The influence of international competitions on the everyday physics teaching

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Abstract

The influence of competitions on physics teaching depends - above all - on their characteristics. In this paper the impact of International Young Physicists' Tournament (IYPT) and International Conference of Young Scientists (ICYS) on the everyday physics education is analyzed. Since the competition's popularity in a given country is related to the national character – which is, of course, in a close connection with the level of the physics education, hence the feedback varies from country to country. It is instructive to compare how competitions affect physics education in two countries which have been involved in the IYPT in almost the same time period (Hungary since 1989 and Belarus since 1992), and which have cardinally different methods for the selection of the students. The influence of the above-mentioned competitions on the different stages of physics education is shown by listing the important points of experience gained during the more-than-ten year's training with students. A special problem – connected to soap films – is shown to illustrate the interaction between the competitions and the education.

Methodological consideration

There exist several kinds of international physics competitions. Probably the most famous the International Physics Olympiad (IPhO), - having been organized since 1967 - which is a competition of individuals. There are some other, newer competitions, which differ from the IPhO by their characters. The International Young Physicists' Tournament (IYPT) is a competition of student teams; the International Conference of Young Scientists (ICYS) is a scientific conference for secondary school students focusing on physics, mathematics, environmental science (ecology), and computer science. These competitions have already been introduced to the readers of this Journal and also to the participants of the 1st Congress of the World Federation of Physics Competitions in Bali.

The existence of the competitions of different characters encourages more students to test their capabilities because they can find the type of the competition which suit to their competence the best.

Here we summarize the most important features of the new types of competitions which can essentially determine their influence.

In the case of the IYPT, prior to the competition 17 problems are specified from various fields of physics and physics-related areas. On the ICYS a conference presentations' topic can be chosen from various fields, specified in advance (as it often happens on a scientific conferences). Both competitions need similar preparation of students, which implies relatively long student-teacher co-operations. During the preparatory work students learn the steps of the scientific research work (for the ICYS from the pointing up the topic

too), as long as they reach the last stage, the summing up the results of their investigation in a foreign-language lecture. Since the ending step of all students' work is the same, a presentation given in English followed by a short scientific discussion, it is just enough to analyze the way of problem solving of IYPT, the usefulness of the acquired knowledge. Seeing the problems of IYPT, we can establish that each of them can be theme for conference too.
The essential difference is the language between the Olympiad and these mentioned competitions. On the IPhO students have to solve the problems on their native language, whereas the new competitions require the students a good command of English, having primary importance in communication and discussions. This difference influences the popularity of the competitions, because it is much easier to find students interested in physics than find students with good English communication and also interested in physics.

Popularity of an international competition

The popularity of a competition differs in various countries and it is closely connected with their influence. The popularity of an international competition is in connection first of all with the level of physics education in a country, which can determine many other factors related with the participation of the students. The popularity can act on the selecting methods for the competitions, on the character of preparatory work done in the secondary schools and at the universities.
It is interesting to consider which factors determine generally the popularity of a competition, what are the motivations of students to participate and of teachers to prepare them. First of all, these international competitions measure the students' competence on the given field. Such a measurement acts as confirmation or critique of the level of the just valid curricula of the physics (or other science) in the secondary education. Students may be interested in attending an international competition like a conference, where they have to make a research work - just like in certain stages of their regular education, for instance, before the final exam. If they have a good topic and a contribution of an appropriate level, the teacher’s task is to decide whether or not the student's English is sufficient for the participation.
The foreign language education is different in the West- and East-European countries. The western countries at the moment have advantages from the point of view of English education for the large number of people – because of their long standing better position – in this field, which lag not so easily but can be compensated. There are some countries where the educational government decided to reward the students who successfully participated on the international competitions by allowing them to enter universities without entrance exams (it was/is practice in Eastern- and Central-European countries, when the physics was a popular science, an attractive subject in the school). That fact can be attractive for the students too.
At the end we have to mention as factor the traveling to abroad. An opportunity to travel or the travel costs - comparing with the average salaries – is not the same in the different countries. Nowadays when the majority of Central-European countries became members of European Community, for that population participation on an international program became easier than was earlier. However for the people from countries where the living is hard not only for the financial difficulties but from the demands of traveling conditions

(visa) participation becomes much rather complicated. They, in the future, in this field need the help of other countries, which are in better positions – and from the actual organizers need to pay on it a greater attention. This fact explains that to travel abroad because of an international competition can be an attractive factor, can enhance the interest of students and teachers too in a country.

