

Thoughts on My Physics Life in Progress

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Introduction

My Story (so far)

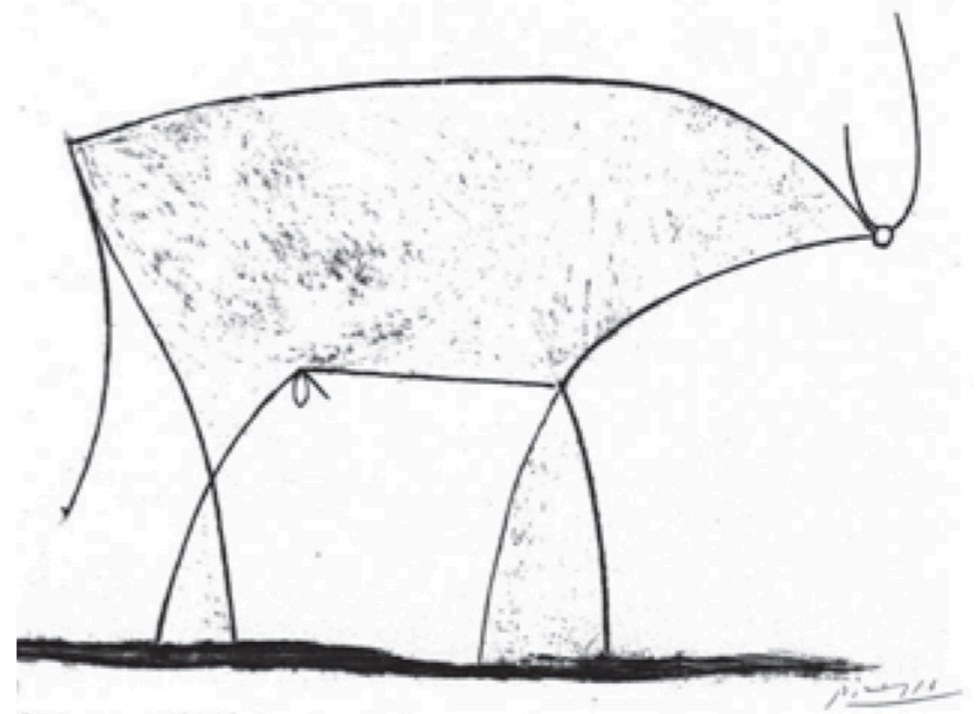
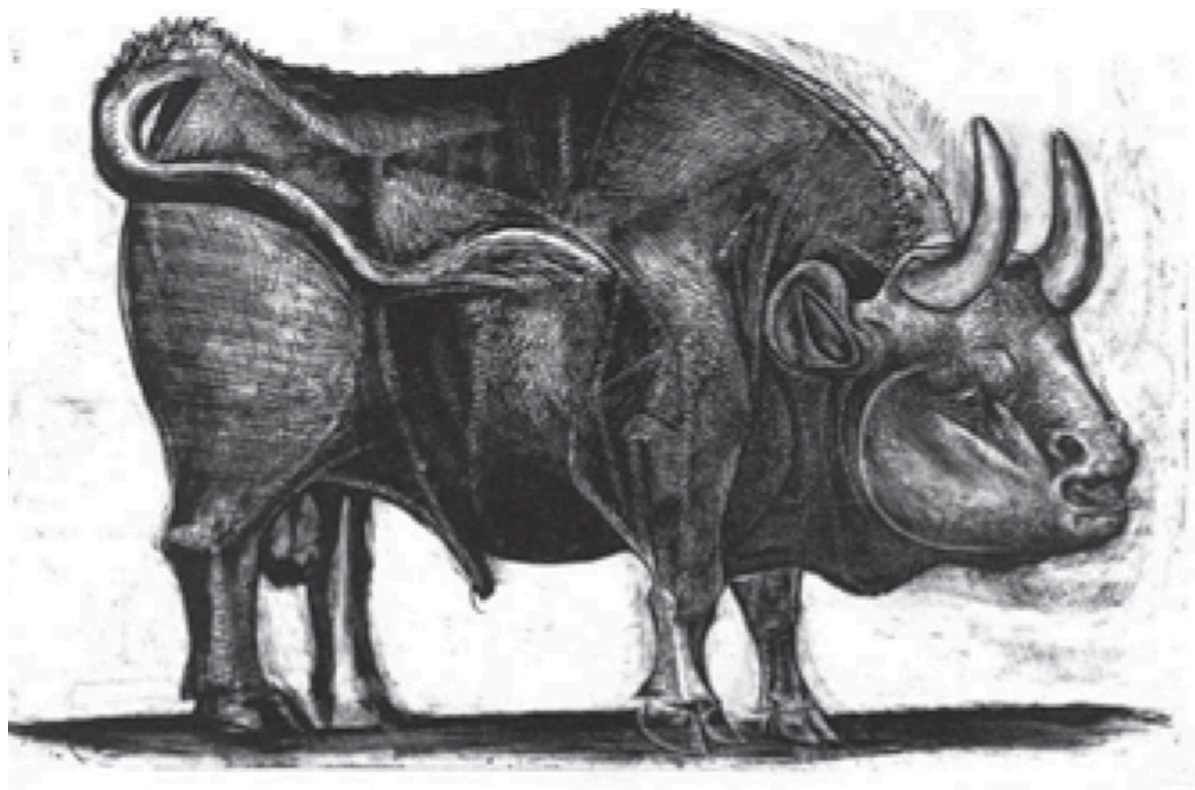
Two Current Research Projects

