Collected Papers Second Half of 2024 - A Special Issue on Physics

Mikko I. Malinen
mikko.i.malinen@gmail.com

11th November, 2024

Preface

This is an article collection of Mikko I. Malinen from second half of year 2024. The articles in the collection share the same field - they are all about physics. To cite an article in this collection, you may do it the following way:

Mikko I. Malinen, "The Article Name Comes Here", in Collected Papers Second Half of 2024 - A Special Issue on Physics, Mikko I. Malinen, Joensuu, Finland, November 2024

Joensuu, Finland 11th November, 2024

Mikko I. Malinen

Contents

Chapter 1

Time dilation in special relativity is not transitive - revised

1.1 Introduction

I show that the time dilation in special relativity is not transitive.

1.2 Derivation

Let elapsed time in a point in space be t_0. A spaceship is sent from that point in space with velocity $\bar{v}$ to a certain direction. Elapsed time at the initial point is

$$\frac{t_1}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{1.1}$$

A second spaceship is sent - at he same time moment - from that point with velocity $2\bar{v}$ to the same direction as the first spaceship. Elapsed time at the initial point caused by the first spaceship and the second spaceship is

$$\frac{\frac{t_2}{\sqrt{1-\frac{v^2}{c^2}}}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{t_2}{1-\frac{v^2}{c^2}}. \tag{1.2}$$

Elapsed time at the initial point that is caused by the second spaceship is

$$\frac{t_2}{\sqrt{1-\frac{4v^2}{c^2}}}. \tag{1.3}$$

Now right-hand side of the Expression (1.2) $\neq$ Expression (1.3). This shows that the time dilation in special relativity is not transitive. This raises a question on the validity of special relativity.

1.3 Graphical Derivation

In Figure 1.1 the spaceships are travelling away from the initial point p_0. Elapsed

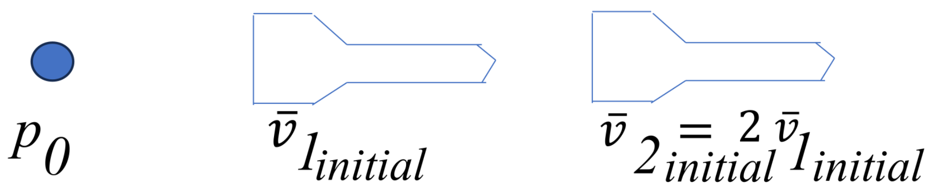

Figure 1.1: Spaceships travel.

time at the initial point caused by the spaceship 1 is

$$\frac{t_1}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}}. \tag{1.4}$$

Elapsed time at the spaceship 1 caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}} \tag{1.5}$$

Elapsed time at the initial point caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{4v_{1_{initial}}^2}{c^2}}}. \tag{1.6}$$

In Figure 1.2 the spaceship 2 has slowly returned to the stopped spaceship 1. When the time to return to the location of the spaceship 1 is denoted by t_3, the elapsed time at the initial point caused by the spaceship 1 is

$$\frac{t_1}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}} + t_3. \tag{1.7}$$

Elapsed time at the spaceship 1 caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}} + t_3 \tag{1.8}$$

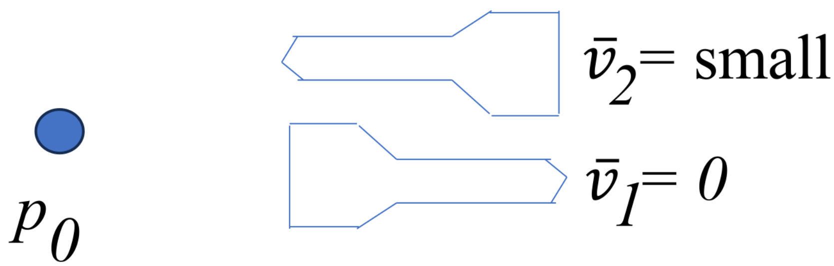

Figure 1.2: Spaceship 2 has slowly returned to the location of spaceship 1.

