Title: TBA

Date: Mar 26, 2018 02:00 PM

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Abstract:

Legendre transform in mechanics

- How many undergraduate math/physics majors in audience?

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- Can you remember what the Legendre transform is?
- Hint: Legendre transform converts between the Lagrangian and Hamiltonian

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- Typical answer: $H(q,p) = p\dot{q} - L(q,\dot{q})$
- But this isn't a *mathematical function transform.* Not unless you include your secret physics knowledge:

$$p = \partial L(q,\dot{q})/\partial \dot{q}$$

Legendre transform in mechanics

- So we're defining a mathematical function transform in terms of a weird substitution procedure…

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- Hmmm…isn't the Legendre transform also used everywhere in thermodynamics? Is it really this ugly?

Legendre transform in mechanics

$f(x) \leftrightarrow g(p)$

(Suppressing q dependence)

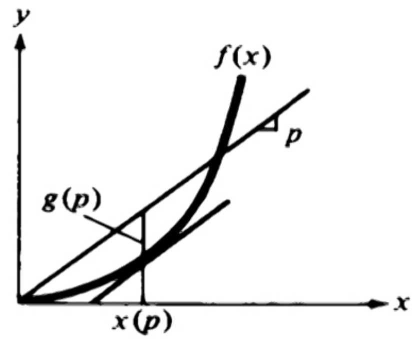
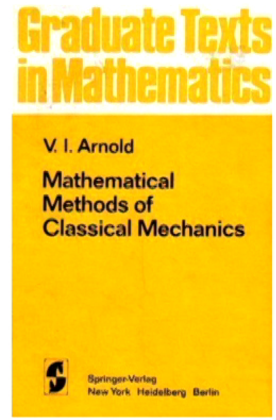


Figure 43 Legendre transformation



Let $y = f(x)$ be a convex function, $f''(x) > 0$.

The *Legendre transformation* of the function f is a new function g of a new variable p, which is constructed in the following way (Figure 43). We draw the graph of f in the x, y plane. Let p be a given number. Consider the straight line $y = px$. We take the point $x = x(p)$ at which the curve is farthest from the straight line in the vertical direction: for each p the function $px - f(x) = F(p, x)$ has a maximum with respect to x at the point $x(p)$. Now we define $g(p) = F(p, x(p))$.

The point $x(p)$ is defined by the extremal condition $\partial F/\partial x = 0$, i.e., $f'(x) = p$. Since f is convex, the point $x(p)$ is unique.[28]

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  - cf. the Fourier transform: unique expansion of arbitrary f in eigenstates of translation operator:

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- Remember: this is *the* link between Lagrangian and Hamiltonian mechanics, the two most important formulations of both classical and quantum physics. **This transformation binds together the fundamental operating system of the universe.**

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- Equivalent definition: f and g are Legendre transforms of each other iff

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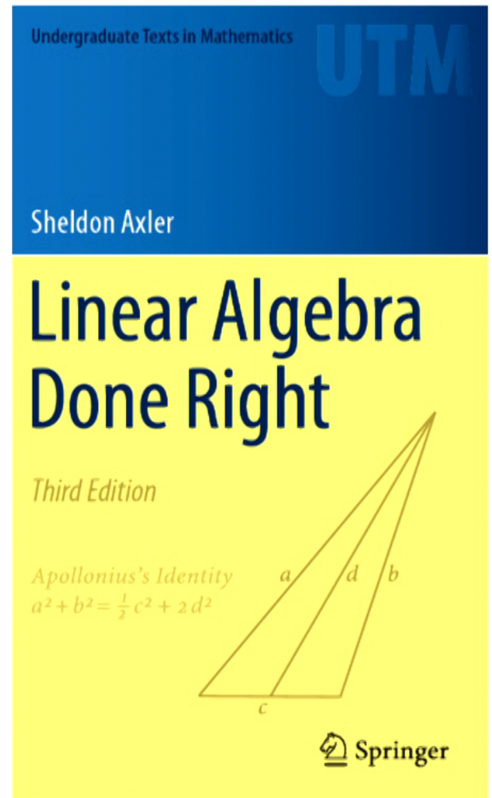
- Bold claim: **essentially no physicist is taught this sensibly**
- We have no reasons to think this is an exception
- (For my longer rant, google "Legendre transform Riedel")

Determinants in linear algebra

- Claim: Nobody wrote a linear algebra textbook that motivates and defines determinants in a sensible way until **1997**.
  - *Linear Algebra Done Right* by Sheldon Axler



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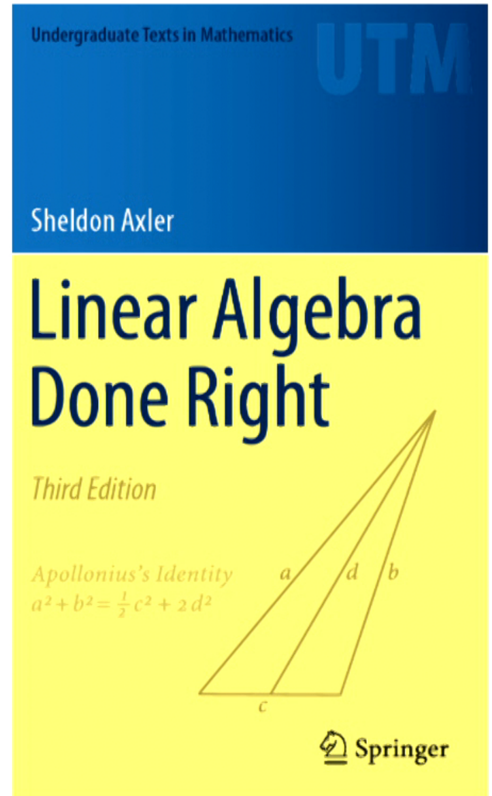

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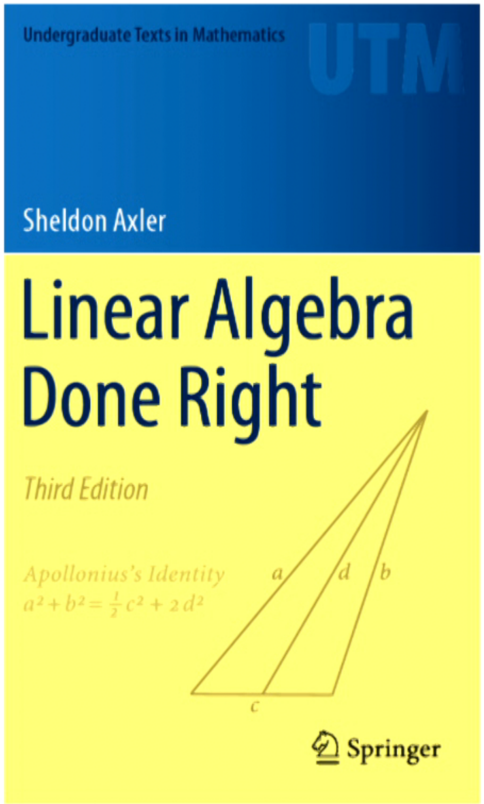

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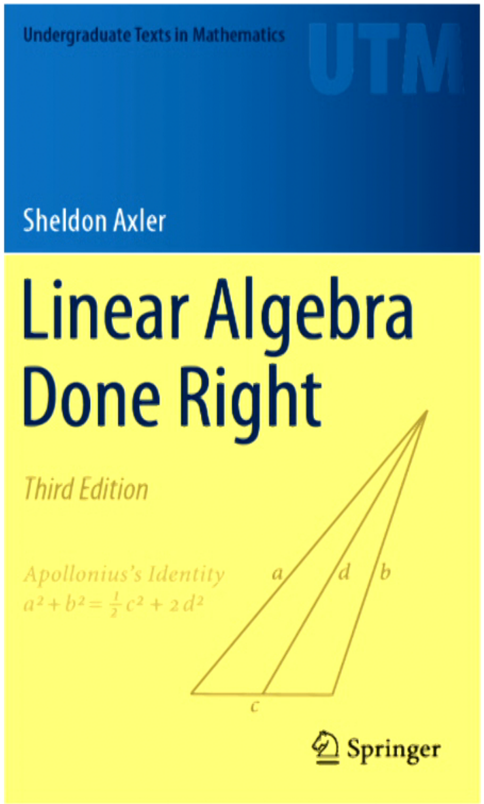
- Consider: it would have been hopeless to just post a paper on the arXiv and expect the to work it’s way into the curriculum; Axler had to write an entire new textbook!



