

# Universal Specificity Investigation 8: Determining Which Frame is Universally Stationary

Daniel Harris  
Northrop Grumman  
Morrisville, USA  
daniel.harris2@ngc.com

Prior investigations into universal specificity (or specificity for short) found a proper conception of time missed in common practice. In addition, it was found that a universally stationary frame (USF) must exist; which led to discovering the cause of total time dilation, shown in Equation (1); which led to a total specific energy model complete with specific internal energy, specific kinetic energy and specific potential energy terms, shown in Equation (2); which finally led to a relationship between specific energy and energy, and updating the total energy model to incorporate potential energy.

$$\begin{aligned} \frac{dt'}{dt} &= \frac{c_0}{c} = \sqrt{1 - \frac{w}{e_T}} \\ &= \sqrt{1 - \frac{\Delta e_t}{e_T}} = \sqrt{1 - \frac{\Delta e_K + \Delta e_P}{e_T}} \end{aligned} \quad (1)$$

$$\begin{aligned} e_T &= e_I + \Delta e_K + \Delta e_P \\ \frac{1}{2}c^2 &= \frac{1}{2}c_0^2 + \frac{1}{2}v^2 + \int_{\infty}^r \nabla e_I dr \end{aligned} \quad (2)$$

$dt'$  is the time rate of change measured by a clock undergoing time dilation;  $dt$  represents the time rate of change measured by an identical clock in the USF infinitely away from gravitational sources;  $c_0$  is the average effective speed of light in the objects reference frame;  $c$  is the speed of light in the USF in a vacuum not under any gravity potential;  $\Delta e_t$  is the object's change in specific total energy in the USF;  $\Delta e_K$  is the object's change in specific kinetic energy in the USF;  $\Delta e_P$  is the object's change in specific potential energy;  $w$  is the specific work done to the object in the USF;  $\nabla e_I$  is the specific internal energy gradient within objects that are within a gravitational field; and  $e_T$  is total specific energy,  $\frac{1}{2}c^2$ . The ratio of time derivatives is termed *inertial time differential* (ITD), which remains constant for any object until specific work,  $w$ , is done.

The focus of the next investigation is to circle back to one of the original questions: is there a way to objectively determine which inertial reference frame is the USF?

## 1. UNIVERSAL INERTIAL FRAME

A *universally stationary frame* (USF) is the only inertial reference frame that is "still" (no velocity) in the universe. There is such a frame for rotation, where it is easy to measure which frame has no angular velocity. A simple water in a buck experiment can tell you if the bucket reference frame is rotating or not. If the bucket is rotating, then the surface

of the water will create a bowl shape; otherwise, if it is not rotating, then the surface will be flat, as shown in Figure 1.

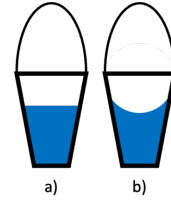


Figure 1. a) Non-rotating bucket of water.  
b) Rotating bucket of water.

A similar experiment cannot determine if a reference frame has velocity relative to the USF, as shown in Figure 2.

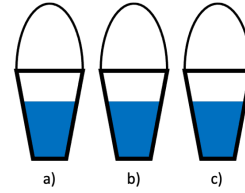


Figure 2. a) Universally stationary.  
b) Velocity is  $0.5c$ .  
c) Velocity is  $0.9c$ .

Michelson and Morely tried (and failed) to determine the relative motion of earth with respect to the USF by measuring the difference in the velocity of light from the same source at different points in earth's orbit, but instead demonstrated the interesting fact that the speed of light measured in any inertial frame is constant [1], or at least the average relative speed of light appears to be constant [2] (also see investigation 2). Something is special about translational velocity, as compared to rotational velocity, where any inertial frame at any translational velocity appears to be stationary, while frames with rotational velocity are immediately noticeable.

Several experiments have been devised [3] that might measure motion relative to the USF, given the correctness of different theories [2]. Our aim in this investigation, given the correctness of specificity, is to devise another experiment that can objectively measure motion relative to the USF.

To begin, you might have noticed a peculiarity about kinetic time dilation, which is that despite the base unit (or just unit for short) changes caused by work done, all pair-wise reference frames seem to agree on their respective relative velocities between each other. This is our first clue as to why translational velocity is special.