Suggestions

Let me introduce myself....I'm a materials-inspired theorist

What's That??

A Visual Analogy from a (Great) Artist



Development of minimalist models for complex materials.....with predictions for experiment!

Something about My Story

My Multicultural Background



U.S.A.



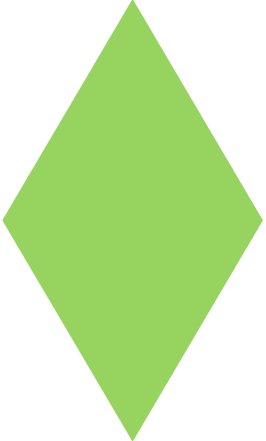
Atlantic Ocean



France



Poland



India



My Grandmother (Poland)



My Grandparents (France)



My Grandmother (India)



My Grandparents
and
My Parents
(India)



My Grandmother,
My Sister
and Me (USA)

Childhood in New Jersey



Very Bad Asthma (Missed Two Years of School)



Don't Give Up....
Start Swimming
Competitively !!

College (Connecticut)

In addition to classes....

Sports



Freshman Women's Crew

Summer Research Project

BELL LABS
NEWS FOR THE PEOPLE OF BELL LABORATORIES



Premala Chandra of Yale put classroom theories into practice during a research program at Bell Labs. page 3

A Taste for Physics
outside the Classroom

Senior Year: Feza and Sonya



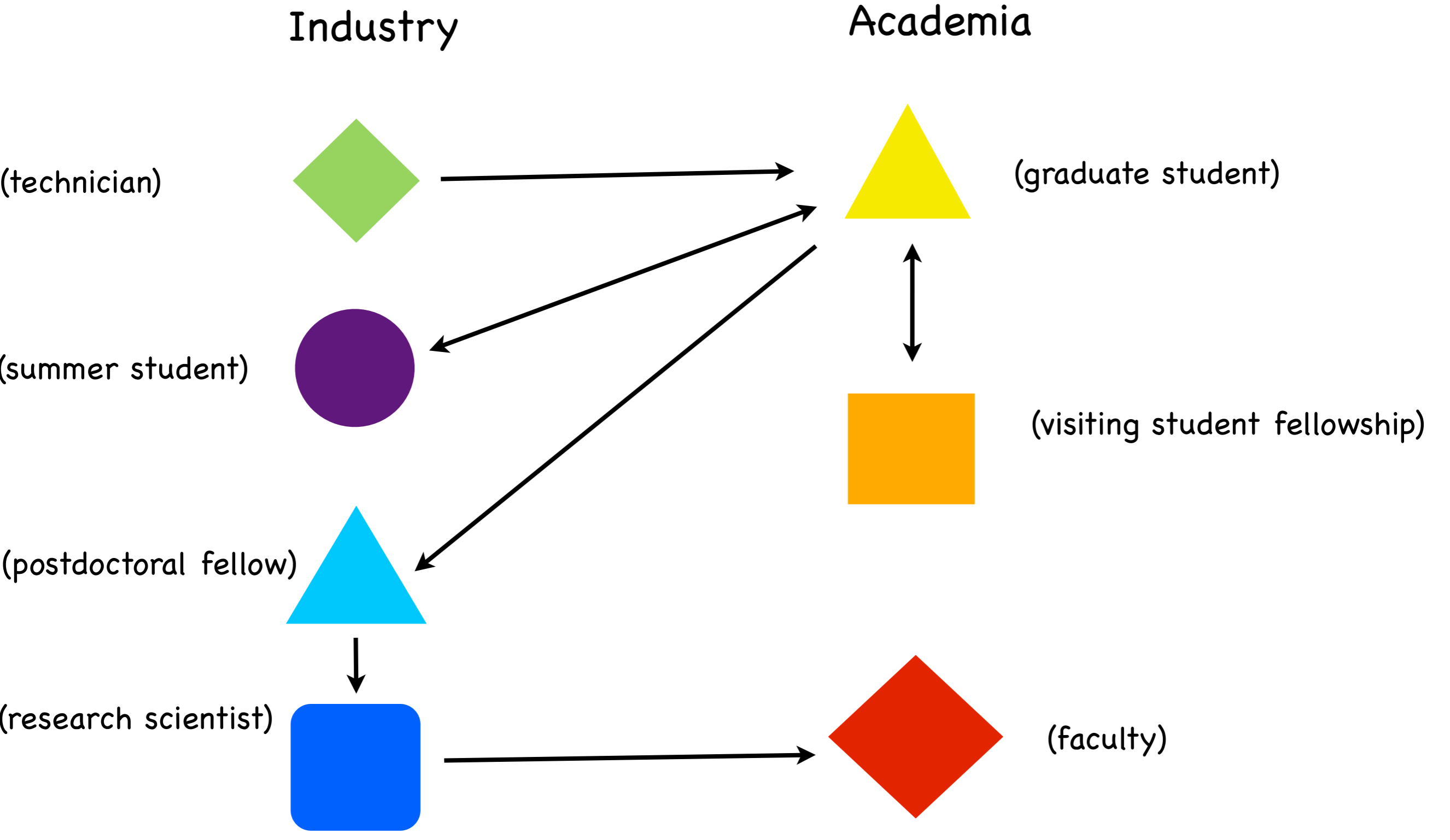
Feza (Gursev)