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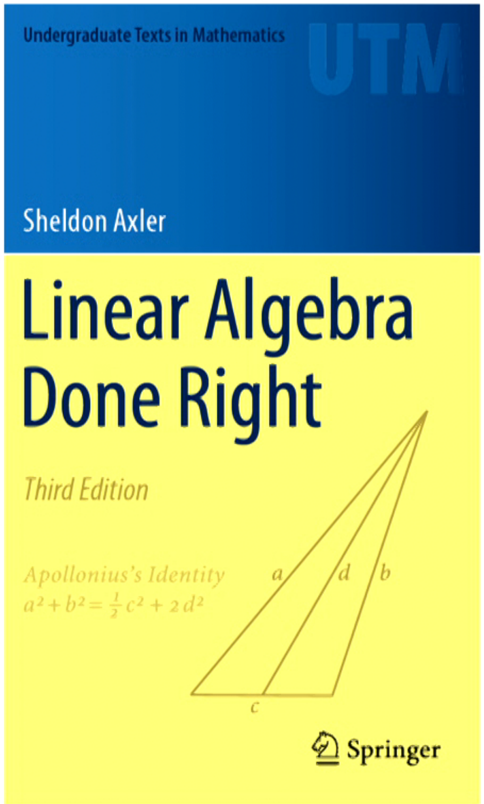
- This is *way* too hard. We are ossifying



Textbook ages

- Classical Mechanics:
  - Goldstein - 1st ed. **67** years; 3rd ed. **17** years
  - Landau & Lifshitz vol. 1 - 1st Russian ed. **58** years; 3rd ed. **42** years
  - Arnold - 1st Russian ed. **44** years; 2nd ed. **21** years
- Quantum mechanics
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- Electromagnetism
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    - Instead, we are allowing our researcher pipeline to slowly decay

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    - If your textbook is better on net, but worse in certain parts, then teaching of those parts will get *worse*

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- Review articles and research articles have similar or worse deficiencies; textbooks are just egregious
- Things get *worse* as things get more specialized
  - E.g., the infinitely-repeated misconception that “Classical sensitivity to initial conditions doesn’t extend to quantum chaos because the Schrödinger equation is linear”

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- Common response: “This information is *known*. It’s not a *secret.* It’s available on Google for goodness’ sake.”

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  - Central location allows iterative improvement

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- The goal of research is **not** for one person to know; if it was, we wouldn’t require publication

Possibilities

- For any document on the arXiv, suppose the reader could…

    1. Give one-click feedback to draw author's attention to issues (confusing, unjustified, etc.)

Increasingly ambitious

Cutting edge

Pedagogy

One-click feedback

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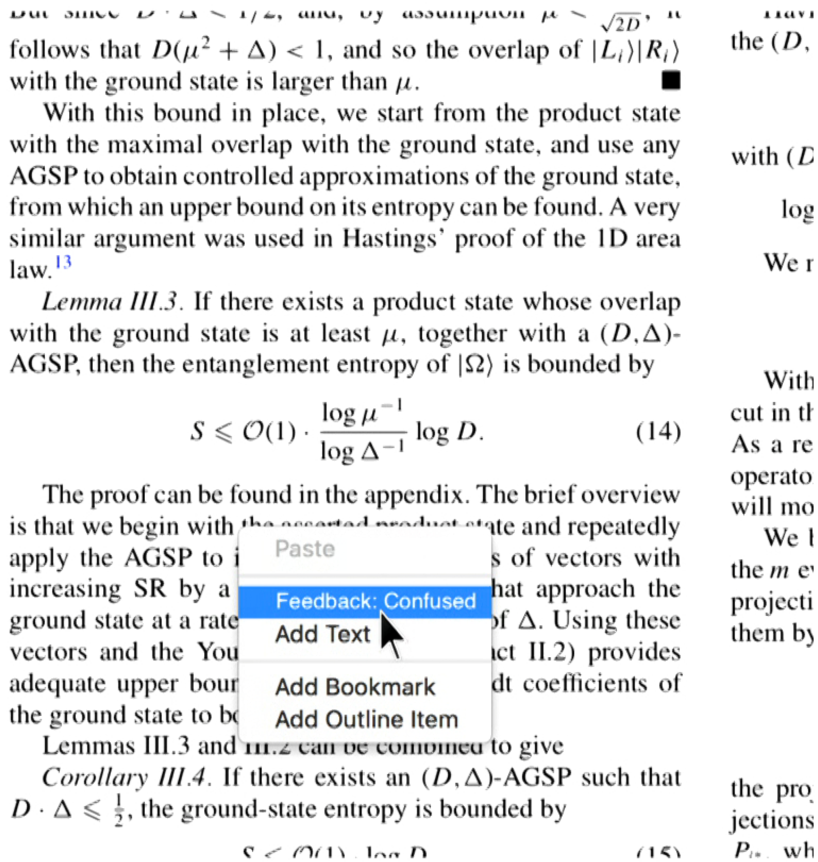

follows that $D(\mu^2 + \Delta) < 1$, and so the overlap of $|L_i\rangle|R_i\rangle$ with the ground state is larger than μ. ■

With this bound in place, we start from the product state with the maximal overlap with the ground state, and use any AGSP to obtain controlled approximations of the ground state, from which an upper bound on its entropy can be found. A very similar argument was used in Hastings' proof of the 1D area law.[13]

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One-click feedback

Reader's view:

But since $D \cdot \Delta < 1/2$, and, by assumption $\mu > \frac{1}{\sqrt{2D}}$, it follows that $D(\mu^2 + \Delta) < 1$, and so the overlap of $|L_i\rangle|R_i\rangle$ with the ground state is larger than μ. ■

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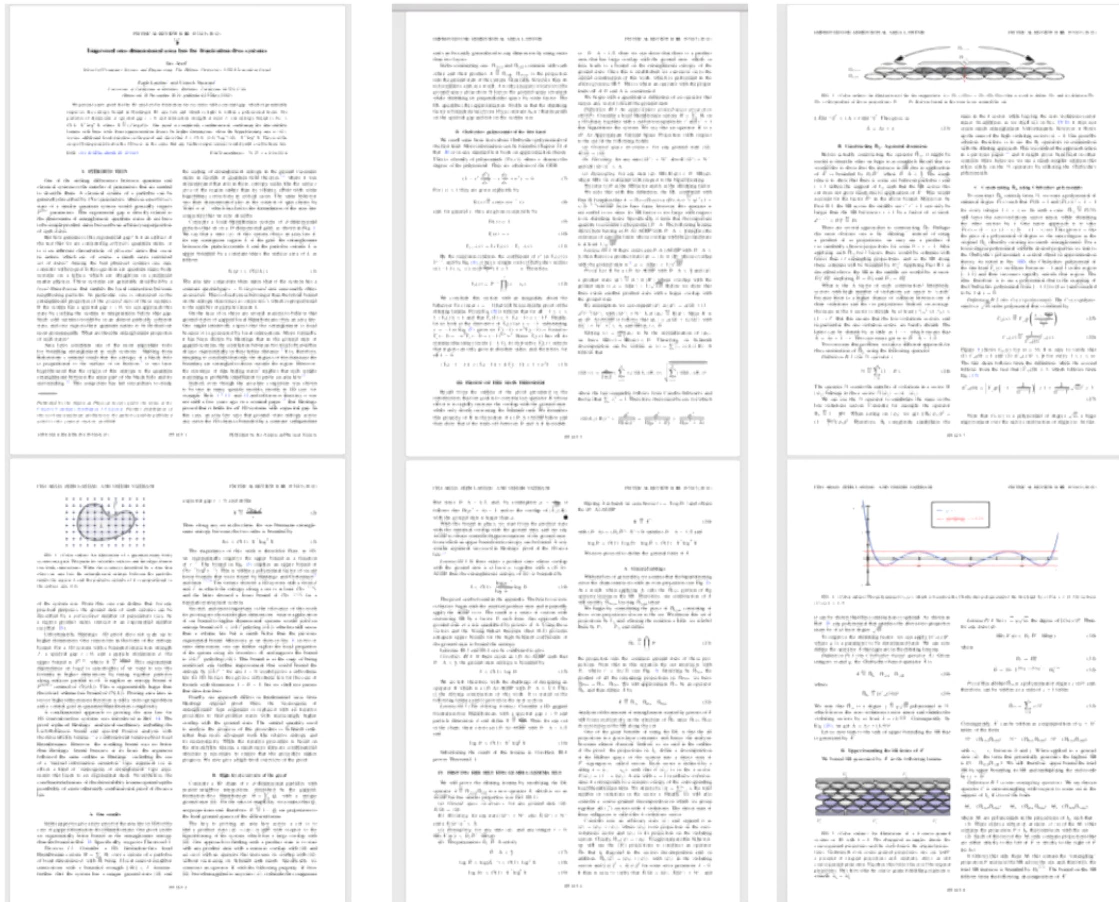

