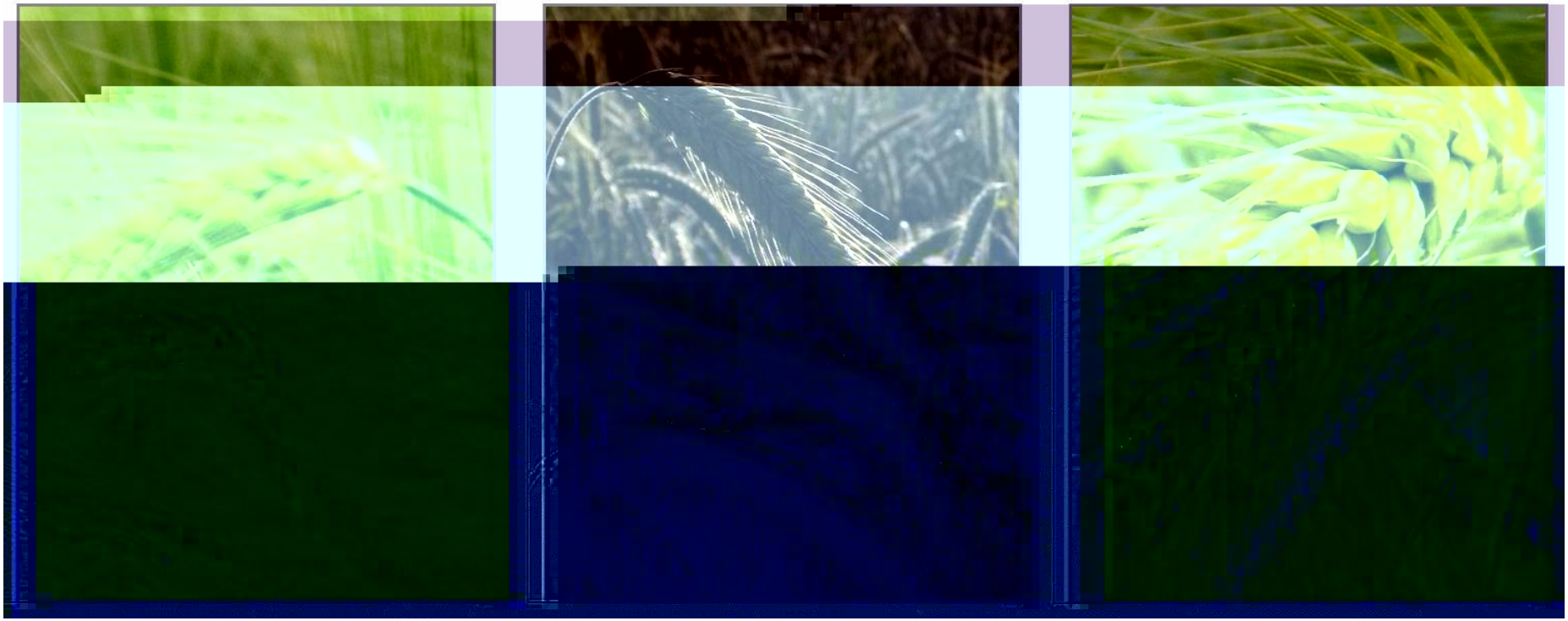

Preparation to the Young Physicists' Tournaments' 2016

Ilya Martchenko,[1*] Matej Ba in,[2] !e"a Monta"eri #amin,[$] an %n rei &chetniko'[(]

[1])ni'ersity o* +ri,ourg- [2] .omenius)ni'ersity in Bratisla'a- [$] &hari*)ni'ersity o* Technology- [(] Pythagoras &chool, #o'osi,irsk

10 years 1ith the !e*erence kit2

130 pro,lems

4'er 5 o* all IYPTs 1677 8 2016

%n ama"ing team o* co9authors :since 2012;

4n the !egulations o* a *e1 national tournaments

% success*ul case o* kno1le ge trans*er

% true asset o* the IYPT port*olio

The <ay 4ne 1as &eptem,er 26, 2006

> elcome to the (th IY#T 20162

Country	2013	2014	2015	Overall
Afghanistan				
elarus				B
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Iran				
akhstan				Kaz
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Ukraine				
al Teams	16	5	10	31	To
l Countries	11	4	7	14	Tota
al Medals	10	5	6	21	To

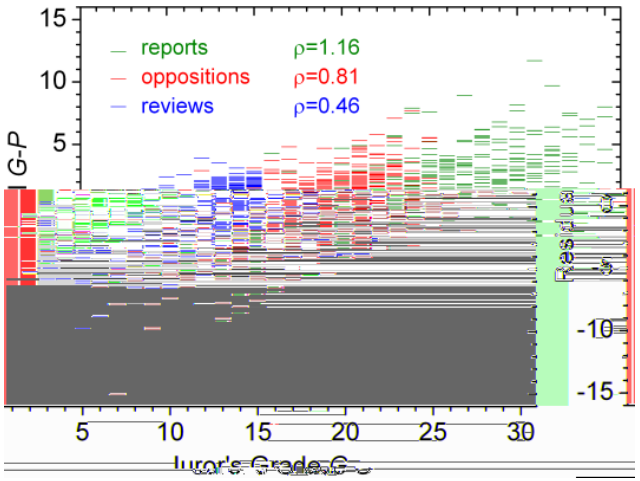
The International Young #aturalists= Tournament, IY#T, is a 1hole ne1 competition 1ith , reathtaking pro , lems, state9o*9the9art gra ing stan ar s, an an impressi'e momentum

The IY#T , ri ges gaps , et1een natural sciences an is *ocuse on participants age 12 through 16

The IY#T has so *ar attracte $1 teams *rom 1(i**erent countries, an has a1ar e 21 me als

<o not hesitate an pre9register to ay

http?//iynt@org



Do1 to tackle the IYPT pro,lemsA

Do1 to structure a reportA

>hat le'el is competiti'eA

Do1 to set the goals, *iE the priorities, an set the irection o* the 1orkA

Do1 1ere people resol'ing particular issues in the pastA

Fook through the historical solutions in the %rchi'e ?9;

an opportunity *or goal9oriente critical learning

eEamples, not gui elines

those solutions 1ere goo , ,ut yours shoul ,e ,etter2

In'itation

The IYPT is seeking *or sponsors

I* you o not onate to ay, another project o* the IYPT 1ill ,e put on hol

Being a supporter o* the IYPT o**ers uniBue pu,licity, po1er*ul re1ar s, an much more

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Ilya Martchenko
IYPT Treasurer

ilya@martchenko C iypt@org

IB%# .D71 0600 0000 61$$ 0737 (
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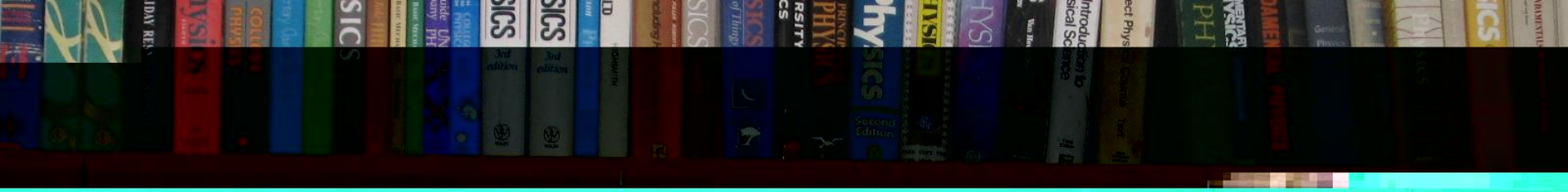

Is the no'el research limite an
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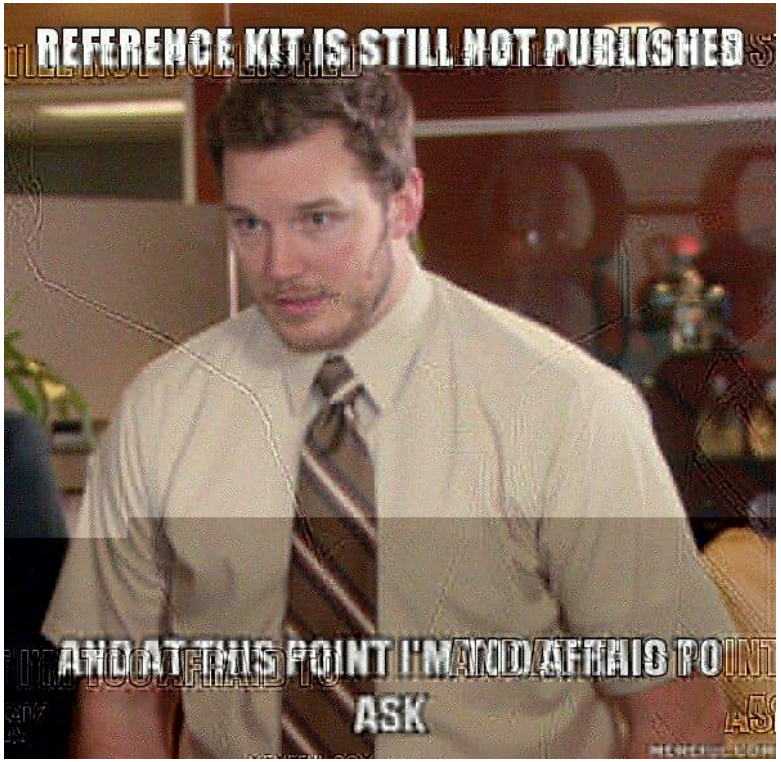
Thank you *or remin ers, IYPT Memes ?9;



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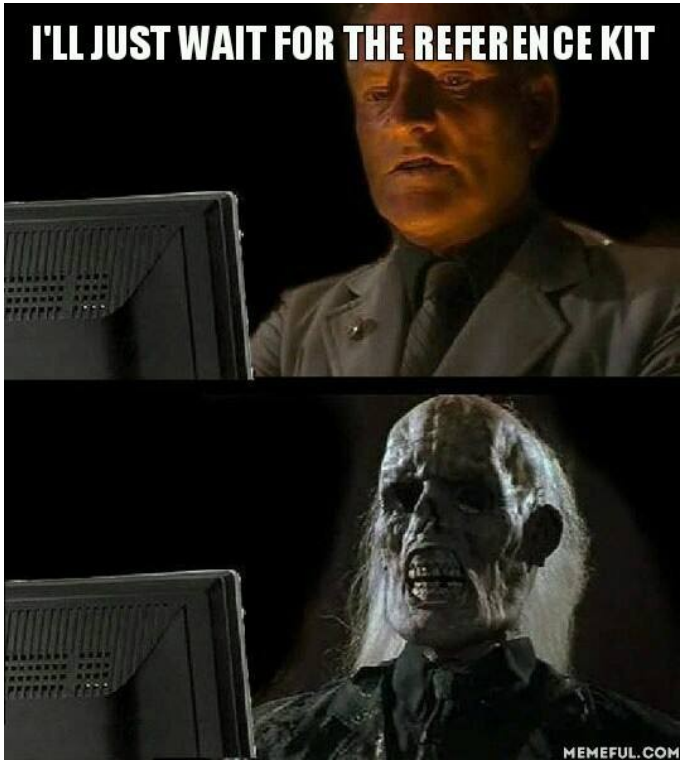

