

Political Economy of the Quantum Information Age

Chris Jay Hoofnagle
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Cyberspace and the Law of the Horse

Frank H. Easterbrook†

When he was dean of this law school, Gerhard Casper was proud that the University of Chicago did not offer a course in "The Law of the Horse." He did not mean by this that Illinois specializes in grain rather than livestock. His point, rather, was that "Law and . . ." courses should be limited to subjects that could illuminate the entire law. Instead of offering courses suited to dilettantes,¹ the University of Chicago offered courses in Law and Economics, and Law and Literature, taught by people who could be appointed to the world's top economics and literature departments—even win the Nobel Prize in economics, as Ronald Coase has done.

I regret to report that no one at this Symposium is going to win a Nobel Prize any time soon for advances in computer science. We are at risk of multidisciplinary dilettantism, or, as one of my mentors called it, the cross-sterilization of ideas. Put together two fields about which you know little and get the worst of both worlds. Well, let me be modest. *I* am at risk of dilettantism, and I suspect that I am not alone. Beliefs lawyers hold about computers, and predictions they make about new technology, are highly likely to be false. This should make us hesitate to prescribe legal adaptations for cyberspace. The blind are not good trailblazers.

Dean Casper's remark had a second meaning—that the best way to learn the law applicable to specialized endeavors is to study general rules. Lots of cases deal with sales of horses; others deal with people kicked by horses; still more deal with the licensing and racing of horses, or with the care veterinarians give to horses, or with prizes at horse shows. Any effort to collect these strands into a course on "The Law of the Horse" is doomed to be shallow and to miss unifying principles. Teaching 100

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¹ "[O]ne finds more than a few courses in law schools entitled 'Law and ____' in which the blank is indeed intellectually blank." Michael Tonry and Norval Morris, *Retirement of Sheldon Messinger*, 80 Cal L Rev 310 (1992).

COMMENTARIES

THE LAW OF THE HORSE: WHAT CYBERLAW MIGHT TEACH

Lawrence Lessig*

INTRODUCTION

A few years ago, at a conference on the "Law of Cyberspace" held at the University of Chicago, Judge Frank Easterbrook told the assembled listeners, a room packed with "cyberlaw" devotees (and worse), that there was no more a "law of cyberspace" than there was a "Law of the Horse";¹ that the effort to speak as if there were such a law would just muddle rather than clarify; and that legal academics ("dilettantes") should just stand aside as judges and lawyers and technologists worked through the quotidian problems that this souped-up telephone would present. "Go home," in effect, was Judge Easterbrook's welcome.

As is often the case when my then-colleague speaks, the intervention, though brilliant, produced an awkward silence, some polite applause, and then quick passage to the next speaker. It was an interesting thought — that this conference was as significant as a conference on the law of the horse. (An anxious student sitting behind me whispered that he had never heard of the "law of the horse.") But it did not seem a very helpful thought, two hours into this day-long conference. So marked as unhelpful, it was quickly put away. Talk shifted in the balance of the day, and in the balance of the contributions, to the idea that either the law of the horse was significant after all, or the law of cyberspace was something more.

* Jack N. and Lillian R. Berkman Professor for Entrepreneurial Legal Studies, Harvard Law School. An earlier draft of this article was posted at the Stanford Technology Law Review, <<http://str.stanford.edu>>. This draft is a substantial revision of that earlier version. Thanks to Edward Felten, Deepak Gupta, David Johnson, Larry Kramer, Tracey Meares, Andrew Shapiro, Steve Shapiro, Polk Wagner, and Jonathan Zittrain for helpful discussions on an earlier draft of this essay. Thanks also to the Stanford and Chicago Legal Theory Workshops. Research assistance, much of it extraordinary, was provided by Karen King and James Stahar, and on an earlier draft by Timothy Wu. I expand many of the arguments developed here in a book published this month, *CODE AND OTHER LAWS OF CYBERSPACE* (1999).