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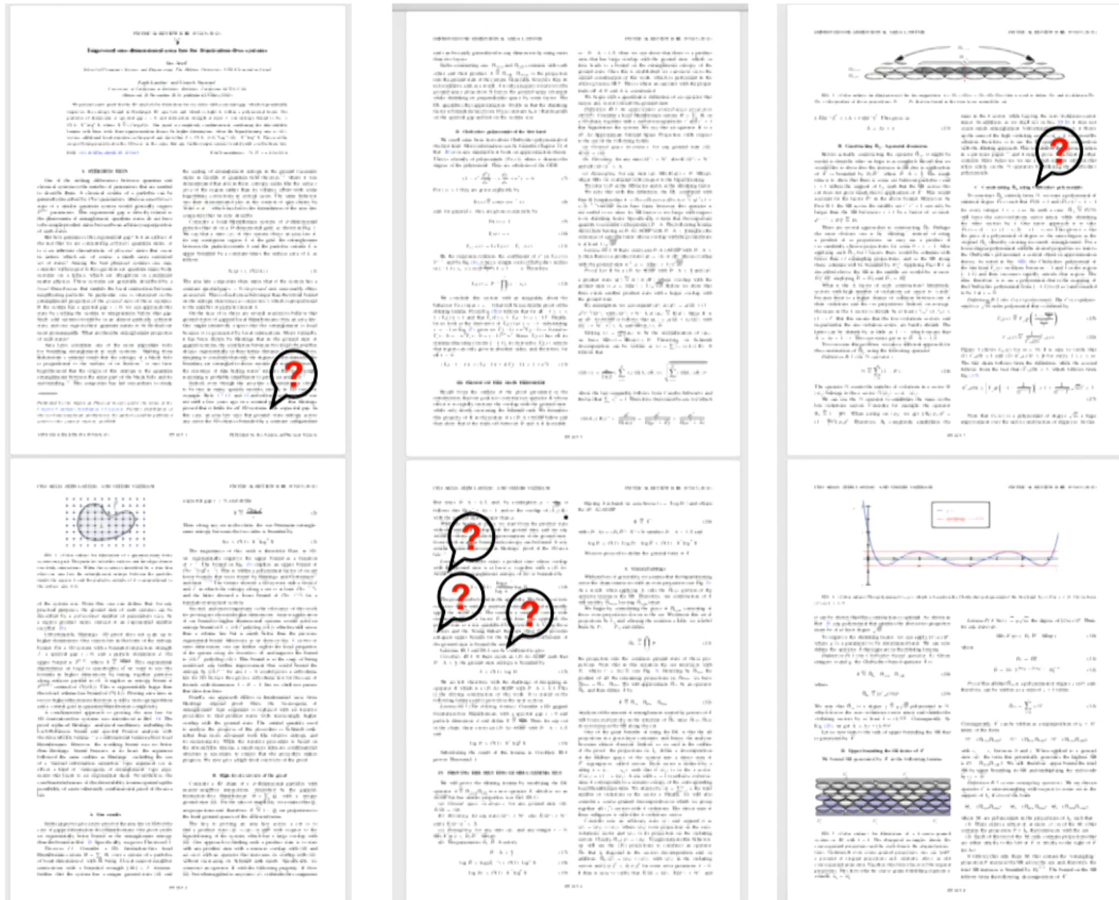

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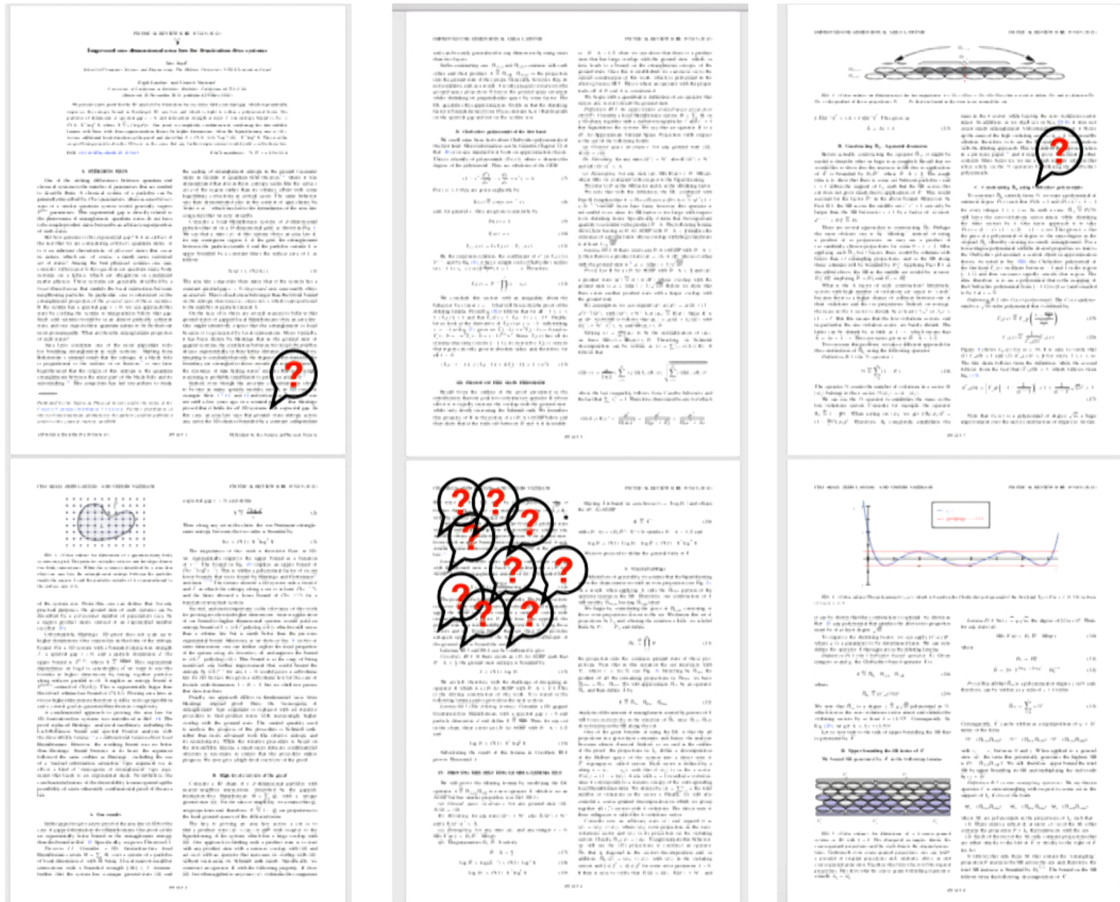

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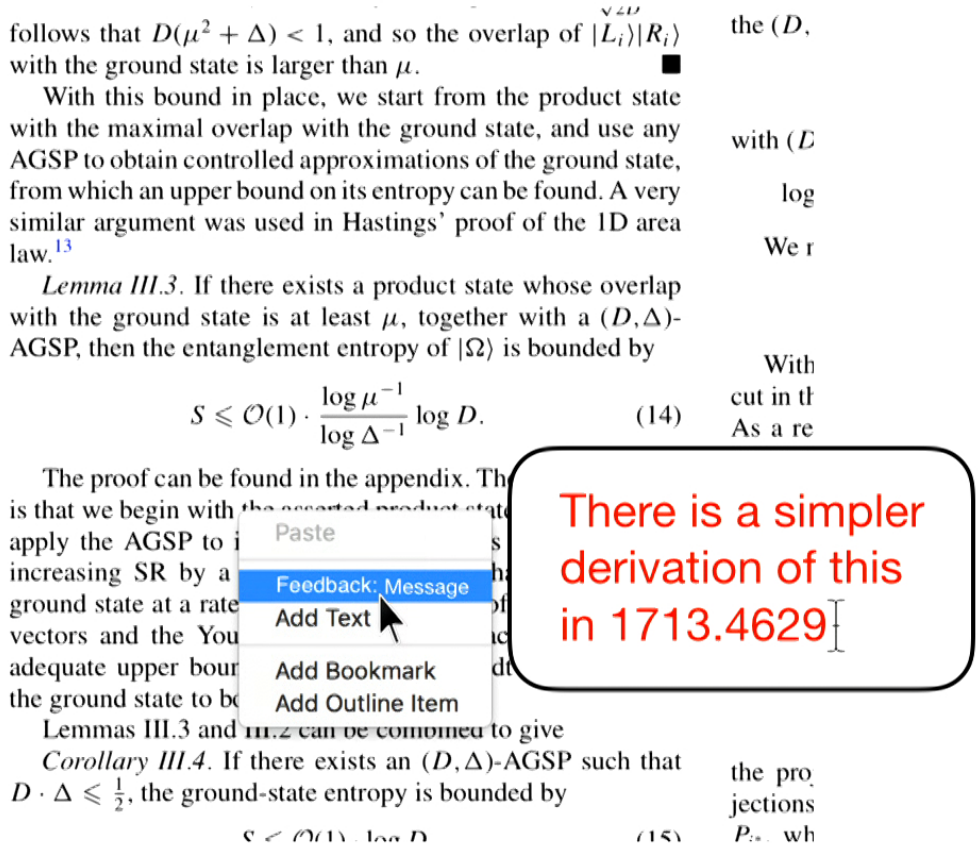