## 2. A SURVEY OF UNIT CHANGES

We know that the units of measurement change for space and time when kinetic work is done, but why not units of velocity? First it is important to know that any two observers always agree on their miscalibrated relative speed [4]. Velocity, being a ratio of a change in distance to a change in time gives us Equation (3).

$$|v_1| = |-v_2| \quad (3a)$$

$$\frac{dx_1}{dt_1} = \frac{dx_2}{dt_2} \quad (3b)$$

$$\frac{dt_2}{dt_1} = \frac{dx_1}{dx_2} \blacksquare \quad (3c)$$

Mind you,  $\frac{dx_1}{dx_2}$  is not length contraction. If we are to use a laser to measure a remote object's velocity, then  $dx_1$  is the measure of distance light appears to travel to the second frame and back (assuming that the speed of light is constant and  $c$ ). Likewise,  $dx_2$  is the measure of distance light appears to travel to the first frame and back. This ratio of apparent distance traveled to apparent duration of travel cancels any noticeable effect that a change in units might otherwise create. This is what makes velocity special. All attempts to date to measure motion relative to a USF has relied on propagating light in some novel fassion, e.g., the one way speed of light experiments [3][5], which have thus far proved incapable of detecting the USF. It is not difficult to see why such attempts have failed to detect the USF, since the only effect of being in an inertial reference frame different from the USF is a change of units caused by specific work done, so of course we ought to expect a failed detection if we use a measurement where the effect is nullified.

What is required to objectively measure the USF is to use a measurement that does not nullify the effect of being in a reference frame different from the USF. What is required is a means to observe the unit change caused by specific work done, so that we can calculate an object's velocity in the USF. Then we can relate that object's velocity to everything else using known methods.

## 3. HOW TO OBJECTIVELY MEASURE THE UNIVERSALLY STATIONARY FRAME

Experimenting with acceleration appears to be where we must first look to detect the USF, since relative observers do not agree on pairwise acceleration estimates [6]. In fact, if one takes a closer look at the bucket experiment, one notices that this test also involved acceleration.

We, therefore, need a similar test involving translational acceleration. Only two forms of translational acceleration that involve a unit change are known: kinetic and gravitational. Only gravitational acceleration ends up being useful.

A kinetic acceleration experiment might involve studying unit changes caused by accelerating a rocket to Alpha Centauri and back, like in the twins paradox setup. The problem with this experiment is that it would rely on remote measurements, which takes time and distance to make these kinds of measurements. The best form of remote measurement involves using photons, like LADAR, to make estimates of speed (via Doppler frequency shifts) and estimates of distance

(via lap time of returns). Therefore, this experiment depends on the speed of light traveling for some time and distance, which nullifies the effects we are attempting to measure. This experiment, therefore, has to fail in detecting the USF.

A gravitational acceleration experiment, on the other hand, only has to rely on local measurements. As an example, one such experiment might involve using six identical gravimeters, like the one shown in Figure 3. If this experiment is set up appropriately, and given that specificity is correct, then it will allow us to calculate which frame is the USF.

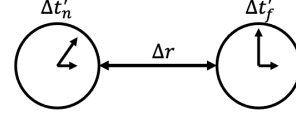


Figure 3. Gravimeter.

Given specificities gravity model, derived in investigation 5 and shown in Equation (4), instrument's measurements relate to gravity as shown in Equation (5):

$$g(r) = -\nabla e_I = -e_T \nabla \frac{e_I}{e_T} \quad (4)$$

$$\nabla \frac{e_I}{e_T} = \nabla \frac{dt'^2}{dt^2} = \lim_{\Delta r \rightarrow 0} \frac{\left( \left( \frac{\Delta t'_f}{\Delta t} \right)^2 - \left( \frac{\Delta t'_n}{\Delta t} \right)^2 \right)}{\Delta r} \quad (5a)$$

$$g(r) = -e_T \lim_{\Delta r \rightarrow 0} \frac{\left( \left( \frac{\Delta t'_f}{\Delta t} \right)^2 - \left( \frac{\Delta t'_n}{\Delta t} \right)^2 \right)}{\Delta r} \quad (5b)$$

