Classical Mechanics
Phy 235, Lecture 07.

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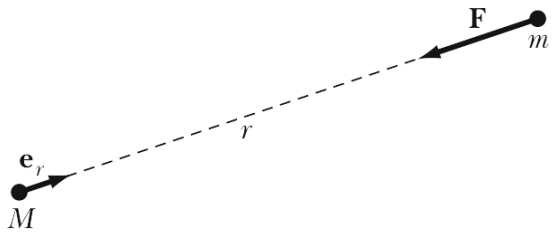
Course Comments

- Exam # 1:
  - Tomorrow, Tuesday, between 8 am and 9.20 am in B&L 109.
  - Material to be covered is Chapters 1 – 4.
  - All exam materials will be in a brown envelope. The same envelope will be used by you to return the materials.
- There will be no office hours on Wednesday and Thursday this week.
- There will be no recitations on Tuesday and Thursday this week.
- Exam # 1 will be returned to you during recitations next week.

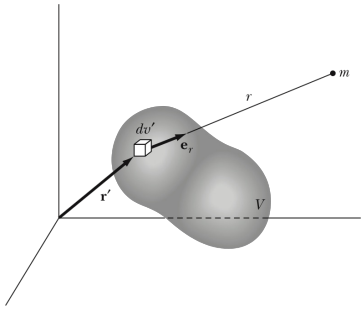
2

The gravitational force between point particles.



3

The gravitational force between a point particle and an extended object.



4

Gravitational Potential

- Gravitational potential:

$$\vec{g} = -\overrightarrow{\nabla\Phi}$$

- Gravitational potential due to a point mass:

$$\Phi = -G\frac{M}{r}$$

- Gravitational potential due to a continuous mass distribution:

$$\Phi = -G\int_V \frac{\rho(\vec{r}')}{r'}dv'$$

- Note: the gravitational potential is a scalar.

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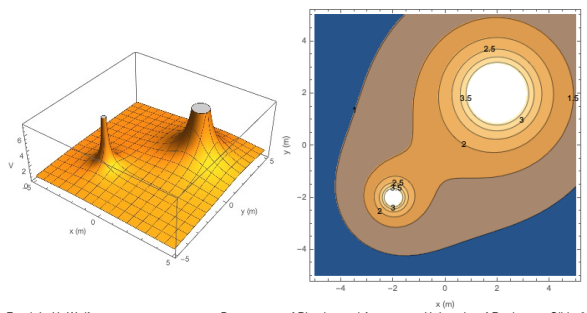
Visualizing the gravitational potential. Two point masses: 1 kg and 4 kg.



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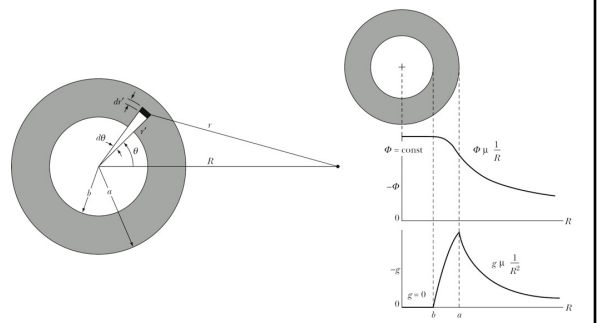
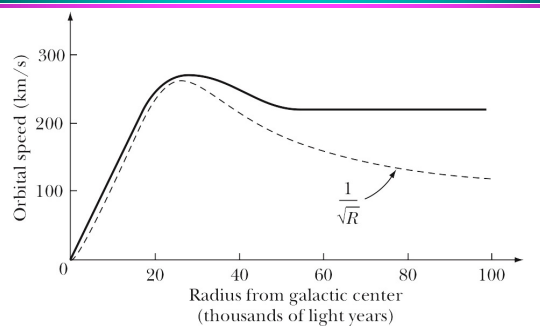
Shell theorem.



7

Measure the rotational velocity, determine the gravitational force, find the enclosed mass.



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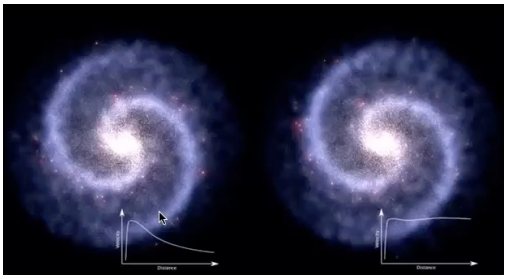
Rotation Curves.



