

Preparation to the Young Physicists' Tournaments' 2016

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10 years with the Reference kit!

- 170 problems
- Over ⅓ of all IYPTs 1988—2016
- An amazing team of co-authors (since 2012)
- On the Regulations of a few national tournaments
- A successful case of knowledge transfer
- A true asset of the IYPT portfolio

The Day One was September 29, 2006

Welcome to the 4th IYNT 2016!

Country	2013	2014	2015	Overall
Afghanistan	1			
Belarus	1		1	
Bulgaria	2	2	0	
China			1	
Croatia			1	
Georgia	1	1	1	
Iran	0			
Kazakhstan	0			
Kyrgyzstan	0			
Moldova	1			
Russia	3	1	0	
Serbia		1	2	
Turkey	1			
Ukraine	0			
Total Teams	16	5	10	31
Total Countries	11	4	7	14
Total Medals	10	5	6	21

- The International Young Naturalists' Tournament, IYNT, is a whole new competition with breathtaking problems, state-of-the-art grading standards, and an impressive momentum
- The IYNT bridges gaps between natural sciences and is focused on participants aged 12 through 16
- The IYNT has so far attracted 31 teams from 14 different countries, and has awarded 21 medals
- Do not hesitate and pre-register today

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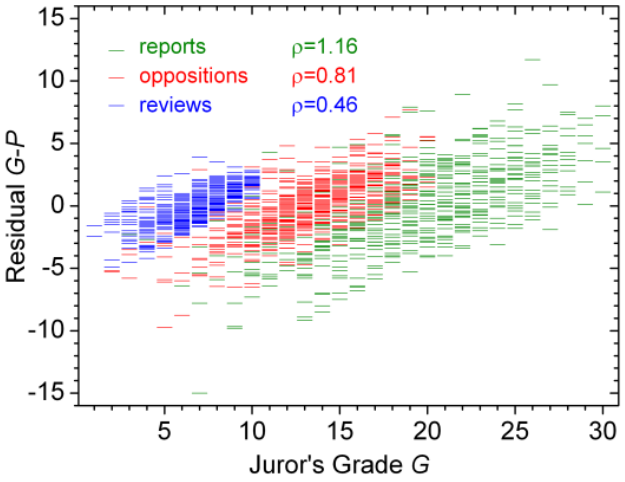

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PHYSICS WORLD CUP

- Do you like what the IYPT organizers do?
- Watch the promo video: http://youtu.be/O51W8D-qeiA
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How to tackle the IYPT problems?

- How to structure a report?
- What level is competitive?
- How to set the goals, fix the priorities, and set the direction of the work?
- How were people resolving particular issues in the past?

- Look through the historical solutions in the Archive :-)
  - an opportunity for goal-oriented critical learning
  - examples, not guidelines
  - those solutions were good, but yours should be better!

iypt archive mc^2 hv

Invitation

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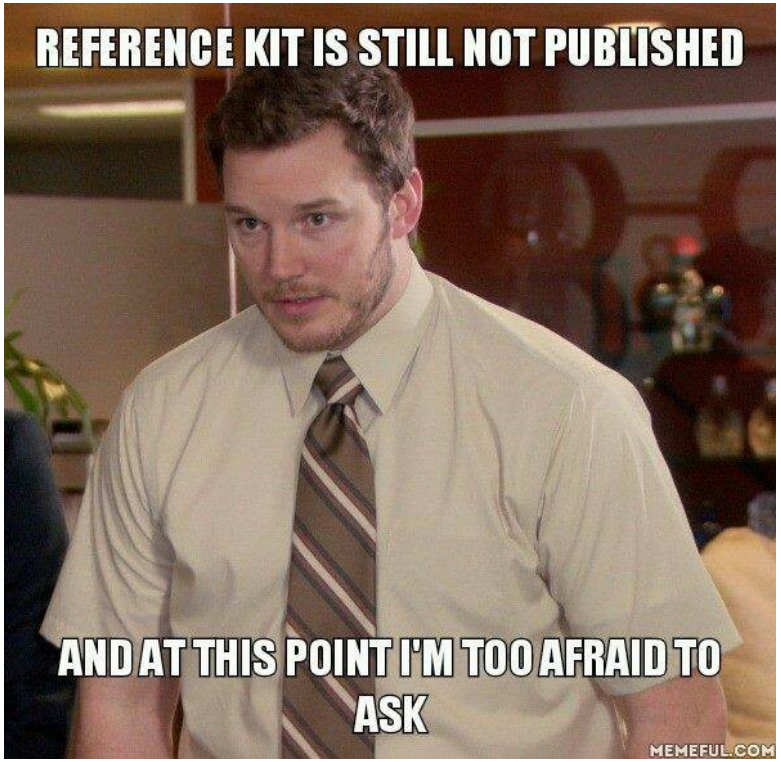
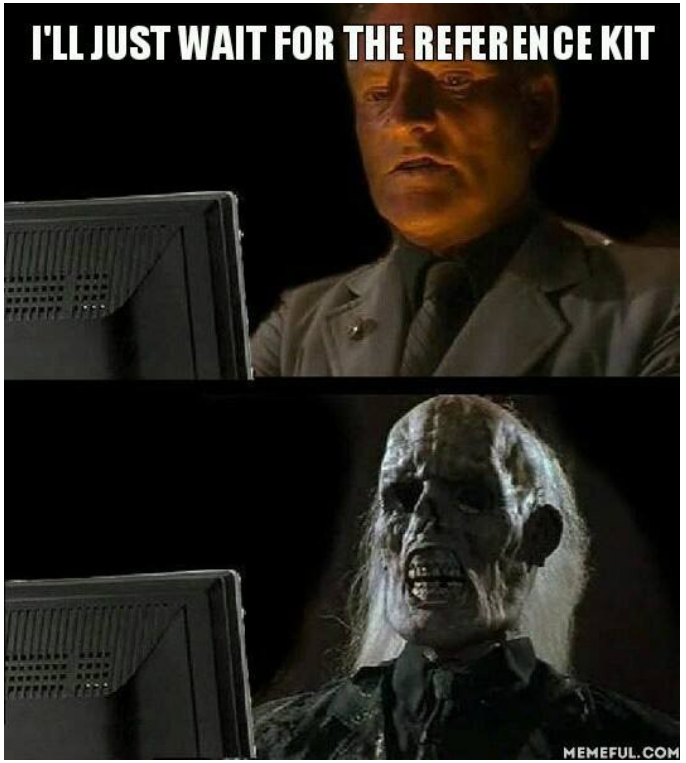
Is the novel research limited and discouraged by the existing common knowledge and the ongoing work of competing groups? :-)

Thank you for reminders, IYPT Memes :-)



July 29, 2015



August 16, 2015

Call for cooperation

- If you are interested in the idea behind the Kit — to structure the earlier knowledge about the physics behind the problems and to encourage students to contrast their personal contribution from the existing knowledge — your cooperation is welcome
- If more contributors join the work on the Kit for 2016, or plan bringing together the Kit for 2017, good editions may be completed earlier
- It would be of benefit for everybody,
  - students and team leaders, who would have an early reference (providing a first impetus to the work) and a strong warning that IYPT is all about appropriate, novel research, and not about “re-inventing the wheel”
  - jurors, who would have a brief, informal supporting material, possibly making them more skeptical and objective about the presentations
  - the audience outside the IYPT, who benefits from the structured references in e.g. physics popularization activities and physics teaching
  - the IYPT, as a community and a center of competence, that generates vibrant, state-of-the-art research problems, widely used in other activities and at other events
  - and also the author (-s) of the Kit, who could rapidly acquire a competence for the future activities and have a great learning experience

166. Der Irrthum ist viel leichter zu erkennen,
als die Wahrheit zu finden.

Goethe*

Maximen und Reflexionen.

// The epigraph for the IYPT 2016 problems approved by the IYPT Founder Evgeny Yunosov
// Translated from the German
* “It is much easier to recognize error than to find truth.” Goethe

Problem No. 1 “Invent yourself”

Truly random numbers are a very valuable and rare resource. Design, produce, and test a mechanical device for producing random numbers. Analyse to what extent the randomness produced is safe against tampering.