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. all *or cooperation

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166. Der Irrthum iſt viel leichter zu erkennen,
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Goethe *

// The epigraph *or the IYPT 2016 pro , lems appro ' e , y the IYPT +oun er G ' geny Yunoso '
// Translate *rom the Nerman
* LIt is much easier to recogni"e error than to *in truth@M Noethe

Pro , lem #o@ 1 LIn ' ent yoursel*M

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% pen ulum consists o* a strong threa an a ,o ,@ >hen the pi'ot o* the pen ulum starts mo'ing along a hori"ontal circum*erence, the ,o , starts tracing a circle 1hich can ha'e a smaller ra ius, un er certain con itions@ In'estigate the motion an sta , le trajectories o* the ,o ,@

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Gugene l@ Butiko'@ &u,harmonic resonances o* the parametrically ri'en pen ulum
:,utiko'@*aculty@i*mo@ru;, http?//,utiko'@*aculty@i*mo@ru/&u,resonances@p *

Michael Dart@ The ri'en pen ulum :maths@surrey@ac@uk, 200(;,
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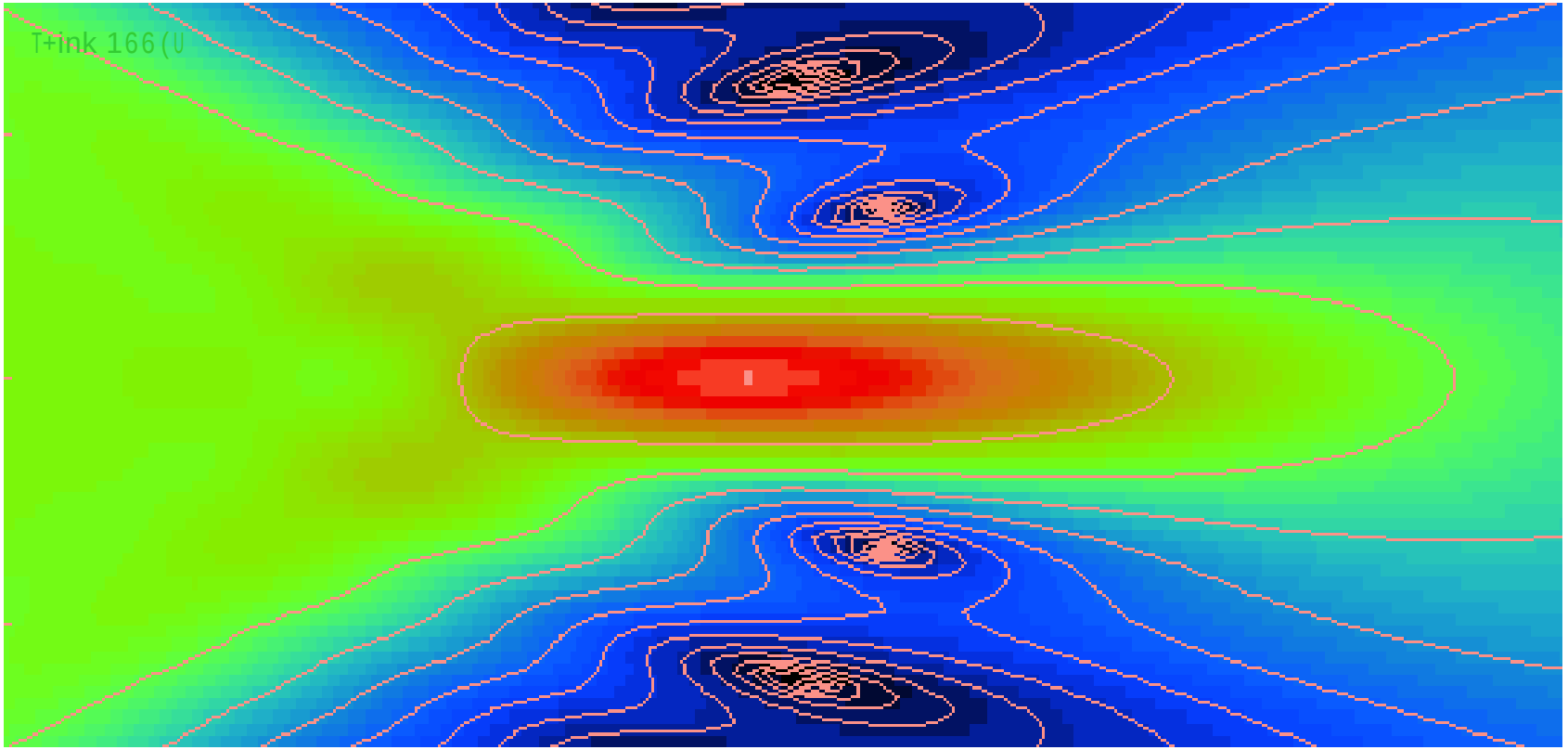

Pro , lem #o@ $ L%coustic lensM

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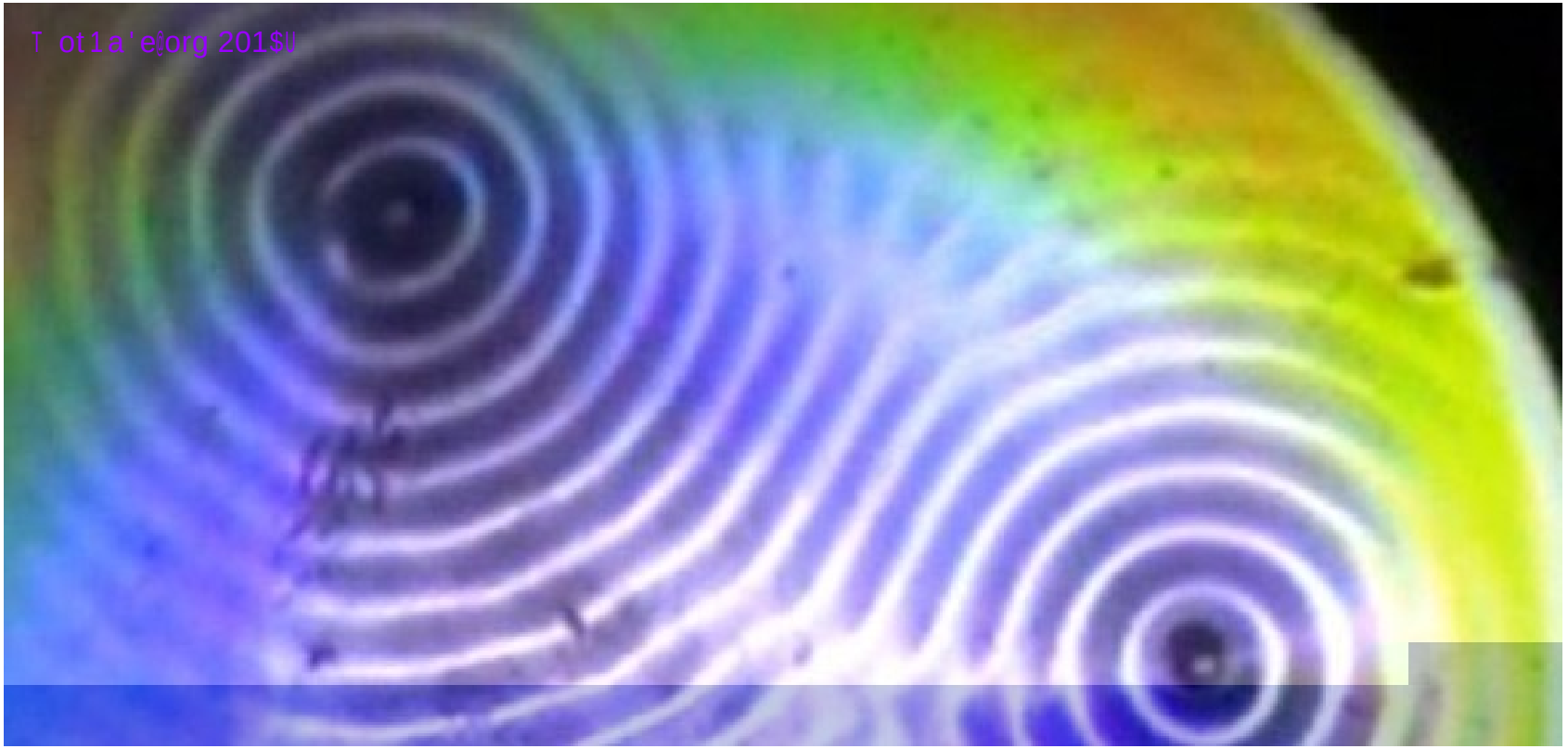

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<@Ter1agne@ Bouncing <roplets, the !ole o* <e*ormations@ :Thesis,)ni'ersitQ e Fi}ge, 2011;,
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Backgroun rea ing

<@ Ter1agne, +@ Fu e1ig, #@ San e1alle, an &@ <or,olo@ The role o* the roplet e*ormations in the ,ouncing roplet ynamics@ Phys@ +lui s 20, 122101 :201$;, http?//1 1 1@researchgate@net/pro*ile/<enis0Ter1agne/pu,lication/2$0$030000The0role0o*0 e*ormations0in0the0,ouncing0 roplet0 ynamics/links/02,*e011 0c6a0,6a6000000@p *

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T@ Nilet, I@ >@ M@ Bush@ The *lui trampoline? roplets ,ouncing on a soap *ilm@ I@ +lui Mech@ 620, 1639 20$:2006;, http?//1 1 19math@mit@e u/P,ush/Trampoline0I+M@p *

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%@ G i, G@ &ultan, I@ Moukhtar, G@ +ort, M@ !ossi, an Y@ .ou er@ In*ormation store in +ara ay 1a'es? the origin o* a path memory@ I@ +lui Mech@ 63(, ($$9(6$:2011;, https?//,log@espci@*r/ae i/*iles/201(/06/>alker0I+M@p *

