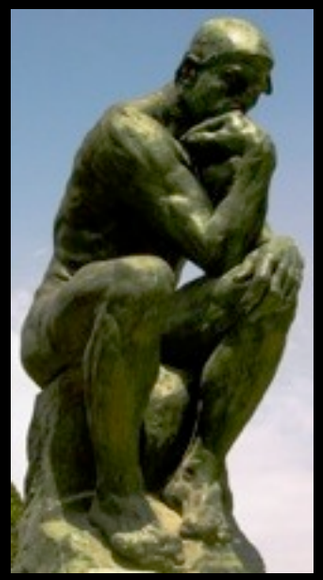

Changing Learning
So We Can
Learn To Change Society

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Outline

The framework: grand challenges of global change: ICSU Visioning and IGFA Belmont Forum

Science, technology, innovation, society

- bellwethers, beacons, and behaviors
- integrating scientific, technical, and social innovation

Knowledge, learning, and societal change (KLSC):

a new initiative to identify and understand the levers and mechanisms of societal change and social innovation

Coping with complexity: multi-level trans-disciplinary computational modeling as an educational strategy

SCIENCE, TECHNOLOGY, AND HUMANITY

Natural science:
BELLWETHERS

Technology and innovation:
BEACONS

Responses of humans:
BEHAVIORS

ICSU Does The Visioning Thing

ICSU Grand Challenges:

1. Forecasting
2. Observing
3. Confining
4. Responding: determine what institutional, economic and behavioral changes can enable effective steps toward global sustainability
5. Innovating: technological, policy, and social responses to achieve global sustainability

"How can improved scientific knowledge of the risks of global change and options for response most effectively catalyze and support appropriate actions by citizens and decision-makers"

IGFA and the Belmont Forum

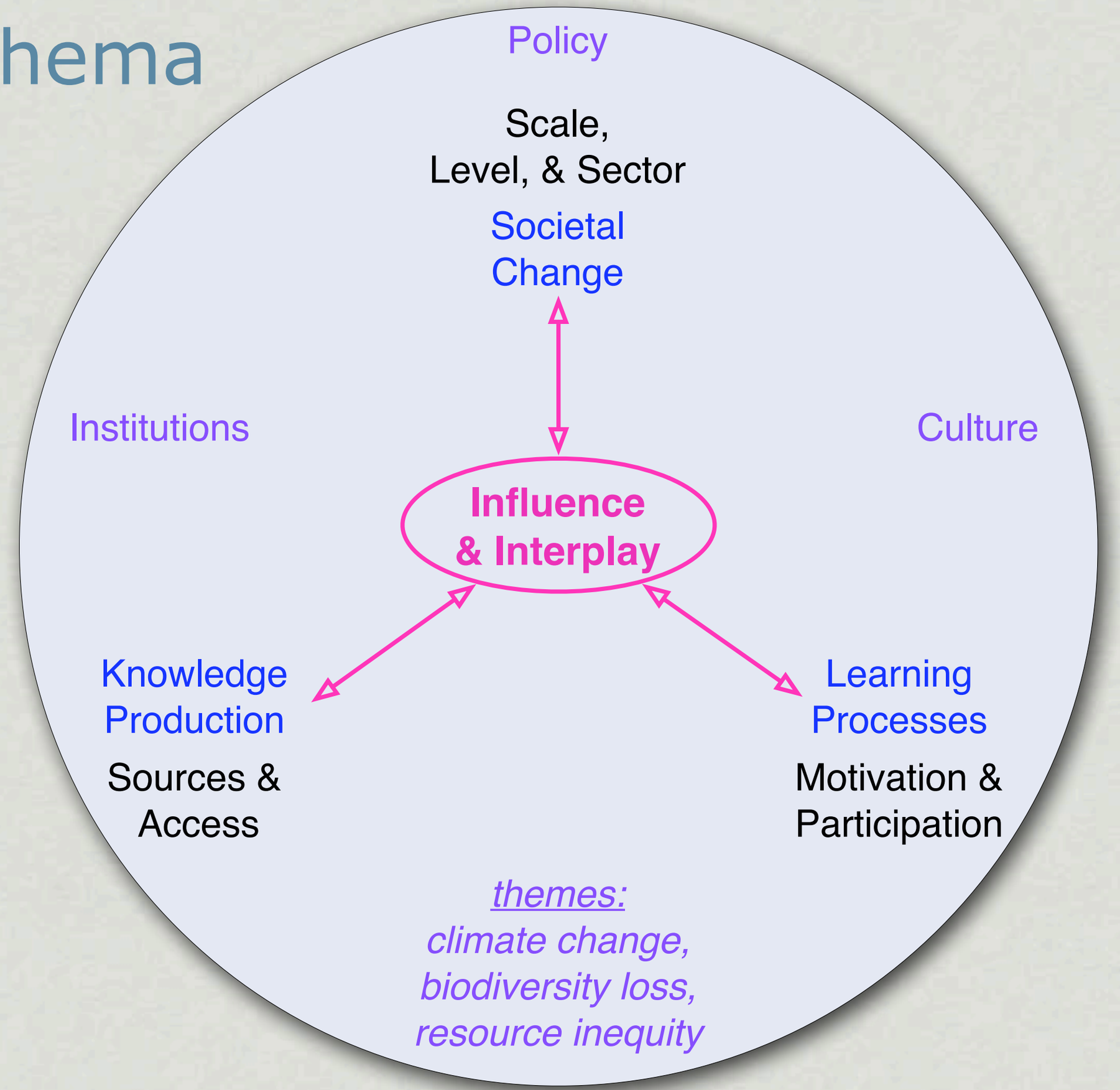
Belmont Forum priorities:

