Simple and beautiful experiments by physics teachers and students in Japan

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(Received 25 July 2011; accepted 3 January 2012)

Abstract

In this workshop, we show the simple and beautiful experiments that attract students to physics. We prepare the materials and explain how to make the apparatus of the experiments, and you can make them with us together. Since the experiments we show are low cost and easily made of daily use, you can bring the experiments in your class soon. As an example, we show the experiments with which students can learn how we can detect radiation, how much are we exposed to the radiation from the natural environment and so on. Most of all, we hope students to have an attitude to make a decision on radiation in a levelheaded manner. This workshop is associated with the special session about Fukushima nuclear plant accident by H. Nitta, A. Kobayashi, and H. Kawakatsu.

Keywords: Workshop, Hands on Experiments, Radiation Education.

Resumen

En este taller, se muestran los experimentos simples y hermosos que atraen a los estudiantes a la física. Preparamos los materiales y se explica cómo hacer los aparatos de los experimentos, y cómo podemos hacerlo juntos. Dado que los experimentos que se muestran son de bajo costo y fácilmente hacer de uso diario, usted puede traer los experimentos de su clase antes. A modo de ejemplo, se muestran los experimentos con los que los estudiantes pueden aprender cómo detectamos nosotros la radiación, en qué medida estamos expuestos a la radiación del entorno natural y así sucesivamente. Por encima de todo, esperamos que los estudiantes tengan una actitud de tomar una decisión sobre la radiación de una manera sensata. Este taller está asociado a la sesión especial sobre el accidente de la central nuclear Fukushima por H. Nitta, A. Kobayashi y H. Kawakatsu.

Palabras clave: Taller, Manos sobre experimentos, Radiación de educación.

PACS: 01.30.Cc, 01.40.E, 01.50.My **ISSN 1870-9095**

I. INTRODUCTION

We propose simple and beautiful science experiments that can demonstrate the principles of physics and improve students' interest. These experiments are easily made, low-cost and popular for students. In the workshop of ICPE 2011, we prepare the materials and explain how to make the apparatus of the experiments, and the participants can make them with us together. Since the experiments we show are easily made of daily use, you can bring the experiments in your class soon. We believe it is meaningful to share superior teaching materials with teachers all over the world.

Our activity is based on the activity of the group: LADY CATS (LADY Creators of Activities for Teaching Science). LADY CATS is an organization of science teachers from primary school to university. We aim to encourage not only the students but also the primary school teachers. This is because, in Japan, there is a problem that many primary school teachers have studied only general science in the college and don't have confidence to teach science, especially the contents about physics.

II. EXPERIMENTS

In this section, we explain the outline of the experiments we show in the work shop in turn.

A. Geiger-Müller counter made of a film case (Group of Meijo U.)

A Geiger-Müller counter (GM counter) is a particle detector that measures ionizing radiation. We can make this apparatus with daily use (See Fig. 1.). The basic idea is to use a film case to make the GM tube [1], and measuring the noise induced by electrostatic discharge in the GM tube with an AM radio receiver [2]. As additional ideas, butane in a lighter is encapsulated in the case to improve the sensitivity to detect the radiation. And also, if it is not humid, a condenser made of plastic cups and aluminum foil can be used to give electric power. In this workshop, in order to supply enough electricity, we also use a high voltage generator with hand crank just in case. With this experiment, students can learn how we can detect radiation.

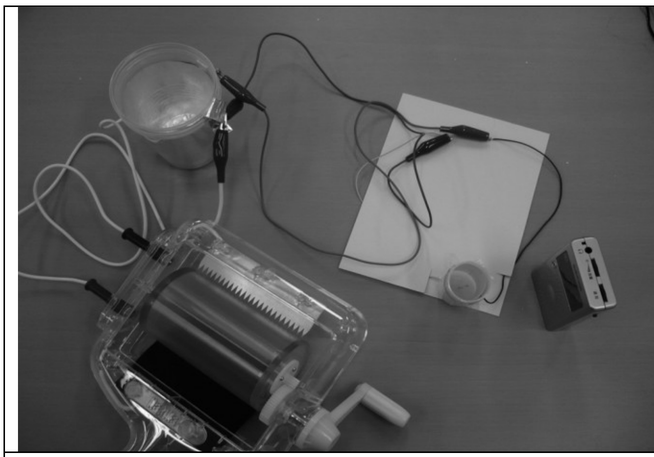

FIGURE 1. Geiger-Müller counter made of a film case. GM tube is made of a film case (center right side), the associated ditector is an AM radio receiver (right side), and the electricity is supplied by the condenser made of plastic cups (upper left side) or a high voltage generator with hand crank (left below).

