

# Atoms and Stars

## IST 2420

Class 9, March 19  
Winter 2007

Instructor: David Bowen

Course web site: [www.is.wayne.edu/drbowen/aasw07](http://www.is.wayne.edu/drbowen/aasw07)

# Agenda

- Midterms back (other work not graded yet)
- Midterm results
- Upcoming assignments
- Essay 2
- Review of readings
- Physical Science and natural disasters:  
Avalanches
- Lab 10: Lenses

# Midterm Results

- Grade inside square is curved, the one that counts
- Other grade inside circle is raw score. To check:
  - Grade for each question is average of grades for each part (question grades inside circle by each question)
  - Raw score is average of question grades
- Curving:  $\text{grade} = \text{raw} \times 0.6211 + 37.888$ , rounded
  - Individual question grades are not curved, only the overall exam grade is
  - 100 curves to 100
  - 67.8 (raw average) curves to 80 (curved average)
  - Comments (review, not again)

# Midterm Results (cont'd)

- Solid average on Q1 (doing problem higher grade than listing steps)
  - You should push me to put more math on exams
- Q2 (Aristotle cf Archimedes) poor (40%)
- Also problems on part Q3 Part C (characteristics of “pillars”) – 40%
- Did very well (95%) on Q4 (procedure, observation, hypothesis)

# Midterm Results (cont'd)

- Q1A – steps are identify, substitute, multiply, divide (check). Question was to name *and describe*. Name gets 50% without description
- Q1B
  - $3 \times 10 = 6 \times V_2$  (substitute)
  - $30 = 6 \times V_2$  (multiply – on the side with two numbers)
  - $V_2 = 30 / 6 = 5$  (divide – divide both sides by 6)
  - $3 \times 10 = 6 \times 5$  or  $30 = 30$ , so OK (check)

# Midterm Results (cont'd)

- Q2 – Aristotle & Archimedes
  - See notes for Class 4, slide 48
- Q3 – the two “pillars” (for me, basic content of this course)
  - A & B: experiment makes science reliable, theory makes it valuable
  - C: experiments are validated, repeatable, public, theories are productive, unifying, consistent with all (most) experiments

# Midterm Makeup

- Makeup for Midterm? Someone has requested one, so it will probably happen
- If there is a makeup for people who missed it, anyone can take it to try for a better grade
- Will be a different exam from the same 29 questions
  - May be repeats
- Would probably be on a Monday 5 – 6
  - Watch for an email announcement

# Tonight

- Handouts:
  - Notes for Class 9
  - Questions for Final Exam
  - Information Sheet for Final Exam
- Due:
  - Report for Lab 13
- March 14 (3-14) was “pi day” or “ $\pi$  day”
  - Also Einstein’s birthday (1879)

# Essay 2

TOPIC: What has this course been about? You should answer this question with a core concept or idea, perhaps with dependent parts, and illustrated by referring to course experiences, such as labs and discussions, and materials, such as readings, notes, lab materials, and so on. A starting point is the “Course Description” section in the Syllabus. You can agree with, make changes to, or disagree with this description, but if you disagree, include an equivalent description – that is, one that covers the course as a whole.

## Essay 2 (cont'd)

- This topic does NOT ask for a simple listing of all of the topics and activities (“laundry list”), and does not ask for an evaluation of me or the course (that’s for SET).
- The topic asks for “a” core concept and suggests a starting point for your analysis
- Due 4/23. Note that we have not covered all of the core topics yet.
- Review Syllabus for other requirements
  - All quotes must have references

# Final Topics / Info Sheet

- Final will be cumulative
  - Could even be repeats
  - Use the review session! Especially if you left questions blank on the Midterm
- Information sheet
  - You will get a clean copy with the Final
  - Some answers directly on this sheet
  - But you must be able to use other words than the ones on the sheet

# Iraq War and Evidence

- War started four years ago today
- WMD rationale for war involves evidence, so that part is relevant to this course (rationale means a fundamental reason)
- Some claims that supported WMD, e.g.:
  - CIA assessment of nuclear program
  - Iraq tried to buy “yellowcake” from Niger
  - Other nations’ assessments
  - Iraq purchased aluminum tubes that were meant for centrifuges to purify uranium

