EVERYTHING
You Ever Wanted To Know About
Dick & Jane
And Mary

The Fly In The Ointment

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v1.7

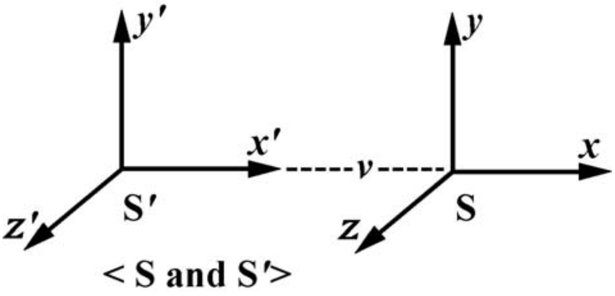
We live in a fantasy world, a world of illusion.
The great task in life is to find reality.
Iris Murdoch

Special thanks
To USC Professor Klingler
Who inspired me to join the ongoing search for reality

My Proofreaders Mary, Julie, Tag
And Math Wizard Megan
Thank You

Sec 2

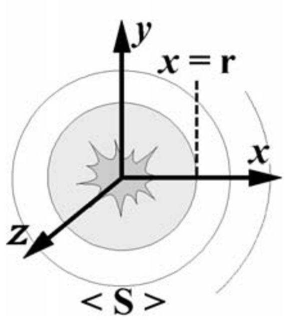
Thought Experiment Setup



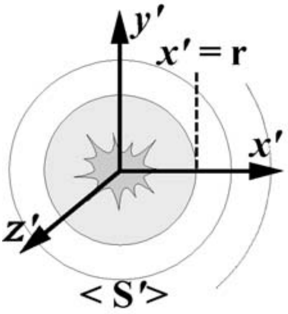
L-3a

Sec 3

Solo Experiments



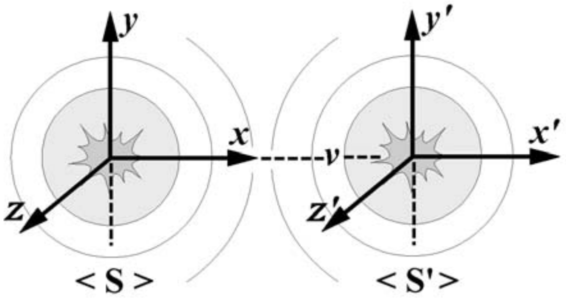
L-1a



L-2a

Sec 4

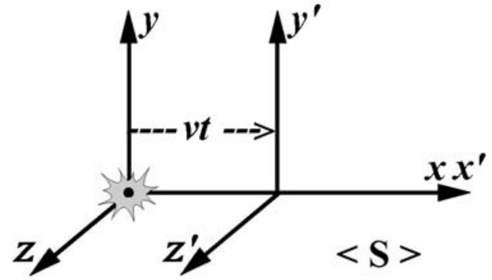
Joint Experiment



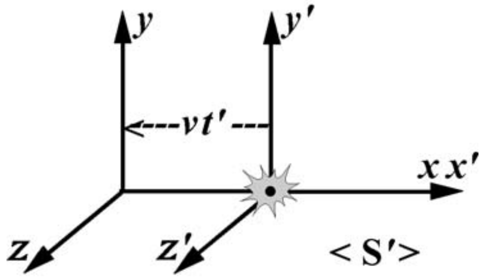
L-4

Sec 5

The Tangled Web To Deceive



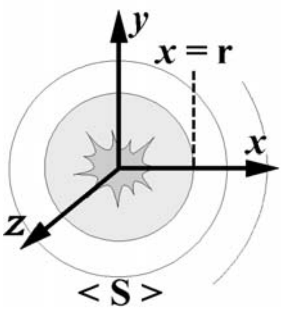
L-10



L-11

Sec 6

Light Propagation

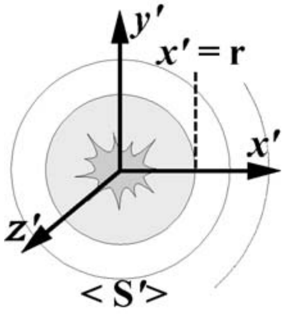


L-1a

< S >

6-1	$t = \lvert \pm x_r \rvert / c$		Light burst expands spherically
	$= \lvert \pm y_r \rvert / c$		from origin at speed ***c*** starting
	$= \lvert \pm z_r \rvert / c$		at time ***t***=0, and reaches the
	$= \mathbf{r} / c$		point **r** on all axes at time ***t***

#6-1



L-2a

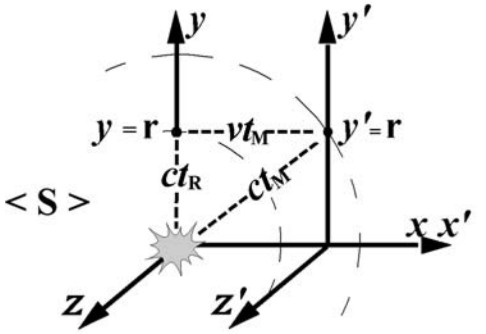
< S′ >

6-1	$t' = \lvert \pm x_r' \rvert / c$		Light burst expands spherically
	$= \lvert \pm y_r' \rvert / c$		from origin at speed ***c*** starting
	$= \lvert \pm z_r' \rvert / c$		at time ***t′***=0, and reaches the
	$= \mathbf{r} / c$		point **r** on all axes at time ***t′***

#6-2

Sec 7

Time Contraction Factor



L-7a

< S >

7-1 $c^2 t_M^2 = v^2 t_M^2 + c^2 t_R^2$ Pythagoras

-2 $c^2 t_M^2 - v^2 t_M^2 = c^2 t_R^2$ rearranged

-3 $t_M^2 (c^2 - v^2) = c^2 t_R^2$ factored left

-4 $t_M^2 / t_R^2 = c^2 / (c^2 - v^2) = \gamma^2$ solve for t_M^2 / t_R^2

-5 $t_M^2 / t_R^2 = 1 / (1 - v^2/c^2) = \gamma^2$ div num/den by c^2

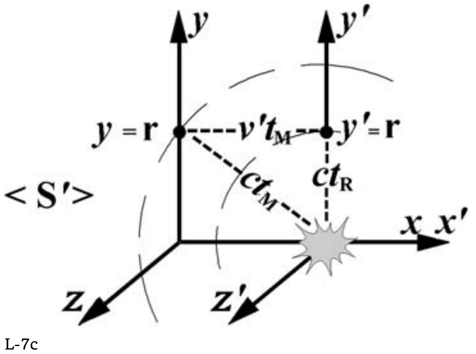
-6 $t_M / t_R = 1 / \sqrt{1 - v^2/c^2} = \gamma$ sqrt both sides

7 # 1-6

< S >

7-7 $\Delta t = \gamma \, \Delta t'$ $\Delta t = t_M$, Dick'sPerceived $\Delta t' = t_R$

