POINT FOCUS

BY

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The aim of science is not things themselves — as the dogmatists in their simplicity imagine — but the relations between things.

Outside those relations there is no reality knowable.

Poincaré
LETT THERE BE

LIGHT

NOBODY KNOWS WHAT LIGHT IS

THERE ARE A LOT OF THEORIES AROUND

THE POOL BALL THEORY

LIGHT
IS A STREAM OF BALLS TRAVELING IN STRAIGHT LINES LIGHT RAYS EXTENDING OUT FROM THE SOURCE IN EVERY DIRECTION BENDING AND BOUNCING ACCORDING TO THE RULES OF THE COSMIC POOL GAME

THE ELECTRIC EEL THEORY

LIGHT
IS A STREAM OF ELECTRIC EELS PHOTONS TRANSPORTING AN ENERGY IN PROPORTION TO THE FREQUENCY OF THEIR VIBRATION BEHAVING SOMETIMES LIKE PARTICLES SOMETIMES LIKE WAVES DEPENDING ON THE EXPERIMENT ACCORDING TO THE RULES OF THE COSMIC DICE GAME

THE VIBRATION THEORY

LIGHT
IS A VIBRATION TRAVELING IN CONCENTRIC BUBBLES WAVEFRONTS EXPANDING OUT FROM THE SOURCE LIKE CIRCLES ON THE COSMIC POND BENDING AND BOUNCING ACCORDING TO THE RULES OF THE COSMIC BLENDING GAME

THE CONSCIOUSNESS THEORY

LIGHT
IS A FIELD OF EXTERNAL CONSCIOUSNESS COLORS BLENDING WITH INTERNAL CONSCIOUSNESS THROUGH THE RAINBOW CHAKRAS IN THE HUMAN BODY CREATING THE PERSONAL HOLOGRAM THE EGO EXPERIENCE REALITY ACCORDING TO THE RULES OF THE COSMIC AWARENESS GAME
Have you ever wanted to focus a lot of sunlight into a point

I mean, trying to make all the sunrays within a large area pass through the same point in space.

Just like a kid playing with a burning glass

But bigger

 Much bigger

Suppose that you could gather all the sunlight that falls in your own backyard and make it fall within the palm of your hand.

Then you would have a fistful of super concentrated solar energy

A real hot spot

Do you know what you could do with it
You could make your own solar furnace
not enough to melt
every material that exists

You could melt some sand
and make silicon cookies
with a boron frosting
to generate an abundance
of dirt cheap solar electricity
without the slightest pollution
of your environment

You could make yourself
all the materials you would ever need
directly from the elements
around you in nature.

You could even make diamond
the hardest substance known to man
which gives you power
to work with all the others

You could become
a 20th century Robinson Crusoe
and live in modern comfort
almost anywhere
on the surface of this planet
without having to buy anything
from anybody.

And if you started to wonder about
what to do with your spare time
you could build your own giant telescope
and open up the windows
to the universe, around you.
Yes indeed
a big point focus machine
could change a lot of things
in your life.

Why
are they not being made.

Why
don't we see them everywhere,
the huge sunburning machines
like we see their oil burning counterparts
all around us.

The art
of creating objects
that can focus parallel light rays to a point
has been practiced by man,
at least since the days of Galilei.

It has so far produced
two different solutions

The convex lens

The parabolic disc

It bends parallel light rays
to a point
by letting them reflect through
a properly shaped
piece of transparent material.

paralllel light rays
have the same direction.

sun rays
are very close to parallel.

It bends parallel light rays
to a point
by letting them reflect off
a properly shaped
mirrorized surface.
These two solutions to the point-focus problem have one important thing in common.

They both have a surface which is curved in both of its dimensions.

A round-round surface.

Such a surface can only be made by grinding and polishing the material towards the shape of mathematical perfection.

This is a very laborious and expensive process.

Even a small surface of good point-focusing quality is therefore an expensive thing to make and the cost of a big one would be astronomical.

So the reason for the lack of a big point-focus is the fact that the two mathematical surfaces that have the point-focusing property are too expensive to approximate physically in large size.
But what if there was a third way to do it

I mean what if there was a third mathematical surface with the point-focusing property

And what if the geometry of this surface was much better adapted to physical reality

What if it could be easily and cheaply approximated in large size

Well then you would have your giant burning glass and all the benefits that come with it

But surely if such a surface existed it would have been discovered in mathematics and communicated to physics a long time ago

I mean this surface would solve the energy problem this surface would create the age of solar power this surface would open a clear window to cosmos

Surely such an incredible surface isn't waiting for you just around the bend
But in fact that is exactly what it does

There is a third way to do it

There is a third mathematical surface with the pointfocusing property

And it has an incredibly simple geometry

It can be easily and cheaply approximated in large size by bending two flat sheets of any flexible material.
I want to show you the third way to do it

The third way to focus parallel light to a point

The third way to focus the energy from the sun.