# Iraq War and Evidence (cont'd)

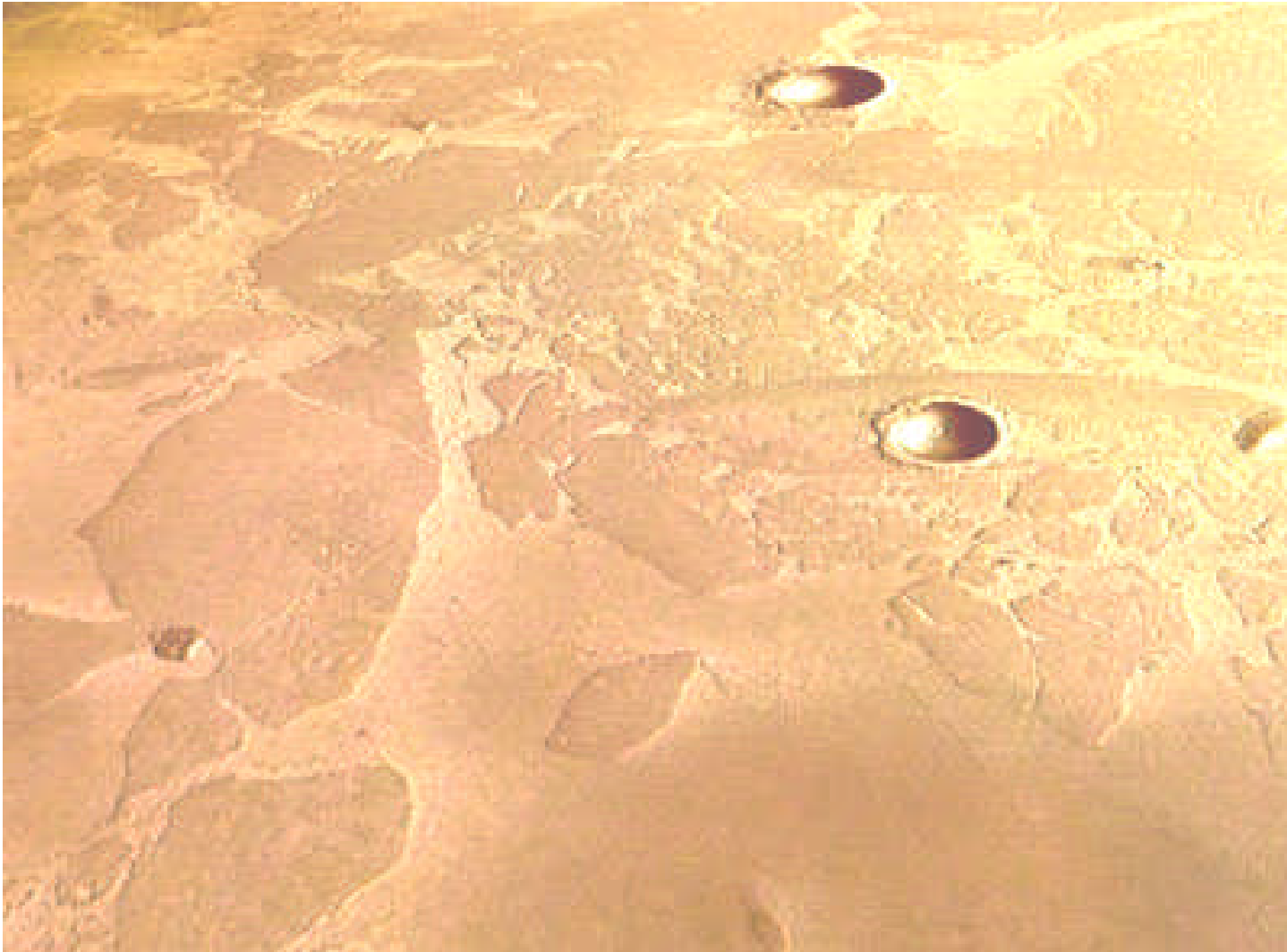
- But, in every case, there was also contrary evidence, e.g.”
  - IAEA had no evidence for nuclear program
    - CIA assessment not based on evidence but on projection
  - Niger evidence unbelievable (Wilson, Plame)
  - Other nations did not support war
  - Aluminum tubes better suited for rockets
- Negative evidence – no other explanation
  - But seems Hussein wanted to bluff neighbors

