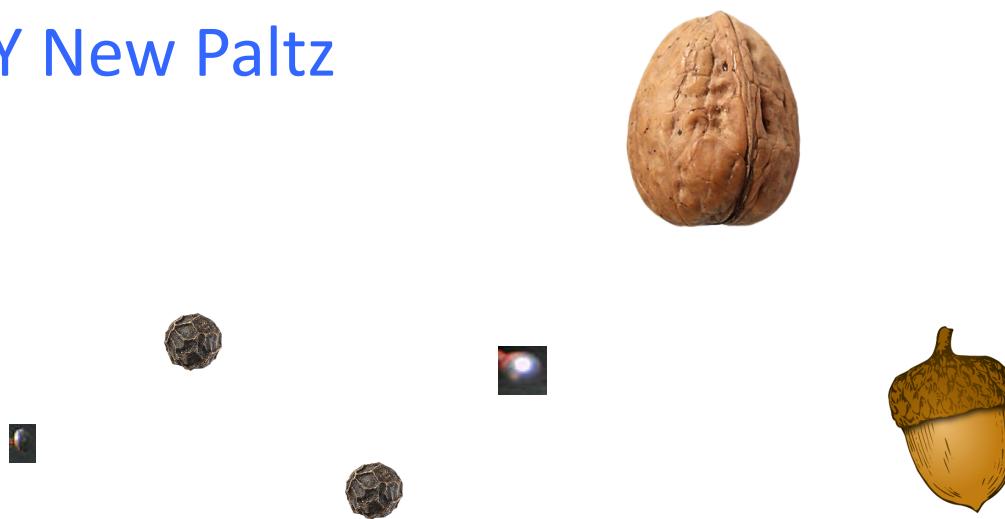
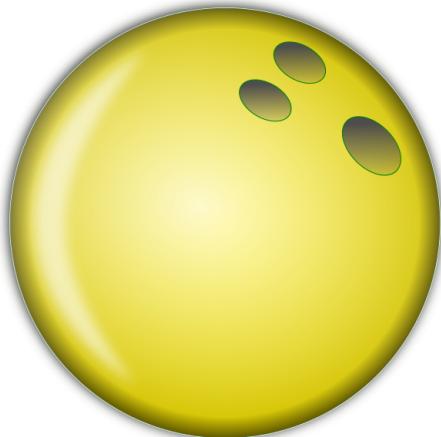


# The Peppercorn Model of the Solar System



# Eric Myers

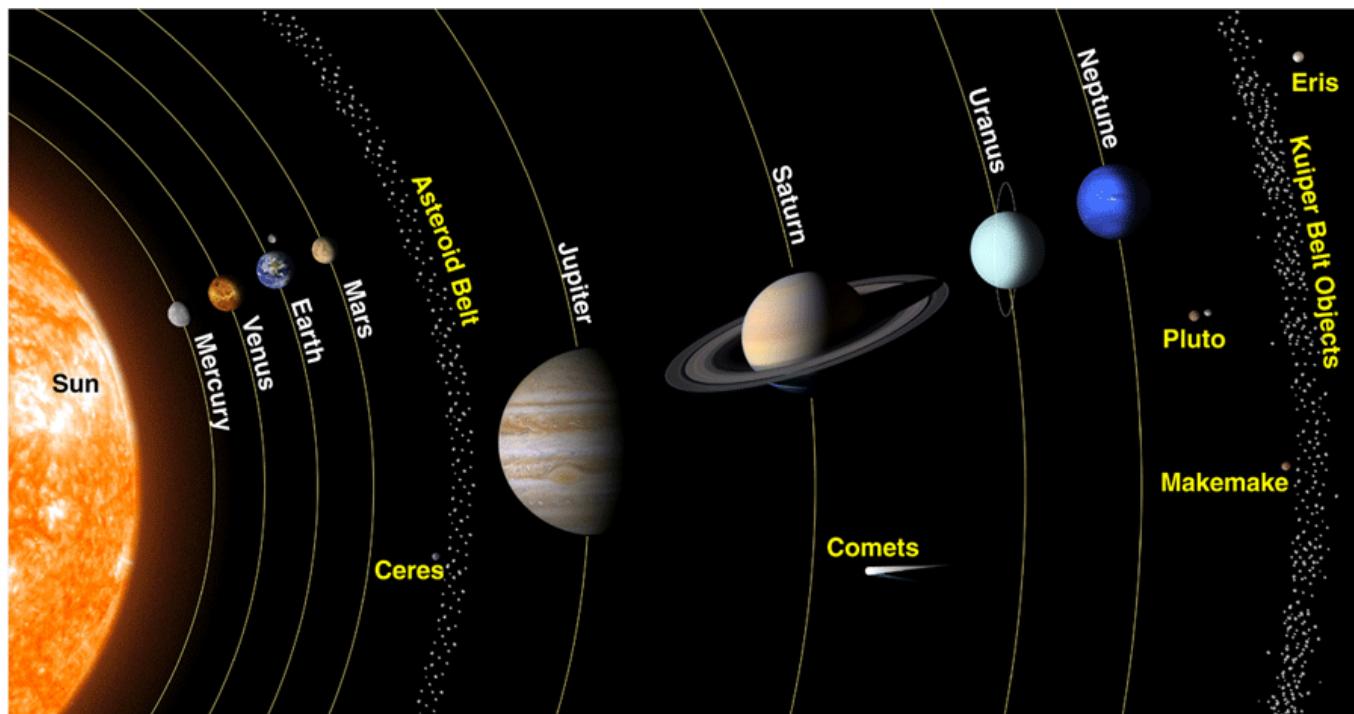
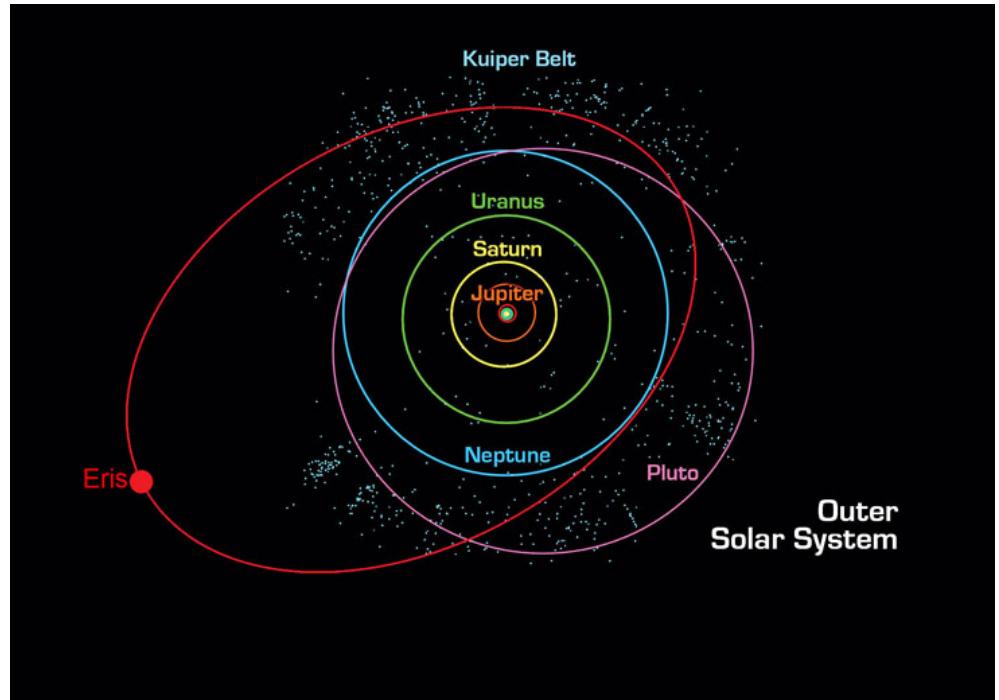
# SUNY New Paltz