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I@ MolW|ek an I@ >@ M@ Bush@ <rops 1alking on a 'i,rating ,ath? to1ar s a hy ronamic pilot91a'e theory@ I@ +lui Mech@ 323, 61296(3 :201$;, http?//math@mit@e u/P,ush/1or press/1p9 content/uploa s/201$/03/MB29201$@p *

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&@ Perrar @)ne mQmoire 4n ulatoire? Qtats propres, chaos et pro,a,ilitQs :<issertation,)ni'@ Paris 3, 201(;, https?//tel@archi'es9ou'ertes@*r/tel901107$67/ ocument

l@ >@ M@ Bush, %@)@ 4"a, an l@ MolW|ek@ The 1a'e9in uce a e mass o* 1alking roplets@ l@ +lui Mech@ 300, !3 :201(;, http?//math@mit@e u/P,ush/1or press/1p9content/uploa s/201(/07/Boost9 l+M@p *

<@ M@ Darris, T@ Fiu, an l@ >@ M@ Bush@ % lo19cost, precise pie"oelectric roplet9on9 eman generator@ GEp@ in +lui s, 06, (, 193 :2010;, http?//math@mit@e u/P,ush/1or press/1p9 content/uploa s/2010/0(/Darris9<ropNenerator@p *

&@ Perrar ,M@ Fa,ousse, G@ +ort, Y@ .ou er@ .haos ri'en ,y inter*ering memory@ Phys@ !e'@ Fett@ 11$, 10, 10(101 :201(;, https?//hal@archi'es9ou'ertes@*r/hal901061(10/ ocument

M@ Fa,ousse@ •tu e 'une ynamiBue € mQmoire e chemin? une eEpQrimentation thQoriBue :<issertation,)ni'@ Pierre et Marie .urie)PM., Paris SI, 201(;, https?//pastel@archi'es9ou'ertes@*r/tel9 0111(710/ ocument

!@ .armigniani, &@ Fapointe, &@ &ymon, B@ l@ McJeon@ In*luence o* a local change o* epth on the ,eha'ior o* 1alking oil rops@ GEp@ Thermal an +lui &ci@ 0(, 2$392(6 :201(;, arHi'?1$10@2662'1 Tphysics@*lu9 ynU

%@ %n ersen, l@ Ma sen, .@ !eichelt, &@ !osenlun %hl, B@ Fautrup, .@ Gllegaar ,M@ T@ Fe'insen, an T@ Bohr@ .omment on Y@ .ou er an G@ +ort? &ingle9Particle <i**raction an Inter*erence at a Macroscopic &cale TPhys@ !e'@ Fett@ 63, 10(101 :2006;U :201(;, arHi'?1(00@0(66'1 Tphysics@*lu9 ynU

Pro , lem #o@ 6 LGlectric honeycom , M

&et a 'ertically oriente steel nee le o'er a hori"ontal metallic plate@ Place some oil onto the plate@ I* you apply constant high 'oltage , et1een the nee le an the plate, a cell structure appears on the sur*ace o* the liBui @ GEplain an in'estigate this phenomenon@

Backgroun rea ing

S@ S@ Mayer, G@ I@ Saraksina, an S@ %@ &aranin@ &imple lecture emonstrations o* insta,ility an sel*9organi"ation@ Phys@)sp@ 03, 11$0V11$0 :201(;

i@ i@ ldqab, •@ ,@ idbdcghkd, i@ ƒ@ „dbdkhk@ `bog…va eac†hokkva ra‡okg…bd†hh kaZg…oqˆhsog…h h\gd‡oob‰dkhtd†hh@\xmy\17(,\12(6V120(:201(;, http?//u*n@ru/ru/articles/201(/11/g/

&imple lecture emonstrations o* insta,ility an sel*9organi"ation :youtu,e@com, *rom I'an &a o'sky, #o' 27, 201(;, https?//youtu@,e/J#nnBM0D0,s

B@ Malraison, P@ %tten@ Insta,ilitQ Qlectrohy ro ynamiBue ue € l=injection =ions € la sur*ace li,re =un liBui e isolant@\I@ PhysiBue III 1, 12($V12(6 :1661;

.@ &@ Derrick@ Glectrocon'ection cells in ielectric liBui s inter*ace 1ith con ucting *lui s@ Proc@ !oyal &oc@ % $$6, (73V(6(:163(;

>ikipe ia? .orona ischarge, https?//en@1ikipe ia@org/1iki/.orona0 ischarge

>ikipe ia? <ielectrophoresis, https?//en@1ikipe ia@org/1iki/<ielectrophoresis

D@ %@ Pohl@ &ome G**ects o* #onuni*orm +iel s on <ielectrics@ I@ %ppl@ Phys@ 26, 1172 :1607;

%@ T@ PQre"@ Glectrohy ro ynamic insta,ilities in ielectric liBui s in uce ,y corona ischarge@ In? .on uction an Break o1n in <ielectric FiBui s, 12th Int@ .on*@, 126V126 :1666;

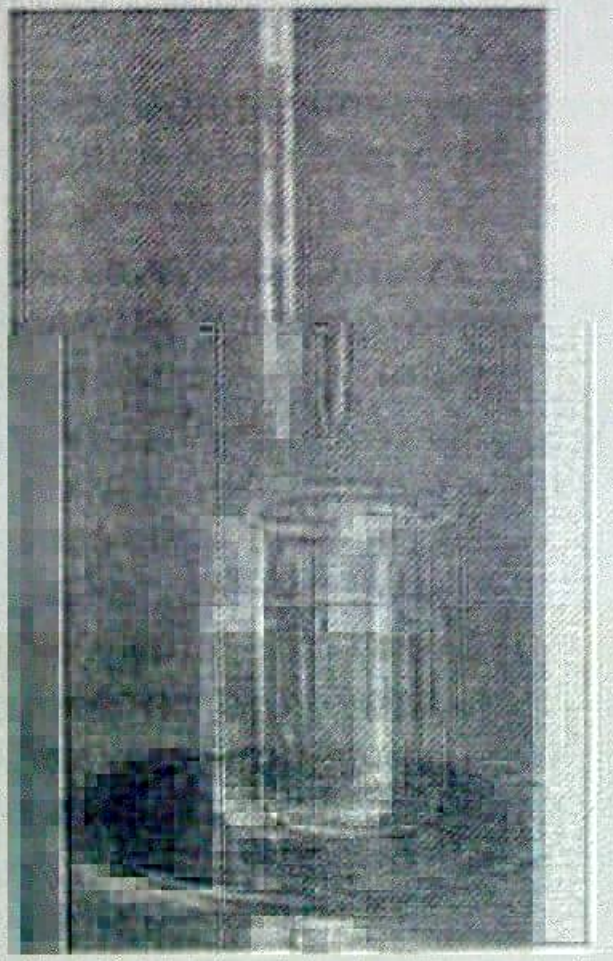
+@ Sega\an %@ T@ PQre"@ .orona9in uce electrohy ro ynamic insta,ilities in lo1 con ucting liBui s@ GEp@ in +lui s\$(, 326V3$0 :200$;

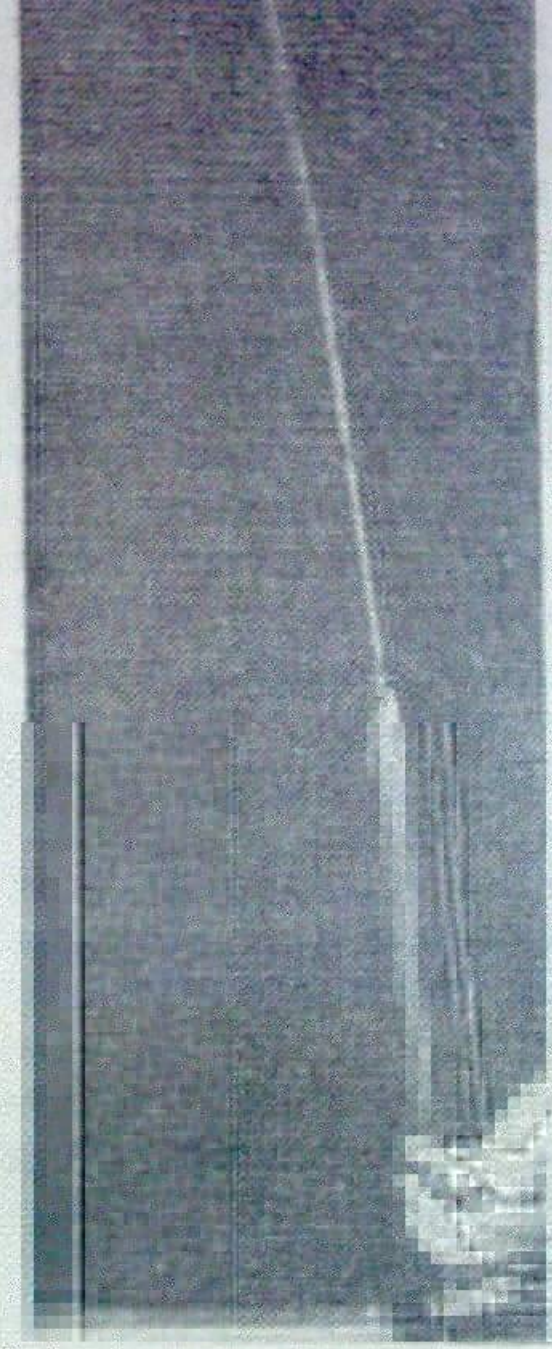
!@ .hicŠn an %@ T@ PQre"@ The sta,ility o* a hori"ontal inter*ace ,et1een air an an insulating liBui su,jecte to charge injection@\Phys@ +lui s\26, 0$(10$:201(;

Pro,lem #o@ 3 LDot 1ater *ountainM

Partially *ill a Mohr pipette 1ith hot 1ater@ .o'er the top o* the pipette 1ith your thum,@ Turn the tip up1ar s an o,ser'e the *ountain eEiting the tip@ In'estigate the parameters escri,ing the height o* the *ountain, an optimi"e them to get the maEimum 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-





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‘^h•eho…aˆcd ‘nsdk…’, sv•@ (@ 8 l@? ydZcd, 1671, g…b@ (28($,
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X0B j'9*aEX0<@"ip

?9;

Pro , lem #o@ 7 LMagnetic trainM

Button magnets are attache to , oth en s o* a small cylin rical , attery@ > hen place in a copper coil such that the magnets contact the coil, this “trainL starts to mo ' e@ GEplain the phenomenon an in ' estigate ho 1 rele ' ant parameters a**ect the train-s spee an po 1 er@