The way of focal power.

I want to show you how to understand it and how to make practical use of it.

It is so incredibly simple.

It only really takes a piece of plastic and you can get it from the hardware store.
Take a look in a plane mirror.

Imagine a ray of light that hits the mirror.

In which direction will it bounce back?

Where is the reflected ray in relation to the incoming ray?

How does Nature figure out where to put it in space?

To each plane there is a unique direction which is perpendicular to it.

This direction has a special name in mathematics.

It is called the normal of the plane.
The reflected light ray leaves in the plane that contains the incoming ray and the normal at the point of impact.

And the two rays form equal angles with this normal.

This is the law of reflection for a plane surface.

But what if the surface is curved?

How do the light rays reflect in a curved mirror?

Each point on a curved surface has a "touching plane."

The touching plane of the point $P$ is the plane that touches the surface at this point.
A light ray that hits a curved mirror will reflect in the same direction as if it were hitting the touching plane at the point of impact.

Therefore, the law of reflection for a plane surface is true also for a curved surface if we let the word normal mean normal to the touching plane.

A ray of light reflects like a ball on the pool table. They both swing a half turn around the normal at the point of impact.
Take a piece of mirrorplex and aim it at the sun.

Bounce the sunlight onto a wall.

Bend the mirror by squeezing and twisting the ends.

Watch the changes of the light shape on the wall.

When the shape gets larger, the energy is spreading thinner.

That is why the shape gets dimmer.

When the shape gets smaller, the energy is concentrating.

That is why the shape gets brighter and hotter.

How much can you concentrate the energy?

How small can you make the shape?

How close can you get to a perfect line?
Is there a perfect line to aim for?

This is a mathematical problem since a perfect line is a mathematical concept.

We are looking for the ideal bending curve for the edge of the mirror.

The curve to aim for when you are bending it.

The curve that would reflect all the parallel light rays of a plane surface into a single point.

Is there such a curve?

And if it exists what does it look like?
The answer to this question has been known to mathematics for a long time.

The curve we are looking for is called 

**The Parabola**

Choose a point (let's call it F) and a line (let's call it L) in the plane.

Then choose another point (let's call it P).

Measure the distance from P to F (called PF) and the distance from P to L (called PL).

No matter where you choose the point P one of these three alternatives will happen:

1. P is closer to F
2. P is closer to L
3. P has the same distance to both

The parabola determined by F and L is the curve of all points that have the same distance to both F and L.
The point F
is called the focal point
and the line L
is called the generating line
of the parabola.

Draw another line
called E₁
which is parallel to L.

Choose a point
called P
on the parabola.

Then
the distance from P to F
is equal to
the distance from P to L.

Therefore,
the sum
of the distance from E₁ to P
and the distance from P to F
is equal
to the distance from E₁ to L.

Therefore
the sum is the same
for every point P
on the parabola.
This fact can be used
to make
a parabola drawing machine

All you need is
a straight edge
two C-clamps
a right angle
a piece of string
a piece of wood
a nail
and some tape

Tie the string
to the piece of wood
and tape it
to the top of the right angle

Tie the other end of the string
to the nail
at a distance
equal to the length of the angle

Fasten the straight edge
to the table
with the C-clamps
wherever you want
the generating line

Pin down the nail
wherever you want
the focal point
Slide the angle along the edge and push the string tight against the side of the angle with the tip of your pen.

Then your pen will trace a parabola on the table.

The edge is the generating line and the nail is the focal point of this parabola.

So now you know what a parabola is.

But how do you know that it is in fact the curve you are looking for?

The curve that will reflect parallel light rays to a point.
Take a look at the parabola machine.

Suppose that we could prove that the path of the string is the same as the path of a light ray reflecting in the parabola.

Then, since all the different string paths meet at the point F, so would all the different light paths.

Now, can we prove that the string path follows the law of reflection in the parabola.

This can be done with the use of formulas and equations.

It is a standard proof of high school mathematics involving trigonometry, analytical geometry, and a bit of calculus.
But there is a simple, and beautiful, intuitive proof based on two fundamental principles of physics:

A principle of energy
and
A principle of balancing forces.