*American Association of Physics Teachers  
New York / New England / New Jersey  
September, 2013*

# Not to scale!

For most scales, if the orbits of the planets are represented to scale, then the planets are too small to see.



Or if the planet sizes are to scale, then the spacing between them will not be to scale.

## The Peppercorn Model

The peppercorn model is a *scale* model of the solar system which demonstrates at the same time both the sizes of the planets and the distances between them – on a *linear* scale.

The Sun and planets are represented by objects familiar from everyday life: The Earth is the size of a small peppercorn, 26 yards from the Sun, which is about the size of a bowling ball. Pluto is a grain of salt just over 1000 yards from the Sun.

*Or, the Sun is the size of your head, and the Earth is the size of the pupil of your eye.*

But the peppercorn model is something you *do*, not just something that you see or hold or touch. It's the experience, not just the object.

www.noao.edu/education/peppercorn/pcmain.html

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**National Optical Astronomy Observatory**  
Kitt Peak National Observatory • Cerro Tololo Inter-American Observatory • NOAO Gemini Science Center

**THE THOUSAND-YARD MODEL  
or, The Earth as a Peppercorn**

Copyright 1989 by Guy Ottewell  
[Universal Workshop](#)  
PO Box 102  
Raynham, MA 02767-0102  
Toll Free: 800-533-5083  
Fax: 508-967-2702  
Email: [customerservice@universalworkshop.com](mailto:customerservice@universalworkshop.com)

This is a classic exercise for visualizing just how BIG our Solar System really is. Both the relative size and spacing of the planets are demonstrated in this outdoor exercise, using a mere peppercorn to represent the size of the Earth. Guy Ottewell has kindly given permission for this electronic presentation of The Thousand-Yard Model; his exercise is presented in its original form, indexed with a few anchors to help you find your way around the large file. We also include [a catalog](#) describing several Ottewell publications. Image of the planets courtesy of [NASA](#).

**Introduction**

Can you picture the dimensions of the solar system?

Probably not, for they are of an order so amazing that it is difficult either to realize or to show them.

You may have seen a diagram of the Sun and planets, in a book. Or you may have seen a revolving model of the kind called an orrery (because the first was built for an Earl of Orrery in 1715). But even the largest of such models--such as those that cover the ceilings of the Hayden Planetarium in New York and the Morehead Planetarium at Chapel Hill--are far too small. They omit the three outermost planets, yet still cannot show the remaining ones far enough apart.