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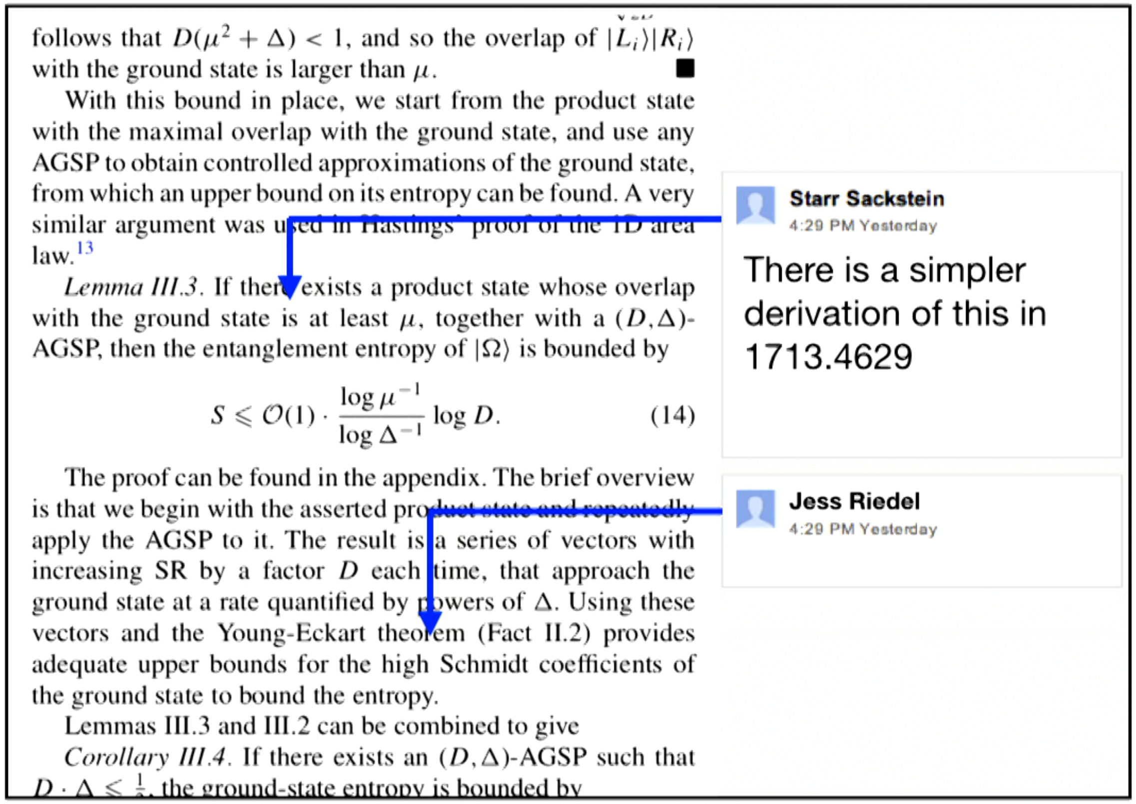

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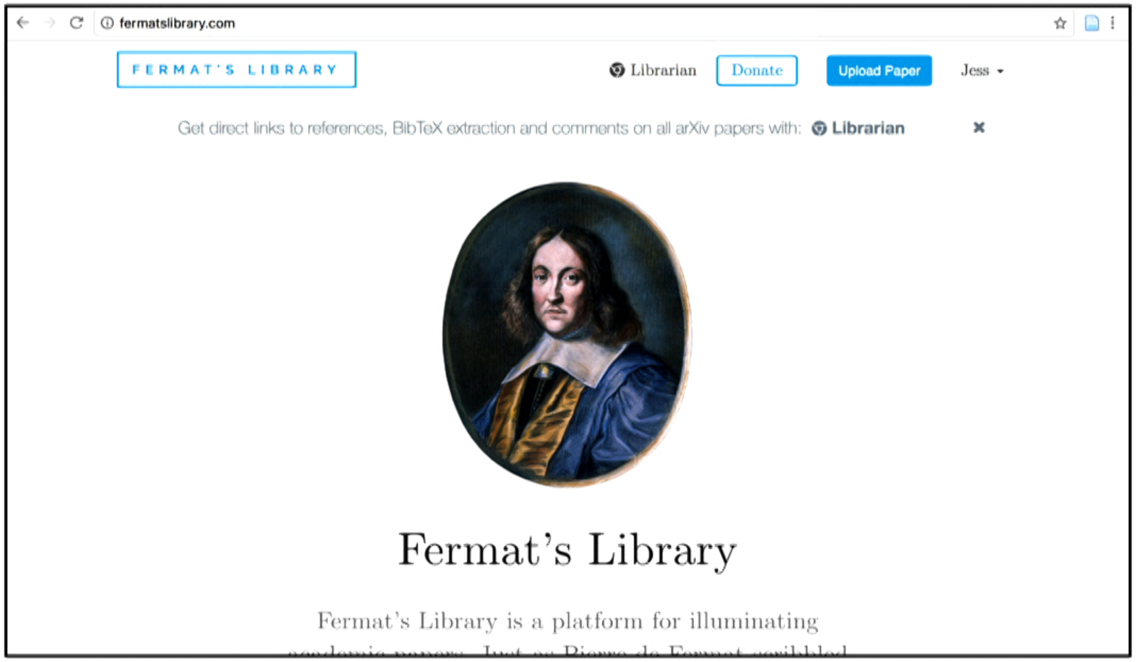

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see the “Librarian” plugin for Chrome


