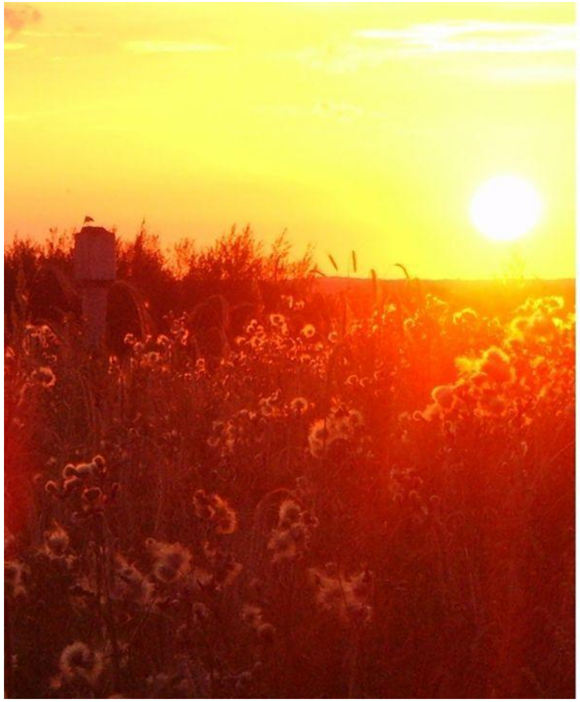
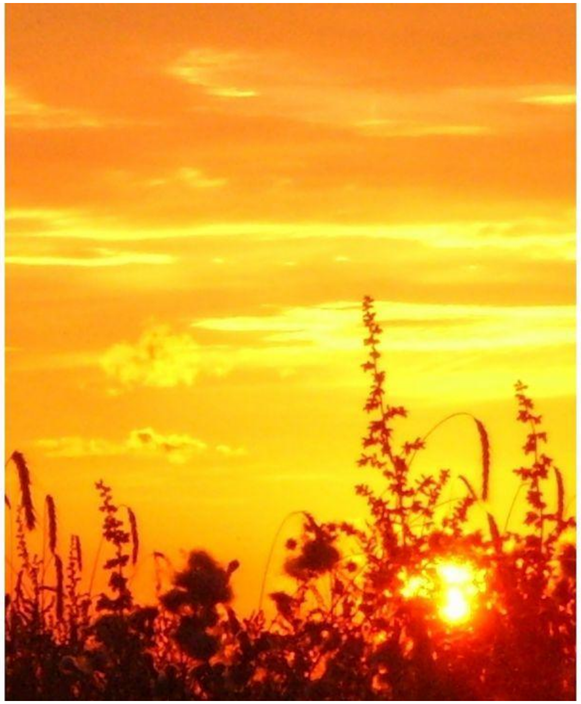
First day draft // July 11, 2014





Preparation to the Young Physicists’ Tournaments’ 2015

Ilya Martchenko, [1*] Andrei Klishin, [2] Reza Montazeri Namin, [3]
Stanisław Świdwiński, [4] Aliaksandr Mamoika, [5] and Stanisłaŭ Piatruša [5]

[1] University of Fribourg and Lund University; [2] Massachusetts Institute of Technology;
[3] Sharif University of Technology; [4] Yale University; [5] Belarusian State University

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 2015, or plan bringing together the Kit for 2016, 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

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

Ilya Martchenko
IYPT Treasurer
Lund University, Box 124,
SE-22100 Lund Sweden
ilya.martchenko@iypt.org

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Invitation

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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!

Meet the UK 1991 team

Photo by Gordon Woods, July 27, 1991

Photo by Sergey Romanchuk, taken nearly simultaneously

The IYPT Archive missed the names of the UK team members at the IYPT 1991

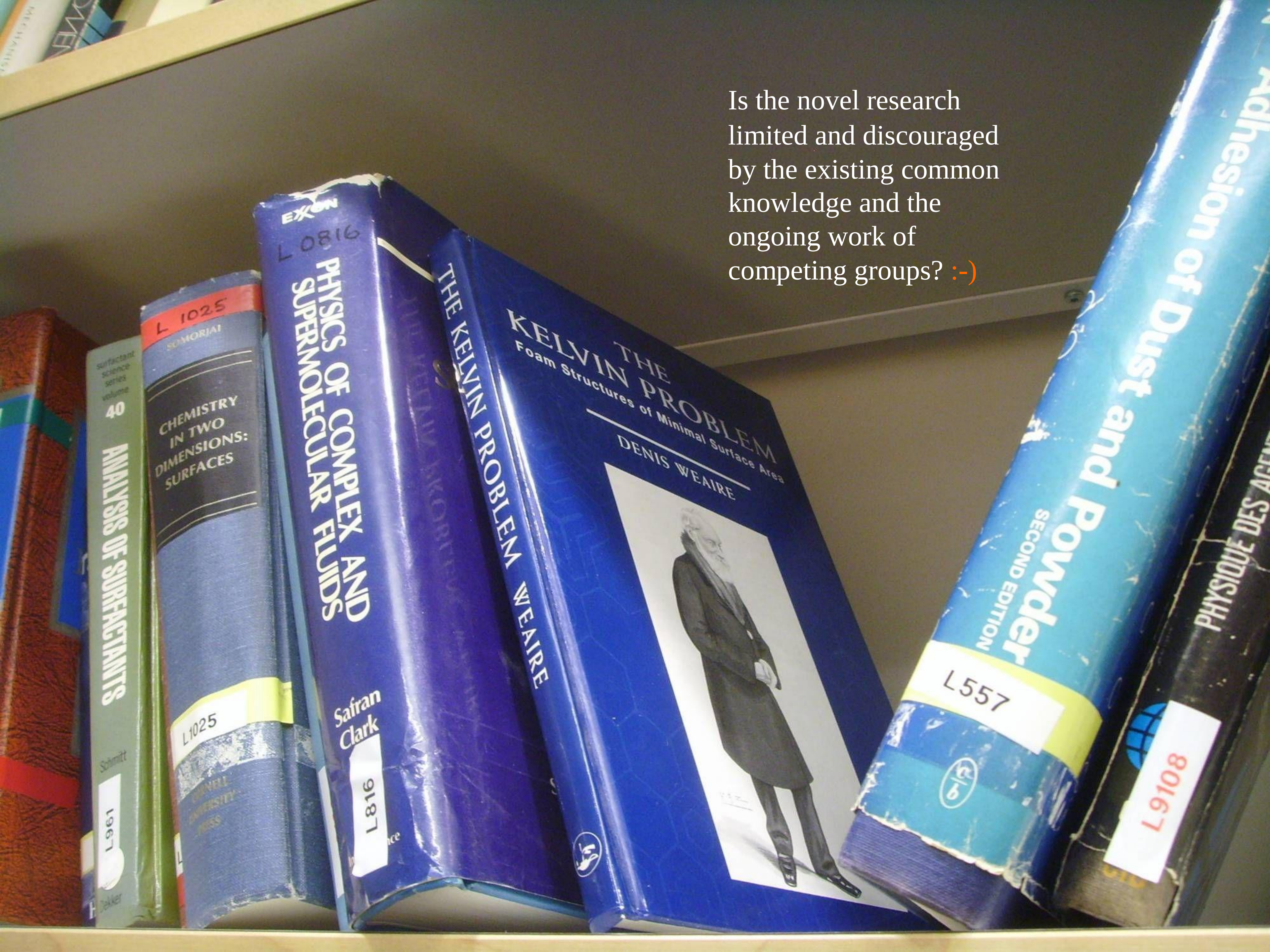
The names are found thanks to Gordon Woods, UK visitor in 1991!