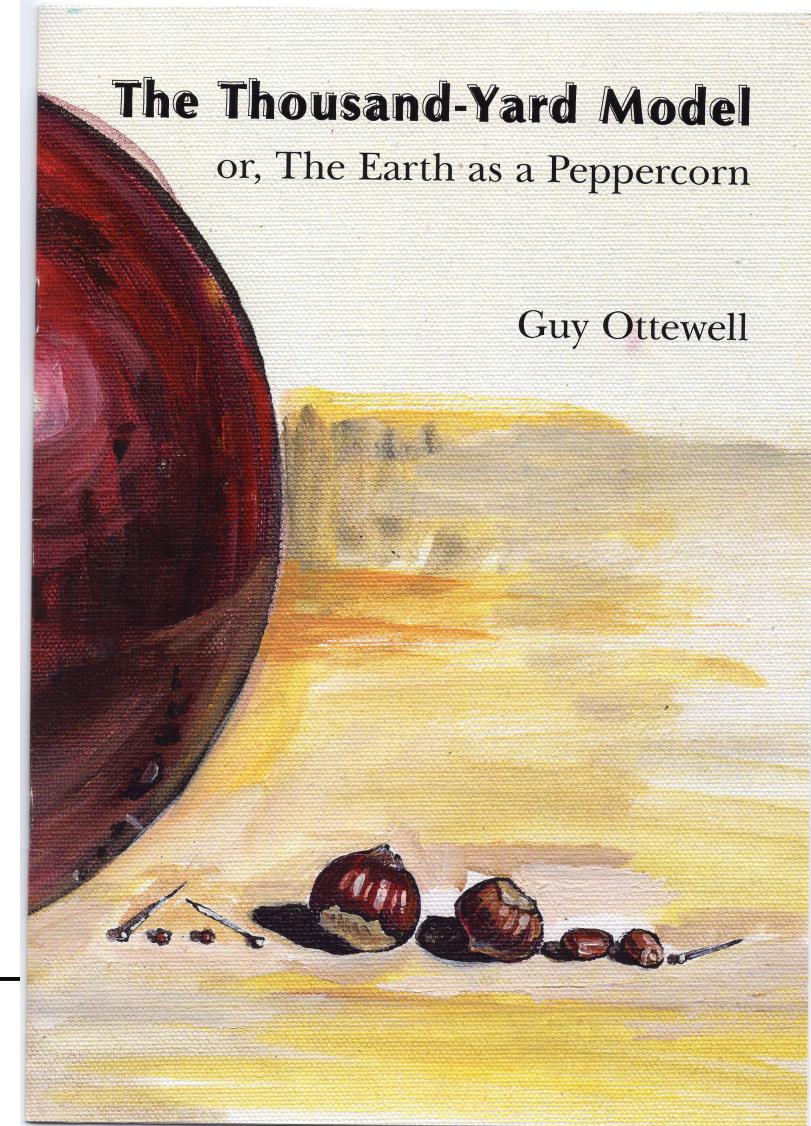
The fact is that the planets are mighty small and the distances between them are almost ridiculously large. To make any representation whose scale is true for the planets sizes and distances, we must go outdoors.

The following exercise could be called a Model, a Walk or a Happening. I have done it more than twenty times with groups of varied ages (once we were televised) or with a single friend; and others, such as elementary-school teachers, have carried it out with these instructions. Since it is simple, it may seem suitable for children only. It can, indeed, be done with children down to the age of seven. Yet it can also be done with a class consisting of professors of astronomy. It will not waste their time. They will discover that what they thought they knew, they now apprehend. To take another extreme, the most uncontrollable high-school students or the most blasé college students unfailingly switch on their full attention after the first few paces of the excursion.

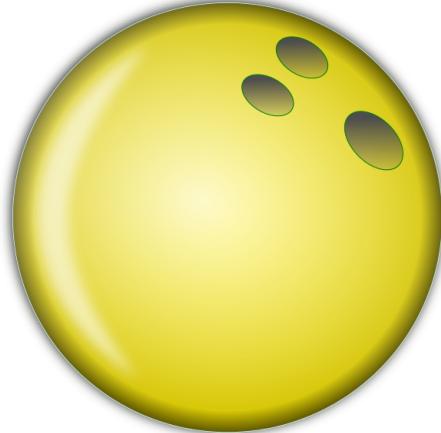
There is one other party that may profitably take the planet-walk, and that is yourself, alone. Reading the following description is no substitute: you must go out and take the steps and look at the distances, if the awe is to set in.

First, collect the objects you need. They are:

Length: 1020 yards      Scale: 1 : 6,336,000,000



# Inner Planets



**The Sun**  
a Bowling Ball  
*about 8" diameter*



**Mercury**  
a pinhead  
*10 yards*



**Venus**  
A peppercorn  
*19 yards*



**Earth**  
a peppercorn  
*26 yards*



**Mars**  
a pinhead  
*39 yards*

# Outer Planets



**Ceres**

a grain of salt  
*72 yards*



**Jupiter**

a walnut  
*134 yards*



**Saturn**

an acorn  
*247 yards*



**Neptune**

a coffee bean  
*777 yards*



**Uranus**

a coffee bean  
*497 yards*



**Pluto**

a grain of salt  
*1014 yards*

# SUNY New Paltz

New Paltz, NY

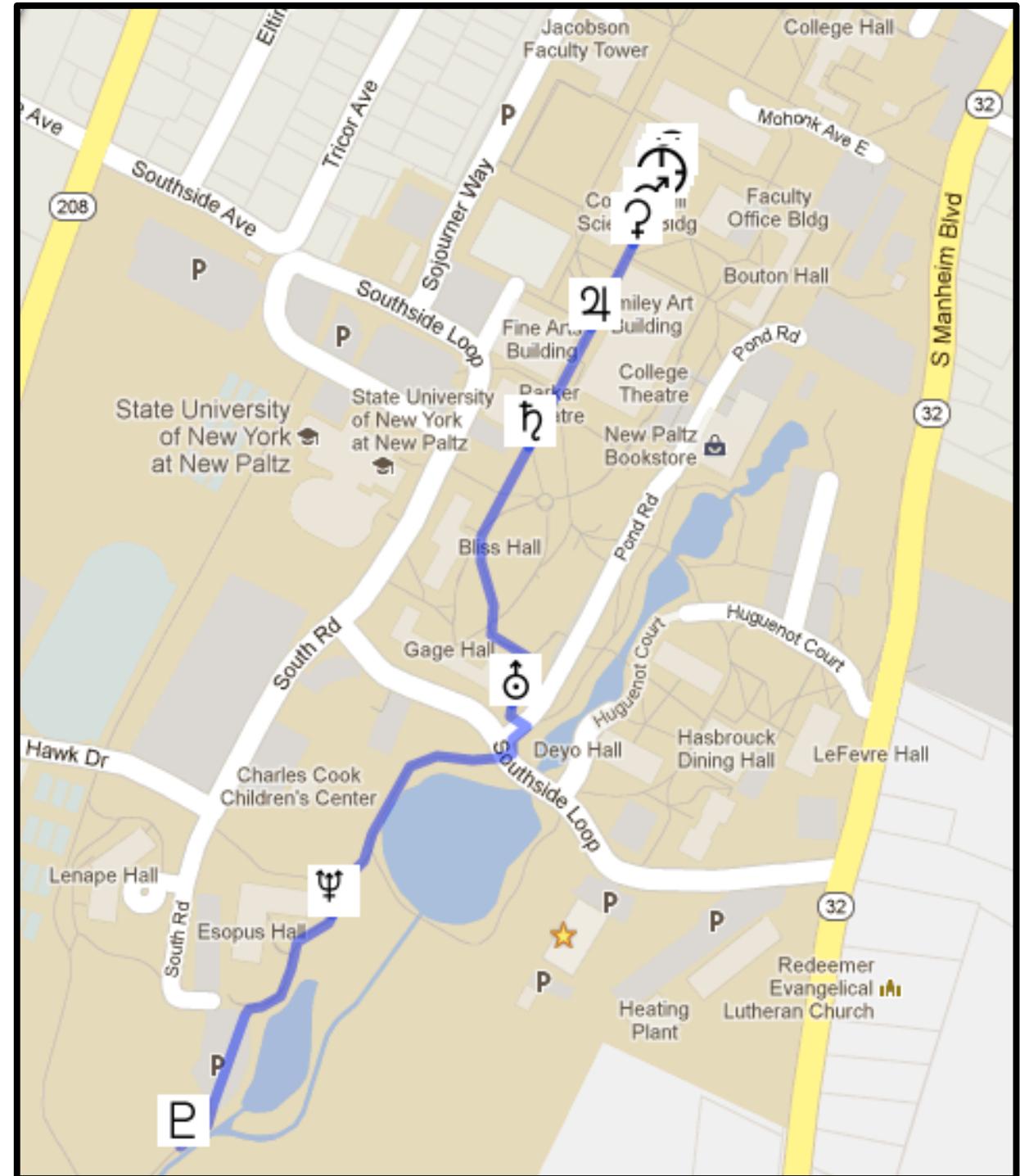
Scale: 1 : 6,336,000,000

Starting at Planetarium in  
Coykendall Science Building,  
past the Art Museum and  
Parker Theater,  
ending just before the  
Smolen Observatory

