FROM THE DESK OF
CHARLES L. HARPER JR.

Jeffrey Epstein (18 pages)
(Via e-mail: jeevacation@gmail.com)

November 4, 2010

Dear Jeffrey:

Thank you for a request for a proposal to support my activity to develop the *"Cryptography in Nature"* project you have envisioned.

I have delayed a few days in preparing a proposal to you. I have been engaging in some depth in the topical material, pursuing various ideas and leads. Especially I have wanted to identify exciting emerging talent by my own "talent scouting" rather than operate from the (excellent) list of names I have already from Scott Aaronson and Seth Lloyd. This in part has had to do with an interest to explore areas where work in cryptography has deeply engaged biology and has also involved experimental discoveries and agendas.

The development in 1994 of *DNA computation* theory and experiment by the polymath and cryptographer Leonard M. Adelman initiated the rapidly expanding field of molecular computation. From the start, this area of cross-disciplinary research has engaged deep issues in cryptography. Indeed, it deeply engages the P versus NP question, the deepest unresolved fundamental issue in basic computer science and cryptography today.

Recently some related and surprising new results have arisen in the study of photosynthesis, where the first clear effects in "quantum biology" have been measured quite strikingly. These relate to issues in evolution, quantum computation and chemical simulation using (futuristic) quantum computers. Also, the study of protein-folding interestingly connects deep issues in computer science with the topical area of biomolecular computation. I have wanted to get my teeth into some of these and related research agendas before writing the proposal to you. Though brief in terms of time expended, my initial findings are very encouraging.

By engaging in this rapid research, I also have wanted to clarify and refine core ideas. The topic you have put forward is a fascinatingly deep and difficult which engages major unsolved problems in computation and biology.

I have identified a number of outstanding young research leaders. These are very exciting first-rate people, A small subset of these, I think, might mix-in very creatively with those nominated by our (prospective co-chairs) Scott and Seth.

One of my concerns has been to avoid gathering together a number of already closely-connected research colleagues linked with MIT. One expects the lists of names I've obtained from them to have that bias to some degree. My focus therefore has been to identify very-high-talent young innovators who are more engaged on the molecular biochemistry and bioengineering side, compared to the pure computer science and quantum computational physics sides, which I expect to be well covered by our prospective co-chairs.

Following this logic, in this document, I provide information in this document on eight candidates working in computer science interfacing with computational molecular biology. These represent the most interesting people I have 'discovered' from a longer list of recently-researched people I have been investigating. The eight I am excited to let you know something about here are:

Yaakov Benenson (ETH, Zurich-Basel)

Alan Aspuru-Guzik (Harvard)

Mohan Sarovar (UC Berkeley)

Peng Yin (Harvard)

Radhika Nagpal (Harvard)

David Soloveichik (CalTech)

Erik Winfree (University of Washington)

Gregory D. Scholes (Toronto)

Some details on each person are provided below., pages 5-13.

I hope you will find these explorations in talent-scouting to be interesting, as I am aware that you are an outstanding talent scout yourself, and are well-know in science for this gift combined with an extraordinary philanthropic generosity to support gifted people creating deep innovations.

Practical maters and budgets appear on page 14 of this document.

Please let me know if you'd like me to follow-up this document with a quick visit. Do not hesitate to call. I'll be doing another project proposal for a client on Friday, but can be available to catch a train to NYC or a plane to Florida on relatively short notice.

Thank you again.

Yours with gratitude for choosing such a deep and fascinating topic and challenge!

Charles Harper

PROJECT DISCUSSION

Some keys to enhance success in developing the project:

My expectation is that some keys to enhance success in developing the project will be to:

-- have a clearly focused set of up one two or three catalyst-focus-challenge questions. at the core of the project. (This for me is a core aspect of the project which will take some time to get just right. For now, I have a set of useful "vectors" in the right direction from discussions with Scott and Seth.)

--bring together extremely bright people crossing boundaries in such a way as to open up possibilities for catalytic networking and cross-fertilization of research agendas.