Preparatory works

It is interesting to compare the work in these two countries which are involved in the IYPT almost in the same time (Hungary 1989, Belarus 1992), and have cardinally different methods for the selection of the students. The popularity of the competitions through the number of the inquiring students has influence on the selection method of the students. The organization of the preparatory work is also affected on these factors.

Hungary

In Hungary the problems of IYPT are published in Hungarian language in the Mathematical and Physical Journal for Secondary Schools (KöMaL) written for **students** already before December each year. Because the competitions in Hungary did not attract enough interest (the largest number was 16 to the ICYS or 18 to the IYPT students in a year) we are not able to organize team competitions in the schools. Every student who wants to participate in the competition has to send three or four solved problems to the organizers until March or April which is followed by a conference at Eötvös Loránd University, Budapest. Then each potential participant gives a lecture in English on a problem chosen by himself/herself before a jury formed by university teachers. The jury selects 5 students, the representatives of Hungary on the IYPT, usually from several parts of the country. English knowledge is a very important factor of the selection. Until this moment the competition is **individual** one, in Hungary the forming the team and learning the teamwork begins after the selection.

The methodology of the preparation of the students varies in different countries. In Hungary there is an intensive training for the **team** at the Eötvös Loránd University in Budapest, which is usually one or two days on a week during 4 weeks immediately before the tournament. Then university professors, specialists of the corresponding branches of physics are invited to give lectures. A very important part of the preparation is the experimenting through which the students learn teamwork and acquire important skills. We help to students in modeling the phenomena, in making video records to be able to analyze the details and the process of a phenomenon. Every member of the Hungarian team is responsible for three or four problems. That means, after the preparing work they have to formulate the reports in English and to present it at the tournament. To be successful each team must have students interested in theoretical analysis, experimental work, need specialists in computer science and pupils with outstanding English.

The announcement of ICYS is usually published in a scientific-popular journal in Hungary because on the conference are different sections from several fields of sciences and on a special internet ("Sulinet") website constructed for secondary education. A national conference is organized usually at the end of February also at the Eötvös Loránd University, where students present their contribution in Hungarian language and summarize the presentation in English. The jury, which have specialists from all fields connected with the topics touching on the earlier sent essays, selects the students to the ICYS. After that the organizers provide them consultations if they need and give them advice to compose the final version of their presentation. The final stage is when the students take us (organizers) their presentation prepared to the ICYS.

Belarus

The publication of 12 problems from the announced 17 occurs usually in November in a journal **for teachers** in Belarusian and Russian languages - in contrast to Hungary - is not addressed to the students but to the teachers. Because of the bigger interest, usually 100-200 students in Belarus, the selection is similar as in sports, and the competition is from the early beginning a team competition. The first selective fights are organized in the schools, then in the towns (villages), and then in some regions. The best teams, usually 15-20 participate on the National YPT, from which the two winner teams, – 10 students– take part on the intensive training organized at the Belarus State University, Minsk. Usually 15-20 days before the IYPT intensive training course of that 10 students occurs at the university. Then lectures and seminars are organized for the students, teachers from the university, specialists from other institutes give lectures. They make together some experiments in laboratories, and some computer simulations are done modelling certain phenomena. Students, as in Hungary too, need the organizers' help in the formulation of the reports (each team member is responsible for 3-4 problems), and in the preparation of the presentation at first in Russian language. After that, students take part on a short English training course when by the help of language teachers translate the presentation to English and practise the report in English. Here happens also the preparing of the students for the job of the opponent and for the reviewer's speech. The final stage of the preparatory work is when the jury – organized from university teachers dealing with the students during all process – chooses 5 students participating on the international competition.

The announcement of ICYS is published in November in the journal for teachers „Fizika: prablemy vykladannja", and in the newspaper „Nastayniczkaja gazeta" in Belarusian and Russian languages. In contrast to Hungary, students have to send only their application to the conference without the made contribution in January. National conference is organized at the end of February on which usually participate more than 100 students from which a jury select 5 students to the ICYS.

Learning physics in connection with the IYPT

The problems of the tournament usually are taken from life and Nature. These are so-called "Kapitza's school's problems", which allow the students to choose their own approach and method during their investigation. Every year there are problems from various fields of physics and from the boundary areas of physics with other sciences. The obtained results and the solutions of the problems generally can not be classified as right or wrong. Every solution can be one of the possible ways of trying to solve the problem.