# Iraq War and Evidence (cont'd)

- In science:
  - Incorporate all the evidence, not just some
    - Otherwise, may end up with what you want to believe, rather than the facts
    - Some say to pay *particular* attention to the evidence *against* your hypothesis or theory
  - Negative evidence (“no other explanation”) is not sufficient
    - Here, your enemy may not think the way you do

# Reading: “The Planet Mars and Kepler’s Three Laws of Planetary Motion”

- “My Very Excellent Mother Just Sent Us Nine Pizzas” – planets and their order out from the sun (oops – only eight planets)
- Mars a special case for Kepler, for mankind too – life on Mars?
- Illusory “canals” on Mars, “War of the Worlds”
- Recent indications of water, “Mars Express” (next slide). Life there?



## A dust-covered frozen sea?

3/19/06

Atoms and Stars, Class 9

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# “The Planet Mars and Kepler’s Three Laws of Planetary Motion”

- Mars (and other planets) get brighter and dimmer
  - In geocentric theory, hard to explain this
  - Heliocentric: natural – closer to & further from us
    - [Retrograde Motion](#) demo
- Kepler’s three laws:
  1. Planetary orbits are ellipses, sun at one focus
  2. Planet sweeps out equal areas in equal times
  3.  $T^2 \propto R^3$  ( $\propto$  means “is proportional to”) – 3/8/1618
    - Period T (length of year), mean radius R

# A Common Sequence

- Brahe → Kepler → Newton
- Accurate measurements → “empirical” theory (little explanatory power, descriptive only) → explanatory theory

# A Common Sequence

- Reader says Physics has no explanation for gravity
  - Modern Physics does have explanations

# Reading: The Crime and Punishment of Galileo Galilei

- Galileo Galilei 1564 – 1642
- Started life as a rather ordinary mathematician
- 1608 Hans Lipperhey invented telescope in Holland
- Galileo got hold of one, improved it, looked at the heavens systematically

# Galileo

- Moon had mountains and valleys
  - Not perfect(ly smooth)
  - Had to study shadows over weeks
- Four moons of Jupiter
  - Earth not unique in this way
  - Had to study motions over time
- 1610 *Siderius nuncias* (Starry messenger)
  - (DB: Galileo was 46 years old then)
  - Sensational

# Galileo

- Left university at Padua for court appointment to Medici in Florence
- Reputation among people and nobles
- Joined private organizations – Academia dei Lincei (Academy of the Lynx-eyed or sharp-sighted)
  - Universities too conservative then, because of church influence
- Controversies about telescope
  - Some refused to look through it
    - But scientists cannot ignore evidence - they can and do dispute it
- Supported Copernican astronomy publicly

# Galileo

- 1616 Church declared Copernicus to be heretical, Galileo had to promise not to “hold or defend” it (but teach?)
- 1623 Galileo’s friend Maffeo Barberini became Pope Urban VIII
- Approved Galileo’s book project (*Assayer*) but said it had to present Ptolemy and Copernicus as equal alternatives

# Galileo

- Pope also changed title to *Dialogue on the Two Chief World Systems*
- 1632 (Galileo 68) book published, formally neutral but really Copernican
  - Advocate for Ptolemy was called Simplicio
  - Simplicio characterized as a high official
  - Phases of Venus (like moon's but require a telescope) incompatible with geocentrism

# Galileo

- o Phases of Venus (“horned Venus”):
  - Lit by sun, we see it from different angles
- o *Worse*: book in popular language (Italian) and popular
- o Also dealt with other difficulties of spinning earth, mainly by saying everything moves along with the earth
- o His argument in this book that tides show earth’s motion is false

# Galileo

- 1632 (same year as publication), Pope ordered sales stopped, copies retrieved, all materials taken from printer, special committee which handed matter over to Inquisition
- Galileo called to Rome, legalistic defense
- Compromise but Pope insisted on heresy charges (punished by burning at stake)

