PIZZA PIZZA !!!

...the Math and Mechanics of building a solar oven

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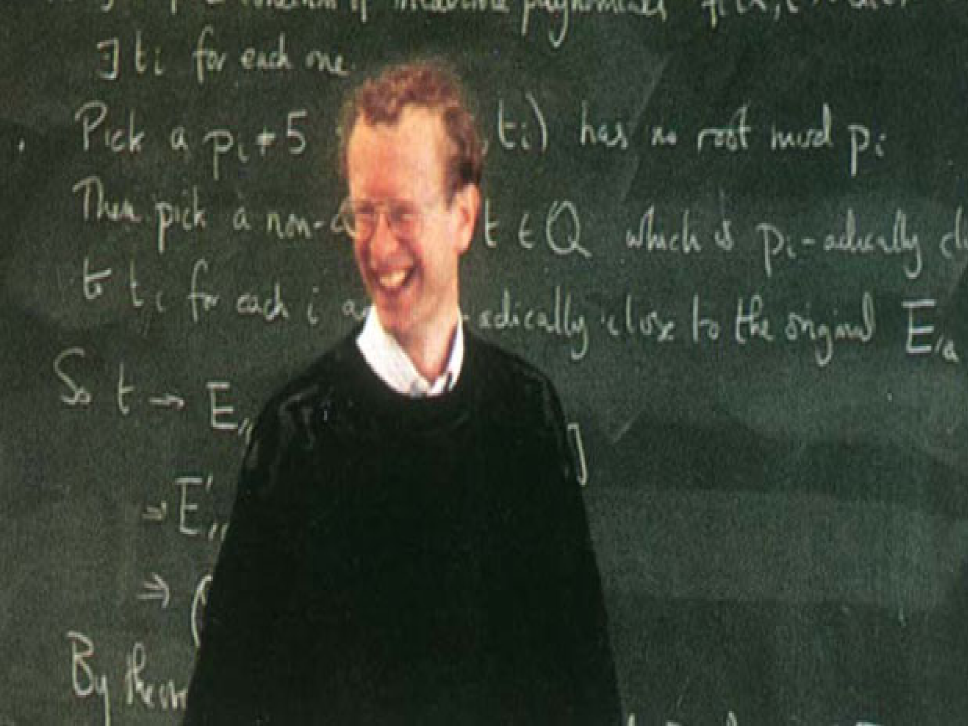
Southern Connecticut State University

January 8, 2015

My split personality

Mathematician or Mad Scientist?


∃ t i for each one.
Pick a p i ≠ 5
t i) has no root mod p i
Then pick a non-
t ∈ Q which is p i -adically
to t i for each i
adically close to the original E

A Gentle Introduction to the Art of Mathematics, version 3.1

Joe Fields

GAP package GUAVA

Authors: Jasper Cramwinckel, Erik Roijackers, Reinald Baart, Eric Minkes, Lea Ruscio, Robert Miller, Tom Boothby, Joe Fields (maintainer), Cen Tjhai, David Joyner
Needs: GAP in version at least 4.5.2, and suggests also installing the GAP package SONATA.
Operating systems: Any, on which GAP 4 is running. (Some functions involving the automorphism group of a code require a linux/unix system or (windows) cygwin installation.)
Current version: 3.12
Contact: fieldsj1@southernct.edu
Download: See below for archives in several formats.

Online Documentation

Here is the documentation of the GUAVA package in several output formats. If you have installed the package as described above you can also access all of these documents from the GAP online help.