¹ See Frank H. Easterbrook, *Cyberspace and the Law of the Horse*, 1996 U. CHI. LEGAL F. 207. The reference is to an argument by Gerhard Casper, who, when he was dean of the University of Chicago Law School, boasted that the law school did not offer a course in "The Law of the Horse." *Id.* at 207 (internal quotation marks omitted). The phrase originally comes from Karl Llewellyn, who contrasted the U.C.C. with the "rules for idiosyncratic transactions between amateurs." *Id.* at 214.

Why quantum is different

- Quantum metrology & sensing
 - See farther, with higher resolution, no voluntariness/awareness of the subject, denial of deception strategies
- Quantum communications
 - Higher strength encryption...yes
 - More importantly awareness of surveillance, quantum teleportation
- Quantum computing
 - Advances in factoring...yes
 - More importantly simulation, ML with continuous variables
 - Reversible ML
 - No cloning = blind quantum computing = intermediary regulation complications

A not unlikely scenario

- My draft is a “political economy” because it focuses so much on who can get quantum, when, and how they are likely to use it
- Governments develop general purpose quantum computers before others and
 - They enjoy stronger encryption than anyone else
 - They can deny/degrade others’ encryption
- Governments develop quantum sensing abilities to
 - Detect weapons under clothing (the 4th A-free contraband detector)
 - See into private spaces (think Kyllo), from remote platforms (satellite based)

Why now?

- China & EU investment
 - Leapfrog over U.S.
 - U.S. response: \$1.2bn authorized
- Tech fundamentals
 - Commercial products can produce quantum effects
 - Some quantum effects do not require supercooling

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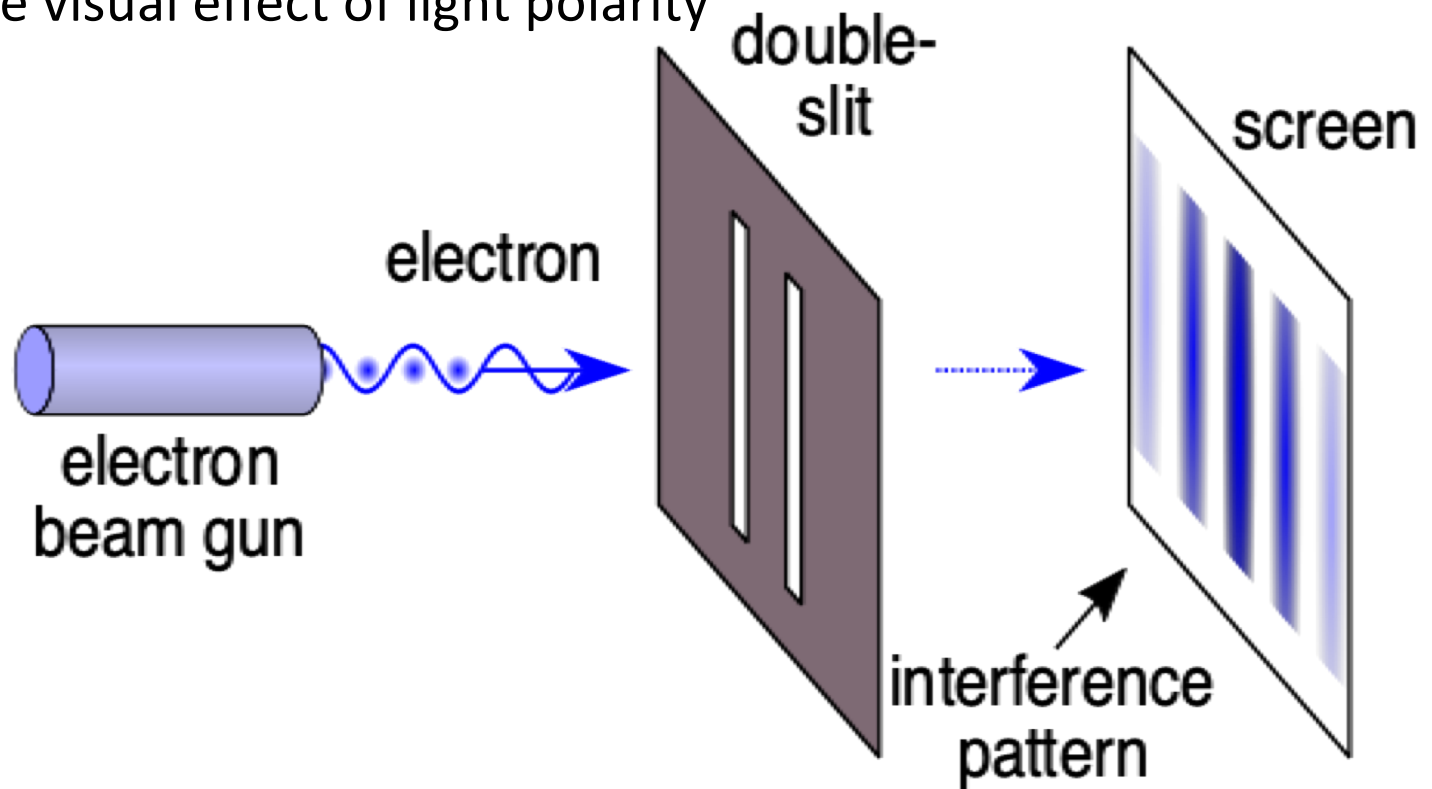