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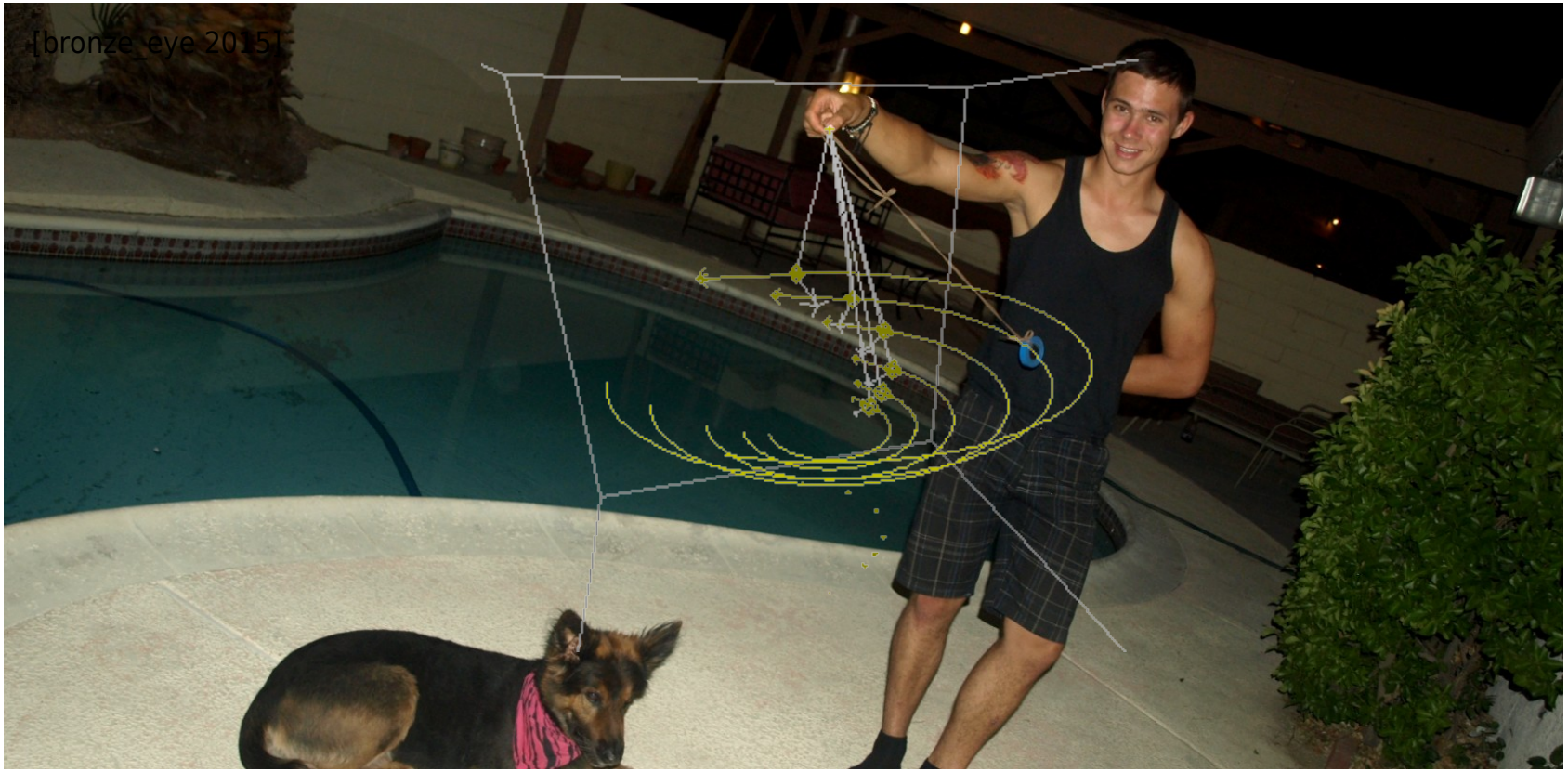

Problem No. 2 “Lagging pendulum”

A pendulum consists of a strong thread and a bob. When the pivot of the pendulum starts moving along a horizontal circumference, the bob starts tracing a circle which can have a smaller radius, under certain conditions. Investigate the motion and stable trajectories of the bob.

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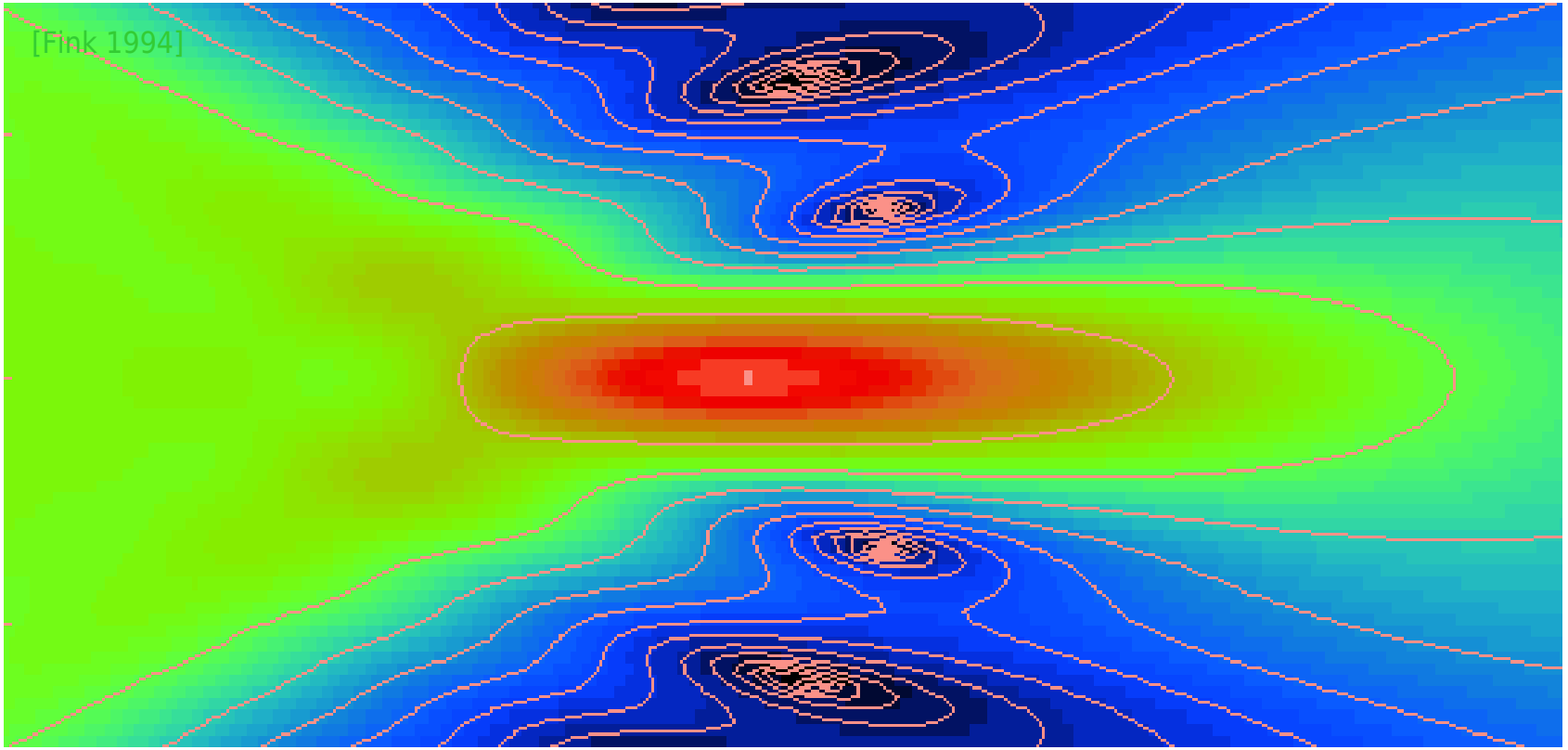

Problem No. 3 “Acoustic lens”

Fresnel lenses with concentric rings are widely used in optical applications, however a similar principle can be used to focus acoustic waves. Design and produce an acoustic lens and investigate its properties, such as amplification, as a function of relevant parameters.