B. Cosmic Rays Detectable Plastic Bottle Cloud Chamber (Hirotaka Hayashi)

Let's construct a high performance cloud chamber by the use of easily obtainable materials as a plastic bottle, with which we can observe cosmic rays (Figs. 2, 3) [3]. Usually, we can hardly observe cosmic rays or beta rays, because the number of ions produced in the chamber is too small to generate visible ionization clouds, comparing with the case of alpha rays. We have developed a high performance cloud chamber, based on an entirely new concept of placing a shallow ethyl alcohol pool at the bottom of the chamber. This high performance cloud chamber enables us to observe traces of radiations without using any radiation source. We can observe traces of cosmic rays falling from the sky, and beta rays emitted from a concrete wall of the buildings. We can also observe the circular traces of beta rays due to Lorentz force, if we place a large strong permanent magnet on the bottom.

Students will enjoy a new world that they have never seen before, and will obtain a plenty of new knowledge on natural science.

C. Realize the existence of Electromagnetic field (Norihiro Sugimoto and Youko Nariai)

We are living in the sea of Electromagnetic field and we use it in the various scenes. However we can't realize the existence of the Electromagnetic field because it is invisible. The experiments below are the equipments to let students realize the existence of the Electromagnetic field.

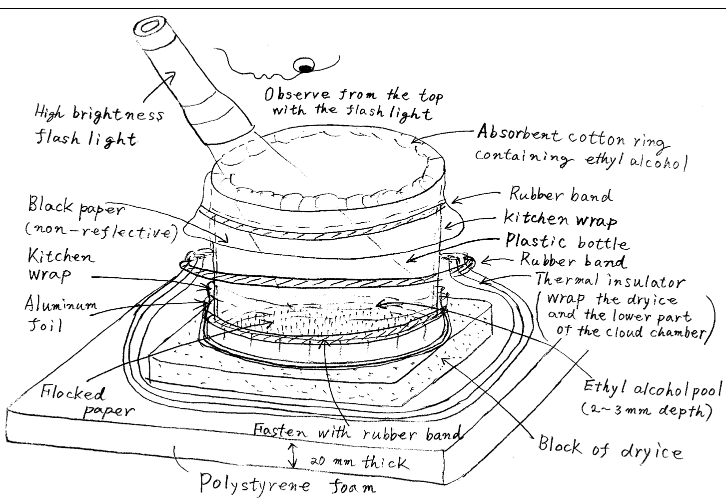

FIGURE 2. The over view of the cloud chamber

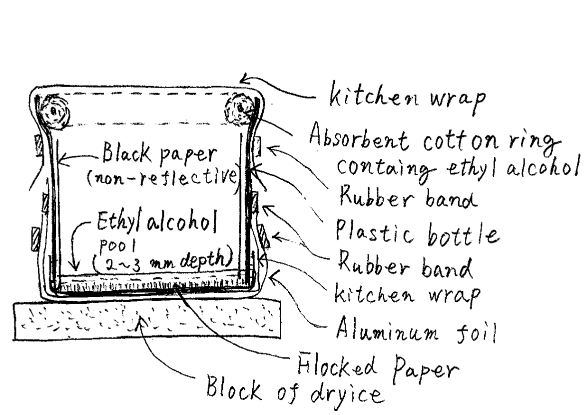

FIGURE 3. The picture of cloud chamber from the side view

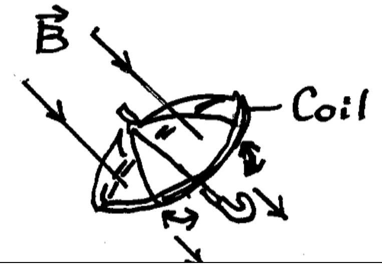

FIGURE 4. The picture of the umbrella coil.

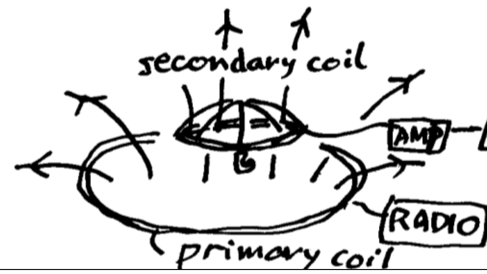

FIGURE 5. The picture of the umbrella coil used as a music amp.