Quantis RNG OEM component

- ▶ Highly resilient to environmental perturbations
- ▶ Designed for mounting on PCB for embedded systems
- ▶ Instant entropy with high bit-rate of 4Mbits/sec
- ▶ Affordable, compact and reliable
- ▶ Uses quantum optic process to create true quantum randomness

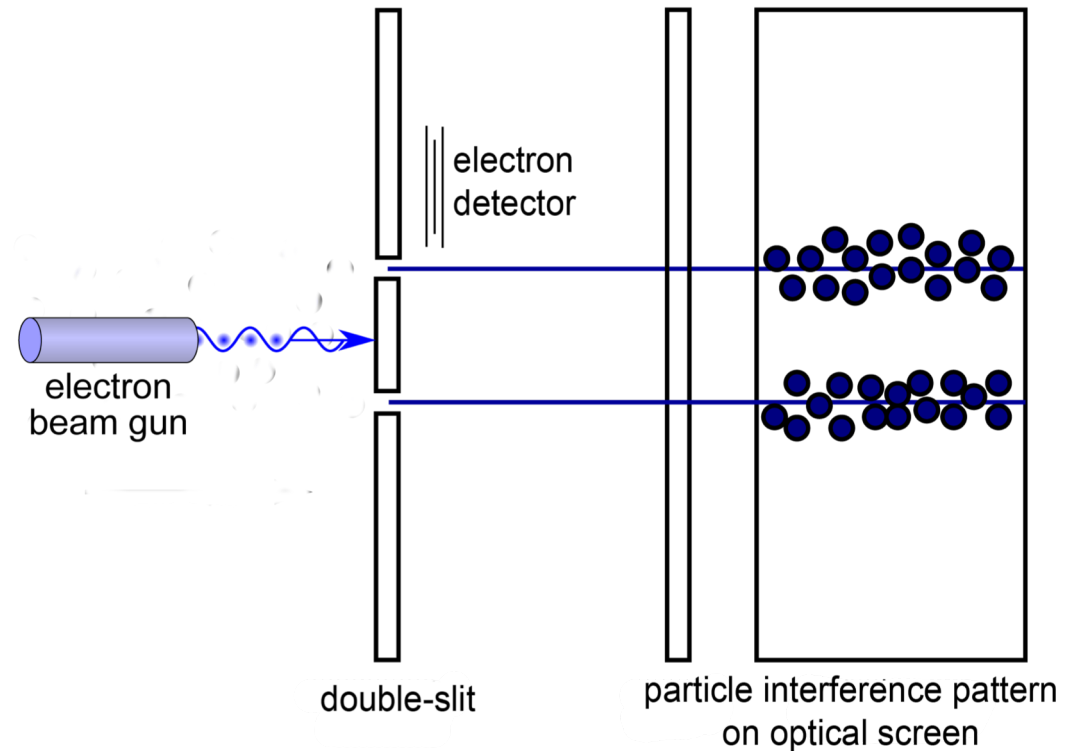
Quantum effects not quantum marketing

- Easy to reproduce visual effect of light polarity
- Superposition
- No-cloning
- Entanglement



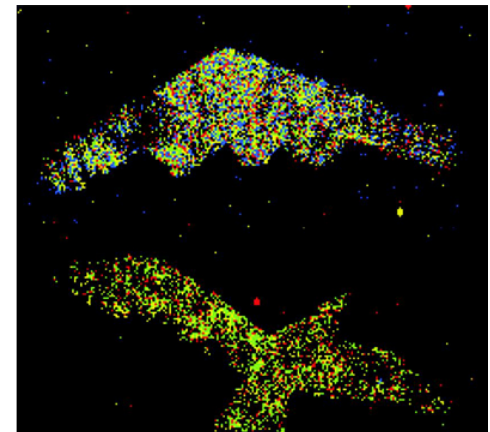
