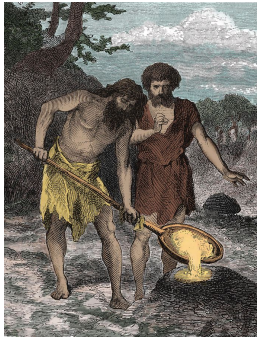
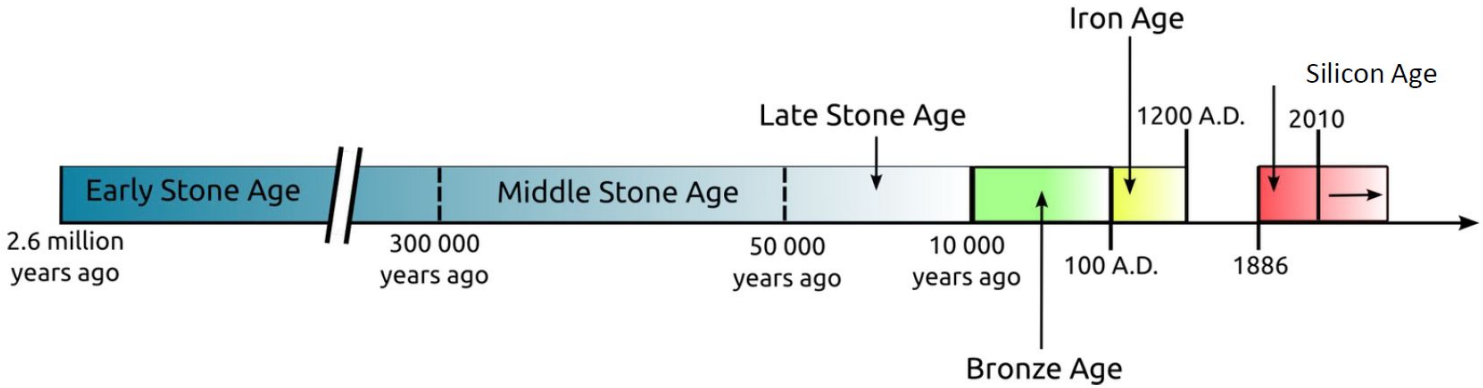
Condensed Matter Experiment & Computation

@ Yale AP

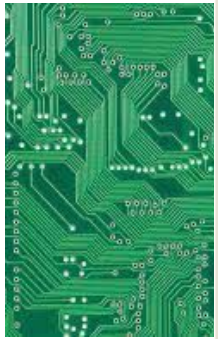
Stones, metals, and beyond





“Quantum” materials engineering

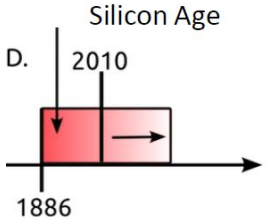
CHM Computer History Museum

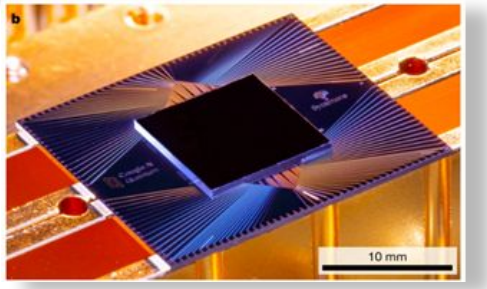


CHM BLOG REMARKABLE PEOPLE

13 SEXTILLION & COUNTING: THE LONG & WINDING ROAD TO THE MOST FREQUENTLY MANUFACTURED HUMAN ARTIFACT IN HISTORY

By David Laws | April 02, 2018





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ON CAMPUS AND AROUND THE WORLD
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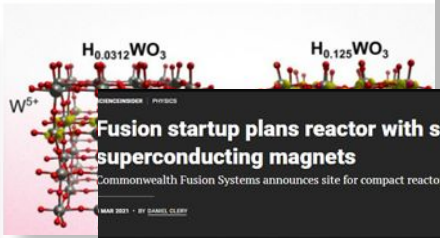
Engineers design a device that operates like a brain synapse

Ion-based technology may enable energy-efficient simulations of the brain's learning process, for neural network AI systems.

David L. Chandler | MIT News Office
June 19, 2020



Fusion startup plans reactor with small but powerful superconducting magnets

Commonwealth Fusion Systems announces site for compact reactor

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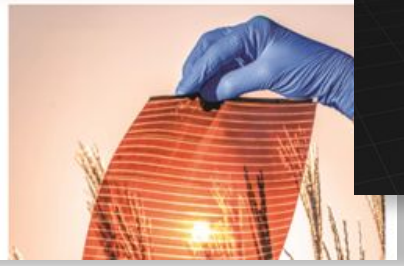
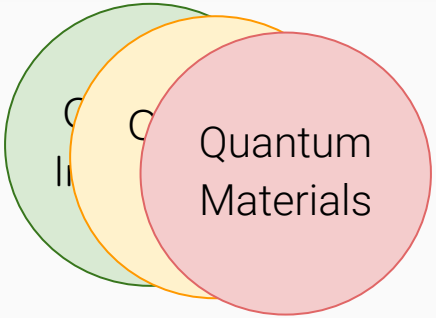
Can the most exciting new solar material live up to its hype?

