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

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 resolvingal

Look through the historical solutions in the Archive :-)

an opportunity for goal-oriented critical learning

examples, not guidelines

Meet the UK 1991 team

Photo by Gordon Woods, July 27, 1991

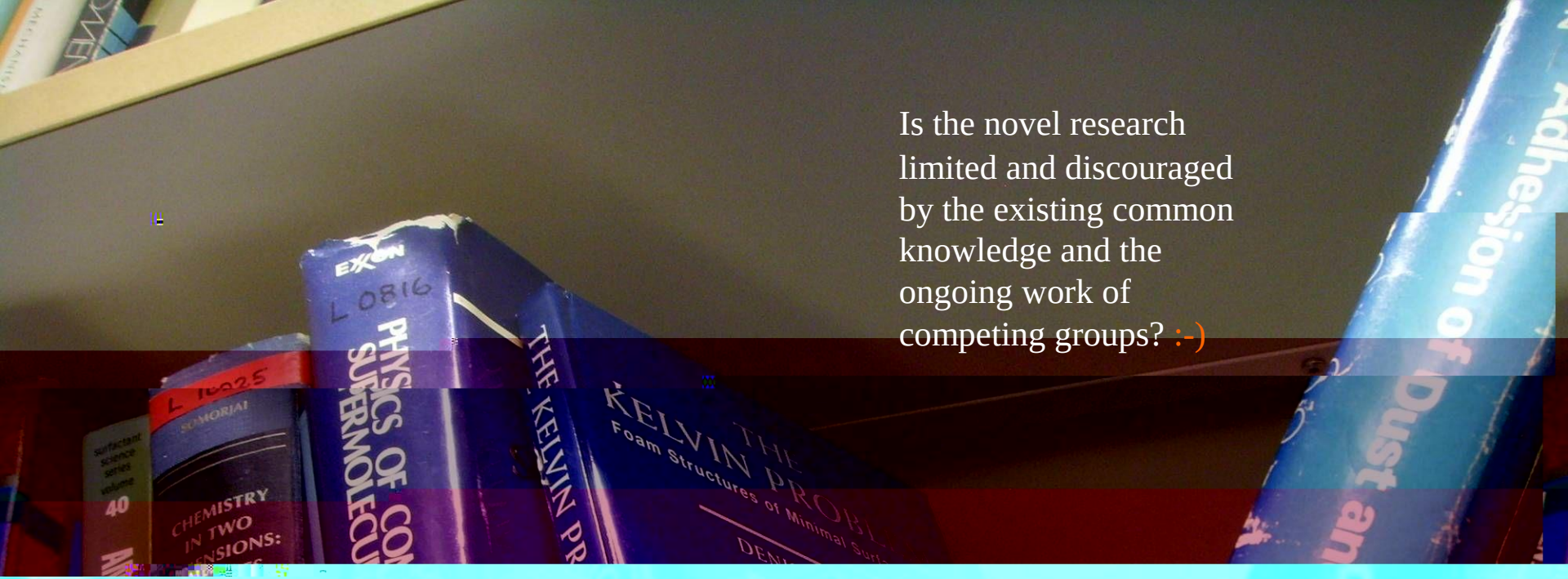
Photo by Sergey Romanchuk, taken nearly simultaneously

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



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 :-)

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

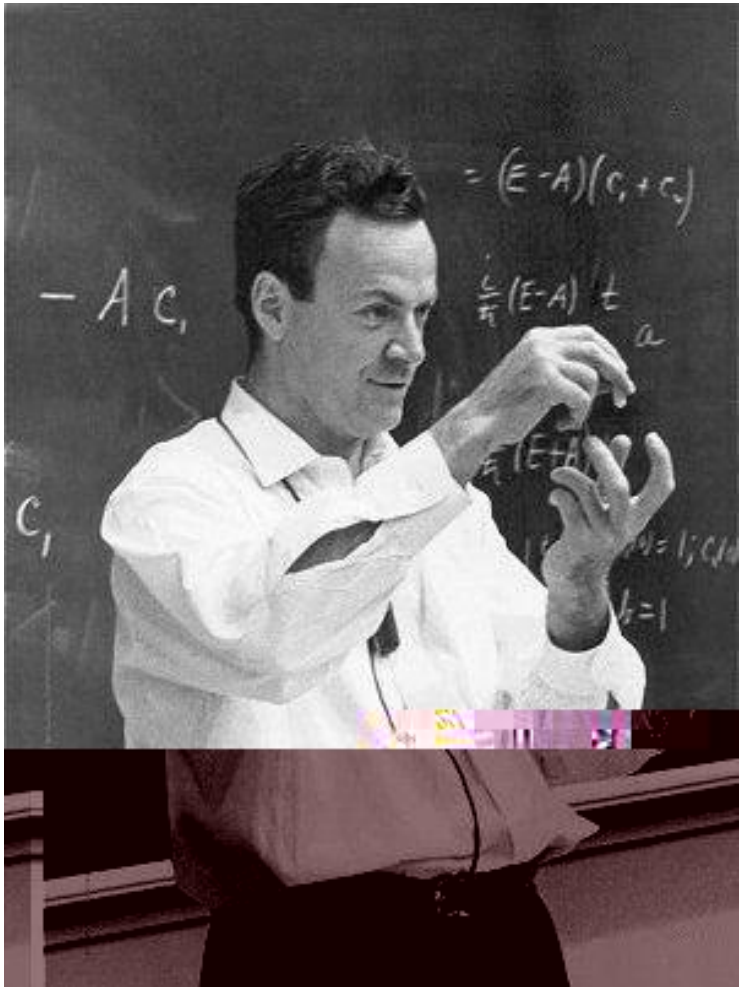
How to give a science talk

- 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.



