

LOOK OUT BELOW!

COMPUTING ON THE SMALL SCALE

TRAVIS L SCHOLTEN

CENTER FOR
COMPUTING RESEARCH
SANDIA NATIONAL
LABORATORIES

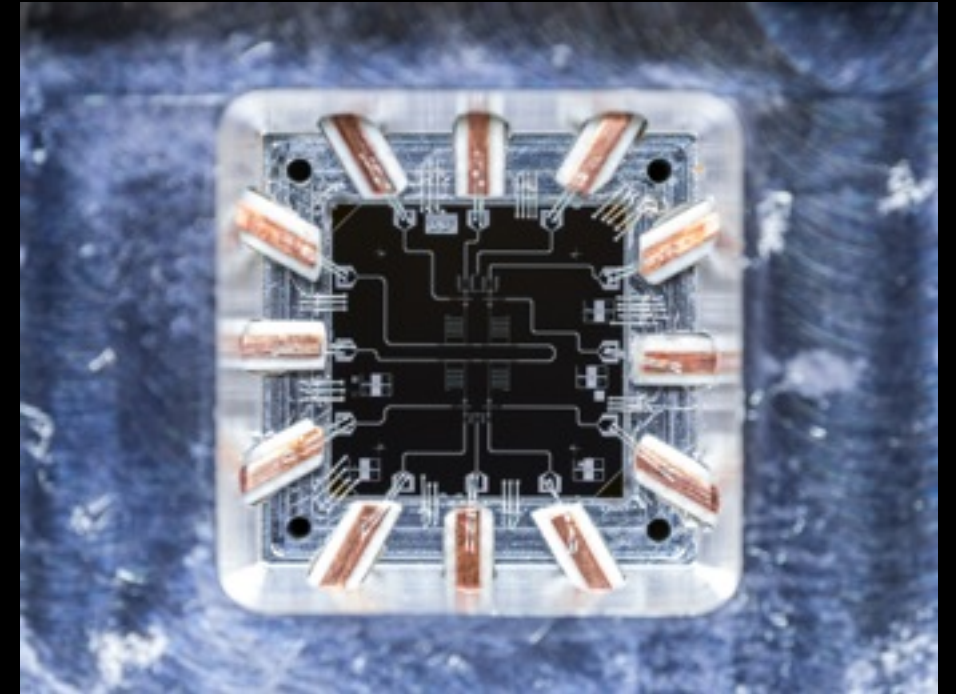
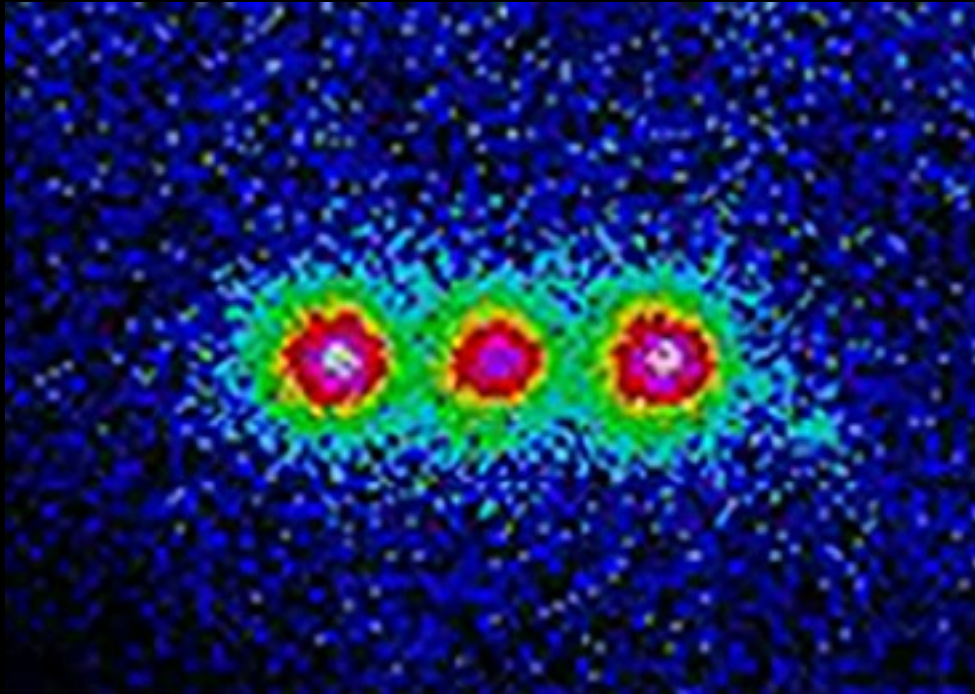
UNM SHARED
KNOWLEDGE
CONFERENCE