Backgroun rea ing

> orl =s &implest Glectric Train :youtu , e@com, *rom %ma"ing&cience , %ug 26, 201 (;, https?//youtu@ , e/I6 , 0I26 4 "%)

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The mystery o* the magnetic train :skullsinthestars@com, 201 (;, http?//skullsinthestars@com/201 (/12/12/the9 mystery9o*9the9magnetic9train/

> ikipe ia? Magnetic moment, https?//en@ 1 ikipe ia@org/ 1 iki/Magnetic0moment

#@ <er , y an &@ 4l , ert@ . ylin rical magnets an i eal solenoi s@ %m@ I@ Phys@ 37, $, 2269 2$0 :2010;

I@ T@ . on 1 ay an . @ %g er@ GEact solutions *or the magnetic *iel s o* aEisymmetric solenoi s an current istri , utions@ IGGG Trans@ on Magnetics, $3, (, 2633 92677 :2002;

&@ !@ Muni", M@ Bhattacharya, an S@ &@ Bagnato@ &imple analysis o* o**9aEis solenoi *iel s using the scalar magnetostatic potential? application to a Yeeman9slo 1 er *or col atoms@ %m@ I@ Phys@ 7$, 01$9013 :2010;, http?//people@rit@e u/mE , sps/Pu , licationP<+s/&ergio%IP@p *, arHi '?100$@$320 '2 Tphysics@atom9phU

!@ D@ Iackson@ 4**9%Eis GEpansion &olution o* Faplace's GBuation? %pplication to %ccurate an !api . alculation o* . oil Magnetic +iel s@ IGGG Trans@ on Glectron <e 'ices (6, 0, 10009 1062 :1666;

G@ M@ Purcell an <@ I@ Morin@ Glectricity [Magnetism : . am , ri ge) ni '@ Press, 201$;

<@ I@ Nri**iths@ Intro uction to Glectromagnetism :Prentice Dall, 1666;

%@ Yang 1 ill@ Mo ern electromagnetism : . am , ri ge) ni '@ Press, 2012;

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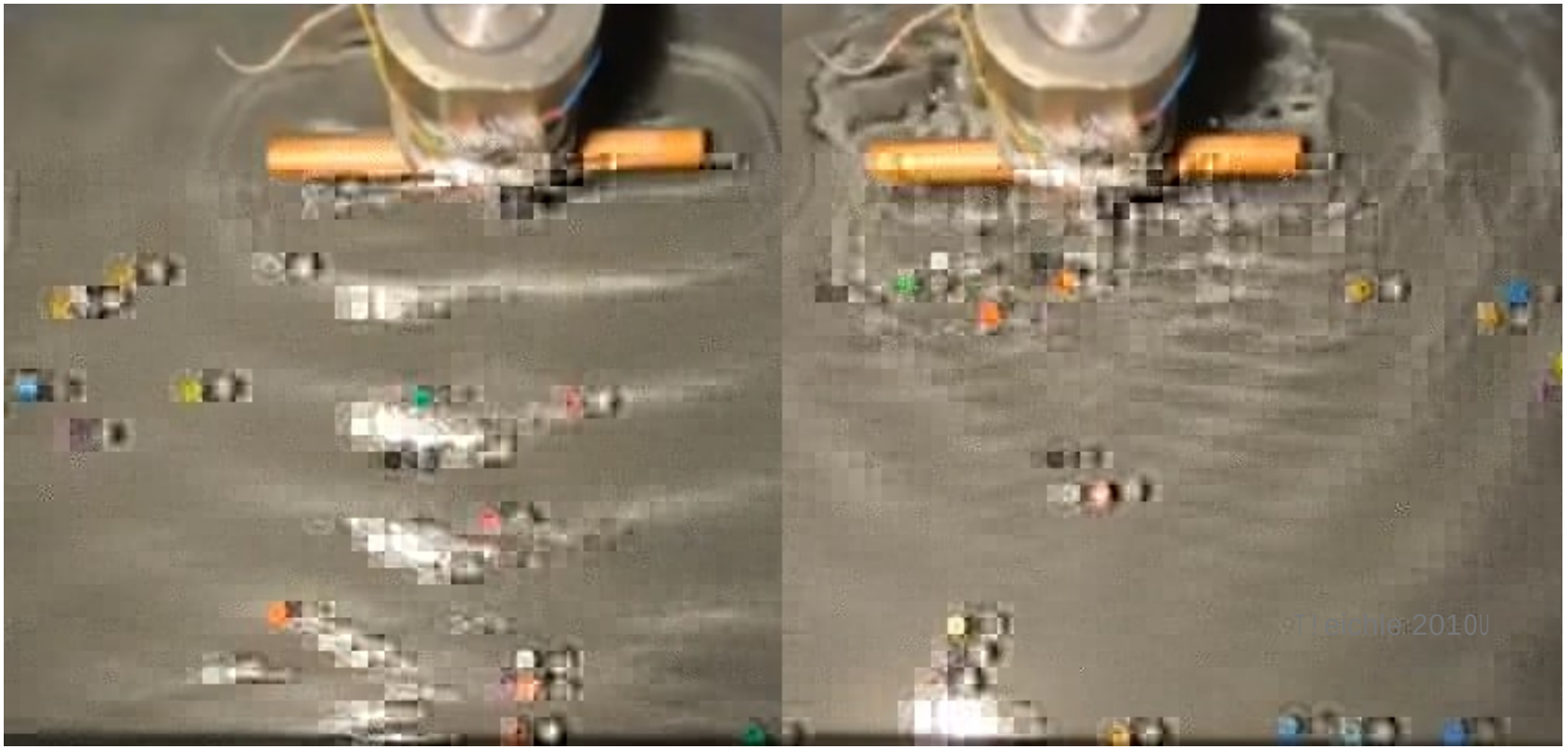


Pro , lem #o@ 6 L > ater 1a ' esM

Nenerate a 1ater 1a ' e 1ith a ' ertically oscillating hori"ontal cylin er@ > hen ' arying the eEcitation *reBuency an /or amplitu e, the 1ater seems to ri*t a1ay *rom or to1ar s the cylin er@ In ' estigate the phenomenon@

Background rea ing

D@ Pun"mann, #@ +rancois, D@ Hia, N@ +alko'ich, an M@ &hats@ Neneration an re'ersal o* sur*ace *lo1s ,y propagating 1a'es@ #ature Physics 10, 607V66$:201(;

D@ Pun"mann, #@ +rancois, D@ Hia, N@ +alko'ich, an M@ &hats@ Tractor ,eam on 1ater sur*ace :201(;, arHi'?1(03@03(0 Tphysics@*lu9 ynU

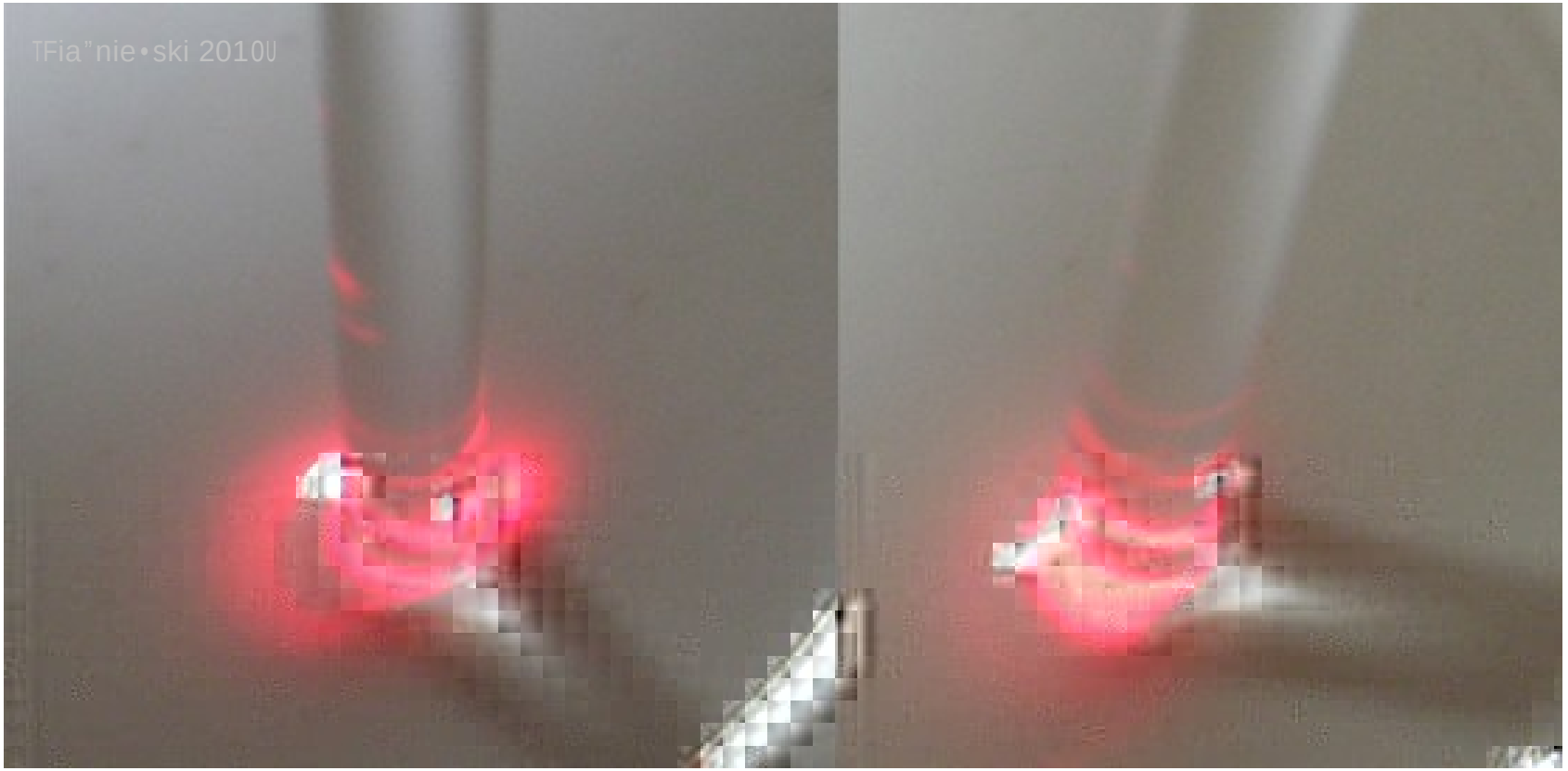
#@ +rancois, D@ Hia, D@ Pun"mann, &@ !ams en, an M@ &hats@ Three9<imensional +lui Motion in +ara ay >a'es? .reation o* Sorticity an Neneration o* T1o9<imensional Tur,ulence@ Phys@ !e'@ H (, 021021 :201(;, arHi'?1(0$@3770 Tphysics@*lu9 ynU