Sonya (Kovalevskaya)

Study of the Kovalevskaya Top using
Modern Methods

A Schematic History of my Professional Life after College



And Now for Some Physics

A Taste for Two of My Current
Research Projects
(One "Blue Sky" and the Other More
Applied)

Background: Phase Transition and Broken Symmetries



Landau 1937

Temperature



$$\Psi = 0$$



Critical
Temperature
32°F, 0°C

$$\Psi \neq 0$$



Breaks rotational symmetry

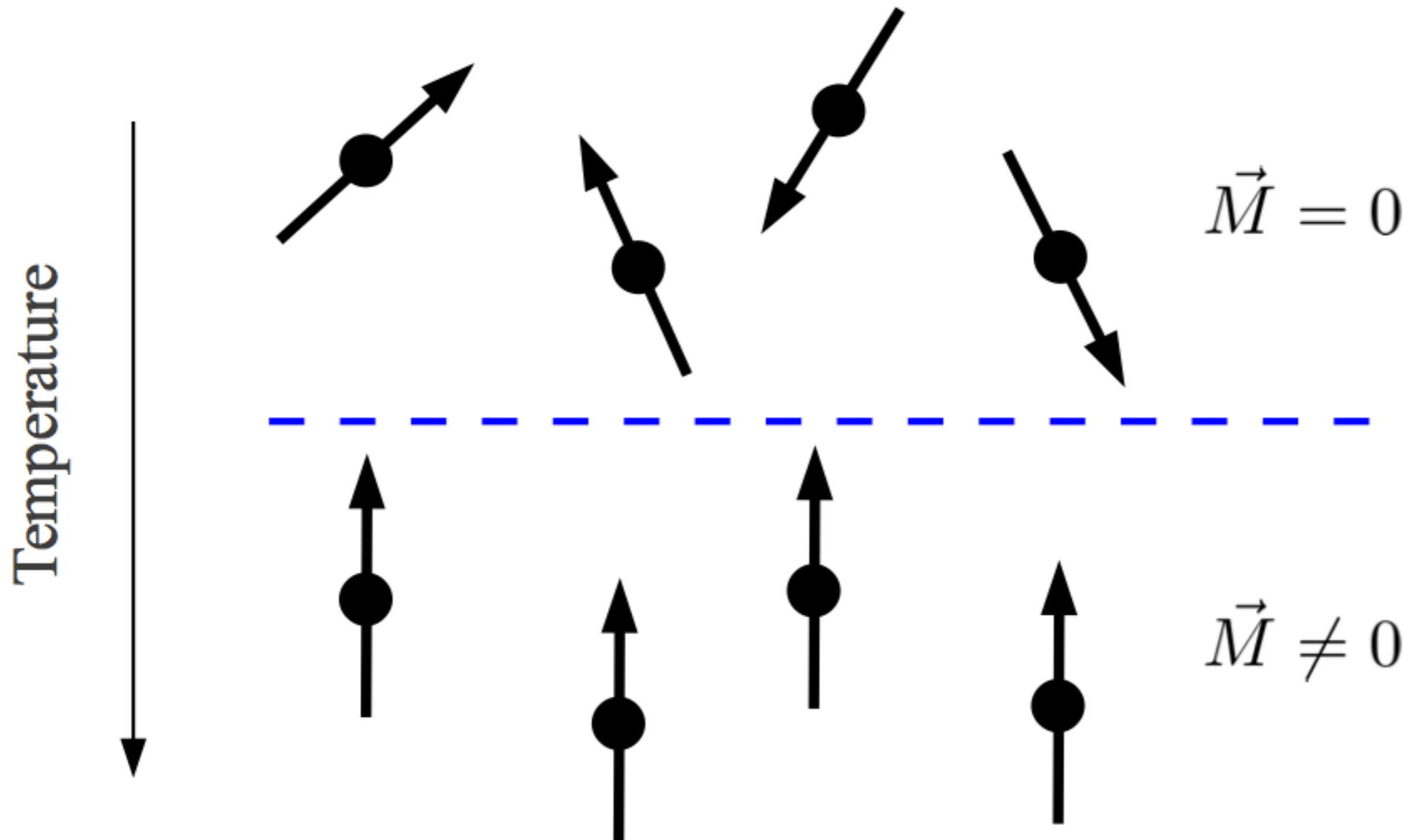
Symmetry breaking measured by *order parameter* Ψ