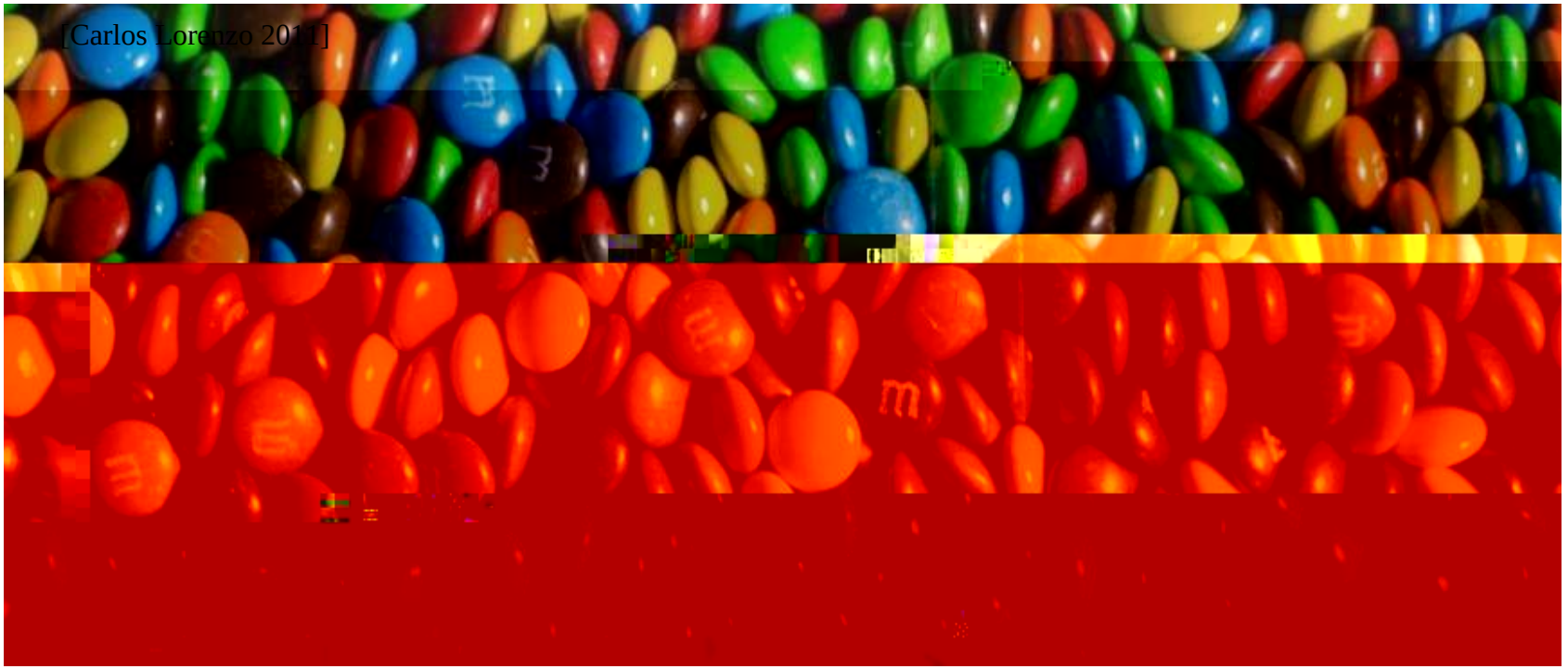
R.P. Feynman. Surely You re Joking, Mr. Feynman (Norton, New York, NY, 1985)

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

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

"That depends a good deal on where y
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

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

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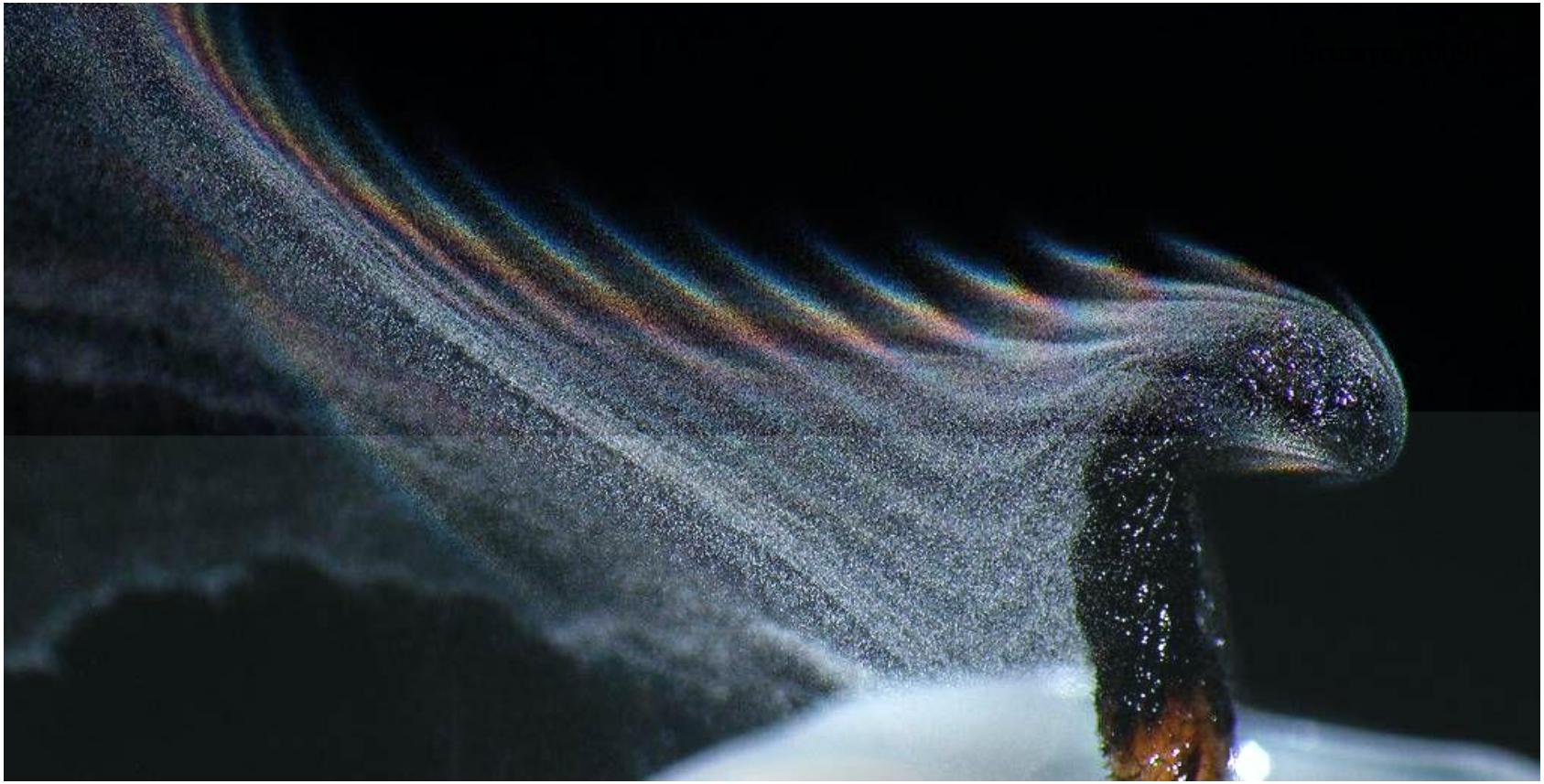
M. P. Ciamarra, A. Coniglio, and M. Nicodemi. Thermodynamics and statistical mechanics of dense granular media. Phys. Rev. Lett. 97, 158001 (2006)