- "develop and deliver the knowledge required to address pressing global to local environmental and societal issues" [insufficient without **meaningful participation**]
- "Identify the objectives and means for effective translation and communication of scientific knowledge for targeted sectors and regions in order to realize the intended benefits from the application of such knowledge" [focus on **co-production of knowledge**]
- "Nurture the next generation of experts" [**next many generations** - start early and don't stop at univ!]

Knowledge, Learning, and Societal Change: Enabling Science And Learning For A Sustainable Future

A new core initiative of the
International Human Dimensions Programme
in Global Environmental Change - IHDP

KLSC schema


Policy
Scale,
Level, & Sector
Societal
Change
Institutions
Culture
Influence
& Interplay
Knowledge
Production
Sources &
Access
Learning
Processes
Motivation &
Participation
themes:
climate change,
biodiversity loss,
resource inequity

Models, Metaphors, and Narratives

Models and metaphors: ways to approximate and describe complex or unfamiliar things and events

- use of models in our thinking is fundamental
- implicit and explicit models
- models are nearly "invisible" in most education
- information is taken out of context and without reference to the conditions of validity

Narratives

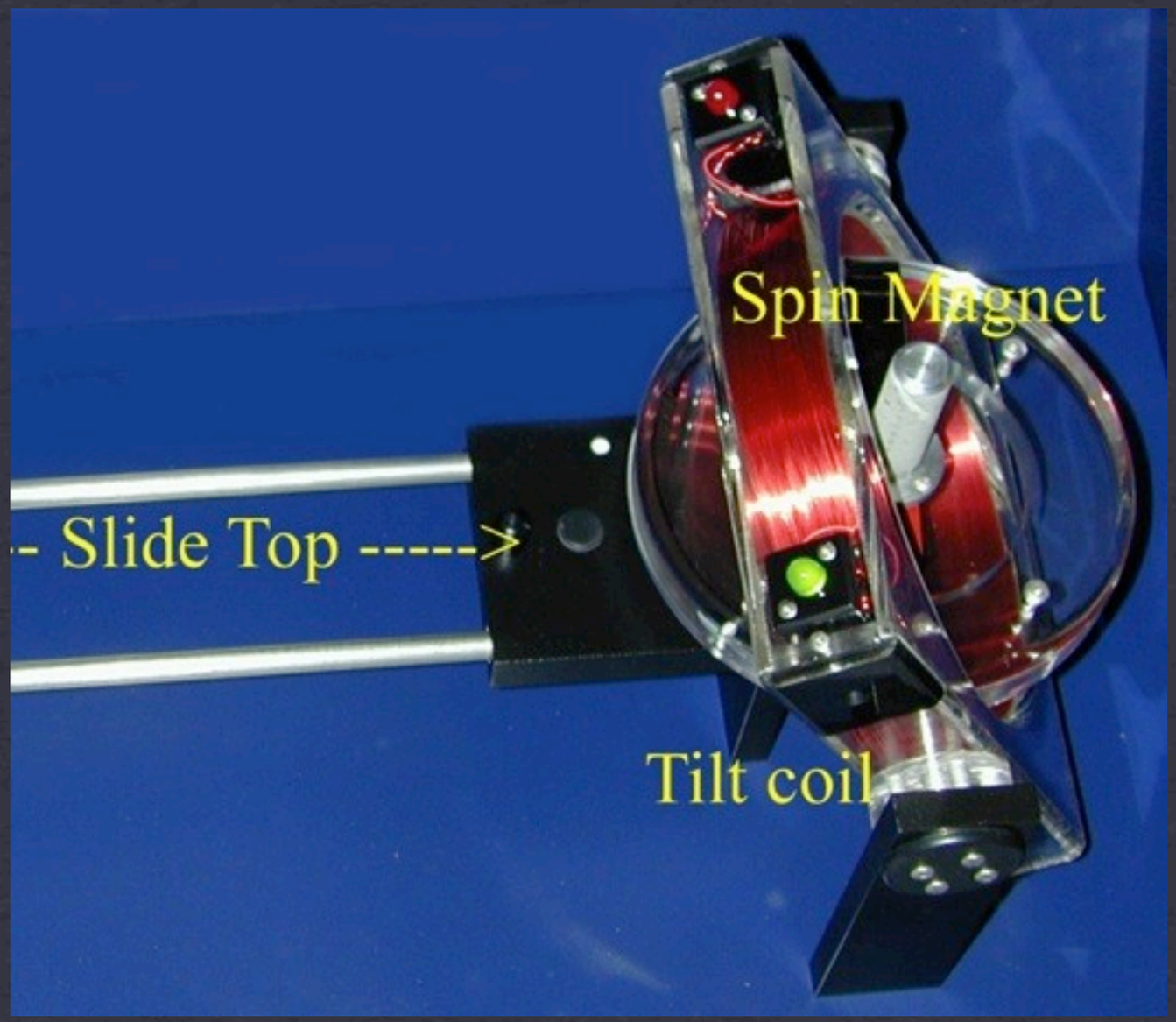
- science is a story both written and told with models and metaphors
- narratives carry emotions and values explicitly and become memorable