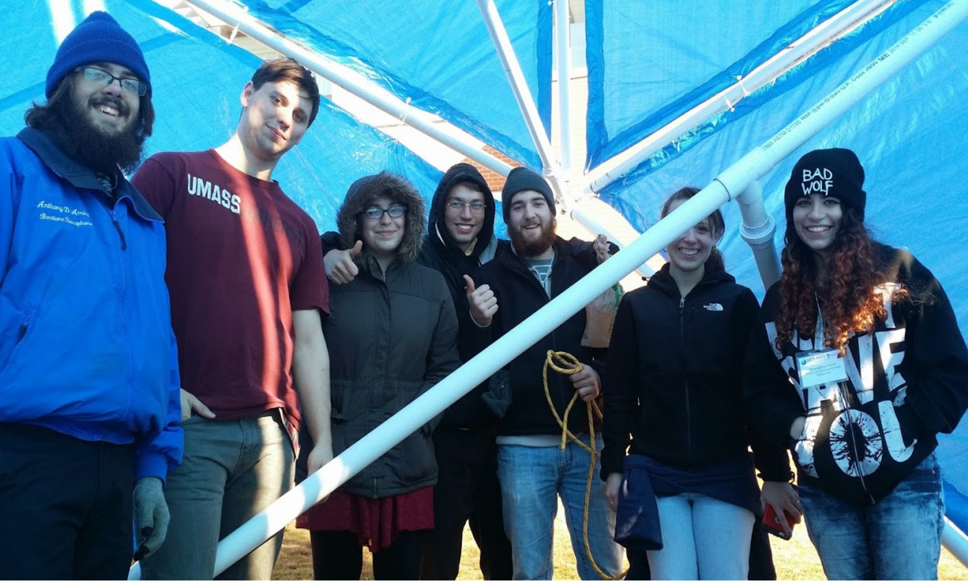
- HTML-version
- pdf

Browse the code: here.

Other GUAVA web pages

- covering codes calculations (under construction)
- **Visual GUAVA:** Thanks to Sergio de los Santos (s.delossantos@amena.com), there is a graphical interface to GUAVA which you can download from http://visualguava.tk. Sergio reports that his program, written in visual basic, is still under construction. It is a windows only program and written in Spanish. (I have not tried this out, being a Linux person, but am interested in feedback from others on this.)

Description


UMASS
BAD
WOLF


NES/MAA
Fall 2014 Section Meeting
SCSU
Southern Connecticut
State University

Apologies

Unfortunately we will not be enjoying solar-cooked french bread pizza today. . .

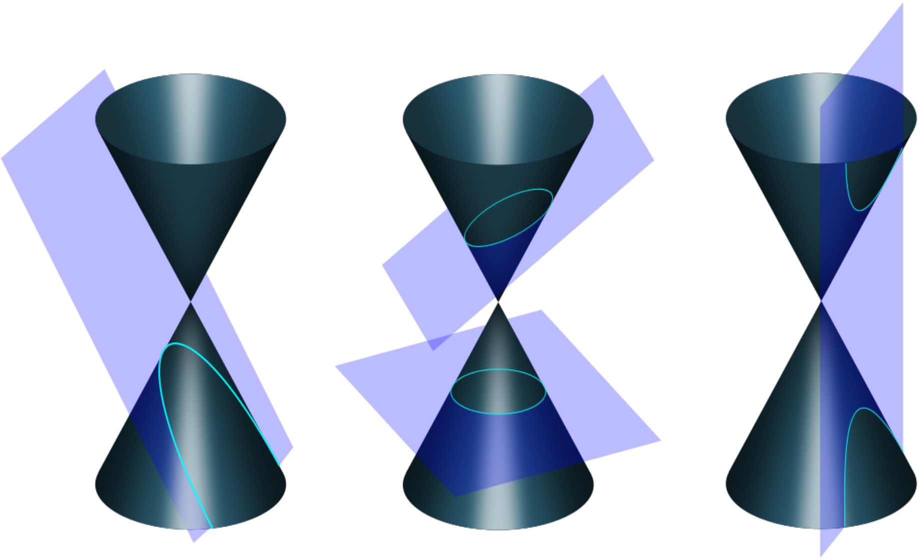
conic sections

The curves that we get from quadratic polynomials in x and y were known to the ancient Greeks.

Which is strange since they didn't know about polynomials.

The deep connections between Geometry and Algebra weren't understood until the 17th century and the groundbreaking work of René Descartes.

The Greeks knew these curves as "conic sections."

