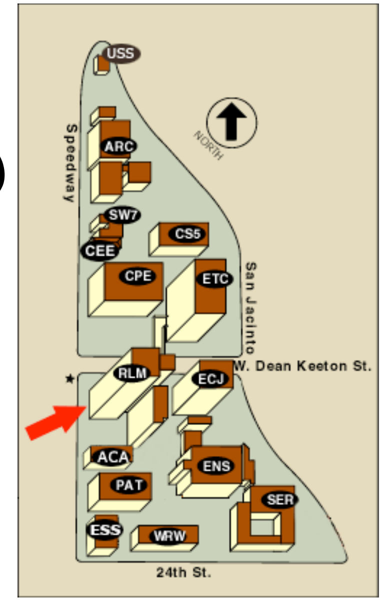
Monday, March 28, 2016



Exam 3, Skywatch 3, Friday, April 1 (no jokes on exam!!) Review sheet posted.

Review session Thursday, 4:30 PM, RLM 15.216B (Backup RLM 15.202A)

Wheeler available most afternoons (but best to make appt.)

Reading for Exam 3: Chapter 6, end of Section 6 (**binary evolution of Type Ia supernovae**), Section 6.7 (**light curves and radioactive decay**), Chapter 7 (SN 1987A). Background in Chapters 3, 4: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.10, 4.1, 4.2, 4.3, 4.4, 5.2, 5.4 (**binary stars and accretion disks**).

Astronomy in the news?

Extra credit on Exam 3 will come from topics that arose during the lectures on Exam 3 material.

Goals:

To understand how Einstein taught us to think about space, time, and gravity.

To understand what we mean by space.

To understand how space can be curved.

Curved Space - explore with straight lines

Definition of straight line

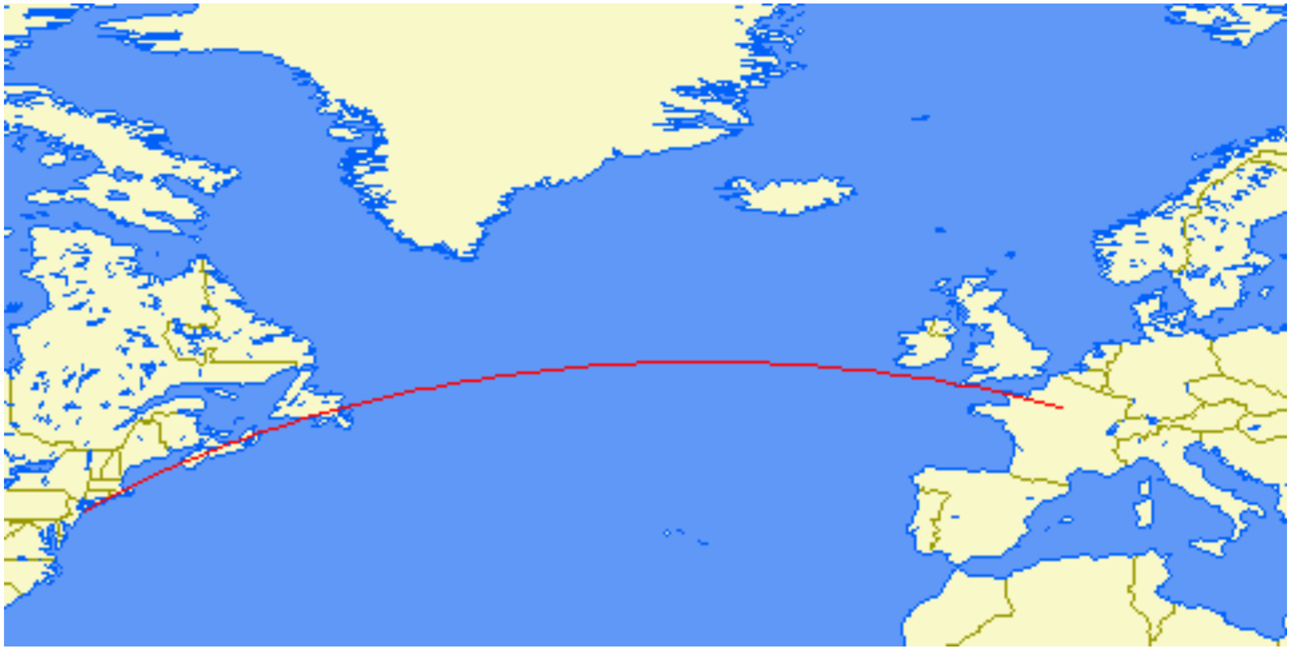
Shortest distance between 2 points - rubber band

Draw a free hand straight line

Parallel propagation - rulers

Parallel propagation will give the shortest distance between two points without necessarily knowing where the two points are in advance.

Parallel propagation works easily, even when the space is *curved*.