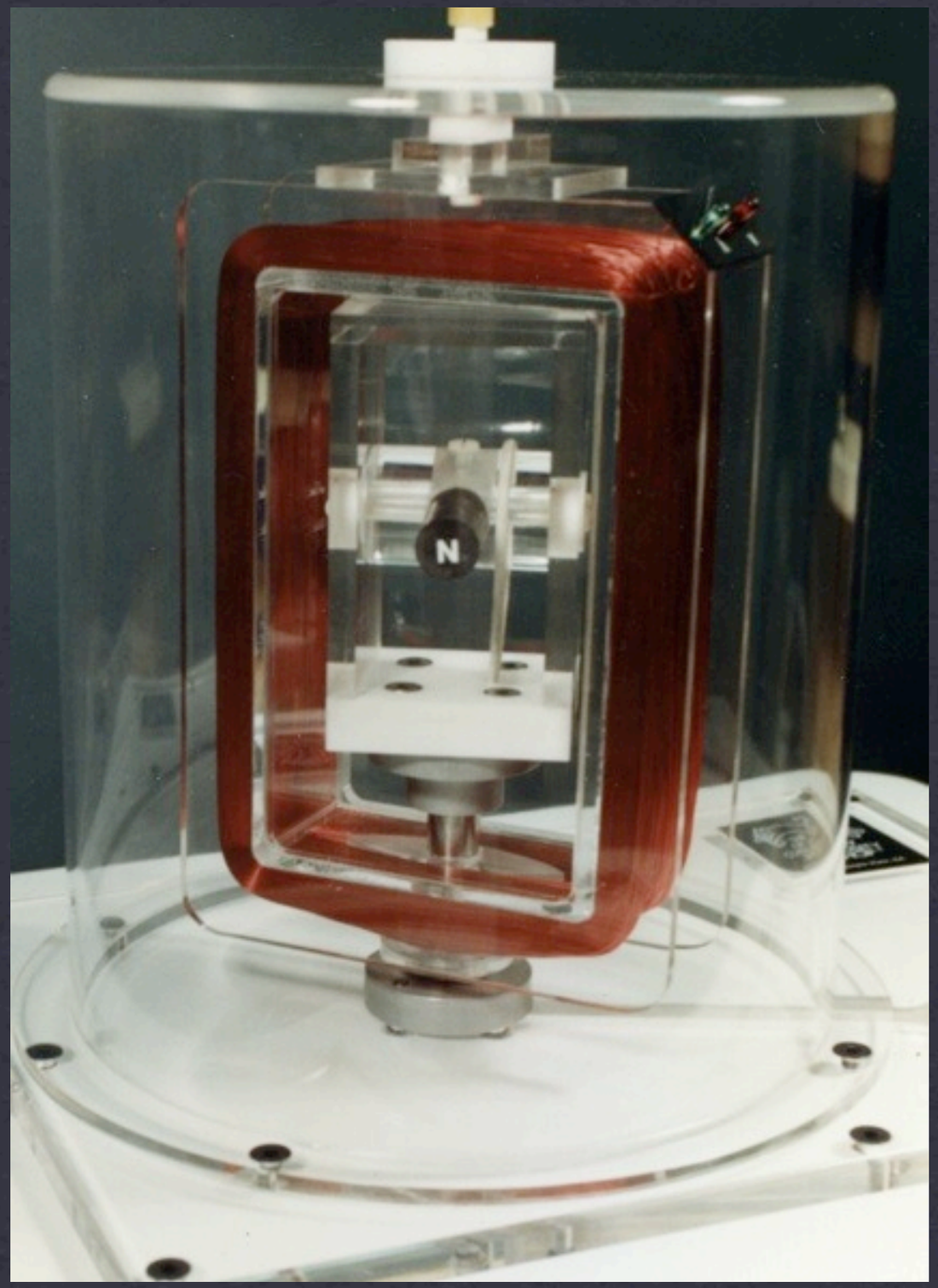
Coping With Complexity Through (Computational) Modeling

Equip the next generations to understand and address complex issues

- make the **fundamental significance** of models clear
- develop **coherent set of strategies** and curricula for progressive development of computational modeling skills
- use **games and simulations** explicitly as model-based systems
- leads to **inherently multi-disciplinary project-based learning**
- **at all levels of education** from elementary school through university and beyond