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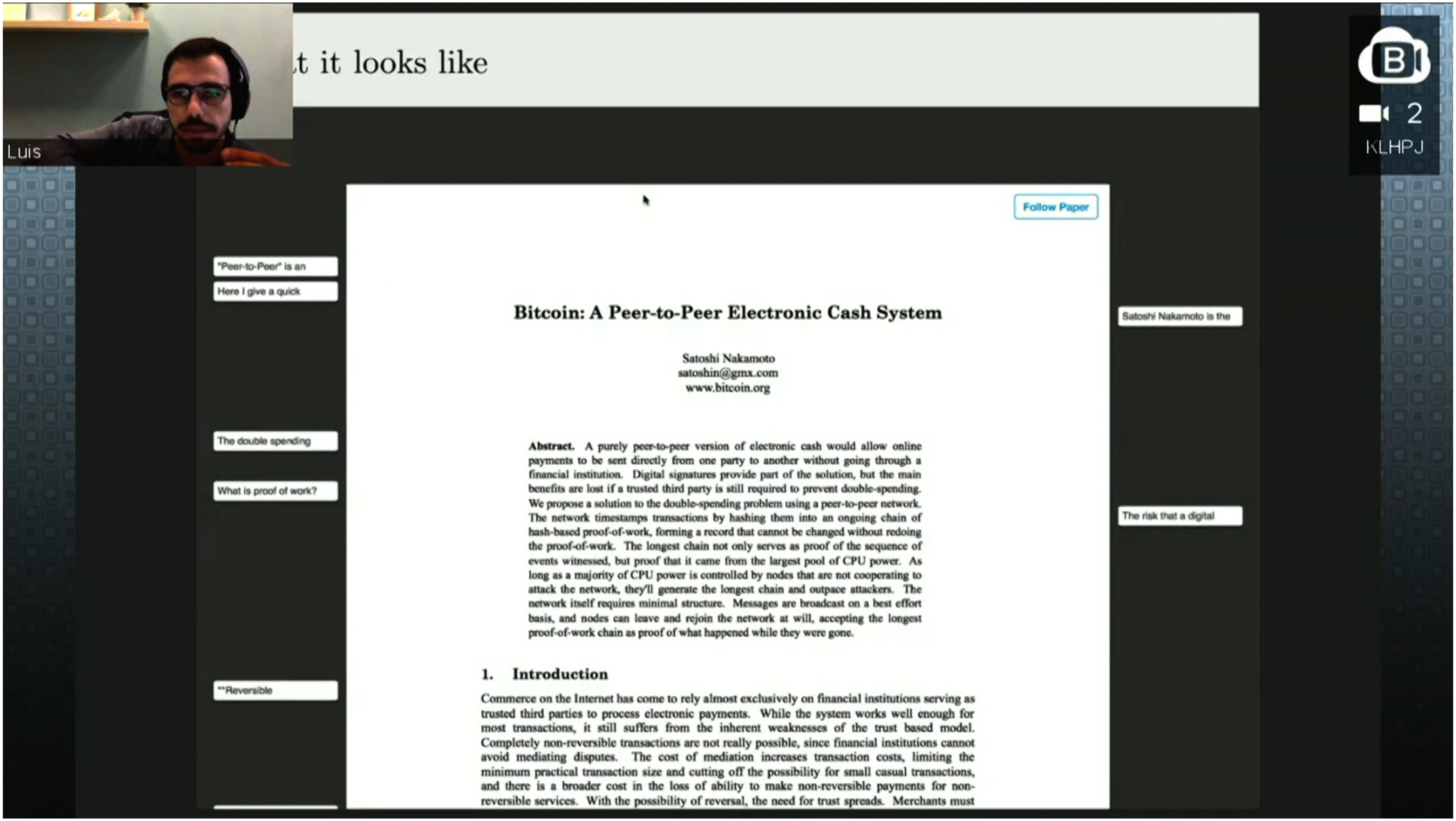
Perimeter Institute, March 2018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The double spending
What is proof of work?
**Reversible
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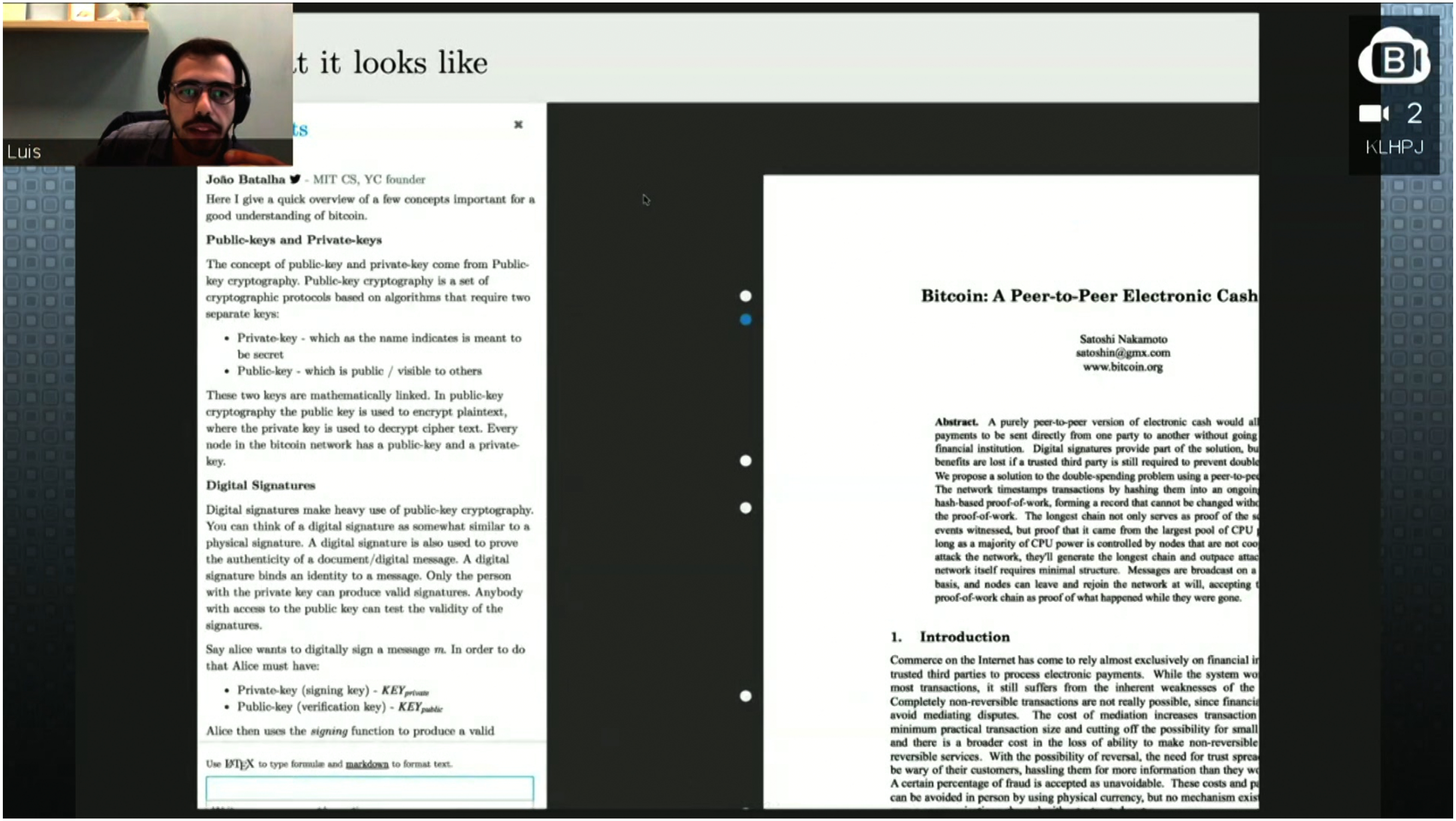
The risk that a digital
Bitcoin: A Peer-to-Peer Electronic Cash System
Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org
Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.
1. Introduction
Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for most transactions, it still suffers from the inherent weaknesses of the trust based model. Completely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes. The cost of mediation increases transaction costs, limiting the minimum practical transaction size and cutting off the possibility for small casual transactions, and there is a broader cost in the loss of ability to make non-reversible payments for non-reversible services. With the possibility of reversal, the need for trust spreads. Merchants must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João Batalha - MIT CS, YC founder
Here I give a quick overview of a few concepts important for a good understanding of bitcoin.
Public-keys and Private-keys
The concept of public-key and private-key come from Public-key cryptography. Public-key cryptography is a set of cryptographic protocols based on algorithms that require two separate keys:
• Private-key - which as the name indicates is meant to be secret
• Public-key - which is public / visible to others
These two keys are mathematically linked. In public-key cryptography the public key is used to encrypt plaintext, where the private key is used to decrypt cipher text. Every node in the bitcoin network has a public-key and a private-key.
Digital Signatures
Digital signatures make heavy use of public-key cryptography. You can think of a digital signature as somewhat similar to a physical signature. A digital signature is also used to prove the authenticity of a document/digital message. A digital signature binds an identity to a message. Only the person with the private key can produce valid signatures. Anybody with access to the public key can test the validity of the signatures.
Say alice wants to digitally sign a message m. In order to do that Alice must have:
• Private-key (signing key) - KEY private
• Public-key (verification key) - KEY public
Alice then uses the signing function to produce a valid
Use LaTeX to type formulæ and markdown to format text.
Bitcoin: A Peer-to-Peer Electronic Cash
Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org
Abstract. A purely peer-to-peer version of electronic cash would
payments to be sent directly from one party to another without going
financial institution. Digital signatures provide part of the solution,
benefits are lost if a trusted third party is still required to prevent
The network timestamps transactions by hashing them into an
hash-based proof-of-work, forming a record that cannot be changed
the proof-of-work. The longest chain not only serves as proof of the
events witnessed, but proof that it came from the largest pool of CPU
long as a majority of CPU power is controlled by nodes that are not
attack the network, they'll generate the longest chain and outpace
network itself requires minimal structure. Messages are broadcast on a
basis, and nodes can leave and rejoin the network at will, accepting
proof-of-work chain as proof of what happened while they were gone.
1. Introduction
Commerce on the Internet has come to rely almost exclusively on financial
trusted third parties to process electronic payments. While the system
most transactions, it still suffers from the inherent weaknesses of the
Completely non-reversible transactions are not really possible, since
avoid mediating disputes. The cost of mediation increases transaction
minimum practical transaction size and cutting off the possibility for small
and there is a broader cost in the loss of ability to make non-reversible
reversible services. With the possibility of reversal, the need for trust
be wary of their customers, hassling them for more information than they
A certain percentage of fraud is accepted as unavoidable. These costs and
can be avoided in person by using physical currency, but no mechanism
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otivation

This gives (ii). The implication $(ii) \to (iii)$ is trivial since, for example,

$$\int_0^1 \|\sum_k r_k(u)\psi(k+t-A)^* x^*\|^2 \, \mathrm{d}u \leq \sup_{\epsilon_k = \pm 1} \|[\sum_k \epsilon_k \psi(k+t-A)]^*\|^2 \, \|x^*\|^2$$

$$\leq C\|x^*\|^2 .$$

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$$\int_0^1 \|\sum_k r_k(u)\psi(k+t-A)^* x^*\|^2 \, du \le \sup_{\epsilon_k = \pm 1} \|[\sum_k \epsilon_k \psi(k+t-A)]^*\|^2 \, \|x^*\|^2$$

$$\le C\|x^*\|^2 .$$

What trivial really means...

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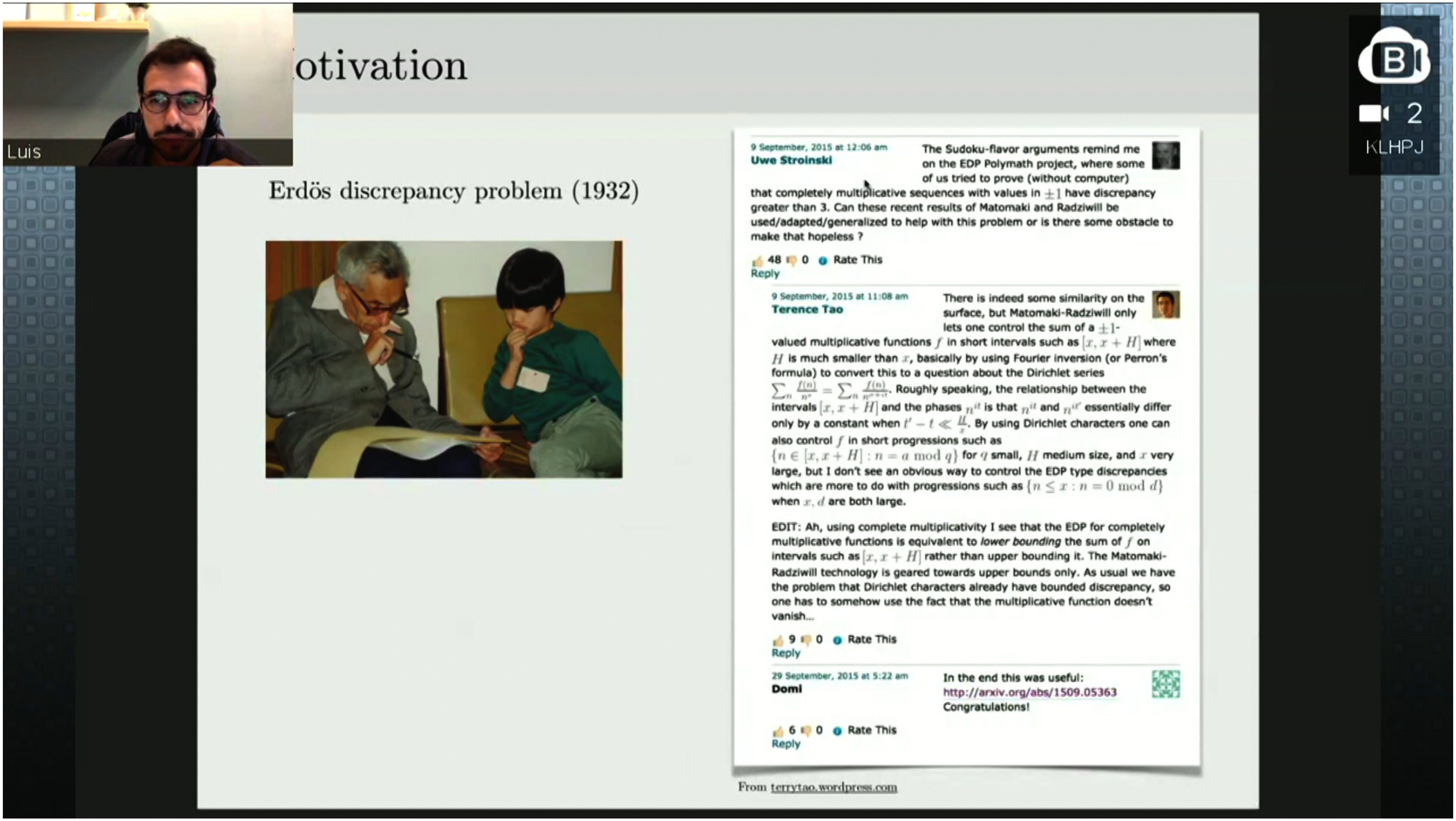
Erdös discrepancy problem (1932)