7 # 7



L-7c

< S' >

7-8 $c^2 t_M^2 = v^2 t_M^2 + c^2 t_R^2$ Pythagoras

-9 $c^2 t_M^2 - v^2 t_M^2 = c^2 t_R^2$ rearranged

-10 $t_M^2 (c^2 - v^2) = c^2 t_R^2$ factored left

-11 $t_M^2 / t_R^2 = c^2 / (c^2 - v^2) = \gamma^2$ solve for t_M^2 / t_R^2

-12 $t_M^2 / t_R^2 = 1 / (1 - v^2/c^2) = \gamma^2$ div by c^2

-13 $t_M / t_R = 1 / \sqrt{1 - v^2/c^2} = \gamma$ sqrt both sides

7 # 8-13

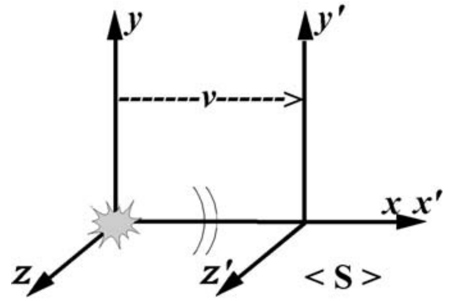
< S >

7-14 $\Delta t' = \gamma \, \Delta t$ $\Delta t' = t_M$, Jane'sPerceived $\Delta t = t_R$

7 # 14

Sec 8

Relative Speed



L-13

< S >

8-1 $t_1 = (x_0 + vt_1)/c$ time pulse 1 hit

-2 $t_2 = (x_0 + vt_1 + v\Delta t)/c$ time pulse 2 hit

-3 $t_{1e} = 2(x_0 + vt_1)/c$ time echo 1 detected

-4 $t_{2e} = 2(x_0 + vt_1 + v\Delta t)/c$ time echo 2 detected

8 # 1-4

< S >

8-5 $2x_0 + 2vt_1 = c\,t_{1e}$ #8-3 mul c and expnd

-6 $2x_0 + 2vt_1 + 2v\Delta t = c\,t_{2e}$ #8-4 mul c and expnd

8 # 5-6

< S >

8-7 $v = (c\,t_{2e} - c\,t_{1e}) / 2\Delta t$ Jane's v #8-6 - #8-5

8 # 7

< S′ >

8-8 $v' = (c\,t_{2e}' - c\,t_{1e}') / 2\Delta t'$ Dick's v'

8 # 8

< S >

7-7 $\Delta t = \gamma\,\Delta t'$ Time slows for Dick's moving clock

! 7 # 7

< S >

8-9 $v' = (c\,t_{2e}' - c\,t_{1e}') / 2\Delta t'$ ← #8-8

-10 $v = (c\,\gamma t_{2e}' - c\,\gamma t_{1e}') / 2\gamma\Delta t'$ #8-9 after fix $v' \rightarrow v$

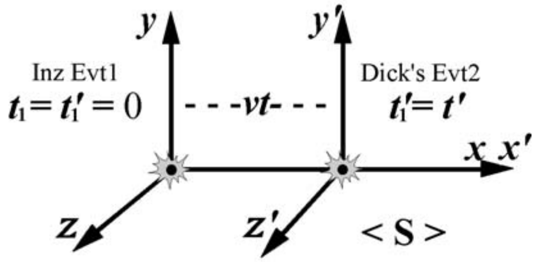
-11 $v = (c\,t_{2e}' - c\,t_{1e}') / 2\Delta t'$ #8-10 after γ_s cancel

-12 $v' = v$ #8-11, #8-9 → RtS=RtS ∴ LtS=LtS

8 # 9-12

Sec 9

Length Contraction Factor



L Delta 2

< S >

9-1 $v = \Delta x / \Delta t$

< S′ >

9-2 $v = \Delta x' / \Delta t'$

9 # 1-2

< S >

9-3	$\Delta x / \Delta t = \Delta x' / \Delta t'$		#9-1 = #9-2
-4	$\Delta t' / \Delta t = \Delta x' / \Delta x$	mul	#9-3 by $\Delta t' / \Delta x$
-5	$\Delta x' = \Delta x / \gamma$	mul	#9-4 by Δx
		from #7-7	$1/\gamma = \Delta t' / \Delta t$

9 # 3-5

< S >

9-6 $l_x' = \gamma\, l_x$ from #9-5 $l_x' = (\Delta x / \Delta x')\, l_x = \gamma\, l_x$

9 # 6

< S′ >

9-7	$\Delta x / \Delta t = \Delta x' / \Delta t'$		#9-1 = #9-2
-8	$\Delta t / \Delta t' = \Delta x / \Delta x'$	mul	#9-7 by $\Delta t / \Delta x'$
-9	$\Delta x = \Delta x' / \gamma$	mul	#9-8 by $\Delta x'$
		from #7-14	$1/\gamma = \Delta t / \Delta t'$

9 # 7-9

< S′ >

9-10 $l_x = \gamma\, l_x'$ from #9-9 $l_x = (\Delta x / \Delta x')\, l_x' = \gamma\, l_x'$