Experiential learning to develop a vocabulary for thinking



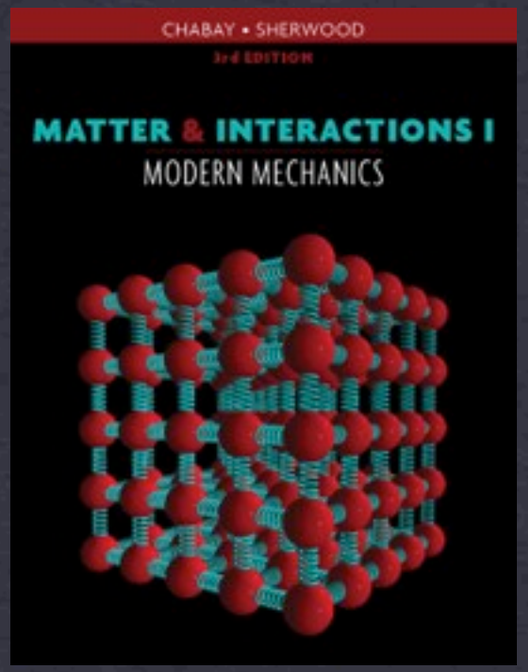


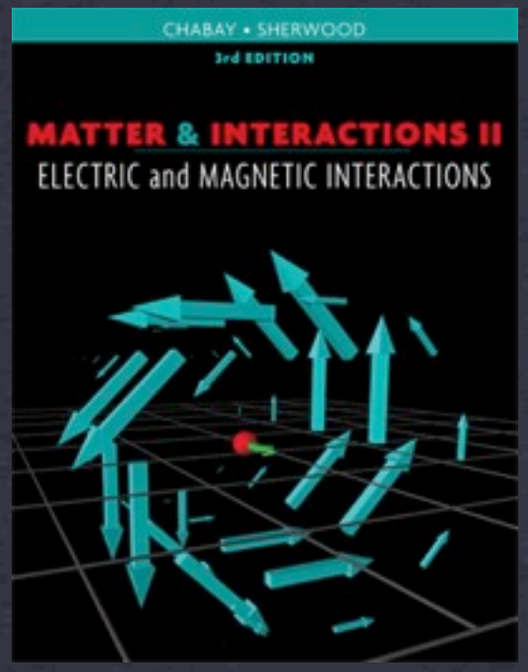
SPINNING MAGNET, SPINNING COIL

Seeing patterns by contrast and comparison

Curiosity and Questions

Stimulate questions first, then together look for answers that lead to further questions





Ruth Chabay and Bruce Sherwood

Matter & Interactions:

Volume 1 - Modern Mechanics,

Volume 2 - Electric and Magnetic Interactions

John Wiley & Sons, 2009

- **Chapter 2:** The Momentum Principle
  - 2.1: System and Surroundings
  - 2.2: The Momentum Principle (22)
  - 2.3: Applying the Momentum Principle (9)
  - 2.4: Momentum Change with Changing Force (1)
  - 2.5: Iterative Prediction of Motion (16)
  - 2.6: Special Case: Constant Force (13)
  - 2.7: Estimating Interaction Times (6)
  - 2.8: Physical Models
  - 2.9: Derivations: Special-Case Average Velocity*
  - 2.10: Inertial Frames*
  - 2.11: Measurements and Units*
  - Computational Problems
- **Chapter 3:** The Fundamental Interactions
  - 3.1: The Fundamental Interactions (1)
  - 3.2: The Gravitational Force (16)
  - 3.3: Approximate Gravitational Force Near the Earth's Surface (5)
  - 3.4: Reciprocity (1)
  - 3.5: Predicting Motion of Gravitationally Interacting Objects (5)
  - 3.6: The Electric Force (5)
  - 3.7: The Strong Interaction (1)
  - 3.8: Newton and Einstein
  - 3.9: Predicting the Future of Complex Systems (1)
  - 3.10: Determinism
  - 3.11: Conservation of Momentum (4)
  - 3.12: The Multiparticle Momentum Principle (2)

Computational modeling as integral part of learning

7. DNA is the source of heritable information in a cell.
- 7-1. The amino acid sequence of proteins is encoded in DNA.
  - 7-1-1. Sets of three letters in the nucleic acid alphabet (that consists of 4 letters) specify one letter in the protein alphabet (that consists of 20 letters)
    - 7-1-1-1. 64 triplet codons: ATG initiating methionine, 3 Stop codons, 60 other codons for the remaining 19 amino acids
- 7-2. Information is encoded in DNA, using different languages that are recognized by different machinery.
  - 7-2-1. DNA encodes when a gene will be expressed or not
    - 7-2-1-1. DNA sequence: promoter, operator, enhancer
    - 7-2-1-2. Protein machinery: activator, repressor, transcription factors
  - 7-2-2. DNA encodes the point at which replication begins
    - 7-2-2-1. DNA sequence: origin of replication (ori).

Julia Khodor, Dina Gould Halme, Graham C. Walker
"A Hierarchical Biology Course Concept Framework:
A tool for Course Design"
Cell Biology Education, V.3, 2004

Finding your way with models & refining the path: schemas, concepts, and hierarchies

AN AUTHENTIC PROCESS OF DOING SCIENCE TOGETHER

Frozen Bubble Box is our laboratory with tools to test our ideas

bubbles float, change size, turn colors, and freeze in a transparent box with dry ice (frozen CO_2 at -78º)

~~THE END~~

THE BEGINNING
OF THE NEXT STEPS
TOWARD A SUSTAINABLE FUTURE