Preparatory work is a relatively long process a close cooperation of teachers and students. During this process we have possibility all to learn physics to get to know that part of physics which are not in the curricula in the secondary education even in courses of university too. There are always some up-to date problems between the given 17 investigated intensively at the moment. Teachers and students can learn from the specialists of the given fields the newest results of the research work during the preparatory process. Some problems draw attention to difficulties of a phenomenon of everyday life which until now seems self-evident. Sometimes a closer look at made by appropriate techniques shows such details which make possibility of a deeper understanding of Nature.

Other benefits
Successful participation of the students increases the prestige of the teachers, of the schools. The better image of a school attract the parents in the choosing a school for their children. Schools in this way obtain better students which improves the reputation of the school.
During the preparatory work happened that some institutes even the industry helped in the solution of a problem giving some equipments or financial support to buy it's for school.

Results
It is interesting to compare the result of mentioned countries attained during the all history of the IYPT. In spite of the fact that Hungary and Belarus have cardinally different selection methods the results are nearly the same. We can meditate whether what may be the decisive factor in this process?

HUNGARY

Winner:
- **1991** Moscow, Russia
- **1997** Cheb, Czech Republic

Second place:
- **1993** Protvino, Russia
- **1995** Spala, Poland

Third place:
- **1994** Groningen, The Netherlands
- **1996** Kutaisi, Georgia
- **1998** Donaueschingen, Germany
- **1999** Vienna, Austria
- **2001** Espoo, Finland
- **2002** Odessa, Ukraine

BELARUS

Winner:
- **1992** Protvino, Russia

Second place:
- **1997** Cheb, Czech Republic
- **2002** Odessa, Ukraine

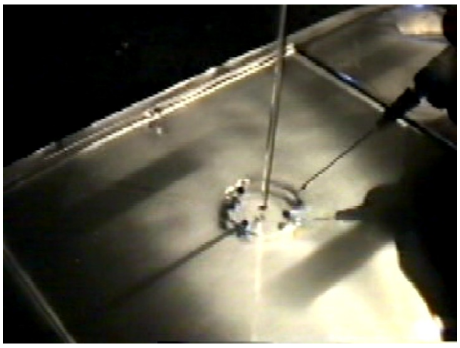
Third place:
- **1994** Groningen, The Netherlands
- **1995** Spala, Poland
- **1998** Donaueschingen, Germany
- **1999** Vienna, Austria
- **2000** Budapest, Hungary
- **2003** Uppsala, Sweden

Characteristic features of the problems of the IYPT

To show the wide variety of the topics we would like to show some problems illustrated by pictures or by video record taken during our work which show the asked phenomenon often emphasized the relevant parameters of the phenomenon.

Jet-spread (1997)

A water jet falling onto a horizontal plane spreads out radially. At some distance from the center the thickness of the layer increases dramatically. Explain the phenomenon.



Flotation (1997)

A piece of chocolate, which is dropped into a glass of soda water, periodically sinks and goes back to the surface. Investigate the dependence of the period of these oscillations on various parameters.

Tea cup (1997)

If one fills a cup with hot tea, a thin layer of steam emerges above the surface. One can see that some parts of the steam layer disappear suddenly and reappear after a few seconds. Investigate and explain this phenomenon.

Spider's web (2002)

A spider's thread looks like a string of pearls. What is the reason for this?
Make experiments to investigate the relevant
parameters.

Splash of water (2000)

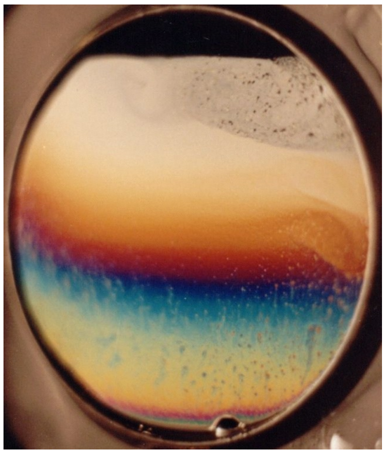
Measure the height reached by splashes of water when a spherical body is dropped into water. Find a relationship between the height of the splashes, the height from which the body is dropped, and other relevant parameters.

The influence of the competitions on the physics teaching
There is influence generally between each kind of competitions and physics teaching from the point of view of students and teachers too. The investigation of the influence to the students can be the subject of another article dealing with the talented students. Here we will analyze the impact on that only from the aspect of teachers:

- on primary education (13-14 year-old children)
- on secondary schools (15-18 year-old)
- on the university level teaching (undergraduate level)
- on postgraduate level: teacher training course

Impacts of the competitions on the physics teaching analyzed through a chosen problem "Soap film"

Soap film (1999)



Explain the appearance and development of colours in a soap film arranged in different geometry.