9 # 10

Sec 10

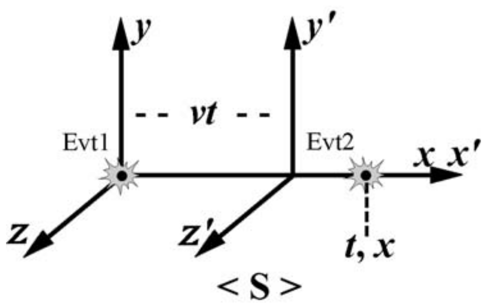
Spatial Transformation Equations

< S >

10-1 $y' = y$

-2 $z' = z$

10 # 1-2



L-18

< S >

10-3 $l_2 = x\text{-}vt$ let l_2 = distance x' =0 to Evt2

10 # 3

< S′ >

10-4 $l_2' = x'$ let l_2' = distance x' =0 to Evt2

10 # 4

< S >

9-6 $l_x' = \gamma\, l_x$ l_x' based on shrunken ruler

! 9 # 6

< S >

10-5 $x' = \gamma\,(x\text{-}vt)$ xx' spatial transform

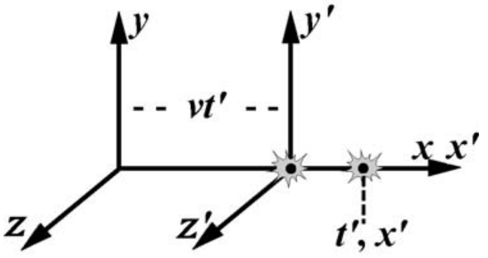
10 # 5

< S′ >

10-6 $y = y'$

-7 $z = z'$

10 # 6-7



< S′>

L-19

< S′ >

10-8 $l_2' = x' + vt'$ let l_2' = distance x =0 to Evt2

10 # 8

< S >

10-9 $l_2 = x$ let l_2 = distance x =0 to Evt2

10 # 9

< S′ >

9-10 $l_x = \gamma\, l_x'$ l_x based on shrunken ruler

! 9 # 10

< S′ >

10-10 $x = \gamma\, (x' + vt')$ $x'x$ spatial transform

10 # 10

Sec 11

Time Transformation Equation

< S >

11-1 $t' = t/\gamma$ #7-7 $\Delta t = \gamma\, \Delta t'$

11 # 1

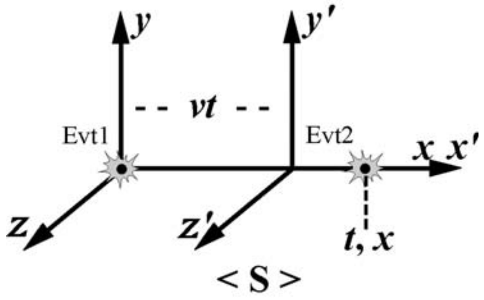
< S >

10-5 $x' = \gamma\,(x - vt)$ xx' spatial transform

< S′ >

10-10 $x = \gamma\,(x' + vt')$ xx' spatial transform

! 10 # 5,10



L-18

< S >

11-2 $x = \gamma\,(x' + vt')$ #10-10

$= \gamma\,(\gamma\,(x - vt) + vt')$ #10-5 $x' = \gamma(x - vt)$

$= \gamma^2\,(x - vt) + \gamma vt'$ carry out mul by γ

11 # 2

< S >

11-3 $t' = \{x - \gamma^2\,(x - vt)\}\,/\,\gamma v$ solve for $\gamma vt'$ first

$= x/\gamma v - \gamma\, x/v + \gamma\, t$ after division by γv

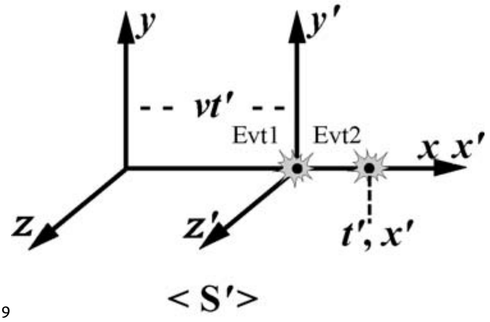
$= \gamma\,(t - x/v + x/\gamma^2 v)$ rearranged

$= \gamma\{t - x/v\,(1 - 1/\gamma^2)\}$ x/v factored

$= \gamma\{t - x/v\,(v^2/c^2)\}$ #11-9 $v^2/c^2 = (1 - 1/\gamma^2)$

$= \gamma\,(t - xv/c^2)$ time transformation

11 # 3



L-19

< S′ >

11-4 $x' = \gamma(x - vt)$ #10-5
$= \gamma(\gamma(x'+vt') - vt)$ #10-10 $x=\gamma(x'+vt')$
$= \gamma^2(x'+vt') - \gamma vt$ carry out mul by γ

11 # 4

< S′ >

11-5 $t = \{-x' + \gamma^2(x'+vt')\}/\gamma v$ solve for γvt first
$= -x'/\gamma v + \gamma x'/v + \gamma t'$ after division by γv
$= \gamma(t' + x'/v - x'/\gamma^2 v)$ rearranged
$= \gamma\{t' + x'/v\ (1 - 1/\gamma^2)\}$ x'/v factored
$= \gamma\{t' + x'/v\ (v^2/c^2)\}$ #11-9 $v^2/c^2 = (1-1/\gamma^2)$
$= \gamma(t' + x'v/c^2)$ time transformation

11 # 5

< S and S′ >

11-6 $\gamma = 1/\sqrt{1-v^2/c^2}$ < #7-6
-7 $\gamma^2 = 1/(1-v^2/c^2)$ squared
-8 $1/\gamma^2 = 1-v^2/c^2$ inverted
-9 $(1-1/\gamma^2) = v^2/c^2$ mul by -1; rearrange

11 # 6-9

< S >

7-7 $\Delta t = \gamma\,\Delta t'$ Time slows for Dick's moving clock

< S >

11-3 $t' = \gamma(t - xv/c^2)$ time transformation

! 7 # 7 , 11 # 3

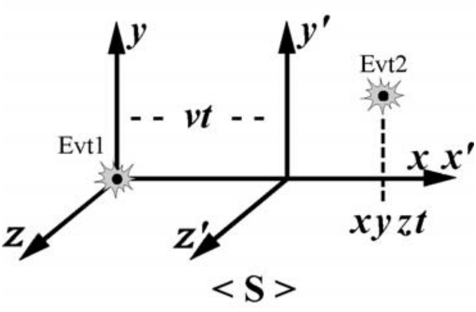
< S >

11-10 $t' = \gamma(t - xv/c^2)$ repeat #11-3
$= \gamma(t - vt\,v/c^2)$ sub vt for x
$= \gamma t(1 - v^2/c^2)$ simplify
$= t/\gamma$ from #7-5 $(1-v^2/c^2) = 1/\gamma^2$

11 # 10

Sec 12

Einstein

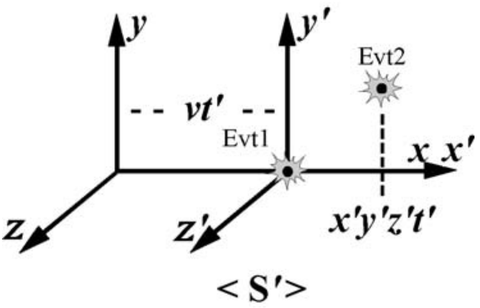


L-18a

< S >

12-1	$x' = \gamma(x - vt)$	← #10-5
-2	$y' = y$	← #10-1
-3	$z' = z$	← #10-2
-4	$t' = \gamma(t - xv/c^2)$	← #11-3
12-5	$\gamma = 1/\sqrt{1 - v^2/c^2}$	← #7-6

12 # 1-5



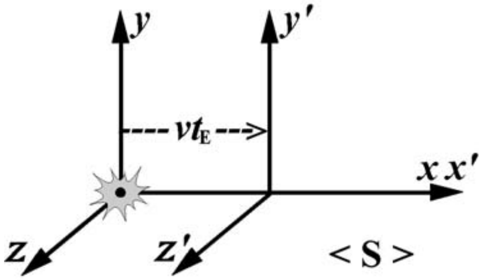
L 19a

< S′ >

12-6	$x = \gamma(x' + vt')$	← #10-10
-7	$y = y'$	← #10-6
-8	$z = z'$	← #10-7
-9	$t = \gamma(t' + x'v/c^2)$	← #11-5
12-10	$\gamma = 1/\sqrt{1 - v^2/c^2}$	← #7-13

12 # 6-10

Employing Lorentz's Primary Set.



L - 20

< S >

12-11 $x = x_E = 0$	
-12 $y = y_E = 0$	EvtE
-13 $z = z_E = 0$	(Jane's frame)
-14 $t = t_E$	

12 # 11-14

< S′ >

12-15 $x_E' = \gamma\,(0 - vt_E) \quad = -\gamma v t_E$	
-16 $y_E' = y_E = 0$	EvtE
-17 $z_E' = z_E = 0$	(Dick's frame)
-18 $t_E' = \gamma\,(t_E - 0\, v/c^2) = \gamma\, t_E$	

12 # 15-18

Navigating The Tangled Web.