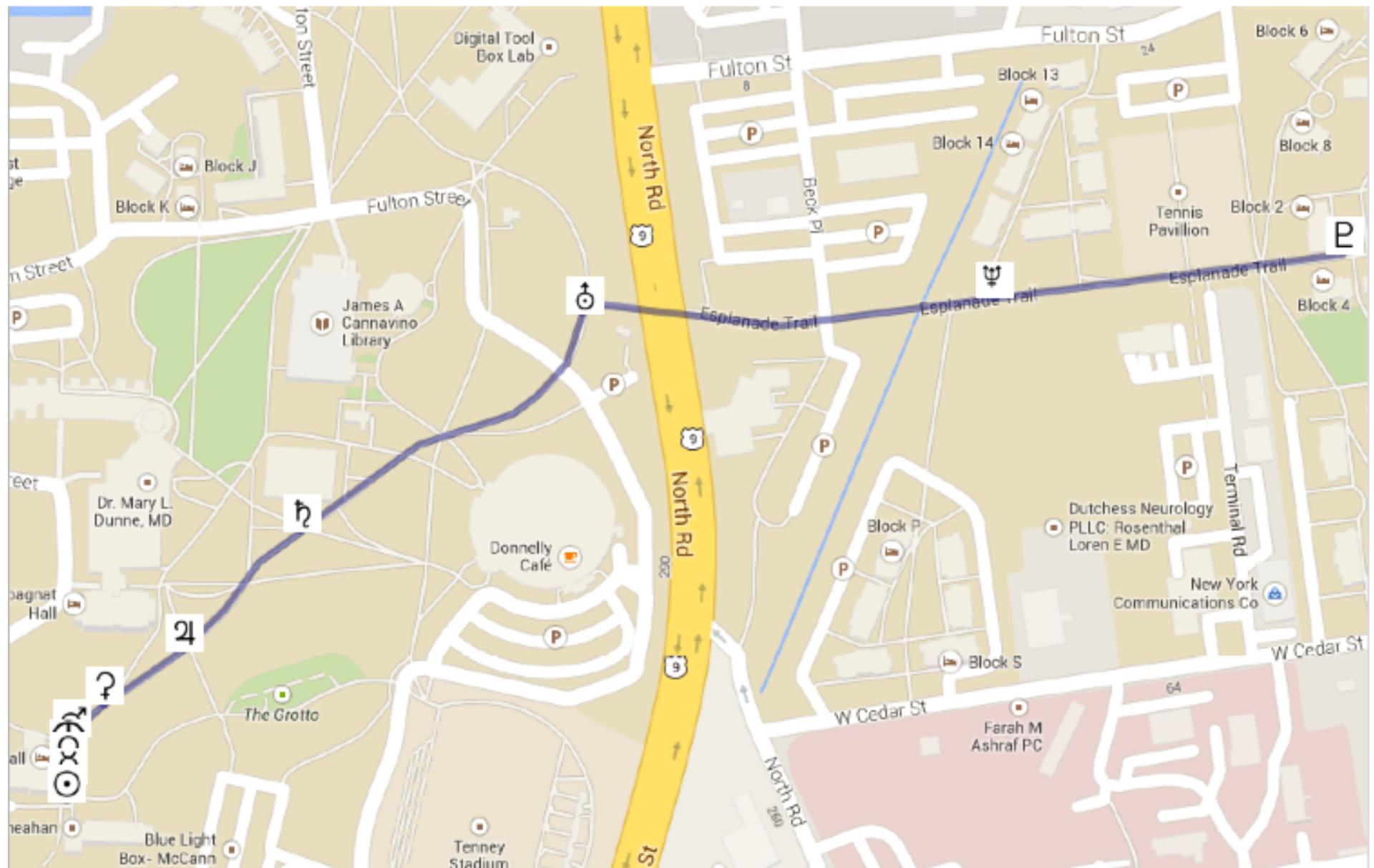
It fits just right!

[Map](#)

[KML](#)



# Marist College, Poughkeepsie, NY



<http://www.spy-hill.com/myers/peppercorn>

## The Peppercorn Model of the Solar System

The Peppercorn Model, also known as the Thousand Yard Model, is a scale model of the solar system which shows at the same time, on a linear scale, both the sizes of the planets and the distances between them. At this scale, the Earth is about the size of a peppercorn, and Pluto is a pin-point about 1000 yards from the Sun.

Object	Diameter of Model Object			Distance AU	Added distance		Total distance	
	inches	Object	cm		yards	meters	yards	meters
Sun ☀	8.7"	a bowling ball	22 cm	0.00			0 yd	0 m
Mercury ♀	0.03"	a pin head	0.08 cm	0.39	+10 yd	+9 m	10 yd	9 m
Venus ♀	0.08"	a peppercorn	0.19 cm	0.72	+9 yd	+8 m	19 yd	17 m
Earth ⊕	0.08"	a peppercorn	0.2 cm	1.00	+7 yd	+7 m	26 yd	24 m
Mars ♂	0.04"	a pin head	0.11 cm	1.52	+13 yd	+12 m	39 yd	36 m
*Ceres ♀	0.01"	a grain of salt	0.02 cm	2.77	+32 yd	+29 m	72 yd	65 m
Jupiter ♃	0.89"	a walnut, or chestnut	2.3 cm	5.20	+63 yd	+57 m	134 yd	123 m
Saturn ♄	0.75"	an acorn or hazelnut	1.9 cm	9.58	+113 yd	+103 m	247 yd	226 m
Uranus ♆	0.32"	a coffee bean	0.81 cm	19.20	+249 yd	+228 m	497 yd	454 m
Neptune ♇	0.31"	a coffee bean	0.78 cm	30.10	+281 yd	+257 m	777 yd	711 m
*Pluto ♉	0.01"	a grain of salt	0.04 cm	39.30	+237 yd	+216 m	1014 yd	927 m
* dwarf planets	inches		cm	AU	yards	meters	yards	meters

On this scale the nearest star, Proxima Centauri, would be about 4,000 miles away!