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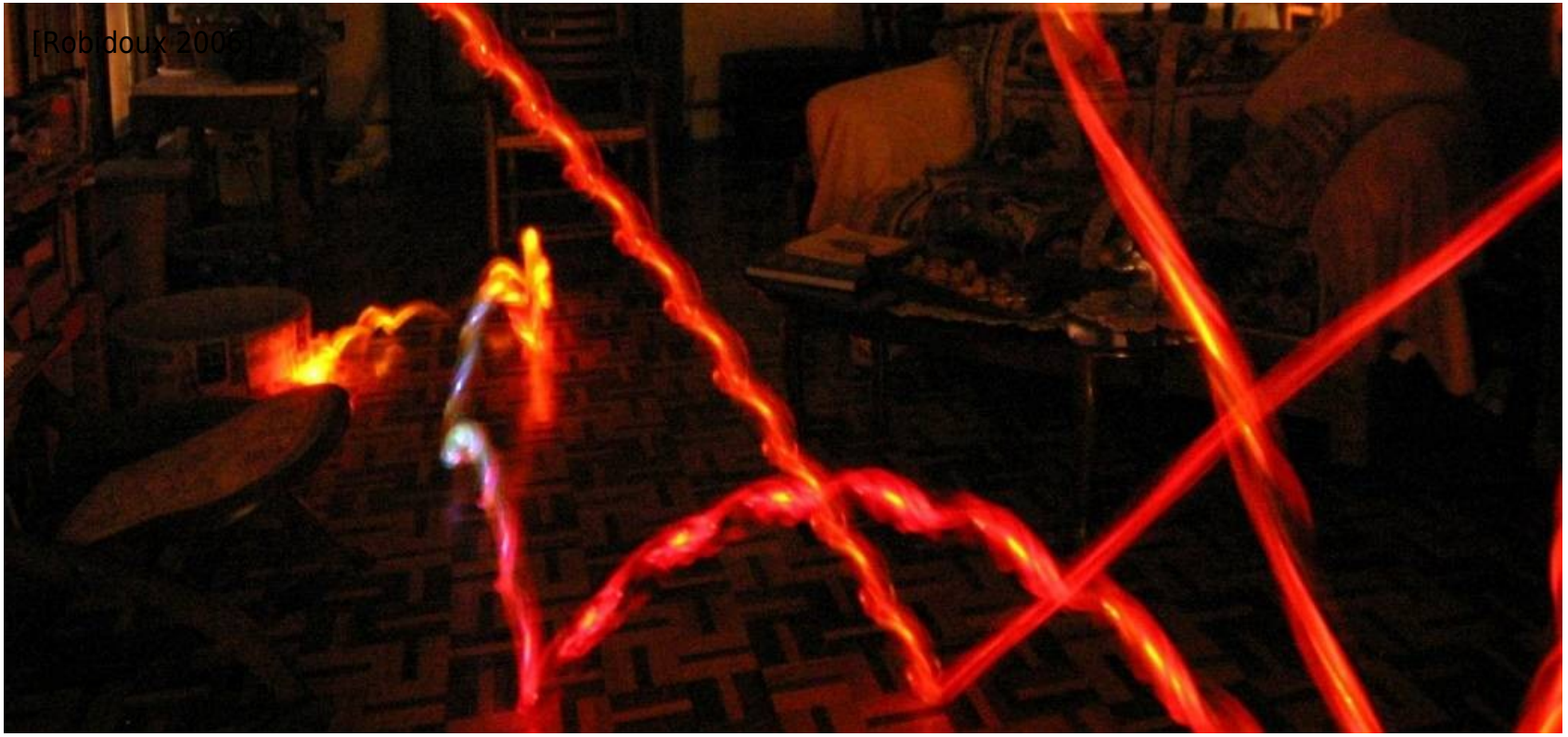

Problem No. 4 “Super Ball”

Throw a highly elastic ball into the space between two plates. The ball starts bouncing and under some circumstances can even be projected back to you. Investigate the motion of the ball and parameters influencing the motion, including the orientation of the plates.

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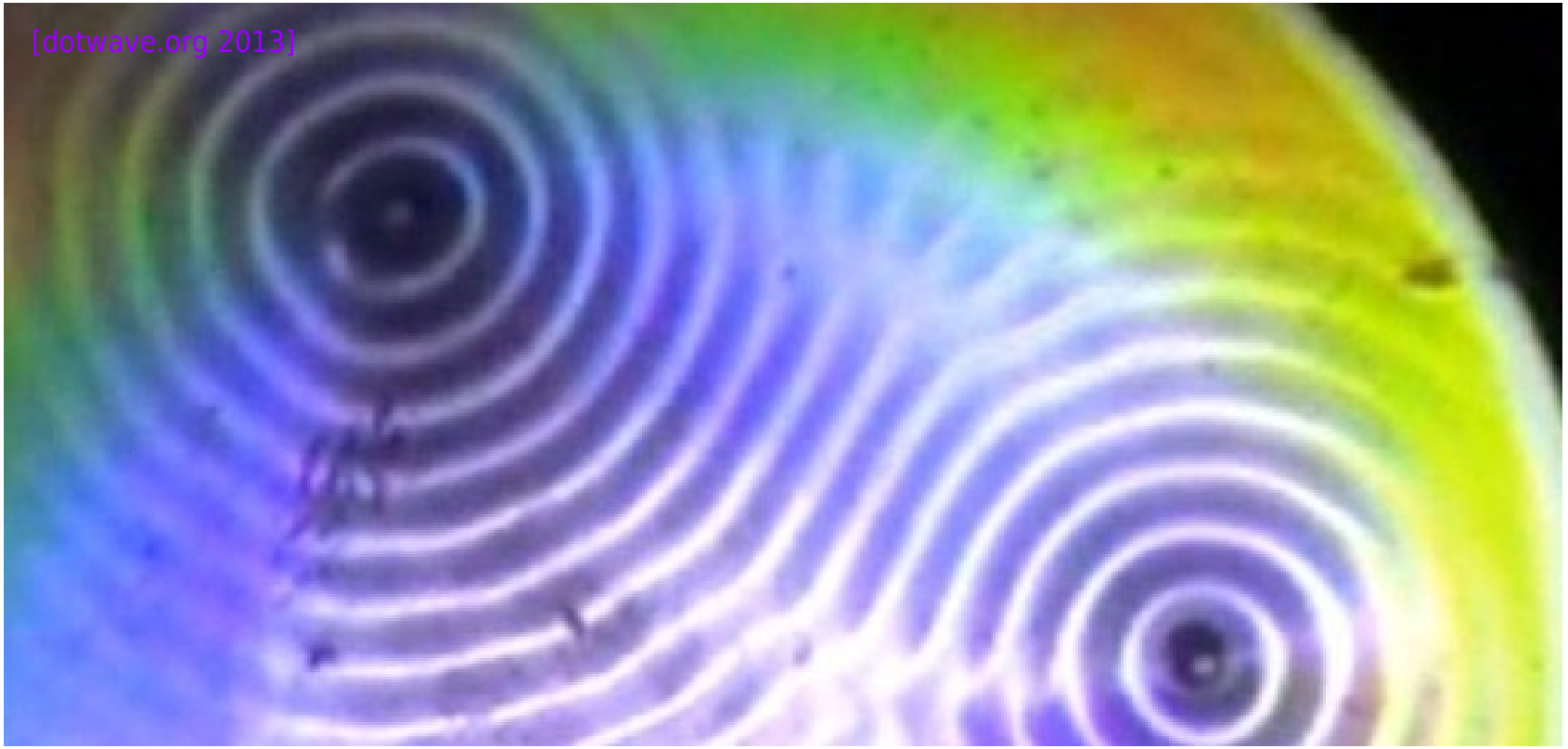

Problem No. 5 “Ultrahydrophobic water”

Set a dish filled with soapy water onto a loudspeaker or other vibrator. When it oscillates, it is possible to hold small droplets on its surface for a long time. Explain and investigate the phenomenon.

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[Mayer 2014]

Problem No. 6 “Electric honeycomb”

Set a vertically oriented steel needle over a horizontal metallic plate. Place some oil onto the plate. If you apply constant high voltage between the needle and the plate, a cell structure appears on the surface of the liquid. Explain and investigate this phenomenon.

