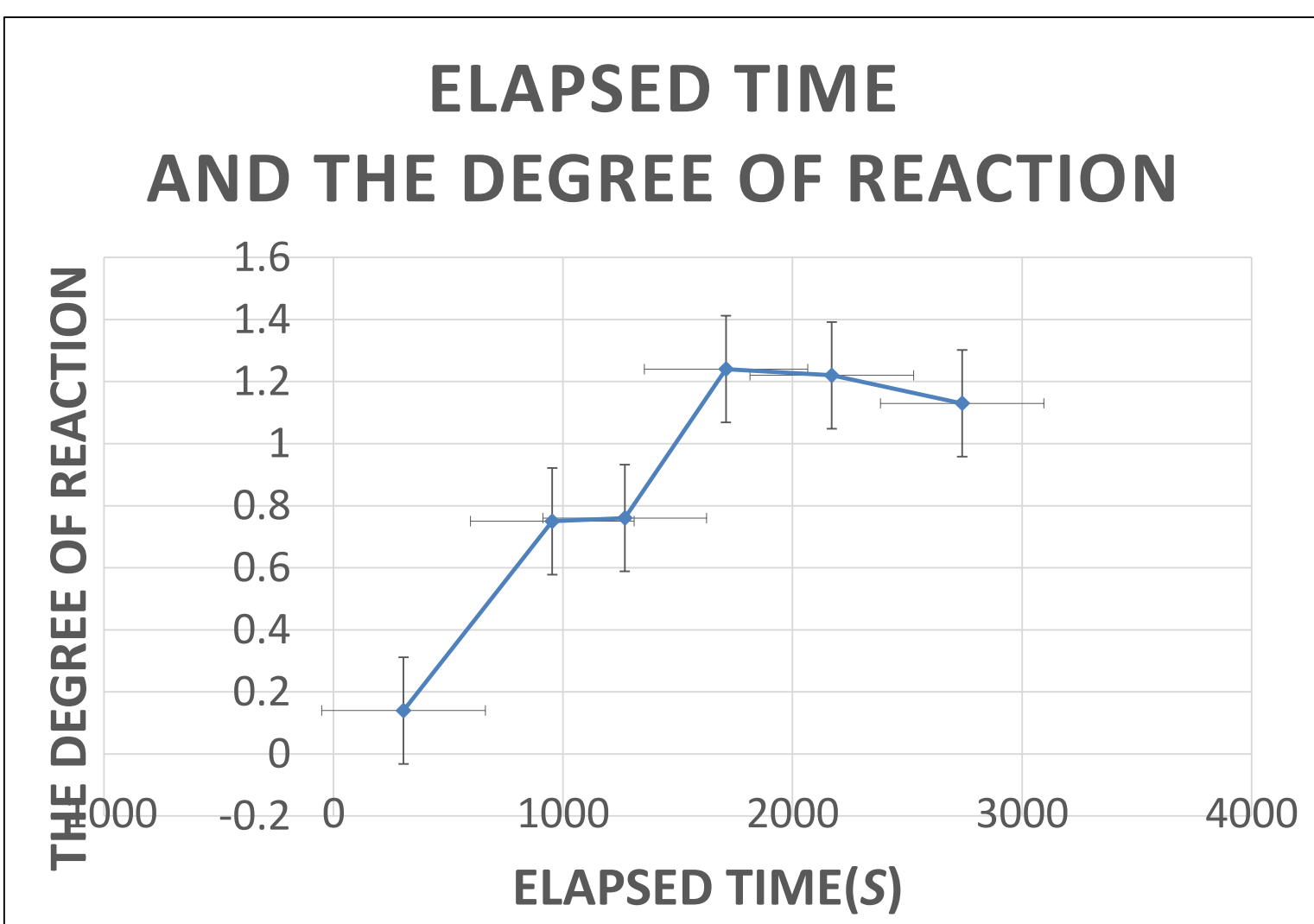
### Experiment 2

This experiment is the same as Experiment1.

We measure the lapse every fiftieth data point.

GRAPH 6

ELAPSED TIME(s)	THE DEGREE OF REACTION
305	0.14
953	0.75
1269	0.76
1710	1.24
2171	1.22
2739	1.13



CORRELATION COEFFICIENT=0.869779...

Figure 6

## Results and Consideration

We found **two things**. First, **the paramecium moved along the lines of magnetic force**. Second, the degree of reaction didn’t have a positive correlation with magnetic field strength, but **had it with the time that the magnetic field was kept applied**. We think it’s because of **the increase of paramecium population that changed membrane potential**; operated the movement of the paramecium.

The importance of time was not paid much attention to in previous research. However, we recognize that **our study suggests the importance of time**.

Reference: <http://molsci.center.ims.ac.jp>

[http://www.toray-sf.or.jp/activity/science\\_edu/pdf/h17\\_06.pdf](http://www.toray-sf.or.jp/activity/science_edu/pdf/h17_06.pdf)