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

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

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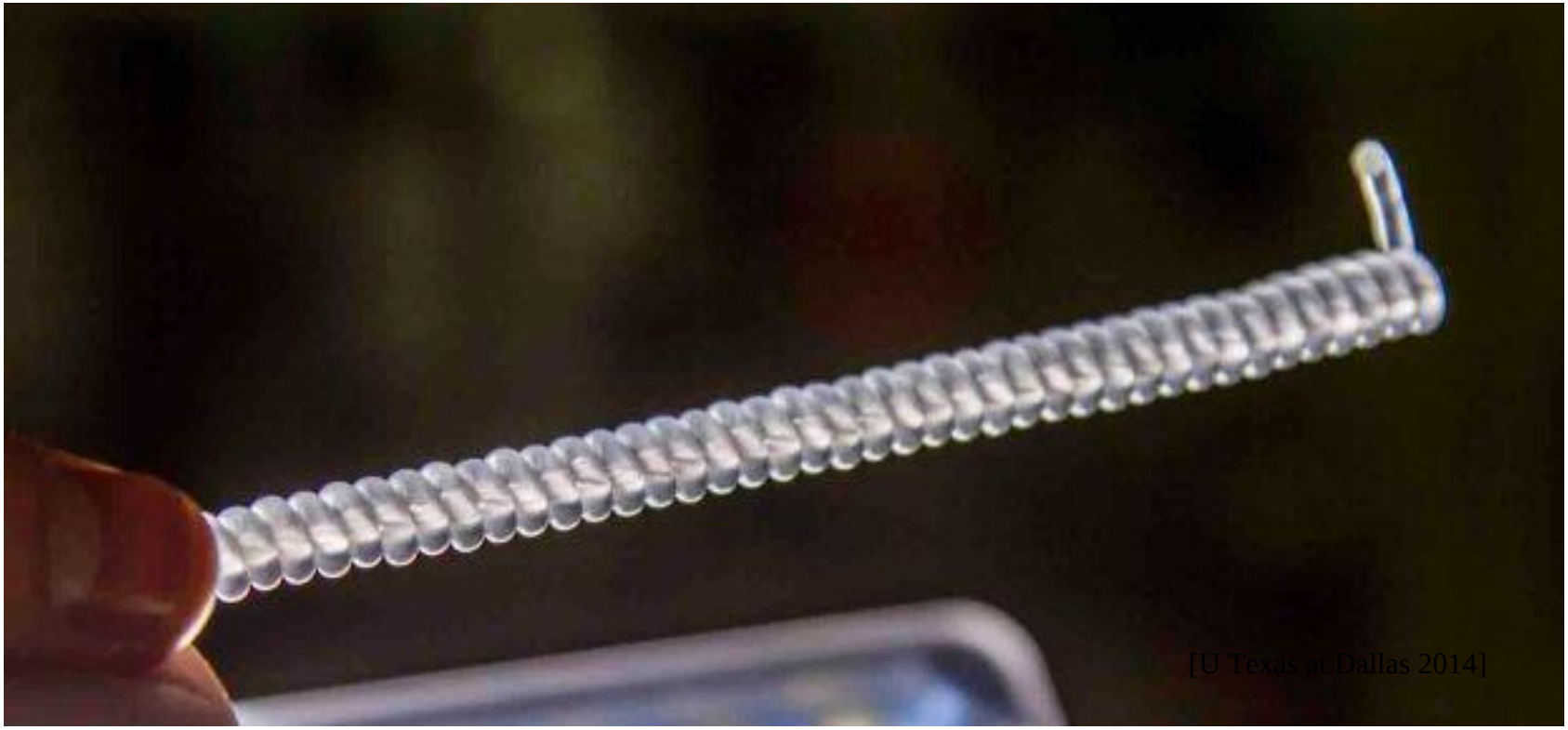
Jearl Walker. The Physics and Chemistry Underlying the Infinite Charm of a Candle Flame: Amateur Scientist. Sci. Am. 238, 4, 154-162 (1978)