Two photos show the team on the stairs of Physics building, Moscow State University

http://archive.iypt.org/people/#1991

The Hills Road team:
Jonathan Hall   Brendan Bromwich   Glenn Foster
Claudia Knights   Chris Pepper   Louisa Murdin   Robert Storey

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



Important information

The basic goal of this Kit is not in providing students with a start-to-finish manual or in limiting their creativity, but in encouraging them to

- 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"

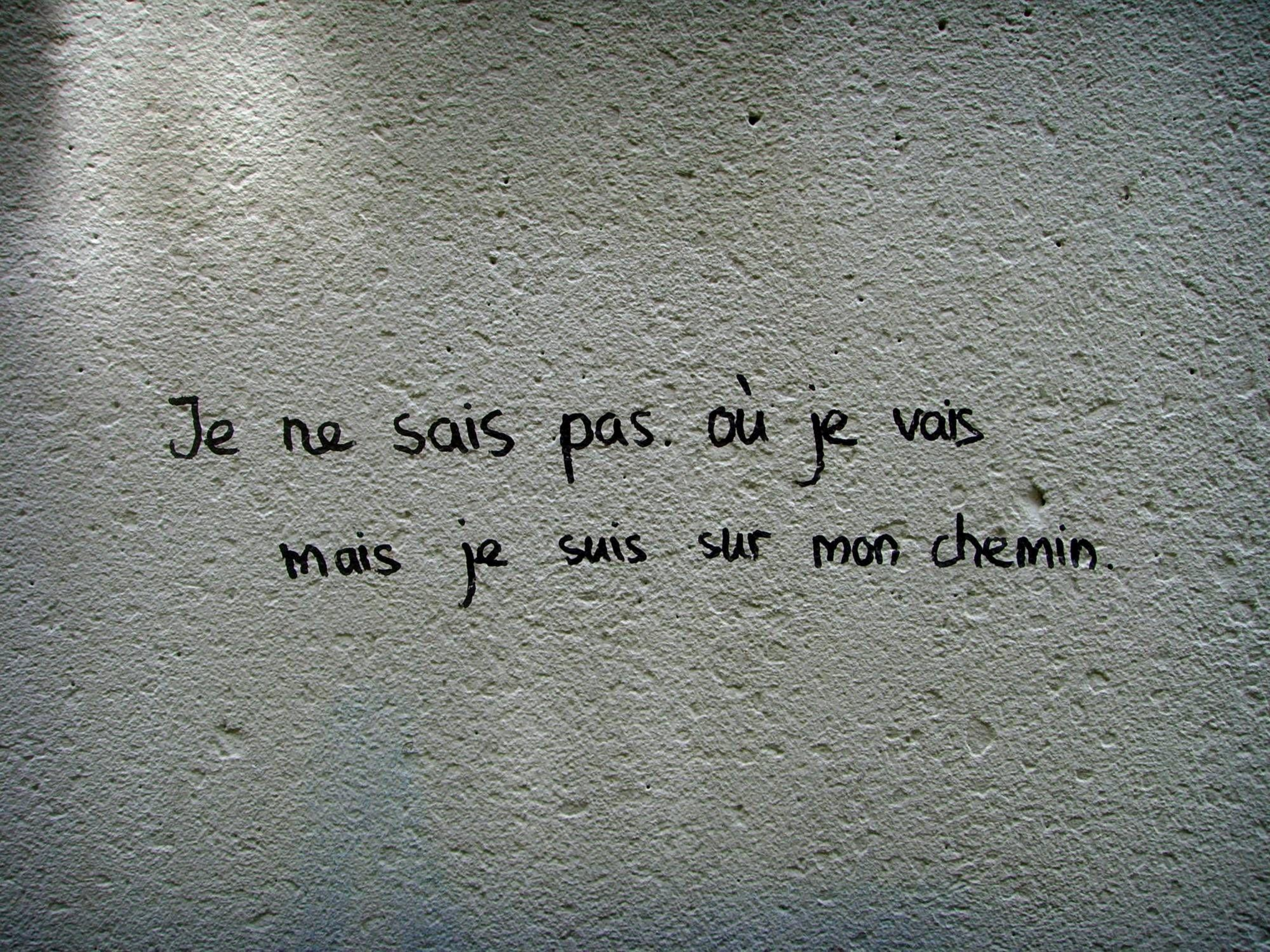
An early exposure to the culture of scientific citations, and developing a responsible attitude toward making own work truly novel and original, is assumed to be a helpful learning experience in developing necessary standards and attitudes

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

Even if linked from iypt.org, this file is not an official, binding release of the IYPT, and should under no circumstances be considered as a collection of authoritative "musts" or "instructions" for whatever competition

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"

All suggestions, feedback, and criticism about the Kit are warmly appreciated :-)


Je ne sais pas. où je vais
mais je suis sur mon chemin.

Habits and customs

Originality and independence of your work is always considered as of a first priority

There is no "correct answer" to any of the IYPT problems

Having a deep background knowledge about earlier work is a must

Taking ideas without citing is a serious misconduct

Critically distinguishing between personal contribution and common knowledge is likely to be appreciated

Reading more in a non-native language may be very helpful

Local libraries and institutions can always help in getting access to paid articles in journals, books and databases

The IYPT is not about reinventing the wheel, or innovating, creating, discovering, and being able to contrast own work with earlier knowledge and the achievements of others?

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

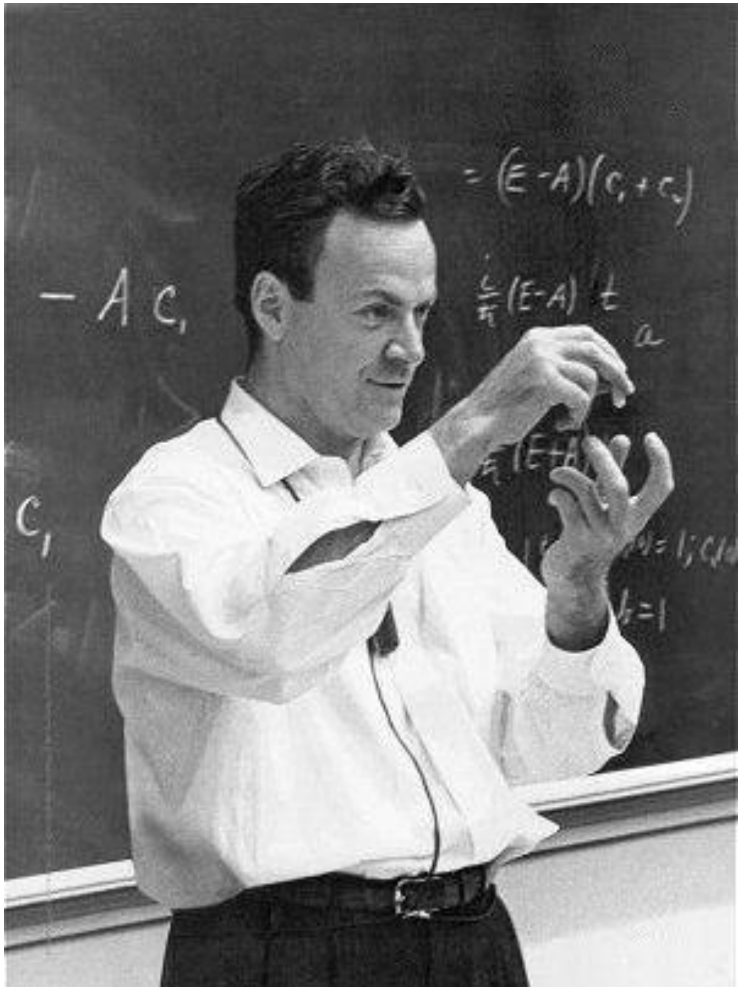
How to give a science talk

- 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?

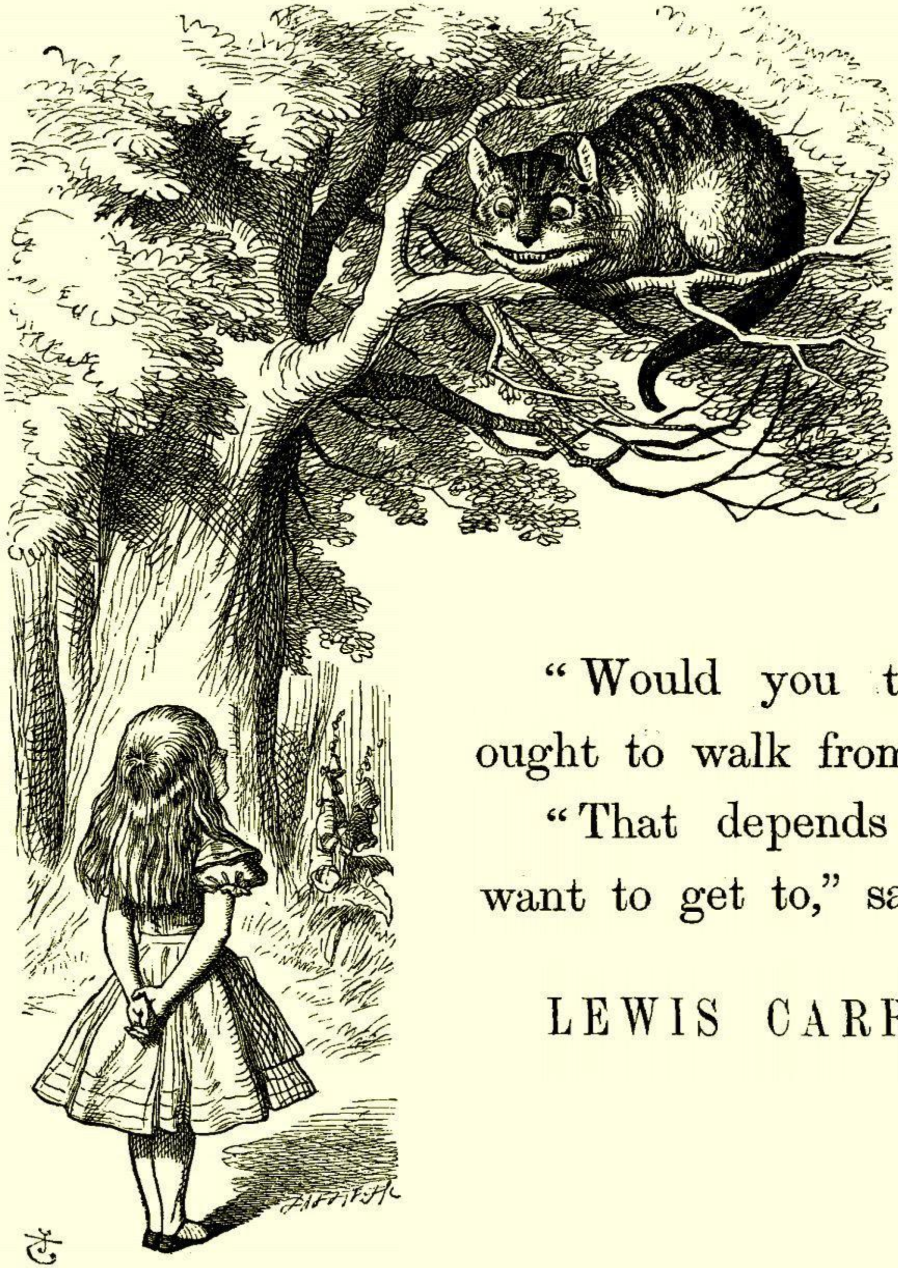
"I've very often made mistakes in my physics by thinking the theory isn't as good as it really is, thinking that there are lots of complications that are going to spoil it