< S >

12-19 $x' = \gamma\,(x - vt)$	← #12-1
-20 $x' = \gamma\, x$	let t=0
-21 $x = x'/\gamma$	rearrange

12 # 19 - 21

< S >

12-22 $t' = \gamma\,(\,t - x\,v\,/c^2\,)$	← #12-4
$= \gamma\,(\,0 - x'/\gamma\;\; v\,/c^2\,)$	sub t=0, x=x'/γ
$= -\,x'\,v\,/c^2$	

12 # 22

< S >

12-23 $t' = -\,x'\;\; v\,/c^2$	← #12-22
-24 $t_0' = \gamma v t_E\; v\,/c^2$	sub #12-15 $x_E' = -\gamma v t_E$
$= \gamma v\;\, t_E'/\gamma\;\, v\,/c^2$	sub #12-18 $t_E = t_E'/\gamma$
$= v\;\, t_E'\; v\,/c^2$	
$= t_E'\; v^2\,/c^2$	

12 # 23 - 24

< S >

12-25 $\Delta \boldsymbol{t} = \gamma\, \Delta \boldsymbol{t}'$ ← #7-7 Jane **vs** Dick tks

-26 $\boldsymbol{t}_k = \gamma\, \boldsymbol{t}_k'$ $\boldsymbol{t}_k$ = Jane tks in $\boldsymbol{t}_E$, $\boldsymbol{t}_k'$ = Dick tks in $\boldsymbol{t}_E$

-27 $\boldsymbol{t}_E' = \boldsymbol{t}_0' + \boldsymbol{t}_k'$ initial + accum tks

$= \boldsymbol{t}_0' + \boldsymbol{t}_k / \gamma$ $\boldsymbol{t}_k'$ from #12-26

$= \boldsymbol{t}_E' \boldsymbol{v}^2 / \boldsymbol{c}^2 + \boldsymbol{t}_k / \gamma$ $\boldsymbol{t}_0'$ from #12-24

$= \boldsymbol{t}_E' \boldsymbol{v}^2 / \boldsymbol{c}^2 + \boldsymbol{t}_E / \gamma$ Jane's $\boldsymbol{t}_0 = 0 \therefore \boldsymbol{t}_k = \boldsymbol{t}_E$

$= \gamma\, \boldsymbol{t}_E \boldsymbol{v}^2 / \boldsymbol{c}^2 + \boldsymbol{t}_E / \gamma$ $\boldsymbol{t}_E' = \gamma\, \boldsymbol{t}_E$ from #12-18

12 # 25 - 27

< S >

12-28 $\boldsymbol{t}_E' = \gamma\, \boldsymbol{t}_E \boldsymbol{v}^2/\boldsymbol{c}^2 + \boldsymbol{t}_E / \gamma$ ← #12-27

$= \gamma\, \boldsymbol{t}_E (\boldsymbol{v}^2/\boldsymbol{c}^2 + 1/\gamma^2)$ factor $\gamma\, \boldsymbol{t}_E$

$= \gamma\, \boldsymbol{t}_E (\boldsymbol{v}^2/\boldsymbol{c}^2 + 1 - \boldsymbol{v}^2/c^2)$ $1/\gamma^2 = 1 - \boldsymbol{v}^2/\boldsymbol{c}^2$

$= \gamma\, \boldsymbol{t}_E$ simplify

12 # 28

Employing Lorentz's Inverse Set.

< S′ >

12-29 $\boldsymbol{x}_E = \gamma\,(\boldsymbol{x}_E' + \boldsymbol{v}\boldsymbol{t}_E') = 0$ | Inverse set

-30 $\boldsymbol{y}_E = \boldsymbol{y}_E' = 0$ | EvtE

-31 $\boldsymbol{z}_E = \boldsymbol{z}_E' = 0$ | (Dick's frame)

-32 $\boldsymbol{t}_E = \gamma\,(\boldsymbol{t}_E' + \boldsymbol{x}_E' \boldsymbol{v}/\boldsymbol{c}^2)$ |

$= \gamma\,(\boldsymbol{t}_E' - \boldsymbol{v}\boldsymbol{t}_E' \boldsymbol{v}/\boldsymbol{c}^2)$ from #12-29 $\boldsymbol{x}_E' = -\boldsymbol{v}\boldsymbol{t}_E'$

$= \gamma \boldsymbol{t}_E' (1 - \boldsymbol{v}^2/\boldsymbol{c}^2)$ from #7-5 $\gamma^2 = 1/(1 - \boldsymbol{v}^2/\boldsymbol{c}^2)$

$= \boldsymbol{t}_E' / \gamma$

12 # 29 - 32

< S′ >

12-33 $\boldsymbol{x}_E' = -\gamma \boldsymbol{v}\boldsymbol{t}_E$ | Primary set

-34 $\boldsymbol{y}_E' = 0$ | EvtE

-35 $\boldsymbol{z}_E' = 0$ | (Dick's frame)

-36 $\boldsymbol{t}_E' = \gamma\, \boldsymbol{t}_E$ | from #12-15..18

12-37 $\boldsymbol{x}_E' = -\gamma \boldsymbol{v}\boldsymbol{t}_E$ | Inverse set

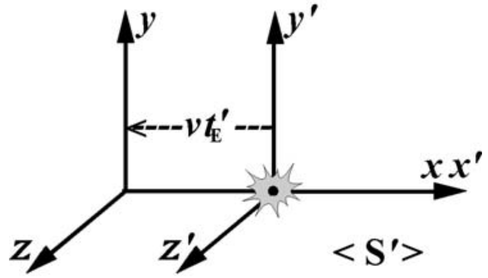
-38 $\boldsymbol{y}_E' = 0$ | EvtE

-39 $\boldsymbol{z}_E' = 0$ | (Dick's frame)

-40 $\boldsymbol{t}_E' = \gamma\, \boldsymbol{t}_E$ | from #12-29..32

12 # 23 - 30

Dick's EvtE



L-22

< S >

12-41 $\boldsymbol{x} = \gamma\,(\boldsymbol{x'} + \boldsymbol{vt'})$	← #12-6
$= \gamma\,(0 + \boldsymbol{vt_E'})$	
$= \gamma\,\boldsymbol{vt_E'}$	
-42 $\boldsymbol{y} = \boldsymbol{y'} = \boldsymbol{y_E'} = 0$	← #12-7
-43 $\boldsymbol{z} = \boldsymbol{z'} = \boldsymbol{y_E'} = 0$	← #12-8
-44 $\boldsymbol{t} = \gamma\,(\,\boldsymbol{t'} + \boldsymbol{x'}\,\boldsymbol{v}\,/\boldsymbol{c}^2\,)$	← #12-9
$= \gamma\,(\,\boldsymbol{t_E'} + 0\,\boldsymbol{v}\,/\,\boldsymbol{c}^2\,)$	
$= \gamma\,\boldsymbol{t_E'}$	

12 # 41-44

< S′ >

12-45 $\boldsymbol{x_E'} = -\gamma\,\boldsymbol{vt_E}$	Dick's perception
-46 $\boldsymbol{y_E'} = 0$	of
-47 $\boldsymbol{z_E'} = 0$	Jane's EvtE
-48 $\boldsymbol{t_E'} = \gamma\,\boldsymbol{t_E}$	from #12-33..36