2015 APRIL 24



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

THE FUTURE OF COMPUTING?

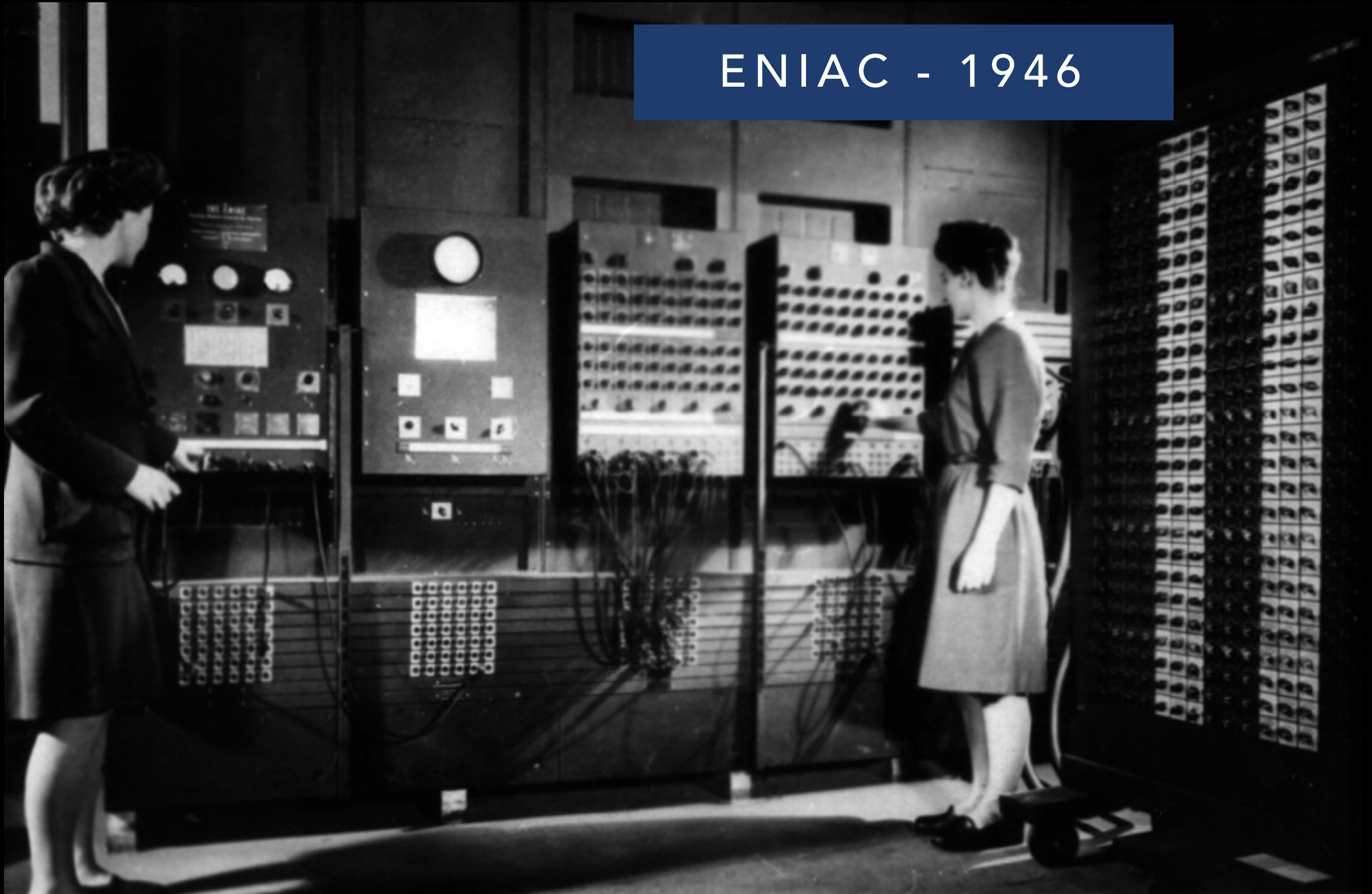


Novel systems
to compute on...
...why?



