DENVER, Feb. 27 — Video game technology and Einstein's work on relativity may at first seem as unlikely a couple as Oscar and Felix.

One bobs in the froth of commercial culture, dodging the scornful radar of educators and parents who wish students were off doing something else like, say, studying Einstein. The other is as highbrow as science gets in its lofty waltz of theoretical physics, where time and space warp in otherworldly ways that have given brain aches to generations of physics students.

But to Andrew J. S. Hamilton, a professor of astrophysics at the University of Colorado, they are perfect together. What gamer programs do with increasing speed, sophistication and computational muscle, Dr. Hamilton said, is visualize things that have never been seen in the real world. And what Einstein described, especially in his theory of general relativity, are forces of time and space literally outside the real world we know, or can know.

"What if you could take people through a wormhole the way Einstein's equations said it would be?" he said in interview in his office on the Boulder campus. "And what if you could bring art and science together in a way that compromised neither?"

That is where black holes come in. Dr. Hamilton's marriage of video game software and relativity, which he has fashioned into a "Black Hole Flight Simulator," is at the heart of a new show at the Denver Museum of Nature and Science that takes viewers on a 23-minute thrill ride to what the program notes call "the other side of infinity."

The show is built on the crunching of numbers that even a black hole might envy: some segments produced by the National Center for Supercomputing Applications at the University of Illinois required 90 hours of supercomputer calculation for each second on screen.
The central goal, Dr. Hamilton said, is both simple and mind-bendingly paradoxical: to visualize what cannot be seen.

Because not even light can escape the gravitational pull of a black hole, the interior of a hole is perhaps the ultimate terra incognita. The absence of light coming out means an absence of all information. Most of what science knows about these objects is thus entirely inferential — from gravitational effects on other objects like nearby stars.

The simulator, to be featured this year in a "Nova" program on PBS about black holes, seeks to lift the veil. Using Einstein's equations and a graphics language called Open GL, developed by Silicon Graphics, Dr. Hamilton told the computer to show how individual vectors of light should behave at the no-man's frontier of the black hole, called the event horizon, and inside the hole itself.

That meant not only creating a visual representation of Einstein's work, but also in a real sense creating from scratch a world that cannot be known. "When I started this, I had no idea what would emerge from the equations," Mr. Hamilton said. Part of the thrill was the exploration. The computer would go where the human mind by itself could not.

That the study of black holes could make for a popular planetarium show is a fairly new frontier. Not too many years ago, black holes were thought to be fairly rare, freaks of the cosmos that were born just under extreme circumstances.

A ho-hum star like the sun, for example, has no chance at black hole celebrity. It may flame out and explode at the end of its life billions of years from now, but it will shrivel only back to a point of déclassé afterlife as a dwarf star.

If a star is large enough, more than about 25 of our suns, the inward collapse becomes unstoppable, a cascade of matter and light that falls forever inward toward a bizarre and unimaginable point of singularity.

And it turns out that in the cosmos, bizarre is pretty common. In many galaxies, including our own, scientists now believe that black holes are the workhorse pivot wheels at the galactic center, massive enough to demand gravitational allegiance from hundreds of millions of stars.

But what happens inside a black hole, and especially what such a place might look like, is another question entirely; no such consensus exists on that one. Dr. Hamilton said what his program predicted, especially in the inner event horizon, was simply where Einstein and his equations led.
A Thrill Ride to 'the Other Side of Infinity'

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There were times when the director Tom Lucas said, 'It doesn't look right,' and my answer became, 'Deal with it,'” said Dr. Hamilton, who is 54 and has been at the university since 1986. "I can't change the visualization to adjust for a conflict with what we expect. It was very important for me to get the science correct."

What the equations produced was very much like a waterfall, except that instead of water, space itself falls into the abyss. But the waterfall analogy went further still. Water that hits the bottom of a waterfall bounces back up to collide with the water falling down to create a maelstrom.

Same thing in a black hole, the equations said. Matter and energy propelled outward by the centrifugal force of the black hole would collide with falling matter to produce a chaotic churn of light.

But Einstein also suggested another outcome, one that science fiction fans are happily aware of as a plot device, the wormhole leading from a black hole to another universe. And Dr. Hamilton shows that part of the journey, as well, as the waterfall-black hole turbulence ends and the audience is flung out and beyond to somewhere even stranger.

"Most people who do computational work stop at the edge," said Lynn R. Cominsky, the chairwoman of the departments of physics, astronomy and chemistry at Sonoma State University and, with Dr. Hamilton, a director of the planetarium show. "As physicists, we stop at the edge at things we can see.

"Andrew Hamilton has gone beyond that and followed the material all the way through the event horizon and made predictions about what should happen inside."
In some ways, Dr. Hamilton's career has been a flight, he said, toward the concrete and visual. Born in Dorset in the West Country of England, he studied mathematics at Oxford. Astrophysics became his home at the University of Virginia, where he received his Ph.D., when felt he wanted more "connection to the real universe."

Now, he says, the connection of gamer gear and science is the frontier. The visualization software that allows players to live and die in cyberworlds like Call of Duty 2, he said, is destined to be the future chalkboard of science.

Hard science is meanwhile galloping ahead just as fast and needs game technology as a tool if students are to master all that must be learned and if members of the public are to glimpse the basics of high-concept science at all.

The world of art, he says, is where all the roads will one day meet, as entertainment technology and science find common ground. He fantasizes real science creeping into Hollywood special effects, as computer geeks in the movie industry realize that the real cosmos as defined by Einstein's legacy is far more mind blowing than fiction.

"I would love to see a 'Star Wars'-type battle take place in the proximity of a black hole, with the physics intact," Dr. Hamilton said.

Hollywood, he added, "simply doesn't realize the richness of nature." Science fiction movies, for example, show light moving in boring straight lines, not twisted into the pretzels that real physics would create.

In fact, the producers of the Denver museum program worried that viewers numbed by movie special effects would not appreciate the depth of science that went into the production. Indeed, Dr. Hamilton said, some members of focus groups who viewed earlier versions of the program "thought they were watching Hollywood."

So the script, read by Liam Neeson, the actor, was tweaked to convey the depth of the research.

Still, Dr. Hamilton concedes that it can be a strange trip following Einstein's math wherever it may lead. Truly a leap in the dark.

Even worse, though, he said, would be not to go at all.

"Is it legitimate science to think we can imagine the inside of a black hole even though it's veiled?" he asked. "Yes. I think so. To make a declaration that it can't be known is to be a defeatist."

And no, he doesn't play video games. Doesn't have the time.