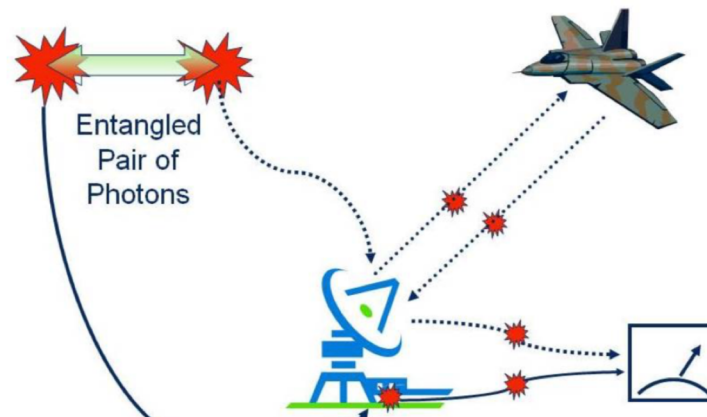
Quantum effects not “quantum...”

- Easy to reproduce visual effect of light polarity
- Superposition
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Sensing & metrology

- Most commonly rely on quantum entanglement and superposition
- Some do not require supercooling
- Electronic warfare driven
- Quantum radar/sonar, ghost
- SIGINT > MASINT



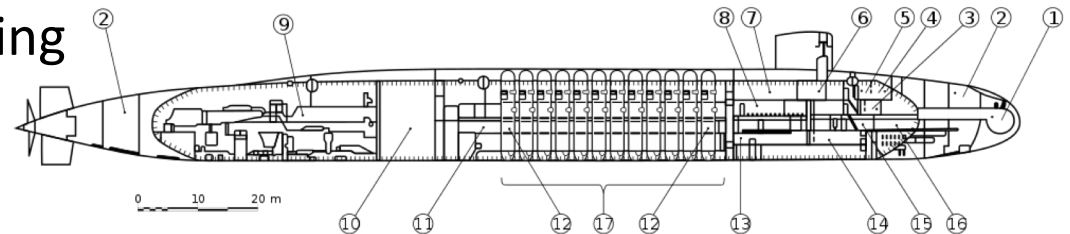
Charting a New Course: Celestial Navigation Returns to USNA