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



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

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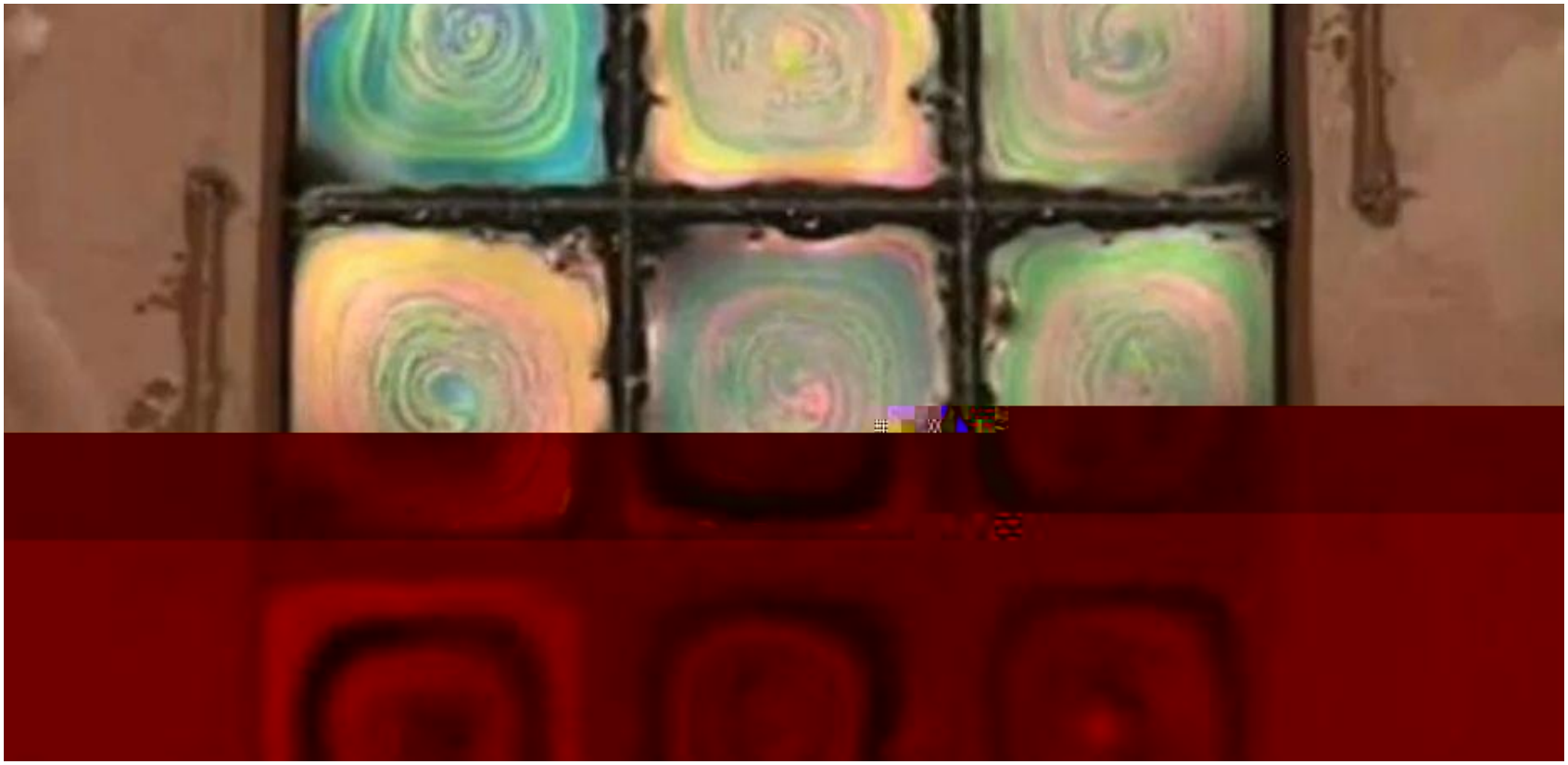
J. Yuan and P. Poulin. Fibers do the twist. Science 343, 845-846 (2014)

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

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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)

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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]

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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]

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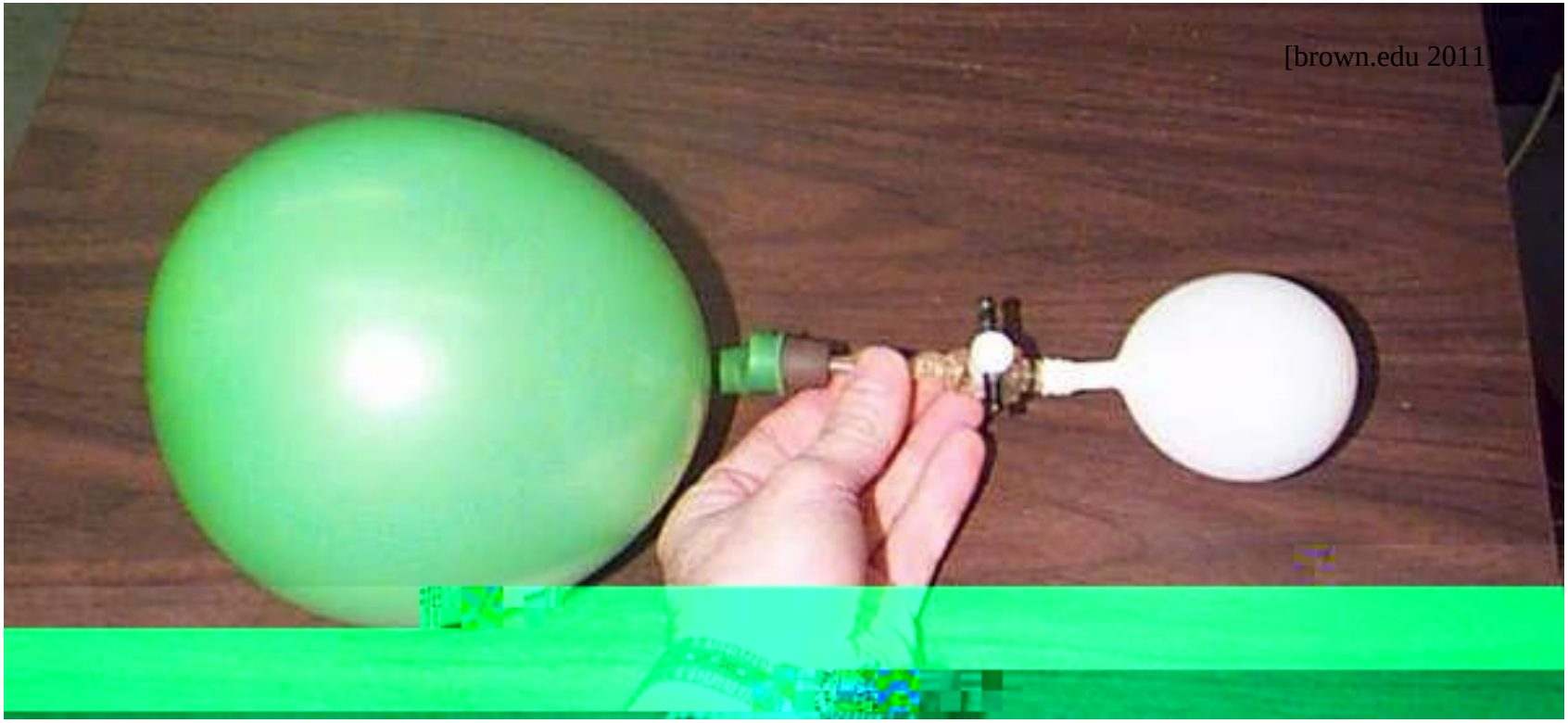
Liquid Motor Revs Up (scientificamerican.com), http://www.scientificamerican.com/gallery/liquid-motor-revs-up/