Background: Phase Transition and Broken Symmetries

Example: Ferromagnetism (Iron)

Broken Symmetry: Spin Rotation, Time-Reversal

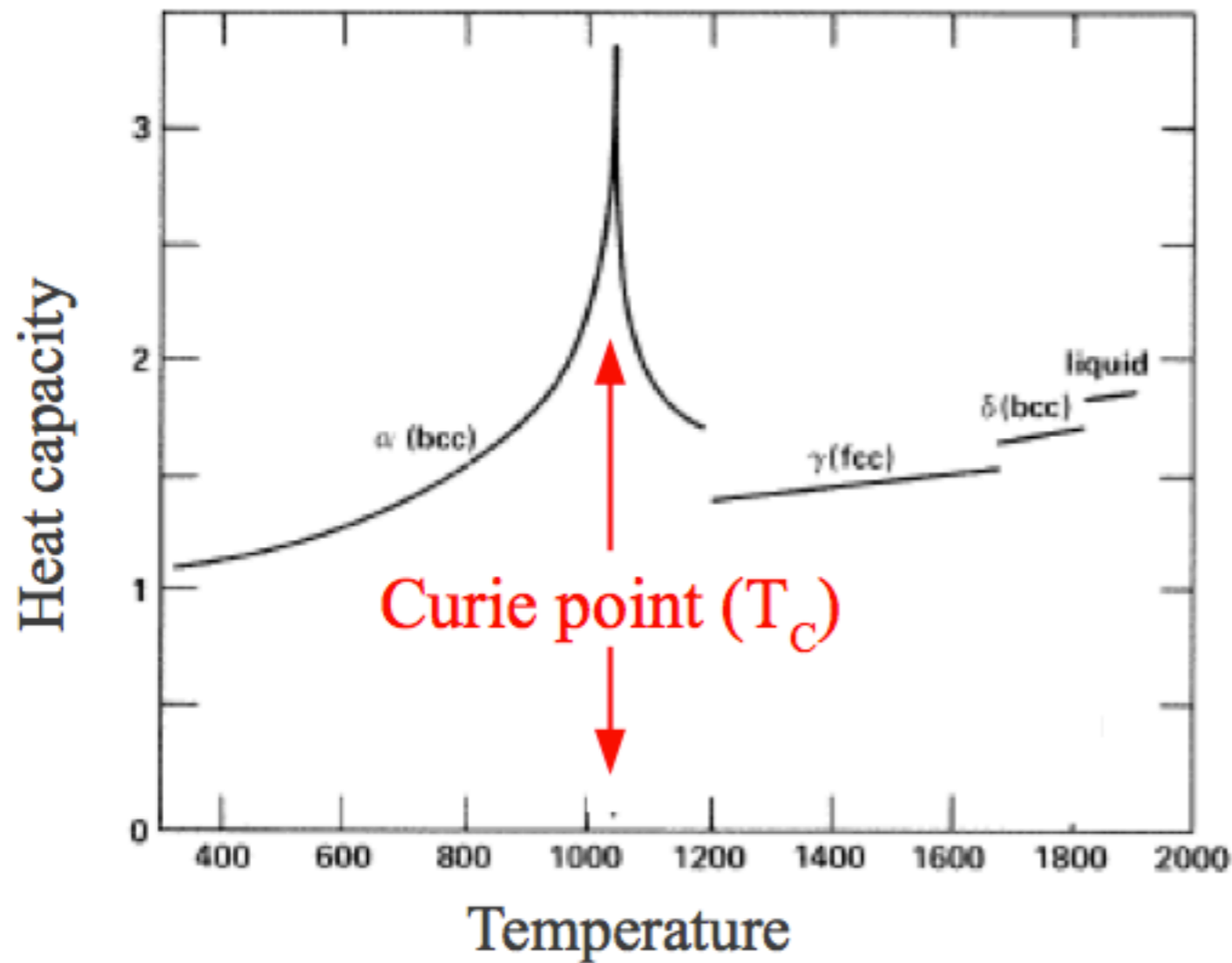
Order Parameter: Magnetization



