NEWSLETTER

ONTARIO ASSOCIATION OF PHYSICS TEACHERS
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International Thermonuclear Experimental Reactor: An Update

By Elzbieta Muir

ITER, International Thermonuclear Experimental Reactor, the world's largest fusion energy research centre and the world's largest international project after the International Space Station, is well under way! In September 2002, a group of international experts from Canada, the European Union, Japan, and the Russian Federation met in Toronto to negotiate the implementation of the project and to assess our proposed Canadian site in Clarington, near Toronto. The adjacent Darlington Nuclear Station would be an ideal source for tritium. Tritium, a by-product of the nuclear plant, and deuterium, found in all water on the planet, are the fuel for the ITER. The other proposed sites in Japan, France, and Spain are being assessed in October and December 2002. The draft of the Joint Implementation Agreement is planned to be finalized by mid-2003.

Fusion research projects started about 50 years ago. The world's first TOKAMAK (an acronym for the Russian words: toroid-kamera-magnit-katushka) was constructed in 1954 in Russia. Today, with 100 tokamaks worldwide (the largest research centres being at JET - Joint European Torus, Princeton, Japan, and Moscow), 30 countries are working to prove fusion can be a viable, large-scale energy source. The largest reactor to date, JET, produced 18 MW of fusion power in 1997. The design of the next generation of plant, ITER, started in 1987. ITER will be three times the height of JET and is expected to produce 500 to 700 MW at an estimated cost of $20 billion.

Are the cost, time, and resources involved in fusion research worth the effort? Obviously the Earth does not have an infinite supply fossil fuels, and other sources of energy like the wind and sun are not easily scaled to meet increasing demands. So, from this perspective alone, the investment seems justified. Fission energy, currently providing about 15% of the world's energy, is a well-established technology and will continue to be part of the energy mix for a long time. However, with nuclear power come concerns over long-term waste storage and security. The up-front capital cost of a fusion plant is high, but it does not have the hazardous waste associated with fission energy or the greenhouse gas emissions of coal and oil. The waste product of fusion is helium, and the radioactive metal remaining after a fusion reactor like the tokamak has reached maturity will not leak into the air or ground, making safe storage much more feasible.

The benefits of hosting the largest Energy R&D Centre on Earth will be significant. The project would bring billions of dollars in economic spin-offs; would attract top scientific and academic people; and would bring jobs, opportunity and reputation. The operation of the research centre of ITER is expected to begin around 2012 and run for about 20 years. Therefore, the fusion electricity generating plants will not be around earlier than the middle of the 21 century.

Technical information on ITER can be found at www.iter.org (there are sections on the Physics and Design of ITER and Fusion Research with links to Frequently Asked Questions; see also the 7-min 5MB film "Star Makers"). Teacher resources on fusion are at http://fusioned.gat.com (see the Fusion Slide Show).

The Demonstration Corner

Acoustical Wheel With Christmas Tree Balls

By Christian Ucke
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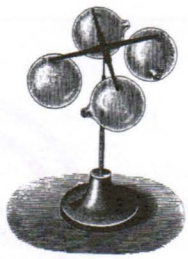

Fig. 1 Acoustical wheel from an old physics book

Figure 1 was taken from an old German physics textbook [1] dating from from 1906. So-called Helmholtz-resonators are fixed on a cross which can rotate easily on a needle bearing. With the right resonance frequency of the Helmholtz-resonators and enough acoustical power from a loudspeaker, this device starts to rotate anticlockwise (view from above).

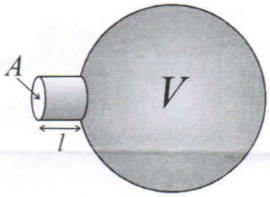

Fig. 2: Helmholtz Resonator

Using the following formula, the resonance frequency of a Helmholtz-resonator can be calculated (fig. 2; derivation in [2])

$$f_{\text{Resonance}} = \frac{c}{2\pi} \cdot \sqrt{\frac{A}{V \cdot (l + \frac{\pi \cdot r}{2})}}$$

(V = volume of the sphere; l = length of the cylinder; r = radius of the cylinder;
A = area of the cylinder; c = velocity of sound)

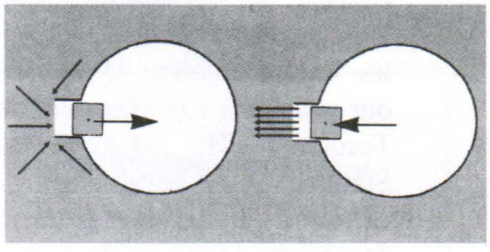

Fig. 3: Explanation of the force

The explanation of the rotation is very similar to that of the well-known water-jet-boat (put-put-boat): The sine-stimulated loudspeaker causes a pressure variation inside the sphere at the resonance frequency. If the pressure in the sphere is smaller than outside, the air is sucked into the sphere from all directions (fig. 3).

If the pressure in the sphere is higher, the air is pressed out of the cylinder and has a preferred direction. Thus, a net force to the left side results.