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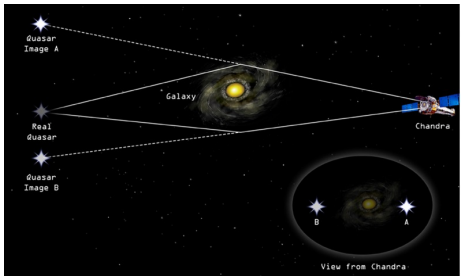
Gravitational Lensing.



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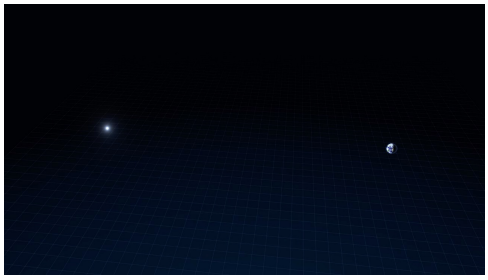
Gravitational Lensing.



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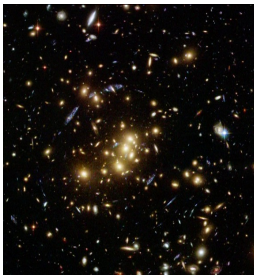
Dark-matter rings in galaxy clusters. Hubble studies of ZwCl0024+1652.



Rings of dark matter.

http://www.esa.int/esaCP/SEM5SHV681F_index_0.html

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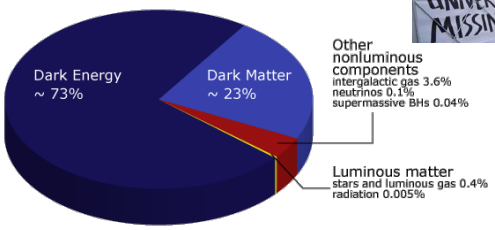
Help!
96% of the universe is missing!



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My research: trying to find dark matter in a gold mine in South Dakota.

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2 Minute 5 Second Intermission.

- Since paying attention for 1 hour and 15 minutes is hard when the topic is physics, let's take a 2 minute 5 second intermission.
- You can:
  - Stretch out.
  - Talk to your neighbors.
  - Ask me a quick question.
  - Enjoy the fantastic music.

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Poisson's Equation.

- Gravitational flux due to a point mass m:

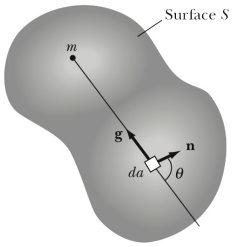
$$\Phi_{flux} = -4\pi G m$$

- When we have a mass distribution inside S:

$$\Phi_{flux} = -4\pi G \int_V \rho dv$$

- This relation can be used to show that the gravitational potential satisfies the following equation:

$$\vec{\nabla}^2 \Phi_{flux} = 4\pi G \rho$$



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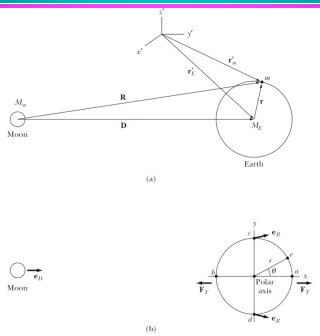
Tides.
The real story.



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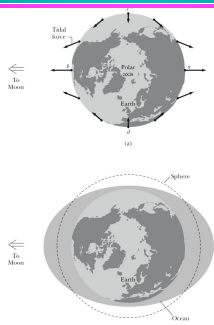
Forces,
as viewed from a reference frame on Earth.



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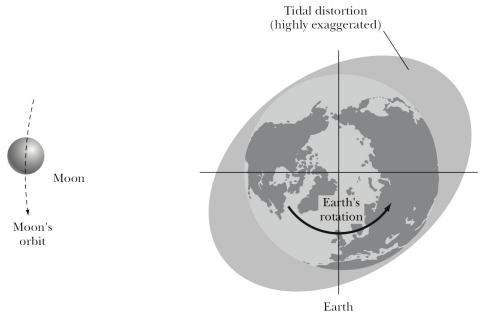
Effect of rotation.



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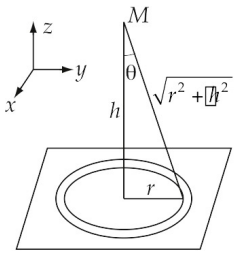
Problem 5.16

- A uniformly charged sphere of mass M and radius R is fixed a distance h above a thin infinite sheet of mass density ρ (mass/area).
- With what force does the sphere attract the sheet?



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ENOUGH FOR TODAY?

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