Engaging Students in Common Core Courses - Arousing Their Interest and Managing Their Expectation

PHYS1006 Astronomy for Beginners

- For students with no physics background.
- Exclusion(s): Level 3 or above in HKDSE 1/2x Physics OR HKDSE 1x Physics, a passing grade in AL/AS Physics

PHYS1006 Course Outline

- PART I Foundations
  - Chapter 1

    The Birth of Modern Astronomy
  - Chapter 2

    The Physics of Astronomy --- Gravitation, Matter, and Light
- PART II Our Solar System
  - Chapter 3

    The Earth, the Moon, and the Sun
  - Chapter 4

    An Inventory of the Solar System

PHYS1006 Course Outline

- PART III The Stars
  - Chapter 5

    The Sun
  - Chapter 6

    Measuring the Stars --- Giants, Dwarfs, and the Main Sequence
  - Chapter 7

    Stellar Evolution
  - Chapter 8

    Neutron Stars and Black Holes

PHYS1006 Course Outline

- PART IV Galaxies and the Universe
  - Chapter 9

    The Milky Way Galaxy
  - Chapter 10

    Galaxies and Dark Matter --- The Large-Scale Structure of the Cosmos
  - Chapter 11

    Cosmology --- The Big Bang and the Fate of the Universe
  - Chapter 12

    Life in the Universe --- Are We Alone?

PHYS1006 Assessment

- **PRS (2 %)**
- **Midterm Exam (38 %)**
- **Final Exam (60 %)**

PHYS007 Physical Phenomena in Everyday Life (2008-2011)

- Many phenomena we observe in everyday life are governed by the laws of Physics. In this course, we shall explore how the basic laws of physics work in our everyday life with simple examples and demonstrations.
- Exclusion: AL Physics

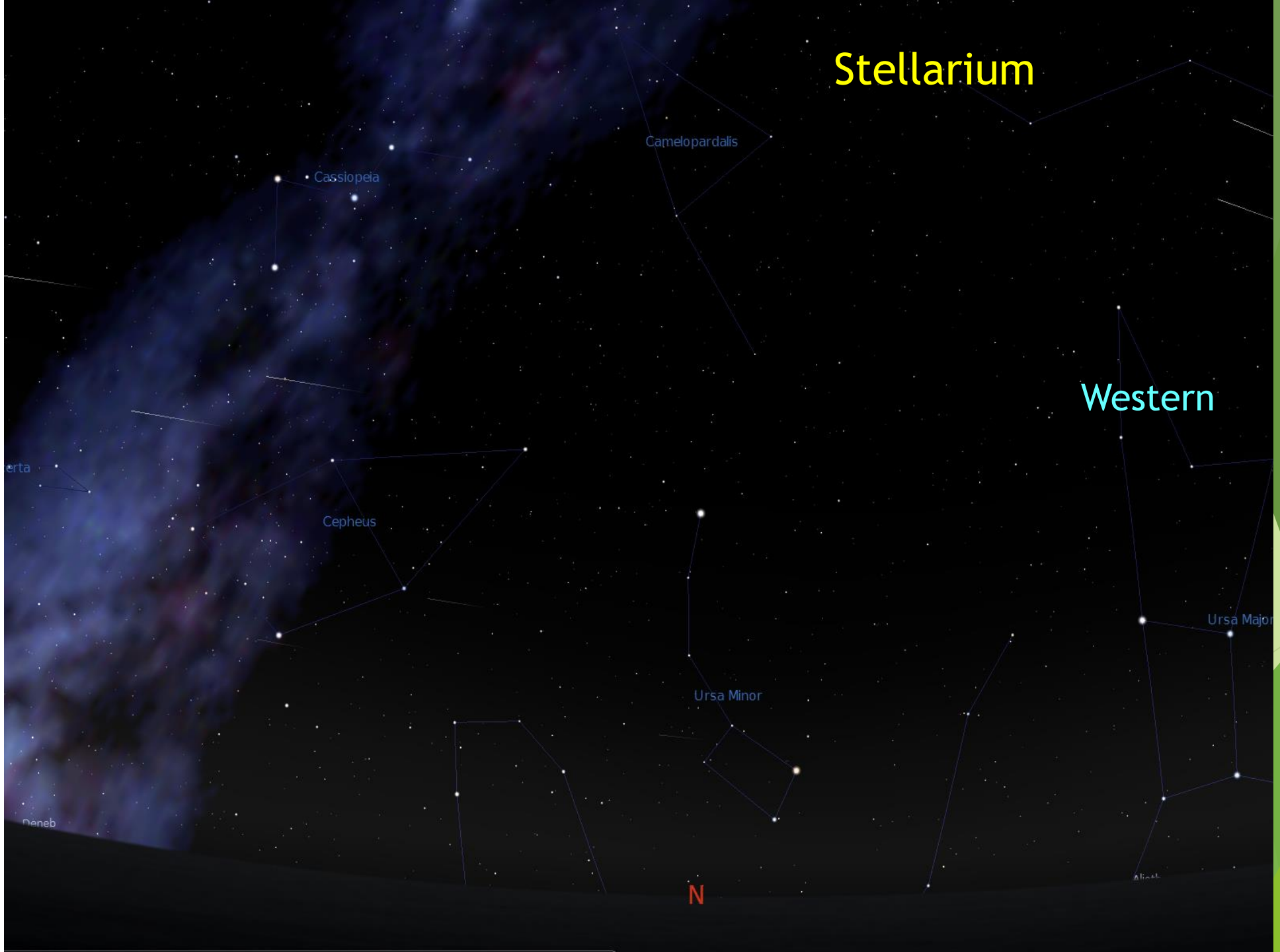
- How to arouse students’ interest in the subject?
- How to manage students’ expectations?