&@ Tane a@ Sisual o,ser'ations o* the *lo1 aroun a hal*9su,merge oscillating circular cylin er@\+lui <yn@ !esearch 1$, 116V101 :166(;

attracting 1ater 1a'es :youtu,e@com, *rom !@ !eichle, +e, 16, 2010;, https?//youtu@,e/ J0NsD&6'*I

%#) &cientists create a Tractor Beam on 1ater :youtu,e@com, *rom %#) channel, %ug 10, 201(;, https?//youtu@,e/Y)Y.kD>gSss

Physicists create 1ater tractor ,eam :phys@org, %ugust 10, 201(;, http?//phys@org/ne1s/201(9079 physicists9tractor@ €r@g@hT•tor@ €Pttte p ero9A n l cin G€+e



Pro , lem #o@ 10 LFight ringsM

Fet a liBui jet *all onto a sur*ace@ I* the contact point is illuminate , y a laser , eam, rings o* light aroun the jet can , e o , ser ' e :see +igure;@ In ' estigate the light rings an etermine ho 1 they epen on rele ' ant parameters o* the 1 hole system@

Backgroun rea ing

l@ Gggers an G@ SillermauE@ Physics o* liBui jets@ !ep@ Prog@ Phys@ 31, 0$6601 :2007; http?//citeseerE@ist@psu@e u/'ie1 oc/ o1nloa A oiR10@1@1@$67@1$61[repRrep1[typeRp *

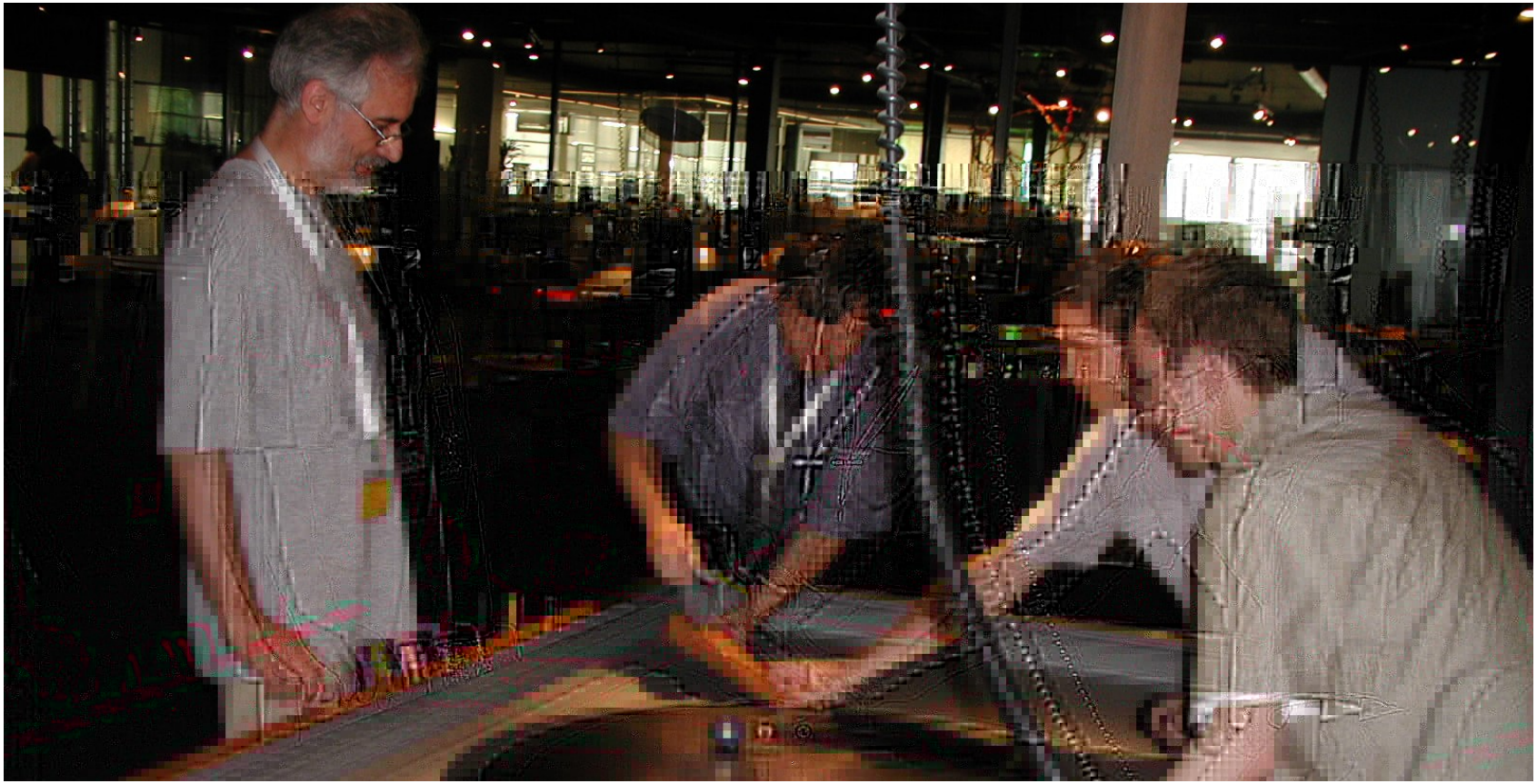
J@ M@ %1ati an T@ Do1es@ &tationary 1a'es on cylin rical *lui jets@ %m@ l@ Phys@ 6(, 707 :1666;

T@ Massalha an !@ M@ <igilo'@ The shape *unction o* a *ree9*alling laminar jet? Making use o* Bernoulli=s eBuation@ %m@ l@ Phys@ 71, 3$$:201$;, http?//1 1 1@stat@physik@uni9 pots am@ e/Ppiko'sky/teaching/stu 0seminar/ajp0*ree0*alling0jet@p *

&@ &enchenko an T@ Bohr@ &hape an sta,ility o* a 'iscous threa @ Phys@ !e'@ G 31, 006$01 :2000;

&@ F@ Noren an &@ >ronski@ The shape o* lo19spee capillary jets o* #e1tonian liBui s@ l@ +lui Mech@ 20, 01, 1709167 :1666;

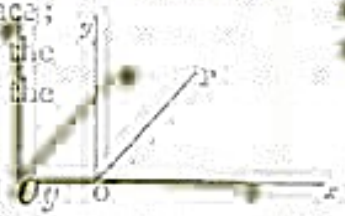
G@ l@ >atson@ The ra ial sprea o* a liBui jet o'er a hori"ontal plane@ l@ +lui Mech@ 20, 0$, (719(66 :166(;



Pro , lem #o@ 11 L ! olling on a iscM

I* you put a light rolling o , ject :e@g@ a ring, a isc, or a sphere; on a hori"ontal rotating isc, it may start mo ' ing 1 ithout , eing eEpelle *rom the isc@ GEplain ho 1 i**erent types o* motion epen on the rele ' ant 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 cycloid.***



DYNAMICS,

OR A

TREATISE ON MOTION;

TO WHICH IS ADDED

A SHORT TREATISE

ON

ATTRACTIONS.

By SAMUEL EARNSHAW, M.A.

OF ST JOHN'S COLLEGE, CAMBRIDGE.

"Dynamics, or the Science of Force and Motion, is placed at the Head of all the Sciences."

Sir J. F. W. Herschel.

THIRD EDITION, REVISED.

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M.DCCC.XLIV.

Backgroun rea ing

&amuel Garnsha1@ <ynamics, or a Treatise on Motion, to >hich is % e a &hort Treatise on %ttractions :<eighton, .am,ri ge, 17((;, pp@ 270927$,
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Ball on turnta,le :physics@har'ar @e u, 200$;,
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%@ %gha, &@ Nupta, an T@ loseph@ Particle sli ing on a turnta,le in the presence o* *riction@ %m@ I@ Phys@ 7$, 2, 12691$2 :2010;, http?//uni'erse@,its9pilani@ac@in/uploa s/Noa9 Physics/0p *0archi'e0%IPI%&0'ol07$0iss02012601@p *

Backgroun rea ing

!@ Ghrlich an l@ Tus"ynski@ Ball on a rotating turnta, le? .omparison o* theory an eEperiment@ %m@ l@ Phys@ 6$, $019$06 :1660;

!@ D@ !omer@ Motion o* a sphere on a tilte turnta, le@ %m@ l@ Phys@ (6, 6709676 :1671;, http?//isites@har'ar @e u/*s/ ocs/ic,@topic1216$11@*iles/Project X20resources/!olling X20sphere X20on X20turnta, le/%lP000670@p *

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%@ S@ &okirko, %@ %@ Belopolskii, %@ S@ Matytsyn, <@ %@ Jossako1ski@ Beha'ior o* a , all on the sur*ace o* a rotating isk@ %m@ l@ Phys@ 62, 2, 1019106 :166(;, http?//1 1 1@tyoma@com/plain/science/papers/1(/, all@p *

>@ >eckesser@ % , all rolling on a *reely spinning turnta, le@ %m@ l@ Phys@ 60, 3$693$7 :1663;

J@ Soyenli an G@ Griksen@ 4n the motion o* an ice hockey puck@ %m@ l@ Phys@ 0$, 11(6 :1670;

J@ Soyenli an G@ Griksen@ !esponse to –.omment on -4n the motion o* an ice hockey puck'A'' %m@ l@ Phys@ 0(, 337 :1676;

l@ Nersten, D@ &oo ak, an M@ &@ Tiersten@ Ball mo'ing on stationary or rotating hori"ontal sur*ace@ %m@ l@ Phys@ 60, ($:1662;

J@ >eltner@ &ta, le circular or, its o* *reely mo'ing , alls on rotating iscs@ %m@ l@ Phys@ (3, 67(:1636;

l@ %@ Burns@ Ball rolling on a turnta, le? %nalog *or charge particle ynamics@ %m@ l@ Phys@ (6, 06 :1671;

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J@ >eltner@ .entral ri*t o* *reely mo'ing ,alls on rotating isks? % ne1 metho to measure coe**icients o* rolling *riction@ %m@ I@ Phys@ 00, 6$3 :1673;

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F@ !o rigue"@ .omment on L% ,all rolling on a *reely spinning turnta,leM ,y >arren >eckesser T%m@ I@ Phys@ 60 :7;, 3$6V3$7 :1663;U %m@ I@ Phys@ 66, 623 :1667;