Since  $\Delta t$  cannot directly be calculated, a laser range finder can estimate the distance,  $r_f$ , to the nearest clock is to find  $\frac{dt'_f}{dt}$  which then allows us to simplify Equation (5) as follows:

$$\frac{dt'_f}{dt} = \frac{\Delta t'_f}{\Delta t} \quad (6a)$$

$$g(r) = -e_T \lim_{\Delta r \rightarrow 0} \frac{\left( \frac{dt}{dt'_f} \right)^2 \left( 1 - \left( \frac{\Delta t'_n}{\Delta t'_f} \right)^2 \right)}{\Delta r} \quad (6b)$$

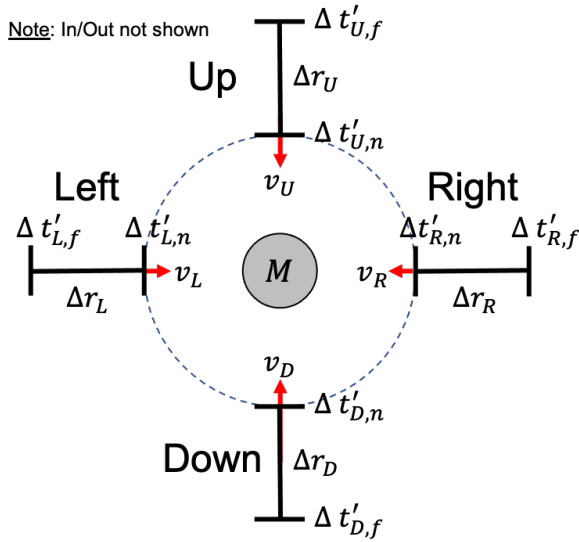
You can assume for instrumentation purposes,  $\Delta r$  is never zero, and you can even drop the  $\frac{dt}{dt'_f}$  term entirely and measure something other than gravity, as shown in Equation (8). The measurement will only be an approximation of gravity, but it will be able to estimate the desired effect—motion in the USF.

(7)

$$\text{Let : } \tau^2 = 1 - \left( \frac{dt'_n}{dt'_f} \right)^2$$

$$\hat{g}(r) = -e_T \frac{\left( 1 - \left( \frac{\Delta t'_n}{\Delta t'_f} \right)^2 \right)}{\Delta r} = -e_T \frac{\tau^2}{\Delta r} \quad (8)$$

The instruments in this experiment would measure the approximated gravitational acceleration,  $\hat{g}(r)$ , of a massive object, but in three orthogonal dimensions (two gravimeters per dimension). The speed of each gravimeter measured in the massed object's reference frame (MOF) would be equivalent and directed towards its center of mass. Two of three dimensions are shown in Figure 4.<sup>2</sup>



**Figure 4. USF detection experimental setup.**

Suppose each clock is counting the number of cycles a light bounces back and forth in identically constructed light clocks, and the counts are continuously sent from the far side of the instrument to the near side. How this experiment works is that once the nearest clock reaches a marked threshold some radius,  $r$ , away from the massed object (as measured in the MOF) the front clock keeps track of the total counts made by the front clock,  $\Delta t_n$ , and the total counts that reach the front clock from the rear,  $\Delta t_f$ . The count stops when the front of the gravimeter reaches another threshold some distance closer to the massed object.

the gravimeter's clocks take a measure of total counts of time for the rear and  $\Delta t'_f$  and  $\Delta t'_n$  once the nearest clock reaches some marked threshold some radius from the center of mass, as measured in the MOF. Each gravimeter, being identical and calibrated to the same initial inertial reference frame, assumes  $\Delta r$  is the same under any condition; however, the radial location,  $r_f$  where  $\Delta t'_f$  is measured, could change since the base unit subsumed under  $\Delta r$  could physically change in different frames due to length contraction. Additionally, for each gravimeter, the physical change to its  $\Delta r$  is independent from all the other gravimeters' physical changes, and only depends on what the particular gravimeter's velocity is in the USF. Lastly, any changes to the ratio  $\frac{\Delta t'_n}{\Delta t'_f}$  in Equation (5)

