Santa Monica Amateur Astronomy Club

April, 2018

The Observer

Upcoming club meeting:
Friday, April 13, 7:00 pm

The Cassini Mission to Saturn

Speaker:
Dr. Earl Maize

Credit: Hubble, Subaru; Composition & Copyright: R. Gendler

INSIDE THIS ISSUE

Dr. Earl Maize to speak on Cassini

S. W. Hawking

OUR MEETING SITE
Wildwood School
11811 Olympic Blvd.
Los Angeles, CA 90064
Free parking:
Garage, SE corner of Mississippi & Westgate.

PICTURES AT LEFT:
The Cassini Mission's last ring portrait of Saturn

April Meeting: Dr. Earl H. Maize will speak on the Cassini Mission to Saturn!

Dr. Earl H. Maize from the Jet Propulsion Lab will be talking about the Cassini-Huygens Mission to Saturn, the landmark mission that has given us a new window on that magnificent world.

How was this mission put together? What did it take to design and build a spacecraft of a size and complexity that far surpassed previous missions? How did it accomplish its scientific goals? What's the story behind the breathtaking images and astounding discoveries?

Dr Maize was Program Manager for the Cassini Mission, and is a speaker in great demand--so don't miss this opportunity to hear first-hand about the amazing project that brought new worlds to our doorstep.

The Cassini Spacecraft, in the Solar Thermal Vacuum Test Chamber at the Jet Propulsion Lab.

Before a craft is deemed "flight-worthy", it must go through rigorous testing. Extreme heat, extreme cold and high vacuum await every spacecraft that ventures beyond our protective atmosphere. There is severe shaking on launch, degassing of materials under low pressure...a lot to consider! Xenon arc lights simulate the blazing sun while cryogenic fluids run chill the walls in JPL's large vacuum test chamber.

UPCOMING EVENTS:

Santa Monica Astronomy Club meeting:

Friday, April 13, 7 pm

Earl Maize, “Cassini”

Carnegie Lectures:

The next Carnegie Lecture at the Huntington Library is already completely ‘sold out’ (talks are free, but require a ticket). These used to be a simple matter of just showing up (like the JPL Open House), but have gotten to be a real challenge, unfortunately.

The talk, on “Asteroid Families”, is on Monday, April 23, which means that tickets for the following talk should open up on Tuesday, April 24 at 10 am.

If you are interested, go to OCIW/Carnegie Observatories for information—and then get on your computer as soon as tickets open up. It’s getting to be a real hustle for these things…

UCLA
METEORITE
COLLECTION

UCLA Meteorite Gallery Lecture Series

Sunday, April 29, 2018 from 2:30 - 3:00 pm

Title: "Rocks beyond our solar system - evidence from dead stars"

Lecture by Prof. Ed Young
University of California, Los Angeles

White dwarf stars are the stellar cores left behind by Sun-like stars after they have exhausted their nuclear fuel. Some of these dead stars still have rocky bodies orbiting them that are similar to our asteroids. These orbiting objects sometimes fall into the stellar atmosphere and vaporize, releasing their elements which then contribute to the spectral lines visible with telescopes. The chemical similarities between rocks in our solar system and the rock-forming elements floating in the atmospheres of white dwarf stars provide good evidence that rocky planets elsewhere in the Milky Way Galaxy are similar to the rocky planets in our solar system. This, in turn, suggests that Earth-like planets are not unusual.

Admission
Free and open to the public.