--be sure to choose a strong proportion of relatively young emerging talent.

--develop philanthropic incentives adjunct to the meeting in order to promote optimal preparation for innovative cross-fertilization of ideas and agendas within the group.

--structure the location and time-plan of the meeting to allow for lots of unstructured time involving some fun activities to allow people to mix & mingle and have unstructured time to discuss ideas together.

A key aspect if success in developing the meeting will be to generate strong interest, excitement and attraction to people who might otherwise be deterred by risks. Anniversaries and celebratory occasions can be excellent 'motivators' and agenda-suspicion-diffusers for high-level academics. They tend very much to enjoy celebration of special accomplishments in the development of their fields of expertise, as well as personal opportunities to honor field founders and field leaders. Therefore I have identified the following significant and variously appropriate scientific anniversaries for the project for a meeting in 2011.

Field-forming landmarks:

i) 75 years since Turing's 1936 paper, *"On computable numbers, with an application to the Entcheidung problem."* This paper was a key inspiration towards the future work of Claude Shannon creating modern cryptographt via his collaboration with Alan Turing at Bletchley Park during WWII. (see: http://en.wikipedia.org/wiki/Claude_Shannon)

ii) 55 years since Kurt Gödel's 1956 letter to John von Neumann first raising the *P versus NP problem.* (See: http://rjlipton.wordpress.com/the-gdel-letter/ Also Lipton's new book: The P=NP Question and Gödel's Lost Letter.)

iii) 40 years since the specific 1971 formalization of the *P vs. NP problem* via 'Cook's theorem' in Stephen A. Cook's seminal paper: *"The complexity of theorem-proving procedures."* (http://4mhz.de/cook.html)

iv) 35 years since the seminal 1976 paper of Whitfield Diffie & Martin Hellman which proposed basic ideas in modern cryptography which in the same year stimulated a joint research effort at MIT by Ron Rivest, Adi Shamir and Leonard Adelman, and which lead two years later in their development of the widely-used RSA (Rivest-Shamir-Adleman) cryptosystem. (See: http://en.wikipedia.org/wiki/RSA http://en.wikipedia.org/wiki/Diffie–Hellman_key_exchange http://people.csail.mit.edu/rivest/Rsapaper.pdf and http://www.msri.org/people/members/sara/articles/rsa.pdf)

v) 30 years since Feynman's famous 1981 lecture at MIT, *"Simulating Physics with Computers,"* where the idea of a quantum computer was

initially introduced. (See: http://www.wisdom.weizmann.ac.il/~naor/COURSE/feynman-simulating.pdf) NB: Appropriately, Scott Aaronson was born in 1981 ! (See below.)

Birthday connections:

iv) Also, the pioneer of the field of molecular computing, and inventor of both DNA computing and the RSA cryptosystem, Leonard M. Adelman of USC, was born on December 31st, 1945. 2011 would be his 65th birthday year. This offers an opportunity for celebration.

v) Also, Scott Aaronson was born on May 21st, 1981. He will be 30 in 2011. The conference could follow a theme of: "hurry to think together with Scott Aaronson while he is still in his 20s and not yet a pitiful over-the-hill geezer in his 30s") This offers another nice opportunity for celebration.

NB: The year 2011 also marks 95 years since the birth and 10 years since the death of Claude Shannon, ---the 'father' of information theory and modern cryptography.

BRIEF DESCRIPTIONS OF THE RECENTLY RESEARCHED EIGHT PERSONS ON MY NEW LIST, FOCUSED IN THE AREA OF BIOMOLECULAR COMPUTATION

(ADDITIONAL TO THE ~20 NAMES I HAVE FROM MEETINGS WITH SCOTT AARONSON AND SETH LLOYD).