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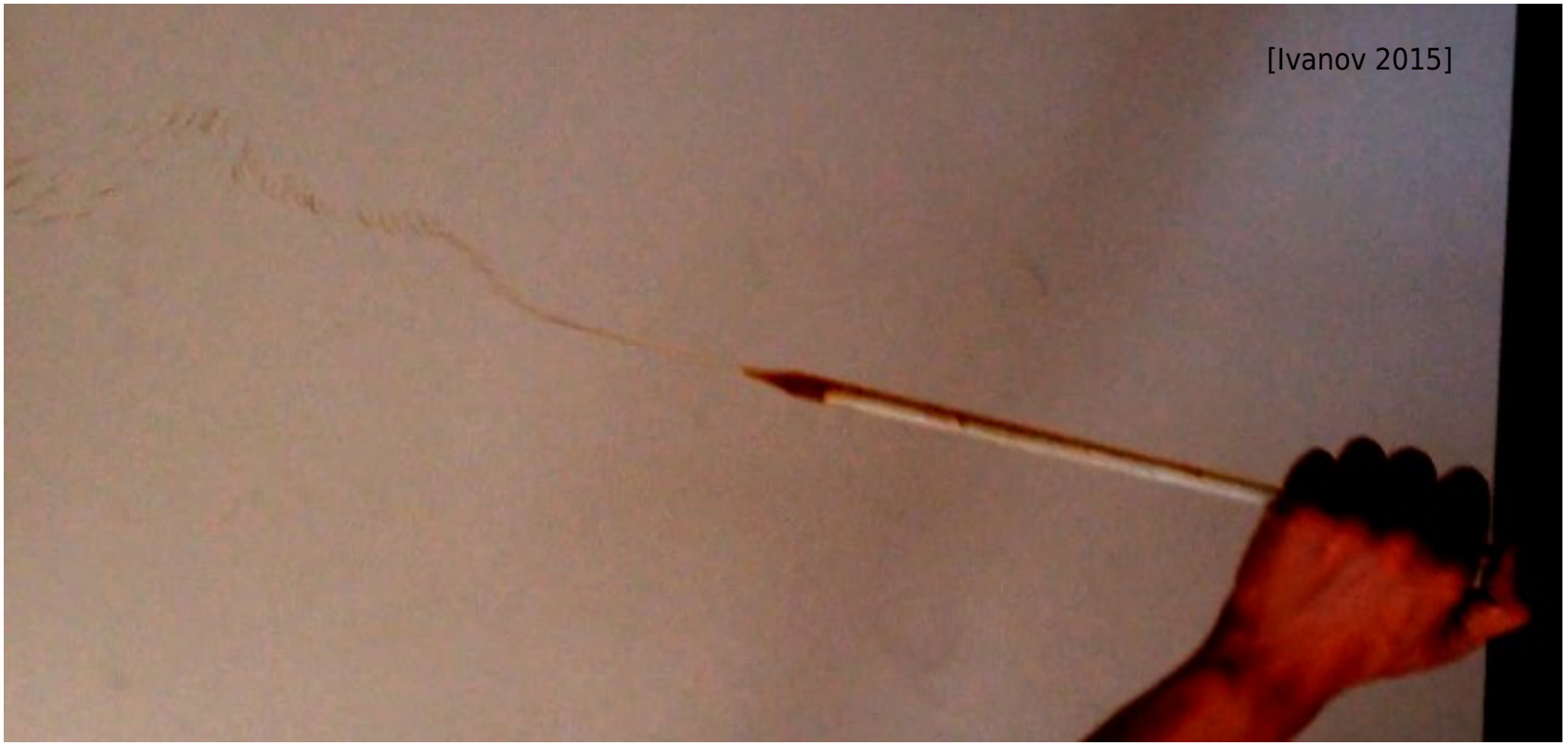


Problem No. 7 “Hot water fountain”

Partially fill a Mohr pipette with hot water. Cover the top of the pipette with your thumb. Turn the tip upwards and observe the fountain exiting the tip. Investigate the parameters describing the height of the fountain, and optimize them to get the maximum height.

ладить (можно даже подуть в трубку), так как высота фонтана зависит от разности температур воздуха и воды, набранной в трубку. Оптимальное количество набираемой в трубку воды колеб-

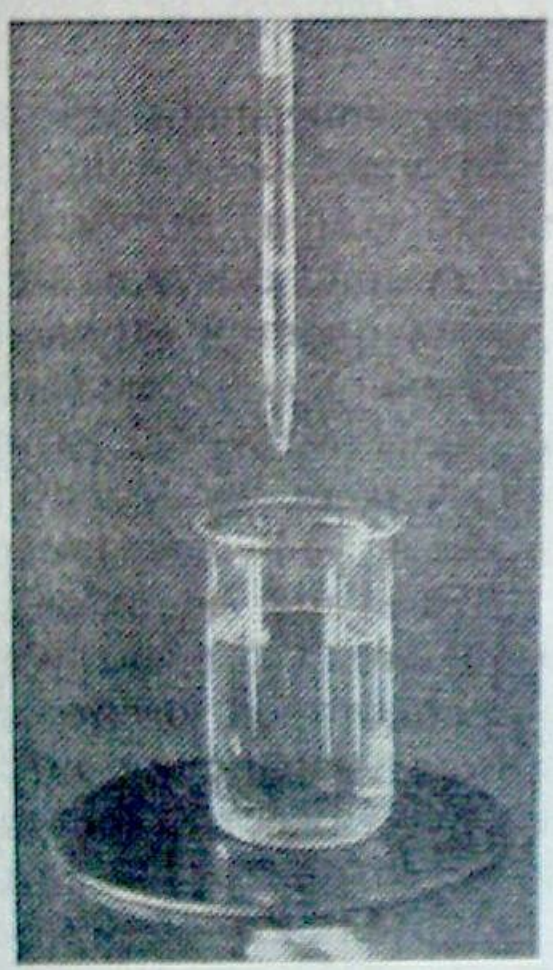
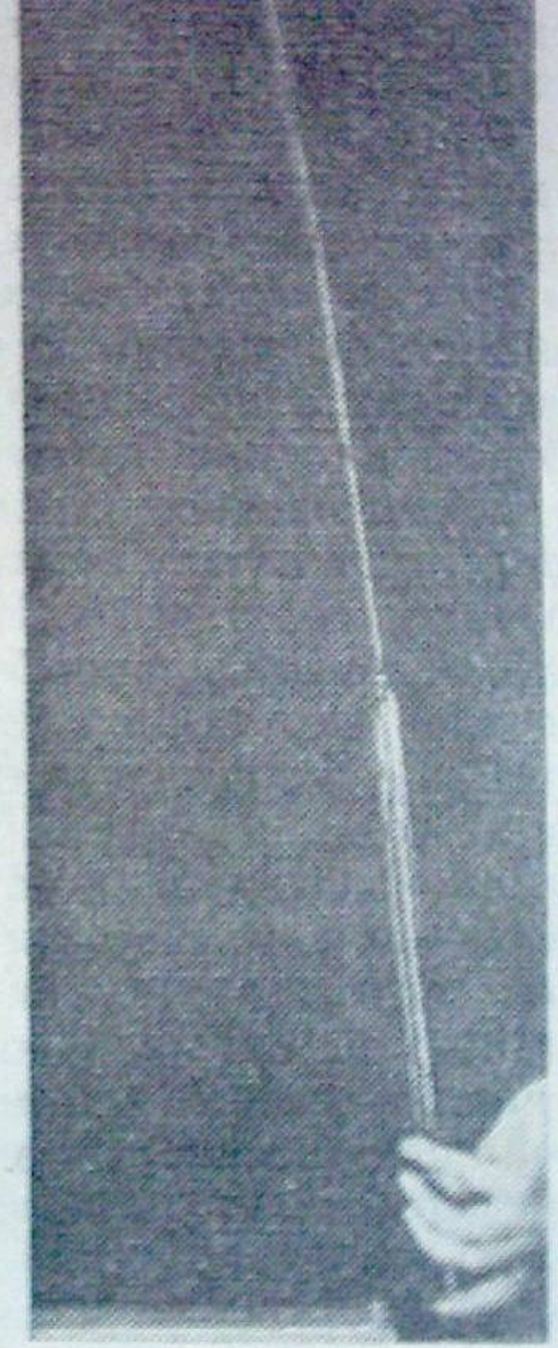


Рис. 41.



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- :-)

Problem No. 8 “Magnetic train”

Button magnets are attached to both ends of a small cylindrical battery. When placed in a copper coil such that the magnets contact the coil, this "train“ starts to move. Explain the phenomenon and investigate how relevant parameters affect the train's speed and power.

