Holger Müller

PROFESSOR of PHYSICS

University of California, Berkeley

Email Correspondence

January 8 – 11, 2015

PREFACE

The whiz kid Müller (first patent at age 14) sees the "fun" in doing Galileo's experiment, thinks it "could be worthwhile," but has insufficient curiosity to take any action to make it happen.

Has Müller tragically lost the inquisitive spirit of childhood? Of a detective in search of the truth, in commitment to leaving no stone unturned? Even if he has no "doubt about the outcome," are we to just leave it at that? Or do we probe *Nature* to justify this peculiar (unscientific) appeal to human *confidence*?

Friendly as his response certainly is, I will never cease to be bewildered and unimpressed by this kind of underlying smugness and loyalty to authority.

Same as it ever was.

To: hm@berkeley.edu
From: Richard J Benish <rjbenish@comcast.net>
Subject: Galileo's Gravity Experiment
Attachments: <Galileo's-Belated-Experiment.pdf> <Mr-Natural-Says-LR.pdf>

Dear Professor Mueller,

The attached paper argues that until we do Galileo's experiment, we cannot be certain whether or not an important stone in gravitational physics has been left unturned.

I hope you have some interest in filling this large gap in our empirical knowledge of gravity.

Thank you for your good work.

Sincerely,

Richard Benish

Holger Mueller, 7/11/15 5:50 PM -0800, Re: Galileo's Gravity Experiment 1

From: Holger Mueller <hmberkeley@gmail.com>
Date: Sat, 11 Jul 2015 18:50:19 -0700
Subject: Re: Galileo's Gravity Experiment
To: Richard J Benish <rjbenish@comcast.net>

> Dear Richard,
>
> I think this is a fun idea. Frankly, I don't think there can be any doubt about the outcome, and so doing the experiment would be more for fun and for instructional purposes, but could be worth doing nevertheless.
>
> Let me estimate the resonance frequency of an object inside a sphere of radius *R* with density rho. Just at the surface, the force is 4 pi G *m* *R* rho/3, so the "spring constant" is 4 pi G *m* rho/3 and the resonance angular freq. is (4 pi G rho/3). For rho=10 g/cm^3, this is about 1 cycle/hour. Is this correct?
>
> How to check it? I'm thinking about a torsion balance holding a pair of little spheres, inside a hole in big spheres that cause the potential...
>
> Holger
>
> Btw, wow about the slide. Are you a professional designer?

To: Holger Mueller <hmberkeley@gmail.com>
From: Richard J Benish <rjbenish@comcast.net>
Subject: Re: Galileo's Gravity Experiment
Attachments: < NewtonOscillationPeriod.jpg >

Dear Professor Mueller,

Your estimate is indeed correct. The equation for the period is:

$$T = \sqrt{\frac{3\pi}{G\rho}},$$

If the density is that of lead (1130 kg/m^3) then the period is almost exactly one hour.

I am very glad that you think doing the experiment would be both fun and worthwhile. Having the demonstration executed would allow all the textbooks and discussions of the prediction (which are many) to at last be accompanied by references to those who carried it out. Whereas the presently accepted practice is to avoid discussing the need for (or at least desirability of) empirical evidence.

The apparatus builder, George Herold, of TeachSpin in Buffalo, New York, once expressed an interest in doing the experiment (with a modified Cavendish balance).

I am also grateful for your feedback on the graphic. Yes, I have a background in visual art. (A few of the elements were "borrowed" from others, notably, R. Crumb.)

Some of my correspondents have shared that gaining the funding to do Galileo's experiment—because its result is presumed to be known—would be a major obstacle. I understand this as a practical reality, of course. And yet it sometimes strikes me as a weak excuse, especially given the high cost of so many other experiments that have been proposed, are under way, or have been carried out.

Do you have any suggestions for how to convince those with the needed resources that doing Galileo's experiment would be a worthwhile endeavor?

Thank you very much.

Sincerely,

Richard Benish

P S

The equation is both pasted in the body copy and attached as bona fide attachment because sometimes only the latter works.

R B

From: Holger Mueller <hmberkeley@gmail.com>
Subject: Re: Galileo's Gravity Experiment
Date: Sun, 12 Jul 2015 15:34:38 +0200
To: Richard J Benish <rjbenish@comcast.net>

>>> To convince funding agencies, we'd need to show that some new science can be gained from it, such as a new limit in deviations from the $1/r$ law at cm distance sales. Do you happen to know how well this has been verified?
>>>
>>> Another possibility would be to ask how well we know the "inside" potential of a sphere. But that would be harder to argue, because we never enter the material itself…
>>>
>>> Holger
>>>
>>> Sent from my iPhone

To: Holger Mueller <hmberkeley@gmail.com>
From: Richard J Benish <rjbenish@comcast.net>
Subject: Re: Galileo's Gravity Experiment
Attachments:

>>>> Dear Professor Mueller,
>>>>
>>>> In 1985 Hoskins et at (*Phys Rev D*, Vol **32** #12 p. 3084) reported on a beautiful experiment involving a torsion arm and a tall movable cylinder (into which the test mass was suspended). The result was that deviations from the inverse-square law had to be smaller than about 10^(−4 or −5). this cast doubt on some of the "fifth force" speculations being contemplated in those days. More recently, I think the EotWash group has yielded even tighter contraints.
>>>>
>>>> I think your idea of measuring the POTENTIAL, on the other hand, is excellent. As you have impled, we have yet to "enter" this kind of measurement inside matter. As I understand it, the potential could be measured two ways: 1) by allowing free-fall motion over a wide range inside a massive body (direct).
>>>>
>>>> Or 2) to measure the rate of one or more clocks insde matter (indirect). This amounts to measuring the gravitational red-shift, as has been done over Earth's surface. Unfortunately, the latter idea would be virtually impossible due to the smallness of the effect for any conveniently accessible bodies. Which therefore leaves us with (1): motion through the center.
>>>>
>>>> Another way of looking at the above relationship is that an experiment involving free-fall motion past the center is an INDIRECT way of testing the Schwarzschild INTERIOR solution, which predicts that clock rates get slower toward, and reach a minimum at, the center. Even though indirect and crude compared to other tests of GR, the test would nevertheless serve to ascertain, as a first approximation, whether clocks do indeed get slower toward the center. (Presently, we have to admit that we don't

really know.)

I like calling the needed aparatus a Small Low-Energy Non -Collider. Sadly, this marketing angle has not yet proven to be of much benefit in selling the idea. Pointing out that the idea was first proposed by the Father of Modern Science, yet remains to be fulfilled, strikes me as a strong selling point. But I'm still knocking on doors.

Thanks for your suggestions.

Sincerely,

Richard Benish

matterwave.physics.berkeley.edu/partners

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PEOPLE

PRINCIPAL INVESTIGATOR

Holger Müller

hm [at] berkeley.edu

Awarded his first patent at the age of 14, Holger continues his inventive spirit as a physicist applying matter-wave interferometry to fundamental and exotic physics.