— 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)

// The epigraph for the IYPT 2015 problems approved
by the IYPT Founder Evgeny Yunosov



"Would you tell me, please, which way I ought to walk from here?"

"That depends a good deal on where you want to get to," said the Cat.

LEWIS CARROLL

Problem No. 1 "Packing"

The fraction of space occupied by granular particles depends on their shape. Pour non-spherical particles such as rice, matches, or *M&M's* candies into a box. How do characteristics like coordination number, orientational order, or the random close packing fraction depend on the relevant parameters?

Background reading

Wikipedia: Kepler conjecture, https://en.wikipedia.org/wiki/Kepler_conjecture

Wikipedia: Random close pack, https://en.wikipedia.org/wiki/Random_close_pack

Wikipedia: Coordination number, https://en.wikipedia.org/wiki/Coordination_number

W. Man, A. Donev, F. H. Stillinger, M. T. Sullivan, W. B. Russel, D. Heeger, S. Inati, S. Torquato, and P. M. Chaikin. Experiments on Random Packings of Ellipsoids. Phys. Rev. Lett. 94, 198001 (2005)

A. Donev, I. Cisse, D. Sachs, E. A. Variano, F. H. Stillinger, R. Connelly, S. Torquato, and P. M. Chaikin. Improving the density of jammed disordered packings using ellipsoids. Science 303, 990-993 (2004)

A. Donev, F. H. Stillinger, P. M. Chaikin, and S. Torquato. Unusually dense crystal packings of ellipsoids. Phys. Rev. Lett. 92, 255506 (2004)

Ch. Song, P. Wang, and H. A. Makse. A phase diagram for jammed matter. Nature 453, 629-632 (2008), arXiv:0808.2196 [cond-mat.soft]

J. D. Bernal and J. Mason. Packing of spheres: co-ordination of randomly packed spheres. Nature 188, 910–911 (1960)

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J. D. Berryman. Random close packing of hard spheres and disks. Phys. Rev. A 27, 1053–1061 (1983)

Background reading

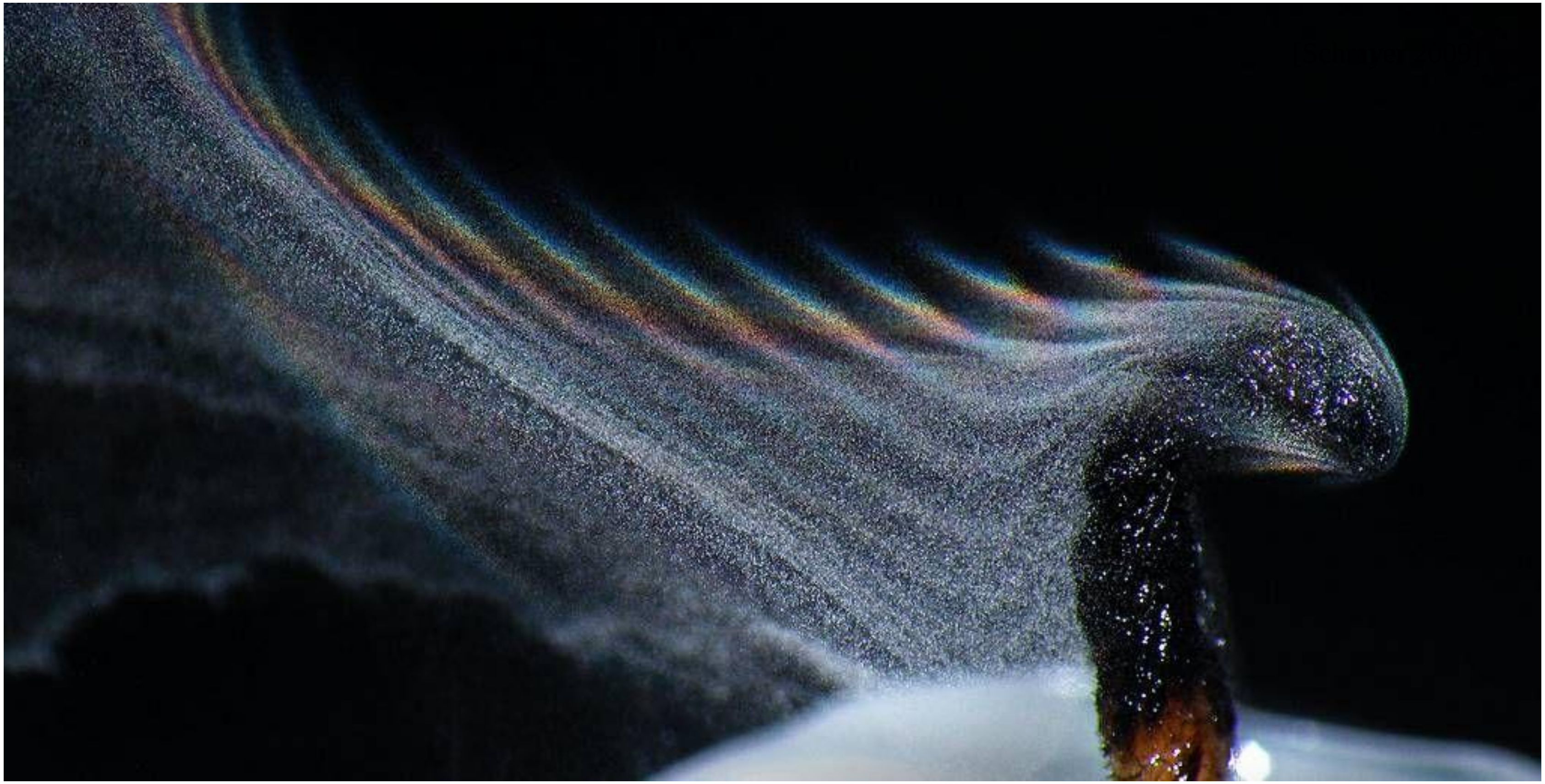
M. P. Ciamarra, A. Coniglio, and M. Nicodemi. Thermodynamics and statistical mechanics of dense granular media. Phys. Rev. Lett. 97, 158001 (2006)

S. Li, J. Zhao, P. Lu, and Y. Xie. Maximum packing densities of basic 3D objects. Chin. Sci. Bull. 55, 2, 114-119 (2010)

G. Delaney, D. Weaire, S. Hutzler, and S. Murphy. Random packing of elliptical disks. Phil. Mag. Lett. 85, 2, 89-96 (2005)

S. Torquato, T. M. Truskett, and P. G. Debenedetti. Is random close packing of spheres well defined? Phys. Rev. Lett. 84, 2064 (2000)

V. Baranau and U. Tallarek. Random-close packing limits for monodisperse and polydisperse hard spheres. Soft Matter, 10, 3826-3841 (2014)



Problem No. 2 “Plume of smoke”

If a burning candle is covered by a transparent glass, the flame extinguishes and a steady upward stream of smoke is produced. Investigate the plume of smoke at various magnifications.