< S >

12-49 $\boldsymbol{x_E} = \gamma\,\boldsymbol{vt_E'}$	Jane's perception
-50 $\boldsymbol{y_E} = 0$	of
-51 $\boldsymbol{z_E} = 0$	Dick's EvtE
-52 $\boldsymbol{t_E} = \gamma\,\boldsymbol{t_E'}$	from #12-41..44

12 # 45-52

Sec 13

The Grand Delusion

Example 1

< S >

13-1 $x_1 = 0$
-2 $y_1 = 0$ Evt1
-3 $z_1 = 0$ (origin)
-4 $t_1 = 0$

13-5 $x_2 = 0$
-6 $y_2 = 0$ Evt2
-7 $z_2 = 0$ (origin)
-8 t_2

13 # 1-8

< S >

13-9 $x_1' = \gamma\,(0 - v\,0) \quad = 0$
-10 $y_1' = y_1 \quad = 0$ Evt1
-11 $z_1' = z_1 \quad = 0$ #13-1..4 → #12-1..4
-12 $t_1' = \gamma\,(0 - 0\,v/c^2) \quad = 0$

13-13 $x_2' = \gamma\,(0 - vt_2) \quad = -\gamma\, vt_2$
-14 $y_2' = y_2 \quad = 0$ Evt2
-15 $z_2' = z_2 \quad = 0$ #13-5..8 → #12-1..4
-16 $t_2' = \gamma\,(t_2 - 0\,v/c^2) \quad = \gamma\, t_2$

13 # 9-16

< S >

13-17 $\Delta t' = \gamma\, t_2$ Dick's $t_2' - t_1'$ = #13-16 - #13-12
-18 $\Delta t = t_2$ Jane's $t_2 - t_1$ = #13-8 - #13-4

13 # 17-18

Example 2

< S >

13-19 $x_1 = 0$
-20 $y_1 = 0$ Jane's Evt1
-21 $z_1 = 0$ (near end)
-22 $t_1 = 0$

13-23 $x_2 = l_0$
-24 $y_2 = 0$ Jane's Evt2
-25 $z_2 = 0$ (far end)
-26 $t_2 = 0$

13 # 19-26

< S′ >

13-27 $x_1' = 0$
-28 $y_1' = 0$ Dick's Evt1
-29 $z_1' = 0$ (near end)
-30 $t_1' = 0$

13-31 x_2'
-32 $y_2' = 0$ Dick's Evt2
-33 $z_2' = 0$ (far end)
-34 $t_2' = 0$

13 # 27-34

< S >

13-35 $0 = \gamma\,(t_2 - l_0 v / c^2)$ #13-23, #13-34 → #12-4
-36 $t_2 = l_0 v / c^2$ rearrange #13-35

13 # 35-36

< S >

13-37 $x_2' = \gamma\,(x_2 - v t_2)$ #13-23, #13-36 → #12-1
$= \gamma\,(l_0 - v\, l_0\, v / c^2)$ #13-23 → #13-37
$= \gamma\, l_0 (1 - v_2 / c^2)$ $(1 - v^2/c^2) = 1/\gamma^2$
$= l_0 / \gamma$

13 # 37

< S and S′ >

13-38 $\Delta x' = l_0 / \gamma$ Dick's $x_2' - x_1'$ = #13-37 - #13-27
-39 $\Delta x = l_0$ Jane's $x_2 - x_1$ = #13-23 - #13-19

13 # 38-39

< S′ >

13-27 $x_1' = \gamma(x_1 - v\,t_1)$

$= \gamma(0 - v\,0)$

$= 0$ rewrite of

-28 $y_1' = 0$ Dick's Evt1

-29 $z_1' = 0$ (near end)

-30 $t_1' = \gamma\,(t_1 - x_1 v \,/\, c^2)$ based on Jane's

$= \gamma\,(0 - 0\,v \,/\, c^2)$ measurement

$= 0$

13-31 $x_2' = \gamma(x_2 - v\,t_2)$

$= \gamma(l_0 - v\,0)$

$= \gamma\, l_0$ rewrite of

-32 $y_2' = 0$ Dick's Evt2

-33 $z_2' = 0$ (far end)

-34 $t_2' = \gamma\,(t_2 - x_2\, v/c^2)$ based on Jane's

$= \gamma\,(0 - l_0\, v \,/\, c^2)$ measurement

$= -\gamma\, l_0\, v\,/c^2$

13-38 $\Delta x' = l_0 / \gamma$ contraction based on original equations before rewrite

13-38 $\Delta x' = \gamma\, l_0$ dilation based on above rewrite equations #13-31 - #13-27

Example 3

< S >

13-40 $x_1 = u_x t_1$
-41 $y_1 = u_y t_1$
-42 $z_1 = u_z t_1$
-43 t_1

Jane
Evt1

13 # 40-43

< S >

13-44 $x_1' = \gamma (x_1 - v t_1)$
$= \gamma (u_x t_1 - v t_1)$
$= \gamma (u_x - v) t_1$

-45 $y_1' = y_1$
$= u_y t_1$

Dick's Perception
Jane's Evt1

-46 $z_1' = z_1$
$= u_z t_1$

-47 $t_1' = \gamma (t_1 - x_1 v / c^2)$
$= \gamma (t_1 - u_x t_1 v / c^2)$
$= \gamma (1 - u_x v / c^2) t_1$

13 # 44-47

< S >

13-48 $u_x' t_1' = \gamma (u_x - v) t_1$
-49 $u_y' t_1' = u_y t_1$
-50 $u_z' t_1' = u_z t_1$
-51 $t_1' = \gamma (1 - u_x v / c^2) t_1$

Dick's Perception
Jane's Evt1

13 # 48-51

< S >

13-52 $t_1 / t_1' = 1 / \gamma (1 - u_x v / c^2)$

13 # 52

< S >

13-53 $u_x' = (u_x - v) / (1 - u_x v/c^2)$

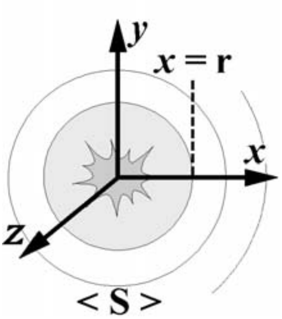
-54 $u_y' = u_y / \gamma (1 - u_x v/c^2)$