Elapsed time at the initial point caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{4{v_1}^2_{initial}}{c^2}}}+t_3. \tag{1.9}$$

When the time to return to the location of the initial point p_0 is denoted by

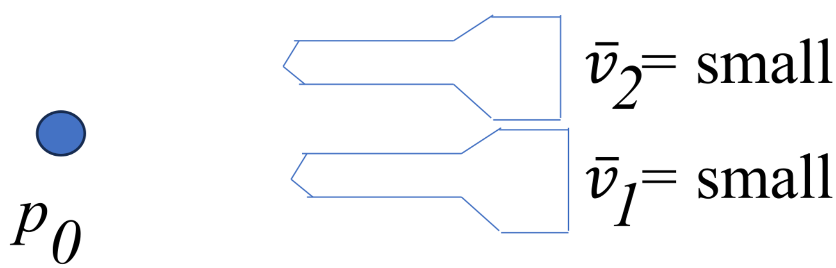

Figure 1.3: Spaceships together start slowly returning to the initial point.

t_4, the elapsed time at the initial point caused by the spaceship 1 is

$$\frac{t_1}{\sqrt{1-\frac{{v_1}^2_{initial}}{c^2}}}+t_3+t_4. \tag{1.10}$$

Elapsed time at the spaceship 1 caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{{v_1}^2_{initial}}{c^2}}}+t_3+t_4 \tag{1.11}$$

Elapsed time at the initial point caused by the spaceship 2 is

$$\frac{t_2}{\sqrt{1-\frac{4{v_1}^2_{initial}}{c^2}}}+t_3+t_4. \tag{1.12}$$

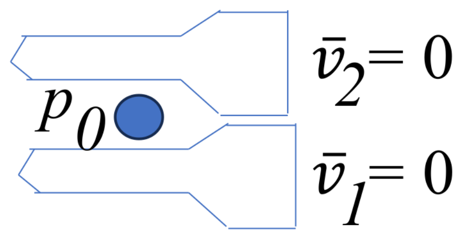

Figure 1.4: Spaceships have slowly returned to the initial point.

Elapsed time at the initial point caused by the second spaceship via the first is

$$\frac{\frac{t_2}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}}}{\sqrt{1-\frac{v_{1_{initial}}^2}{c^2}}} + t_3 + t_4 = \frac{t_2}{1-\frac{v_{1_{initial}}^2}{c^2}} + t_3 + t_4. \tag{1.13}$$

As we can see, the right-hand sides of the Expressions (1.12) and (1.13) are not equal. This raises a question of the validity of the Special relativity.

We tried also a numerical example by putting $v_{1_{initial}} = 0,45 \cdot c$ and $v_{2_{initial}} = 0,9 \cdot c$ and return speeds $100.000 m/s$. Return times t_3 and t_4 was used as such and additionally also relativistically calculated. The numerical results corresponding to the right-hand sides of the Expressions (1.12) and (1.13) support the theoretical result.

Chapter 2

Efficiency of a heat exchanger depends on the direction of flow

2.1 Introduction

Heat exchangers are important f.eg. in distilling and in district heating. See an example of a heat exchanger in Figure 2.1. See an alternative heat exchanger, in which the direction of the cooling liquid is reversed, in Figure 2.2. We do a comparison of these heat exchangers by simulation and find if another of them is more efficient in exchanging heat.