Arousing Students' Interest

1. Demonstrations, videos, animations

- Help students visualize the concept
- Intuitive and easy to understand

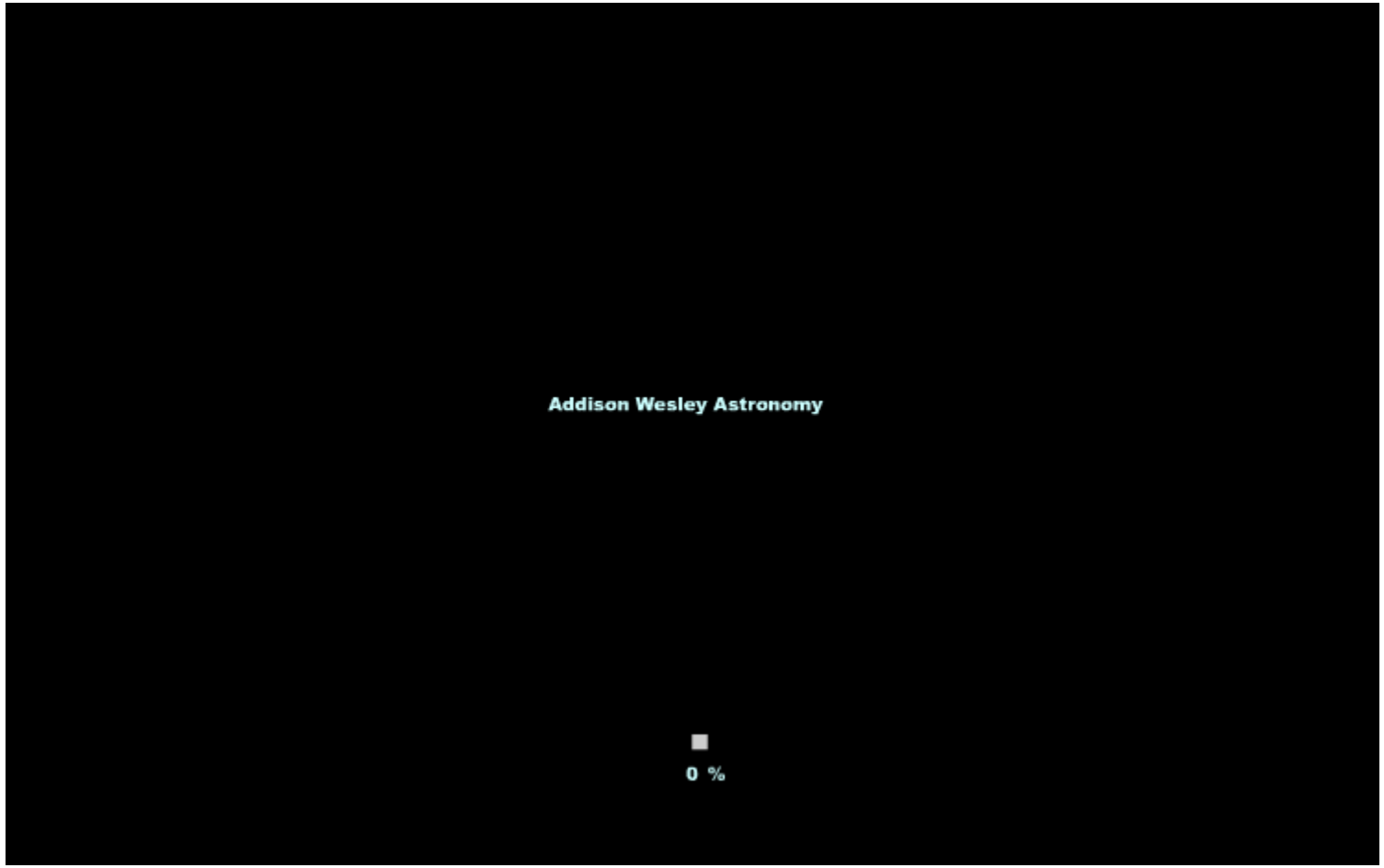
Stellarium



Western


Lynx
Camelopardalis
Cassiopeia
Ursa Major
Cepheus
Ursa Minor
Alioth
N

Celestial Sphere



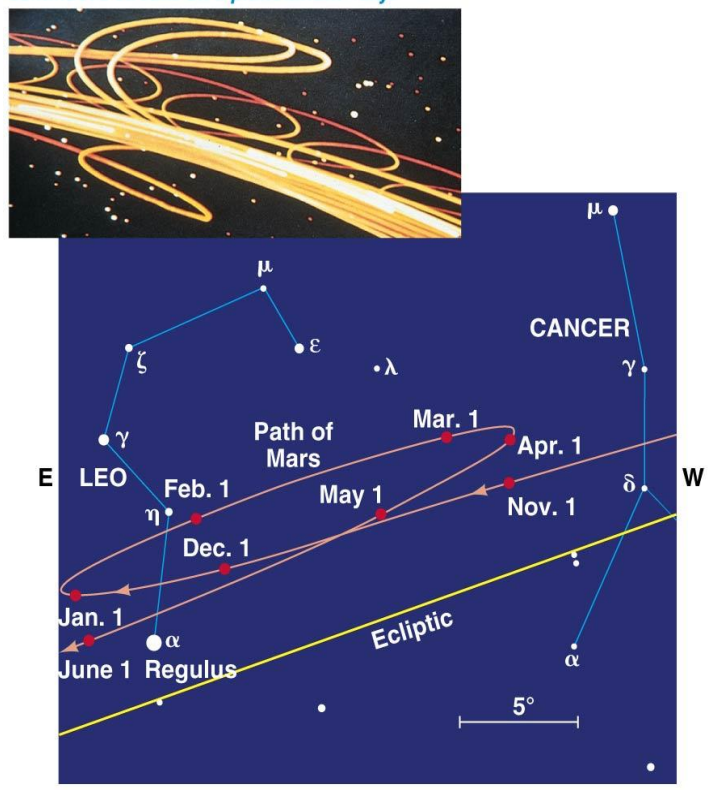
MotionNightSky.swf

celsphere1.avi

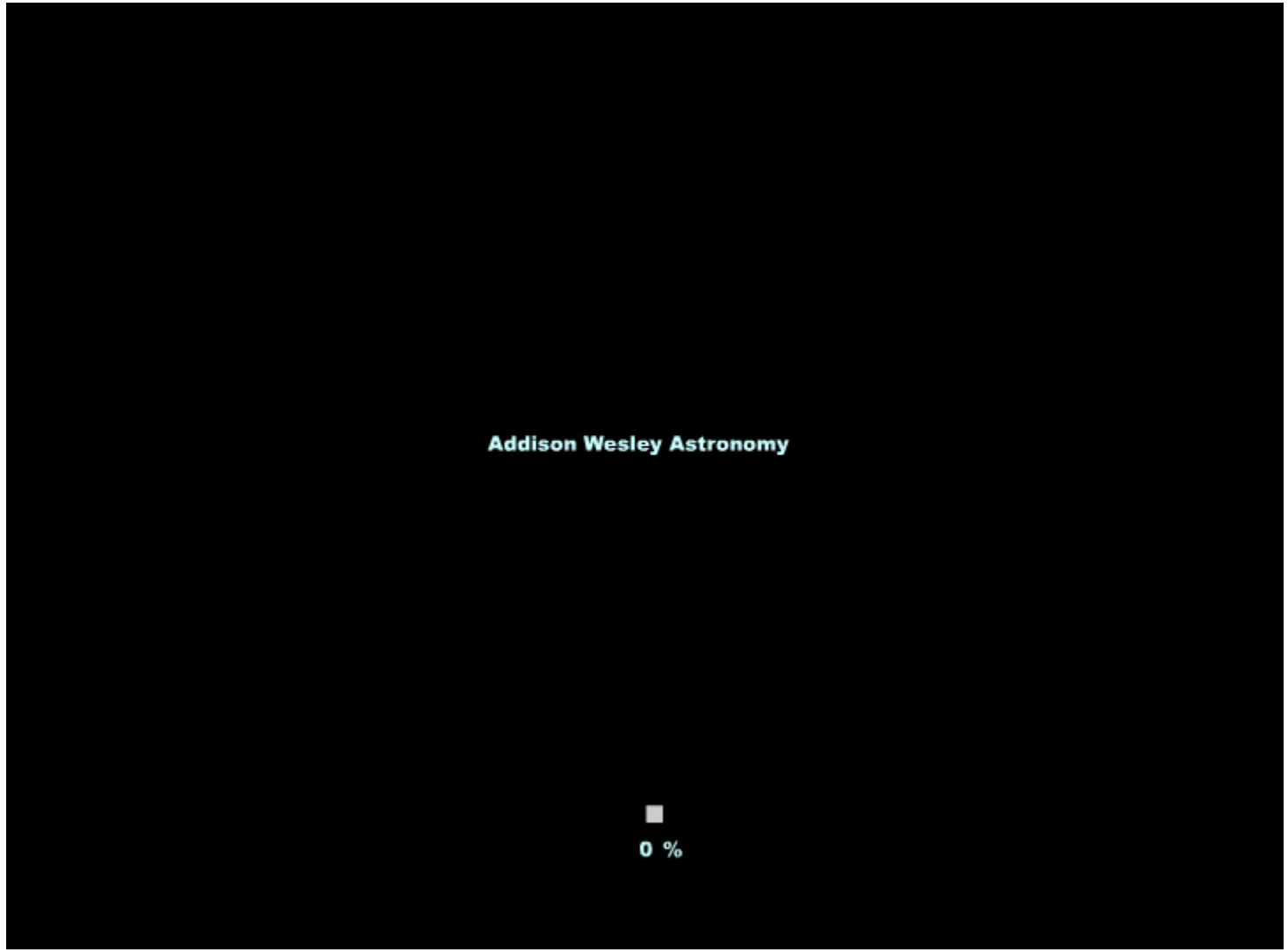
Retrograde Motion of Planets

- Planets drift from W to E from night to night
- Over some periods, they will drift in opposite directions (from E to W)
- This is called *retrograde motion*

Motions of the planets relative to the stars produce continuous streaks on a planetarium "sky."



Observed planet motions can be complicated because each planet travels with a different speed around the Sun.