RELENTLESS MINIATURIZATION POWERS OUR TECHNOLOGICAL DEVELOPMENT

ENIAC - 1946



RELENTLESS MINIATURIZATION POWERS OUR TECHNOLOGICAL DEVELOPMENT

APPLE IIC - 1984



SONY VAIO - 1997



RELENTLESS MINIATURIZATION POWERS OUR TECHNOLOGICAL DEVELOPMENT

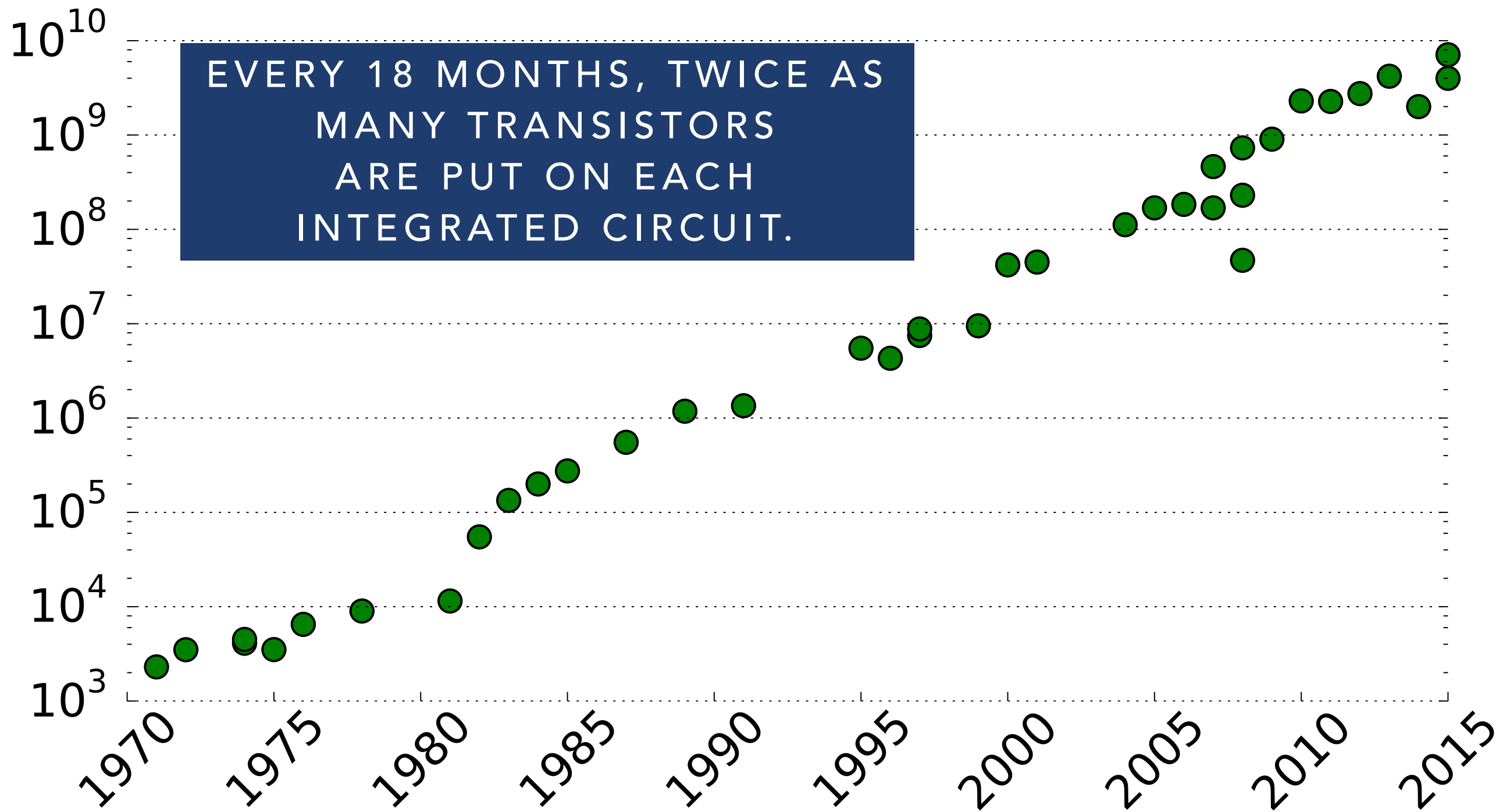
GOOGLE GLASS - 2013



IPHONE - 2007



THE **END** OF MINIATURIZATION: MOORE'S LAW

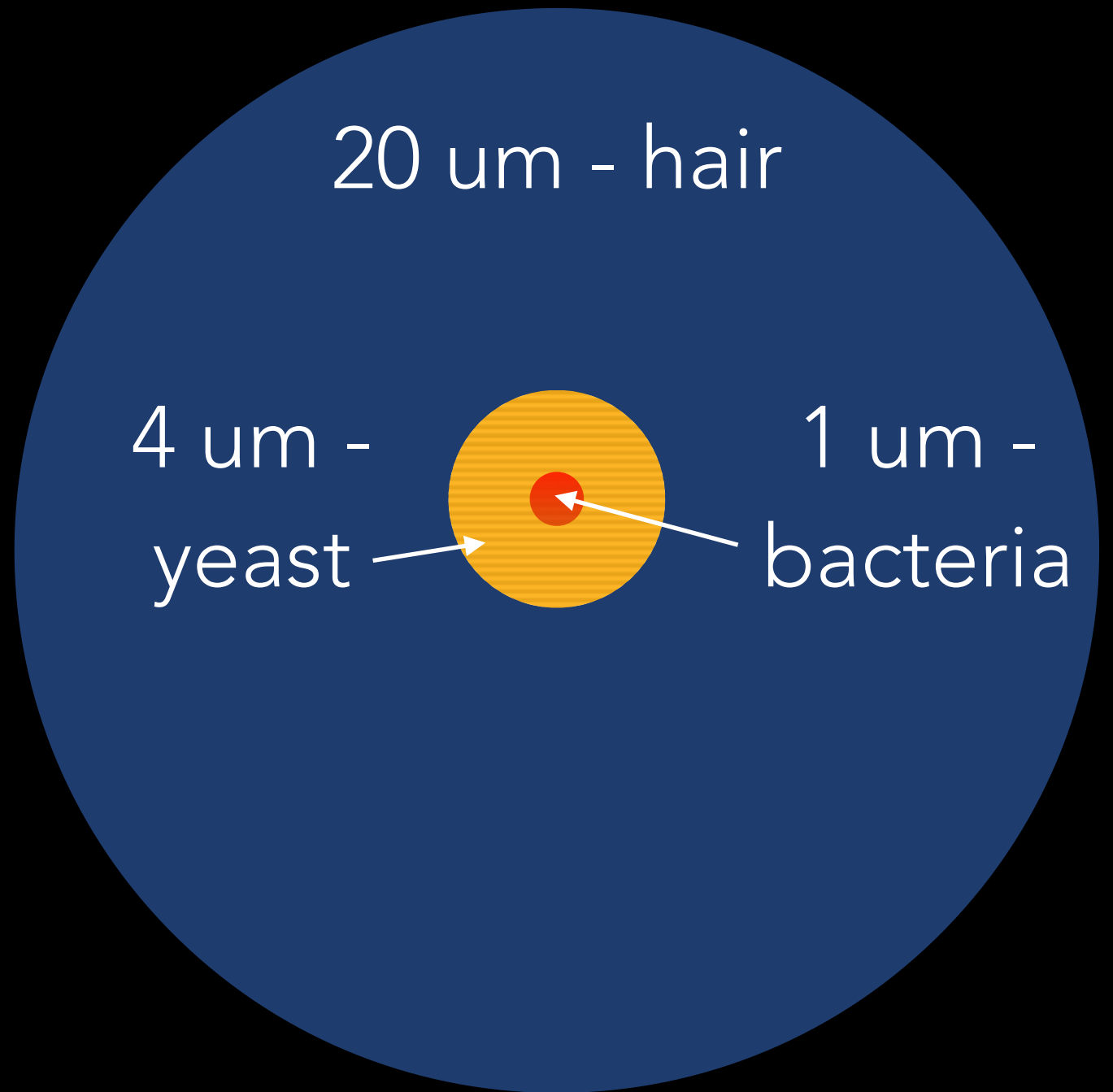


THE **END** OF MINIATURIZATION: MOORE'S LAW

Typical feature
size of IC = ~ 10 nm
(a hundred atoms)

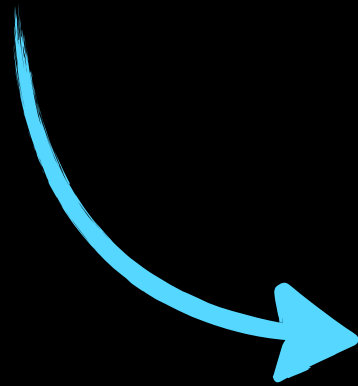
Quantum-mechanical
effects become
important.

GAME OVER?