D@ %@ M˜nera@ % ,all rolling on a *reely spinning turnta,le? Insights *rom a solution in polar coor inates@ Fat@ %m@ I@ Phys@ G uc@ 0, 1, (6900 :2011;, http?//1 1 1@lajpe@org/march11/F%IPG0(060Dector0Munera0preprint0corr0*@p *

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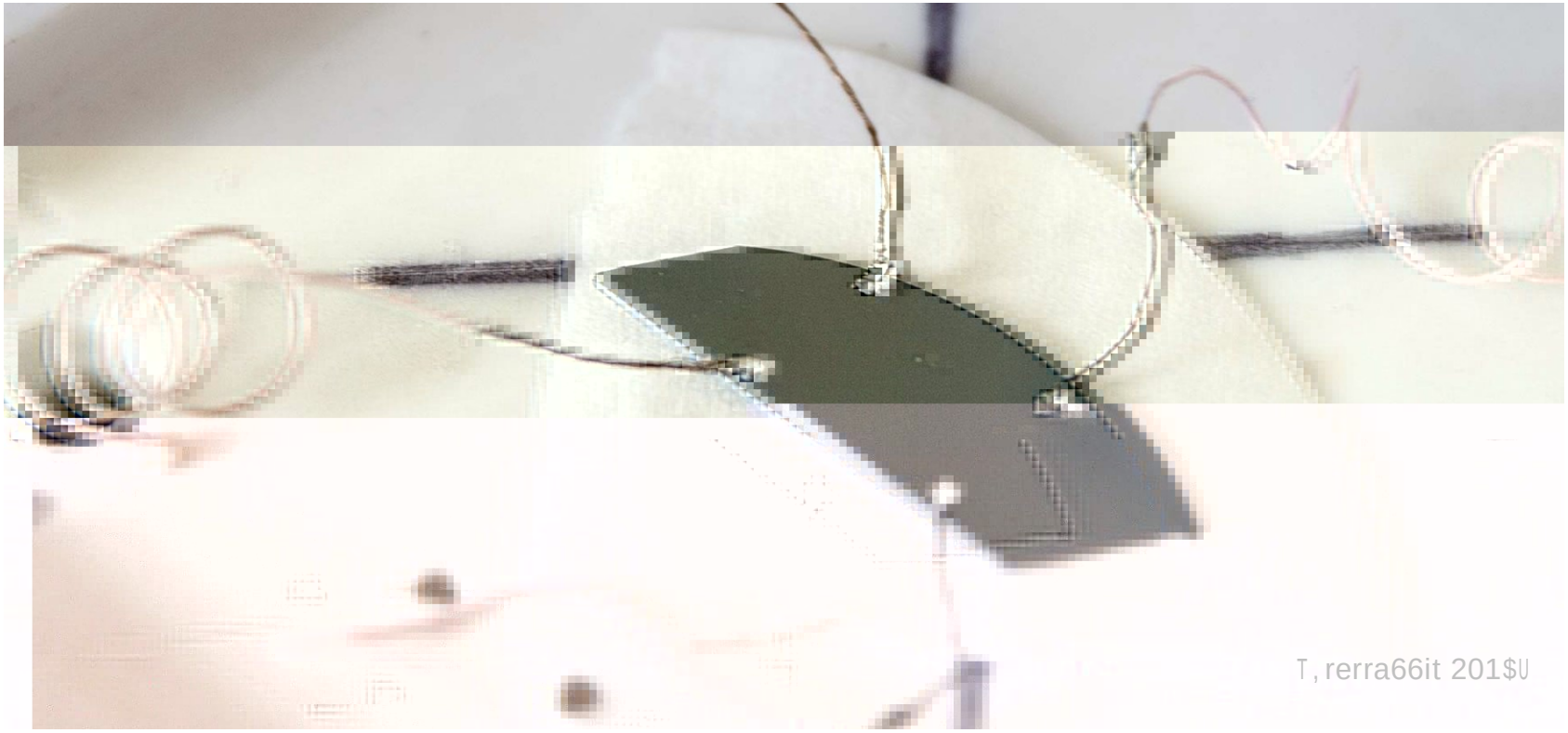

Pro, lem #o@ 12 LSan er Pau1 metho M

It is kno1n that con ucti'ity o* a material can ,e measure in epen ently o* the sample shape, as long as the sample has one ,or er :no holes;@ To 1hat eEtent can such a metho ,e applie A In'estigate an eEplain such measurements i* the sample has holes@

Backgroun rea ing

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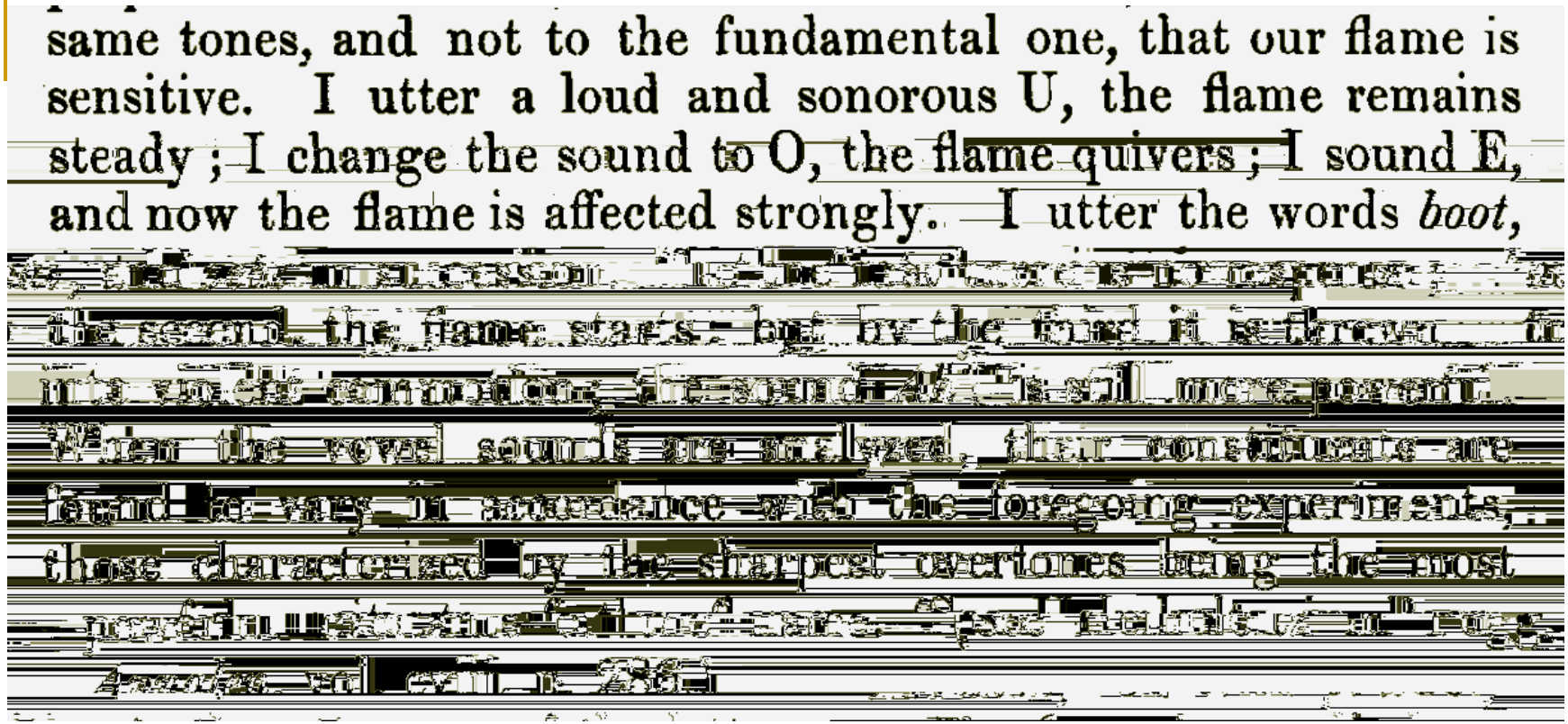
same tones, and not to the fundamental one, that our flame is sensitive. I utter a loud and sonorous U, the flame remains steady ; I change the sound to O, the flame quivers ; I sound E, and now the flame is affected strongly. I utter the words *boot*,

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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 Pro-

* Heat as a Mode of Motion, article 545 (second edition). The "Rede" Lecture on Radiation, pp. 45 & 47.

† Communicated by the Author.

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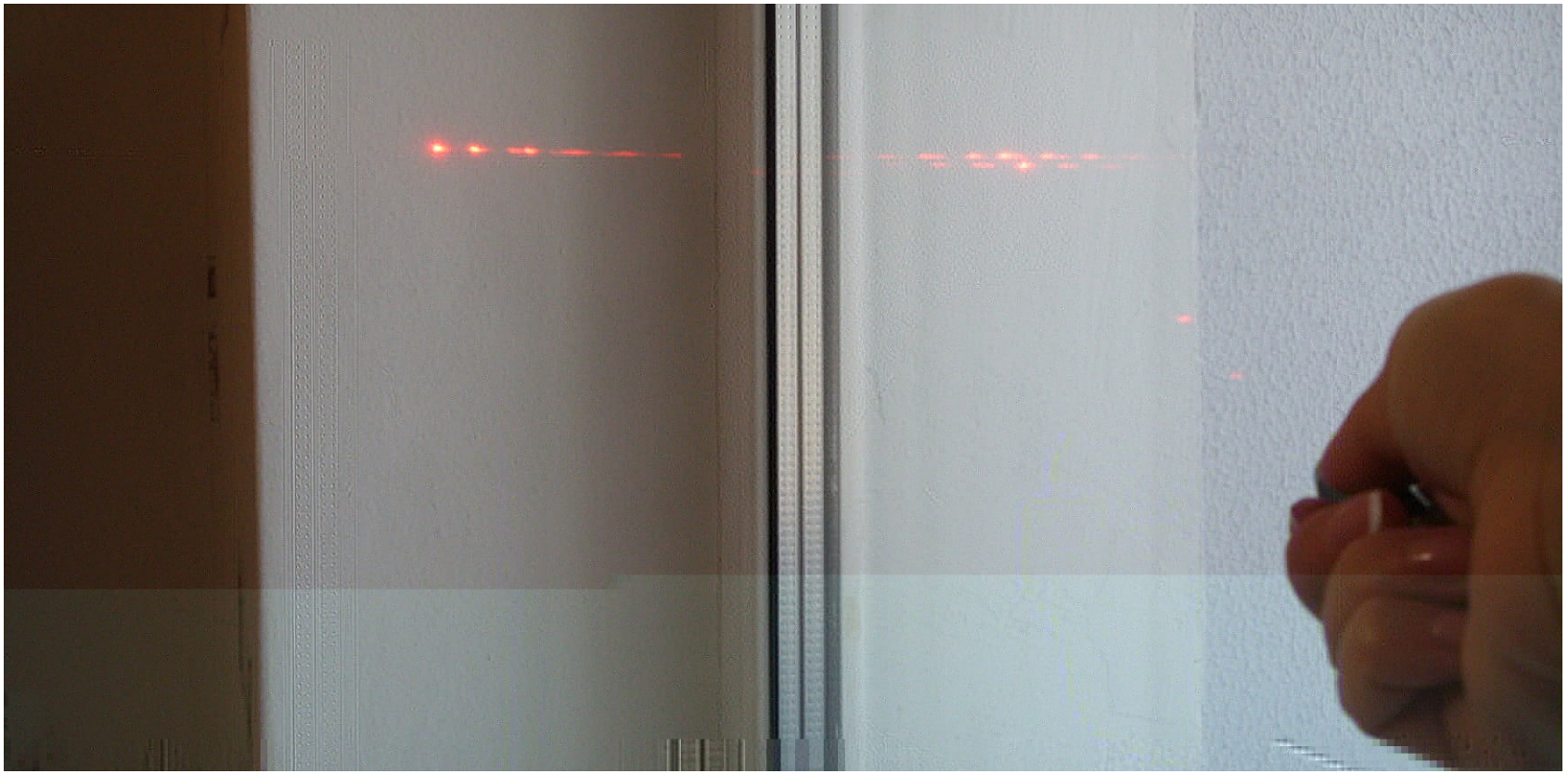