Location
UCLA, Geology Building, Room 3656 (near Meteorite Gallery in Geology 3697)
595 Charles Young Drive East
Los Angeles, CA 90095

Contact
UCLA Meteorite Collection (www.meteorites.ucla.edu)
Email: meteorites@ucla.edu

Steven W. Hawking

1942-2018

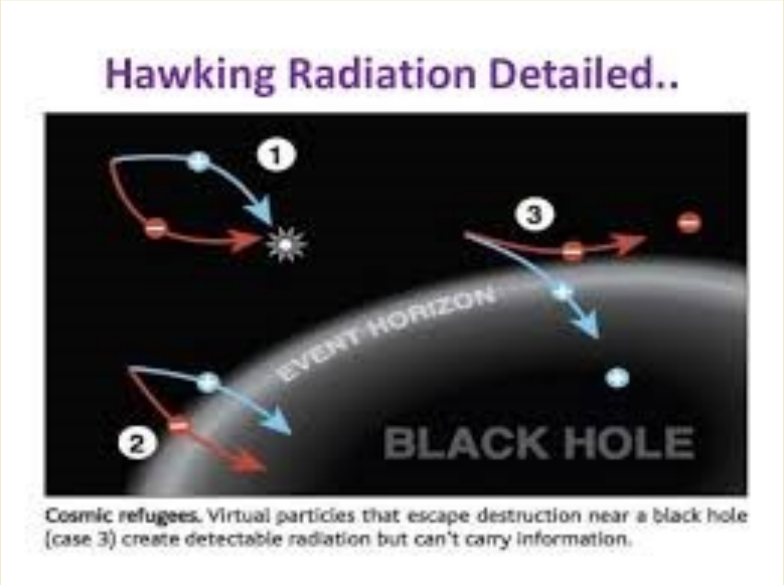
In 1642, Galileo passed away, and Isaac Newton was born. Galileo established many of the laws of moving and falling bodies—but it was up to Newton to explain the causes of motion, in terms of forces, the subject he pioneered.

In 1942, Stephen Hawking was born. He was proud of the coincidence, even editing a book titled “300 Years of Gravitation”.

On March 14 of this year, Hawking passed away at the age of 76. And it just so happened to be....as well as Pi Day...Einstein’s birthday.

Hawking was, of course, best known for his application of Einstein’s theory of gravitation to black holes, and to the universe at large. The passing of this remarkable traveler leaves a different kind of void, both for his scientific work and his role in our cultural space and time.

“Black Holes are not as black as they paint…”



John Wheeler of Princeton, who coined the term “black hole” after tiring of “completely gravitationally collapsed object”, noted that he was bothered by this conundrum: If you have a hot and a cold teacup, and you put them together, their temperatures will equalize, and entropy (related to disorder, but actually a measure of the number of available states of a system) will increase. The system will reach an equilibrium, a state which can be described by a minimum of information, but with a maximum number of possible configurations.

But what happens if you drop the teacups into a black hole? Is the information lost? Does thermodynamics stop at the event horizon? What about predictability? The laws of physics allow us to run the universe forward and backward…if black holes “eat information”, and we can’t run the laws of physics backward to reveal the past, is this a violation of the very nature of scientific law?

As for the thermal conundrum, it led to the famous idea of “Hawking Radiation” in the mid-1970s.

(NB: In quantum physics, though probability rules, the laws are still deterministic, visibly so for large ensembles of systems.)

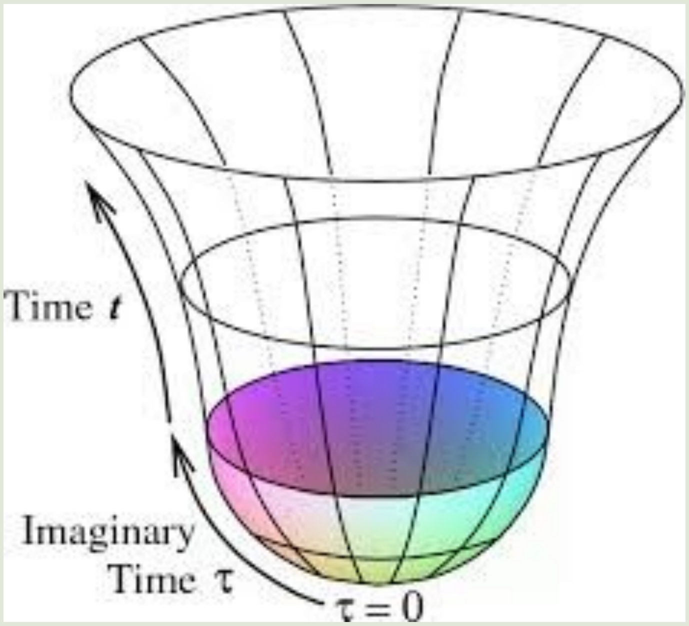
Perhaps black holes <u>*do*</u> have a temperature. But in thermodynamics, all bodies with a temperature will radiate energy. How does this make sense for a black hole, which isn't supposed to radiate anything?