BEYOND MOORE COMPUTING: PUTTING QUANTUM TO WORK

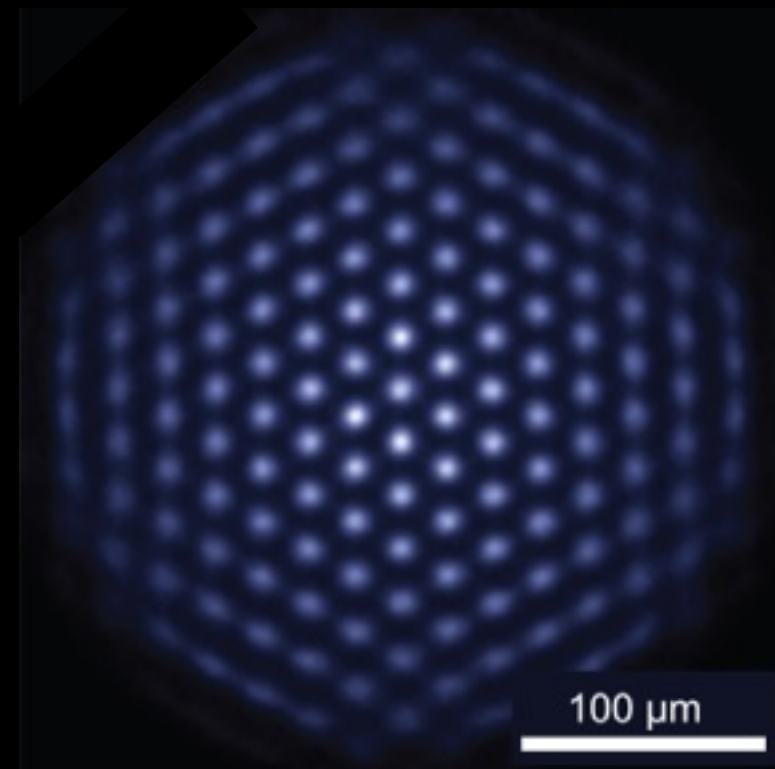
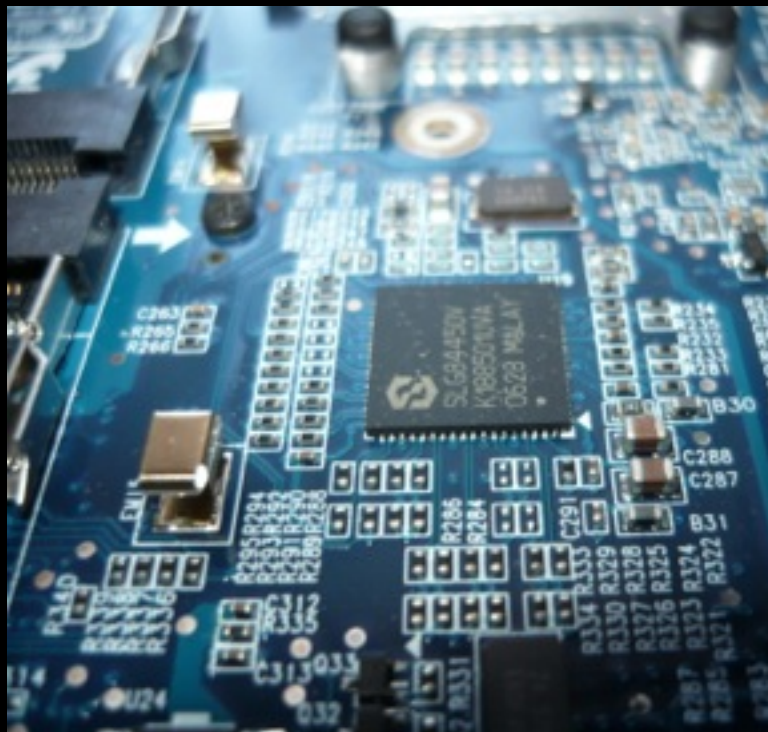
End of
Moore's Law



Embrace
quantum
mechanics

BEYOND MOORE COMPUTING: PUTTING QUANTUM TO WORK

Quantum computers require **rethinking** architecture, design, and **manufacture of computers**.



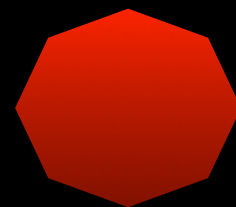
Good questions for **engineers**....

BEYOND MOORE COMPUTING: PUTTING QUANTUM TO WORK

Quantum computers can **speed up** solving **some problems**, but (probably) not **all**.