Background: Phase Transition and Broken Symmetries



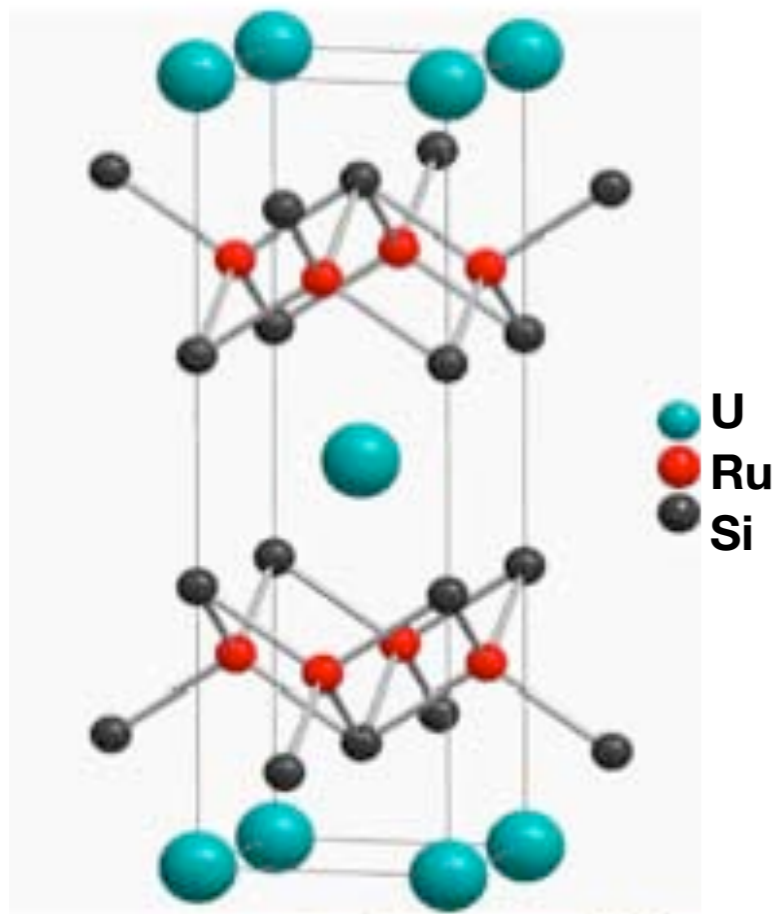
Example: Ferromagnetism (Iron)



$C(T)$ displays structure at phase transitions !!

