

Universal Specificity Investigation 8: Determining Which Frame is Universally Stationary

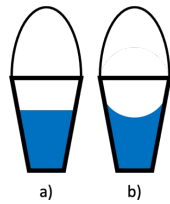
Daniel Harris
Northrop Grumman
Morrisville, USA
daniel.harris2@ngc.com

Prior investigations into the theory of universal specificity (or specificity for short) found a proper conception of time missed in common practice; which led to the realization that a universally stationary frame must exist; which led to the discovery that for any inertial reference frame the average effective speed of light, c_0 , is less than or equal to c , and equal in all directions; which led to discovering the cause of total time dilation; which led to a total specific energy model complete with specific internal energy, specific kinetic energy and specific potential energy terms; which finally led to a relationship between specific energy and energy, and updating the total energy model to incorporate potential energy.

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

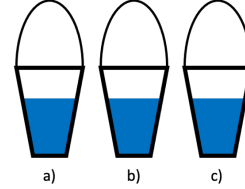
A *universally stationary frame* (USF) is the only inertial reference frame that is still (no velocity) in the universe. There is such a frame for rotation, where it is easy to measure which frame has no angular velocity. A simple water in a bucket experiment can tell you if the reference frame anchored to the bucket 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.

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 is 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



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

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 work is done, but why not 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 (1).

$$|v_1| = |-v_2| \quad (1a)$$

$$\frac{dx_1}{dt_1} = \frac{dx_2}{dt_2} \quad (1b)$$

$$\frac{dt_2}{dt_1} = \frac{dx_1}{dx_2} \blacksquare \quad (1c)$$

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 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 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. Rotational velocity might only correlate to the test result—rotational acceleration might be the cause.

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 derived in investigation 5, shown in Figure 3. If this experiment is set up appropriately, and given that the specificity is correct, then it will allow us to calculate which frame is the USF.

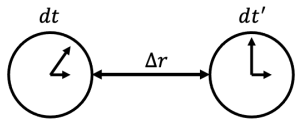


Figure 3. Gravimeter.

Recall from investigation 5 that the gravimeter is measuring two rates of change in time, dt and dt' , via identical clocks some distance, Δr , apart from each other. Additionally, Δr is

normal to the time dilation gradient, and dt is farther from the center of mass than dt' . Lastly, these measurements translates to gravitational acceleration as shown in Equation (2).

$$\text{Let : } \nabla\tau^2 = \frac{\tau^2}{\Delta r} = \frac{\left(1 - \left(\frac{dt'}{dt}\right)^2\right)}{\Delta r} \quad (2a)$$

$$g(r) = \lim_{\Delta r \rightarrow 0} -e_T \nabla\tau^2 \quad (2b)$$

The gravimeter in this experiment would measure the gravitational acceleration of a massive object, but in three orthogonal dimensions (two gravimeters per dimension). The speed of each gravimeter would be equivalent, measured in the massed object's reference frame (MOF), and directed towards its center of mass. Two of three dimensions are shown in Figure 4.²

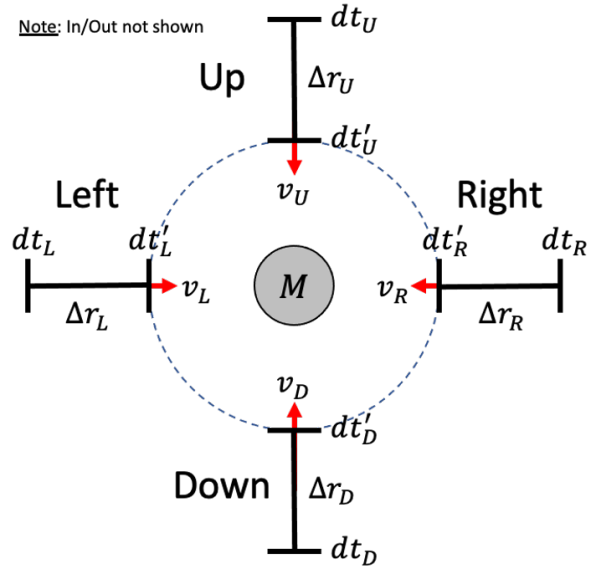


Figure 4. USF detection experimental setup.

How this experiment works is that the gravimeter's clocks take a measure of dt and dt' once the forward 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 Δr is the same under any condition; however, the radial location where dt is measured could change since the base unit subsumed under Δr could physically change in different frames due to length contraction. Additionally, for each gravimeter, the physical change to its Δr 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 $\frac{dt'}{dt}$ in Equation (2) due to kinematic time dilation is nullified, in the same way it is nullified for velocity; therefore, the only change in the ratio $\frac{dt'}{dt}$ will be due to changes in the location where dt 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

²Note: in and out of paper dimension is not show.

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, Δr , 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).

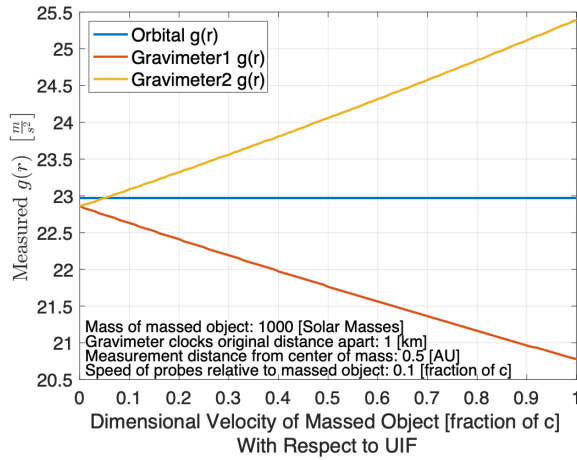


Figure 5. Simulated results.

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.

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

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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_probel_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_probel      = r_measure;                                % [m] nearest clock
        distance to MO
63     dtn_dtf_probel = frames_dtn_dtf(r_f_probel , r_n_probel); % [-] clock differential
64     g_m_probel     = gravimeter(dtn_dtf_probel , 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_probel_all  = [ gr_probel_all g_m_probel];
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_probel_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 end
117 end

```