Story Number: NNS151015-27 Release Date: 10/15/2015 3:34:00 PM



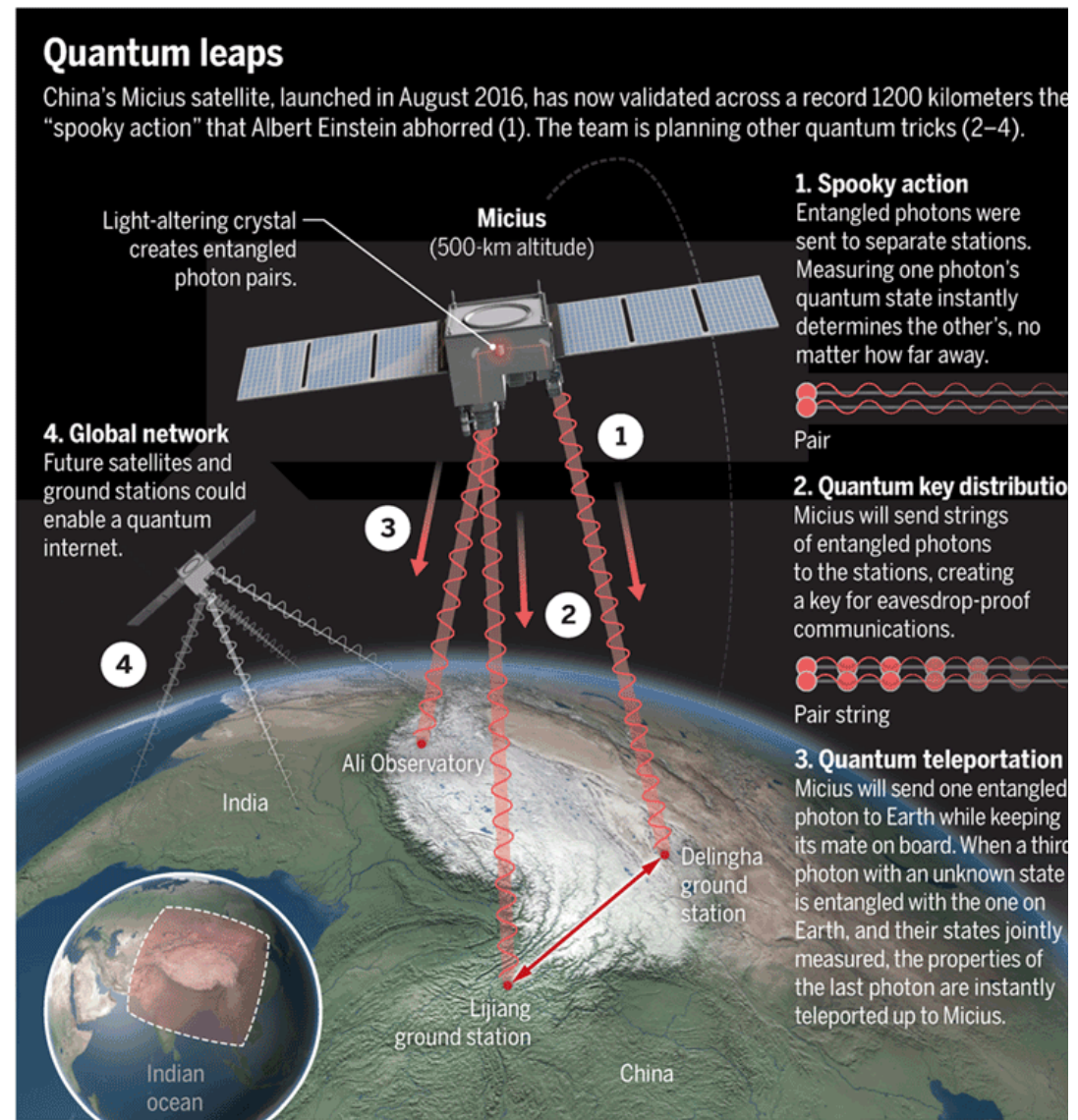
By Lt. j.g. Devin Arneson, U.S. Naval Academy Public Affairs

ANNAPOLIS, Md. (NNS) -- Picture this: A naval vessel is navigating the high seas thousands of nautical miles from land. Suddenly all navigation systems become inoperable. What happens next? What does this mean?