Background reading

K. Hill. Waxbows: The Incredible Beauty of a Blown Out Candle (scientificamerican.com, 2013), http://blogs.scientificamerican.com/but-not-simpler/2013/09/09/waxbows-the-incredible-beauty-of-a-blown-out-candle/

Grover Schrayer: Candle album on Flickr (2009), https://www.flickr.com/photos/14833125@N02/sets/72157625152859983/

J. Hemmings. Why do candles only smoke after they've been extinguished? (sciencefocus.com, 2013), http://sciencefocus.com/qa/why-do-candles-only-smoke-after-theyve-been-extinguished

Hollow Flame - looking inside a candle flame (thenakedscientists.com, 2010), http://www.thenakedscientists.com/HTML/content/kitchenscience/exp/-25aeab656d/

S. R. Hanna. Concentration fluctuations in a smoke plume. Atmospheric Environment 18, 6, 1984, 1091-1106 (1967)

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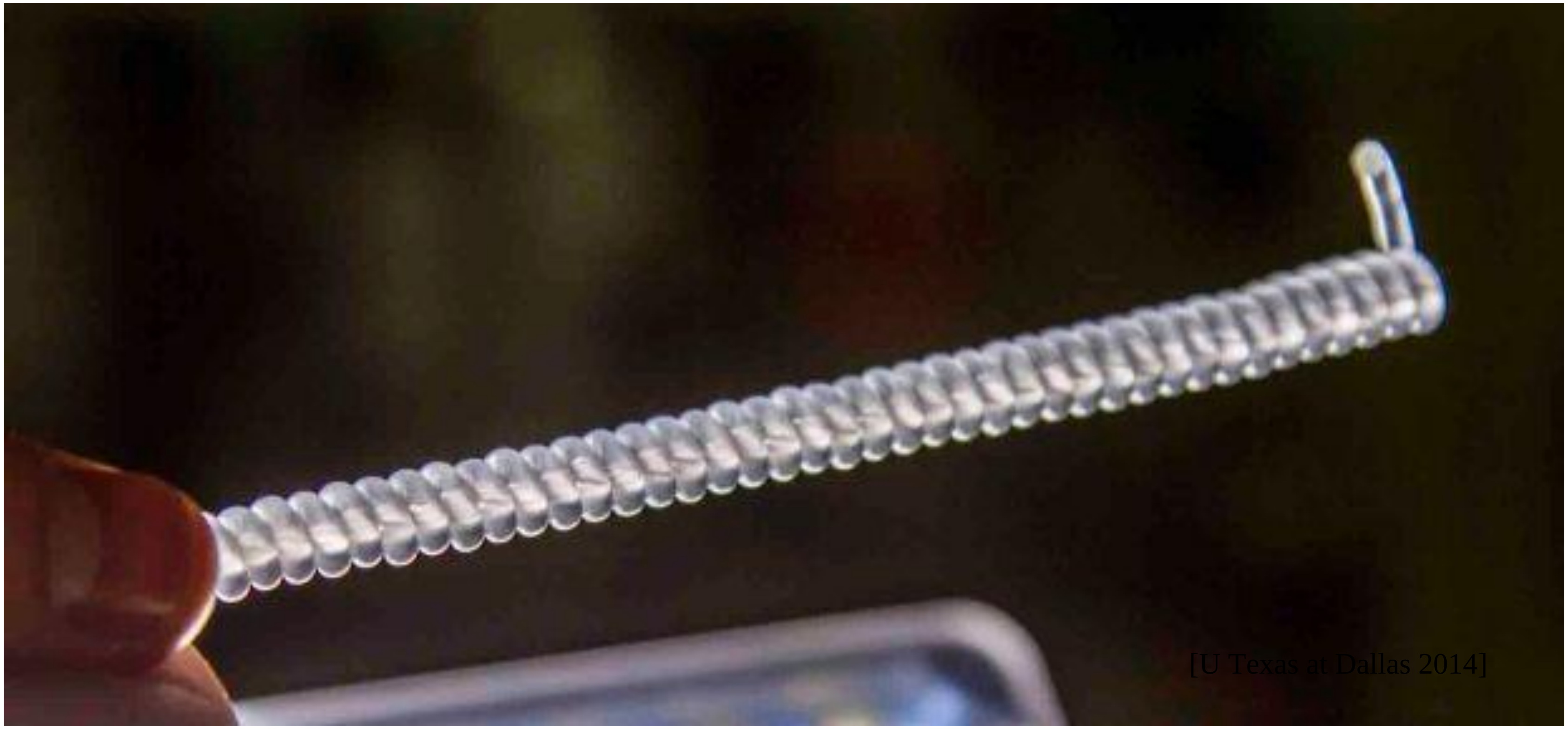
Jearl Walker. The Physics and Chemistry Underlying the Infinite Charm of a Candle Flame: Amateur Scientist. Sci. Am. 238, 4, 154-162 (1978)

Wikipedia: Nucleation, https://en.wikipedia.org/wiki/Nucleation


[U Texas at Dallas 2014]

Problem No. 3 “Artificial muscle”

Attach a polymer fishing line to an electric drill and apply tension to the line. As it twists, the fibre will form tight coils in a spring-like arrangement. Apply heat to the coils to permanently fix that spring-like shape. When you apply heat again, the coil will contract. Investigate this ‘artificial muscle’.

Background reading

C. S. Haines, M. D. Lima, N. Li, G. M. Spinks, J. Foroughi, J. D. W. Madden, S. H. Kim, S. Fang, M. J. de Andrade, F. Göktepe, Ö. Göktepe, S. M. Mirvakili, S. Naficy, X. Lepró, J. Oh, M. E. Kozlov, S. J. Kim, X. Xu, B. J. Swedlove, G. G. Wallace, and R. H. Baughman. Artificial muscles from fishing line and sewing thread. Science 343, 6173, 868-872 (2014), http://gnusha.org/~nmz787/pdf/Artificial_Muscles_from_Fishing_Line_and_Sewing_Thread.pdf

J. Yuan and P. Poulin. Fibers do the twist. Science 343, 845-846 (2014)

Fishing Line Artificial Muscles (youtube.com, from ACESElectromaterials, 19.02.1014), http://youtu.be/Tba8Nf02OSI

A. Khan. Watch: Scientists make super-strong artificial muscle from fishing line (LA Times, 2014), http://www.latimes.com/science/sciencenow/la-sci-sn-artificial-muscle-fishing-line-sewing-thread-power-20140220,0,1798223.story#axzz2uJMtxhrk

D. Cooper. Spun fishing line turned into muscle. (ABC Science, 2014), http://www.abc.net.au/science/articles/2014/02/21/3948996.htm

Problem No. 4 “Liquid film motor”

Form a soap film on a flat frame. Put the film in an electric field parallel to the film surface and pass an electric current through the film. The film rotates in its plane. Investigate and explain the phenomenon.

Background reading

A. Amjadi, R. Shirsavar, N. Hamedani Radja, and M. R. Ejtehadi. A liquid film motor. Microfluid and nanofluid. 6, 5 711-715 (2009)

E. V. Shiryaeva, V. A. Vladimirov, and M. Yu Zhukov. Theory of rotating electrohydrodynamic flows in a liquid film. Phys. Rev. E 80, 4, 041603 (2009), arXiv:0902.3733v1 [physics.flu-dyn], http://maths.york.ac.uk/www/sites/default/files/PhysRevE_film.pdf

Zh.-Q. Liu, Y.-J. Li, G.-C. Zhang, and S.-R. Jiang. Dynamical mechanism of the liquid film motor. Phys. Rev. E 83, 2, 026303 (2011)

R. Shirsavar, A. Amjadi, A. Tonddast-Navaei, and M. R. Ejtehadi. Electrically rotating suspended films of polar liquids. Exp. Fluids, 50, 2, 419-428 (2011)

Z.-Q. Liu, G.-C. Zhang, Y.-J. Li, and S.-R. Jiang. Water film motor driven by alternating electric fields: Its dynamical characteristics. Phys. Rev. E 85, 3, 036314 (2012)

Z.-Q. Liu, Y.-J. Li, K.-Y. Gan, S.-R. Jiang, and G.-C. Zhang. Water film washers and mixers: Their rotational modes and electro-hydrodynamical flows induced by square-wave electric fields. Microfluid. and Nanofluid. 14, 1-2, 319-328 (2013)

A. Amjadi, R. Nazifi, R. M. Namin, and M. Mokhtarzadeh. States of motion in an AC liquid film motor: experiments and theory (2013), arXiv:1305.1779v1 [physics.flu-dyn]

Background reading

A. Amjadi, M. S. Feiz, and R. M. Namin. Liquid soap film generates electricity: A suspended liquid film rotating in an external electric field as an electric generator. Microfluid. and Nanofluid. 5, 1-7 (2013), arXiv:1305.7165v2 [cond-mat.soft]

2009-Water Film Motor (Dept Physics, Sharif Univ. Tech., 2009), http://phys.sharif.edu/web/medphyslab/2009-water

2010-Rotation of Polar Liquid Films (Dept Physics, Sharif Univ. Tech., 2010), http://phys.sharif.edu/web/medphyslab/2010-rotation

2010-Instability and Rotation of Liquid Crystal Films (Dept Physics, Sharif Univ. Tech., 2010), http://phys.sharif.edu/web/medphyslab/2010-instability

Liquid Motor Revs Up (scientificamerican.com), http://www.scientificamerican.com/gallery/liquid-motor-revs-up/

Problem No. 5 “Two balloons”

Two rubber balloons are partially inflated with air and connected together by a hose with a valve. It is found that depending on initial balloon volumes, the air can flow in different directions. Investigate this phenomenon.