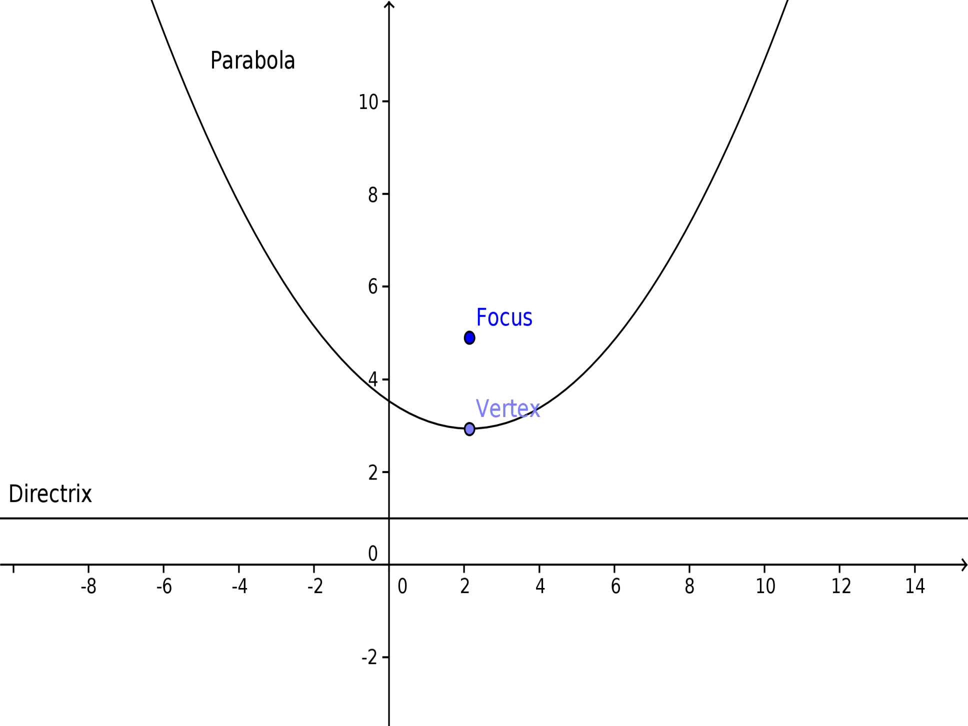


① ② ③

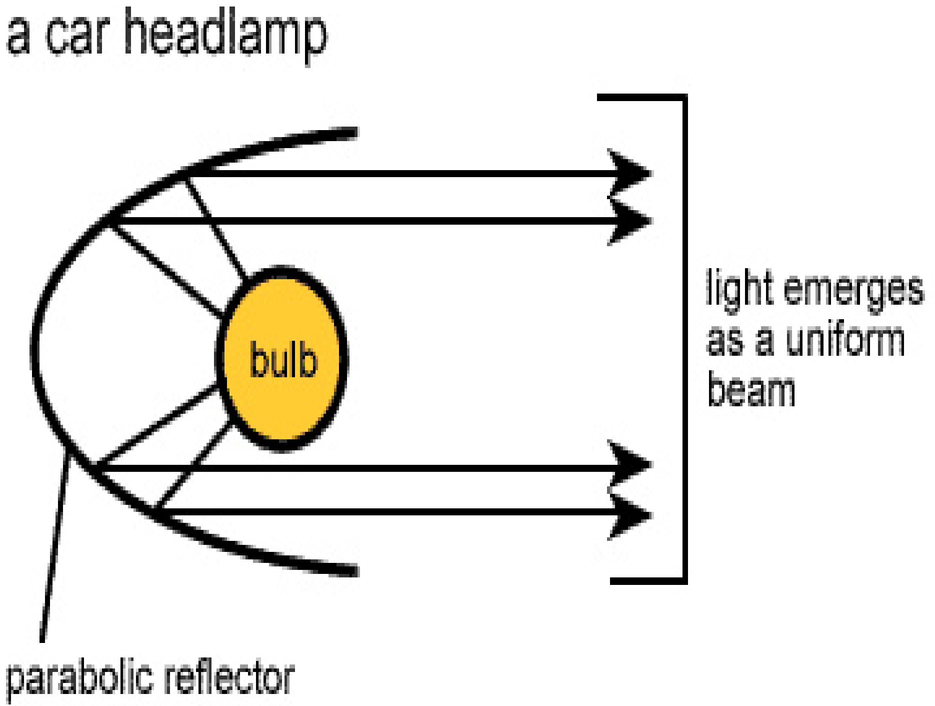
definition

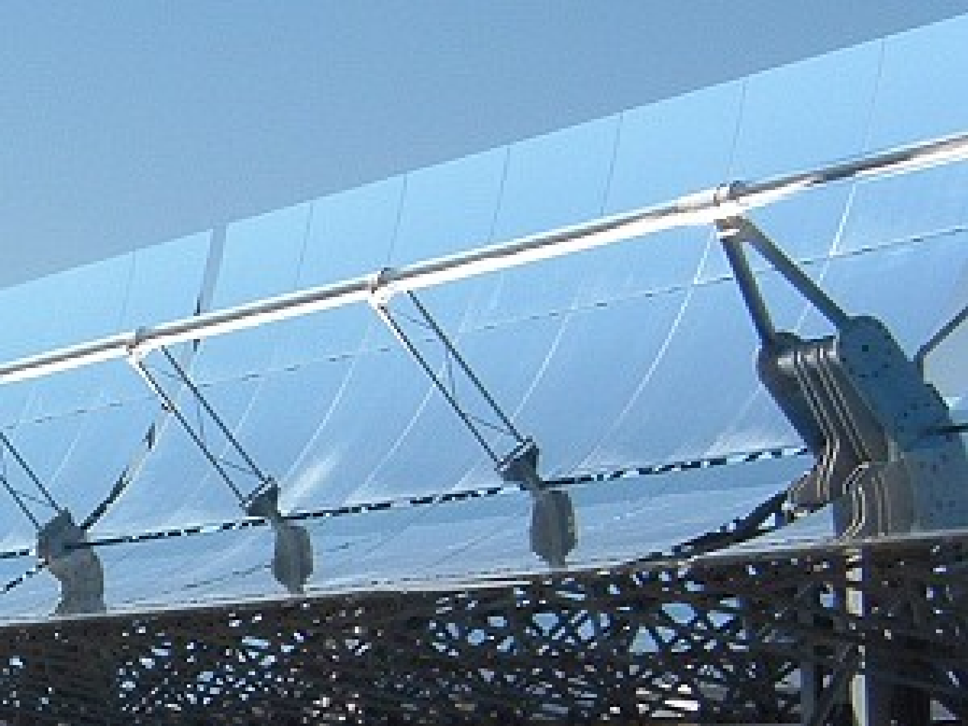
A parabola is defined as the set of points that are equidistant from a point and a line.

The point is called the *focus* of the parabola and the line is known as the *directrix*.


Parabola
Focus
Vertex
Directrix
10
8
6
4
2
0
-2
-8
-6
-4
-2
0
2
4
6
8
10
12
14


LUCAS


a car headlamp
bulb
light emerges as a uniform beam
parabolic reflector




Windsurfer
D-Link


My Drive - Google Dri
parabolic reflector - G
parabolic solar stove
www.loupiote.com/photos/18327559.shtml
Apps
Joe Fields' Homep
Sage: Open Source
Amazon.com: Onli
SCSU
Google
General
Sign in · GitHub
Portable RV Solar Kits
overlandsolar.com
Set your RV up with solar in less than 1 minute. Plug and play solar.
Share
View Album
Download Image
money down. Cheaper, Greener, Solar! Learn More
parabolic solar stove
baby-sloth.jpg
sloth.jpg
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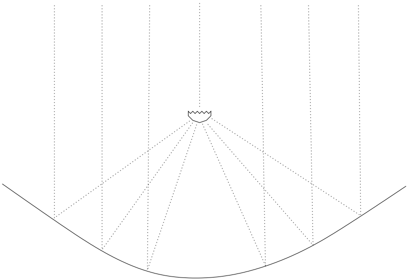
the inspiration