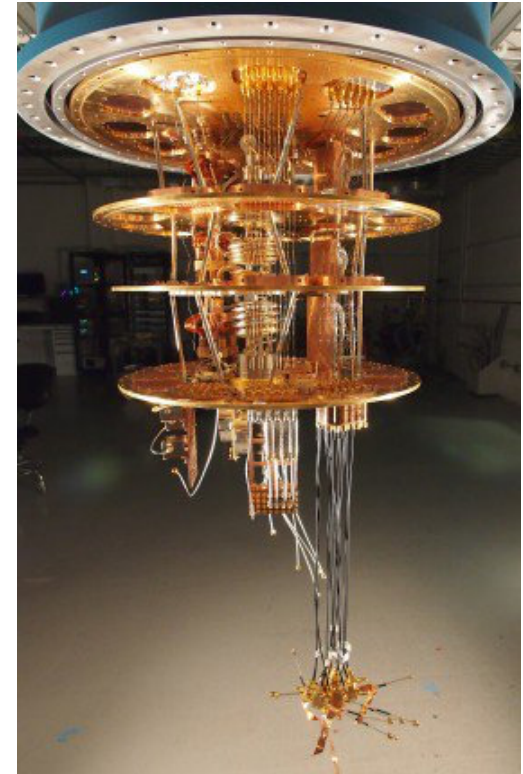
Quantum coms

- Relies on entanglement, no cloning
- Most consequential developments:
 - Awareness of eavesdropper
 - Where communications “take place” (quantum teleportation)
 - QNG & QKD = stronger encryption
- Fundamental problem with repeaters—they are not quantum devices, thus, coms must be “repeated” classically
 - No problem for China, much of Europe!



Quantum computing

- Simulation, analog (annealing), NISQs
- State of the art in factoring
 - 20-bit number using Dwave annealer
 - 768-bit number using classical computers
 - NAS: RSA collapse not likely in the next decade
 - Google: to factor a strong key in a day, “would take 100 million qubits, even if individual quantum operations failed just once in every 10,000 operations.”
- Current NISQs will not scale to general purpose computers
 - Significant minority warns of quantum winter
- Realistic uses (not your CC#s)



Countermeasures

- There are always countermeasures
- D5: disruption, denial, degradation, destruction, and deception
- Noise
- Weather
- Light
- ASAT...



Research agenda

- Highest level: a number of technologies are eroding autonomy in important ways. Where should we be concerned? What might we do?
 - Political economy: what if quantum is limited to IC? LEA? Non-LEA agencies? Companies? Citizens?
 - Political philosophy level questions: Zuboff: who knows, who decides who knows
 - What will quantum governance require?
 - Secrecy & oversight considerations—who practically can understand, regulate?
 - Scott (Seeing Like a State): liberal economic order, private sphere, civil society
 - Consumer law: how will quantum alter the seller/consumer balance of power?
 - Property: will quantum erode fundamental property rights?
 - Contract: will quantum enable guile/opportunism?

Research agenda continued

- Strategic considerations
 - Is quantum destabilizing?
 - How will quantum change conflict (ASAT, submarine)
 - Space law questions
 - How will quantum change intelligence
- Industrial policy
 - Openness, immigration, innovation
- Law enforcement
- Quantum & the environment
 - Gravimetric sensing = more mining & extraction?
 - OTOH, more efficient extraction + simulation of energy intensive processes



Figure1: schematic diagram of the airborne Superconducting FTMG system.

Research agenda continued

- Economic
 - What are quantum's capital costs?
 - How will it be affected by network effects?
- Quantum and privacy
 - Ban decryption?
 - Start requiring deletion
 - Start requiring 2048+ keys
- Quantum ML
 - Procedural fairness: reversibility
 - Substantive fairness
 - Tensions sounding in 1st Amendment “freedom to observe and understand the world” and practically regulating conduct from those learnings