Background reading

F. Weinhaus and W. Barker. On the equilibrium states of interconnected bubbles or balloons. Am. J. Phys. 46, 978-982 (1978)

Wikipedia: Two balloons experiment, http://en.wikipedia.org/wiki/Two-balloon_experiment

Wikipedia: Elasticity, http://en.wikipedia.org/wiki/Elasticity_(physics)

Y. Levin and F. L. da Silveira. Two rubber balloons: Phase diagram of air transfer. Phys. Rev. E, 69, 051108 (2004)

Y. Levin and F. L. da Silveira. To grow or to shrink: A tale of two rubber balloons (2004), arXiv:cond-mat/0403171v1 [cond-mat.soft]

Pressure inside a balloon (SCIPP), http://scipp.ucsc.edu/outreach/balloon/labs/InflationExp.htm

B. Denardo and R. Masada. Rubber hysteresis experiment. Phys. Teach. 28, 7, 489-491 (1990)

P. Zendedel Nobari, R. M. Namin, and H. Azizinaghsh. Energy losses and efficiency in a balloon powered car. IYPT Proc. 2010-2011 (AYIMI, IYPT Archive, 2011), http://archive.iypt.org/iypt_book/2011_5_Car_Iran_PZN_RMN_HA_v6.pdf

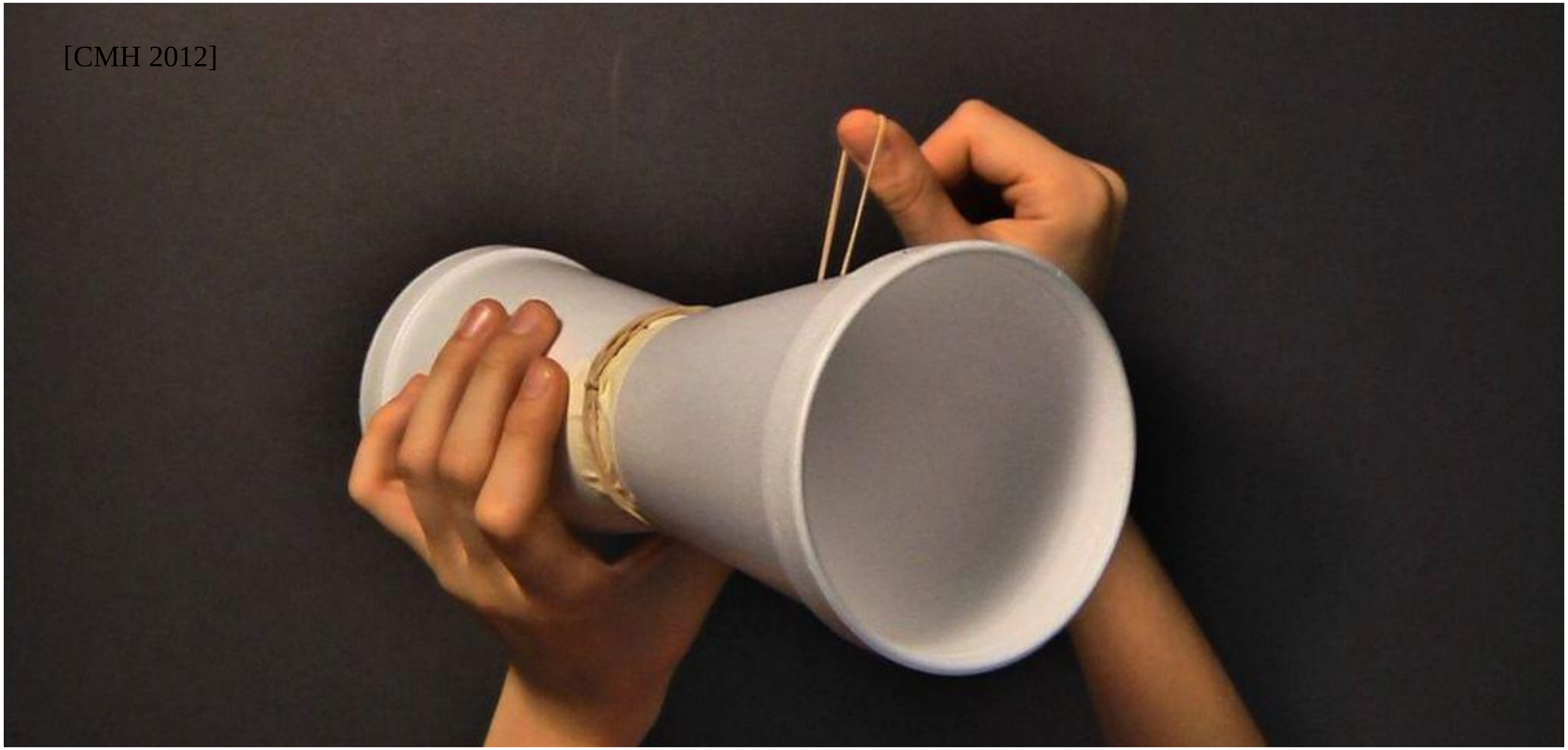
Wikipedia: Mullins Effect, http://en.wikipedia.org/wiki/Mullins_effect

Wikipedia: Laplace Pressure, http://en.wikipedia.org/wiki/Laplace_pressure

Try this: Baffling balloons (csiro.au), http://www.csiro.au/helix/sciencemail/activities/laplace.html

2A10.51 Rubber Balloons (brown.edu), https://wiki.brown.edu/confluence/display/physlecdemo/2A10.51+Rubber+Balloons

Ch.-Sh. Chen. Two interconnected rubber balloons as a demonstration showing the effect of surface tension (circle.ubc.ca, 2009), https://circle.ubc.ca/bitstream/handle/2429/7914/08WT2ChiehShanChen.pdf



Problem No. 6 “Magnus glider”

Glue the bottoms of two light cups together to make a glider. Wind an elastic band around the centre and hold the free end that remains. While holding the glider, stretch the free end of the elastic band and then release the glider. Investigate its motion.

Background reading

Wikipedia: Magnus effect, https://en.wikipedia.org/wiki/Magnus_effect

Wendy Sadler - Magnus Effect.mp4 (youtube.com, from Wendy Sadler, 21.06.2011), http://youtu.be/DlO774GyRrw

Magnus Glider (youtube.com, from Children's Museum of Houston, 20.06.2012), http://youtu.be/I1rdHsTtG_w

Magnus Glider by Childrens Museum of Houston (instructables.com, 2012), http://www.instructables.com/file/FJP44INH461WTRW

Keith Ostfeld. Make Your Own Magnus Glider (CMH, 2010), http://www.cmhoustonblog.org/2010/04/26/make-your-own-magnus-glider/

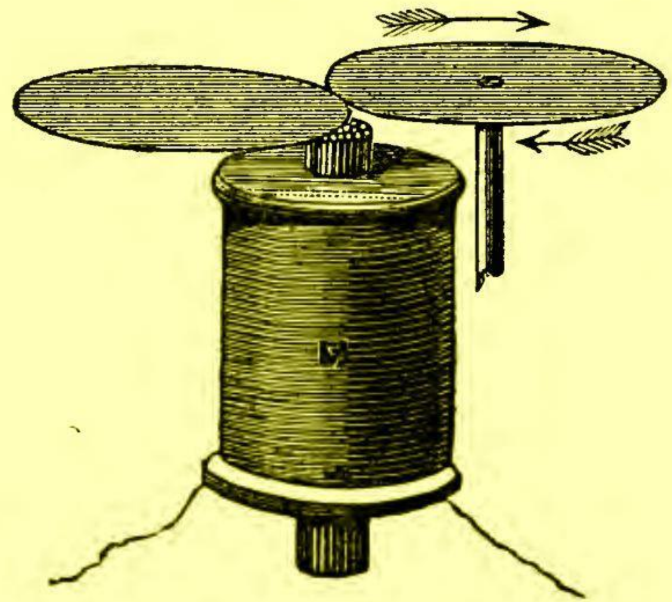
R. Nichols. Examination of the aerodynamic characteristics of a Magnus effect glider. PhD Thesis (California Polytech. State Univ., 2008)

H. M. Barkla and L. J. Auchterlonie. The Magnus or Robins effect on rotating spheres. J. Fluid Mech. 47, 03, 437 (1971)

W. M. Swanson. The Magnus effect: A summary of investigations to date. J. Basic Eng. 83, 3, 461 (1961)

and in the movable one. The fixed disc shields part of the other from the induction of the pole, and hence causes the induced currents in that plate and disc to be so located that they are in positions to cause continual attraction between one another and continuously pull round the movable disc into fresh positions, so creating regular rotation. This principle of "shading" a pole is employed in constructing the polar coils of the magnet used in our experiment a moment ago, and the experiments present us with

Fig. 11.