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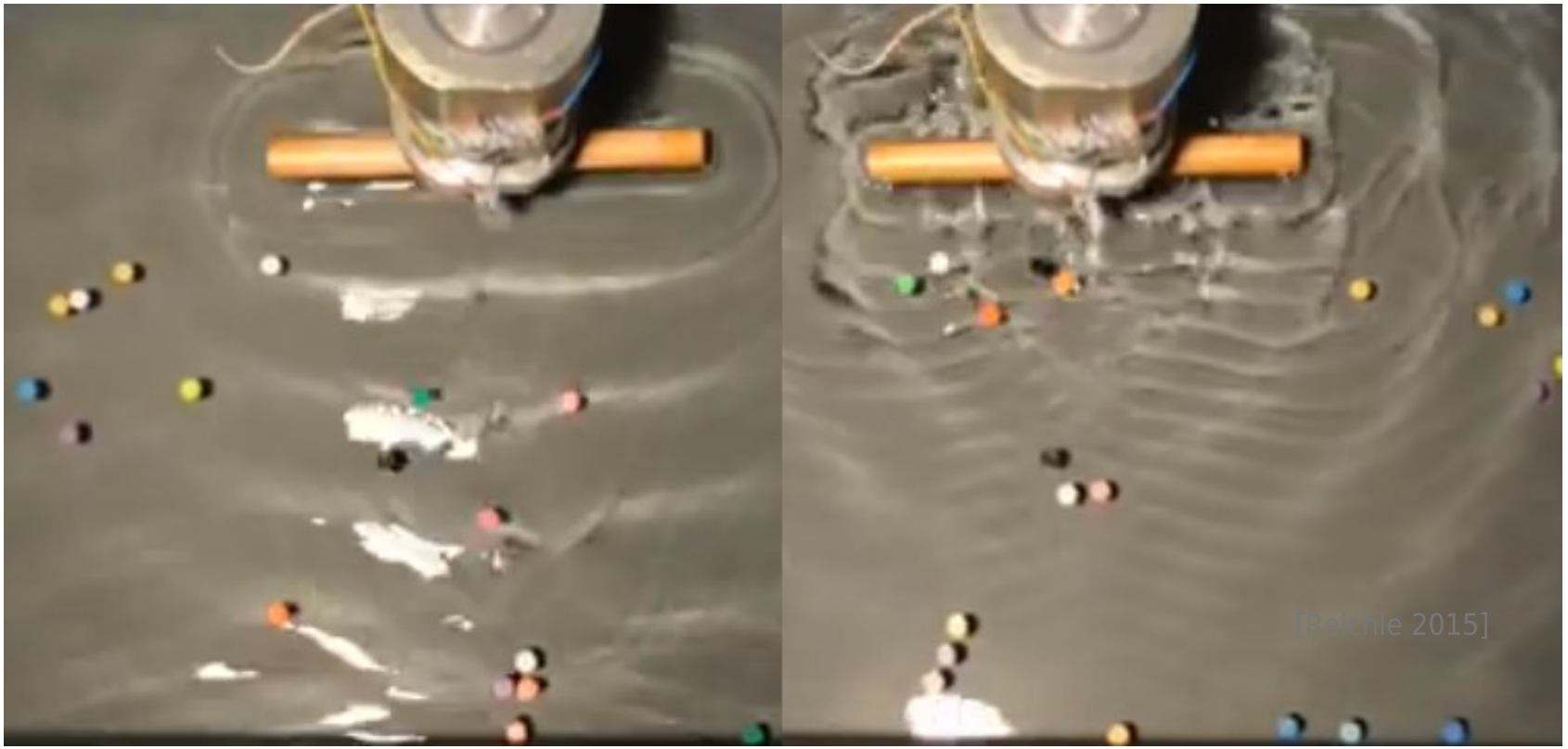

Problem No. 9 “Water waves”

Generate a water wave with a vertically oscillating horizontal cylinder. When varying the excitation frequency and/or amplitude, the water seems to drift away from or towards the cylinder. Investigate the phenomenon.

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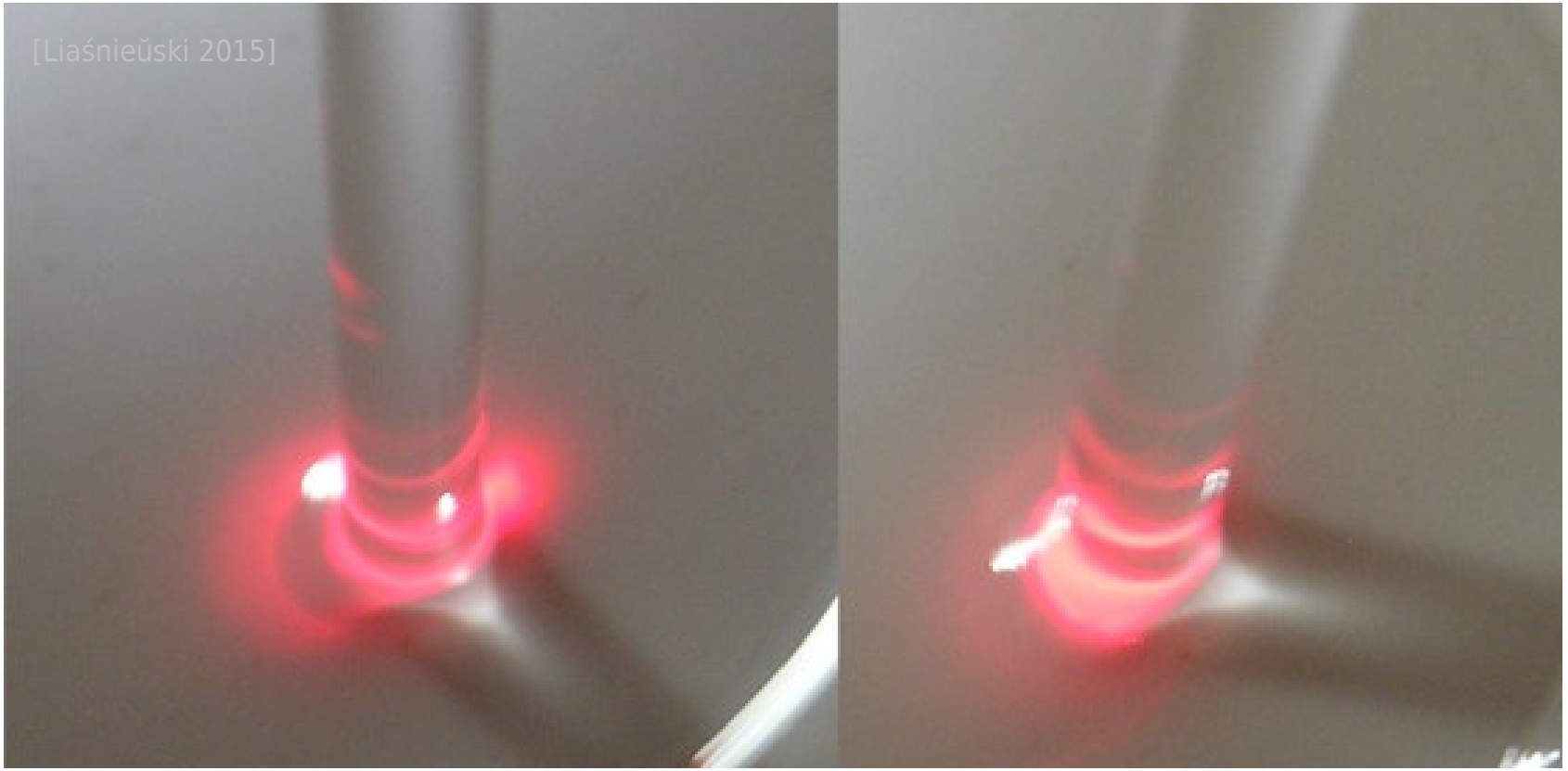

Problem No. 10 “Light rings”

Let a liquid jet fall onto a surface. If the contact point is illuminated by a laser beam, rings of light around the jet can be observed (see Figure). Investigate the light rings and determine how they depend on relevant parameters of the whole system.

Background reading

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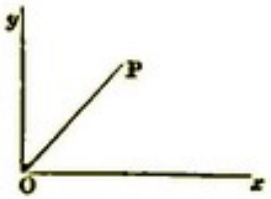
Problem No. 11 “Rolling on a disc”

If you put a light rolling object (e.g. a ring, a disc, or a sphere) on a horizontal rotating disc, it may start moving without being expelled from the disc. Explain how different types of motion depend on the relevant parameters.

20. ***On a rough horizontal plane revolving uniformly about a vertical axis a rough sphere is placed: determine its initial motions, and shew that its path in space will be a circle.***

Let O be the point about which the plane revolves; Ox, Oy co-ordinate axes fixed in space; P the place of contact of the ball at the time t; x, y its co-ordinates. Suppose the plane to revolve from x towards y.



F, G the friction parallel to Ox and Oy respectively.

ω = the angular velocity of the plane.

a = the radius of the ball, m = its mass,

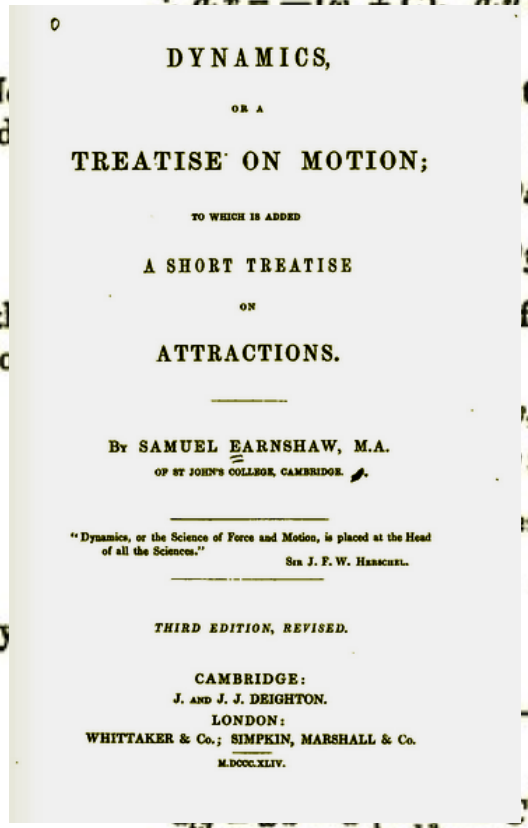
mk^2 = its moment of inertia about a diameter,

$r = OP$.