Teachers can apply the knowledge collected during the preparatory work for the competition in the everyday physics teaching from the lower grade and secondary education until the university. We would like to show as an example how can do that through an optionally chosen problem „Soap film".

Soap films and soap bubbles are not only beautiful, but involve also physics problems. The shape, motions and colours of films and bubbles provide a simple means of demonstrating many interesting phenomena to students, at all academic levels, from primary school to university. It can already be known from the history of soap films and bubbles that this topic is interesting not only for physicists but also for the chemists, biologists, mathematicians even with special aspects, and for artists. For this reason this topic can be utilized not only in the several fields of physics education but we can investigate the joining points of sciences, from which we can emphasize the importance of the interdisciplinarity of various disciplines. Combining the students' knowledge acquired separately in the lessons of different subjects in the schools, they attain a deeper understanding of the investigated phenomena. Therefore the knowledge obtained about the soap films in the course of the normal education and during the preparatory work can be connected with the following fields of physics and other sciences.

The following scientific expressions, phenomena, mechanisms can be in connection with the soap films, bubbles and foams:

- Surface tension, surfactants, molecular structure of amphypatic molecules, washing mechanism, stability of soap film and foams
- Shapes of soap films illustrate important principles in physics and mathematics (bubbles, drops, minimal surfaces on wire-frames)
- Optical properties (reflection of light)
- Colours (the origin of the coloures)
- Vibrations of a film and of a bubble
- Mechanism of the thinning process (laminar flow, evaporation)

In the following parts the utilizing of the acquired knowledge connecting with the soap films will be shown in details on the several level of physics education.

Structure and stability of a soap film

The structure and the properties of soap molecules are in the curricula on the secondary school chemistry and knowing these features of the amphypatic molecules teachers among the other things can explain the mechanism of washing process too.

We can summarize the properties of soap solutions on physics lessons. Students know that each soap molecule in an aqueous solution is dissociated to a sodium-ion and to a long chain fatty acid ion. The fatty acid ions are amphypatic in character, they consist of two dissimilar parts. One of them, the so-called carboxyl 'head, has hydrophilic ("water loving") character, tends to become surrounded by water molecules. The other part, the hydrocarbon 'tail' is hydrophobic ("water-hating"), so it tends to avoid to be in the neighborhood of water molecules.

Making a big bubble (capilarity).

For this reason a soap film consists of a thin layer of soap solution bordered by two surfaces on which amphypatic ions are accumulated. We can explain the students that this structure is responsible for the stability and thus for the long life of the soap films; bubbles remain stable through continuous restoring of local changes of surface tension.

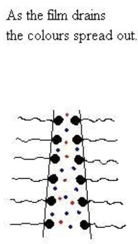
Even the very simple act of blowing a big bubble needs some knowledge of physics and chemistry. By the traditional ways of bubble-blowing - as by some toys - we are not able to blow a big bubble, because it needs some additional soap solutions. We can do that by a rolled sheet of paper or by a frame rolled up in cotton thread immersed in the solution. These materials have many very thin capillary tubes filled with soap solutions which are the source of the additional soap solutions. This explanation can be understood even for the young school pupils.

Optical properties (physical optics) I.

Thin-film interference (physical optics)
The most attractive and conspicuous feature of the soap films is their colours. The mechanism of the development of the coloured pattern can be the subject of secondary school physics lesson and of a university lecture too, depending on the depth of explanation. The origin of Newton's-rings can be treated with a quantitative description only in the special classes organized for the talented students in the secondary schools. The thin film interference can be discussed too in this kind of classrooms evaluating the optical path difference or the phase difference between the interfering beams. The calculation of the reflected intensity as a function of relevant parameters can be explained only at the university because of the lack of mathematical background in the secondary schools. After dealing with the thin-film interference we can explain the development of the pattern observable on the surface of the thinning vertical soap film. One of the processes of the thinning of soap films is drainage of the solution of the film. An element of such film has a wedge-shaped profile produced by the vertically draining fluid. If this kind of soap film is illuminated by white light a characteristic interference pattern associated with the wedge can be observed. It consists of alternate horizontal coloured bands produced by the superposition of all visible wavelengths in the white spectrum. As the film drains the colours spread out. The bands are closer to each other at the lower portion of the film, because of the thickness increases more rapidly at the bottom of the wedge.