Revolution of a shaded copper plate held over an alternate-current magnetic pole.

Problem No. 7 "Shaded pole"

Place a non-ferromagnetic metal disk over an electromagnet powered by an AC supply. The disk will be repelled, but not rotated. However, if a non-ferromagnetic metal sheet is partially inserted between the electromagnet and the disk, the disk will rotate. Investigate the phenomenon.

WEEKLY EVENING MEETING,

Friday, March 6, 1891.

William Crookes, Esq. F.R.S. Vice-President, in the Chair.

Professor J. A. Fleming, M.A. D.Sc. *M.R.I.*

Electro-magnetic Repulsion.

§ 1. On the 2nd day of October, 1820, Ampère presented to the Royal Academy of Sciences in Paris an important memoir, in which he summed up the results of his own and Arago's previous investigations in the new science of electro-magnetism, and crowned that labour by the announcement of his great discovery of the dynamical action between conductors conveying electric currents.* Respecting that achievement, when developed in its experimental and mathematical completeness, no less a writer than Clerk Maxwell calls it "one of the most brilliant in the history of physical science." Our wonder at what was then accomplished is increased when we remember that

Background reading

J. A. Fleming. On electromagnetic repulsion. Proc. Royal Inst. of Great Britain (March 1891), pp. 72-92, https://ia600706.us.archive.org/20/items/RoyalInstitutionLibraryOfScience-PhysicalScienceVol4/RoyalInstitutionVol04_text.pdf; and Journ. Soc. of Arts (May 14, 1890), pp. 296-316, https://ia600301.us.archive.org/32/items/proceedings13roya/proceedings13roya_bw.pdf

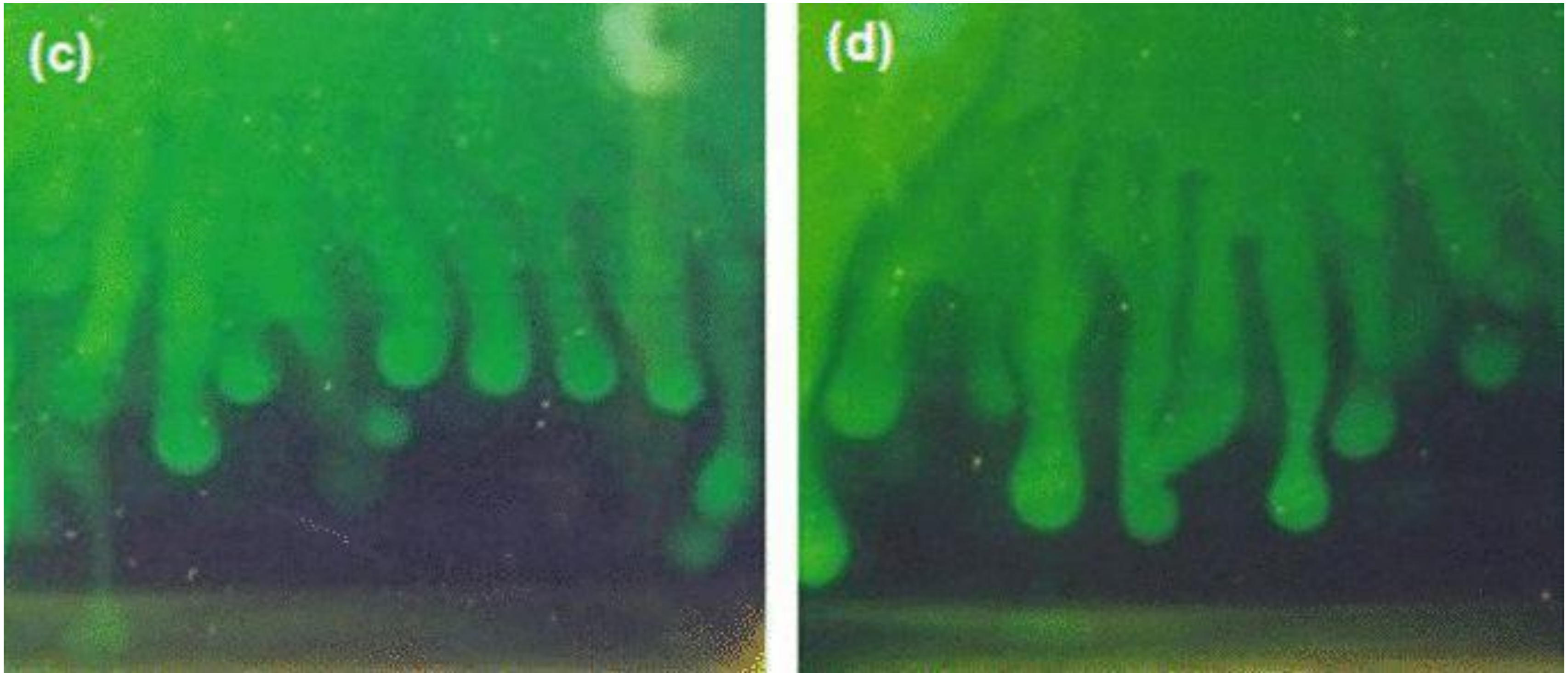
Jearl Walker. 6.22: Turning in the shade of a magnetic field. In: The Flying Circus of Physics with Answers (John Wiley & Sons, 1975), https://ia601208.us.archive.org/4/items/TheFlyingCircusOfPhysicsWithAnswers/Walker-TheFlyingCircusOfPhysicsWithAnswers_text.pdf

Wikipedia: Shaded-pole motor, http://en.wikipedia.org/wiki/Shaded-pole_motor

Easy shaded pole motor experiment (youtube.com, from stroll365, 11.07.2009), http://youtu.be/VvvEvccXRGs

Shaded pole motor experiment (youtube.com, from Thomas Kim, 30.07.2013), http://youtu.be/2jOOwyzFCj0

Keith Gibbs. (v) The shaded pole motor (schoolphysics, 2013), http://www.schoolphysics.co.uk/age16-19/Electricity%20and%20magnetism/Electromagnetism/text/Electric_motor_ac/index.html



Problem No. 8 “Sugar and salt”

When a container with a layer of sugar water placed above a layer of salt water is illuminated, a distinctive fingering pattern may be seen in the projected shadow. Investigate the phenomenon and its dependence on the relevant parameters.

Background reading

Wikipedia: Schlieren photography, http://en.wikipedia.org/wiki/Schlieren_photography

J. Taylor and G. Veronis. Experiments on double-diffusive sugar-salt fingers at high stability ratio. J. Fluid Mech. 321, 315–333 (1996)

O. P. Singh and J. Srinivasan. Effect of Rayleigh numbers on the evolution of double-diffusive salt fingers. Phys. Fluids 26, 062104 (2014)

R. W. Schmitt. The characteristics of salt fingers in variety of fluid systems, including stellar interiors, liquid metals, oceans, and magmas. Phys. Fluids 26, 9, 2373–2377 (1983)

Wikipedia: Rayleigh-Taylor instability, http://en.wikipedia.org/wiki/Rayleigh%E2%80%93Taylor_instability

P. Garaud, J. Brown, A. Traxler, S. Stellmach, and T. Radko. Fingering convection (UC Santa Cruz), http://chandra.as.arizona.edu/~cmeakin/stellarhydro/pdf_slides/Garaud_SantaFe_Workshop.pdf

Y.-N. Young, H. Tufo, A. Dubey, and R. Rosner. On the miscible Rayleigh–Taylor instability: two and three dimensions. J. Fluid Mech. 447, 377-408 (2001)

J. Yoshida and H. Nagashima. Numerical experiments on salt-finger convection (phys.ocean.dal.ca), http://www.phys.ocean.dal.ca/programs/doubdiff/final_pdfs/salt-finger_numerical.pdf

T. G. L. Shirtcliffe and J. S. Turner. Observations of the cell structure of salt fingers. J. Fluid Mech., 41, 4, 707-719 (1970)

J. Walker. The salt fountain and other curiosities based on the different density of fluids. Amateur Scientist. In: Sci. Am. 10 (1977), http://jesseenterprises.net/amsci/1977/10/1977-10-body.html

The initial growth of salt fingers: Fig. 2 (Univ. of Victoria), http://csa.phys.uvic.ca/teaching/multi-physics-projects-with-comsol/fluid-mechanics/the-initial-growth-of-salt-fingers/fig-2/view

Mixing Physics Science Experiment (youtube.com, from Physics Central, 10.01.2013), http://youtu.be/NI85oC-3mJ0

Problem No. 9 “Hovercraft”

A simple model hovercraft can be built using a CD and a balloon filled with air attached via a tube. Exiting air can lift the device making it float over a surface with low friction. Investigate how the relevant parameters influence the time of the ‘low-friction’ state.