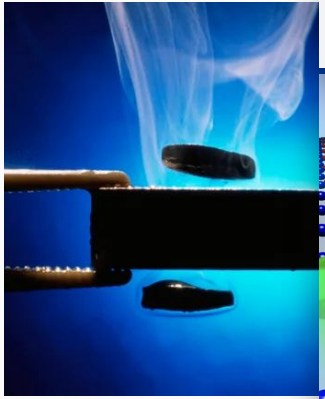


Condensed Matter Experiment & Computation at Yale AP&P

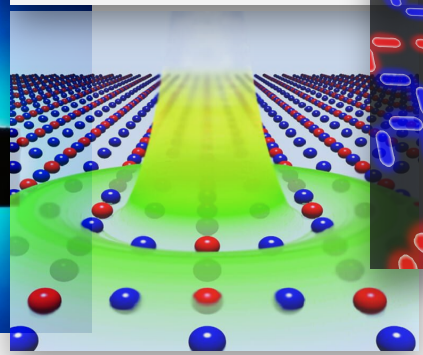


- Understand the microscopic mechanisms behind material properties
- Predict material properties with advanced theory tools
- Control and create material properties with experimental methods

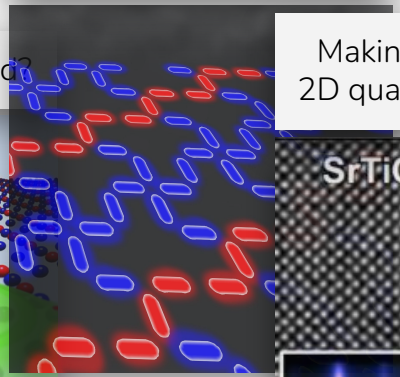
Why is Tc so high?



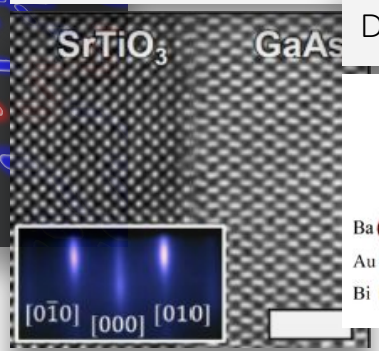
Can $F = e^2/r^2$ be twisted?



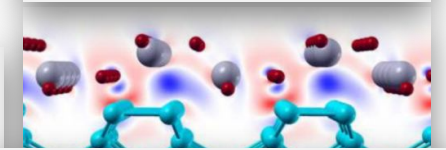
Harnessing the power of nano-magnetism



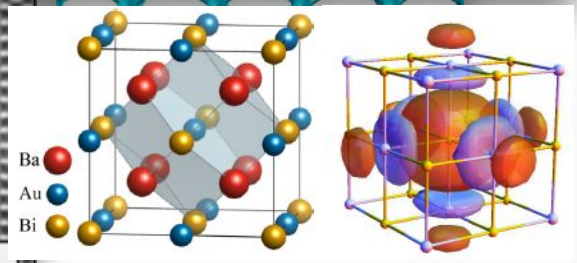
Making wafer-scale 2D quantum materials



How to best functionalize surfaces and interfaces



Designing next gen energy materials



Condensed Matter Experiment & Computation at Yale AP&P

Quantum Materials

- Understand the microscopic mechanisms behind material properties
- Predict material properties with advanced theory tools
- Control and create material properties with experimental methods

We do theory with...

- First principles calculation for electronic structure prediction
- Machine learning for quantum mechanics
- Supercomputing facilities for high performance computing

We do experiment with ...

- Molecular beam epitaxy
- Bulk single crystal synthesis
- Nano-fabrication
- Scanning tunneling spectroscopy
- Photoemission spectroscopy
- Synchrotron X-ray scattering
- Magnetic imaging and low-T transport
- Scanning nearfield optical microscopy ...

Condensed Matter Experiment & Computation at Yale AP&P

Quantum Materials

- **EVERY** experimentalist here has a strong tie to the national labs
- Close collaborations with other departments in SEAS and FAS
  - Chemical Engineering, MEMS, Physics, Chemistry…

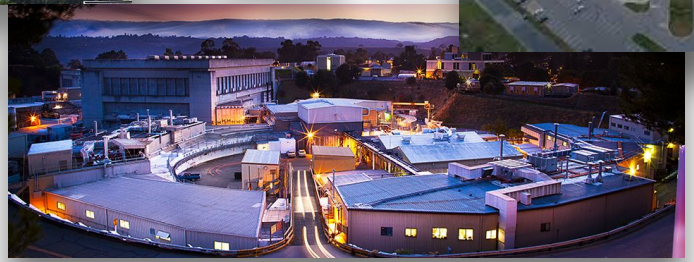
BROOKHAVEN NATIONAL LABORATORY

SLAC NATIONAL ACCELERATOR LABORATORY

BERKELEY LAB

ESRF The European Synchrotron

Argonne NATIONAL LABORATORY



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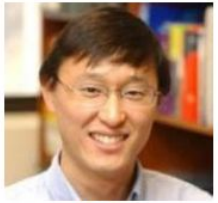

Ahn

Novel complex oxide interfaces:

- water splitting
- artificial neurons
- spintronics & ferroelectrics

MBE, RIXS, XRD, transport…

da Silva Neto

Atomically resolved electronic states:

- topological state of matter
- nematicity and superconductivity
- vortex and density waves

STS, SNOM, RIXS, ARPES…

He

Momentum resolved electronic states:

- high-Tc superconductivity
- magnetic metals and vdW materials
- correlated electronic systems

ARPES, IXS, INS, growth…

Ismail-Beigi

Electronic structure w/ first principles:

- solid-gas/solid-solid interfaces
- electron correlation in oxides
- 2D material and nanostructure

DFT, Green's function, slave boson…

Ozolins

Electronic property w/ numerical methods:

- materials for energy applications
- machine learning in materials physics
- exotic magnetism

DFT, MD, Monte Carlo, Machine learning…

Schiffer

Magnetic nanostructures:

- topological designer magnets
- artificial spin ice
- low temperature transport properties

nano-lithography, SEM, MFM, PEEM…

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EDUARDO H. DA SILVA NETO

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