2.2 Theory

The heat exchange between two objects may be modelled by an equation

$$\frac{dQ}{dt} = kA\frac{T_H - T_C}{L} \tag{2.1}$$

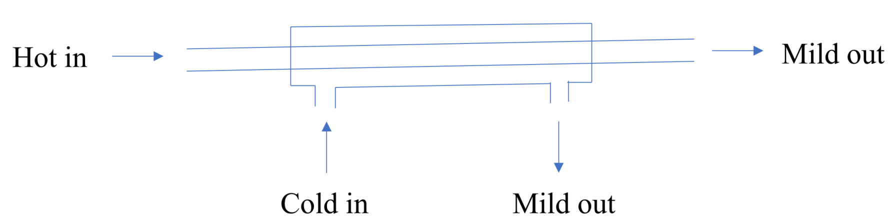

Figure 2.1: An example of a heat exchanger

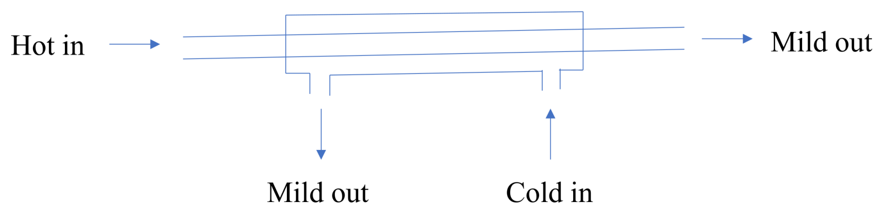

Figure 2.2: An alternative heat exchanger

from $[1, 2, 3]$, where Q is the heat energy of object 2, k is thermal conductivity, A is the cross-section area of the conducting material, T_H is the temperature of object 1, T_C is the temperature of object 2 and L is the distance between objects 1 and 2. This may be written shortly

$$\frac{dQ}{dt} = b(T_1(t) - T_2(t)) \tag{2.2}$$

from $[2, 3]$, where Q is the heat energy of object 2, b is a positive proportionality constant, T_1 and T_2 are temperatures of objects 1 and 2, and t is time (or location). Because heat energy is comparable to temperature, we can write

$$\frac{dT_2(t)}{dt} = a(T_1(t) - T_2(t)) \tag{2.3}$$

from $[2, 3]$, where a is a proportionality constant.

2.3 Calculation

Without losing generality we divide both the hot pipe and the cold pipe to 100 elements, see Figure 2.3, set $a = 0.01$, iterations $= 100.000$, temperature of fresh hot liquid $= 100$ $[^oC]$ and temperature of fresh cold liquid $= 10$ $[^oC]$. Index t expresses the number of element and varies 1..100 depending on the location in the pipe. Increasing the number of iterations does not change the result. See algorithm in Figure 2.4.

2.4 Results

Output temperature from hot liquid pipe is 61.0897^oC when the directions of flows are the same and 58.671^oC when the directions of flows are opposite. This means -2.4625^oC difference in temperatures. It is around 4% cooler when the flows are in opposite directions. See plots of T_1, T_2, T_3 and T_4 in Figures 2.5 and 2.6.

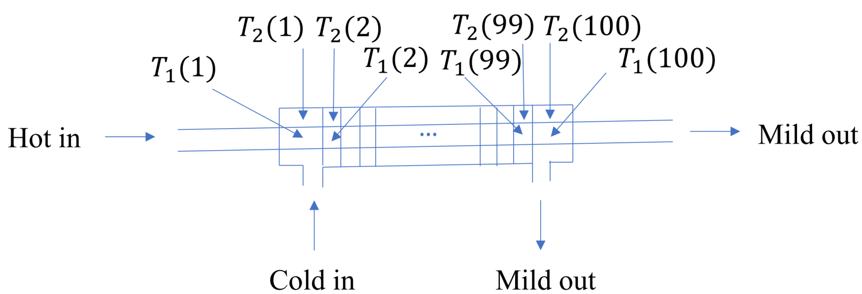

Figure 2.3: Dividing pipes to 100 elements each

-Initialize all elements to temperatures 100 (hot pipe) and 10 (cold pipe).
for iterations = 1 to 100.000
  -Transfer proportion of temperature difference from all elements in hot pipe to corresponding elements in cold pipe, that is,
  $T_2(t) = T_2(t) + a \cdot (T_1(t) - T_2(t))$
  -Transfer proportion of temperature difference from all elements in cold pipe to corresponding elements in hot pipe, that is,
  $T_1(t) = T_1(t) - a \cdot (T_1(t) - T_2(t))$
  -Propagate values of elements in hot pipe in to next elements in the hot pipe following the direction of flow, that is,
  $T_1(t+1) = T_1(t)$.
  -Propagate values of elements in cold pipe into next elements of cold pipe following the direction of flow, that is,
  $T_2(t+1) = T_2(t)$
  -Set the temperature value of first elements to 100 (hot pipe) or 10 (cold pipe). This corresponds to new liquid coming in. That is,
  $T_1(1) = 100$, $T_2(1) = 10$.
end for
-Plot $T_1(t)$ and $T_2(t)$