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Problem No. 10 “Singing blades of grass”

It is possible to produce a sound by blowing across a blade of grass, a paper strip or similar. Investigate this effect.

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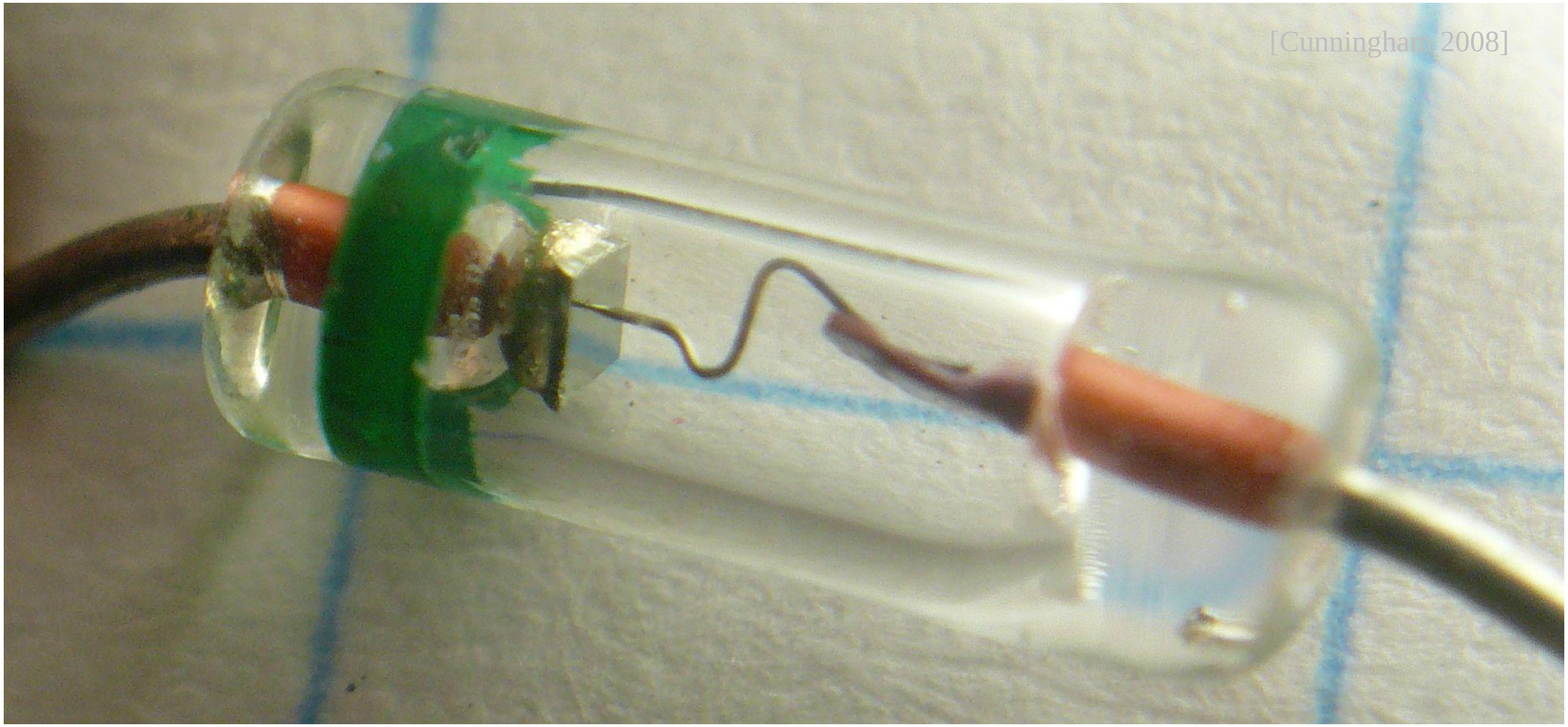

Problem No. 11 “Cat’s whisker”

The first semiconductor diodes, widely used in crystal radios, consisted of a thin wire that lightly touched a crystal of a semiconducting material (e.g. galena). Build your own ‘cat’s-whisker’ diode and investigate its electrical properties.

Background reading

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Problem No. 12 “Thick lens”

A bottle filled with a liquid can work as a lens. Arguably, such a bottle is dangerous if left on a table on a sunny day. Can one use such a ‘lens’ to scorch a surface?

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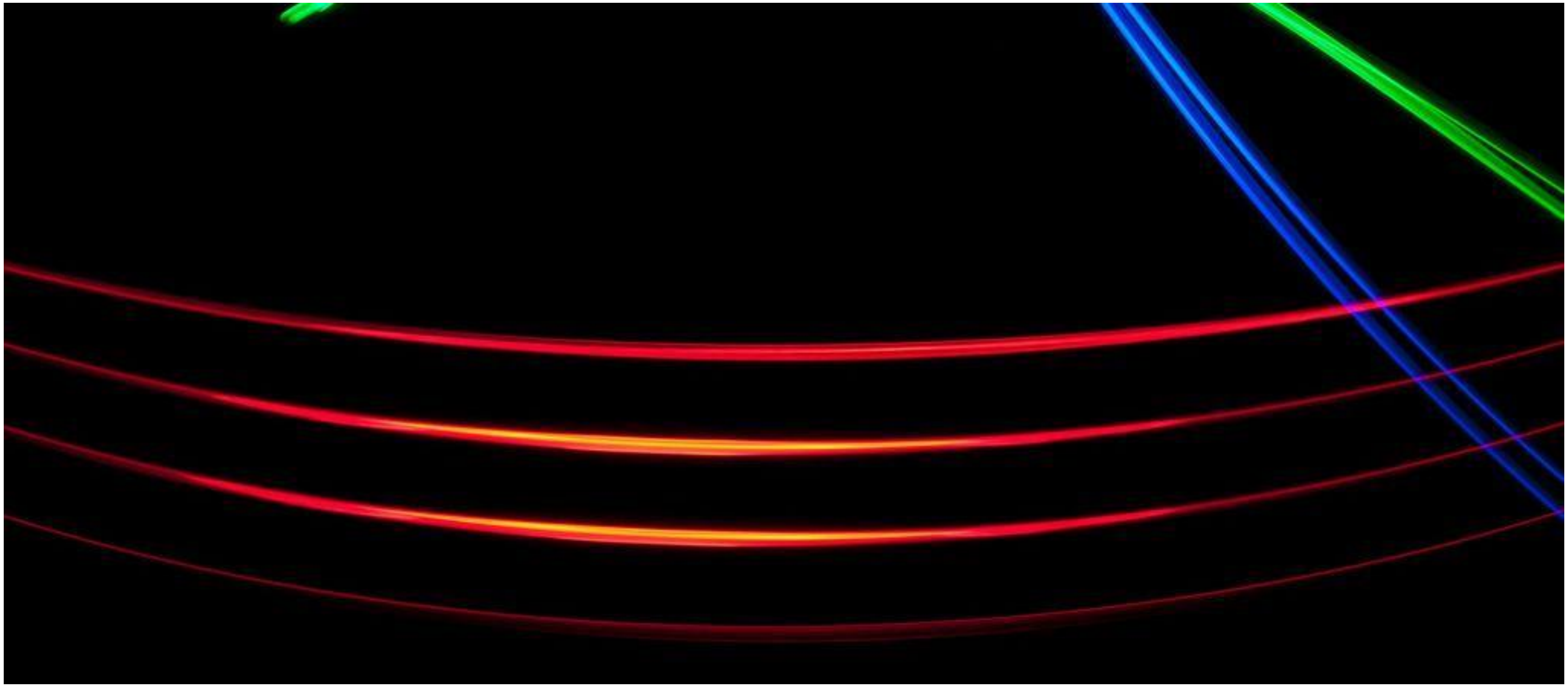

Problem No. 13 “Magnetic pendulum”

Make a light pendulum with a small magnet at the free end. An adjacent electromagnet connected to an AC power source of a much higher frequency than the natural frequency of the pendulum can lead to undamped oscillations with various amplitudes. Study and explain the phenomenon.