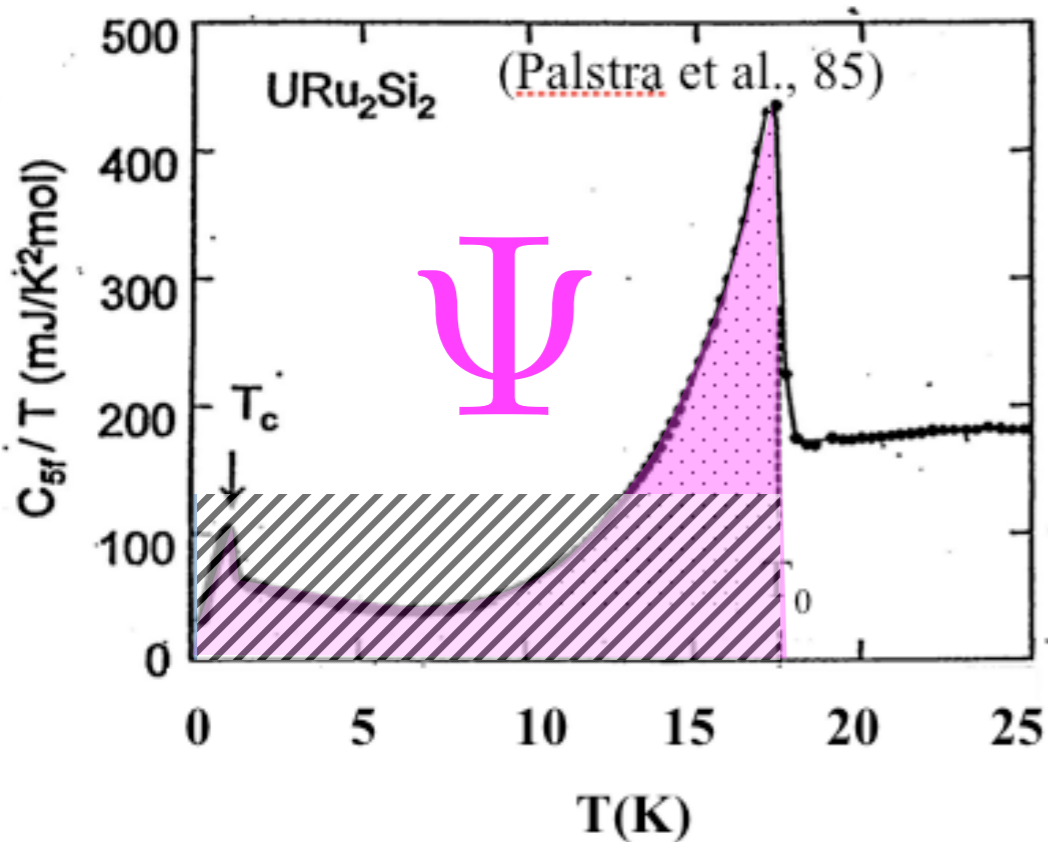
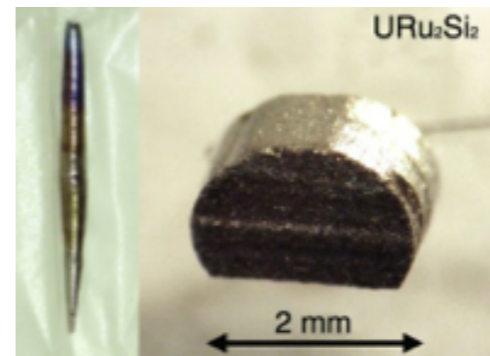
Heat Capacity $C(T)$: The amount of energy needed to raise the temperature 1K

The Mystery of URu₂Si₂



$$\Delta S = \int_0^{T_0} \frac{C_V}{T} dT = 0.14 \times 17.5 \text{ K} = 2.45 \text{ J/mol/K} = 0.42 R \ln 2$$

Large entropy of condensation.



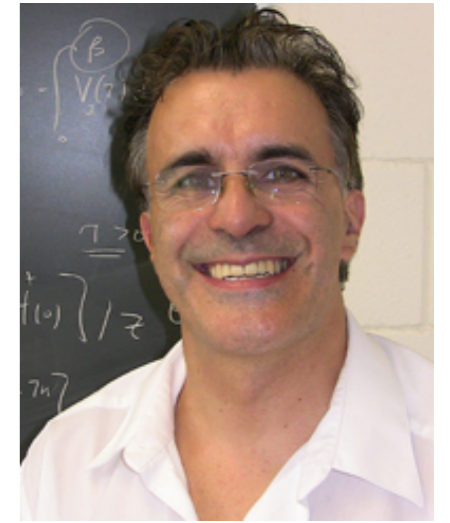
Broken Symmetry: ??
Order Parameter : ??

What is the nature of the hidden order?