mars_retrograde_motion.swf

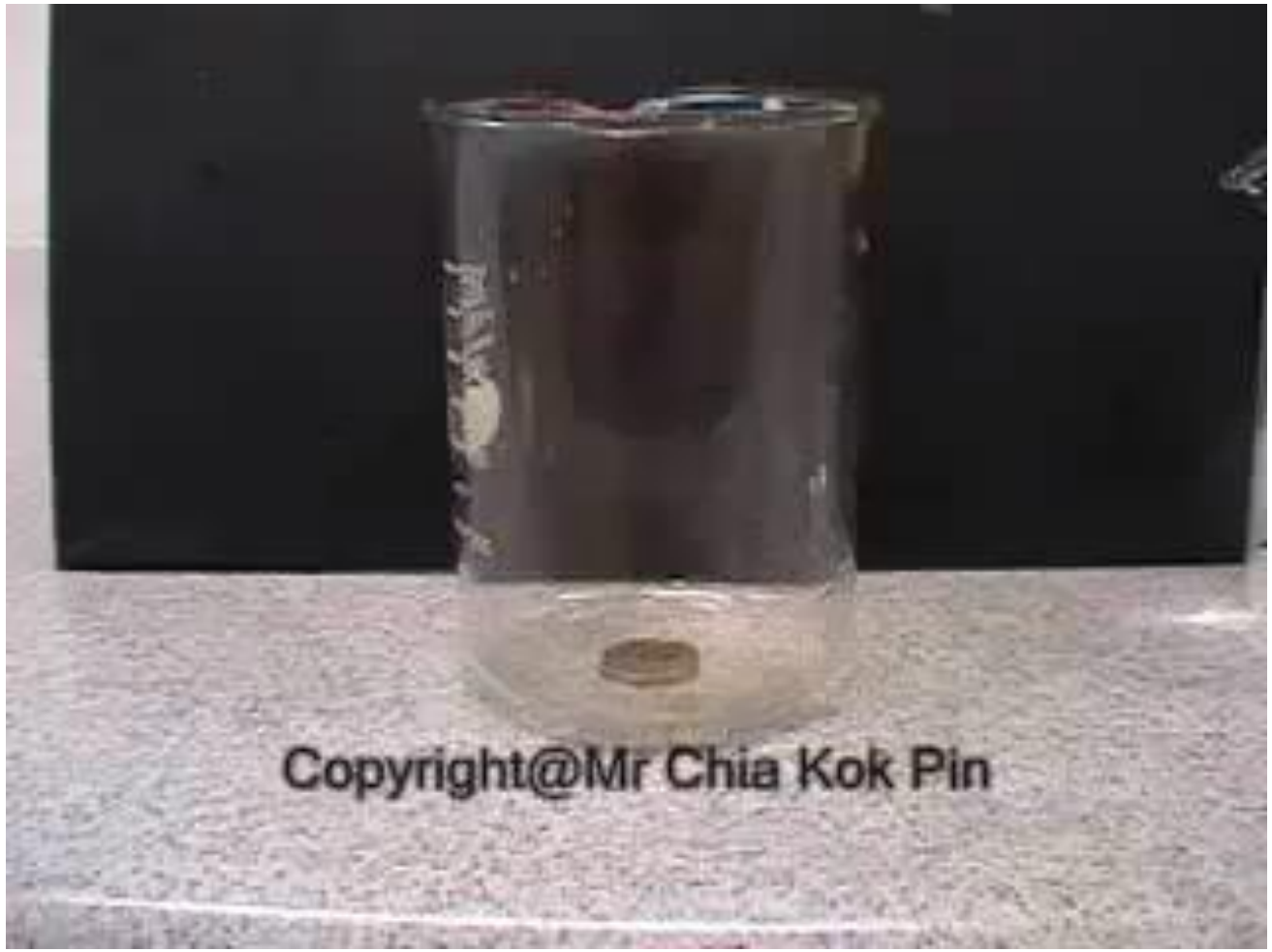
Sun

Earth

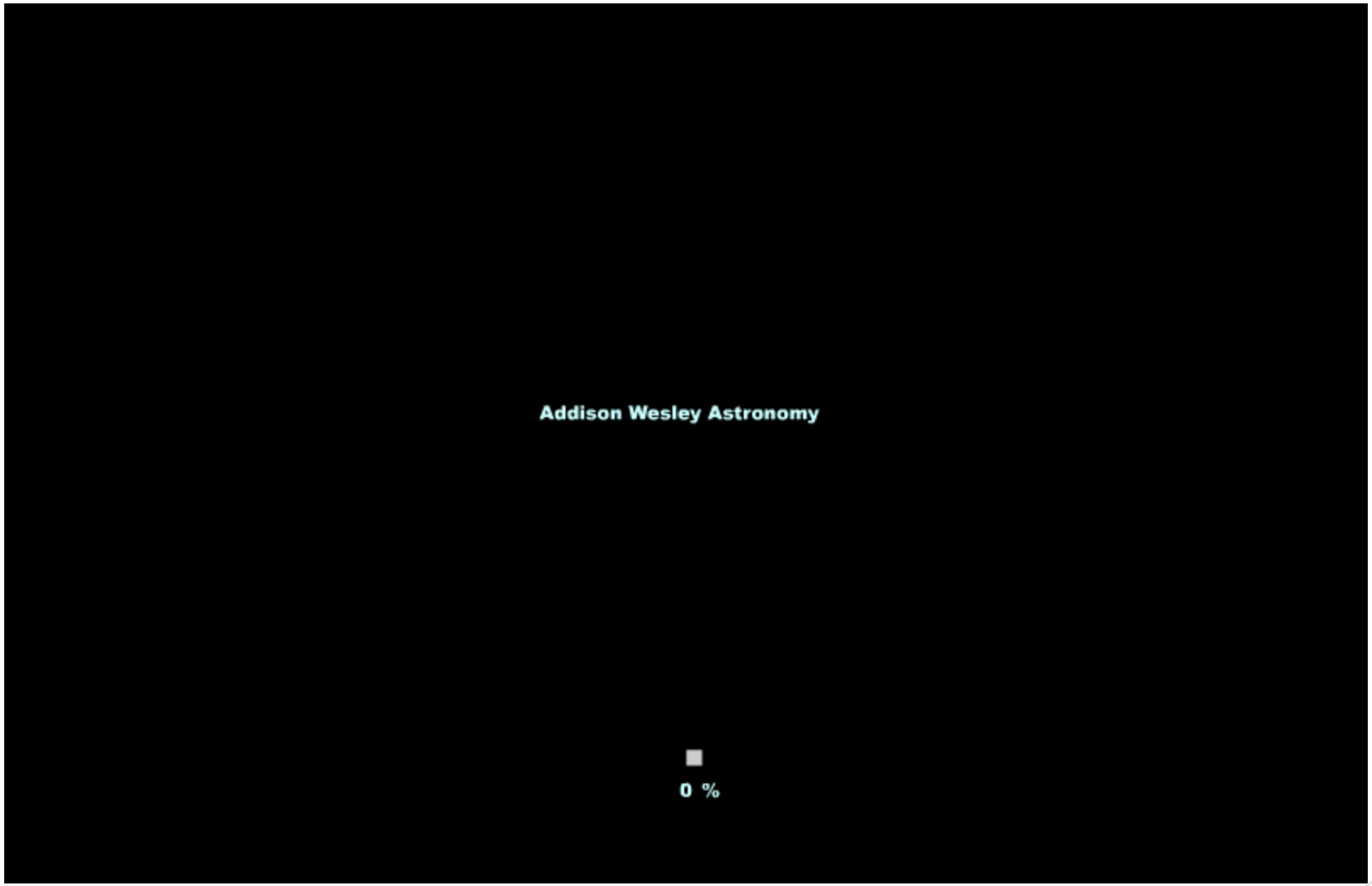
Mars

Laws of Motions

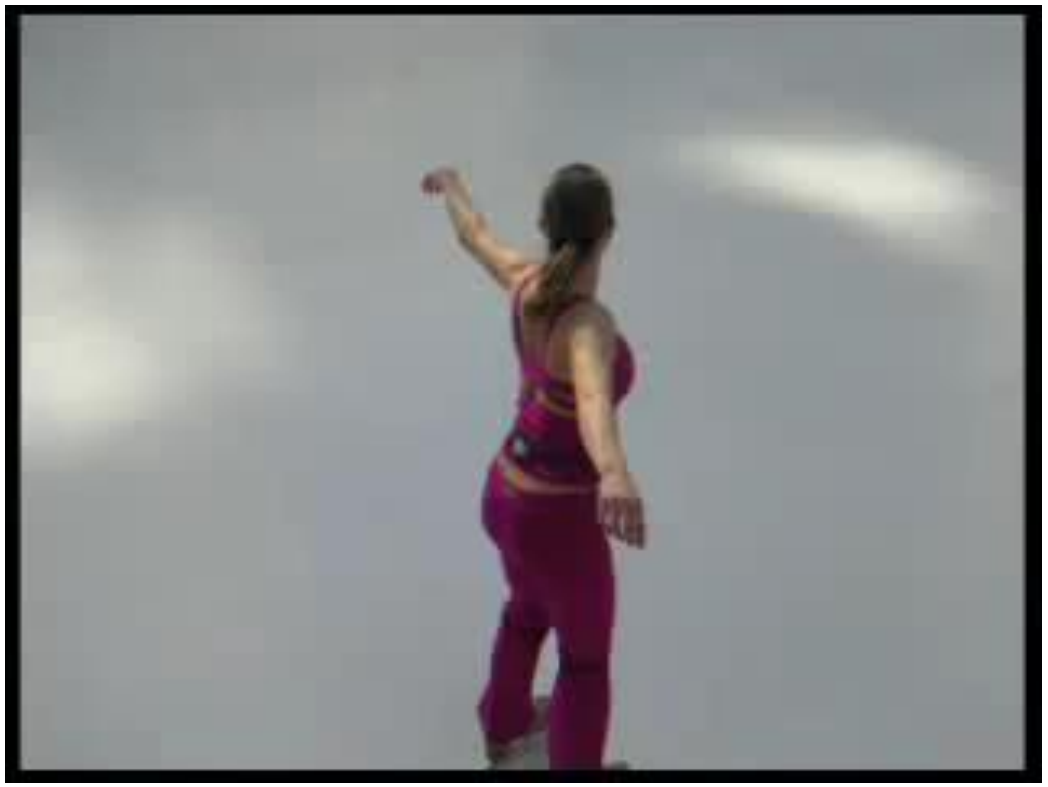
Total Internal Reflection



Kepler's Second Law

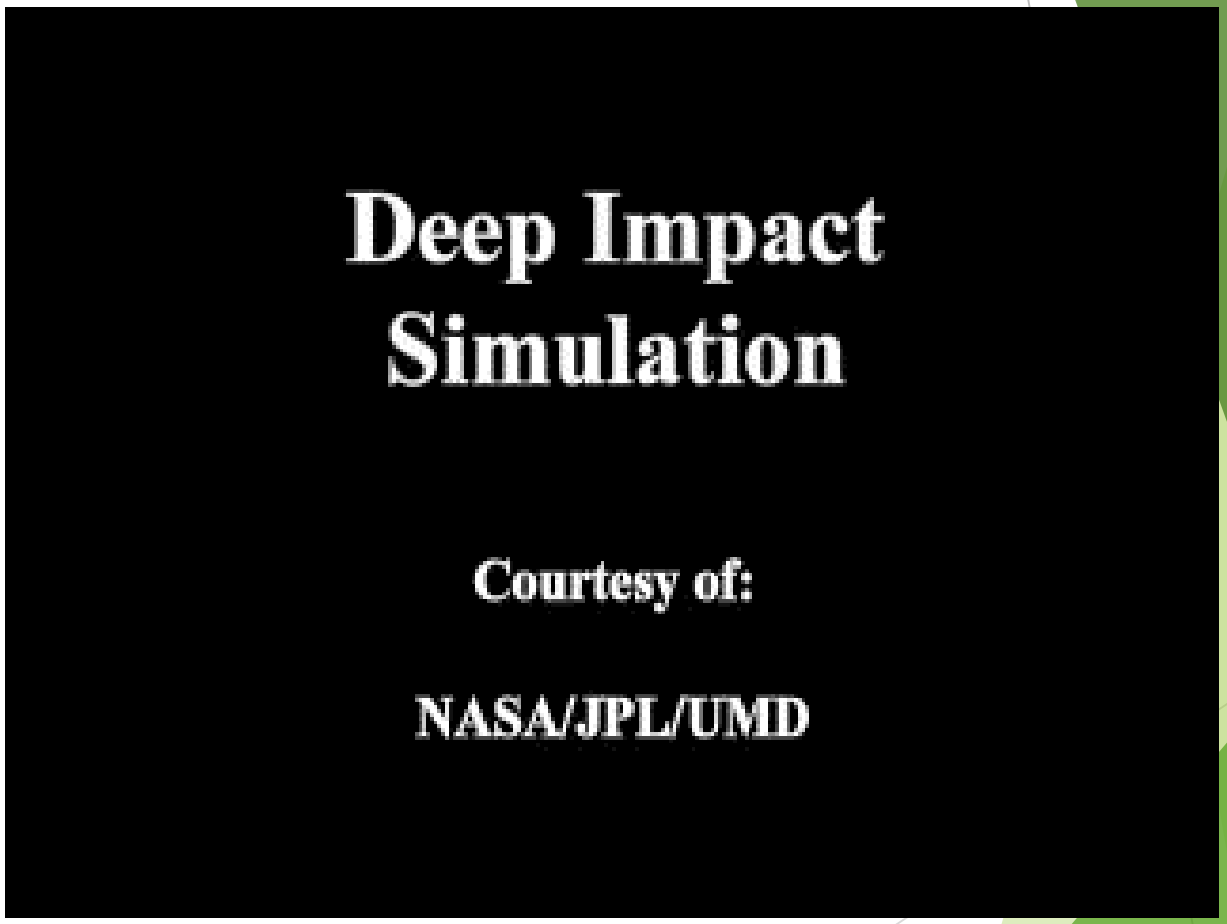


kepler_2_velocty_vs_orbit_r.swf



World Record Figure Skating Spin.mp4

Comet --- Deep Impact

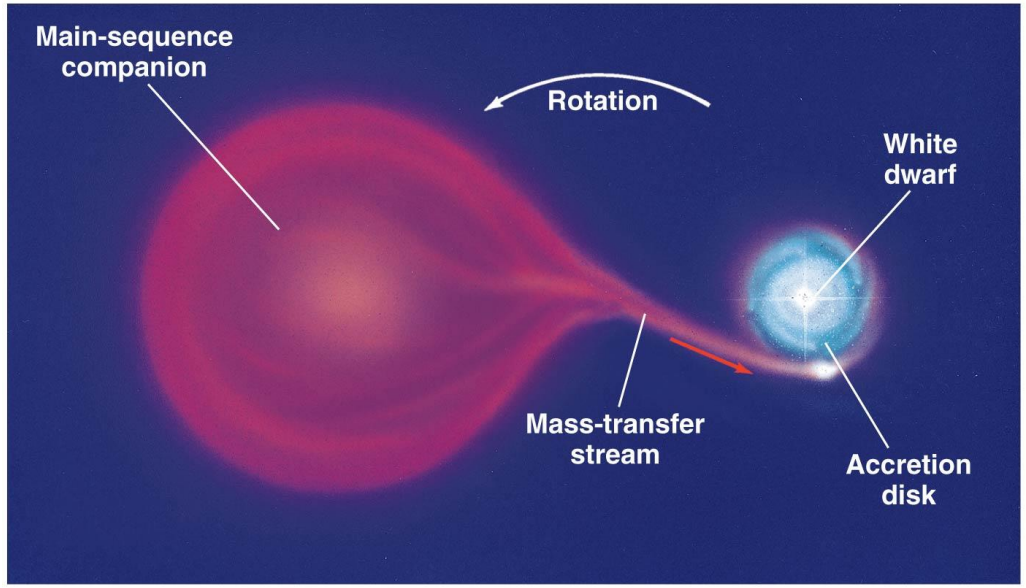


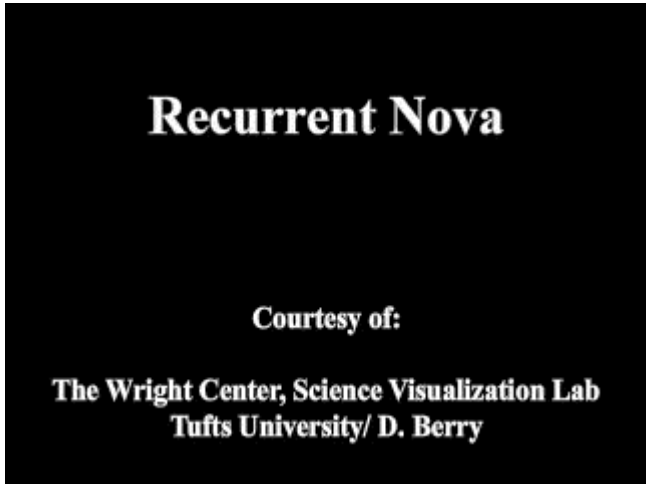