1 AU = 1 Astronomical Unit = average (mean) distance between the Earth and the Sun =  $1.4960 \times 10^{11}$  meters =  $9.2956 \times 10^7$  miles

Scale: 1 inch = 100,000 miles

# Sagan Planet Walk

## Ithaca, New York

Scale: 1 : 5,000,000,000

Length: 1200 meters

Get your passport stamped  
at local shops

**SAGAN PLANET WALK**  
PASSPORT to the SOLAR SYSTEM MAP

The map shows a walking route starting at 'THE COMMONS' and ending at 'SCIENCENTER'. The route is marked with a dashed orange line and numbered points 1 through 13. Points 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 are located along the route, while point 13 is located near the Sciencenter building itself. The Sciencenter building is also labeled '13'. The route passes through several city blocks, including Adams St, Franklin St, Seneca St, Cayuga St, Erie St, Court St, and State St. The Sciencenter is located at the intersection of Adams St and Franklin St.

**PASSPORT STAMPING LOCATIONS**

- Sun, Mercury, Venus, Earth and Mars**  
1 M&T Bank  
The Commons  
Customer Service Desk
- 15 Steps Gallery**  
171 The Commons
- Asteroids**  
3 Tompkins Trust  
Company Drive Thru  
Inside of the Teller Line  
116 E Seneca St.
- Jupiter and Saturn**  
4 The Cat's Pajamas  
DeWitt Mall
- Saturn and Uranus**  
5 Kinney Drugs  
513 N. Cayuga St.
- Neptune**  
6 F&C Market  
212 Hancock St.  
Customer Service Desk
- Pluto**  
7 Sciencenter  
601 First St.

If you are unable to get your passport stamped at one or more locations, you can get it stamped at the Sciencenter.

**AUDIO TOUR**  
Learn more about the Solar System and the planets as you explore the Sagan Planet Walk! This free tour is narrated by Bill Nye the Science Guy.

Listen to the tour by phone at:  
**703.637.6237**

Download the tour as a podcast from iTunes or:  
[www.sciencenter.org/saganpw](http://www.sciencenter.org/saganpw)

**PACE THE SPACE**  
The Sagan Planet Walk is a model of our Solar System at one five-billionth (1/5,000,000,000) of the actual size. Starting with the Sun on the Commons in downtown Ithaca, this  $\frac{1}{4}$  mile (1200 meter) walking tour leads to the Sciencenter. Both the size of the planets and the distance between them are accurately scaled and displayed.



## Capital Mall Washington, DC

Scale: 1 : 10,000,000,000



*"On the scale of the Voyage exhibition, the Sun is the size of a large grapefruit in Washington, DC, Earth is smaller than the head of a pin 50 feet (15 m) west of the Sun, and the nearest star to the Sun, Proxima Centauri, is the size of a cherry on the California coast."*



A tour of Voyage begins at the Sun for a Washington, D.C. class of sixth grade students.

Credit: Washington Times, 2009



HOME    VOYAGE IN DC    CONTACT US    SITE MAP/SEARCH    LINKS    NCESSE

### COSTS TO BECOME A VOYAGE COMMUNITY

#### BECOME A VOYAGE COMMUNITY

PACKAGE OF  
RESOURCES

SUPPLEMENTARY  
PROGRAMS

COMMUNITY  
BENEFITS

MILESTONES

TESTIMONIALS

COSTS

EXHIBITION

EDUCATION

EXISTING  
COMMUNITIES

MEDIA

GALLERY

RALLYING SUPPORT  
IN YOUR COMMUNITY

VOYAGE AND PLUTO

The total cost per Voyage Community is \$250,000,  
and includes:

- The complete exhibition of 13 stanchions, with customized site maps and acknowledgment of funders on the storyboards.
- An installation manual and installation support from National Center for Earth and Space Science Education staff.
- Master files of the Voyage K-12 Education Lessons and family/home activities.
- A Professional Development workshop for up to 60 educators, and a public/family program.
- Ongoing support from our educators and planetary scientists.

The cost reflects full cost recovery by the National Center for Earth and Space Science Education.

There are also a number of real and potential additional costs borne by the community that must be considered:

- Delivery of the exhibition.
- Site preparation, at a minimum requiring construction of 13 small concrete footings.
- Regular exhibition cleaning.
- Insurance against vandalism.
- Copying of grade K-12 lessons, and family/home activities for dissemination to the general visitorship, educators, and families.
- Bulk purchase of Outdoor Exploration Guide (customized tour brochure).



Zoom

Voyage ribbon cutting on opening day, October 17, 2001.

Credit: ©Smithsonian Institution, Jeff Tinsley

\$

# Sweden Solar System

Scale: 1 : 20,000,000

Sun's diameter is 110 m (includes corona)



Earth's diameter is 65 cm,  
7.6 km from the Sun  
(Moon's diameter is 18 cm)



Jupiter's diameter is 7.5 m,  
40 km from the Sun



Neptune's diameter is 2.5 m,  
229 km from the Sun

Pluto's diameter is 12 cm,  
300 km from the Sun



# Theodor Jacobsen Observatory of the University of Washington

In the  
Seattle  
Olympic Sculpture  
Park

March 10, 2007  
1 to 2 PM



# Installation or Event?

Is it better to do the walk as an event,  
or create a permanent installation?

## Event

1. Minimal cost.
2. Counting out paces focuses attention on the distances and relative scales. You *feel* it.
3. Adds a sense of adventure as you find the next station.