Hawking showed how, with virtual particle pairs continually being created in the quantum "vacuum" of space, pairs near the event horizon can be separated—one partner becoming "real", and the other taking negative energy into the black hole.

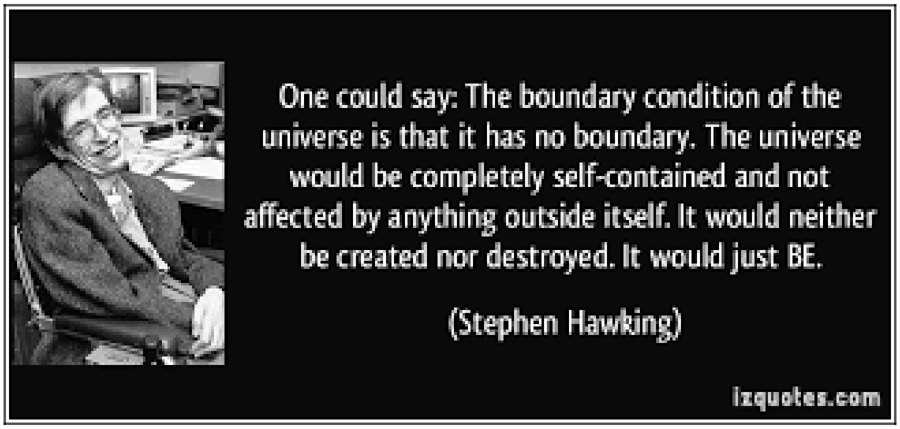
In effect, black holes should radiate, with a temperature related to the size of the black hole itself.

A radical idea, it provoked strong reactions—but soon, strong acceptance.

This was a remarkable 'pairing' itself—of Einstein's gravity with quantum mechanics.



What's before the first instant of time? What's south of the South Pole? Hawking, along with James Hartle, came up with the concept of the "no boundary" boundary condition, applied to the Big Bang. You can't go south of the south pole (try it!), but there is no 'boundary' there. Similarly, if you use 'imaginary time' (not fictional, but something to do with negative signs!), the universe doesn't have a beginning moment. Technically, this relates to the concept of differential equations requiring boundary values, in order to peg down predications everywhere within the boundary. But it is an imaginative, if not imaginary, bit of thinking…a provocative idea about a still-enigmatic beginning.