For the motion of the centre of gravity of the ball we have

$$d_t^2 x = \frac{F}{m}, \quad d_t^2 y = \frac{G}{m}.$$

To determine the angular motion of the ball, we may suppose its centre of gravity fixed. If then ω_1, ω_2, be its angular velocities about axes through its centre parallel to Ox and Oy, the former being estimated in such a direction as would elevate Oy *above* the paper, and the latter to elevate Ox above the paper: then



DYNAMICS,

OR A

TREATISE ON MOTION;

TO WHICH IS ADDED

A SHORT TREATISE

ON

ATTRACTIONS.

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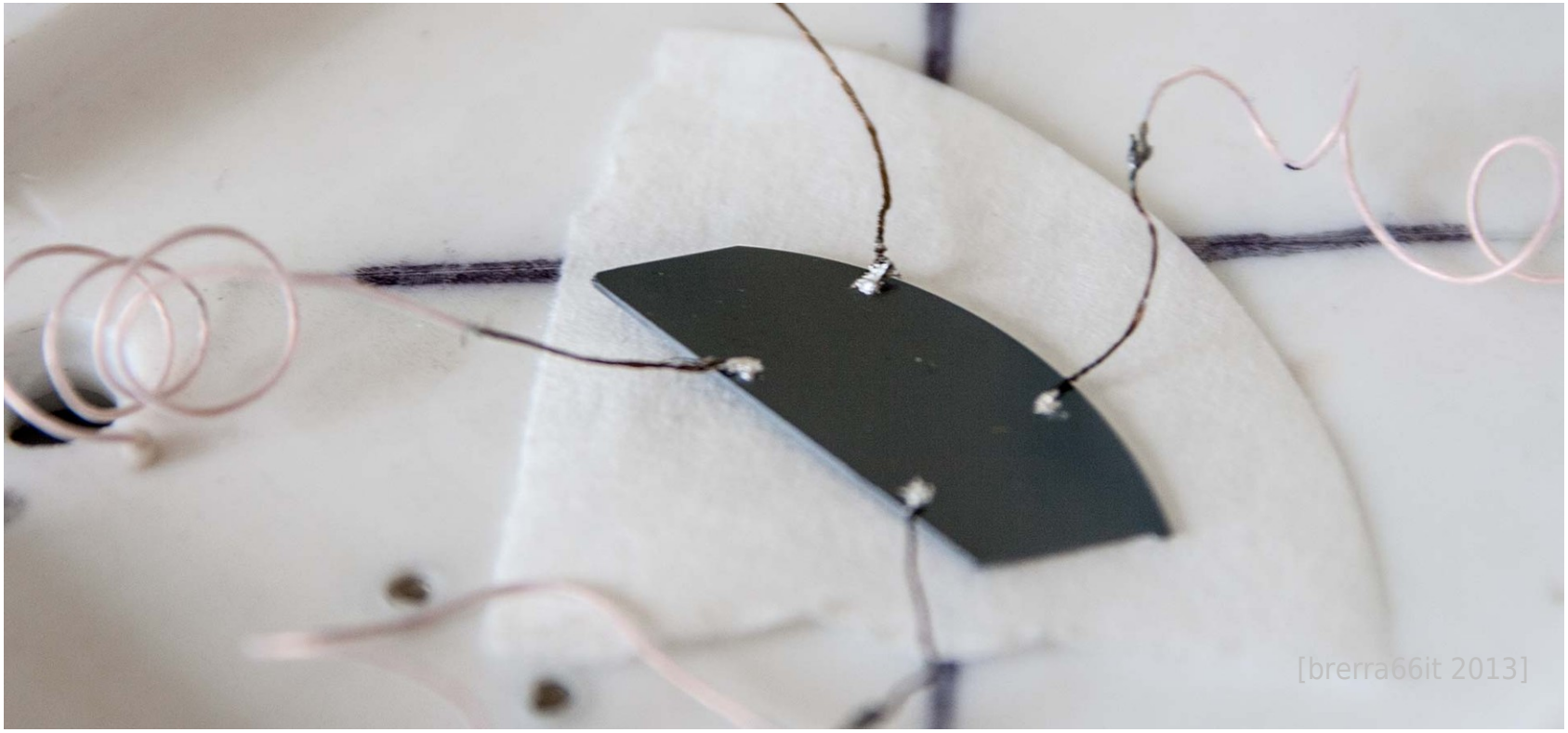

Problem No. 12 “Van der Pauw method”

It is known that conductivity of a material can be measured independently of the sample shape, as long as the sample has one border (no holes). To what extent can such a method be applied? Investigate and explain such measurements if the sample has holes.

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Problem No. 13 “Paper vice”

Take two similar paperback books and interleave a few pages at a time. Push the books together. Hold the two books by their spines and try to pull them apart. Investigate the parameters that set the limits of being able to separate the books.

Background reading

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- Can the Frictional Force Between Two Interleaved Phone Books Lift A Car? [W/Video] (arborsci.com, 2013), http://www.arborsci.com/cool/can-friction-between-two-interleaved-phone-books-lift-a-car
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same tones, and not to the fundamental one, that our flame is sensitive. I utter a loud and sonorous U, the flame remains steady; I change the sound to O, the flame quivers; I sound E, and now the flame is affected strongly. I utter the words *boot*, *boat*, and *beat* in succession. To the first there is no response; to the second, the flame starts; but by the third it is thrown into violent commotion; the sound *Ah*! is still more powerful. When the vowel sounds are analyzed, their constituents are found to vary in accordance with the foregoing experiments, those characterized by the sharpest overtones being the most powerful excitants of the flame. (See Helmholtz in Pogg. *Annalen*, vol. cviii. p. 286.)

Problem No. 14 “Sensitive flame”

A combustible gas (e.g. propane) streams vertically out of a fine nozzle and then through a fine metallic mesh at a distance of about 5 cm. The gas is lit and produces a flame above the mesh. Under some circumstances, this flame reacts very sensitively to sound. Investigate the phenomenon and the relevant parameters.

XXIX. *Note on "Sensitive Flames." By* W. F. Barrett, *Teacher of Experimental Science at the London College of the International Education Society, late Assistant in the Physical Laboratory of the Royal Institution*†.

IN the last Number of the Philosophical Magazine Professor Tyndall has published the abstract of his Friday evening lecture at the Royal Institution, "On Sounding and Sensitive Flames." In the historical note prefixed to that abstract, Professor Tyndall has stated my relationship to the latter subject. It is briefly this. In 1865, while preparing the experiments for one of the Christmas lectures at the Royal Institution, I noticed that the higher harmonics of a brass plate (which I was sounding with a violin-bow in order to obtain Chladni's figures) had a remarkable effect on a tall and slender gas-flame that happened to be burning near. At the sound of any shrill note the flame shrank

* Heat as a Mode of Motion, article 546 (second edition). The "Rede" Lecture on Radiation, pp. 45 & 47.

† Communicated by the Author.