-55 $u_z' = u_z / \gamma (1 - u_x v/c^2)$

Vel
Transform

13 # 53-55

Example 4



L 1a

< S >

13-56 $x_1 = \mathbf{r}$

-57 $y_1 = 0$ Jane's Evt1

-58 $z_1 = 0$

-59 $t_1 = \mathbf{r}/c$

13-60 $x_2 = -\mathbf{r}$

-61 $y_2 = 0$ Jane's Evt2

-62 $z_2 = 0$

-63 $t_2 = \mathbf{r}/c$

13#56-63

< S >

13-64 $x_1' = \gamma(x_1 - vt_1) = \gamma(\mathbf{r} - v\ \mathbf{r}/c)$

-65 $y_1' = y_1 = 0$ <u>Dick's Evt1</u>

-76 $z_1' = z_1 = 0$ <u>#13-56..59 → #12-1..4</u>

-77 $t_1' = \gamma(t_1 - x_1 v/c^2) = \gamma(\mathbf{r}/c - \mathbf{r}v/c^2)$

13-78 $x_2' = \gamma(x_2 - vt_2) = \gamma(-\mathbf{r} - v\ r/c)$

-79 $y_2' = y_2 = 0$ <u>Dick's Evt2</u>

-80 $z_2' = z_2 = 0$ <u>#13-60..63 → #12-1..4</u>

-81 $t_2' = \gamma(t_2 - x_2 v/c^2) = \gamma(\mathbf{r}/c + \mathbf{r}v/c^2)$

13 # 64-81

< S >

13-82 $\Delta t' = 2\gamma\,\mathbf{r}\,v/c^2$ Dick's $t_2' - t_1'$ = #13-81 - #13-77

-83 $\Delta t = 0$ Jane's $t_2 - t_1$ = #13-63 - #13-59

13 # 82-83

< **S** >

13-84 $x_1 = 0$
-85 $y_1 = \mathbf{r}$ Jane's Evt1
-86 $z_1 = 0$
-87 $t_1 = \mathbf{r}/c$

13-88 $x_2 = 0$
-89 $y_2 = -\mathbf{r}$ Jane's Evt2
-90 $z_2 = 0$
-91 $t_2 = \mathbf{r}/c$

13 # 84-91

< **S** >

13-92 $x_1' = \gamma\,(x_1 - vt_1) = \gamma\,(0 - v\ \mathbf{r}/c) = -\gamma v\,\mathbf{r}/c$
-93 $y_1' = y_1 = r$ Dick's Evt1
-94 $z_1' = z_1 = 0$ #13-84..87 → #12-1..4
-95 $t_1' = \gamma\,(t_1 - x_1 v/c^2) = \gamma\,(\mathbf{r}/c - 0v/c^2)$

13-96 $x_2' = \gamma\,(x_2 - vt_2) = \gamma\,(0 - v\,r/c) = -\gamma v\,\mathbf{r}/c$
-97 $y_2' = y_2 = -r$ Dick's Evt2
-98 $z_2' = z_2 = 0$ #13-88..91 → #12-1..4
-99 $t_2' = \gamma\,(t_2 - x_2 v/c^2) = \gamma\,(\mathbf{r}/c + 0v/c^2)$

13 # 92-99

< **S** >

13-100 $\Delta t' = 0$ Dick's $t_2' - t_1'$ = #13-99 - #13-95
-101 $\Delta t = 0$ Jane's $t_2 - t_1$ = #13-91 - #13-87

13 # 100-101

Sec 14
The Problem With Mary

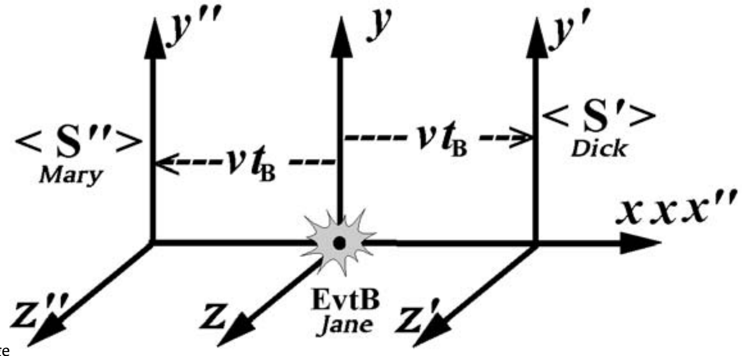
Example 5

< S >

14-1 $x = x_B = 0$
-2 $y = y_B = 0$
-3 $z = z_B = 0$
-4 $t = t_B$

Jane's EvtB
(Jane at rest)

14 # 1-4



BonVoyage

< S'' >

14-5 $x'' = x_B'' = \gamma\,(0 + vt_B) \quad = \gamma\, vt_B$
-6 $y'' = y_B'' = 0$
-7 $z'' = z_B'' = 0$
-8 $t'' = t_B'' = \gamma\,(t_B + 0\, v/c^2) = \gamma\, t_B$

Mary's EvtB
from
#12-1..4
(Jane at rest)

< S' >

14-9 $x' = x_B' = \gamma\,(0 - vt_B) \quad = -\gamma\, vt_B$
-10 $y' = y_B' = 0$
-11 $z' = z_B' = 0$
-12 $t' = t_B' = \gamma\,(t_B - 0\, v/c^2) \quad = \gamma\, t_B$

Dick's EvtB
from
#12-1..4
(Jane at rest)

14 # 5-12

Example 6

< S'' >

14-13 $x'' = x_S'' = \gamma\, vt_B$
-14 $y'' = y_S'' = 0$
-15 $z'' = z_S'' = 0$
-16 $t'' = t_S'' = \gamma\, t_B$

Mary's EvtS
(Jane at rest)

14 # 13-16

< S′ >

14-17 $x' = x_S' = -\gamma\, v t_B$

-18

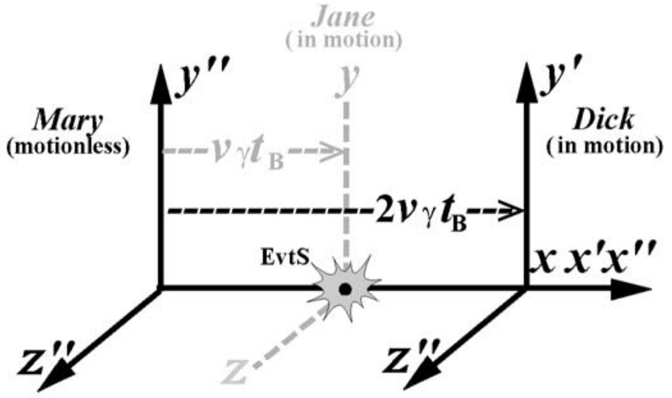
< S′ >

-19 … = 0

-20 $t' = t_S' = \gamma\, t_B$

Dick's EvtS
(Jane at rest)
From #14-9..12

14 # 17-20



< S″>

Lorentz 24

< S″ >

14-21 $x' = x_S' = \gamma_2 (x_S'' - 2v t_S'')$

$= \gamma_2 (\gamma v t_B - 2v\, \gamma t_B)$

$= \gamma_2\, \gamma v t_B (1-2)$

$= -\gamma_2 \gamma\; v t_B$

-22 $y' = y_S' = 0$

-23 $z' = z_S' = 0$

-24 $t' = t_S' = \gamma_2 (t_S'' - x_S''\, 2v/c^2)$

$= \gamma_2 (\gamma\, t_B - \gamma\, v t_B\, 2v/c^2)$

$= \gamma_2\, \gamma\, t_B (1 - 2v^2/c^2)$

$= \gamma_2\, \gamma\, t_B / \gamma_2^2$

$= \gamma / \gamma_2\; t_B$

Einstein/Poincare
Dick's EvtS
Transformed direct
Mary To Dick
From #14-13..16

Note: γ_2 is γ based on $2v$ instead of v

14 # 33-36

< S′ >

14-17 $x' = x_S' = -\gamma\, v t_B$

-18 $y' = y_S' = 0$

-19 $z' = z_S' = 0$

-20 $t' = t_S' = \gamma\, t_B$

Dick's EvtS
(Jane at rest)