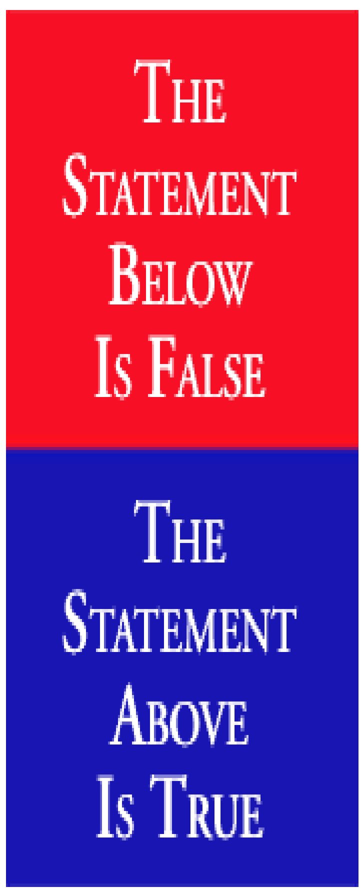


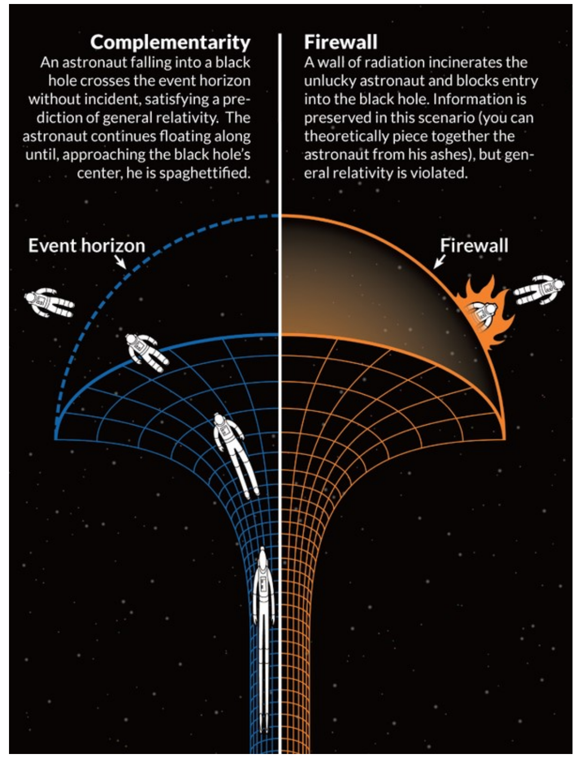
Hawking built on methods of differential geometry pioneered by mathematician Roger Penrose to show that, according to general relativity, the universe should begin at a singularity. He and the late Jacob Beckenstein developed the laws of black hole thermodynamics. Hawking's work, particularly from the 1970s and 80s, was a series of trailblazing ideas. He wasn't the only one in the field, but he lead the way on a lot of topics. As astronomer Virginia Trimble put it, Hawking was famous in the scientific community for "doing very good work under very difficult circumstances."

Mathematician Kurt Godel is famous for his "Incompleteness Theorem". Math is consistent, but incomplete—there are some propositions in any system of axioms and theorems that cannot be proven. Math cannot be fully 'systematized'.

Physics, on the other hand, appears complete, but inconsistent: Quantum theory and relativity give opposing predictions about black holes, among other things.

Hawking's view was that, someday, physics would share its consistency with mathematics—but lose its completeness.





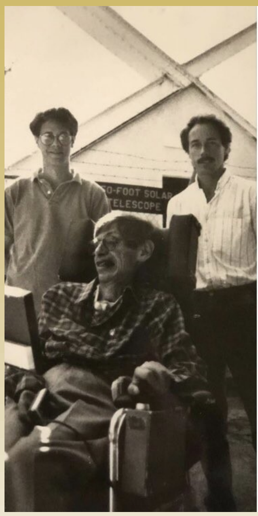
According to general relativity, black holes are simple objects. They have mass, charge and spin. (These are things conserved by nature. Energy and momentum conservation are related to mass.) As the saying goes, "Black holes have no hair." The complexity of the infalling material quickly disappears, damped out by the collapse into gravity's well.

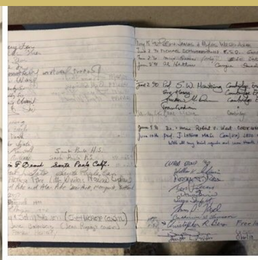
But in quantum physics, information is conserved—it's a fundamental law, related to energy conservation.

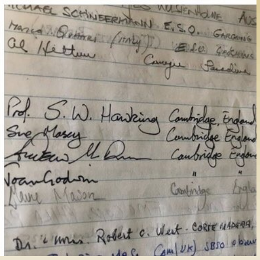
So, which is it? Hawking radiation is supposed to be random, a bundle of entropy which reveals nothing about the material that formed the black hole. If a black hole completely evaporates, what happened to the information that went down its gullet?

