

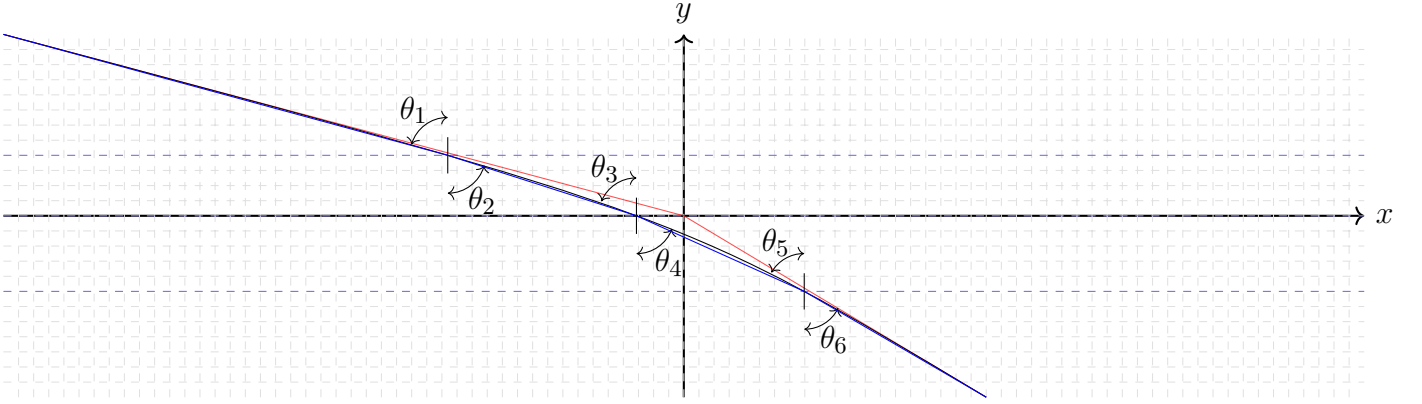
Joint Research of Optics and Fluid Interface

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1 Differential Analytic

$$\forall i \in \mathbb{N} : \frac{\sin \theta_{2i-1}}{\sin \theta_{2i}} = \frac{v_{2i-1}}{v_{2i}} \quad (1)$$

Let the ray inbound from upper toward lower and refracts at origin. Let $\theta(y)$ be the acute angle between the velocity vector at that instant and the y-axis.

Let $y = P(x)$ be the path light actually taken, now our goal is to solve $P(x)$ and also the function of speed of light within specific y $v(y) = v(P(x))$.

$$\lim_{\Delta x \rightarrow 0} \frac{\sin \theta(P(x))}{\sin(P(x) + \Delta x)} = \frac{v(P(x))}{v(P(x) + \Delta x)} \quad (2)$$

$$\lim_{\Delta y \rightarrow 0} \frac{\sin \theta(y)}{\sin(y + \Delta y)} = \frac{v(y)}{v(y + \Delta y)} \quad (3)$$

$$\lim_{r \rightarrow 0} \frac{\sin \theta(y)}{\sin(\theta(y) + r\theta'(y))} = \frac{v(y)}{v(y) + rv'(y)} \quad (4)$$

$$\lim_{r \rightarrow 0} \sin \theta(y)v(y) + rv'(y) = v(y)\sin(\theta(y) + r\theta'(y)) \quad (5)$$

2 Setup

Let Δ be the total width the light travels with path not being straight, hence:

$$\forall x \notin [-\frac{\Delta}{2}, \frac{\Delta}{2}] : \frac{d^2}{dx^2}y = 0 \quad (6)$$

Now define the light ray incoming from left-hand side towards right-hand side and (suppose transition layers' width approaches zero) refracts at origin. And let h be the thickness of the transition layers.

Now let's assume the incoming transition layer has the same thickness as outbounding transition layer, hence we get:

$$\Delta = \frac{h}{2}(\tan \theta_{in} + \tan \theta_{out}) \quad (7)$$

Now we can first confirm our path function is a function of $\theta_{in}, \theta_{out}, h$

$$P(\theta_{in}, \theta_{out}, h) = \quad (8)$$

3 Continuous Geometric Mean

$$v(x) = \begin{cases} a, & x < -\frac{h}{2} \\ b, & x > \frac{h}{2} \\ a \sqrt[\frac{h}{a}]{(\frac{b}{a})^{(x+\frac{h}{2})}} & \text{otherwise} \end{cases} \quad (9)$$

4 Analyzing

Given a full path from v_1 to v_n , whose path will be $y(v_1, v_n, h)(x)$, we could separate it into different sections.

$$\Delta_{i \rightarrow i+1} = \frac{h}{n-1} \frac{1}{2} [-\tan \theta_i, \tan \theta_{i+1}] \quad (10)$$

$$\sum_{i=1}^{n-1} \Delta_{i \rightarrow i+1} = \frac{h}{2} (\tan \theta_1 + \tan \theta_n)$$

$$\forall x \in \Delta_{i \rightarrow i+1} : \quad (11)$$

$$(x, y(v_1, v_2, h_{12})(x)) + (\Delta_{2 \rightarrow n}, h_{2 \rightarrow n})$$

5 Finding path

5.1 Constructing Layers

Let function $v(\theta_{in}, \theta_{out}, \Delta, \delta)$ be the velocity of layer δ (from the entry interface), whose entry velocity is θ_{in} , exit velocity is θ_{out} , and the whole layer thickness is Δ .¹

$$a = v(x, y, \beta - \alpha, \alpha) \quad (12a)$$

$$b = v(x, y, \beta - \alpha, \beta) \quad (12b)$$

$$\alpha \leq \beta \quad (12c)$$

Let $a = v(x, y, \alpha)$ and $b = v(x, y, \beta)$ ($\alpha \leq \beta$), $\forall p \in [\alpha, \beta] : v(a, b, p - \alpha) = v(x, y, p)$

5.2 Fractal Structure

$$\text{Let } P(\theta_{in}, \theta_{out}, h) \text{ be the path taken} \quad (13)$$

$$P(\theta_{in \rightarrow \alpha}, \alpha) = P(\theta_{in}, \theta_{\alpha}) \quad (14)$$

¹ Here we suppose every layer paraelles

6 Regarding Special Relativity

So first let the real velocity v , whom maintains the linear properties of traditional non-relativistic velocity.