14-21 $x_S' = -\gamma_2 \gamma\, v t_B$

-22 $y_S' = 0$

-23 $z_S' = 0$

-24 $t_S' = \gamma / \gamma_2\, t_B$

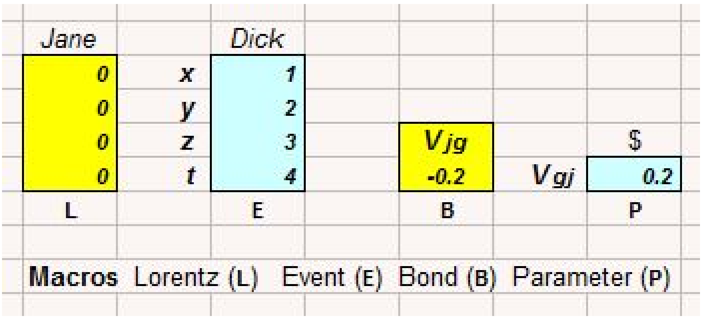
<u>Einstein/Poincare</u>
Dick's EvtS
Transformed direct
Mary To Dick

Note: γ_2 is γ based on $2v$ instead of v

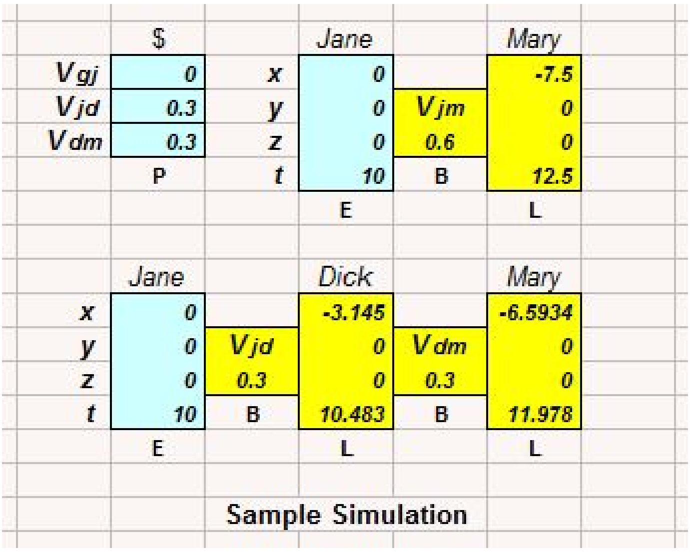
! 14 # 25-32

Sec 15

The Numerical Approach



15 # 1



15 # 2

Sec 16

Finding Reality

Fresh Look. Postulates

● *LorentzTransformation* This postulate asserts that the *Lorentz Transformation* is a fundamental law of physics.

● *Space* This postulate asserts that Space is the three dimensional quantifiable expanse in which matter and energy can exist either in a state of motion or in a state of rest, relative to the expanse. This term "quantifiable" simply denotes that matter and energy (including observers) can have a positional relationship in three dimensions within space, regardless of whether there is a coordinate system defined to characterize the three dimensions.

● *EmptySpace* This postulate asserts that empty space is a region of space without matter and without significant amounts of attributes of matter, but may contain energy. This postulate is simply a definition but it introduces some amount of ambiguity because of the blurred distinction between matter, attributes of matter, and energy. This postulate seems to be universally accepted.

● *Event* This postulate asserts 1) that an event is an irreversible occurrence that happens at a specific time and location in space like a firecracker detonation, and 2) that an event has a specific spacetime coordinate in each inertial frame, and 3) that although the spacetime coordinates for an event are different for different frames, they are all related to each other in accordance with the Lorentz Transformation. *Corollary*: Two or more events that are perceived to be simultaneous and coincident (same time and location) in one inertial frame, will be perceived to be simultaneous and coincident in all inertial frames.

● *LightSpeed* This postulate asserts that the perceived speed of light in empty space by inertial observers is ***c***, and is independent of the motion of the emitting body. *Corollary*: A light burst in empty space is perceived by inertial observers to propagate spherically at speed ***c***, relative to the location in the observer's coordinate system where the detonation is perceived to have occurred. This postulate is based solely on measurement data. The postulate is identical to the *Light Speed* postulate defined in **Section 1**.

● *SpaceTimeAlteration* This postulate asserts that an observer's perception of space and time is altered as a function of the observer's speed relative to space. This postulate is based on the assumption that space is quantifiable, and on measurement data indicating that space and time between two inertial observers is altered as a function of their relative motion.

Lorentz Application Constraint.

Application Constraint. The Lorentz Transformation applies to two inertial observers one of whom must be at rest relative to space.

The *PhysicsLaw* Postulate.

< S >

16-1	$x_g = \gamma_{jg}(x - v_{jg} t)$	Jane→God #12-1
-2	$t_g = \gamma_{jg}(t - x v_{jg} / c^2)$	Jane→God #12-4
-3	$x_g / (x - v_{jg} t) = \gamma_{jg}$	div#16-1 by $x - v_{jg} t$
-4	$t_g / (t - x v_{jg} / c^2) = \gamma_{jg}$	div#16-2 by $t - v_{jg}/c^2$
-5	$x_g / (x - v_{jg} t) = t_g / (t - x v_{jg} / c^2)$	#16-3=#16-4
-6	$x_g / t_g = (x + v_{gj} t) / (t + x v_{gj} / c^2)$	g ratio

16 # 1 - 6

< G >

16-7 $x' = \gamma_{gd}(x_g - V_{gd} t_g)$ God→Dick #12-1

-8 $t' = \gamma_{gd}(t_g - x_g V_{gd}/c^2)$ God→Dick #12-4

-9 $x'/(x_g - V_{gd} t_g) = \gamma_{gd}$ div#16-7 by $x_g - V_{gd} t_g$

-10 $t'/(t_g - x_g V_{gd}/c^2) = \gamma_{gd}$ div#16-8 by $t_g - x_g V_{gd}/c^2$

-11 $x'/(x_g - V_{gd} t_g) = t'/(t_g - x_g V_{gd}/c^2)$ #16-9=#16-10

-12 $x'/(x_g/t_g - V_{gd}) = t'/(1 - x_g/t_g\, V_{gd}/c^2)$ mul by t_g

16 # 7-12

< S >

16-13 $x'/[\{(x+V_{gj}t)/(t+xV_{gj}/c^2)\} - V_{gd}] =$ #16-6

$t'/[1 - \{(x+V_{gj}t)/(t+xV_{gj}/c^2)\}V_{gd}/c^2]$ →16-12

-14 $x'[1 - \{(x+V_{gj}t)/(t+xV_{gj}/c^2)\}V_{gd}/c^2] =$ rearrange

$t'[\{(x+V_{gj}t)/(t+xV_{gj}/c^2)\} - V_{gd}]$

16 # 13-14

< S >

16-15 $x'[1 - \{(x + V_{gj}t)/(t + xV_{gj}/c^2)\}(V_{gj} + V_{jd})/c^2] =$

$t'[\{(x + V_{gj}t)/(t + xV_{gj}/c^2)\} - (V_{gj} + V_{jd})]$

16 # 15

< S >

16-16 $x'[1 - \{(x + V_{gj}t)/(t + xV_{gj})\}(V_{gj} + V_{jd})] =$

$t'[\{(x + V_{gj}t)/(t + xV_{gj})\} - V_{gj} - V_{jd}]$

16 # 16

< S >

16-16L $x'[1 - \{(x + V_{gj}t)/(t + xV_{gj})\}(V_{gj} + V_{jd})] =$

$x'[1 - (x + V_{gj}t)(V_{gj} + V_{jd})/(t + xV_{gj})] =$

$x'[(t + xV_{gj} - (x + V_{gj}t)(V_{gj} + V_{jd}))/(t + xV_{gj})] =$

$x'[(t + xV_{gj} - xV_{gj} - V_{gj}^2 t - xV_{jd} - V_{gj}tV_{jd})/(t + xV_{gj})] =$