1. Yaakov Benenson (ETH, Zurich-Basel)

Yaakov Benenson is a brilliant and hugely innovative protege of Ehud Shapiro at the Weizmann Institute. He has pioneered a number of new approaches in molecular biological computation. His publishing and placement

record is outstanding. The nature of his work is apparent in the following titles from a selection of his research publications:

Programmable and autonomous computing machine made of biomolecules. (Nature 2001)

DNA molecule provides a computing machine with both data and fuel. (PNAS 2003)

Molecular computing machines
(Dekker Encyclopedia of Nanoscience and Nanotechnology. 2004)

An autonomous molecular computer for logical control of gene expression. (Nature, 2004)

Bringing DNA computers to life: Tapping the computing power of biological molecules gives rise to tiny machines that can speak directly to living cells. (Scientific American 2006)

Biocomputers: from test tubes to live cells.
(Mol. Biosyst. 2009)

RNA computers in live cells: results and prospects.
(Curr. Opin. Biotechnol. 2009)

Logic integration of mRNA signals by an RNAi-based molecular computer. (Nucleic Acids Research 2010)

Rationally designed logic integration of regulatory systems in mammalian. cells (Nature Nanotechnology 2010)

A quotation of particular interest to me was in his bio of the Harvard Systems Biology website: *"We also hope, through this work, to uncover fundamental principles pertaining to information processing by living systems, in much the same way as the development of a steam engine led to the foundation of thermodynamics."*

Benenson recently was appointed to an ETH professorship (resident in a new European bioengineering research complex based in Basel). See his ETH bio here: http://www.bsse.ethz.ch/research/Professors/benenson_cv

Also, see his recent Harvard Systems Biology "Bauer Fellows" program bio here: http://sysbio.harvard.edu/csb/research/benenson.html

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http://www.systemsbiology-phd.ethz.ch/research/index
(E-mail: kobi.benenson@bsse.ethz.ch)

2004 Technology Review 100 recognition at age 28:
http://excellence.technion.ac.il/Excellence/UploadFiles/pgallery/0843521876.jpg

2. Alan Aspuru-Guzik (Harvard)

Alan Aspuri-Guzik (age 34) is an astonishingly gifted young professor in Harvard's Department of Chemistry and Chemical Biology. He recently was honored by Technology Review as one of this year's "young investigators under 35." His research is focused on quantum computation, chemical simulation, photosynthesis, and the challenge of developing artificial photosynthesis. His impressive activity is apparent from the following selection of his research's group's papers, *quite amazingly all from 2010* (from: http://aspuru.unix.fas.harvard.edu/Publications/):

Modified-scaled hierarchical equation of motion approach for the study of quantum coherence in photosynthetic complexes.

Characterization and quantification of the role of coherence in ultrafast quantum biological experiments using quantum master equations, atomistic simulations, and quantum process tomography

Simulating chemistry using quantum computers

Quantum process tomography via photon echo experiments .

Simulation of Classical Thermal States on a Quantum Computer: A Renormalization Group Approach

General Bound on the Rate of Decoherence.

Theory of Excitation Broadening using Time-Dependent Density Functional Theory for Open Quantum Systems.

Adiabatic Quantum Simulators

Quantum Computing Resource Estimate of Molecular Energy Simulation,

Separation of electromagnetic and chemical contributions to surface-enhanced Raman spectra on nanoengineered plasmonic substrates .

A study of heuristic guesses for adiabatic quantum computation.

Optical Absorption and Emission Properties of End-Capped Oligothienoacenes: A Joint Theoretical and Experimental Study.

Förster Coupling in Nanoparticle Excitonic Circuits.

Accelerating correlated quantum chemistry calculations using graphical processing units.

Failure of Conventional Density Functionals for the Prediction of Molecular Crystal Polymorphism: A Quantum Monte Carlo Study.

Discrete single-photon quantum walks with tunable decoherence.

Engineering directed excitonic energy transfer

Quantum Process Estimation via Generic Two-Body Correlations

Theoretical Characterization of the Air-stable, High-mobility Dinaphtho[2,3-b:2'3'-f]thieno[3,2-b]-thiophene Organic Semiconductor

Quantum stochastic walks: A generalization of classical random walks and quantum walks.