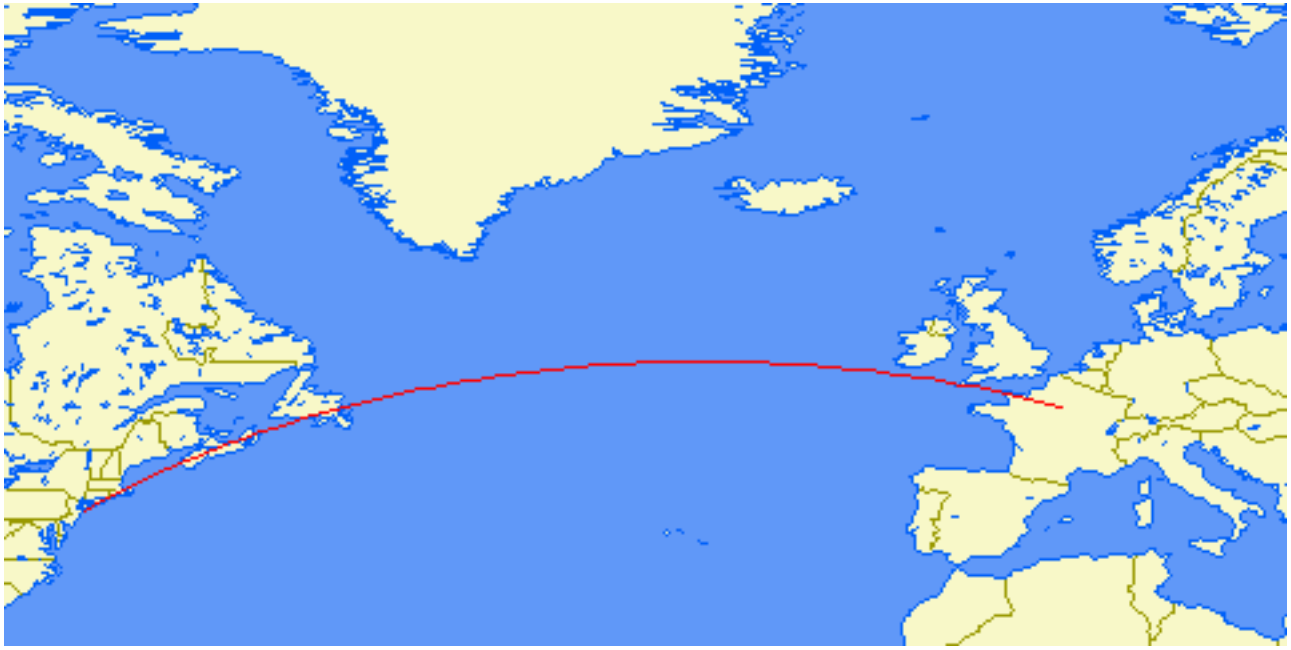


Route from JFK airport to Paris Orly.

Is this a straight line?

Geometry on the 2D surface of the balloon

Exercises of drawing straight lines



Route from JFK airport to Paris Orly.

Is this a straight line?

Balloon

Surface is curved 2 D space

3 D space around the balloon, inside the balloon is ***hyperspace*** with respect to the 2D surface

Imagine a 2 D creature that can only perceive 2 D space.

2 D creatures can learn all about the curvature of the space they inhabit by doing geometry in 2 D - they never need to know about or care about “hyperspace.”

That’s us in 3 D! There might be 4D (or higher!) hyperspace around us, but we don’t perceive it.

We can, in principle, learn everything we need to know about our 3D Universe by doing 3D observations and experiments in the confines of our own dimensionality, just as 2D creatures could learn of their universe, the surface of the balloon.

What you need to know about the ***surface*** of the balloon -

What is a straight line, what is not?

What is “inside” the surface? What is “outside” the surface

Where is the “center” of the **surface**?

What does it mean to go from surface point to surface point “through” the balloon interior?

How do you determine the shape of the surface by doing geometry?

Real 3 D curved space (for us!!) might curve in a 4 D “hyperspace,” but we do not directly perceive that hyperspace.

We can determine the curvature, shape of our real 3 D space by doing 3 D geometry.

Do not need to ask about 4 D (but will!)

Can 3-dimensional space be "flat?"

Yes, it can be flat or curved, just as 2-dimensional space can.

3-dimensional space is regarded as flat if the result of doing geometry is the same as ordinary flat two dimensional space, the sum of interior angles of triangles is 180 degrees, parallel lines remain parallel.

If flat space geometry does not apply, the space is curved, or non-Euclidian.

Can 4-dimensional space be flat?

One Minute Exam

In a curved space:

- ➡ Straight lines always connect to themselves
- ⬅ Straight lines are the shortest distance between two points
- ⬆ There are no straight lines
- ⬇ The sum of the interior angles of a triangle is 180 degrees

One Minute Exam

Compared to the two-dimensional surface of a balloon, the inside of the balloon is:

➡ A two-dimensional hyperspace

⬅ A three-dimensional hyperspace

⬆ A four-dimensional hyperspace

⬇ Accessible to a two-dimensional creature

One Minute Exam

An intelligent ant crawls around on a surface, drawing triangles as the intersection of 3 straight lines. She finds that the sum of the interior angles is always more than 180 degrees and that triangles of the same size always give the same results. She deduces that the following will be true:

➡ If she draws two straight lines that are initially parallel they will begin to diverge.

⬅ The surface she is walking on is three-dimensional

⬆ If she walks off in a straight line she will never return to her point of origin

⬇ If she walks off in a straight line she will return to her point of origin