

# THE DIRECTOR'S CORNER

## THE HAPPIEST THOUGHT: $g \sim a$

So here's a question for you: What is the happiest thought of your life?

Merely asking the question packs on the pressure, since **THE** 'happiest thought' probably shouldn't be too trivial or selfish, nor, it seems, should it be too ponderous or weighty. What qualifies as your happiest thought? Does it involve romance, vacation, childhood memories, relief of suffering, recent thrills, retribution justly delivered, or what?

I was struck by this phrase while working on a presentation for the World Year of Physics about Einstein (who else?). According to Gerald Holton<sup>1</sup>, Einstein expressed in his own handwriting in 1920 that his happiest thought ("der gluecklichste Gedanke meines Lebens") was actually a thought experiment. It came to him in 1907, and it involved a man falling from a roof and trying to drop an object as he fell. His realization that the dropped object would move alongside the man led him to the equivalence principle, that gravity and acceleration are equivalent. So Einstein's happiest thought could be represented succinctly as  $g \sim a$ !

Recently, I have been trying to make more sense of the ramifications of Einstein's happiest thought, pulling out my vastly under-used copy of Misner, Thorne and Wheeler's classic text, *Gravitation*. This book is so thick that it is flagrantly self-referential, detectably warping space-time in the neighborhood of my bookshelf, or so the joke goes. Anyway, it is one of my long-term ambitions to fully understand the rubber sheet geometry model that is often invoked when describing general relativity. In this model, a horizontal rubber sheet plays the role of a 2-D version of space-time, and a heavy ball rolling on the surface mimics a planet warping space-time as it moves. Lighter balls orbit the planet as satellites, but in general relativity this is viewed not as an effect of an attractive gravitational force but rather because geodesics of space-time have been warped by the pres-

ence of the heavy ball. Thus, it is said that space-time tells matter how to move and matter tells space-time how to curve, and this message is conveyed in the rubber sheet model very well.

But what of the details of the rubber sheet model? Will the orbiting balls satisfy Kepler's Laws, making elliptical orbits, as one expects from real gravity; or do they satisfy some 2-D equivalent? You may be surprised to learn (or maybe not!) that I have spent a lot of time with my students investigating these questions, and in the course, becoming something of an expert on the physics of Spandex, of all things. One very happy result (perhaps not the happiest of my life, but up there) was the prediction and verification that the depth of the depression caused by a heavy ball on a sheet of Spandex goes as the cube root of the mass of the ball<sup>2</sup>.

A related quest to determine whether the Spandex supports gravitational waves in any way reminiscent of Einstein's equations led me to the hefty tome mentioned above, but I have a lot to learn before I get some answers. One interesting fact that I have learned already is that 2-D general relativity does not support gravitational waves in the usual way; three dimensions are required. So, whatever kind of waves one can produce on a rubber sheet, they are surely distinct from gravitational waves in many ways.

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Sigma Pi Sigma Director Gary White (far right) involves physicists in an orbital experiment utilizing spandex at the annual meeting of the National Society of Black Physicists (photo by Dr. Lynwood Randolph).



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You, too, can join in the quest to better understand gravitational waves—real ones, not the rubber sheet model versions—even to help detect them. In this issue of Radiations, we feature an amazing project in distributed computing with the potential to connect each of us to the physics of gravitational waves. As World Year of Physics 2005 celebration projects go, this is my favorite, by far. You personally can help in the effort to detect gravitational waves, using your computer's spare time in screen saver mode to analyze data from the Laser Interferometer Gravitational-wave Observatory (LIGO). See the primer on page 5 for more information. In addition, in this final issue celebrating the World Year of Physics, we have an elegant summary of one of Einstein's remarkable papers from 1905, an article by famed textbook author Wolfgang Panofsky about nuclear

non-proliferation, and a first person account from L. Worth Seagondollar about the making of the first atomic bomb.

Whether your happiest thought is related to science or not, consider filling out the form below; I would love to hear from you. If I get some interesting responses, I will press the editor to let us devote a little space in a future issue to the topic.

— Gary

<sup>1</sup> "Einstein's Third Paradise," Gerald Holton, *Daedalus*, Fall 2003, pp. 26-34. The title of Einstein's manuscript in which this quote appears is translated as "Fundamental Ideas and Methods of Relativity."

<sup>2</sup> "The shape of 'The Spandex' and orbits upon its surface," Gary D. White and Michael Walker, *American Journal of Physics*, **70** (1) January, 2002, pp. 48-52.; see also the comment by Don S. Lemons and T. C. Lipscombe, *American Journal of Physics*, **70** (10) October, 2002, pp. 1056-1058.



LIGO in Livingston, LA, one of two sites for this gigantic gravitational antenna. There are two, perpendicular 4-kilometer arms in this interferometer, one stretching toward the reader in the photo, while the other continues beyond the image edge to the left.

Image credit: LIGO Laboratory  
[http://www.ligo.caltech.edu/LIGO\\_web/200002news/200002liv.html](http://www.ligo.caltech.edu/LIGO_web/200002news/200002liv.html)



Einstein said that the happiest thought of his life was the realization of the equivalence between gravity and acceleration,  $g \sim a$ . Sigma Pi Sigma, the physics honor society, wants to know "the happiest thought of your life." Please take a moment to send us your happy thoughts, physics related or not:

Name \_\_\_\_\_

Induction school and year \_\_\_\_\_

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