Searching a List
Factoring Numbers

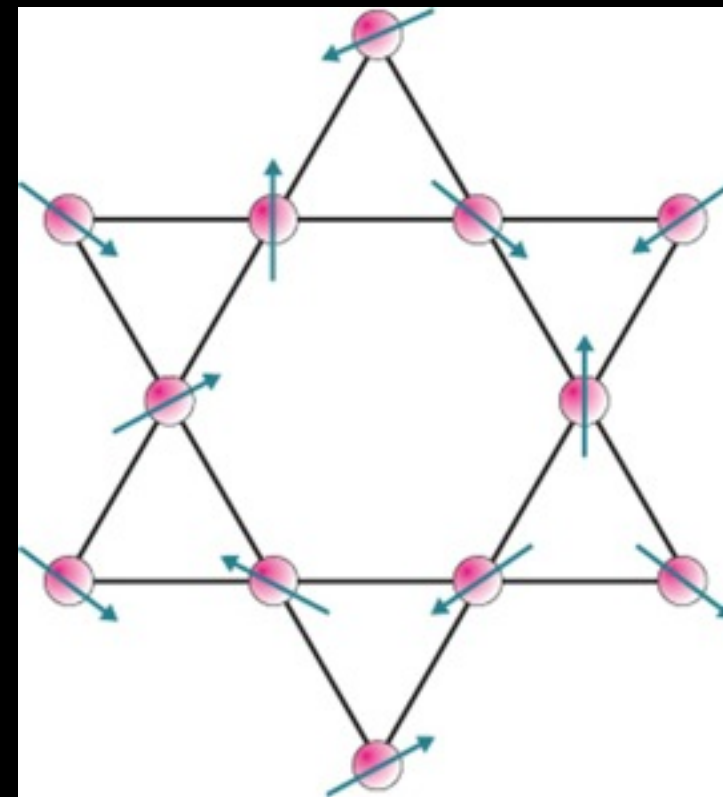
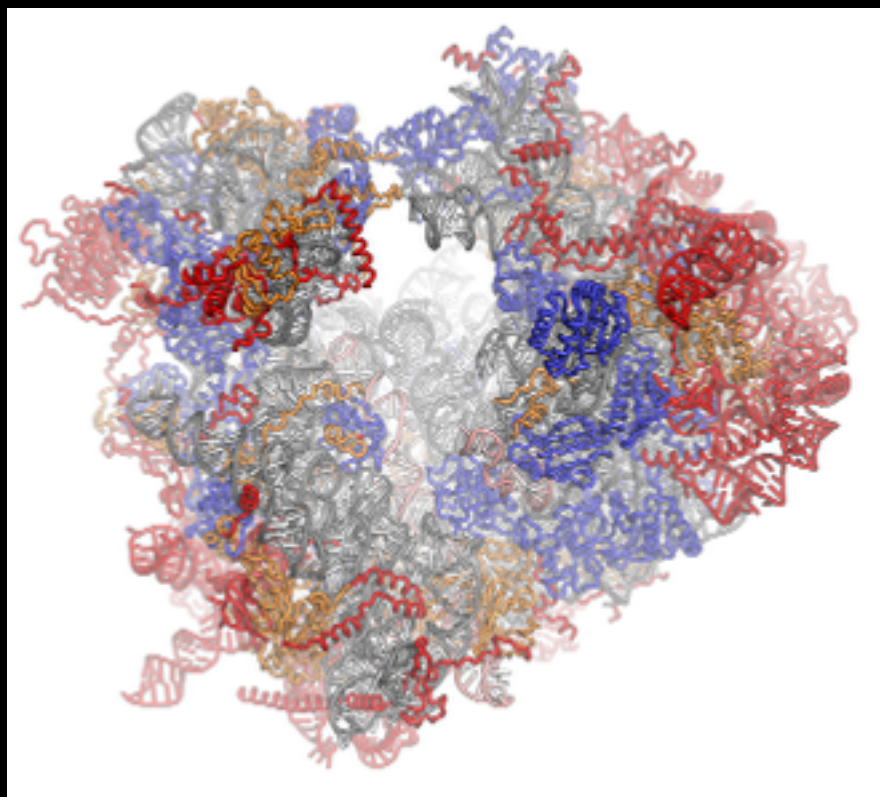


Planning a road trip

Good questions for computer scientists....

BEYOND MOORE COMPUTING: PUTTING QUANTUM TO WORK

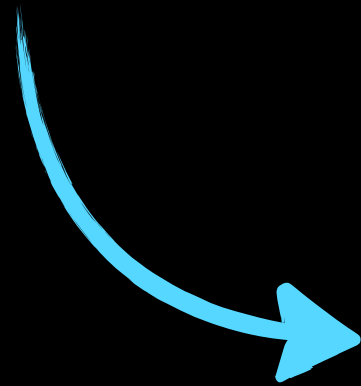
The difficulty of simulating systems
might **tell us something about nature.**