DeepImpactSimulation.mov

U.S. Geological Survey


MOVIECLIPS.COM

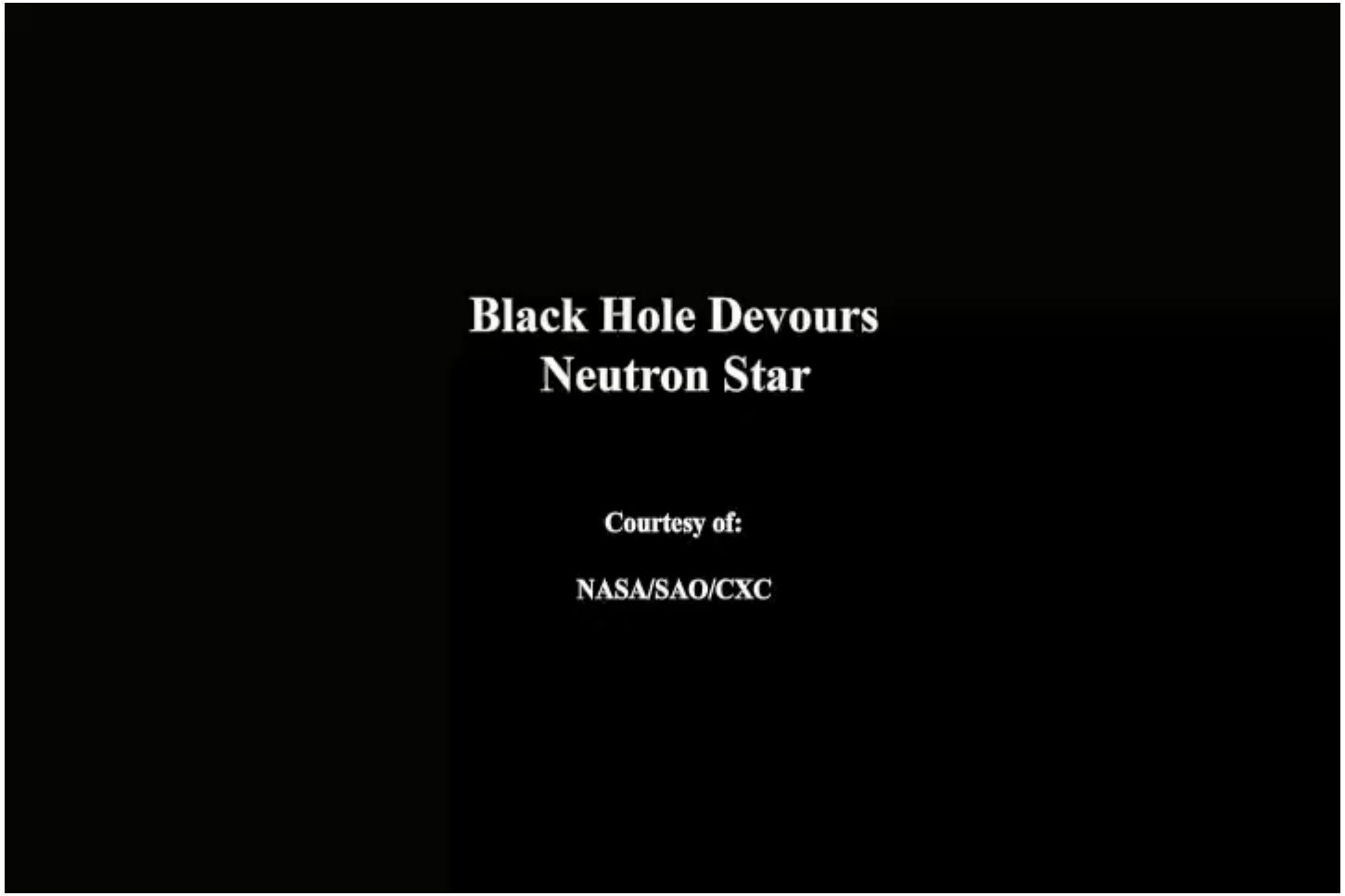
Nova





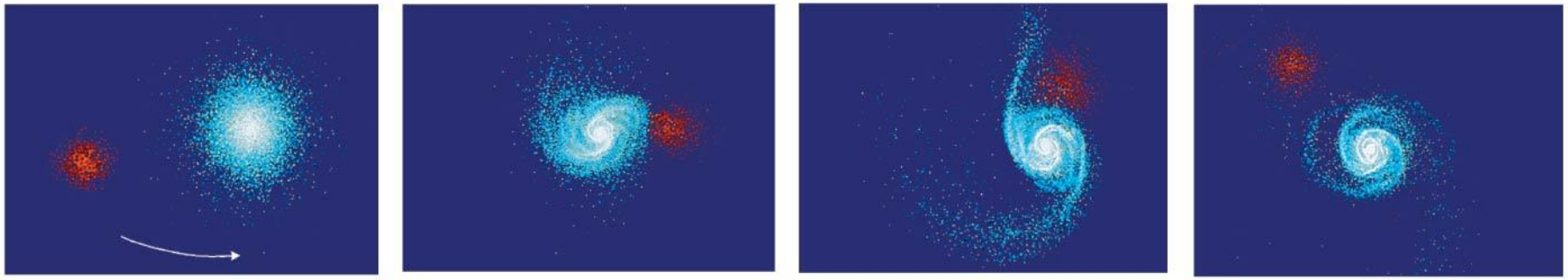
RecurrentNova.mov

Black hole Tidal Force



BlackHoleDevoursStar.mov

Galaxy Collision



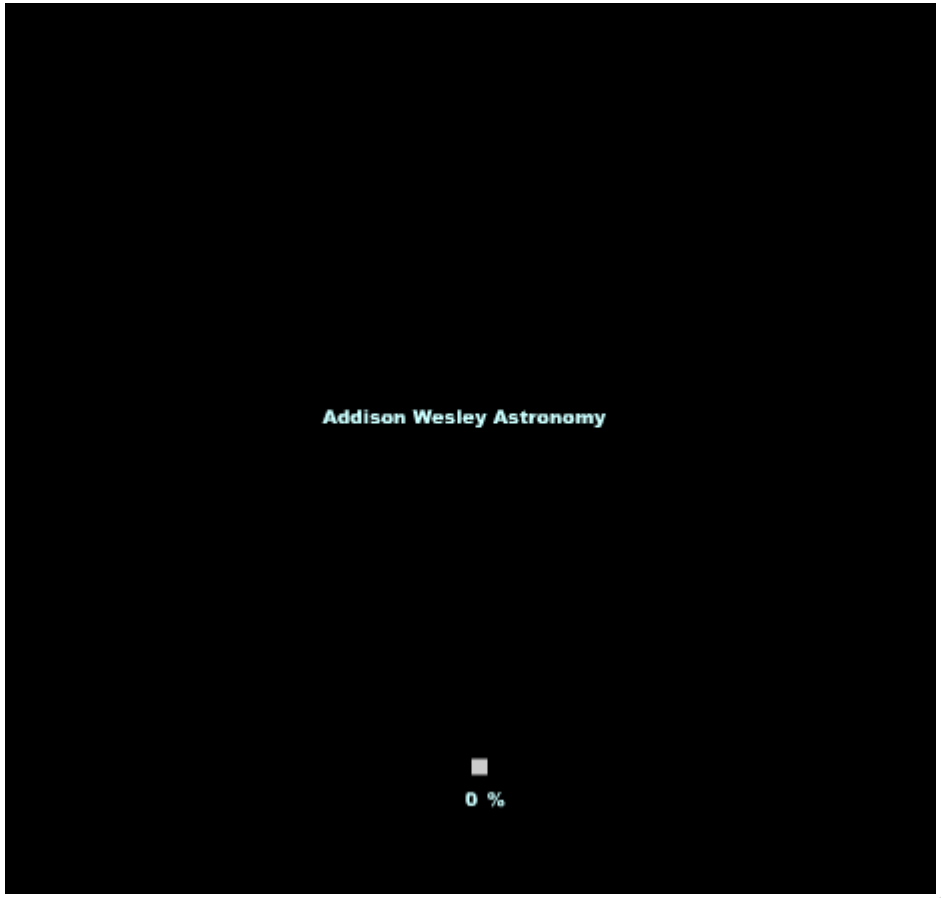
GalaxyCollision2.mov

2. Relating the subject to students' daily lives

- Arouse their interest
- Easier to understand

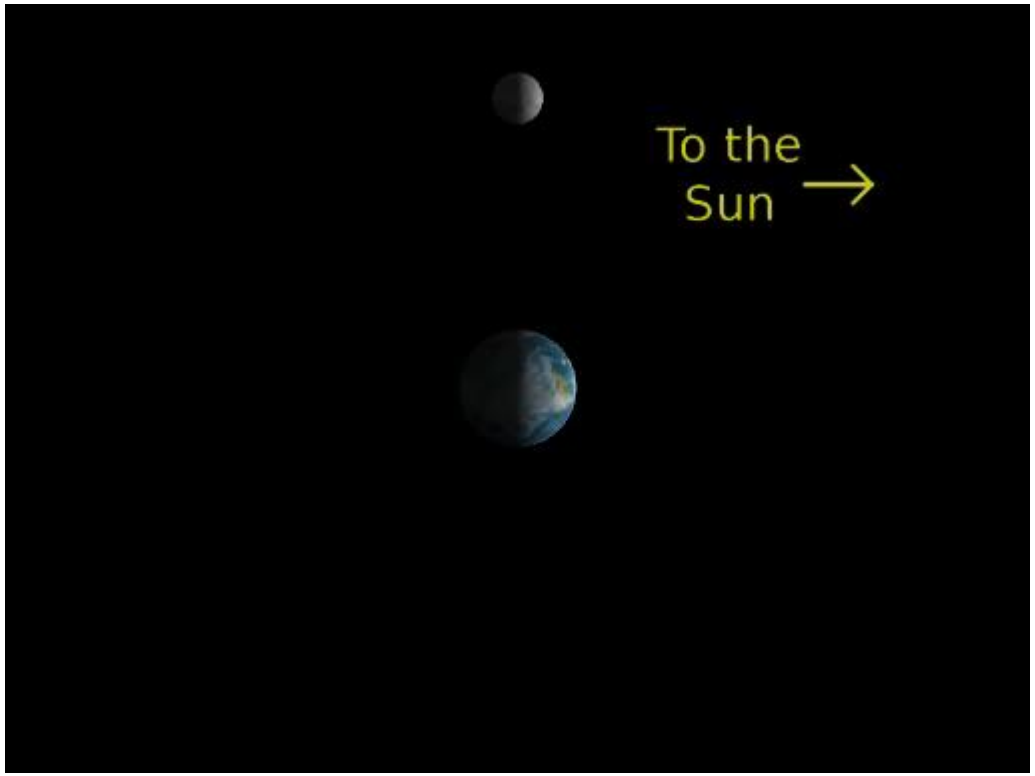
What causes seasons?