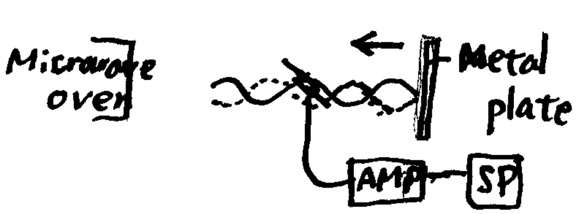

FIGURE 6. The picture of the simple experiment to visualize radio wave

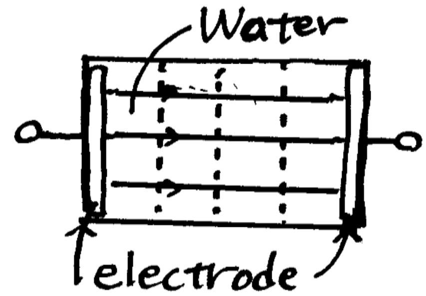

FIGURE 7. The picture of the instrument to feel the electric field

C.1 Umbrella Coil

According to Faraday's law V=-dφ/dt. As φ=B･S (S is a square measure of the area), dφ/dt is also produced by changing S. I. made a flexible coil (Umbrella Coil) that makes it possible to change S quickly. By turning the top of the Umbrella Coil toward the direction of the geomagnetic field line and opening or closing the umbrella, electromagnetic induction occurs (Fig. 4). Another use of the Umbrella Coil is a mutual inductance. Make a big primary coil with a long cord and use the Umbrella Coil as a secondary coil. By passing a musical sound current to the primary coil, alternative magnetic field appears from it.

When you put the opened umbrella above the primary coil, many magnetic field lines pass through the coil and you can listen to musical sound from the amplifier connected to the Umbrella Coil. (Fig. 5) Through examining the direction of the magnetic field by the Umbrella Coil, students can image the magnetic field that spreads from the primary coil.

C2. Simple experiment to visualize radio wave

Radio wave from a microwave oven or a cellular phone is detected by a shot key diode. Connect a shot key diode to an AC amplifier. Because the radio wave is modulated, you can magnify the signal by the audio amplifier. When you put the diode near the working microwave oven you can find the radio wave emitted from it by hearing the sound from the speaker. You can also investigate whether something emitted from the oven is a wave or not. Prepare a metal plate. If something emitted from the oven is a wave, it makes a standing wave between the source and the metal plate. Fix the diode between the source and the board and moving the board towards the source. Then you can hear the sound from the speaker change the loudness periodically. (Fig. 6)

C3. Feel the Electric field

Charges make electric field around them and the electric field is decided by the distribution of the charge. One charge makes a radial electric field and charges distributed on the plane make a uniform electric field. By this experiment students feel the appearance of the electric field around charges. Prepare a big tray. Put electrodes on each inside of the edges as Fig. 7 and fill the tray with water. By applying voltage (high frequency and high voltage) between two electrodes there appears uniform electric field. Though it is alternative electric field, uniform electric field exists in every instant. Stick two fingers into the different place in the water, you feel the electric field by an electric shock. (a little). You can make a radial electric field by using a round tray.

D. The PET bottle fiber, the acrylic fiber (Fumiko Okiharu)

An optical fiber is a transparent fiber made of quartz glass to transmit light. Light propagating within a glass will be total reflection if it strikes the glass-air surface at an angle of 41.1 degree or greater. Our teaching materials will contribute for school teachers to teach the principle of light reflection.