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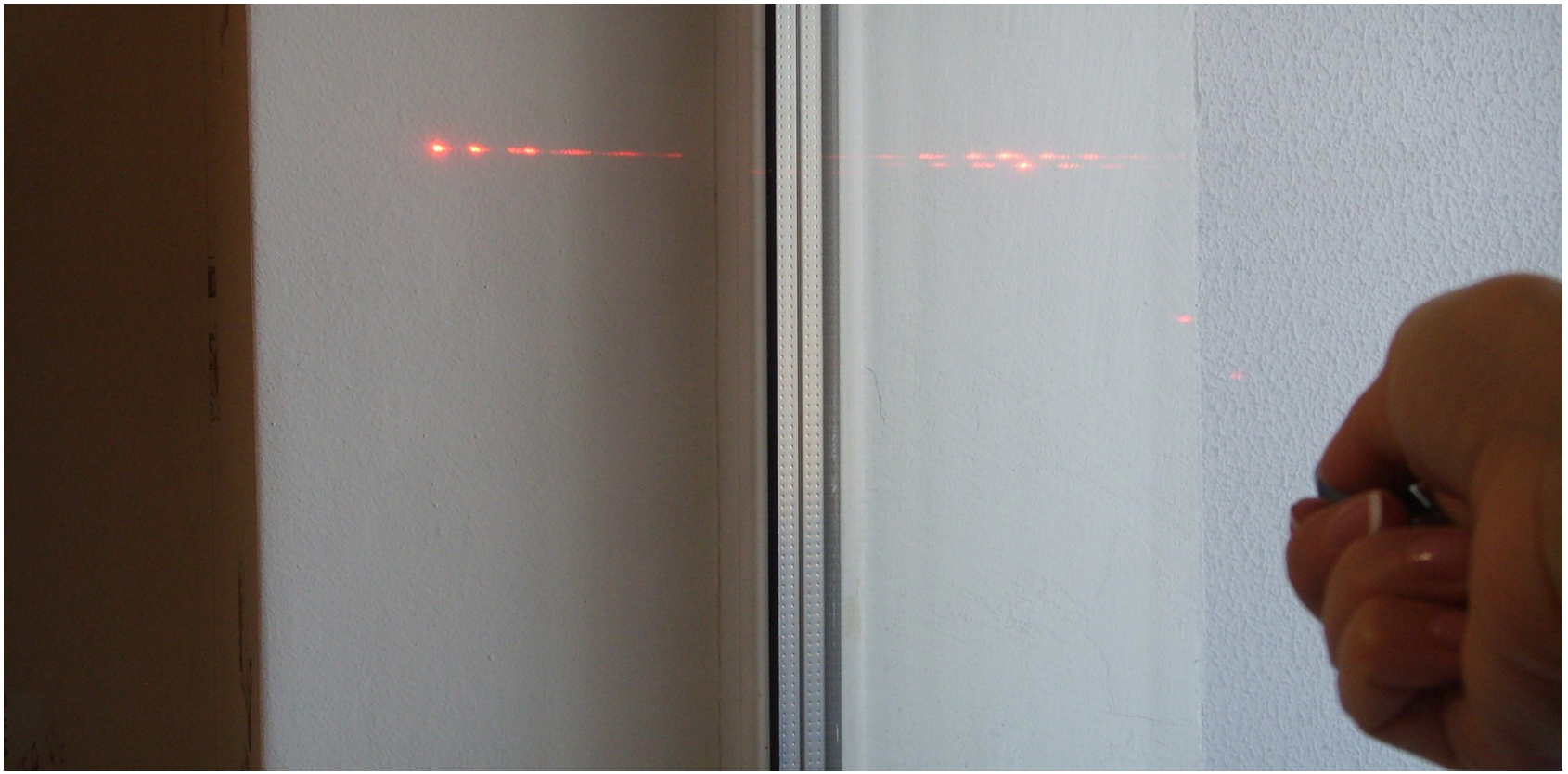

Problem No. 15 “Contactless calliper”

Invent and construct an optical device that uses a laser pointer and allows contactless determination of thickness, refractive index, and other properties of a glass sheet.

Background reading

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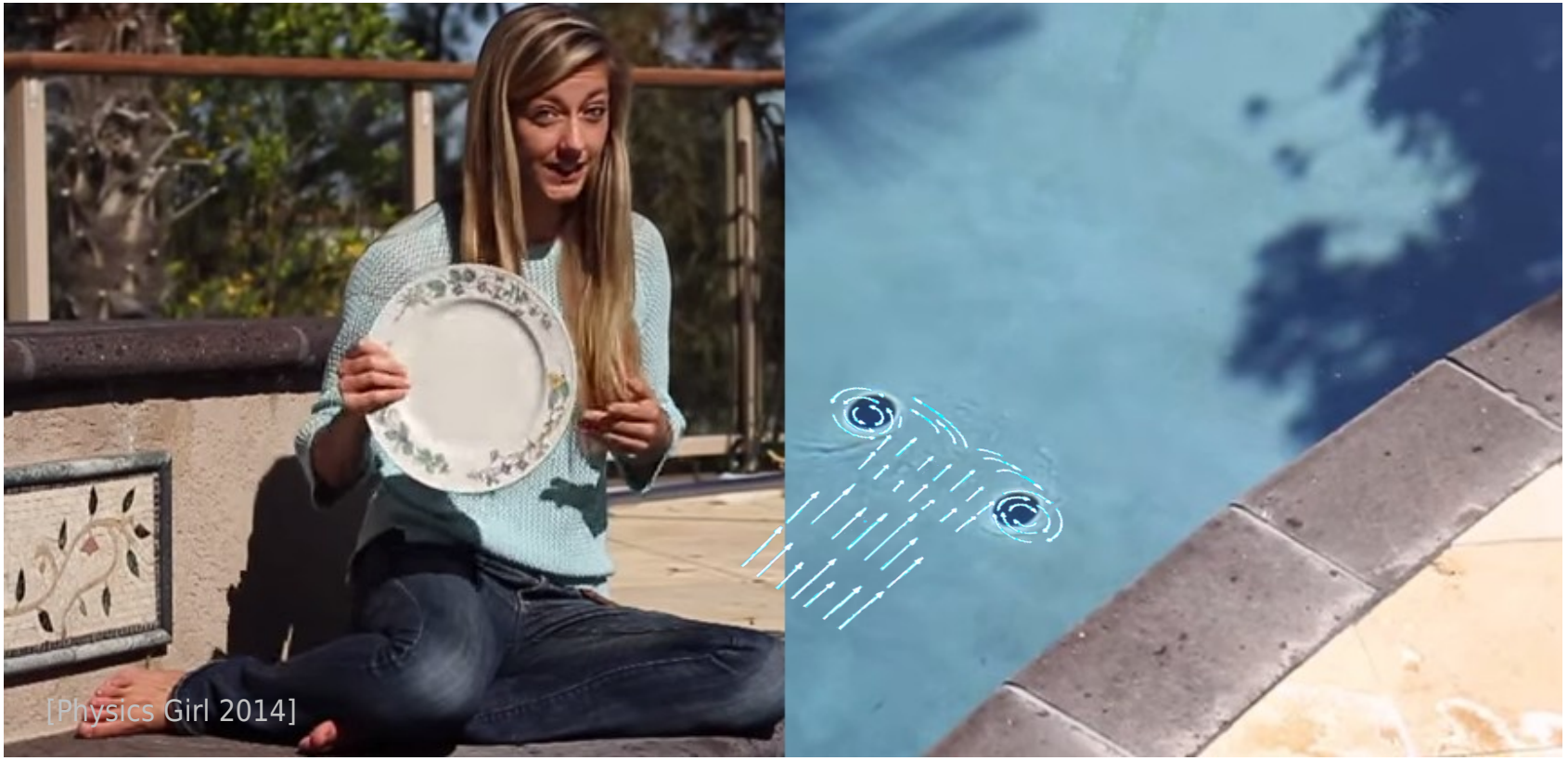

Problem No. 16 “Frisbee vortices”

When a vertical plate is partially submerged in water and pulled in a direction normal to the plate, a pair of vortices is created in the surface of the water. Under certain conditions, these vortices travel along the surface for a long distance. Investigate the parameters influencing the motion and stability of these vortices.

Background reading

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- Crazy pool vortex (youtube.com, from Physics Girl, Nov 22, 2014), https://youtu.be/pnbJEg9r1o8
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- Mini Pool Vortex Rings (youtube.com, from Cool Science, Jan 20, 2015), https://youtu.be/WFTvPByynv4

Problem No. 17 “Crazy suitcase”

When one pulls along a two wheeled suitcase, it can under certain circumstances wobble so strongly from side to side that it can turn over. Investigate this phenomenon. Can one suppress or intensify the effect by varied packing of the luggage?