What_Causes_Earth_s_Seasons.avi



ReasonForSeasons.swf

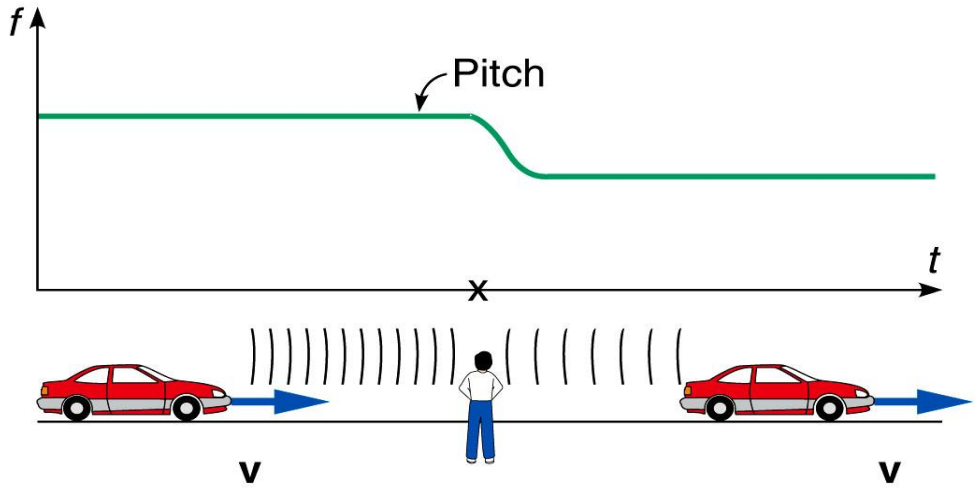
Lunar Phases



LunarPhases.avi

Doppler Effect: Light → Sound

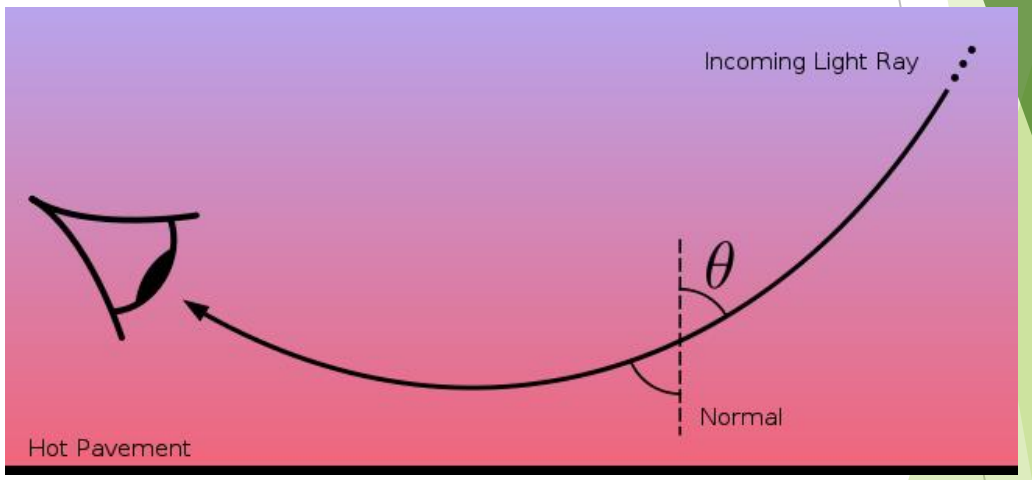
An approaching (receding) source has a higher (lower) frequency according to the stationary observer

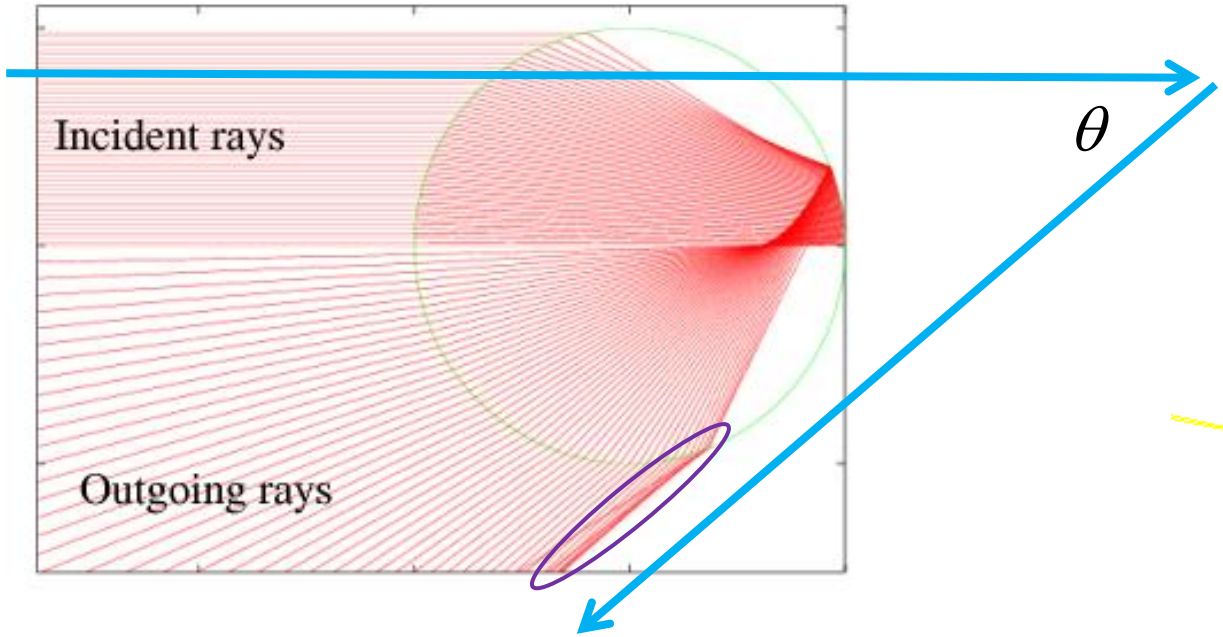


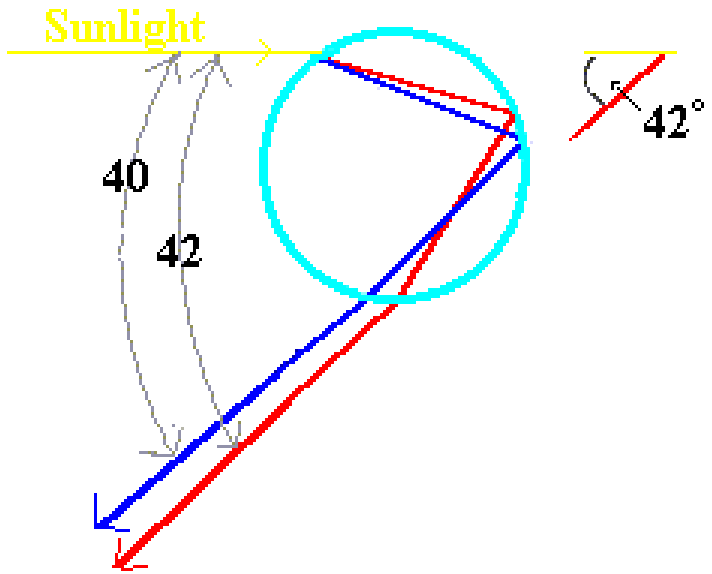
Beat and Musical Scales

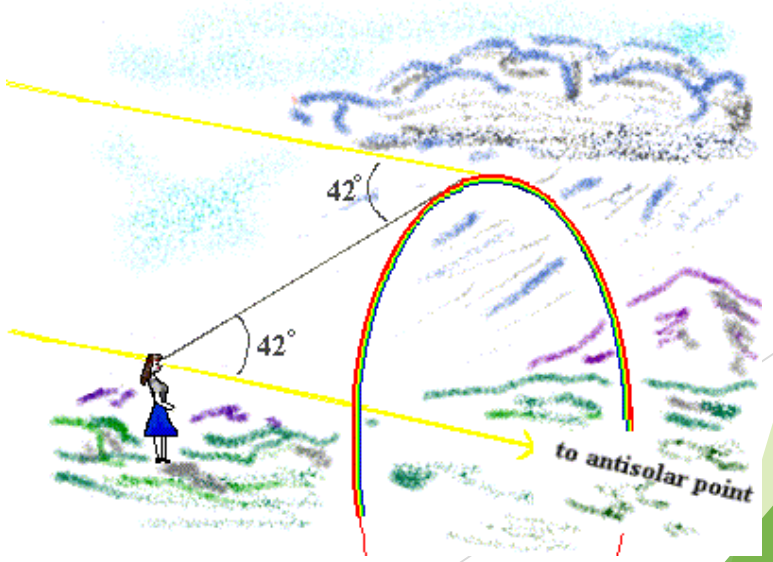
Name	12-TET	Just Intonation
Unison (d)	$2^{0/12} = 1.000000$	1:1 = 1.000000
Minor second (#d)	$2^{1/12} = 1.059463$	16:15 = 1.066667
Major second (r)	$2^{2/12} = 1.122462$	9:8 = 1.125000
Minor third (#r)	$2^{3/12} = 1.189207$	6:5 = 1.200000
Major third (m)	$2^{4/12} = 1.259921$	5:4 = 1.250000
Perfect fourth (f)	$2^{5/12} = 1.334840$	4:3 = 1.333333
Diminished fifth (#f)	$2^{6/12} = 1.414214$	7:5 = 1.400000
Perfect fifth (s)	$2^{7/12} = 1.498307$	3:2 = 1.500000
Minor sixth (#s)	$2^{8/12} = 1.587401$	8:5 = 1.600000
Major sixth (l)	$2^{9/12} = 1.681793$	5:3 = 1.666667
Minor seventh (#l)	$2^{10/12} = 1.781797$	7:4 = 1.750000
Major seventh (t)	$2^{11/12} = 1.887749$	15:8 = 1.875000
Octave (d)	$2^{12/12} = 2.000000$	2:1 = 2.000000

Reflection and Refraction → Mirage and Rainbow




Incident rays
Outgoing rays
θ

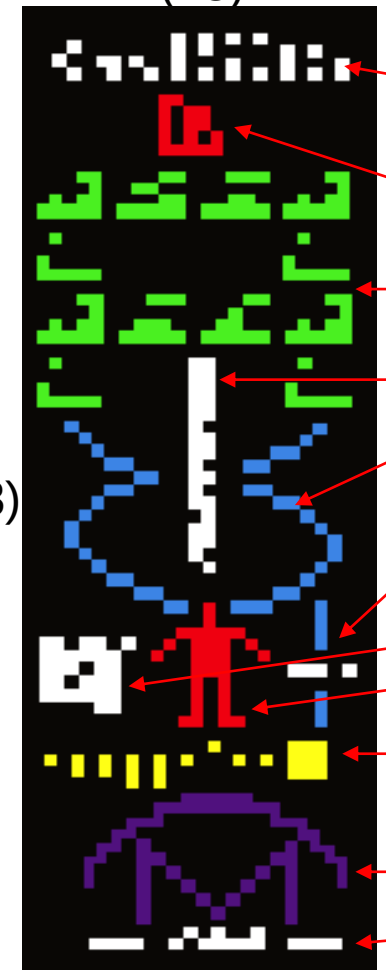

Sunlight
40
42
42°


42°
42°
to antisolar point

Search for extraterrestrial life

(23)

(73)