Our Approach to URu₂Si₂



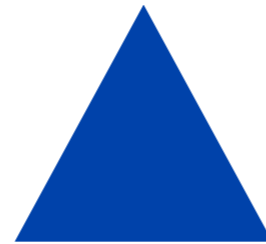
Rebecca Flint



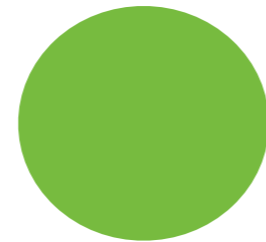
Piers Coleman



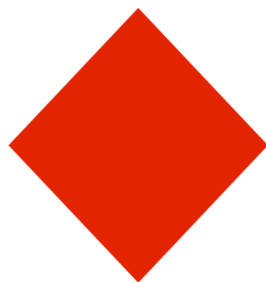
Experiment



Phenomenology



Microscopic Model



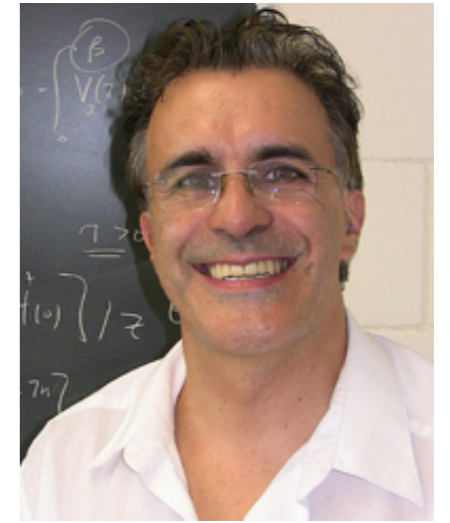
Predictions for
Future Experiment



Rebecca Flint

Our Proposal for URu₂Si₂

Hastatic Order



Piers Coleman

A Fundamentally New Way to Break
Time-Reversal Symmetry (TRS)

Broken Symmetry: Single and Double TRS
Order Parameter: Hybridization Spinor



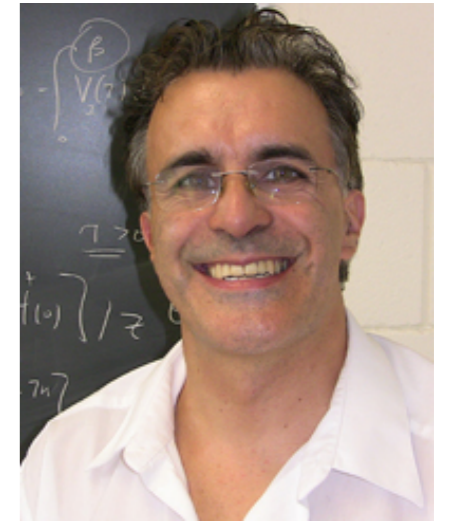
hasta: spear (latin)



Rebecca Flint

Our Proposal for URu₂Si₂

Hastatic Order



Piers Coleman

A Fundamentally New Way to Break
Time-Reversal Symmetry (TRS)

ARTICLE

doi:10.1038/nature11820

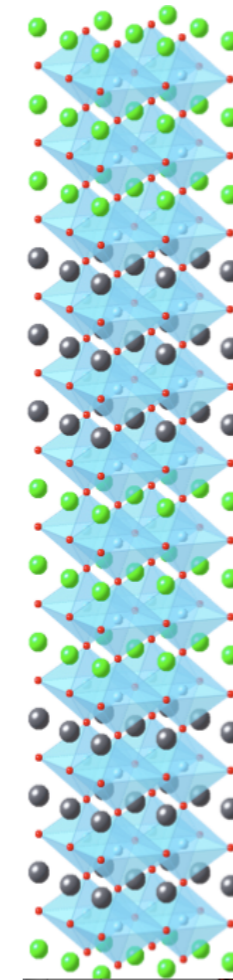
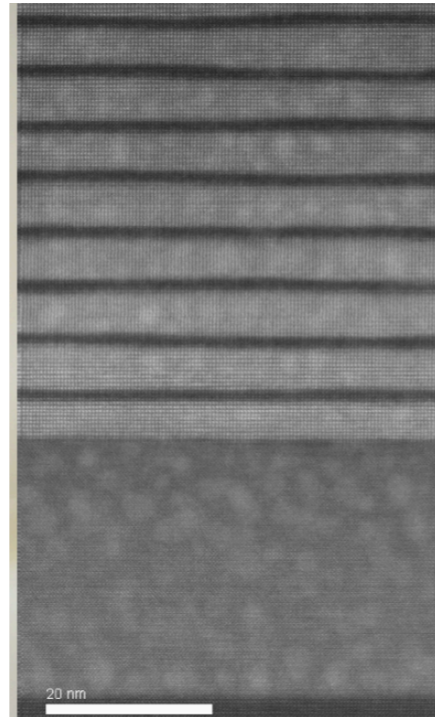
Hastatic order in the heavy-fermion compound URu₂Si₂

Premala Chandra¹, Piers Coleman^{1,2} & Rebecca Flint³

But the predictions for experiment need
some refinement...more work to be done!