Towards Quantum Chemistry on a Quantum Computer.

Time-Dependent Density Functional Theory for Open Quantum Systems with Unitary Propagation.

Accelerating correlated quantum chemistry calculations using graphical processing units and a mixed-precision matrix multiplication library

3. **Mohan Sarovar (UC Berkeley)**

Mohan Sarovar is a phyicist specializing in quantum computation working in two research groups in the Berkeley Department of Chemistry, both doing research on the quantum mechanics of light harvesting in photosynthesis. His research activity can be seen from titles of some of the following of his research papers (from: http://www.cchem.berkeley.edu/kbwgrp/mohan/Site/Welcome.html and http://www.cchem.berkeley.edu/kbwgrp/mohan/Site/Welcome_files/sarovar_cv.pdf):

Environmental correlation effects on excitation energy transfer in photosynthetic light harvesting.

Stroboscopic generation of topological protection.

Quantum entanglement in photosynthetic light harvesting complexes. (Nature Physics 2010).

Limits of quantum speedup in photosynthetic light harvesting.

Complete characterization of mixing time for the continuous quantum walk on the hypercube with Markovian decoherence

Optimal quantum multiparameter estimation as applied to dipole- and exchange-coupled qubits.

Quantum non-demolition measurements of single spins in semiconductors.

Adaptive homodyne phase discrimination and qubit measurement.

Optimal estimation of one parameter quantum channels.

High fidelity measurement and quantum feedback control in circuit QED.

Continuous quantum error correction by cooling.

Quantum control and quantum error correction.

Practical scheme for error control using feedback.

4.Peng Yin (Harvard)

Peng Yin is a recently appointed core faculty member in Harvard's new (and VERY impressive) Wyss Institute for Biologically Inspired Engineering. where he runs a group including several post-doctoral research fellows. He is a computer scientist who worked in Reiff's group at Duke and at CalTech in Erik Winfree's group. His webpage is: http://www.ist.caltech.edu/~py/ His research activity is, "at the interface of information science, molecular engineering, and biology. The current focus is to engineer information directed self-assembly of nucleic acid (DNA/RNA) structures and devices, and to exploit such systems to do useful molecular work, e.g. probing and programming biological processes for imaging and therapeutic applications." Some key publications:

Programming Biomolecular Self-Assembly Pathways. (Nature 2008)

Programming DNA Tube Circumferences. (Science 2008)

A Unidirectional DNA Walker That Moves Autonomously Along a Track.

A Self-Assembly Model of DNA Tiles with Time Dependent Glue Strength.

Complexity of Graph Self-Assembly in Accretive Systems and Self-Destructible Systems.

Compact Error-Resilient Computational DNA Tiling Assemblies.

Theoretical and Practical Advances in Genome Halving.

A Direct Linkage Between the Phosphoinositide 3-Kinase-AKT Signaling Pathway and the Mammalian Target of Rapamycin in Mitogen-Stimulated and Transformed Cells

Lower Bound for Sparse Euclidean Spanners.

5. Radhika Nagpal (Harvard)

Radhika Nagpal is a Professor of Computer Science at Harvard and also is a core faculty member of the Wyss Institute. Her specialization is in self-organizing systems and collective "swarm" robotic systems. Her webpage is: http://www.eecs.harvard.edu/~rad/ Her research group works in three areas:

- **Bio-inspired Multi-agent Models and Theory**
  We explore artificial multi-agent models inspired by self-organising and self-repairing behavior in developmental biology. We are especially interested in global-to-local compilation and theory, i.e. how user-specified global goals can be translated into local agent interactions and how one can reason about the correctness and complexity of agent rules. Our goal is to show how biological design principles can be formally captured, generalized to new tasks, and theoretically analyzed.