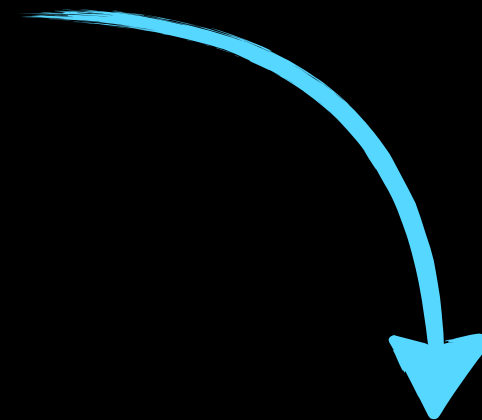
Good questions for **physicists**....

THE FUTURE OF COMPUTING?

End of
Moore's Law



Embrace
quantum
mechanics



A new way of
computing

PHOTO CREDITS

SONY SMARTWATCH: [HTTP://IMG.CLUBIC.COM/07589733-PHOTO-SMARTWATCH-3-IFA-SONY.JPG](http://img.clubic.com/07589733-photo-smartwatch-3-ifa-sony.jpg)

GOOGLE GLASS: [HTTPS://CDN3.ICONFINDER.COM/DATA/ICONS/FREE-GOOGLE-GLASS-ICON-SET/1024/GOOGLE_GLASS.PNG](https://cdn3.iconfinder.com/data/icons/free-google-glass-icon-set/1024/google_glass.png)

SONY VAIO: [HTTP://IT-REVIEW.NET/UPLOADS/IMAGES/ARTICLE/2008/SONYERICSSON/NUD72LJV9RABJHE19DS21A.JPG](http://it-review.net/uploads/images/article/2008/sonyericsson/NUD72LJV9RABJHE19DS21A.jpg)

HTC PHONE: [HTTP://CDN1.XDA-DEVELOPERS.COM/DEVDB/DEVICEFORUM/SCREENSHOTS/594/20120618T082619.JPG](http://cdn1.xda-developers.com/devdb/deviceforum/screenshots/594/20120618T082619.jpg)

IPHONE: [HTTP://CDN.ARSTECHNICA.NET/WP-CONTENT/UPLOADS/2013/09/IMG_7240.JPG](http://cdn.arstechnica.net/wp-content/uploads/2013/09/img_7240.jpg)

QUANTUM SIMULATOR: [HTTP://PATAPSCO.NIST.GOV/IMAGEGALLERY/RETRIEVE.CFM?IMAGEID=1045&DPI=300&FILEFORMAT=JPG](http://patapSCO.NIST.GOV/IMAGEGALLERY/RETRIEVE.CFM?IMAGEID=1045&DPI=300&FILEFORMAT=JPG)

ENIAC: [HTTP://COMMONS.WIKIMEDIA.ORG/WIKI/FILE%3ATWO_WOMEN_OPERATING_ENIAC_\(FULL_RESOLUTION\).JPG](http://commons.wikimedia.org/wiki/File:%3ATWO_WOMEN_OPERATING_ENIAC_(FULL_RESOLUTION).JPG)

MOORES LAW - RAW DATA AVAILABLE VIA [HTTP://EN.WIKIPEDIA.ORG/WIKI/TRANSISTOR_COUNT](http://en.wikipedia.org/wiki/Transistor_Count)

RIBOSOME - "80S 2XZM 4A17 4A19" BY FVOIGTSH - OWN WORK. LICENSED UNDER CC BY-SA 3.0 VIA WIKIMEDIA COMMONS
- [HTTP://COMMONS.WIKIMEDIA.ORG/WIKI/FILE:80S_2XZM_4A17_4A19.PNG#/MEDIA/FILE:80S_2XZM_4A17_4A19.PNG](http://commons.wikimedia.org/wiki/File:80S_2XZM_4A17_4A19.PNG#/media/File:80S_2XZM_4A17_4A19.PNG)