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Erdös discrepancy problem (1932)
9 September, 2015 at 12:06 am
Uwe Stroinski
The Sudoku-flavor arguments remind me on the EDP Polymath project, where some of us tried to prove (without computer) that completely multiplicative sequences with values in ± 1 have discrepancy greater than 3. Can these recent results of Matomaki and Radziwill be used/adapted/generalized to help with this problem or is there some obstacle to make that hopeless ?
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9 September, 2015 at 11:08 am
Terence Tao
There is indeed some similarity on the surface, but Matomaki-Radziwill only lets one control the sum of a ± 1-valued multiplicative functions f in short intervals such as $[x, x+H]$ where H is much smaller than x, basically by using Fourier inversion (or Perron's formula) to convert this to a question about the Dirichlet series $\sum_n \frac{f(n)}{n^s} = \sum_n \frac{f(n)}{n^{\sigma+it}}$. Roughly speaking, the relationship between the intervals $[x, x+H]$ and the phases n^{it} is that n^{it} and $n^{it'}$ essentially differ only by a constant when $t' - t \ll \frac{H}{x}$. By using Dirichlet characters one can also control f in short progressions such as $\{n \in [x, x+H] : n = a \mod q\}$ for q small, H medium size, and x very large, but I don't see an obvious way to control the EDP type discrepancies which are more to do with progressions such as $\{n \leq x : n = 0 \mod d\}$ when x, d are both large.
EDIT: Ah, using complete multiplicativity I see that the EDP for completely multiplicative functions is equivalent to *lower bounding* the sum of f on intervals such as $[x, x+H]$ rather than upper bounding it. The Matomaki-Radziwill technology is geared towards upper bounds only. As usual we have the problem that Dirichlet characters already have bounded discrepancy, so one has to somehow use the fact that the multiplicative function doesn't vanish...