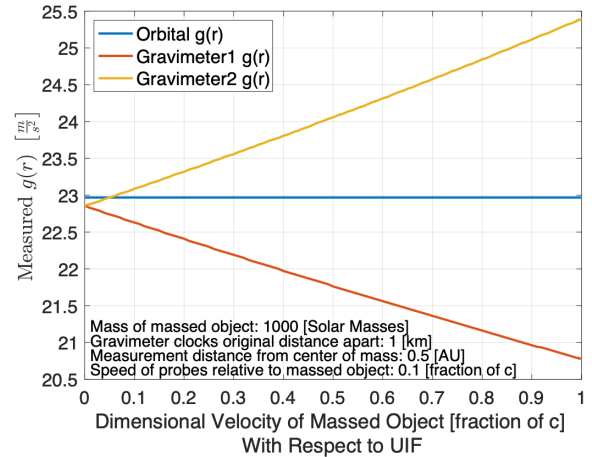
due to kinematic time dilation is nullified, in the same way it is nullified for velocity; therefore, the only change in the ratio  $\frac{\Delta t'_n}{\Delta t'_f}$  will be due to changes in the location where  $\Delta t'_f$  is measured, which is ultimately governed by the velocity of the MOF in the USF.

Once gravitational acceleration is measured by each gravimeter, an analytical solution for the velocity of the massed object relative to the USF might not be possible because of the set of non-linear equations. However, a simulation can run the set of possible velocities relative to the USF and experimental results can be compared to simulated results. That way the simulated results that line up with experimental results will indicate the MOF's relative velocity in the USF for a given dimension. Subtracting that velocity from the MOF tells us which frame, relative to the MOF, is the USF.

Even though we lack experimental results, a simulation was ran for a notional case to demonstrate how this simulated numerical solution would appear. In order to gain the necessary precision, the gravitational acceleration in orbit measured in the MOF, and the speed of all the gravimeters in the MOF, had to be quite large. A simulation for a single dimension was ran (see code in Appendix), and the parameters for the executed simulation were:

- Mass of object: 1000 [Solar Masses]
- Original distance,  $\Delta r$ , clocks were apart in MOF: 1 [km]
- $dt$  measurement distance from center of mass: 0.5 [AU]
- Speed of gravimeters in the MOF: 0.1 [fraction of  $c$ ]

The results of this simulation can be seen in Figure 5. From the results we can see how the MOF's velocity in the USF (x-axis) affects the gravimeter readings (y-axis). Three gravimeters were simulated: an orbital gravimeter, a gravimeter traveling faster than the MOF in the USF (gravimeter1), and a gravimeter traveling slower (gravimeter2).



**Figure 5. Simulated results.**

Suppose we were able to execute a real experiment with such parameters, and found that the measured gravitational acceleration,  $g(r)$ , were found to be  $21.75 [ms^{-2}]$  and  $24.05 [ms^{-2}]$  for gravimeter1 and gravimeter2 respectively. That would mean the MOF had a dimensional speed of  $0.5c$  relative to the USF in the direction of gravimeter1's velocity.

<sup>2</sup>Note: in and out of paper dimension is not show.

## 4. CONCLUSION

In conclusion, it was shown that it is possible to detect the USF if measurements are taken that do not nullify the effects of changes of units caused by work done. The designed experiment involving sending gravimeters hurtling towards the center of mass of a massive object is capable of such a detection, if specificity is correct.

The last question to be investigated by this specificity series is: if spacetime is not a real thing, and therefore, cannot be responsible for any time dilation, as an environmental affect on objects, then what causes everything in the same reference frame to be effected by time dilation to the same degree? Addressing that question is the focus of the next (and last) investigation.

## REFERENCES

- [1] A. Michelson & E. Morley, *On the relative motion of the Earth and the luminiferous ether*, American Journal of Science, vol. s3-34, no. 203, pp. 333–345, 1887.
- [2] K. Szostek and R. Szostek, *Kinematics in the special theory of ether*, Moscow University Physics Bulletin, vol. 73, no. 4, pp. 413–421, 2018.
- [3] K. Szostek and R. Szostek, *The concept of a mechanical system for measuring the one-way speed of light*, Technical Transactions, No. 2023/003, e2023003, 1-9, 2023, ISSN 0011-4561
- [4] R. Buenker, *On the equality of relative velocities between two objects for observers in different rest frames*. Apeiron, Volume 20, No. 2., December 2015.
- [5] *One-way speed of light*. Wikipedia. Retrieved March 15, 2023, from [https://en.wikipedia.org/wiki/One-way\\_speed\\_of\\_light](https://en.wikipedia.org/wiki/One-way_speed_of_light)
- [6] *Acceleration (special relativity)* Wikipedia, 29-July-2022. [Online]. Available: [https://en.wikipedia.org/wiki/Acceleration\\_\(special\\_relativity\)](https://en.wikipedia.org/wiki/Acceleration_(special_relativity)). [Accessed: 26-Sep-2022].