- **Bio-inspired Distributed Systems in Robotics and Sensor Networks**
  We study bio-inspired approaches for programming embedded systems that rely on large numbers of relatively cheap and simple agents, e.g. reconfigurable modular robots, swarm robotics, and sensor networks. We design, analyze, and implement decentralized algorithms and use these as the basis for global-to-local compilers that provably achieve wide classes of user-specified global goals. We also build prototype robot systems using inspira-

tion from biology, e.g. self-adapting modular robots and insect-inspired mobile robots, that implement the algorithmic ideas.

- **Multi-cellular Systems Biology**
  We develop mathematical and computational models of cell behavior to investigate how system-level properties emerge in multicellular development. Our goal is to elucidate the relationship between local cell programs and global tissue-level outcomes during development and disease. This work is in close collaboration with experimental biologists, and most of our current work is focused on epithelial tissues and fruit fly development.

Her research papers for 2010 include:

Distributed Colony-Level Algorithm Switching for Robot Swarm Foraging

Two Foraging Algorithms for Robot Swarms Using Only Local Communication

A Self-Adaptive Framework for Modular Robots in Dynamic Environment: Theory and Applications

Positional Communication and Private Information in Honeybee Foraging Models

Biologically-Inspired Control for Multi-Agent Self-Adaptive Tasks

Collective Decision-Making in Multi-Agent Systems by Implicit Leadership

Coordinating Collective Locomotion in an Amorphous Modular Robot

KiloBot: A Robotic Modules for Demonstrating Collective Behaviors

Mechanical Design and Locomotion of Modular-Expanding Robots

6. David Soloveichik (University of Washington)

David Soloveichik is a postdoc at the University of Washington and was recently a research fellow at CalTech in the Natural Computation Group under the direction of Erik Winfree (see below). Some of his publications are (from: http://www.dna.caltech.edu/~davids/CV.pdf):

DNA as a Universal Substrate for Chemical Kinetics

Signal Propagation and Propagation Delays in Molecular Circuits

Statistical Learning of Arbitrary Computable Classifiers

Programmability of Chemical Reaction Networks

Robust Stochastic Chemical Reaction Networks and Bounded Tau-Leaping Computation with Finite Stochastic Chemical Reaction Networks

Combining Self-Healing and Proofreading in Self-Assembly

Complexity of Self-Assembled Shapes

Enzyme-Free Nucleic Acid Logic Circuits

Complexity of Compact Proofreading for Self-Assembled Patterns

The Computational Power of Benenson Automata

7. Erik Winfree (CalTech)

Erik Winfree is Professor of Computer Science, Computation and Neural Systems and Bioengineering at CalTech, where he directs the "DNA and Natural Algorithms Group." (See: http://www.dna.caltech.edu/~winfree/ and http://en.wikipedia.org/wiki/Erik_Winfree) He was awarded a McArthur "genius" fellowship in 2000. His publications are listed here: http://www.dna.caltech.edu/DNAresearch_publications.html
He was recognized by Technology Review as a YEAR TR35 innovator-honoree in 1991 at the age of 30. (See: http://www.technologyreview.com/tr35/Profile.aspx?Cand=T&TRID=517)

8. **Gregory D. Scholes (Toronto)**

Greg Scholes is a Professor in the University of Toronto's Department of Chemistry where he works on the quantum mechanics of photosynthesis. (See: http://www.chem.utoronto.ca/ppl/faculty_profile.php?id=59 and http://www.chem.utoronto.ca/staff/SCHOLES/scholes_home.html)

For interesting coverage of his recent research results in WIRED magazine, see: www.wired.com/wiredscience/2010/02/quantum-photosynthesis/

Recent publications include:

Quantum-coherent electronic energy transfer: Did Nature think of it first?"

Coherently wired light-harvesting in photosynthetic marine algae at ambient temperature. (Nature 2010)

Coherent dynamics in resonance energy transfer at room temperature: Quantum-mechanical energy migration along MEH-PPV chains.

Quantum coherent energy migration in a conjugated polymer at room temperature (Science 2009).

The following proposal provides specifics on tasks, time and budgeting.