1 to 10 in binary

Atomic numbers of DNA elements

Chemical formulae of DNA molecules

Number of nucleotides

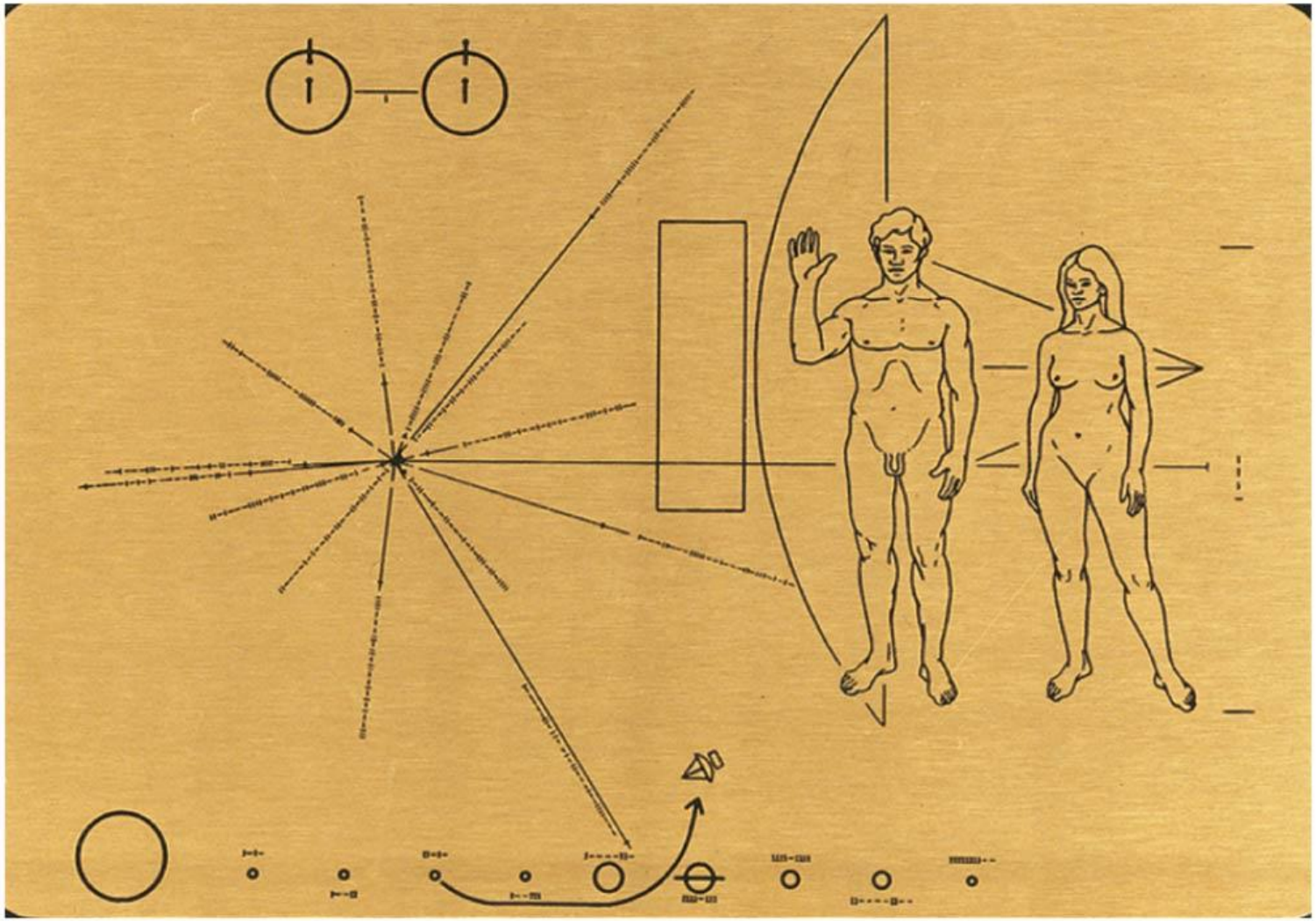
Double helix depicting DNA

Average height and population of mankind in 1974

Picture of a human

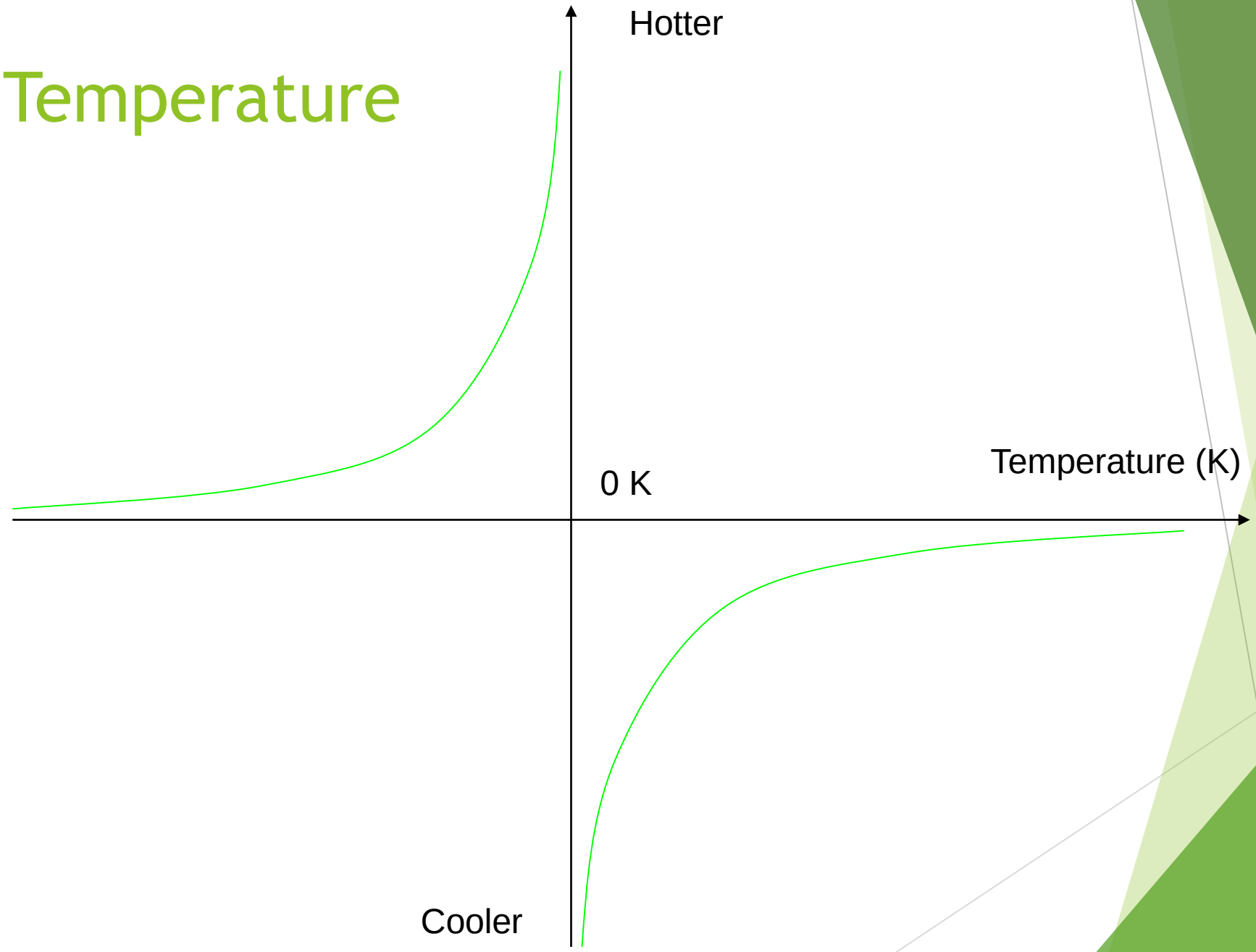
Earth’s location in solar system

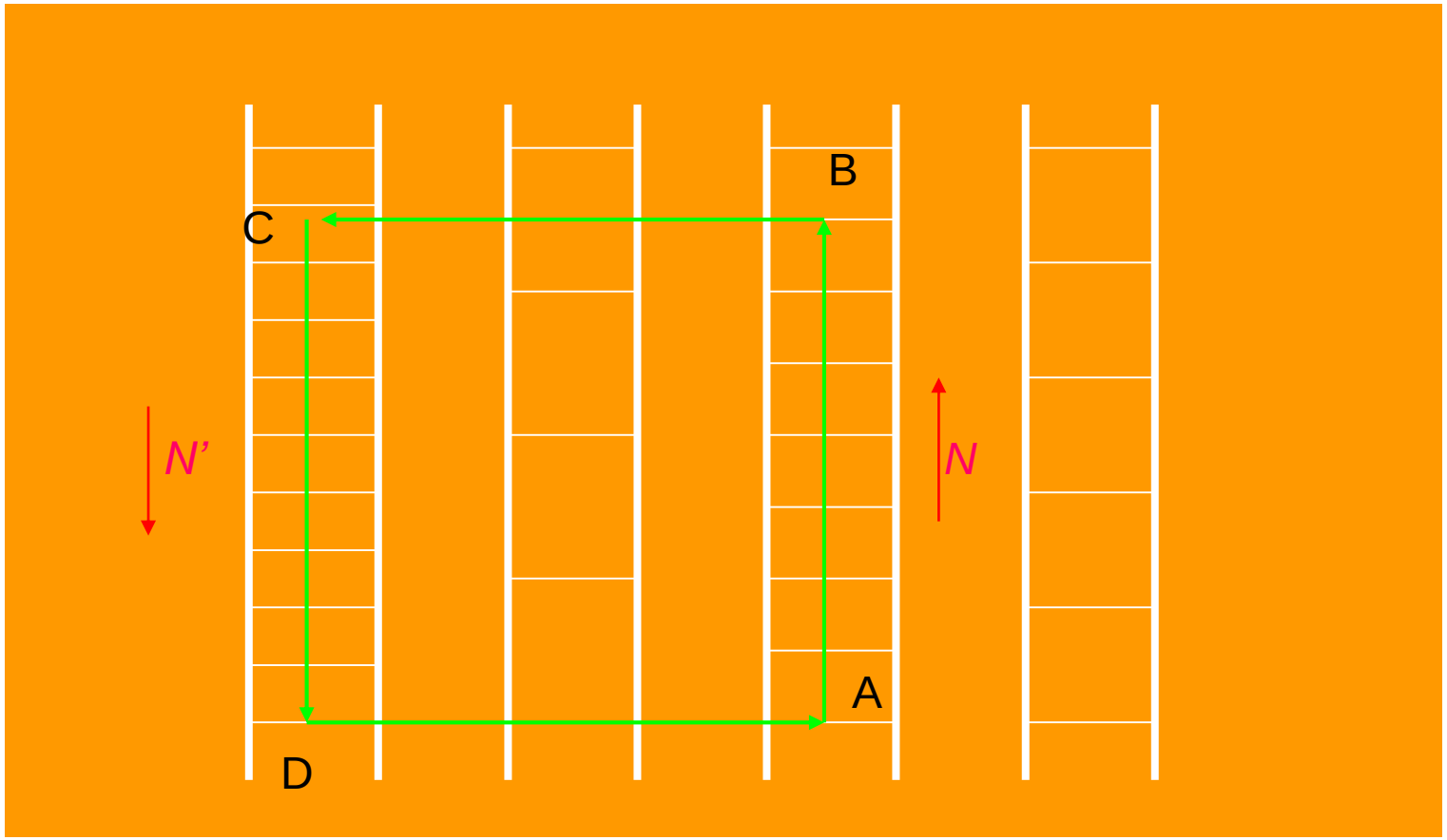
Arecibo telescope and its diameter

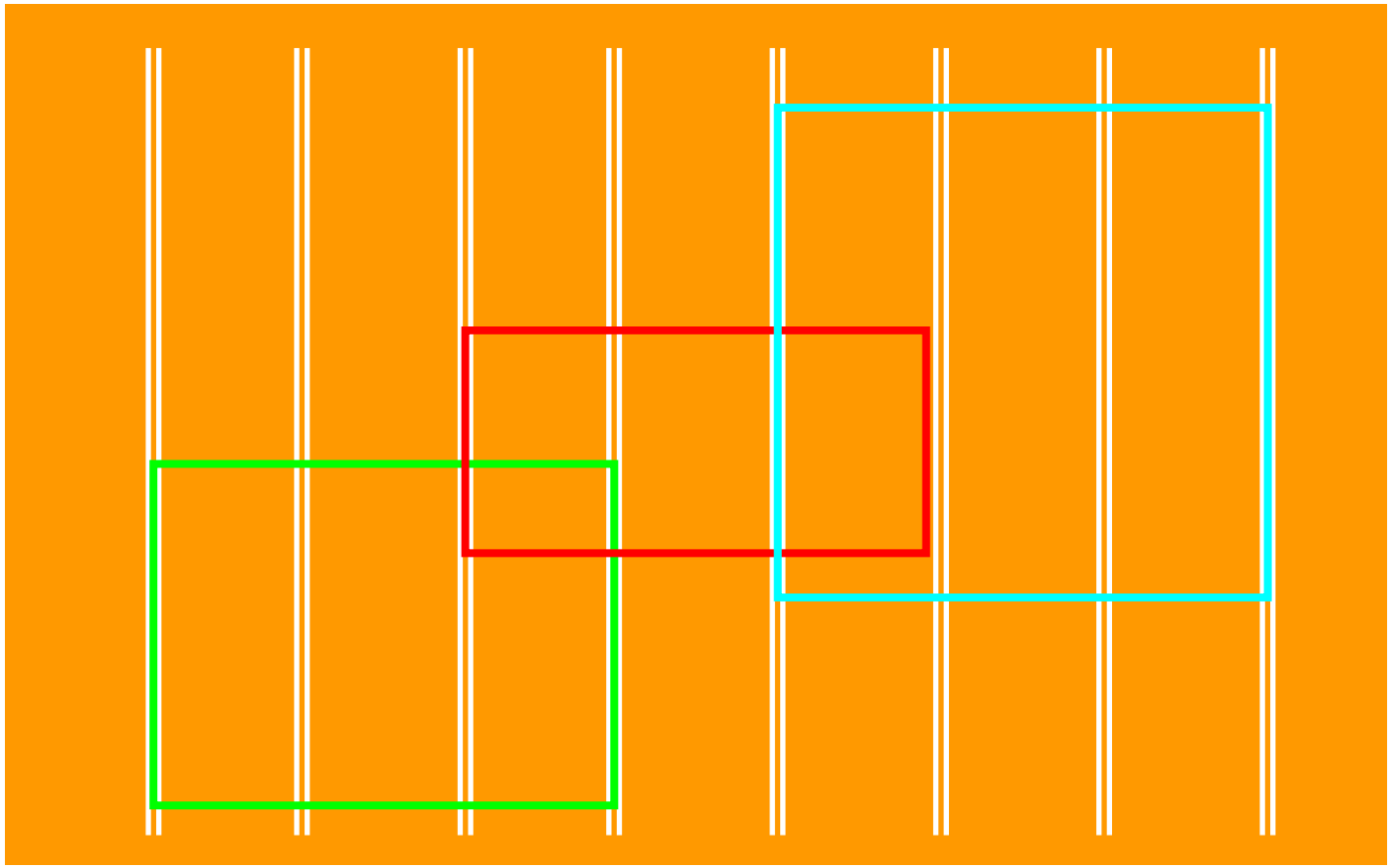


NASA

Kevin Temperature




B
C
N’
N
A
D

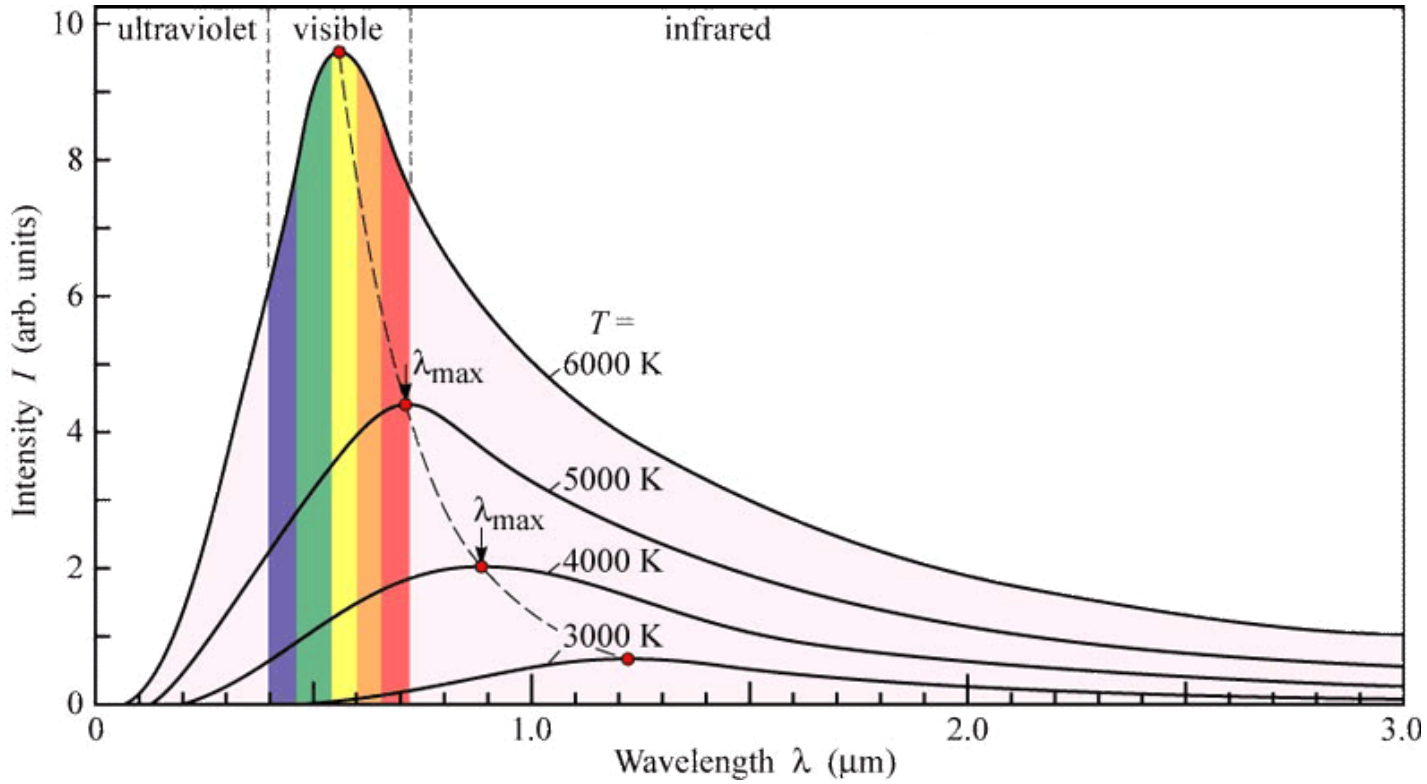


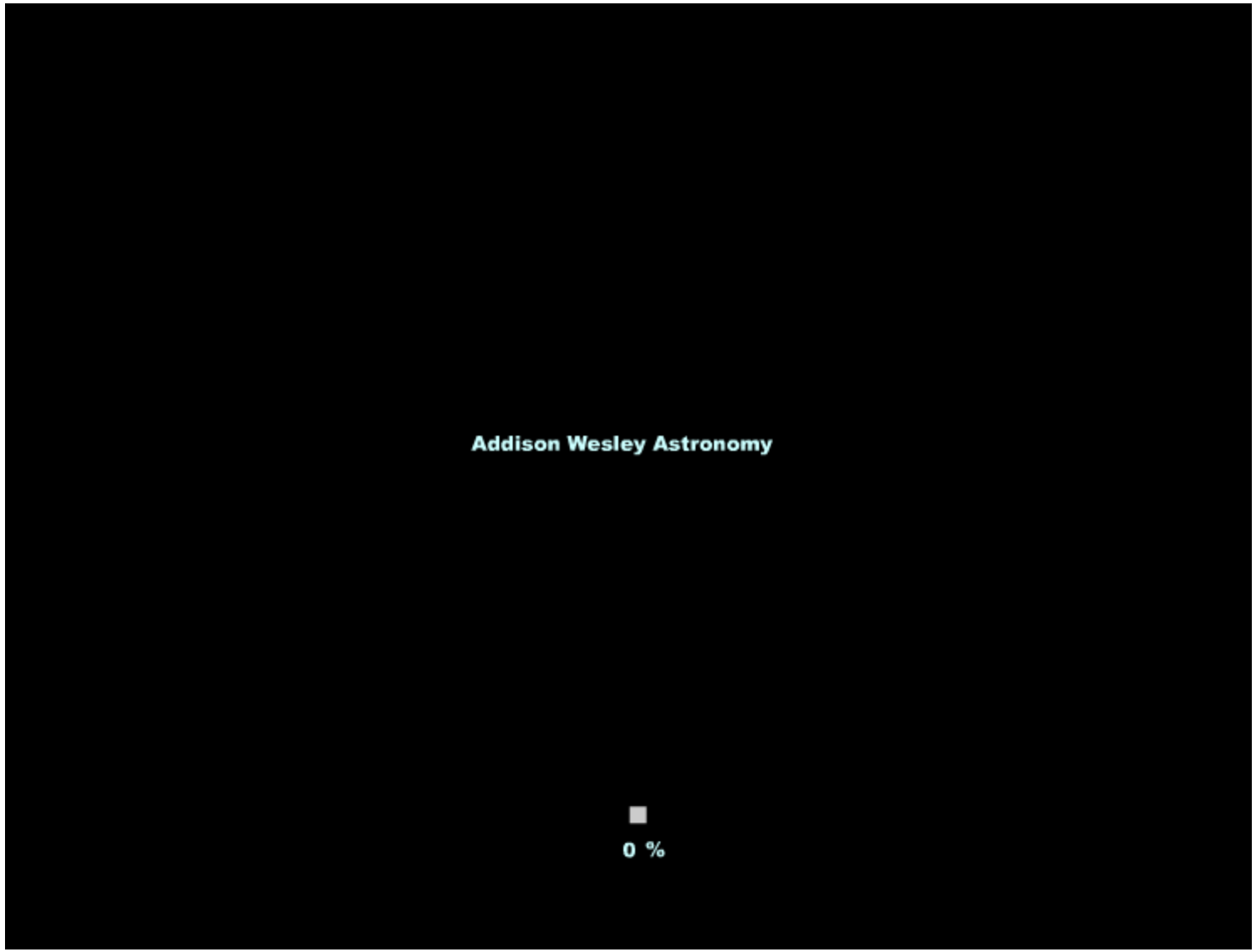
Students' Expectation

Learning the ideas and concepts with minimal mathematics content

Cosmic Background Radiation

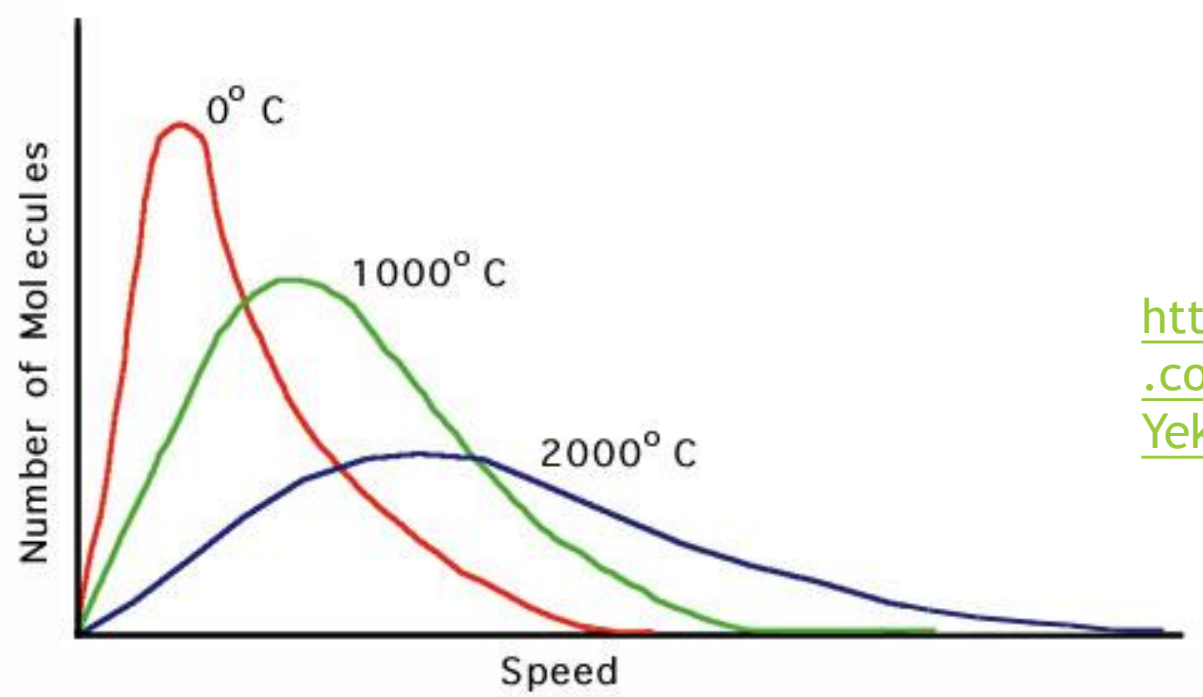