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]

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

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

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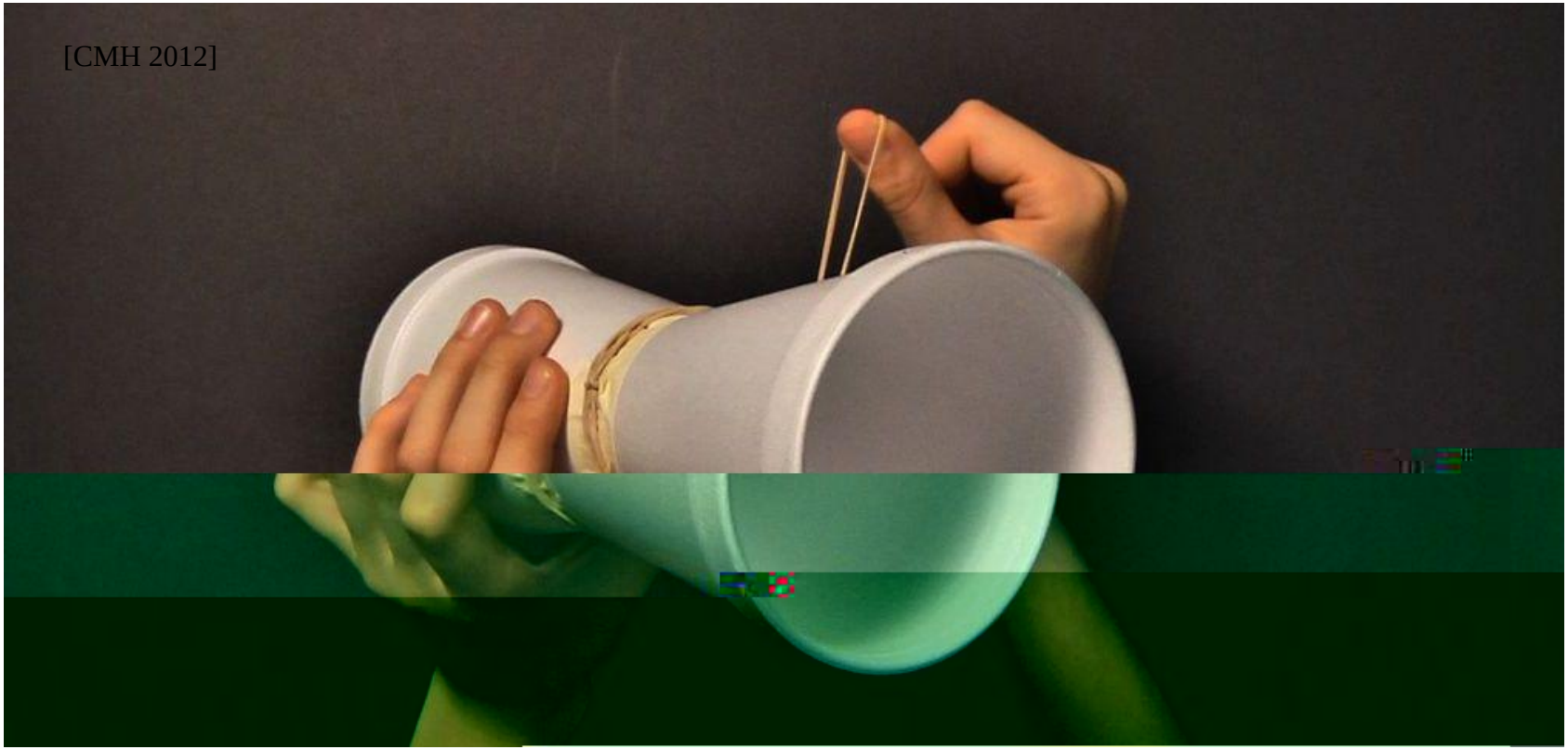

Problem No. 6 Magnus glider

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

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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/