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Domi
In the end this was useful: http://arxiv.org/abs/1509.05363
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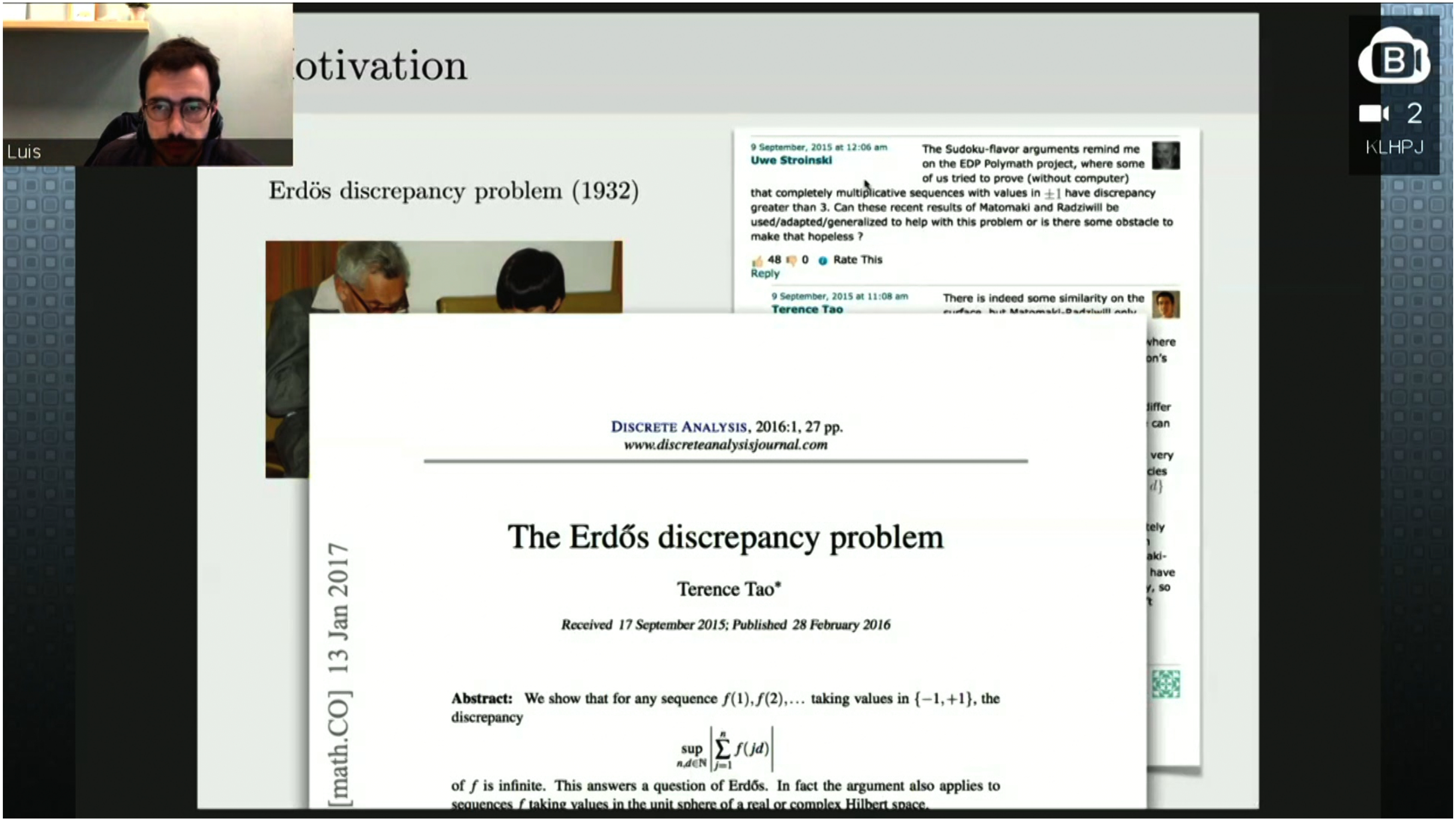
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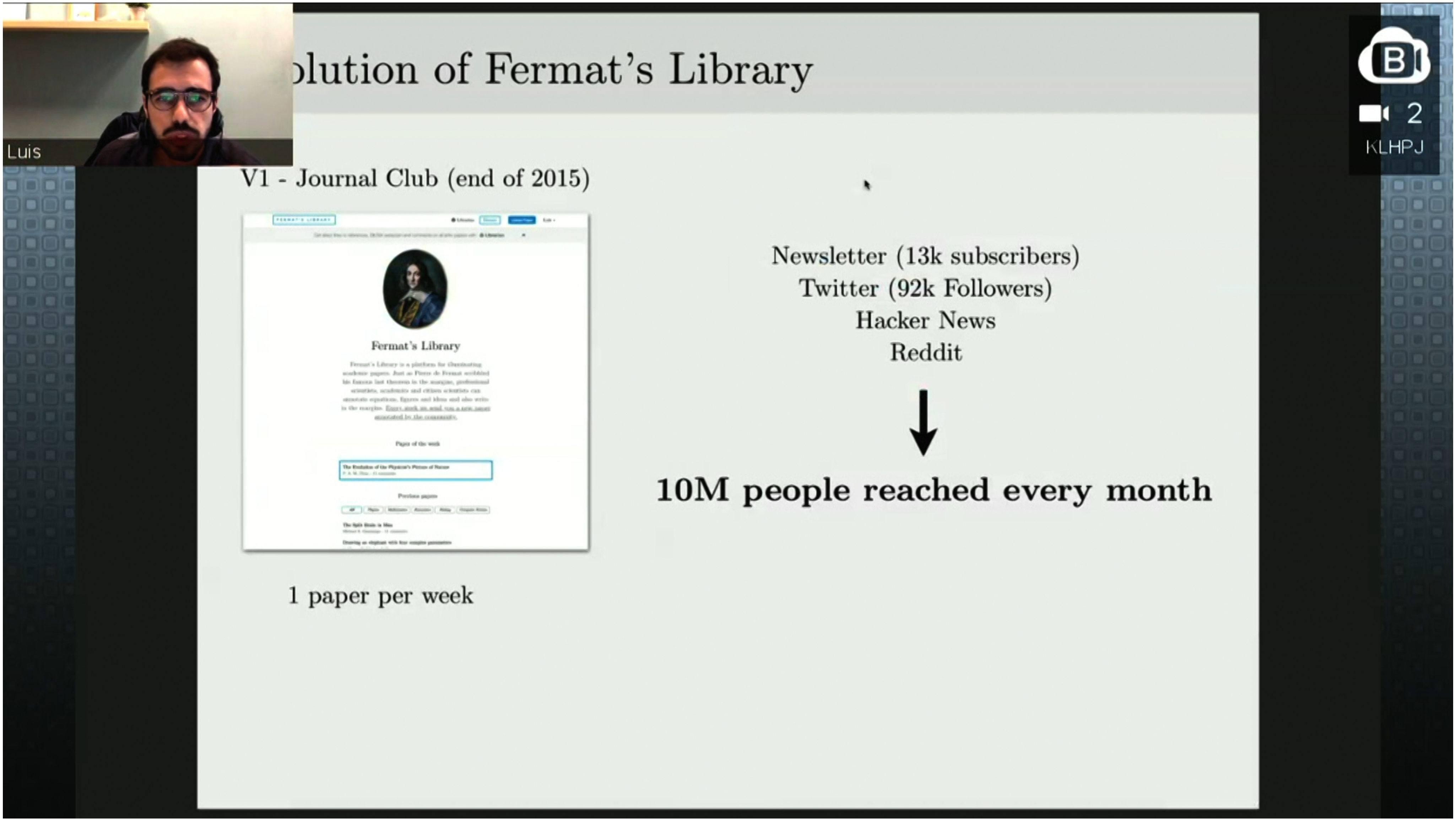
Terence Tao
There is indeed some similarity on the
Discrete Analysis, 2016:1, 27 pp.
www.discreteanalysisjournal.com
The Erdős discrepancy problem
Terence Tao*
Received 17 September 2015; Published 28 February 2016
Abstract: We show that for any sequence f(1), f(2), ... taking values in {−1, +1}, the discrepancy
sup n,d∈N |Σ_{j=1}^{n} f(jd)|
of f is infinite. This answers a question of Erdős. In fact the argument also applies to sequences f taking values in the unit sphere of a real or complex Hilbert space.
[math.CO] 13 Jan 2017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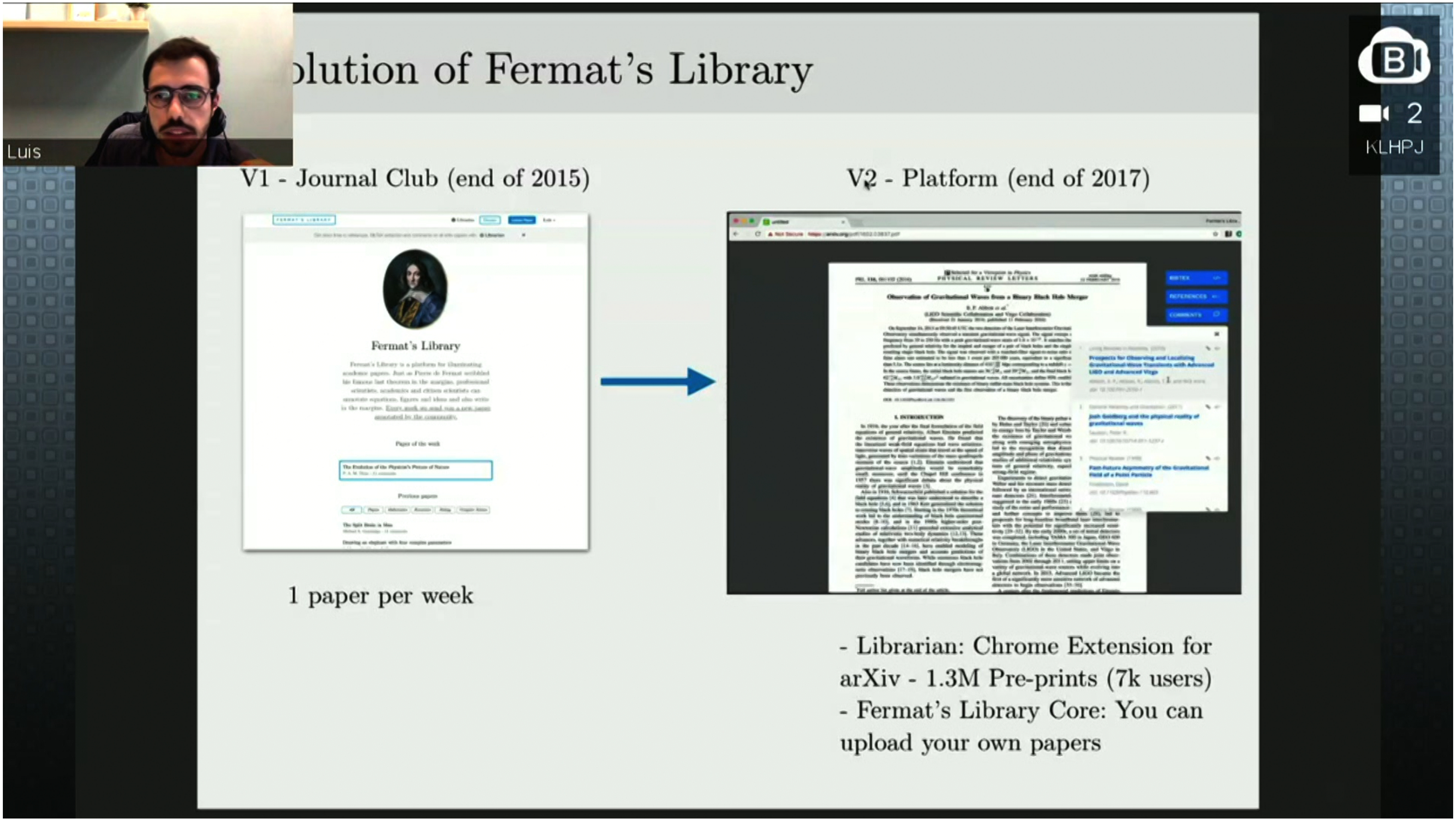
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V2 - Platform (end of 2017)
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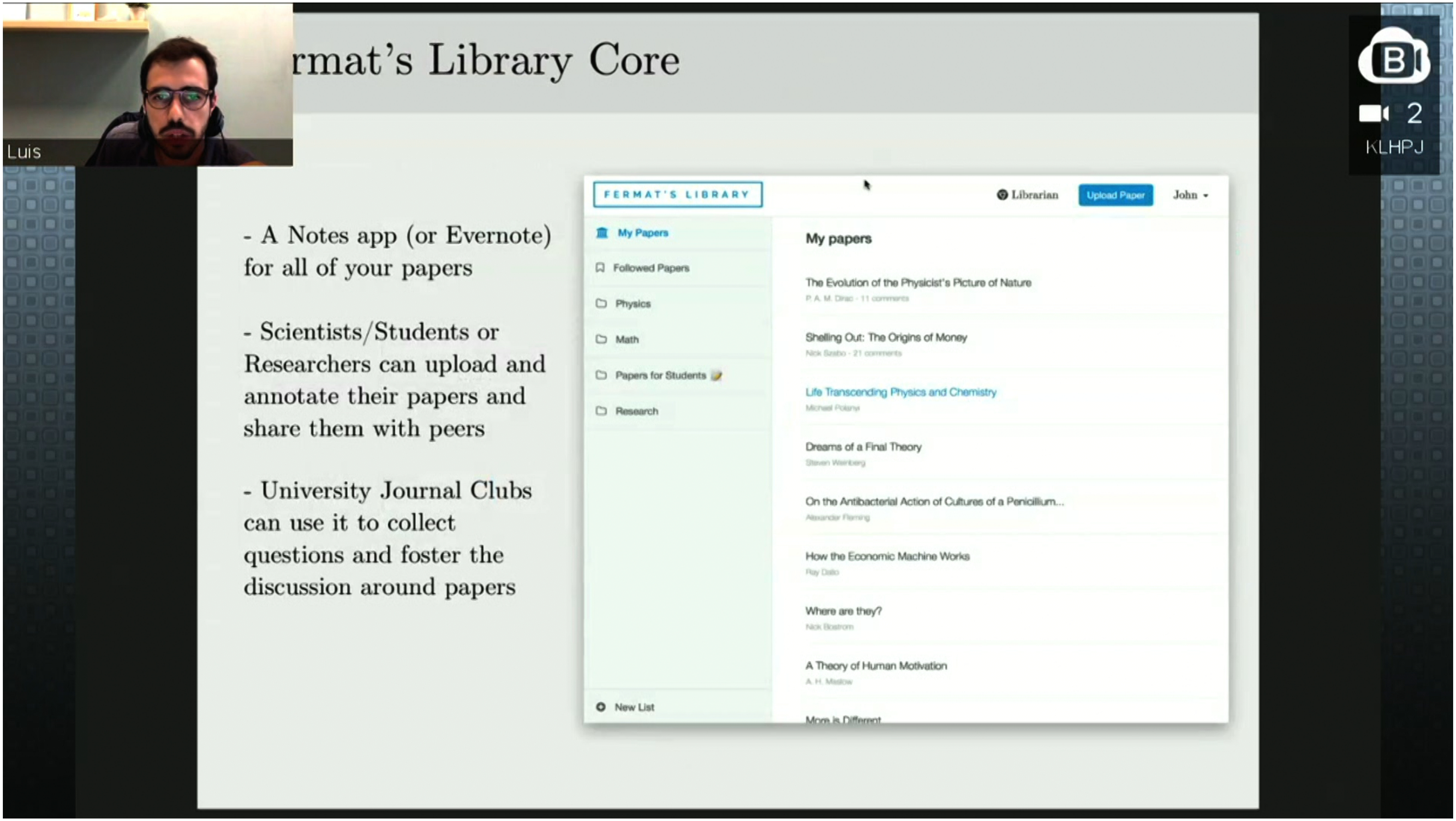
- Fermat's Library Core: You can upload your own papers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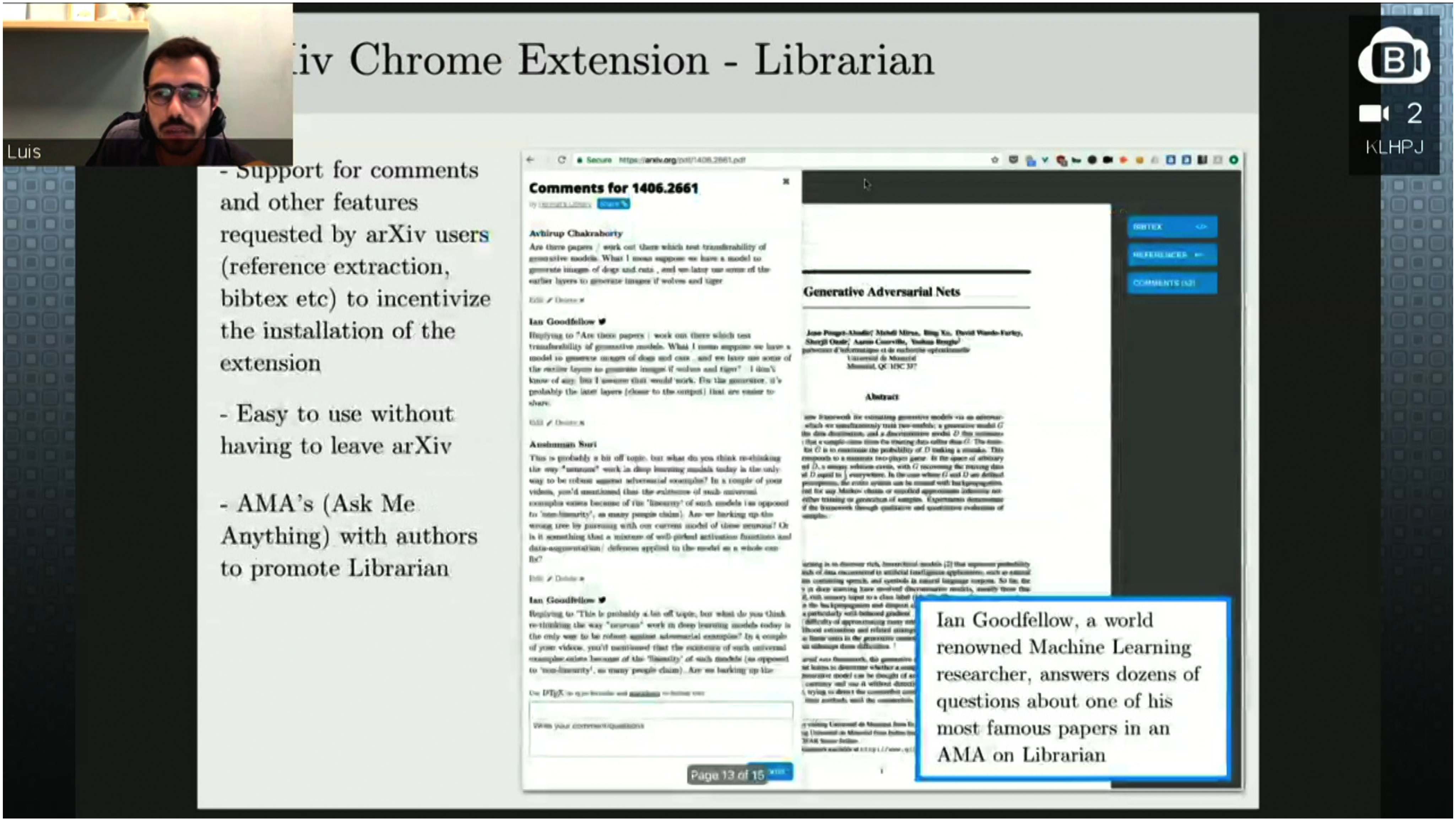
Where are they?
A Theory of Human Motivation
More is Different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Ian Goodfellow, a world renowned Machine Learning researcher, answers dozens of questions about one of his most famous papers in an AMA on Librarian
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uture Perspectives