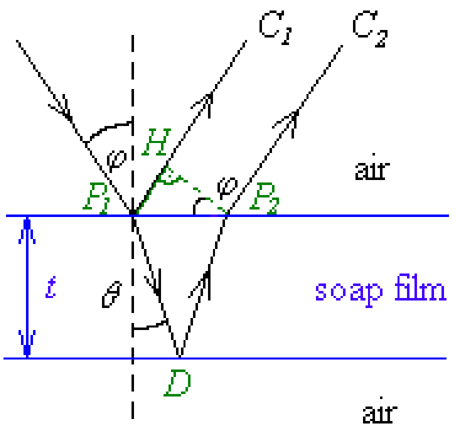
When the film is appreciably thinner than the wavelength of light, destructive interference will result. A black band, called **Newton's black film** appears at the top of the film and spreads down as the film becomes thinner. The thickness of the black film is typically in the range of 5-30 nm.

The quantitative description of thin-film interference, calculating the conditions of the constructive and destructive interference can be made on the following manner.



Coloured bands and the wedge shaped structure of a vertically drained soap film.

Thin film interference (schematic figure)



Constructive interference will occur, if the optical path difference between the C_1 and C_2 beams is

$$2\mu t\cos\theta + \frac{1}{2}\lambda = n\lambda ,$$

where n is an integer, the order of the interference. It is important to emphasize the presence of the additional π phase difference (or λ /2 path difference) appearing when the beam reflects from an optically denser medium. Otherwise the existence of Newton's black film is one of the most important proof of the existence of π phase difference.

The interference is destructive, if

$$2\mu t\cos\theta + \frac{1}{2}\lambda = \left(n + \frac{1}{2}\right)\lambda .$$

According to this the phase difference is

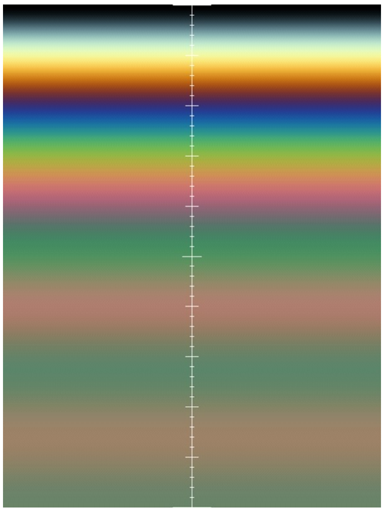
$$\delta = \frac{2\pi}{\lambda}\left(2\mu t\cos\theta + \frac{1}{2}\lambda\right).$$

The reflected intensity for the λ wavelength will be

$$I_r = 4I_i R\sin^2\left(\frac{2\pi}{\lambda}\mu t\cos\theta\right),$$

where I_i is the incident intensity, R is the refractivity, μ he refractive index of the soap solution, the meaning of the other parameters you can see on the 9.figure. The colour of each region of the film will be determined by its thickness.

Computer-generated image of interference colours in the function of the thickness of the soap film (from 0 to 1000 nm)



The formula of reflected intensity gives opportunity to simulate the interference pattern in special cases. The simulation is made when the white light is incident normally on a vertical soap film with a refractive index $\mu = 1.41$.

Optical properties (geometrical optics) I.

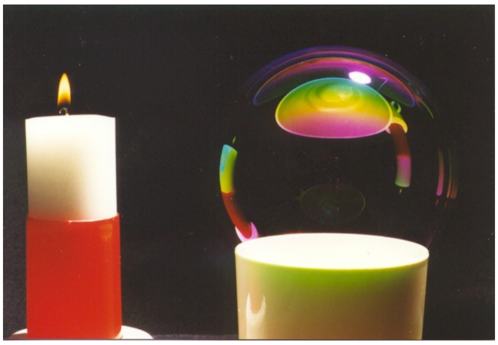
It is well known from the everyday life that soap bubbles act as mirrors forming small bright images of its neighborhood. These properties of a soap film can be successfully used in the physics teaching of the image formation of different mirrors. A long life soap film made from an appropriate soap solution is suitable to show optical experiments simultaneously demonstrated by teacher and students in the class room. Devices of the so-called hands-on experiments are inexpensive; you can use common household materials to show its.

Add 100 ml glycerin to 100 ml tap water and add 2 teaspoonful of detergent to this fluid (washing-up fluid, shampoo...). The solution will be better if you make it a week before using it. **Dip** the mouth of a can (tea box or coffee box) into this solution, and place it on the table so that the surface of the soap film was vertical. (Paint the inside of the box dull black or cover it with black paper to avoid the disturbing reflections).