PROPOSAL

To develop a very-high-dynamism two-day research meeting involving about 8-10 researchers (plus perhaps up to about 4 observers) focused on the theme:

"Cryptography in nature"

with a goal to explore, frame and inspire new deep innovation agendas. The project includes developing practical options for developing post-meeting strategic research sponsoring opportunities.

WORK TASKS:

To develop the:

-- key advance work by making a few visits to interact w potential invitees & to consult with a few senior figures to refine ideas.

-- strategic 'framing' of the meeting, including the vision and role of the supporting donor and communication of potential future opportunities arising from the interactions.

-- topical focus details for the meeting

-- arrangements/agreements with the meeting chairs

--date, location, time plan and special activities schedule

-- large invitation list and descriptions for deliberation to finalize

-- attractive description of the meeting, appended with invitations

--correspondence management with invitees

-- communication to the whole group of carefully selected research portfolios of each participant for pre-meeting preparation.

-- pre-meeting e-exchange discussions based on the above distribution of information and effort to generate discussion interest across disciplines and expertise.

--follow-up strategies for possible new philanthropic agendas arising from insights gained and relationships developed via this project.

Also, to play the role of meeting manager representing the donor at the event and to "meet, greet & troubleshoot, etc."

To be available to vector attendees with any what-to-do issues regarding re-imbursement via Jeffrey Epstein's operations if/as needed.

PROJECT MANAGEMENT DIRECT BUDGET

(For a high-intensity *very high quality* effort involving active VIP recruiting and extensive pre-meeting focusing and participant-interaction development.)

Time estimate: 6 weeks FTE preparation effort + direct meeting activity time (~5 days) + follow-up strategy development (~5 days).

Total: 8 weeks
Fee: $90,000

Payable in 3 equal amounts:

a) upon initiation of the project.

b) post- 6 weeks from project initiation (est. Year end 2010)

c) 30 days post the meeting.

Expenses (research expenses + travel + supplies): **Limited to $10,000**

Payable upon project initiation.

Unspent expenses to be deducted from final payment.

Pre-meeting networking and ideas engagement:

Offer $2,000 each to three attendees to engage in leading group pre-meeting serious-level preparatory discussions.

Total: $6,000

Extra fee for co-chairs: $1,000 each: Total: $2,000

Total: $8,000

DIRECT MEETING EXPENSES:

Not included in this budget. T&L and activities at the meeting would be covered directly by Jeffrey Epstein's people.

(unless requested otherwise.)

The question of honoraria (say, $1K to participants) is undecided. I suggest that $1,000 honorarium be paid to each attendee who writes-up substantial remarks and distributes then 14 days prior to the meeting. Total for ~10 persons: $10,000)

BUDGET SUMMARY:

Planning management & running:	$100,000
Contingent honoraria (suggested only):	$10,000
Pre-meeting exchange:	$6,000
Extra for co-chairs:	$2,000
Meeting T&L & special events:	TBD
Total:	**$118,000 + Meeting T&L & special events**

Appendix: Brief discussion of some

POSSIBLE POST-MEETING PROJECT OPTIONS & BUDGETS

#1: A small-scale follow-up aimed at the identification of hot young emerging talent and ideas:

Possible post-conference essay contest via the FQX network

(if Max Tegmark agrees. Max would be invited to, and warmly welcomed to the meeting as an expert-observer).

Use a small session in the meeting to refine the set question or questions for the contest.

Prizes (3): 1st: $15,000; 2nd: $10,000; 3rd: $5,000	Total: $30,000
Overhead to the FQX program:	$25,000
Total expense:	$45,000

(This can be done with or without management oversight by Charles Harper)

#2: Developing one or more serious-scale follow-up research grants programs.

Some basic options are:

-- invest substantially in one to a few researchers in the same modality as with Martin Nowak (which seems to have been a huge success)

-- run an open international grants competition

-- add-on a new module expansion into the FQX program

--add-on a new module expansion to Martin Nowak's group

-- develop an entirely new institute with a hyper-ambitious vision (as in the very interesting and very well negoti ated case of the Wyss Institute at Harvard