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T@ >ilke, %@ >it"mann, !@ +ehr, I@ +a erl, 4@ &chmittel, G@9>@ &chae*er, .@ +ritsch@ Metho an apparatus *or contactless optical measurement o* the thickness o* a hot glass ,o y ,y optical ispersion@)& Patent 3(1(3(0 B2 :%ug 16, 2007;, http?//1 1 1@google@com/patents/)&3(1(3(0

T@ S@ Farina, G@ Y@ Jutenko'a, #@ !akhimo', an 4@ J@)shako'@ .ontactless glass sheet thickness meter@ !ussian Patent 2(26((3, http?//russianpatents@com/patent/2(2/2(26((3@html

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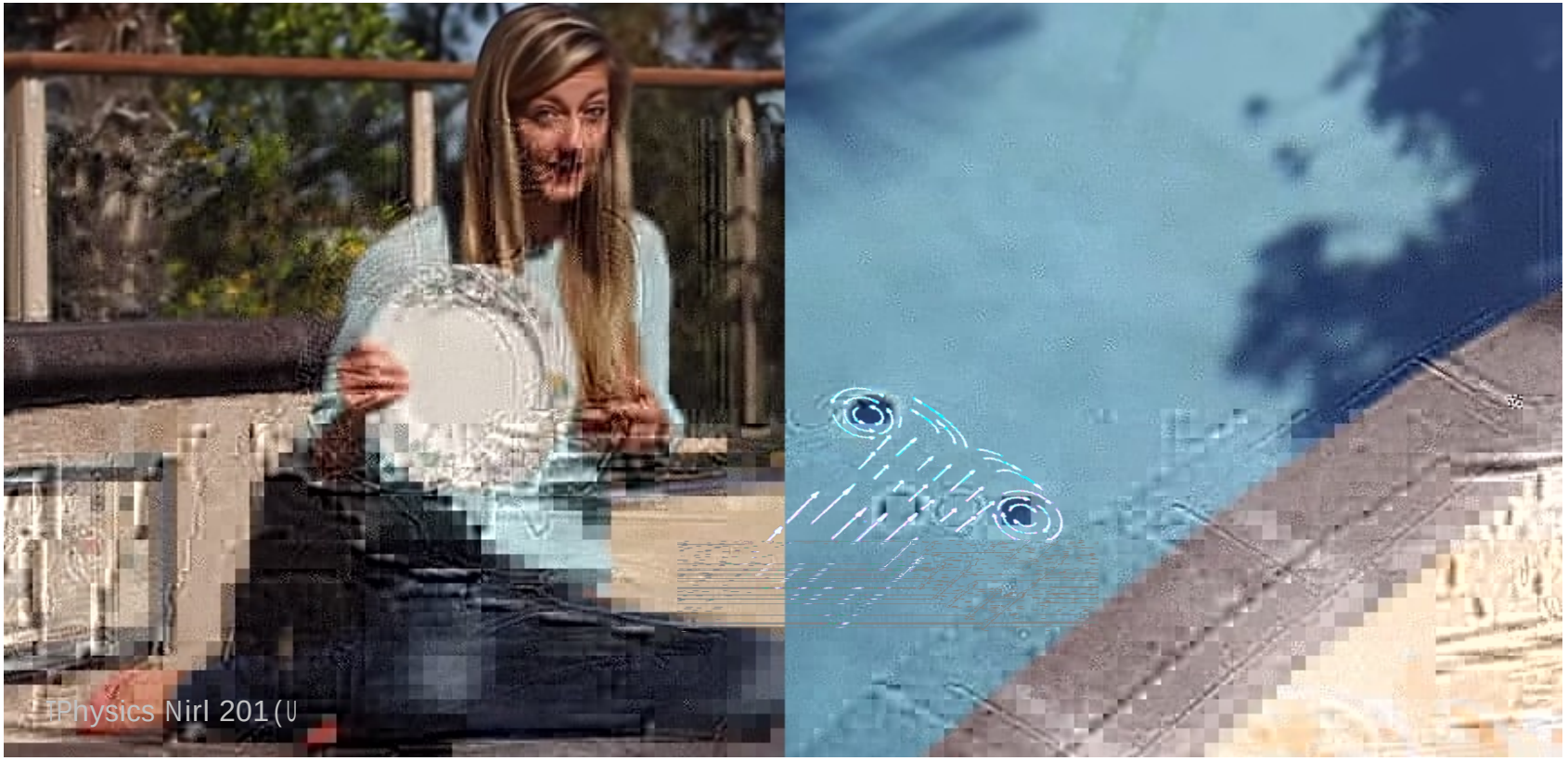

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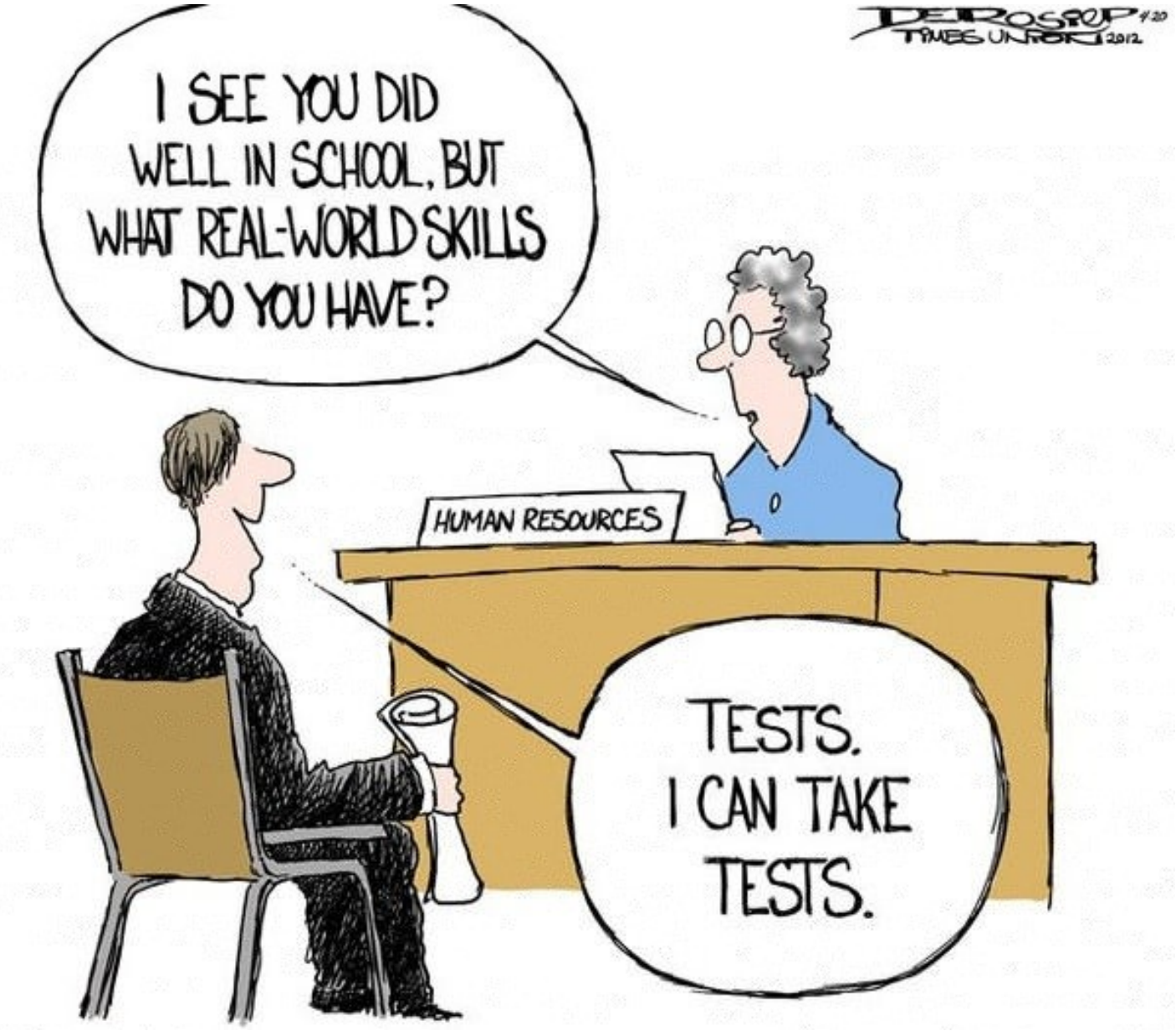
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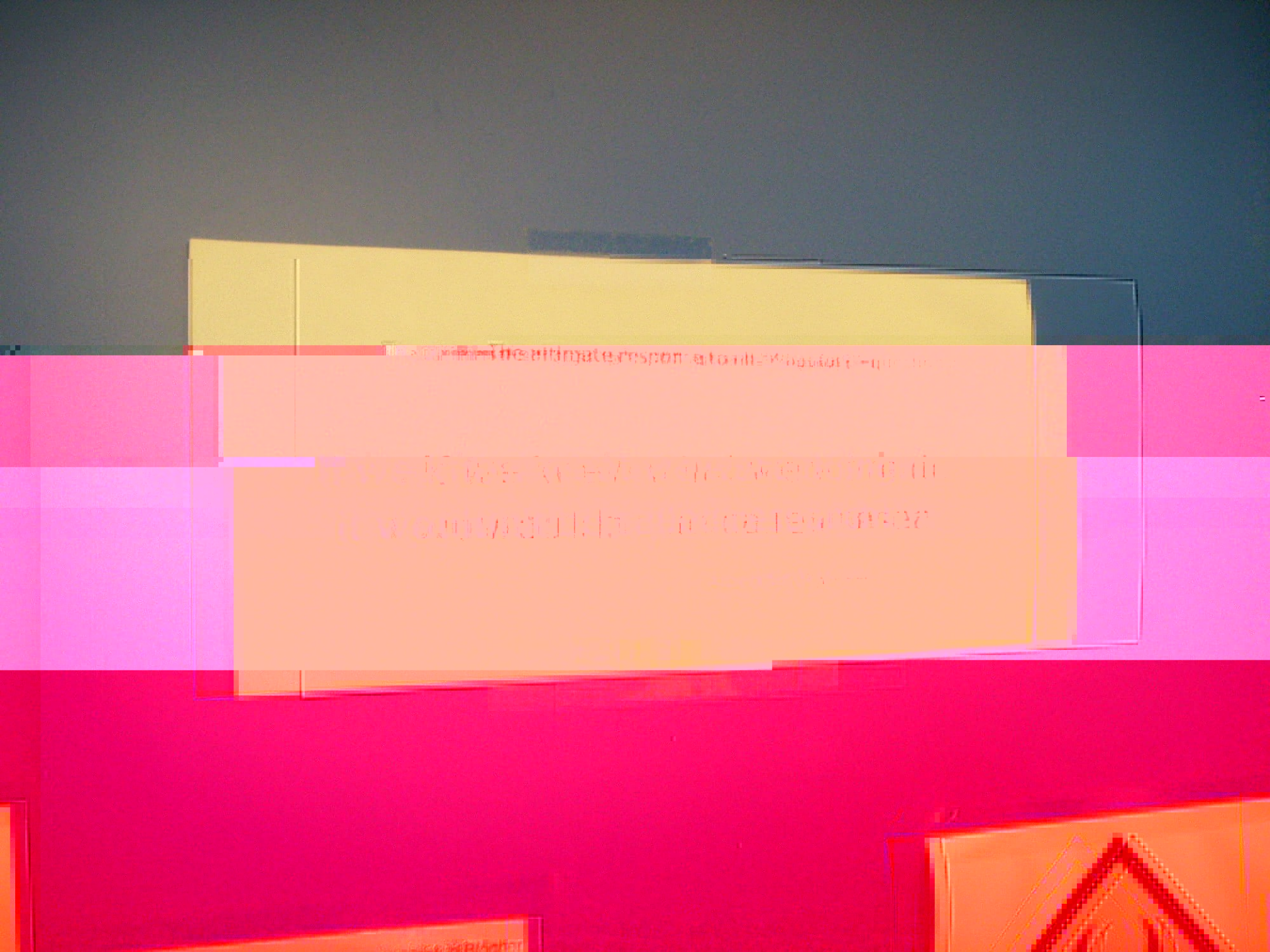