Linear to non-linear (relativistic) velocity:

$$v_S = \frac{v_{\mathfrak{I}} \mathfrak{I}_S^{\mathfrak{I}}}{\mathfrak{I}_S S} = v_{\mathfrak{I}} \mathfrak{I}_S^{\mathfrak{I}} \quad (15)$$

6.1 Constant force/acceleration

Let a point located at origin, with initial velocity $v(0) = 0$.

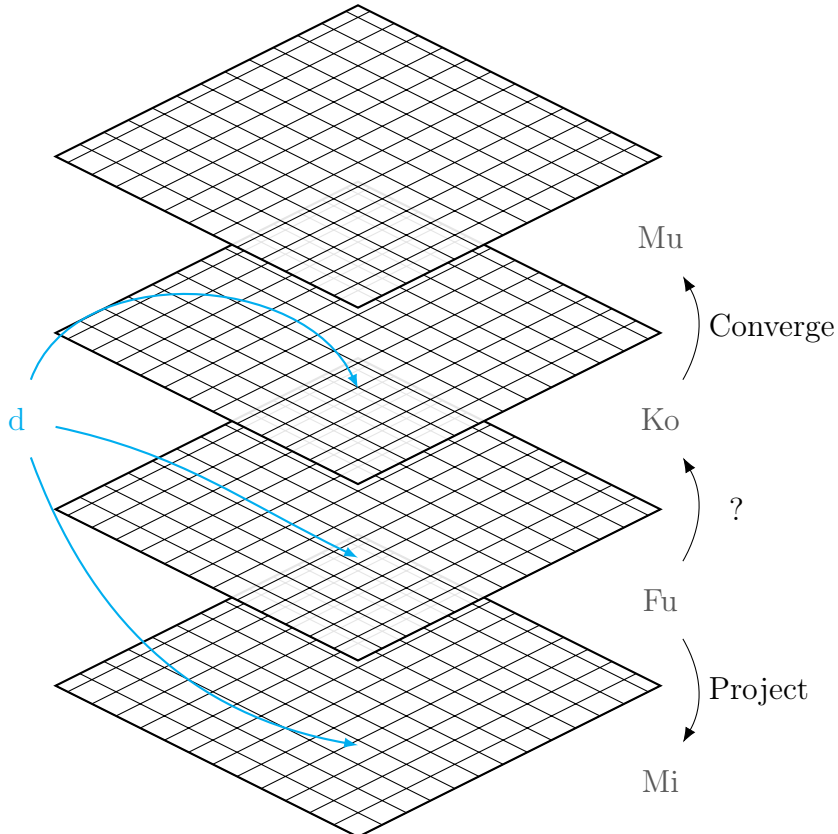
$$a_{\mathfrak{I}}(v, F, m_{rest}) = \frac{F}{m_{rest}} \sqrt{1 - \frac{v^2}{c^2}}^3 \quad (16a)$$

$$a_{\mathfrak{I}}(t) = k \quad (16b)$$

$$v_{\mathfrak{I}}(t) = v_{\mathfrak{I}} \mathfrak{I}_S^{\mathfrak{I}} = kt \mathfrak{I}_S^{\mathfrak{I}} \quad (16c)$$

$$v_{\mathfrak{I}}(t) = \int \frac{F}{m_{rest}} \sqrt{1 - \frac{v_{\mathfrak{I}}(t)^2}{c^2}}^3 \quad (16d)$$

7 Model of Particles



8 Conclusion

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Acknowledgment

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References

- [1] https://www.mail-archive.com/dou-geometry@googlegroups.com/msg00004/-----_.docx

A Playing with Bezier Curve (failed)

First setup the environment

```
h, t=var("h t")
hh=h/2
theta=var("theta")
tprime=var("tprime", latex_name=r"\theta^{\prime}")
assume(h, "constant")
assume(h>0)
assume(0<theta, theta<pi/2)
assume(0<tprime, tprime<pi/2)
```

And now we could try to solve functions like $y(x)$ from parametric bezier curve:

```
# x(t)=(t-1)^2*tan(theta)*hh*-1+t^2*tan(tprime)*hh
y=(t-1)^2*hh-t^2*hh
```

First we try to find $t(x)$

```
result=[]
[((abs(res.rhs()(x=tan(theta)*hh*-1)(h=2, theta=0.2, tprime=0.4))<1e-12 and
abs(res.rhs()(x=tan(tprime)*hh)(h=2, theta=0.2, tprime=0.4)-1)<1e-12) and
result.append(res))
for res in solve((t-1)^2*tan(theta)*hh*-1+t^2*tan(tprime)*hh==x, t)]
t=result[0].rhs() if len(result)==1 else None
```

Where we get two solutions and only one will satisfied our assumptions (the first print is 0 and the second yields 1^2), which is:

² Here we use $EPS = 1e - 12$ as we're testing it with arbitrarily chosen values which makes them no longer symbolic.

$$t(x) = \frac{h \tan(\theta) - \sqrt{h^2 \tan(\theta) \tan(\theta') - 2(h \tan(\theta) - h \tan(\theta'))x}}{h \tan(\theta) - h \tan(\theta')}$$

And substituting back to $y(t)$ we could get

B Appendix head