## APPENDIX

### MATLAB CODE

```

1 % Code designed to demonstrate detection of universally stationary frame (USF)
2 function USF_via_gravity()
3 %% initializations, constants and simple functions
4 % initialization
5 clear all
6 clc
7 close all
8
9 % constants
10 c = 299792458; % [m/s] speed of light
11 G = 6.6744e-11; % [m^3/(kg s)] gravitational constant
12 Me = 5.97219e24; % [kg] earth's mass
13 Ms = 333000*Me; % [kg] sun's mass
14 et = 0.5*c^2; % [m^2/s^2] specific total energy
15 AU = 152.03e9; % [m] distance from sun to earth
16
17 % simple functions
18 gamma = @(v) 1./sqrt(1-v.^2);
19 add_vel = @(v1_in,v2_in) (v1_in+v2_in)/(1 + v1_in*v2_in);
20 grav_2_dt = @(g,r) sqrt(1-g*r/et);
21 r_2_gravObj = @(M,r) G*M/r^2;
22 gravimeter = @(dtnear_dtfar,dr) (c^2/(2*dr))*(1-(dtnear_dtfar)^2);
23
24 %% experiment: travel two gravimeters (probes) towards center of massed object (MO)
25 % set conditions (in MO's frame)
26 MMO = 1e3*Ms; % [kg] mass of object at center of experiment
27 r_measure = AU/2; % [m] nearest clock distance from center of MO
28 probe_dv = 0.1; % [frac of c] speed of probes relative to MO
29 gmtr_dr = 1000; % [m] clocks distance apart when stationary
30
31 % initialize
32 gr_orbit_all = [];
33 gr_probe1_all = [];
34 gr_probe2_all = [];
35
36 % loop through range of MO velocities
37 v_obj_all = [0:0.01:0.99 0.99:0.001:0.999]; % [frac of c] speed of MO (in USF)
38 for ivo = 1 : length(v_obj_all)
39     % (in USF)
40     v_obj = v_obj_all(ivo); % [frac of c] velocity of MO
41     v_p1 = add_vel(v_obj,probe_dv); % [frac of c] velocity of probe1
42     v_p2 = add_vel(v_obj,-probe_dv); % [frac of c] velocity of probe2
43     drUSF_drp_obj = gamma(v_obj); % [-] kinetic differential for MO
44     drUSF_drp_p1 = gamma(v_p1); % [-] kinetic differential for probe1
45     drUSF_drp_p2 = gamma(v_p2); % [-] kinetic differential for probe2
46
47     % determine kinetic time/space dilation effects on gravimeters (in USF)
48     gmtr_dr_USF_obj = gmtr_dr/drUSF_drp_obj; % [m] clocks distance apart
49     gmtr_dr_USF_p1 = gmtr_dr/drUSF_drp_p1; % [m] clocks distance apart
50     gmtr_dr_USF_p2 = gmtr_dr/drUSF_drp_p2; % [m] clocks distance apart
51
52     % determine effects on gravimeter from orbit of MO (in MO frame)
53     dr_orbit = drUSF_drp_obj*gmtr_dr_USF_obj; % [m] clocks distance apart
54     r_f_orbit = r_measure+dr_orbit; % [m] farthest clock
55     % distance to MO
56     r_n_orbit = r_measure; % [m] nearest clock
57     % distance to MO
58     dtn_dtf_orbit = frames_dtn_dtf(r_f_orbit,r_n_orbit); % [-] clock differential
59     g_m_orbit = gravimeter(dtn_dtf_orbit,gmtr_dr); % [m/s^2] measured g
60
61     % determine effects on gravimeter from probe 1 (in MO frame)
62     dr_p1 = drUSF_drp_obj*gmtr_dr_USF_p1; % [m] clocks distance
63     % apart
64     r_f_probe1 = r_measure+dr_p1; % [m] farthest clock
65     % distance to MO