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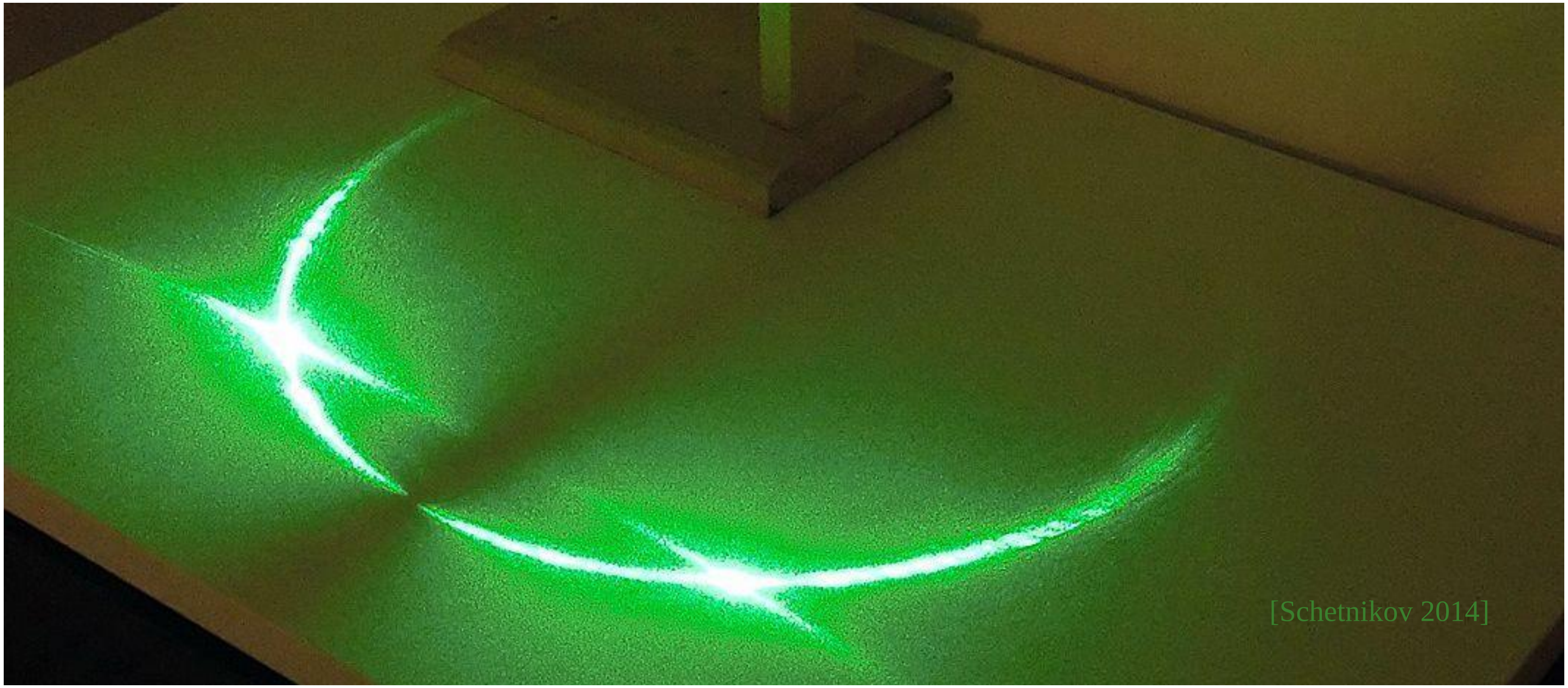

Problem No. 14 “Circle of light”

When a laser beam is aimed at a wire, a circle of light can be observed on a screen perpendicular to the wire. Explain this phenomenon and investigate how it depends on the relevant parameters.

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Problem No. 15 “Moving brush”

A brush may start moving when placed on a vibrating horizontal surface. Investigate the motion.

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Problem No. 16 “Wet and dark”

Clothes can look darker or change colour when they get wet. Investigate the phenomenon.

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Problem No. 17 “Coffee cup”

Physicists like drinking coffee, however walking between laboratories with a cup of coffee can be problematic. Investigate how the shape of the cup, speed of walking and other parameters affect the likelihood of coffee being spilt while walking.

Background reading

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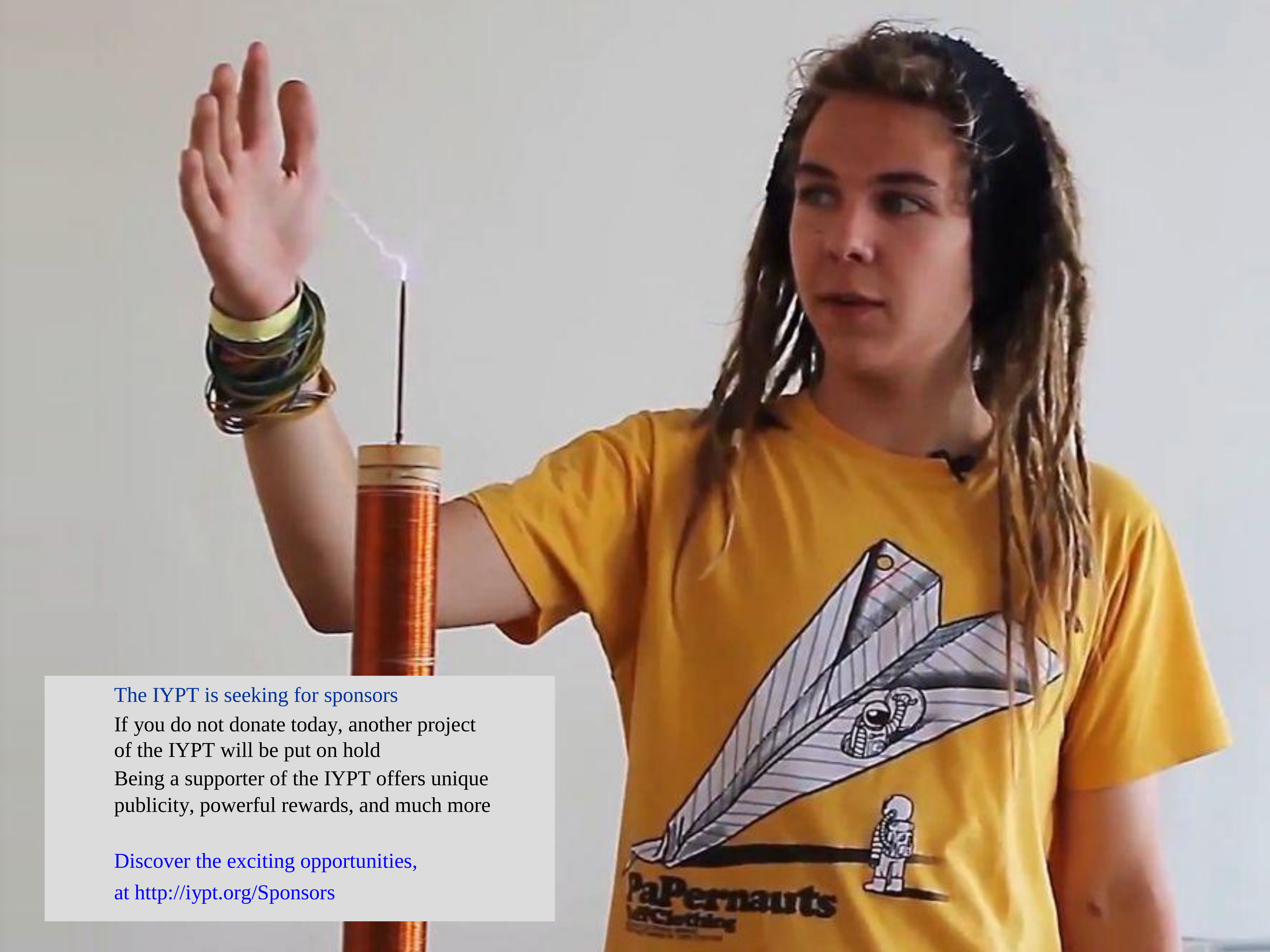

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Ilya Martchenko, [1*] Andrei Klishin, [2] Reza Montazeri Namin, [3] Stanisław Świdwiński, [4] Aliaksandr Mamoika, [5] and Stanisłaŭ Piatruša [5]

[1] University of Fribourg and Lund University; [2] Massachusetts Institute of Technology; [3] Sharif University of Technology; [4] Yale University; [5] Belarusian State University

July 12, 2014

* to whom correspondence should be addressed:

ilya.martchenko@iypt.org http://ilyam.org