This object can be realized in a entertaining way with appropriate Christmas tree balls. The balls must have an open, cylindrical part. They can be fixed and balanced very easily with adhesive tape on a simple cross made of rectangular wood rods (fig. 4). One can even combine two crosses with different ball sizes and opposite rotation sense. These crosses have to be hung on a string with swivel snaps (as on fishing lines) so that they can rotate freely.

Fig. 4: The acoustical double wheel with Christmas tree balls. At the bottom the loudspeaker can be seen.

What you need now is a powerful amplifier with hundred-watt power, a good loudspeaker and a frequency generator. A computer loudspeaker (about 50 W) connected with a soundcard works also, but then the wheel rotates only slowly. The resonance frequency of the Christmas tree balls can be calculated only roughly with the formula because often the cylindrical part is not complete and not entirely cylindrical. Then one can find the best resonance frequency simply by experimenting. I was successful with

Christmas tree balls with diameters of 4.4 cm ($f_{resonance} \approx 380$ Hz) and 5 cm ($f_{resonance} \approx 580$ Hz). The resonance frequency of a Christmas tree ball is relatively sharp.

It is also possible to operate the whole device with the right music which contains the resonance frequency. The power of music in contemporary discothèques is probably high enough. It is not recommended to use powerful Christmas music under the Christmas tree because this might disturb the meditative atmosphere of the festival of Christmas.

References:

[1] Mueller-Pouillet's Lehrbuch der Physik und Meteorologie, Braunschweig, Vieweg 1906, page 790
[2] Bergmann-Schaefer, Lehrbuch der Experimentalphysik Bd 1, Mechanik, Akustik, Waerme, Berlin 1975, page 523

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Submissions describing demonstrations will be gladly received by the column editor.

Simulation Experiments for Teaching Physics

By Rolly Meisel

The new version of Geometer's Sketchpad, GSP4, has recently been licensed for use in Ontario schools. Although it was designed as a dynamic geometry program, it is also a powerful tool for creating interactive physics demonstrations. For example, one of the "canned" files bundled with the software simulates refraction and dispersion of light in a triangular prism. The student can use a slider to adjust the relative indices of refraction among the colours, and instantly see the effect.

In addition, GSP4 includes an Export utility that allows a simulation to be saved as a Java applet. Students do not need to have GSP4 installed on their computers in order to run the applet. The applet runs under standard web browsers such as Netscape or Microsoft Internet Explorer. You can store these applets on a web site accessible to students through the Internet, and assign virtual experiments to be done at home.

If the full version of GSP4 has not yet reached your school, you can download an evaluation version at www.keypress.com. It is fully functional, other than Save and Print functions. The site also contains information on creating Java applets using GSP4.

OAPT Grade 11 Physics Contest

This year's OAPT Prize Contest will be written on **Tuesday, May 6, 2003**. This contest is for students who have taken or who are taking SPH3U1. Students who have taken SPHOA or SPH4U are ineligible.

For information on the contest e-mail Terry Price at: thprice@sympatico.ca

Applications and information is also available on the OAPT web site at:
http://www.physics.uoguelph.ca/OAPT/contest/contest.html

Schools must register by April 4, 2003.

Let's Play: Quotable Quotes!

Here's the deal. Identify the famous scientist who said the quote below. Be the first person to email your response (c/w mailing address) to the editor, Paul Passafiume, at paulpassafiume@hotmail.com and you'll win a prize! It's that easy. Here we go!

"Nothing in life is to be feared. It is only to be understood."

Bonus round. Bragging rights only!

"It is only with the heart that one can see rightly. What is essential is invisible to the eye."

Do you want to give back to your profession? Participate in the OAPT!

This wonderful organization needs volunteer help in the following capacities:

- Guest presenters
- Conference organizers, and facilitators
- Members of the executive committee
- Article, and classroom idea contributors for the Newsletter

New articles, ideas, or other information items may be sent to Glen Wagner (glenn.wagner@ugdsb.on.ca) or Paul Passafiume (paulpassafiume@hotmail.com). Ideas for demos may be sent to Ernie McFarland (elm@physics.uoguelph.ca).

Membership Matters!

Join the Ontario Association of Physics Teachers! Members receive a Newsletter and reduced registration rates at the annual conference.

As well, from time to time, the Association makes available special resources. Examples have included reprints of **"Demonstration Corner"** articles from the **Newsletter**, and the videotape, **"The Physics of Dance,"** from a presentation at one of the annual conferences.

To become a member of the OAPT, send a cheque for $8 (or a multiple thereof) payable to OAPT to:

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Useful Web Site for the Physics of Waves

The following site, submitted by John Childs, contains an extraordinary amount of information about and simulations of wave phenomena. Thanks for your input, John!
http://www.hazelwood.k12.mo.us/~grichert/sciweb/waves.htm

If you find a web site that is particularly useful, send it to the editor, Paul Passafiume (paulpassafiume@hotmail.com) , so that it can be included in the next release of the NewsLetter.