Take a rectangular table with the edge as the generating line, cut a parabolic track in it.

Make a peg that slides smoothly in the track.

Drill a hole through the focal point F.

Put a string through the hole and around the peg across the edge of the table, and hang a pound weight from each of its ends.
Then choose a point $S$ and drill a hole through it.

Tie a string to the peg drop it through the hole and hang a 1 pound weight from its other end.

Finally oil the table with superglue to make all motions frictionless.

When the weights are hanging freely the position of the peg will adjust itself to the point where the total energy of the weights is minimal.

That is the point where the weights are as close to the floor as they can be.

The point where the total length of the strings under the table is as large as possible.

The point where the total length of the strings on top of the table is as small as possible.
But
the string FPE
is identical to
the string of
the parabola machine.

Therefore,
it's length is always the same
no matter where the peg is.

So
the position of the peg
must be the point
where the string SP
is as short as possible.

The point
that is closest to S
on the parabola.

The point
where SP is perpendicular
to the curve.

The point
where SP is the normal
to the touching line
of the parabola.

Now
think of the forces
acting on P.

The peg is pulled
with equal force
towards F and E.

This action is balanced
by a pull towards S.
Therefore, the direction SP must split the angle FPE in two equal parts.

But SP is the normal direction at P.

Therefore, for each choice of the point S the string FPE is identical to the path of a ray of light reflecting at P.

So we finally arrive at the conclusion.

A mirrorized parabola will reflect all the parallel light rays that are perpendicular to its generating line through its focal point.

The Parabola is the curve of perfect point focus in a two dimensional universe.
So now you have a two-dimensional point focus.

But how can you focus three-dimensional light with it?

This problem suggests a motion of the parabola in space.

Rotation is the motion of things in circles.

Translation is the motion of things in parallel lines.

They are the basic motions of geometry.

Together they combine into all possible motions of rigid things.
Rotate the parabola around its axis of symmetry.

The trace of the curve will be a pointfocus in our universe.

It is called the parabolic disc or the paraboloid of revolution.

Translate the parabola perpendicular to its plane.

The trace of the curve will be a linefocus in our universe.

It is called the parabolic cylinder.

The parabolic disc is a very common surface on this planet.

It is a symbol of our age.

It is the pointfocus of modern technology.
But
the parabolic disc
is not the only way
to do it

There is a way
to make a point focus
with two parabolic cylinders

A parabolic cylinder
has a focal line
and a generating plane.

If you slice the cylinder
perpendicular to its focal line
you get
a plane of point focus
for the cylinder.

The corresponding cut
in the generating plane
is called
a generating line
for the cylinder.

It is
the generating line
of the parabola
which is the corresponding cut
in the cylinder.
Take a look at this parabolic cylinder. Let's call it $C_1$.

The light that hits it parallel to the axis of symmetry will bounce back aiming for the focal line $L$.

Suppose that we catch the light with a second parabolic cylinder $C_2$.

I claim that if $C_2$ is placed so that the focal line of $C_1$ is identical to a generating line of $C_2$ then the light will come to a perfect point focus.
To prove this look at the plane \( P_f \).

The broken lines in the figure are all in the plane \( P_f \).

The plane of parallel light rays that hits \( C_1 \) along the line \( b, c_1 \) will be reflected in the plane \( P_f \) as parallel light rays perpendicular to the generating line of the \( P_f \) parabola.

Therefore, this plane of light rays will be reflected by the \( P_f \) parabola to its focal point \( F \).

Now look at the plane of light rays \( A, q, d, D \) perpendicular to \( b, c_1 \).

But the same argument is true for any plane of light rays that is parallel to this one.

Therefore, they must all be reflected to the point \( F \) which proves the point focus property.
THE PARABOLA
THE 2-DIMENSIONAL POINTFOCUS MIRROR

TRANSLATION

SPACE PACE
ACCELERATION
TRANSLATION

THE TWO FUNDAMENTAL MOTIONS

SPACETIME

ROTATION

MOTION IN LINES
SPACE PACE
MOTION IN CIRCLES
SPACE PACE

C1

C2

THE NAIVE CROSS
TRANSLATED PARABOLIC POINTFOCUS MIRROR
BEAD + BEAD CYLINDRICAL FLAT SHEETS CHEAP

THE PARABOLOID
ROTATED PARABOLIC POINTFOCUS MIRROR
GRIND SPHERICAL CURVATURE EXPENSIVE