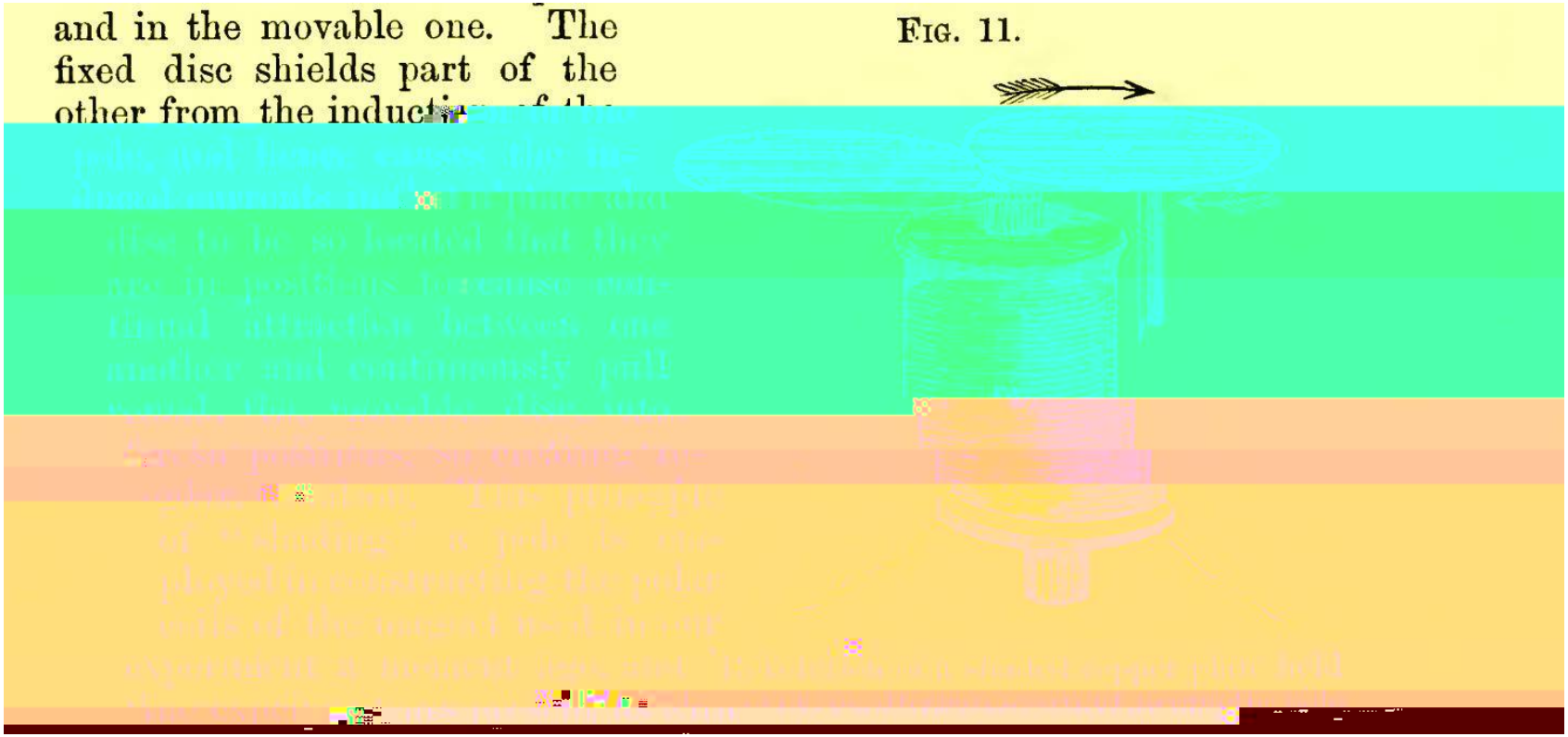
R. Nichols. Examination of the aerodynamic characteristics of a Magnus effect glider. PhD Thesis (California Polytech. State Univ., 2008)

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 induc-

FIG. 11.



WEEKLY EVENING MEETING,

Friday, March 6, 1891.

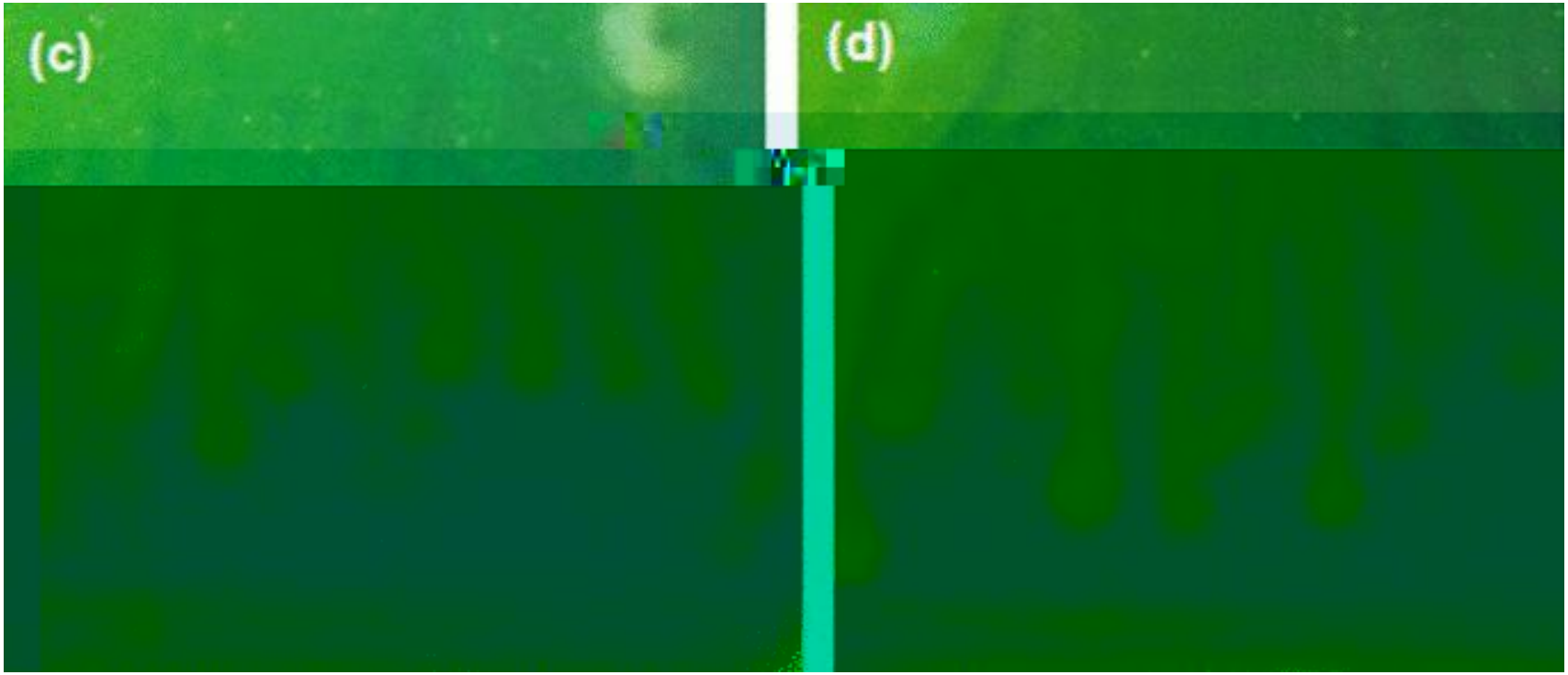
WILLIAM CROOKES, Esq. F.R.S. Vice-President, in the Chair.