Put a lighted candle in front of the film and try to find the image made by this „soap film plane mirror". Immerse a straw in the soap solution and suck out some air by the wet straw from the box thus making a „concave mirror" from the soap film. You can investigate the image formation of that mirror looking to the soap film from the direction of the optical axis of the arrangement. Move the candle from a distance close to the mirror and observe the changing of the image. After that blowing some air to the box, make convex surface from the film. Investigate the image formation of the convex mirror similarly than of the case of concave one. It is interesting to follow how changes the image when the object distance is fixed, but the curvature of the mirror changes from concave through plane to convex cases.

Soap film as a mirror

Blow a big soap bubble to the rim of a cup and put close to it a lighted candle in a dark room. Observe the images of the candle. The image formed by the front surface is upright and is between the front surface and the centre of curvature. That image which is formed by the back surface is inverted and is between the centre and the back surface. We can observe some similar images very close to the back surface of which origin is not so clear. It can be investigated! Try to draw the images produced on the convex (outside) and on the concave (inside) bubble surfaces!



Soap bubble as convex and concave mirror at the same time.

Taking some pictures in a dark room from the image formation of a soap film depending on the relative position of camera and films it can happen that the film remains invisible. On the photos will be seen only the object and the image together in several different positions. The taken pictures as an „optical black-box" can be useful on a lesson summing up the image formation topic, or a problem on a competition organizing for the primary school students.

„optical black-box"

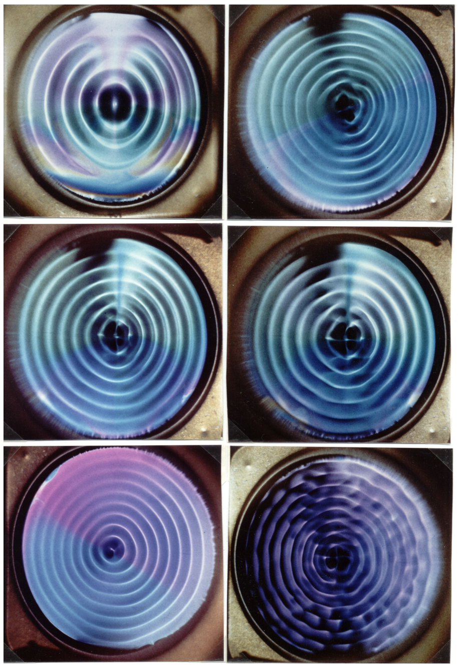
Standing waves

Experimental demonstration of standing waves are in curricula of secondary school physics but the mathematical description is possible in one dimensional version, the normal modes of a vibrating string fixed at both ends can only be calculated. The quantitative analysis of two dimensional standing wave patterns – with simple boundary conditions –, can be carried out only at the university level.

A soap film has many properties in common with an elastic membrane. If it is contained by a circular ring it can be made to vibrate transversely, in a direction perpendicular to the ring, like a drum skin. These vibrations are similar to those produced by an elastic string which is fixed at both ends. A membrane is a "two dimensional string".

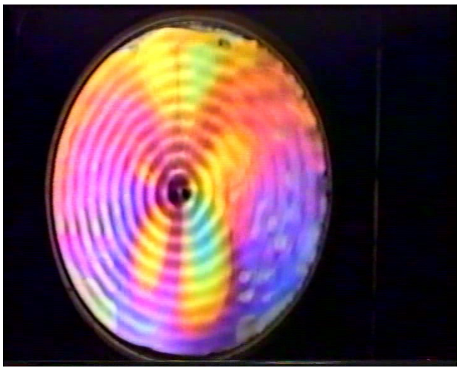
The normal modes of a soap film membrane with a rectangular boundary, a circular boundary or boundary of any other shape can be easily demonstrated experimentally. The lower frequency modes can often be demonstrated by hand. A wire frame of any shape can be oscillated or vibrated at the appropriate normal mode frequency to produce a vibrating film with the characteristic nodal line pattern.

The higher frequency modes can not easily be obtained by hand. Soap film can vibrate as such a drum skin, which "drumstick" is the sound. To produce a normal mode vibration pattern, it is necessary to use an electrically driven vibrator. A loudspeaker system driven by a sound-generator with a variable frequency has been used to produce the normal modes. The antinodes on the photos show up as bright lines.