Figure 2.4: The simulation algorithm

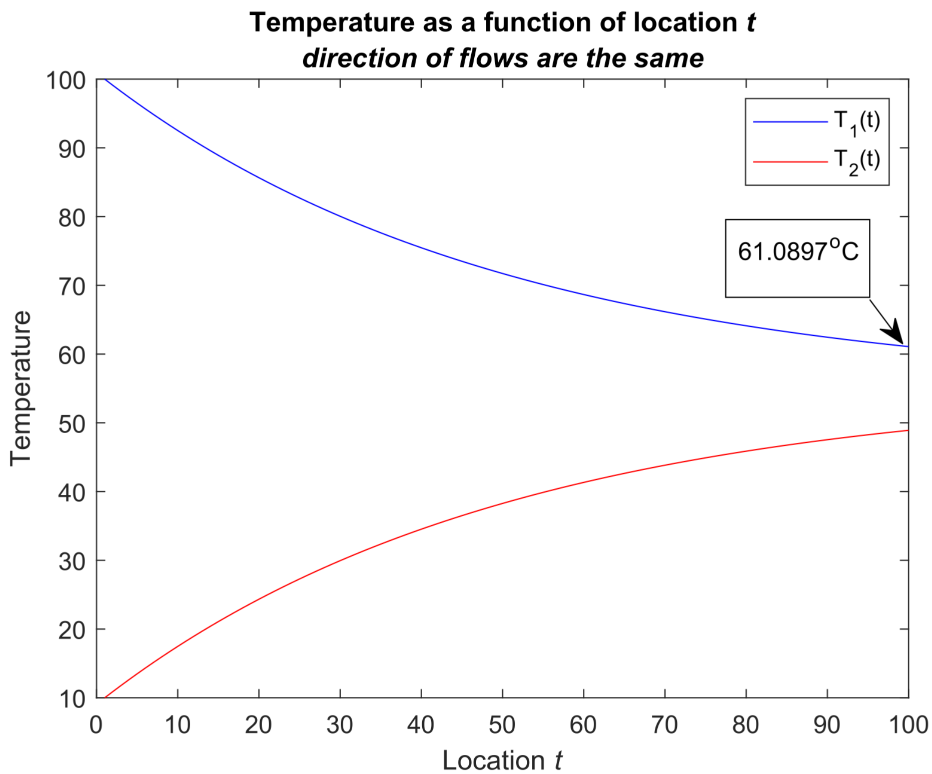

Figure 2.5: Temperature distributions, same direction of flows.