Blackbody Radiation





Illustrating_Kirchhofs_Laws.swf

Maxwell Boltzmann Distribution

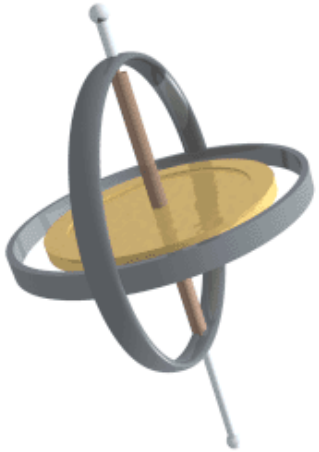


https://www.youtube.com/watch?v=qmsn2YekYhc

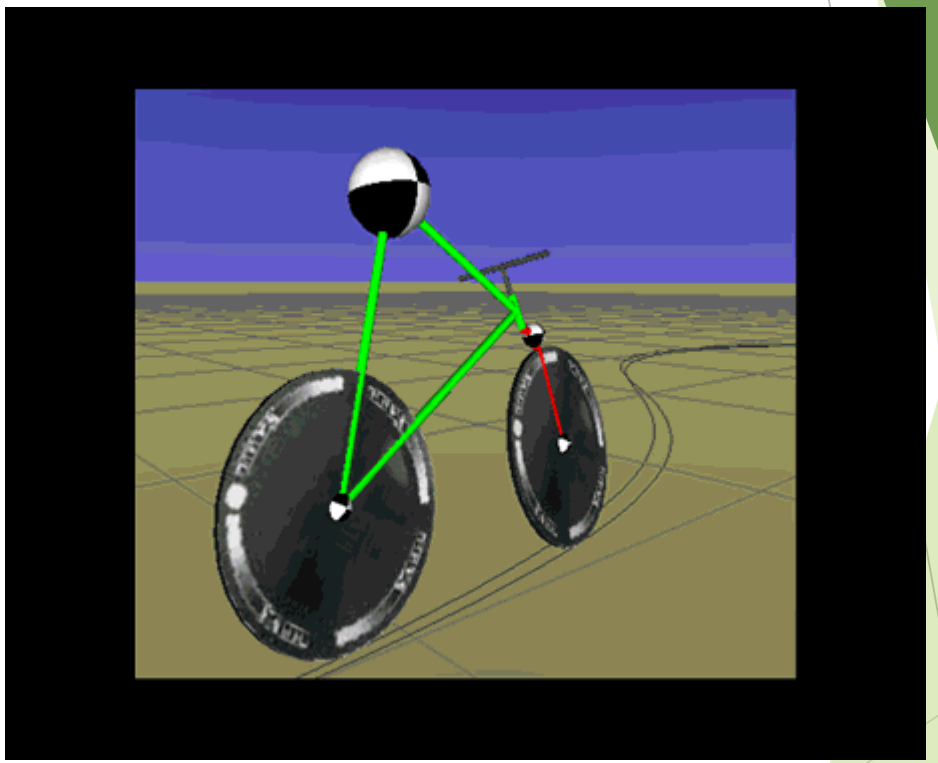
Coriolis Effect

$$\mathbf{F} = -2m\boldsymbol{\omega} \times \mathbf{u}$$

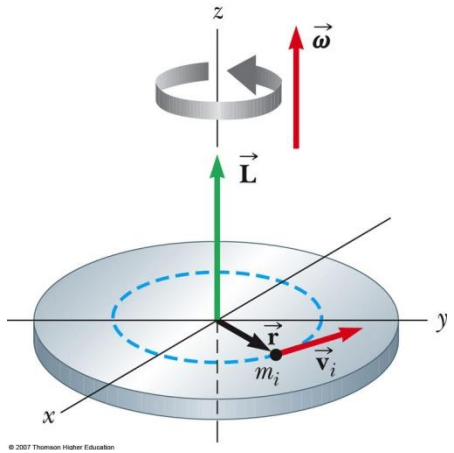
Gyroscopic Effect

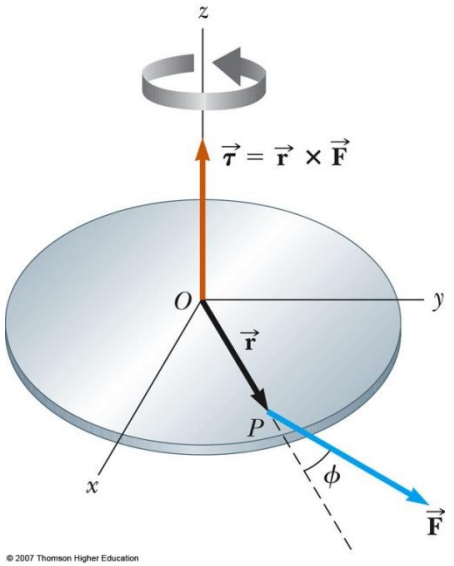


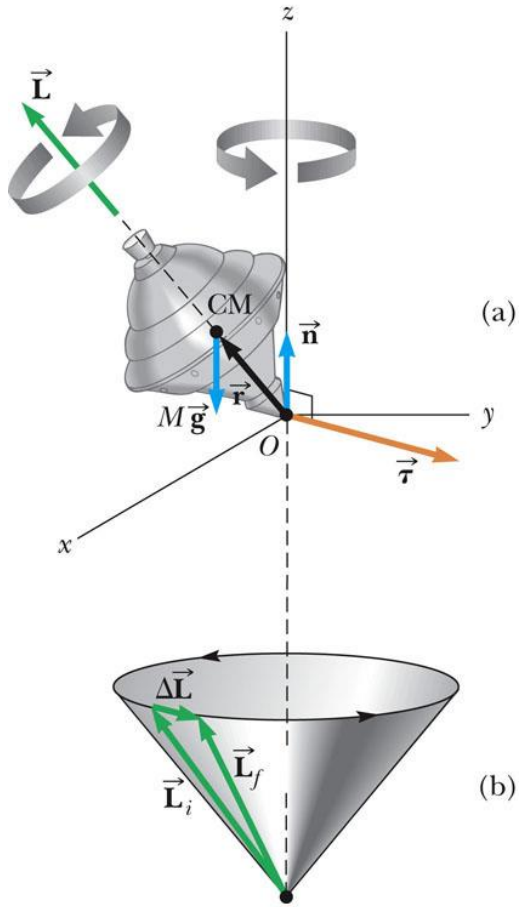
- Related to self-stability of bicycles



Mathematical explanation

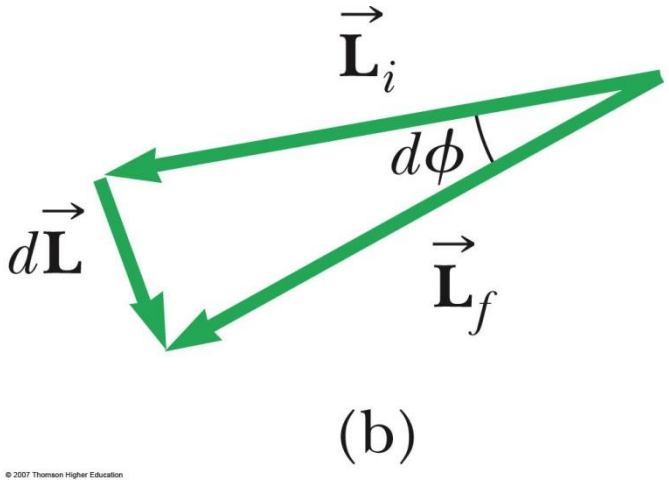






(a)

(b)

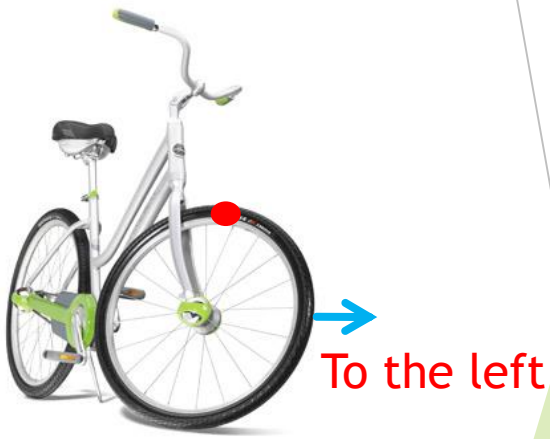


(b)

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

Heuristic Explanation

- When the wheel is not rotating, the effect of an external torque as shown in the figure will tip the wheel
- For example, the two points in red in the first figure will have the tendency to move in the directions shown
- The dynamics of an object is different when it is under rotation because the two points move to new positions at the same time
- The same motion of the two points at the new positions gives rise to precession of the wheel



Summary

- How to arouse students' interest
  - Demonstrations, videos, animations …
  - Relate subject to students' daily lives
- Students' expectation: Learning the ideas and concepts with minimal mathematics content
  - Teaching with visualization tools
  - Employing heuristic and intuitive explanations
- Using PRS to improve interaction