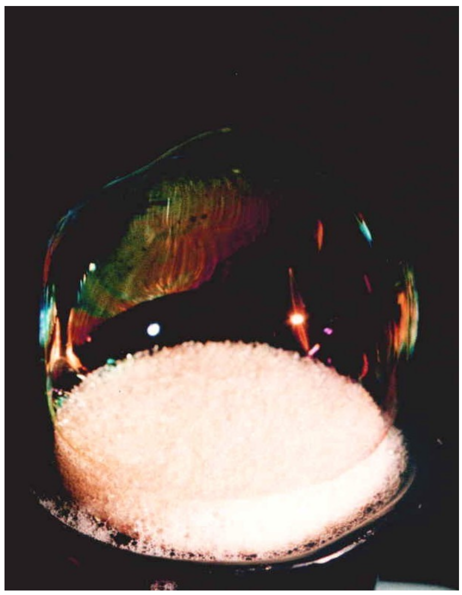


It is very interesting to observe the formation of a standing wave pattern "in vivo". Not only the nodes and antinodes are visible on the surface of a soap film, but appear two or four vortices too, circulated according to the law of the conservation of angular momentum. The so-called „butterfly-like" picture is astonishing because of the very fast circulation inside that very thin soap film.

Two dimensional standing waves on a vertical soap film.



Standing waves with vortices



We can easily demonstrate three dimensional standing waves appearing on a soap bubble made by a common device for massage.

Three dimensional standing waves on a vibrating soap bubble

Thinning mechanism of a soap film

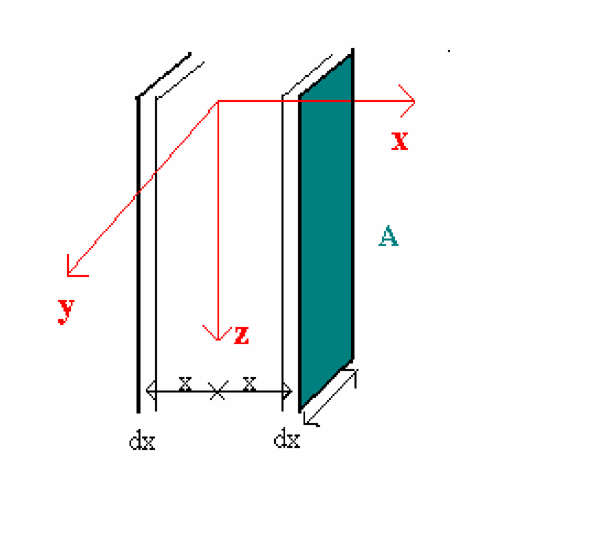
The thinning mechanisms of a soap film depend on the solution from which are it formed.

The thinning mechanisms of a vertical soap film can be divided into two main groups, one of them is the static and the other one is dynamic mechanism. The static mechanism is that in which the position of the surface of the film remains fixed. The so-called rigid films formed from soap solution prepared with the addition of a quantity of glycerin. One of the thinning processes of rigid film is viscous flow, which is actually a two dimensional laminar flow. The dynamic mechanism produces movement of the elements of the surface area of the film. Films formed from highly concentrated solutions are thinning by dynamic mechanism.

The mathematical description of a special thinning mechanism of soap films can be explained to the students only at the universities.

Using a simple model for the thinning process of a rigid soap film we can calculate the volume of fluid emerging per unit time, the Hagen-Poiseuille law in two dimensions. Instead of the total description we would like to show some stages of the calculation.

Model: viscous fluid flows between the completely rigid, inextensible walls (evaporation is neglected).



Model for thinning (schematic figure)

(Viscous flow)

$$mg + 2\eta A \frac{\partial v}{\partial x} = 0$$

$$\frac{1}{2}\rho g\left(\frac{t^2}{4} - (x')^2\right) = v(x')\eta \quad \Rightarrow \quad v(x') = \frac{\rho g}{8\eta}\left(t^2 - 4x'^2\right)$$

$$\int_{x'}^{\frac{t}{2}} \rho g x dx = -\int_{v(x')}^{0} \eta\, dv$$

$$Q' = 2\int v(x')\, df = 2\int_0^{\frac{t}{2}} \frac{\rho g}{8\eta}\left(t^2 - 4x'^2\right) l dx'$$

where t is the thickness, l the width of the film, η and ρ the viscosity and density of fluid respectively, τ the time measured from the forming of the soap film.