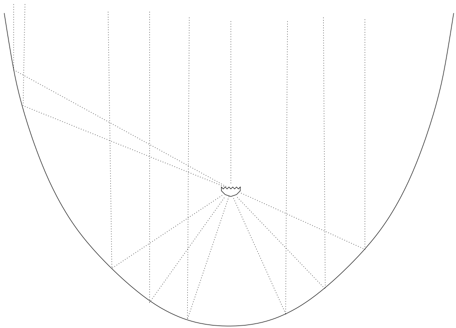
The Solar Death Ray:

http://youtu.be/TtzRAjW6KO0

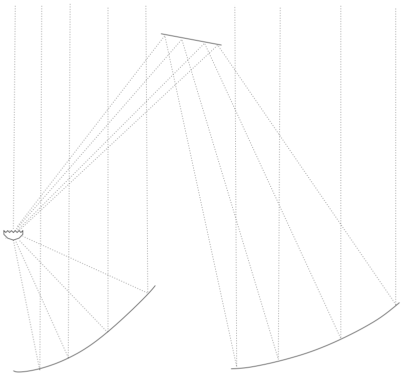
So how do we get the cheese to melt?



The bottom of the bread is getting 5000 suns, but the cheese is only getting 1.



By extending the parabola above the focus, we get some of the reflected light to give the cheese at least a glancing blow. . .



Using a second parabolic reflector (with a longer focal length) and a flat secondary mirror we are able to apply significant energy to both top and bottom.

The equation of a line through two given points.
The equation of a line through a point and perpendicular to a given line.
A point on a line at a given distance from another.
Distance between a line and a point.
Solving quadratic equations.

http://youtu.be/b1q1pPI79TY

quiz

What is the equation of a parabola whose vertex is at $(2, 1)$ which also goes through the point $(0, 3)$?

We can start with the "ordinary" parabola $y = x^2$ and shift it so that the vertex is in the desired location.

$$y = (x - 2)^2 + 1$$

Unfortunately that one doesn't go through $(0, 3)$, but if we shrink it a bit vertically, it will.

$$y = \frac{1}{2}(x - 2)^2 + 1$$

Finding that scale factor is a great example of "doing" algebra!

GeoGebra

Geogebra is free, open-source software for doing geometry and algebra.

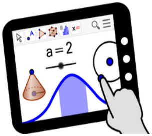
GeoGebra ×

www.geogebra.org

Apps | Joe Fields' Home | Sage: Open Sourc | Amazon.com: On | SCSU | Google | General | Sign in · GitHub

