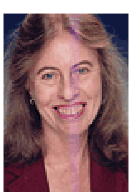
## Technology





WonderQuest
April Holladay

# Making black holes in the lab (conclusion), and space's extra dimension



**Q: Can scientists create a black hole in a laboratory? What would it take to create a black hole in a lab?***Teodor, Bucharest, Romania*



This, the third of a three-part article, describes a strange universe in which black hole production in the lab is possible. How? Because space may have a fourth, warped dimension.

But how can we exist in such a strange universe, and not know it?

Everything we know about our universe comes from observing forces and particles. What if all forces (except gravity) and all particles (except particles that communicate gravity's force) were trapped in a three-dimensional region of a larger four-dimensional space? The region is called the 'Weakbrane'; see the figure at left showing our world residing on the Weakbrane.

Weakbrane is the world we know. Light, for example, is stuck in the Weakbrane. Since not even light can leave our brane, we can't see beyond the brane to detect the larger universe. Likewise, other than gravity and gravitons (particles that carry gravity's force), nothing we know can leave our brane to explore the larger universe. We cannot detect the 4-D space, at least not easily, and then only using the effects of gravity.

So, that's the reason we don't know a larger universe exists (if it does).

A brane is a theoretical notion, envisioned as a membrane-like object that traps particles and forces. The brane exists in a higher-dimensional space. Just as a black hole traps everything inside the hole, so a brane traps forces and particle within its region. Harvard physicist Lisa Randall illustrates the idea of a brane as a shower curtain. Water droplets are trapped on the 2D-curtain within the 3D-room. The curtain is the brane (membrane-like object) in a higher dimensional space, namely, the bathroom.

Professor Randall and her collaborator, physicist Raman Sundrum, professor at John Hopkins University, devised a geometry where two branes enclose another dimension — a fourth dimension in space. See figure. (Time is a fifth dimension.) Gravity on the Gravitybrane is extraordinarily strong. If we could visit the Gravitybrane (which we can't), gravity would increase ten million billion (10^16) times. Then, if we could step back along the 4th dimension, we would experience a gravity force that decreased sharply (exponentially) at each step of the way back home to Weakbrane. Gravity would then, on Weakbrane, be as we have always known it.

Moreover, it's not just gravity that decreases sharply going along the fourth dimension from Gravitybrane to Weakbrane. Energy and mass scale in exactly the same fashion, by 10^16, which is the warp factor. Furthermore, length increases by the same warp factor.

But this means that the unattainably high Planck's density value, set on Gravitybrane, shrinks (by a factor of 10^64) to a feasible value at our home, Weakbrane. In fact, the Planck density value for generating a black hole is a mere 10^33 kilograms per cubic meter on Weakbrane.

The upgraded Large Hadron Collider (LHC) can produce the smaller Planck value needed on Weakbrane. So, the lousy density of about 10^34 kilograms per cubic meter that our colliding protons can achieve will do the job.

Black holes in the lab may soon be a reality. We should know in 2008.

By the way, Randall and Sundrum solved Einstein's relativity equations over the fifth-dimension, warped geometry they devised. The theory, therefore, checks. But experimental evidence is the only true test.

Randall and Sundrum's model is one of many. In fact, in 2001, two groups (Greg Landsberg of Brown University and Savas Dimopoulos, Steven B. Giddings and Scott Thomas) that originally suggested the possibility of black hole production at the LHC and other colliders did their calculations in a different model with extra dimensions.

In conclusion: "Of course, these are incredibly speculative ideas. We'll find out soon enough whether there is anything to them!" says physicist Erik Ramberg of Fermilab.

**Further Reading**:

Making black holes in the lab, Part 1, WonderQuest

Making black holes in the lab, Part 2, WonderQuest

How black holes trap light, WonderQuest

How black holes die, WonderQuest

Tracking black holes — do they exist? WonderQuest

Quantum black holes, *Scientific American*

Fermilab at Work, Fermilab

How do physicists study particles, CERN

Black holes at Future Colliders and Beyond by Greg Landsberg, Brown University

*Warped Passages: unraveling the mysteries of the universe's hidden dimensions* by Lisa Randall, Harvard University

*The Charm of Strange Quarks: Mysteries and Revolutions of Particle Physics*

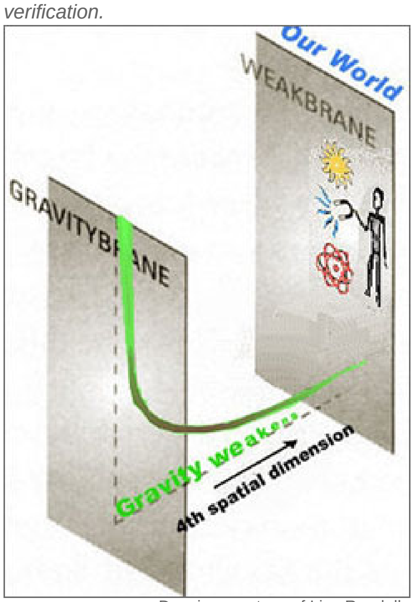
Quantum physics, Hyperphysics

Universe review

*(Answered June 18, 2007)*

*April Holladay, science journalist for USATODAY.com, lives in Albuquerque, New Mexico. A few years ago Holladay retired early from computer engineering to canoe the flood-swollen Mackenzie, Canada's largest river. Now she writes a column about nature and science, which appears Fridays at USATODAY.com. To read April's past WonderQuest columns, please check out her site. If you have a question for April, visit this informational page.*






Enlarge

Drawing courtesy of Lisa Randall, modified by author

Space may have an extra fourth dimension that warps gravity by a factor of ten million billion.

The elliptical galaxy M87 in the Virgo Cluster. The black hole located in the center of M87 is one of the most massive in the universe.

NASA/CXC/CfA/W. Forman et al.



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