Background reading

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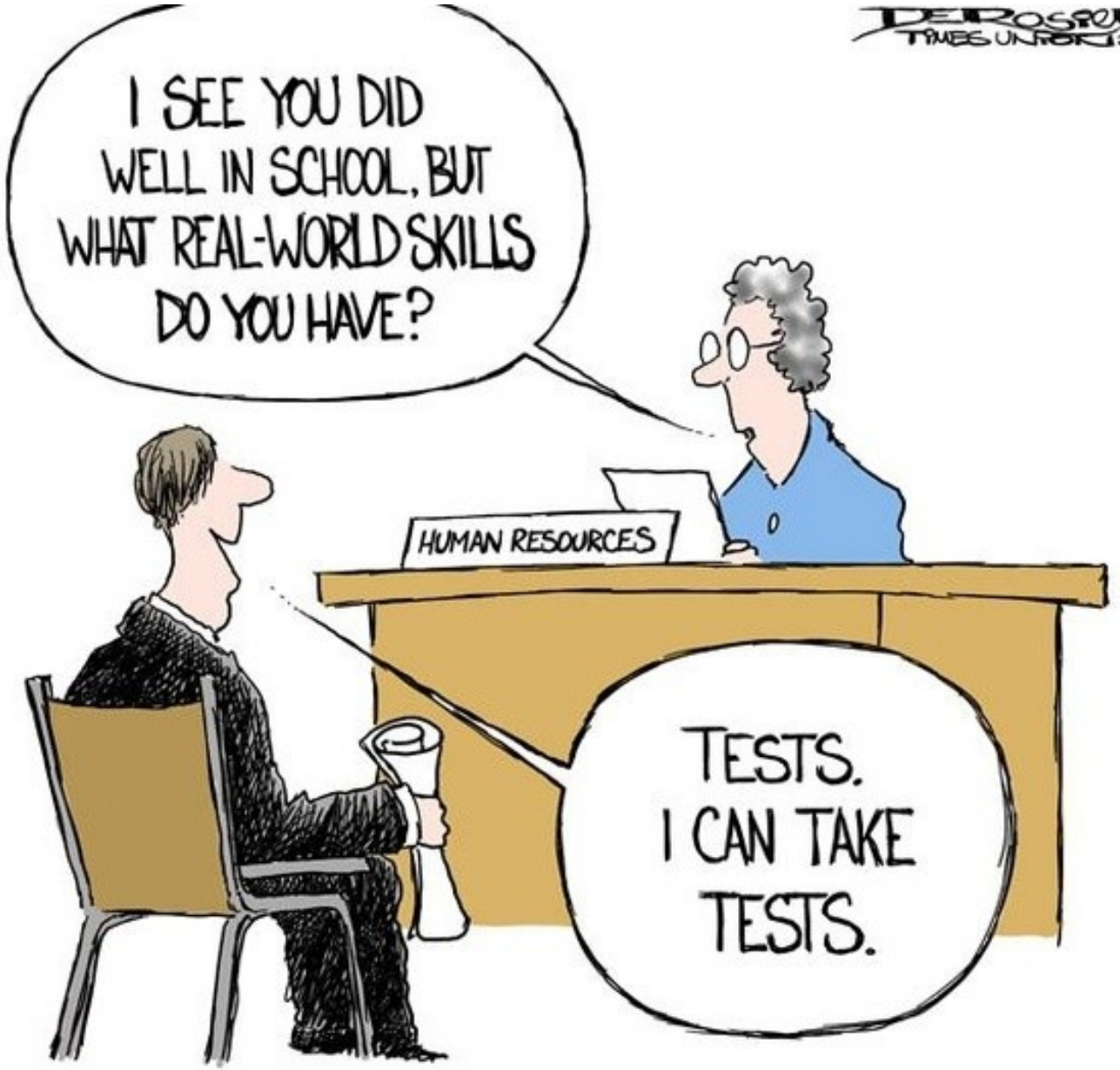
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  - regard their work critically,
  - look deeper,
  - have a better background knowledge,
  - be skeptical in embedding their projects into the standards of professional research,
  - and, as of a first priority, be attentive in not “re-inventing the wheel”
- An early exposure to the culture of scientific citations, and developing a responsible attitude toward making own work truly novel and original, is assumed to be a helpful learning experience in developing necessary standards and attitudes
- Good examples are known when the Kit has been used as a concise supporting material for jurors and the external community; the benefits were in having the common knowledge structured and better visible
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- Serious conclusions will be drawn, up to discontinuing the project in its current form, if systematic misuse of the Kit is detected, such as explicit failure of citing properly, replacing own research with a compilation, or interpreting the Kit itself as a binding “user guide”
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- Originality and independence of your work is always considered as of a first priority
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- Is IYPT all about competing, or about developing professional personal standards?

Requirements for a successful IYPT report

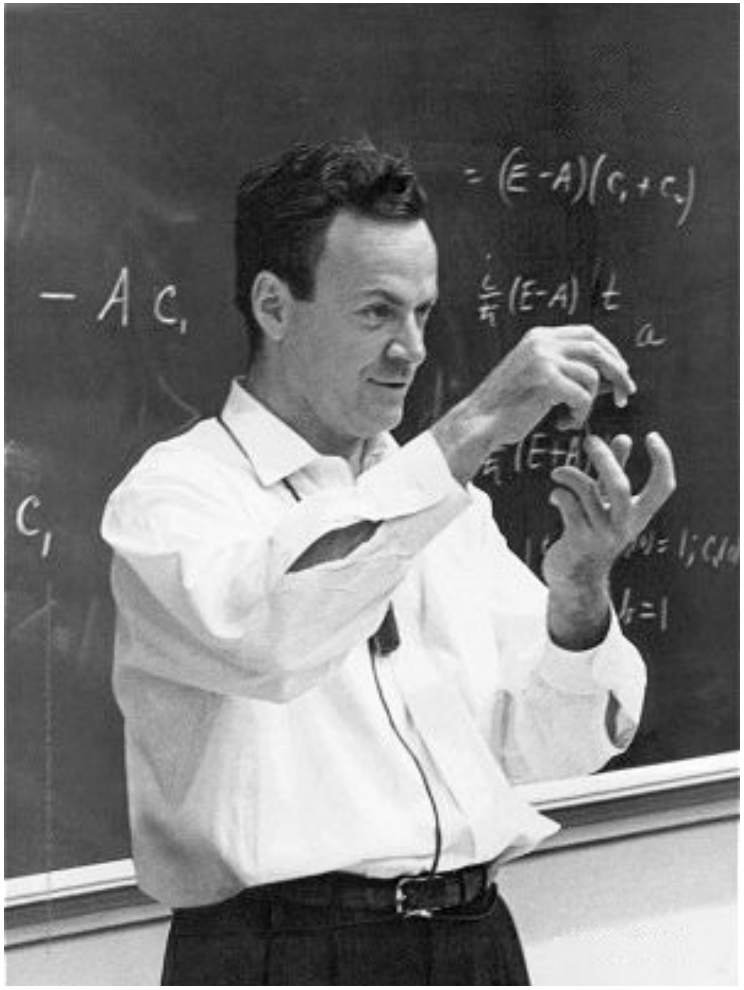
- Novel research, not a survey or a compilation of known facts
- Balance between experimental investigation and theoretical analysis
- Comprehensible, logical and interesting presentation, not a detailed description of everything-you-have-performed-and-thought-about
- Clear understanding of the validity of your experiments, and how exactly you analyzed the obtained data
- Clear understanding of what physical model is used, and why it is considered appropriate
- Clear understanding of what your theory relies upon, and in what limits it may be applied
- Comparison of your theory with your experiments
- Clear conclusions and clear answers to the raised questions, especially those in the task
- Clear understanding of what is your novel contribution, in comparison to previous studies
- Solid knowledge of relevant physics
- Proofread nice-looking slides
- An unexpected trick, such as a demonstration *in situ*, will always be a plus

How to give a science talk

- Take care of your listeners
  - if they all don't get what you say, it's your problem
  - it's your job to do science work and make conclusions. It's their job to listen
- Put yourself in context of existing results
  - your novelty is only visible in contrast with existing knowledge
  - making profound conclusions is harder than measuring and writing formulas and reading papers
  - be proud of your higher-level achievements (if you have such)
- Present a compelling argument
  - you want to say that you solved the required problem
  - saying how much you've struggled on it doesn't help the case
- Cut the non-essential information
  - if your math is thick, show only core assumptions and derived results, we trust algebra and simulations
  - if your data is big, show us trends / slopes / averaging / fits, not all of it
  - very often, less is more

Feynman: to be self-confident?

- “I’ve very often made mistakes in my physics by thinking the theory isn’t as good as it really is, thinking that there are lots of complications that are going to spoil it
- — an attitude that anything can happen, in spite of what you’re pretty sure should happen.”



R.P. Feynman. Surely You’re Joking, Mr. Feynman (Norton, New York, NY, 1985)

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- PROBLEMS 2016
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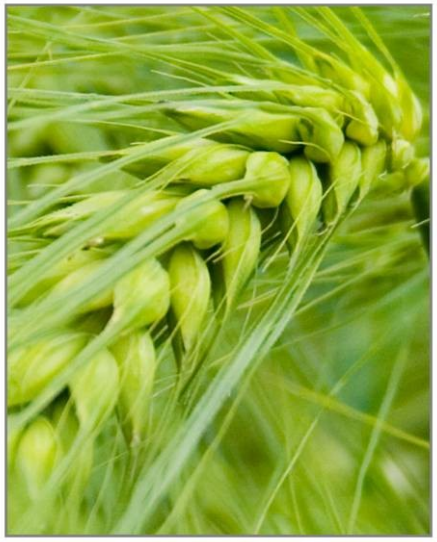

Preparation to 29th IYPT' 2016: references, questions and advices

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