```

```

62     r_n_probe1      = r_measure;                                % [m] nearest clock
        distance to MO
63     dtn_dtf_probe1 = frames_dtn_dtf(r_f_probe1 , r_n_probe1); % [-] clock differential
64     g_m_probe1     = gravimeter(dtn_dtf_probe1 , gmtr_dr);      % [m/s^2] measured g
65
66     % determine effects on gravimeter from probe 2 (in MO frame)
67     dr_probe2      = drUSF_drp_obj*gmtr_dr_USF_p2;            % [m] clocks distance
        apart
68     r_f_probe2      = r_measure+dr_probe2;                      % [m] farthest clock
        distance to MO
69     r_n_probe2      = r_measure;                                % [m] nearest clock
        distance to MO
70     dtn_dtf_probe2 = frames_dtn_dtf(r_f_probe2 , r_n_probe2); % [-] clock differential
71     g_m_probe2     = gravimeter(dtn_dtf_probe2 , gmtr_dr);      % [m/s^2] measured g
72
73     % store results
74     gr_orbit_all    = [ gr_orbit_all g_m_orbit];
75     gr_probe1_all   = [ gr_probe1_all g_m_probe1];
76     gr_probe2_all   = [ gr_probe2_all g_m_probe2];
77 end
78
79 % plot results
80 fig = figure(1);
81 hold off
82 plot(v_obj_all , gr_orbit_all , 'LineWidth',2);
83 hold on
84 plot(v_obj_all , gr_probe1_all , 'LineWidth',2);
85 plot(v_obj_all , gr_probe2_all , 'LineWidth',2);
86
87 % clean up plot
88 legend('Orbital g(r)', 'Gravimeter1 g(r)', 'Gravimeter2 g(r)', 'FontSize',16, 'location',
        'NW');
89 xlabel({'Dimensional Velocity of Massed Object [fraction of c]', 'With Respect to USF',
        '}, 'FontSize',16);
90 ylabel('Measured  $g(r) \sim \left[\frac{m}{s^2}\right]$ ', 'FontSize',16, 'Interpreter', '
        latex');
91 grid on
92 a = get(gca, 'XTickLabel');
93 set(gca, 'XTickLabel', a, 'fontSize',16)
94 xticks([0:.1:1]);
95 annotation(fig, 'textbox', [.13 .10 .8 .2], 'String'...
96     , sprintf('Mass of massed object: %d [Solar Masses]',MMO/Ms) ...
97     , 'EdgeColor','none', 'FontSize',14);
98 annotation(fig, 'textbox', [.13 .07 .8 .2], 'String'...
99     , sprintf('Gravimeter clocks original distance apart: %d [km]', gmtr_dr/1e3) ...
100    , 'EdgeColor','none', 'FontSize',14);
101 annotation(fig, 'textbox', [.13 .04 .8 .2], 'String'...
102    , sprintf('Measurement distance from center of mass: %0.1f [AU]', r_measure/AU) ...
103    , 'EdgeColor','none', 'FontSize',14);
104 annotation(fig, 'textbox', [.13 .01 .8 .2], 'String'...
105    , sprintf('Speed of probes relative to massed object: %0.1f [fraction of c]',
        probe_dv) ...
106    , 'EdgeColor','none', 'FontSize',14);
107
108 %% supporting function
109 function dtn_dtf = frames_dtn_dtf(r_f , r_n)
110     % (in MO frame)
111     g_f      = r_2_gravObj(MMO, r_f); % gravitational specific force at clock
        farthest from MO
112     g_n      = r_2_gravObj(MMO, r_n); % gravitational specific force at clock
        nearest to MO
113     dt_f     = grav_2_dt(g_f, r_f);    % time dilation of clock farthest from MO
114     dt_n     = grav_2_dt(g_n, r_n);    % time dilation of clock nearest to MO
115     dtn_dtf = dt_n/dt_f;              % relative time differential between
        closest and farthest clock
116
117 end

```