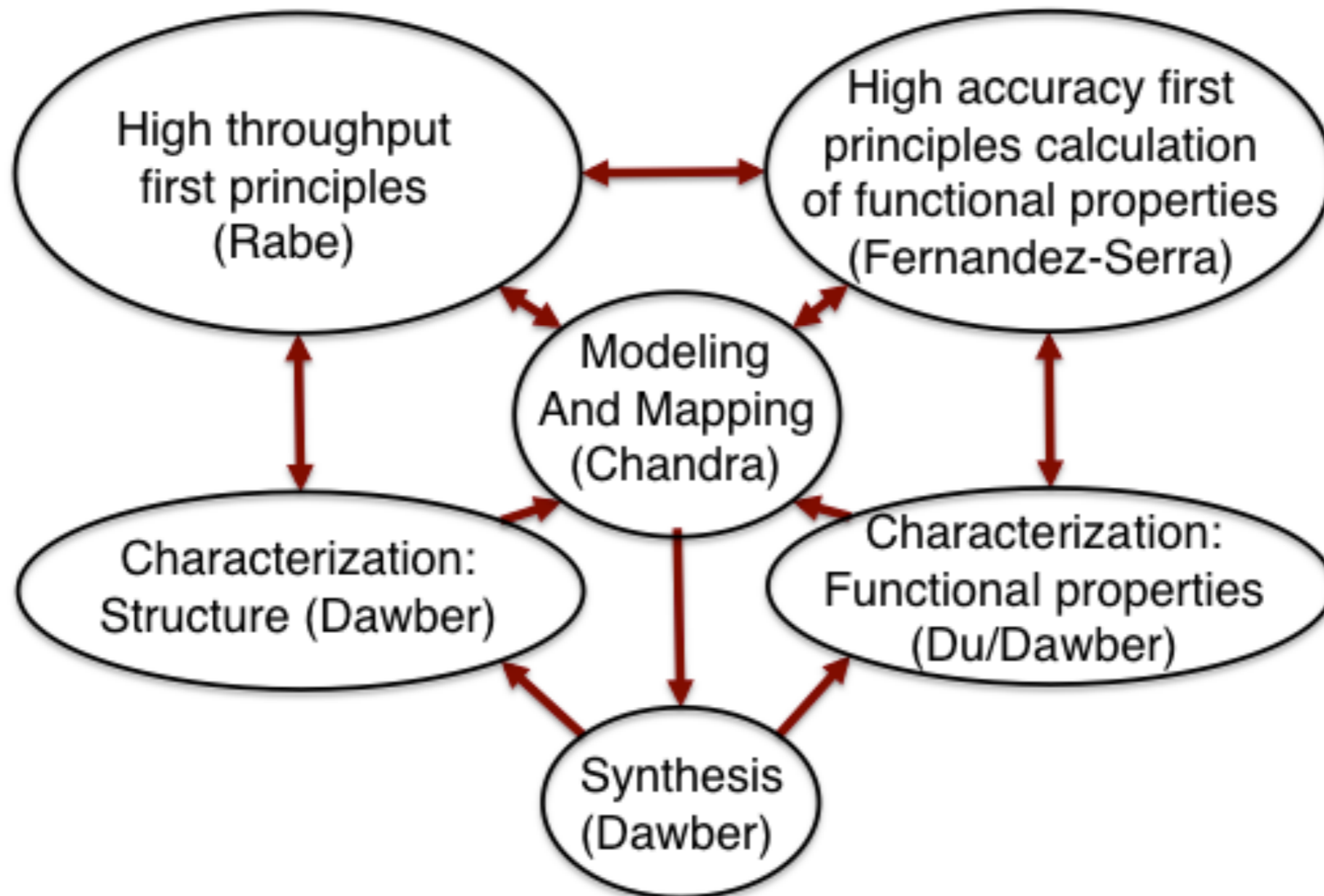
And Now for Something Completely Different....

Tremendous Advances in Synthesis of Artificially Structured Materials



Goal: Identify and characterize multicomponent heterostructures with desirable properties **distinct** and/or **enhanced** from those of its bulk parents

Schematic of the Relationships between Different Components of the Project (Computation, Modelling and Experiment)



My Additions to the Family Tree



England added to the mix!

My father-in-law, my husband
and me (Disneyland)

My Additions to the Family Tree



Our Family (Turkey)

Suggestions:

1. Prioritize, Organize and Simplify !!
2. Don't Give Up When the Going Gets Tough !!
3. Develop a Life Support System !!
(Exercise, Friends, Music, Knitting,
Kickboxing....)
4. If You Need Something, Recognize that You
Can Make It Happen -- and Let Your
Professors, Classmates and Friends
Help You !!

Thank you very much

and

Best of Luck with Your Adventures
(Scientific and Otherwise) !!