## Installation

1. Minimal preparation.
2. Not distracted by counting paces, so it's easier to talk (about anything)
3. Exposure to casual visitors, spreading the idea wider.

---

*"Professors of astronomy will discover that what they thought they knew, they now apprehend."*  
- Guy Ottewell

There is a list of scale model installations of all sizes on Wikipedia under "[Solar System Model](#)"

# False Dichotomy!

## Temporary Installation

The sun sits on a tripod,  
(and is lighted from below for  
night)

Each station has a card with  
simple information about the  
planet (held in place by a  
solar lamp for night).

Two kinds of bases work on  
hard surface (eg. sidewalk or  
bridge) or in grass or ground.





## Poughkeepsie Railway Bridge

Length: 1.28 miles = 6758 ft = 2253 meters

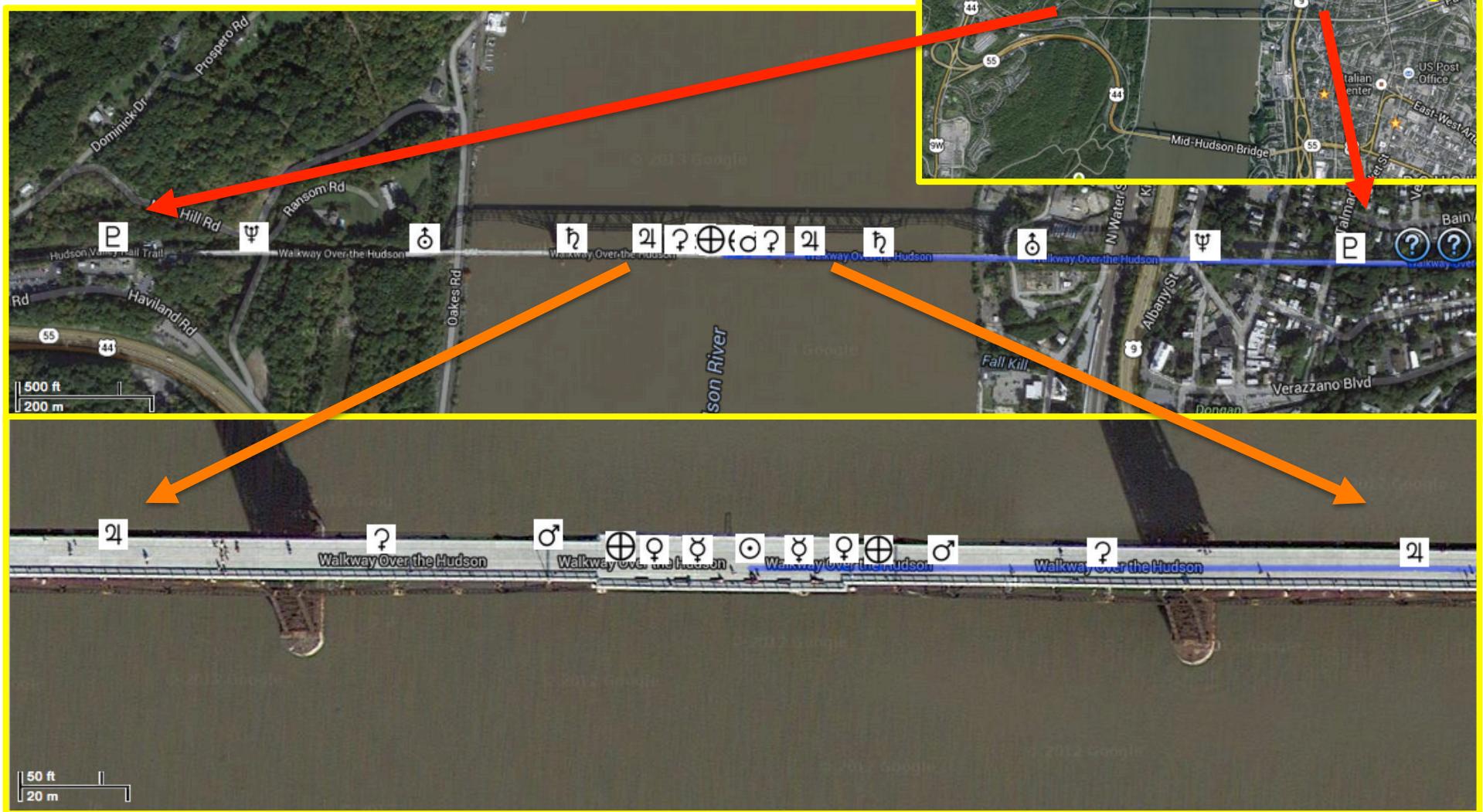
To scale, that is 86 AU, so the Kuiper belt would fit (but not Sedna)

Or, simply double the distances of the Thousand Yard model and it still fits.

Or, put the Sun in the middle and mark distances to the planets on both sides of the bridge, as lines or curves. You don't just walk out of the solar system, you cross it!