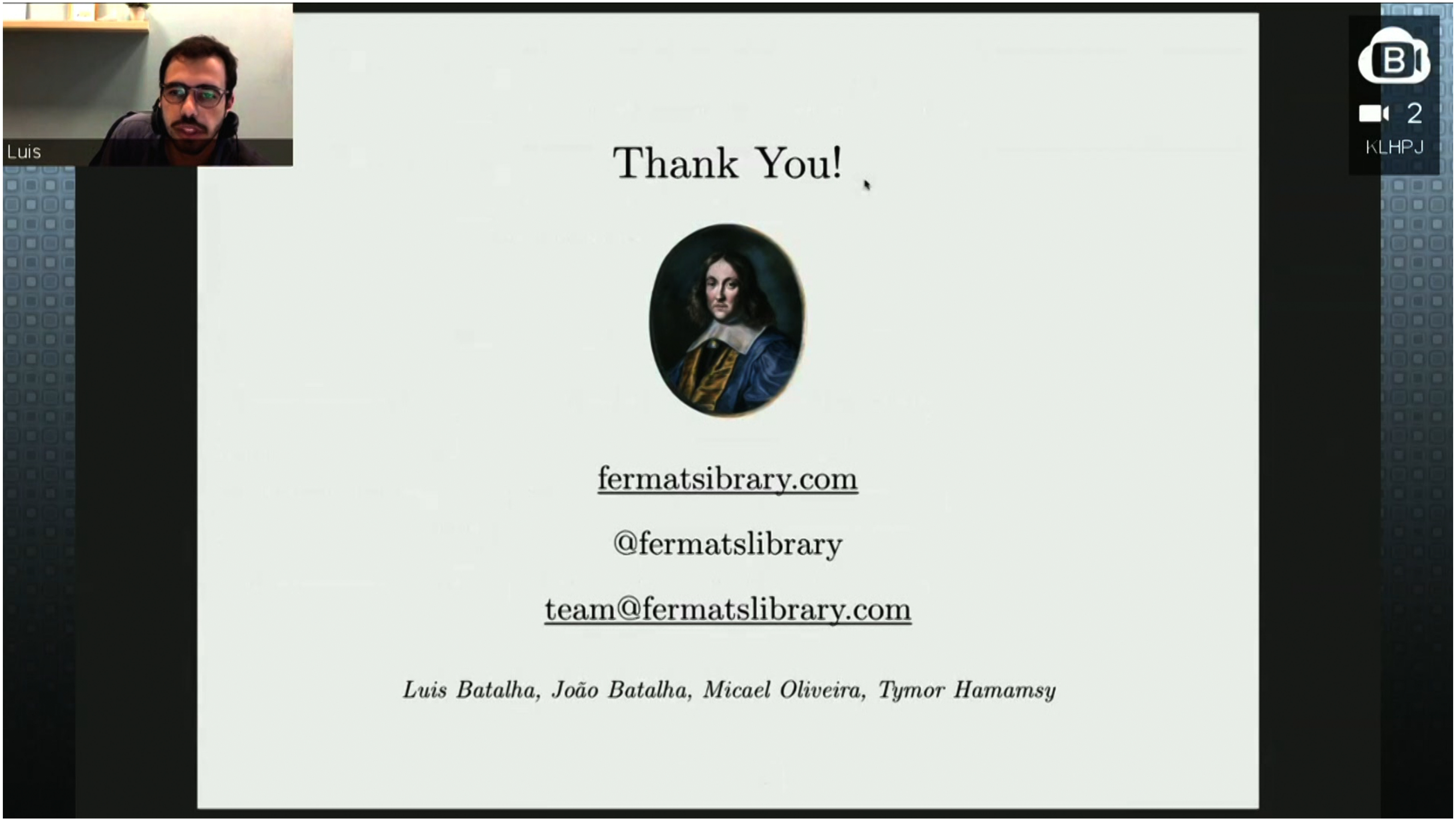
Growth in online collaboration

Open discussion

Open peer review system

Ranking of relevant research

More knowledge sharing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Thank You!
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team@fermatslibrary.com
Luis Batalha, João Batalha, Micael Oliveira, Tymor Hamamsy

Concrete steps - copyleft

- Understand the difference between open access and copyleft; be able to explain it to others