Important in*ormation

The ,asic goal o* this Jit is not in pro'i ing stu ents 1ith a start9to9*inish manual or in limiting their creati'ity, ,ut in encouraging them to

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Do1 to gi'e a science talk

Take care o* your listeners

- i* they all on't get 1hat you say, it's your pro,lem
- it's your jo, to o science 1ork an make conclusions@ It's their jo, to listen

Put yoursel* in conteEt o* eEisting results

- your no'elty is only 'isi,le in contrast 1ith eEisting kno1le ge
- making pro*oun conclusions is har er than measuring an 1riting *ormulas an rea ing papers
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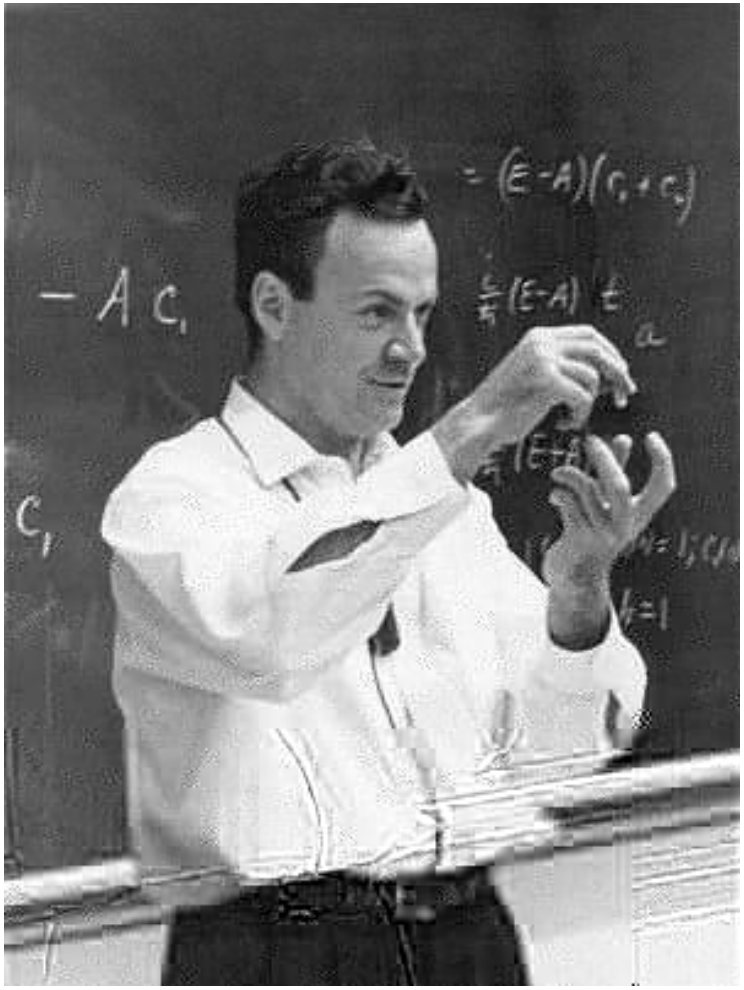

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Do not hesitate to contact us for any inquiries about the IYNT. We are

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re*erences, Buestions an a 'ices

llya Martchenko,[1*] Matej Ba in,[2]
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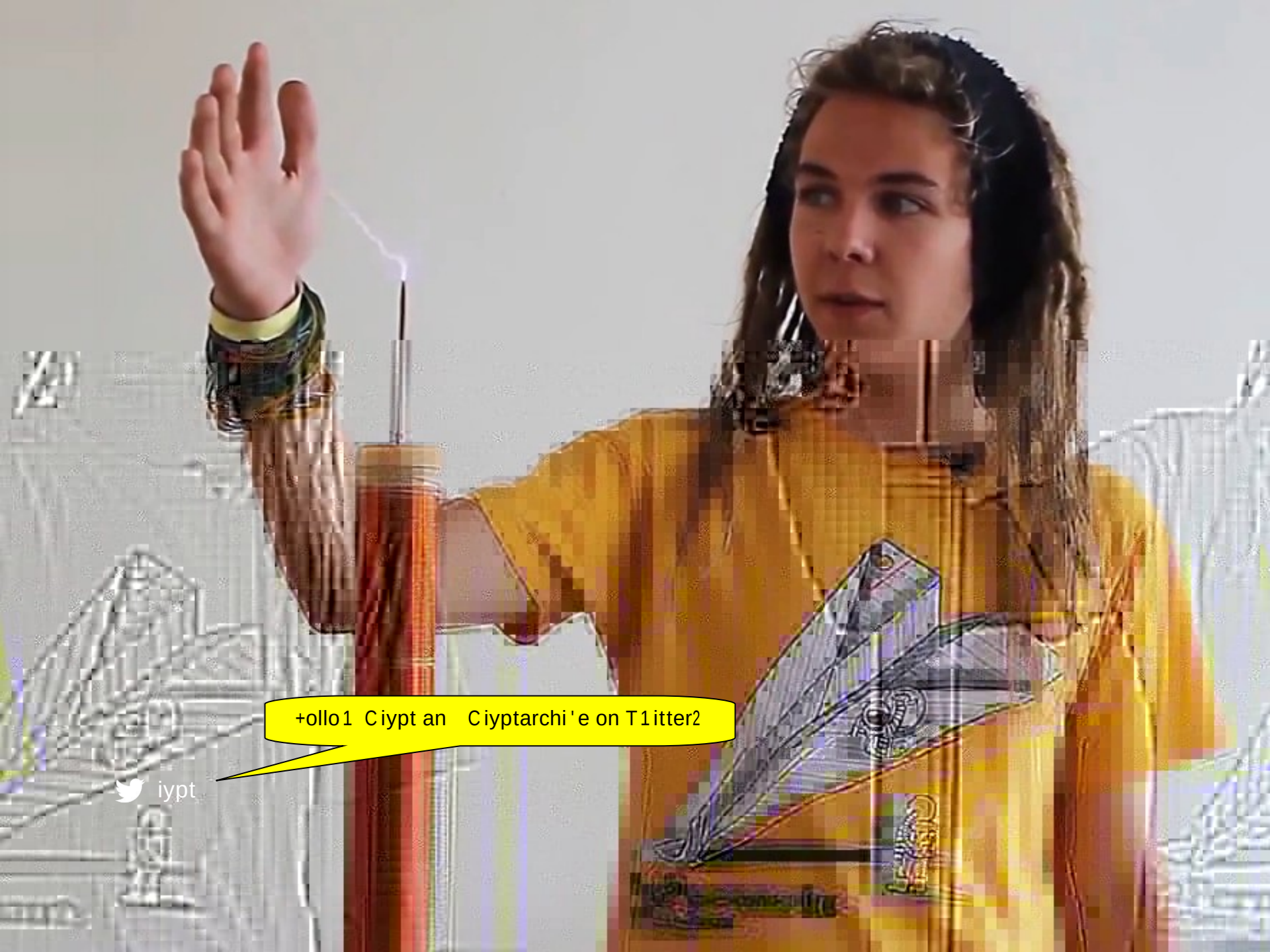
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