PROFESSOR J. A. FLEMING, M.A., D.Sc., M.I.E.E.

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



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)

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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

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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.

Background reading

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B. R. Elbing, E. S. Winkel, K. A. Lay, S. L. Ceccio, D. R. Dowling, and M. Perlin.. Air-layer Induced Skin-friction Drag Reduction (umich.edu, 2007), http://sitemaker.umich.edu/belbing/files/aldr_rev1.pdf

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C. Kapfer and A. Kraushaar. Hovercraft: The Myth, The Legend, The Science (Tualatin High School), http://tuhsphysics.ttsd.k12.or.us/Research/ib00/KapfKrau/hoverpage.htm

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T. Denery. Multi-domain modeling of the dynamics of a hovercraft for controller development (MathWorks, 2005), http://www.mathworks.com/tagteam/28442_AIAA-2005-6293_Denery.pdf

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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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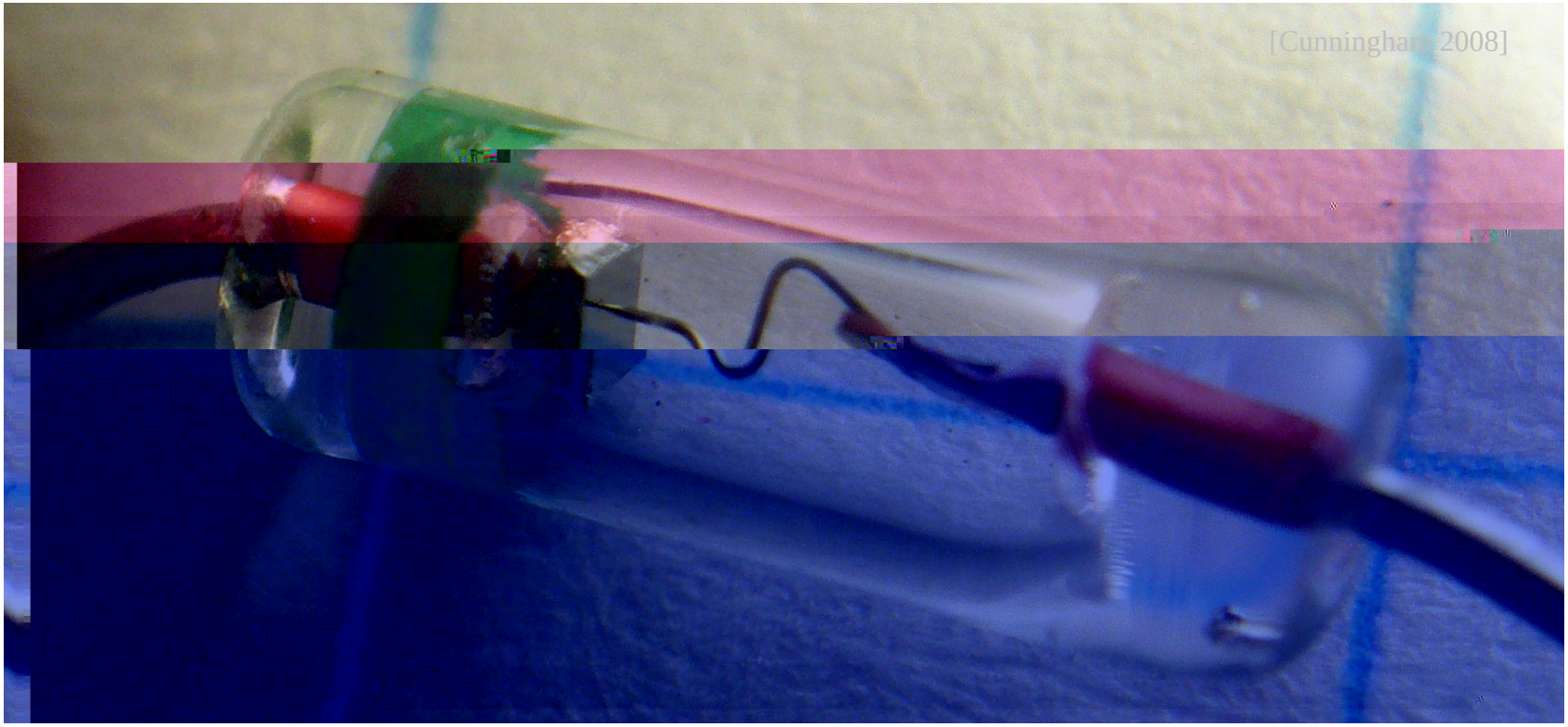

Problem No. 11 Cat s whisker

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?