Parabolic profile of the cross section of a rigid soap film can be calculated by taking into account that the Q is function of z, being the distance from the top of the frame and of the τ lifetime of the film:

$$Q = Q(z,\tau)$$

With the boundary conditions that no liquid be supplied to the film at the top, we can get the thickness of the film as a function of other relevant parameters:

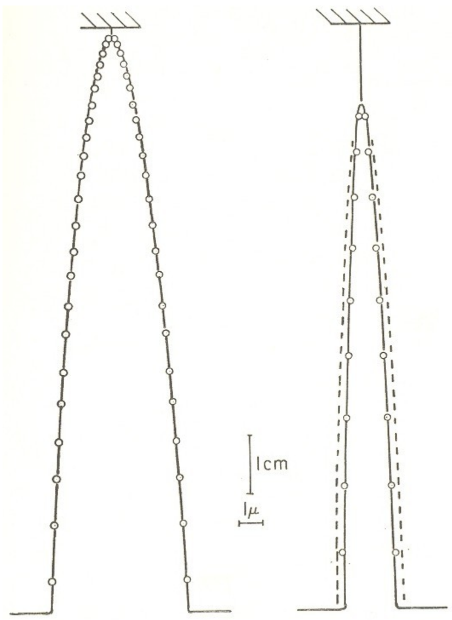
$$Q = 0 \quad at \quad z = 0$$

$$\frac{\partial t}{\partial \tau} = -\frac{\partial Q}{\partial z}$$

$$z = \frac{\rho g}{4\eta} t^2 \tau$$

$$Q' = \frac{\rho g}{12\eta} t^3 l$$

$$t = \sqrt{\frac{4\eta}{\rho g}\frac{z}{\tau}}$$



Parabolic profile of the Cross section of the soap film.

(schematic figure)

Physics and Aesthetics

Soap bubbles in Art

What can be attractive for an artist in this topic?

The beauty of soap films and soap bubbles fascinated the artists, especially the colours of soap films, the short „life-time", and the „excellent" shape of bubbles. The interesting reflection pattern on a soap bubble they associated with the distorted „reality". Soap bubble is a *„Vanitas- symbol.*

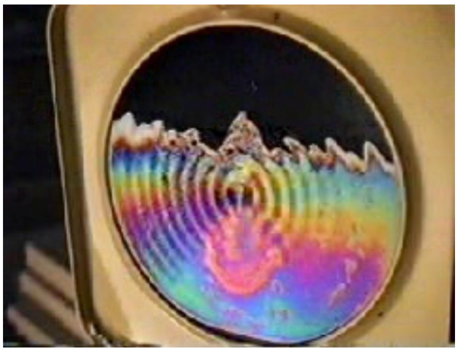
Bubble as a topic of art history appeared as „Vanitas still-life" in the 17th century in the Dutch painting as a symbol of mortality, of delicate beauty of illusory and momentary glory of human life. We can meet soap bubbles also in the 18th-19th centuries in some genre paintings.

Some illustrations by painting

David BAILLY: Portrait with vanitas symbols, 1651,
Jean-Baptiste-Simeon CHARDIN:
Stedelijk Museum “De Lakenhal”, Leiden. Soap bubble,
nearly 1739,
Metropolitan Museum
of Art,
New York.

Jan van KESSEL I.: Vanitas still life, Jan II. de HEEM: Vanitas still life
nearly 1665, National Gallery of Art, with flowers, 1685, Louvre, Paris.
Washington, DC.

An entertainment



Musically excited colour pattern on a soap film

You have to make a soap solution with high detergent content. (Content: 5 spoons of detergent, 5 spoons of glycerin to 100 ml of tap water. Do not use tap water with iron content! Prepare the solution a week before using it.) Dip the rim of a can (soup, coffee or tea can) into this solution and place it on the table so that the surface of the soap film is vertical. Paint the inside of the box matte black or line it with black paper to avoid disturbing reflections.

Play music on a tape recorder placed near the film. The fluctuations in the air pressure distort the film locally. The colours dance over the film somewhat in rhythm of the music. In certain frequency ranges the film begins to resonate with the music. Voice of a singer, – which is a relatively clear sound with nearly fixed frequency –, force standing waves on this membrane. The soap film vibrates as a drum of which “drumstick” is the pressure difference at the surface of the film.

While you are watching the soap film experiment and hearing the music you can discover many phenomena from the various fields of physics and other sciences.

On the teacher training courses we usually discuss on one hand the solution methods of such kind open-ended problems and the other hand the details of many details of phenomena discovered during the solution. It is interesting to show the teachers some ways of the utilizing the acquired knowledge too.

Literature

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