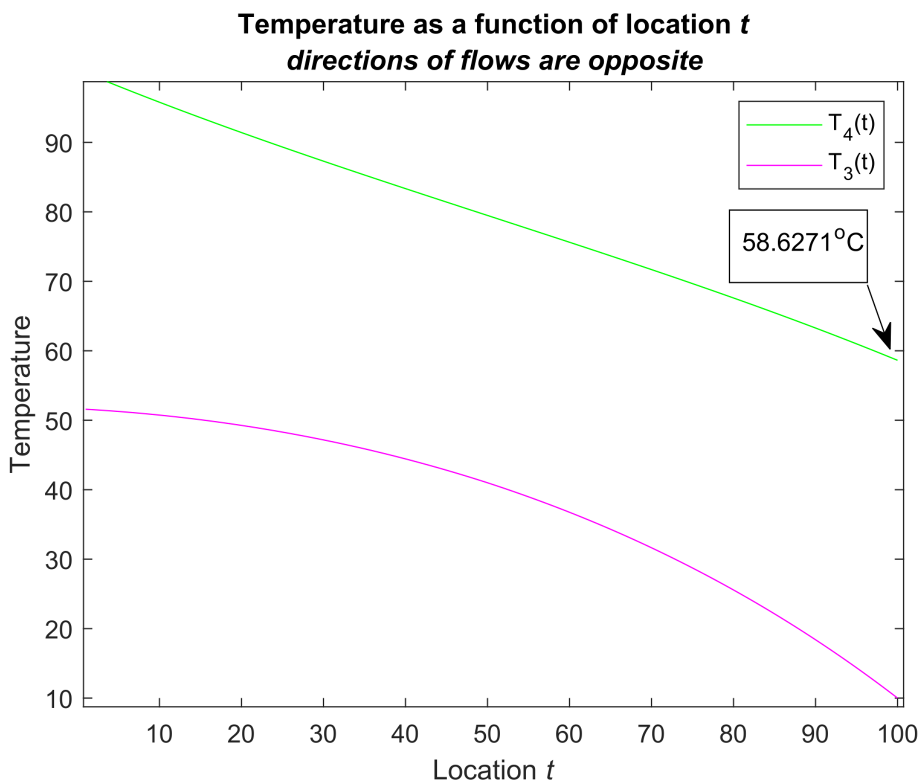

Figure 2.6: Temperature distributions, opposite directions of flows.

2.5 Summary

We have shown that putting flows opposite in heat exchanger we get more efficient exchange of heat.

References

[1] Hugh D. Young and Roger A. Freedman, University Physics, 9th Edition, Addison-Wesley, 1996
[2] Mikko Malinen, "Dynamiikkaa, derivaattoja ja ennustavia kuumemittareita", in Mikko Malinen, Collected Papers 2000-2009, 2012
[3] Mikko Malinen, "Dynamiikkaa, derivaattoja ja ennustavia kuumemittareita", Matematiikkalehti Solmu, 3/2008

Chapter 3

Dependency of power of four in physics

3.1 Introduction

It has been said that there are very few dependencies of power of three of higher in physics. I here show one example of dependency of power of three and one example of dependency of power of four.

3.2 Dependency of power of three

Volume of a sphere (Figure 3.1) is

$$V = \frac{1}{3}\pi r^3 \tag{3.1}$$

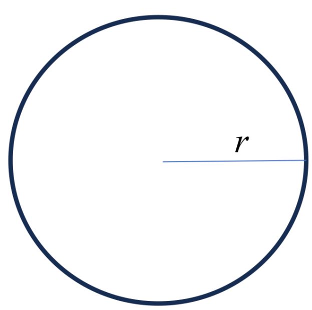

Figure 3.1: A sphere and its radius

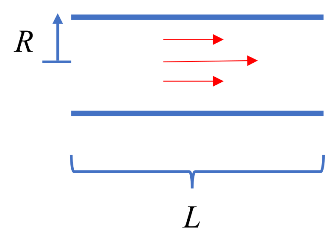

Figure 3.2: A needle and its radius.

3.3 Dependency of power of four

Flow through a needle of a pipe (Figure 3.2) is by Poiseuille's equation [1]

$$\frac{dV}{dt} = \frac{\pi}{8}(\frac{R^4}{\eta})(\frac{p_1 - p_2}{L}), \tag{3.2}$$

where R is radius, η is viscosity and p_1 and p_2 are pressures in ends. This equation contains R^4, a dependency of power of four.

References

[1] Hugh D. Young and Roger A. Freeman, "University Physics", 9th Edition, Addison-Wesley, 1996

Chapter 4

Exploding growth is polynomial growth

4.1 Theory

The term ”exploding growth” is often used for something that grows very fast, f.eg. exponential growth, that is,

$$f(n) = a^{bn}, \tag{4.1}$$

where f(n) grows exponentially with respect to n. But, actually, exploding growth is polynomial growth. Lets consider an explosion in the air. The fragments form a ball, of which radius grows linearly. It is known that the volume of a ball is

$$V(r) = \frac{1}{3}\pi r^3, \tag{4.2}$$

where r is the radius. We do not know anything in explosion that grows faster than the volume, so we can say that exploding growth is polynomial growth.