Background reading

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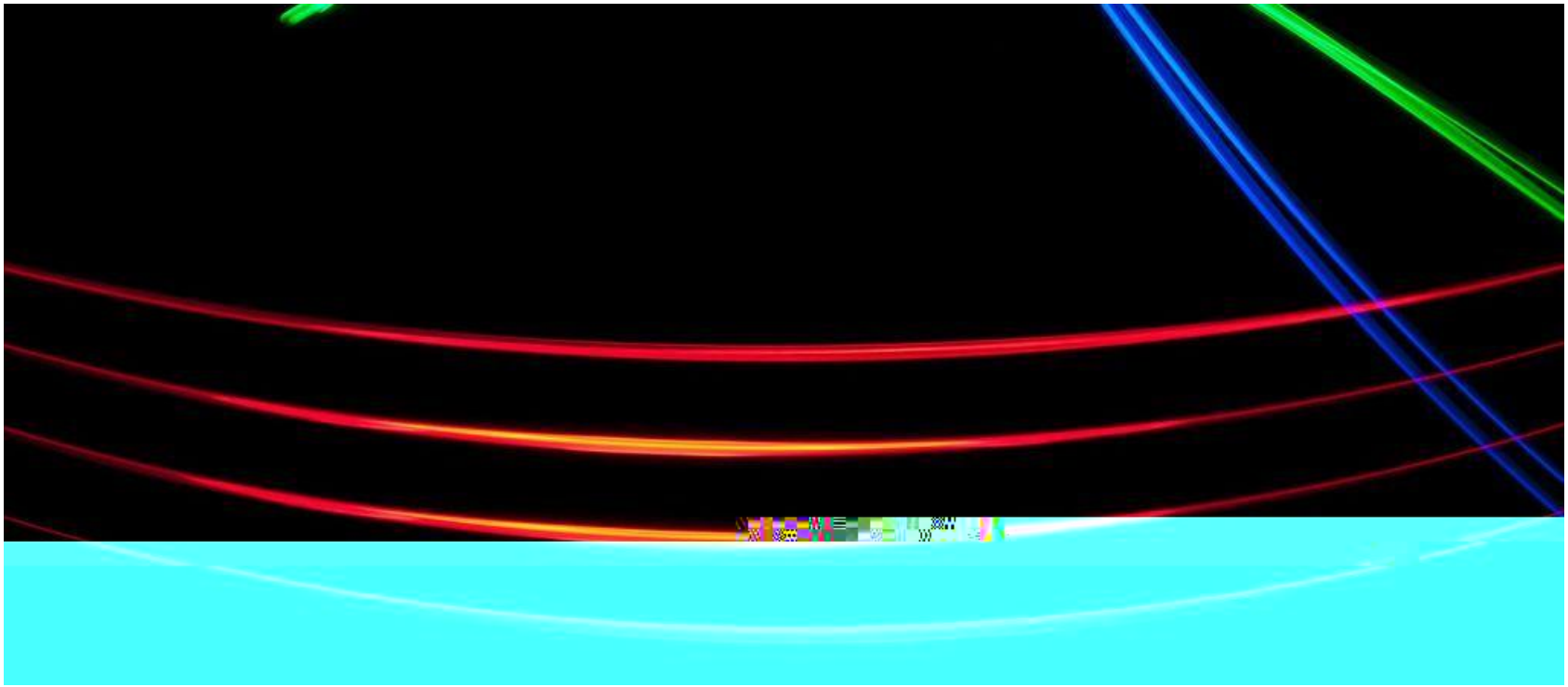

Problem No. 13 Magnetic pendulum

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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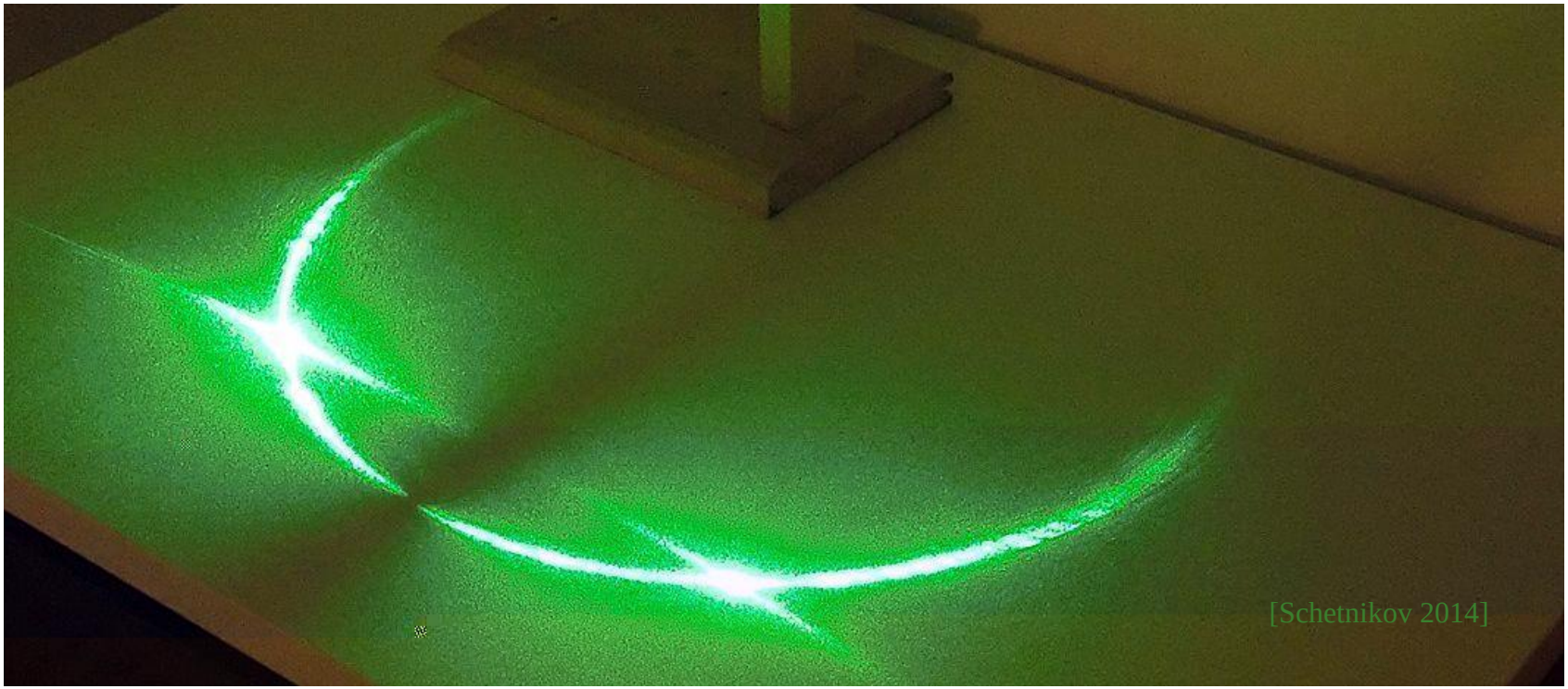

Problem No. 14 Circle of light

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.

Background reading

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Problem No. 15 Moving brush

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

Background reading

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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.

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Yeling Dai. Why does coffee spill? (UCSD, 2012), http://x-ray.ucsd.edu/mediawiki/images/1/1d/11-19-12_group_meeting_coffee_spilling.pdf

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Ilya Martchenko, [1 *] Andrei Klishin, [2] Reza Montazeri Namin, [3] Stanis aw widwi ski, [4] Aliaksandr Mamoika, [5] and Stanis a Piatru a [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