# Galileo

- 1633 convicted on lesser charge, forced to denounce Copernicus and supporters, house arrest
- Started a new career.
- 1638 Discourses on Two New Sciences  
returned to earlier work
  - o Strength of beams (advance)
  - o Balls rolling down tracks

# Galileo

- Used experiments to confirm hypothesis  
 $s \propto t^2$  for gravitational motion
  - Does not show data, discuss errors
- Then projectile motion
  - Horizontal (circular) and vertical motions independent
  - Inertia
  - Gunnery tables from theory, but not needed

# Post-Galileo

- Theories did not take hold in Italy
  - Inquisition
  - Galileo's manner, e.g. controversy, did not train students
- Scientific revolution moved north and east to France, Holland, England

# Post-Galileo

- 1596 – 1650 René Descartes
  - “Cartesian” coordinates –  $x$ ,  $y$ ,  $z$  (3D)
  - Mechanical universe 1644 Principles of Philosophy (vague, not modern)
- Others in Holland: Huygens, van Leeuwenhoek (microscope, “animalcules”)
  - Englishman Robert Hooke 1635 – 1703
  - Slow acceptance of miniature world

# Post-Galileo

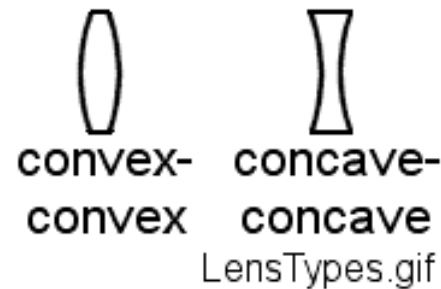
- Isaac Newton 1642 – 1727
- Science is active, promotes human welfare, contrasts with passive Greek concept
  - Archimedes an exception among Greeks
- 1561 – 1626 Francis Bacon – philosopher of science (what is the logic behind science?)
  - Scientific method
  - Skepticism
  - Importance of experiment

# Natural Disasters (one more)

- Hurricanes, tornadoes, earthquakes, tsunamis, mudslides and now, avalanches
- Avalanche depends on layers of snow resting on icy crusts
  - Each melt, freeze, snow cycle adds a layer
  - Then a sharp loud sound can trigger avalanche
  - We can tell when conditions are right
  - We can trigger avalanches by, say, firing a cannon. Makes area safe at that time.

# Lab 10: Lenses

- General – light is easier to see than bunny
- Lenses are in tissue paper inside envelopes
- Labels on envelopes do not mean anything
- Each envelope has five lenses – keep track by type – write a description of each lens
  - o Three convex with increasing thickness
  - o One concave
  - o Other types: plane, plano-convex, plano-concave
  - o Need to match measurements with lens later

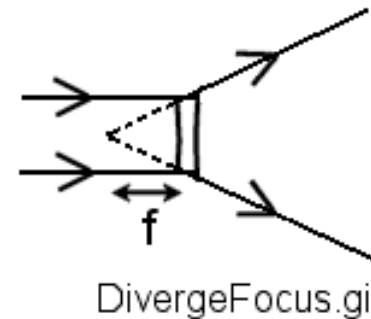


# Lab 10 (cont'd)

- Exercise I.
  - o For this part, start with the lens touching the paper. As you move the lens towards you, if you see a dramatic change in the image, keep the lens closer to the paper.
    - Afterwards – what happens as you move lens past the point of dramatic change?
  - o What type of lens is magnifying? Reducing?
  - o For magnifying lens, how does focal length vary with curvature?

# Lab 10 (cont'd)

- Exercise II: image properties
  - Real (can be projected on a screen) Vs Virtual (behind lens, can be seen but not projected)
  - Inverted (upside down) Vs Non-Inverted
  - Magnified (larger than object) Vs Reduced
- Measure focal length in mm
  - Measuring focal length for reducing lens
    - Skip this



# Lab 10 (cont'd)

- Exercise III (telescope):
  - Two lenses are objective (closer to object) and eyepiece (closer to your eye)
  - Good telescope – focal length for objective is longer than for eyepiece –  $M = \frac{f_{obj}}{f_{eye}}$   
*choose lenses*
  - Hold eyepiece up to eye (close)
  - Distance between lenses approximately the sum of focal lengths
- Do not do the WRITING ASSIGNMENT