Dynamic mathematics for learning and teaching

Browse materials



Start creating

Download now

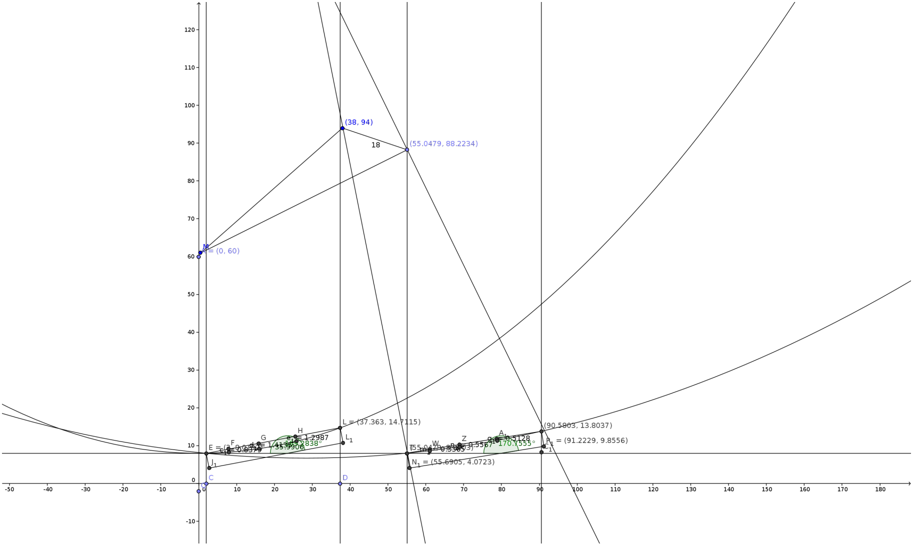
GEOGEBRA

IS A MULTI-PLATFORM MATHEMATICS SOFTWARE THAT GIVES EVERYONE THE CHANCE TO EXPERIENCE THE

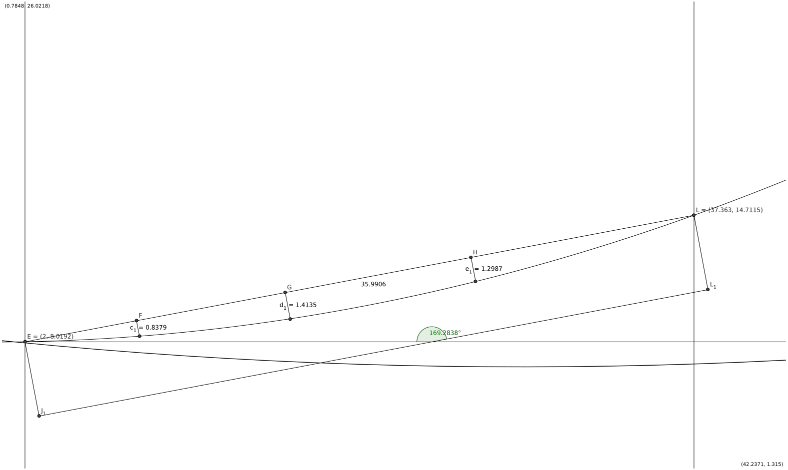
EXTRAORDINARY INSIGHTS THAT MATH MAKES POSSIBLE

Geogebra comes in to play for two primary purposes.

- Optimizing the layout of the second parabola and the flat reflector.
- Calculating the “form” of the parabolas for actually making them from wood.



(38, 94)
18
(55.0479, 88.2234)
A = (0, 60)
M
L = (37.363, 14.7115)
(90.5803, 13.8037)
P1 = (91.2229, 9.8556)
N1 = (55.6905, 4.0723)
C
D


(0.7848, 26.0218)
L = (37.363, 14.7115)
H
e1 = 1.2987
35.9906
G
d1 = 1.4135
L1
F
c1 = 0.8379
E = (2, 8.0192)
169.2838°
J1
(42.2371, 1.315)

In theory there is no difference between theory and practice, but in practice. . .

Guess what temperature is reached at the focus of one of my primary mirrors.

$$135^\circ \text{ F}$$

Why am I getting 1.7 suns rather than 5000?

- Focus is a line segment not a point.
- Diffuse reflection
- Error in parabolic form?

I accumulated appproximately 28 years of bad luck in trying to bend mirrors to fit the forms for the primary mirror. (The secondary mirrors do work with this idea – they are much less curved.)

Solution: I acquired some aluminized 5 mil mylar film which has 98% reflectivity and is "optical grade".

A single mirror section is sufficient to light a piece of paper on fire. . .

Fahrenheit 451!

When two of my mirror segments are angled so they both illuminate a pizza their “focus” is a really a pair of crossing line segments. Can we design a mirror with compound curvature whose focus is truly a line segment?

Can this be done in such a way that the energy will be evenly distributed along the line segment?

Is it possible to achieve a focus of arbitrary shape?

These questions are answered using Calculus and Partial Differential Equations.

The geometry I've shown here would work best at noon on the Equator.

Can we improve the design to work when the sun is near the horizon?

Is it possible to have an adjustment so that sun positions near the zenith *and* near the horizon can be accomodated?

that's all folks!

Thanks for your kind attention.

Questions?