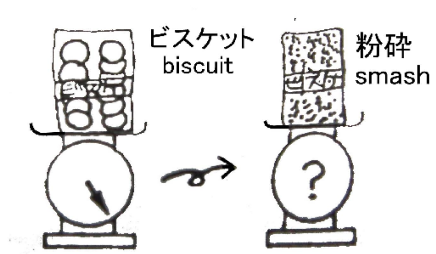

FIGURE 8. The picture of the experiment **E.(1)**

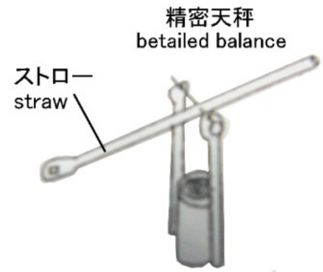

FIGURE 9. The picture of the experiment **E.(2)**

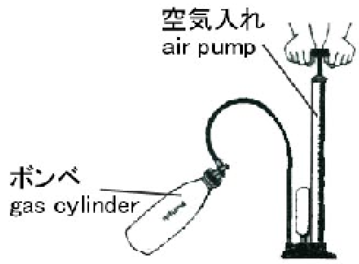

FIGURE 10. The picture of the experiment **E.(3)**

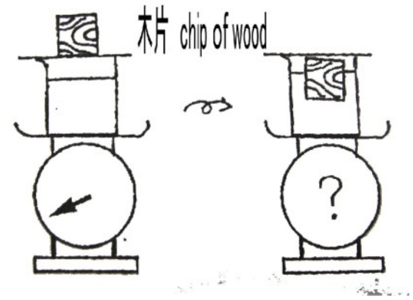

FIGURE 11. The picture of the experiment **E.(4)**

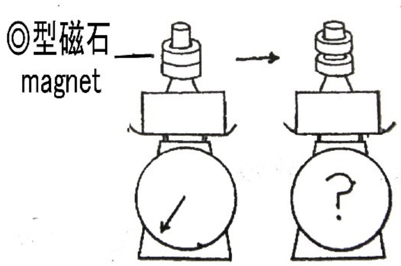

FIGURE 12. The picture of the experiment **E.(5)**

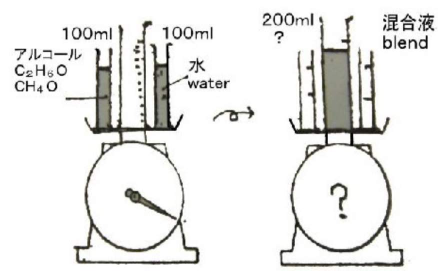

FIGURE 13. The picture of the experiment **E.(6)**

E. An experiment introduction to straighten misrecognition of the weight (Sadao Yasue)

A target child 11 years old-12 years old.

(1) If powder a cookie with a bag; How weight do you groan? (Fig. 8)
(2) Weight of the paper which is thin with the precision balance using the straw I measure. Does the paper of the small piece have the weight? (Fig. 9)
(3) In an inflator, I air the PET bottle. How do the weight turn out? (Fig. 10)
(4) When I had a chip of wood in water, how does the weight turn out? When I floated a ring type magnet (Fig. 11)
(5) How about the weight is it changing? (Fig. 12)
(6) When I mixed 100ml of alcohol and 100ml of water How does the weight turn out? Is the volume 200ml? (Fig. 13)

F. The feature of Solar Cells (Hisashi Kogetsu)

We will examine the feature of solar cells by comparing chemical cells. We will connect a midget bulb with a small resistance to cell(s) and examine the brightness of the bulb. We will do examinations following 4 ways: 1) We will compare a chemical cell and 2 chemical cells in series. 2) We will compare a chemical cell and 2 chemical cells in parallel. 3) We will compare a solar cell and 2 solar cells in

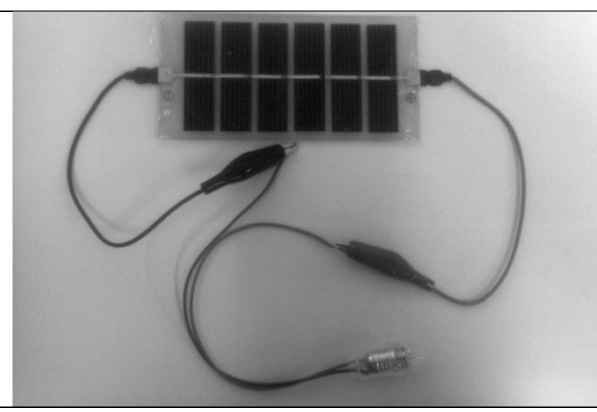

FIGURE 14. The picture of solar cells.

series. 4) We will compare a solar cell and 2 solar cells in parallel. In this workshop, we will explain the reason of the result of those examinations and the feature of solar cells.

III. SUMMARY

We introduce simple and beautiful science experiments that can demonstrate the principles of physics and can improve students' interest in the workshop of ICPE 2011. These experiments are easily made, low-cost and popular for students. And since the experiments we show are easily made of daily use, the participants can bring the experiments in your class soon. We believe it is meaningful to share superior teaching materials with teachers all over the world.

In the future work, we plan to whether the popularity of these experiments are universal and how these experiment are effective to motivate the students to study physics.

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