$x'[(-V_{gj}^2 t + xV_{gj} - xV_{gj} - V_{gj}tV_{jd} - xV_{jd} + t)/(t + xV_{gj})] =$

$x'[(-V_{gj}^2 t - V_{gj}tV_{jd} - xV_{jd} + t)/(t + xV_{gj})] =$

$(-x't V_{gj}^2 - x't V_{jd}V_{gj} - xx'V_{jd} + x't)/(t + xV_{gj}) =$

16 # 16 L

< S >

16-16R
$$= t' \left[\{(x + V_{gj}\, t) / (t + x\, V_{gj})\} - V_{gj} - V_{jd} \right]$$
$$= t' \left[\left((t + x\, V_{gj})(- V_{gj} - V_{jd}) + x + t\, V_{gj} \right) / (t + x\, V_{gj}) \right]$$
$$= t' \left[\left(-t\, V_{gj} - x V_{gj}^2 - t\, V_{jd} - x V_{gj}\, V_{jd} + x + t\, V_{gj} \right) / (t + x\, V_{gj}) \right]$$
$$= t' \left[\left(- x V_{gj}^2 - x V_{jd}\, V_{gj} + x - t\, V_{jd} \right) / (t + x\, V_{gj}) \right]$$
$$= \left(- x\, t'\, V_{gj}^2 - x\, t' V_{jd}\, V_{gj} + x t' - t\, t' V_{jd} \right) / (t + x\, V_{gj})$$

16 # 16 R

< S >

16-17
$$-x't\, V_{gj}^2 - x't\, V_{jd}\, V_{gj} - x x' V_{jd} + x't =$$
$$- x\, t'\, V_{gj}^2 - x\, t' V_{jd}\, V_{gj} + x t' - t\, t' V_{jd}$$

16 # 17

< S >

16-18
$$(x t' - x' t)\, V_{gj}^2 +$$
$$(x t'\, V_{jd} - x' t\, V_{jd})\, V_{gj} +$$
$$(x' t - x t' - x x' V_{jd} + t\, t' V_{jd}) = 0$$

16 # 18

< S'' >

16-19
$$(x t'' - x'' t)\, V_{gj}^2 +$$
$$(x t''\, V_{jm} - x'' t\, V_{jm})\, V_{gj} +$$
$$(x'' t - x t'' - x x'' V_{jm} + t\, t'' V_{jm}) = 0$$

16 # 19

mul #16-18 by $(x t'' - x'' t)$

< S >

16-20
$$(x t'' - x'' t)(x t' - x' t)\, V_{gj}^2 +$$
$$(x t'' - x'' t)(x t'\, V_{jd} - x' t\, V_{jd})\, V_{gj} +$$
$$(x t'' - x'' t)(x' t - x t' - x x' V_{jd} + t\, t' V_{jd}) = 0$$

16 # 20

mul #16-19 by $(x t' - x' t)$

< S'' >

16-21
$$(x t' - x' t)(x t'' - x'' t)\, V_{gj}^2 +$$
$$(x t' - x' t)(x t''\, V_{jm} - x'' t\, V_{jm})\, V_{gj} +$$
$$(x t' - x' t)(x'' t - x t'' - x x'' V_{jm} + t\, t'' V_{jm}) = 0$$

16 # 21

#16-20 - #16-21

< S >

$$16\text{-}22\quad (xt'' - x''t)(xt'\,V_{jd} - x't\,V_{jd})\,V_{gj} + (xt'' - x''t)(x't - xt' - xx'V_{jd} + t\,t'V_{jd}) - (xt' - x't)(xt''\,V_{jm} - x''t\,V_{jm})\,V_{gj} - (xt' - x't)(x''t - xt'' - xx''V_{jm} + t\,t''V_{jm}) = 0$$

16 # 22

solve #16-22 for V_{gj}

< S >

$$16\text{-}23\quad V_{gj} = \{(xt' - x't)(x''t - xt'' - xx''V_{jm} + t\,t''V_{jm}) - (xt'' - x''t)(x't - xt' - xx'V_{jd} + t\,t'V_{jd})\} \,/\, \{(xt'' - x''t)(xt'\,V_{jd} - x't\,V_{jd}) - (xt' - x't)(xt''\,V_{jm} - x''t\,V_{jm})\}$$

<< Voilà ! >>

16 # 23

	$		Jane		God		Dick
V gj	0.1919	x	0		0.20		-0.1065
V jd	0.1	y	0	V jg	0	V gd	0
V dm	-0.2	z	0	-0.1919	0	0.3	0
	P	t	1	B	1.02	B	1.0057
			E		L		L

		Jane		God		Mary
x		0		0.20		0.1023
y		0	V jg	0	V gm	0
z		0	-0.1919	0	0.0919	0
t		1	B	1.02	B	1.0052
		E		L		L

Simulation. Dick and Jane in motion relative to God

16 N 3

Equation #16-18 V gi = 0.1919 -0.292
Equation #16-23 Vgi = 0.1919

16 N 4 a

	$		Jane		God		Dick
Vgj	0.2	x	1		1.84		-0.3536
Vjd	0.3	y	2	Vjg	2	Vgd	2
	P	z	3	-0.2	3	0.5	3
		t	4	B	4.29	B	3.8891
			E		L		L

Simulation. Dick and Jane in motion.

16 N 4

	$		Jane		God		Dick
Vgj	0	x	1		1.00		-0.2097
Vjd	0.3	y	2	Vjg	2	Vgd	2
	P	z	3	0	3	0.3	3
		t	4	B	4.00	B	3.8787
			E		L		L

Simulation. Jane at rest

16 N 5

	$		Jane		Dick
Vgj	0	x	1		-0.2097
Vjd	0.3	y	2	Vjd	2
	P	z	3	0.3	3
		t	4	B	3.8787
			E		L

Simulation. Jane at rest

16 N 6

	$		Jane		Dick
Vgj	0.2	x	1		-0.2097
Vjd	0.3	y	2	Vjd	2
	P	z	3	0.3	3
		t	4	B	3.8787
			E		L

Simulation. Dick and Jane in motion.

16 N 7

~