# Walkway over the Hudson

Poughkeepsie/Highland, New York

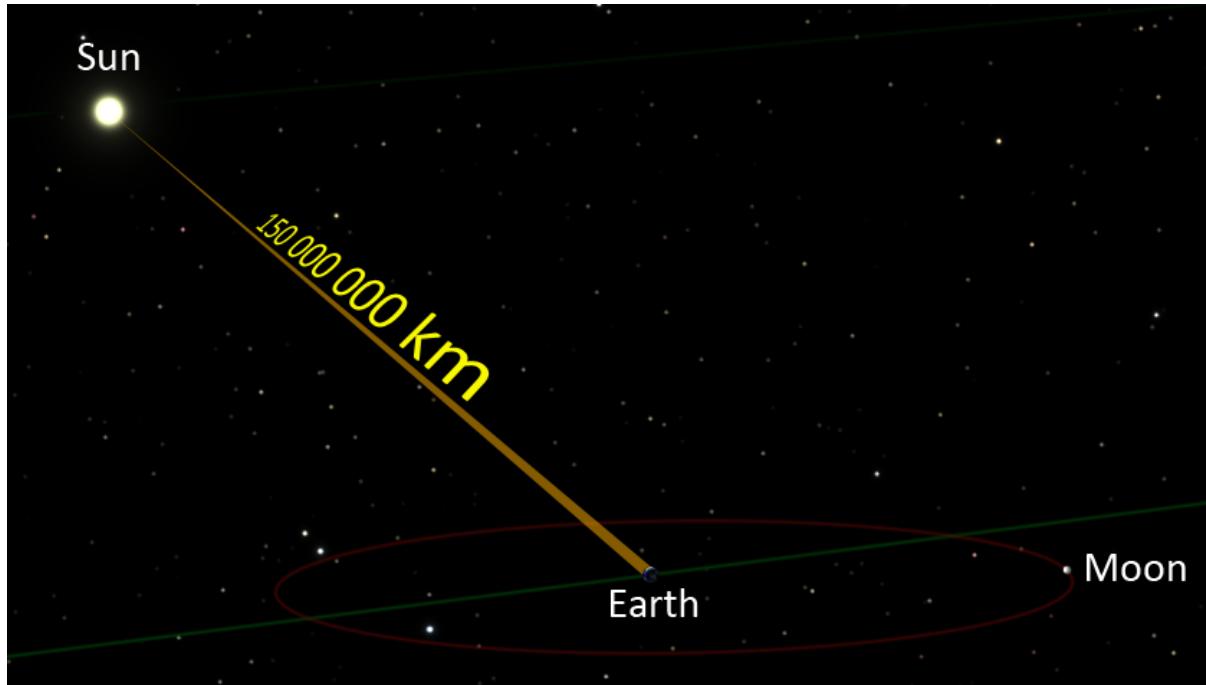


# The Lightspeed model of the Solar System

Instead of pacing off distances between planets, use the time it takes for light to travel out to that planet from the Sun.

(Hat tip to Paul Dellechiaie, MHA)

$$\frac{1 \text{ AU}}{c} = \frac{1.4960 \times 10^{11} \text{ m}}{2.9978 \times 10^8 \text{ m/s}} = 499 \text{ s} = 8 \text{ minutes } 19 \text{ seconds}$$



Good exercise for a long car trip, or for travel by airline or train.

(Now the sizes of the planets varies with the speed of the vehicle.)

# The Lightspeed Model of the Solar System

Object (*dwarf planets)	Distance, in AU (semi-major axis)	Δ Time (H:mm:ss)	Σ Time (H:mm:ss)
Sun	0.00	0:0:00	0:00:00
Mercury	0.39	3:15	3:15
Venus	0.72	2:44	5:59
Earth	1.00	2:20	8:19
Mars	1.52	4:19	12:38
Ceres*	2.77	10:24	23:02
Jupiter	5.20	20:13	43:15
Saturn	9.58	36:26	1:19:41
Uranus	19.2	1:20:00	2:39:41
Neptune	30.1	1:30:39	4:10:20
Pluto*	39.3	1:16:31	5:26:51
Haumea*	43.1	31:36	5:58:28
Makemake*	45.8	22:27	6:20:55
Eris*	67.7	3:02:08	9:23:04

# What can we do?

“That’s nice”

(or perhaps “Wow!”)

Tell others.

Do the walk on your own,  
or with a friend

Do the walk before meetings

Do the walk before star parties

Do the walk at special events

Build portable stations.

Find other suitable locations.

(Tell me! MyersE@newpaltz.edu)

Save acorns and walnuts

Make a kit.

Create an App.

# The Peppercorn Model

The peppercorn model (or the Thousand Yard model) is a scale model of the solar system which demonstrates at the same time, on a linear scale, both the sizes of the planets and the distances between them.

*Just the right size for both!*

The Sun and planets are represented by objects familiar from everyday life: The Earth is the size of a peppercorn (or the pupil of your eye), 26 yards from the Sun, which is the size of a bowling ball (or the size of your head). Pluto is just over 1000 yards from the Sun.

*Let's include Ceres.*

But the peppercorn model is something you **do**, not just something that you see or hold or touch.      It's the experience, not just the object.

The peppercorn model can be an event, or it could be turned into a permanent installation.      Either way, there are multiple sites in the area --- probably in every locality.

Slides for questions  
or from previous talks

# Dutchess County Rail Trail

Poughkeepsie, NY

Starting at Morgan Lake,  
ending just before Grand Avenue

Scale: 1 : 6,336,000,000

[Map](#)

[KML](#)