Does the black hole leave a 'remnant' of facts? Is the information somehow stored on the event horizon itself, in the form of supersymmetric strings, from String Theory? Is it possible that the paradoxical nature of a black hole requires that the Event Horizon is actually a barrier, and there is no "inside"?

In Hawking's wake, the debates continue...





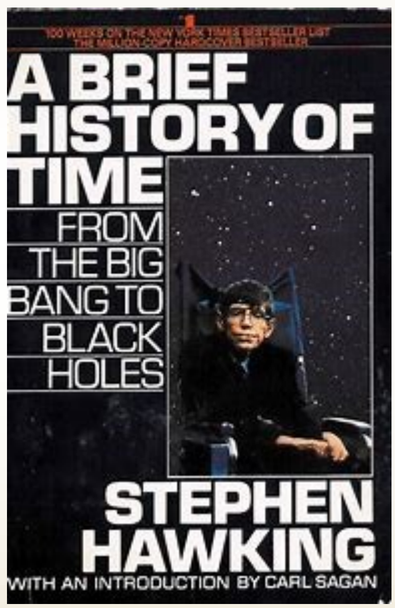


Hawking visited Mt. Wilson Observatory several times, this one in June of 2001. His thumb print is stil l there, in the guest log. The last time Hawking actually signed his full name was under the signature of one Isaac Newton, when Hawking was appointed Lucasian Professor at Cambridge—Newton's old chair.

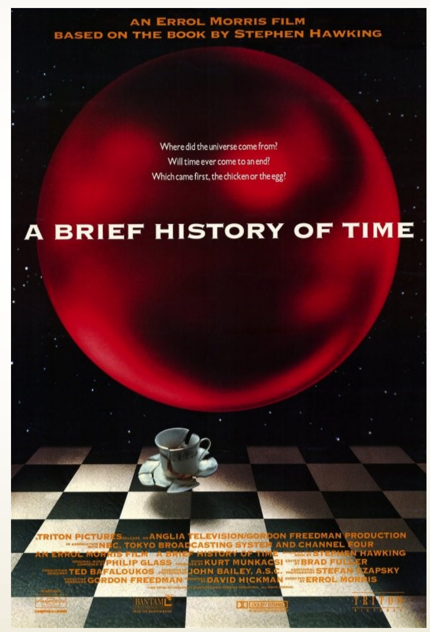
Hawking losing a bet, which he conceded to Caltech's John Preskill (right). Several of us from the club were in the audience that night. This one was on black hole information. Hawking also conceded a bet on Cygnus X-1, to Kip Thorne, accepting that it was, indeed, demonstrated beyond reasonable doubt to be a black hole. (You'd think he'd take the other side, right?)

Ed. note—I first met Hawking when he gave a series of lectures at Harvard, back in the late '70s. He could still talk back then—albeit with difficulty—but, with what was left of his voice, he was quite expansive on his subjects. Since then, many of us have been to his talks, and have taken friends and students—many of whom were moved, and even inspired, by the occasion of meeting a scientific celebrity, who spoke with wit, passion and humor about our strange but wondrous universe, and our ongoing quest to understand it.

Eddie Redmayne as Stephen Hawking in the popular movie "Theory of Everything". It is based on a book by his first wife, Jane Wilde. If you have an interest in Hawking's life and work, this might be a very enjoyable place to start. Redmayne did a fantastic job of copying Hawking's mannerisms—an amazing achievement, given the obvious difficulties—and the movie does give a faithful view of Hawking's struggles and triumphs. (Only his influential mom, Isobel Hawking, is somewhat mysteriously missing.)



The book that catapulted Hawking to fame. Millions of copies were sold—although Hawking wonders how many were actually read! You can find any number of his books today, of course, from highly technical to popularly pictorial.



A lesser-known gem is the Errol Morris documentary, based on the book. Someone called it "A work by one genius, about another genius." This is a wonderful journey, with emphasis both on Hawking's life and his science.

Its interview subjects include physicists and upper class British—"an interesting lot", quipped one reviewer, who noted the saying, "One tends to get lost in one's ones." One certainly ought to see this!