

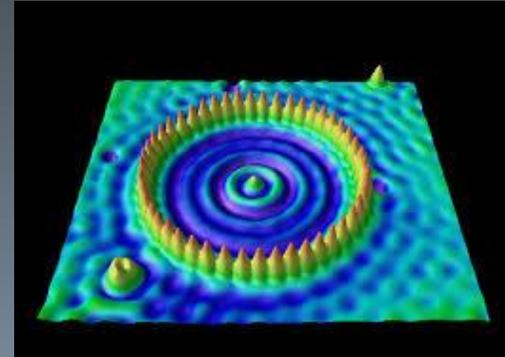
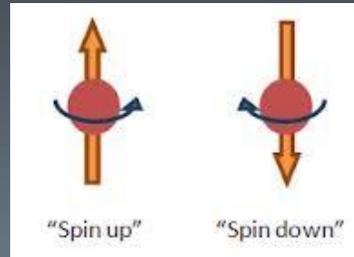
Welcome to Where the Arts meet Physics



[Course Website – \(Under Construction\)](#)

The Universe

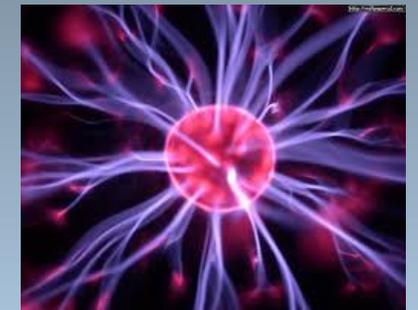
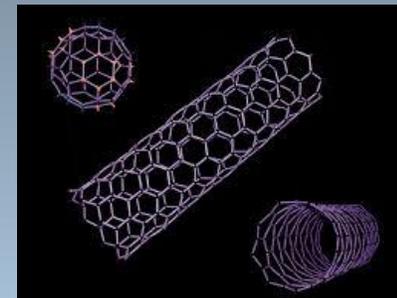
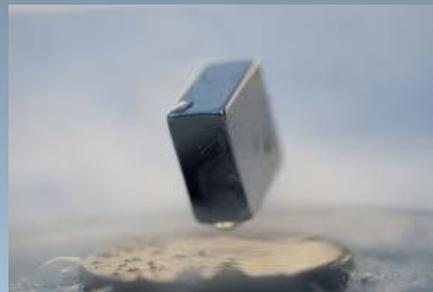
The Quantum World; Condensed Matter



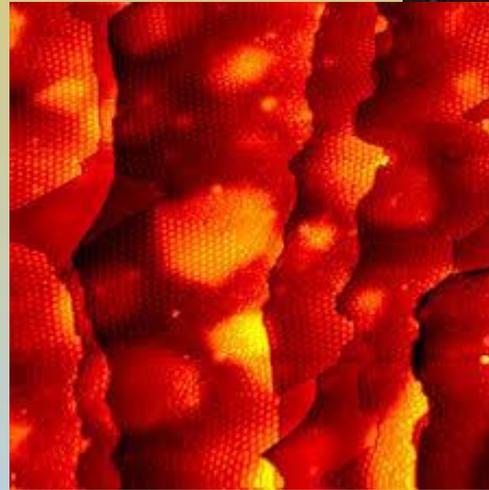
Matter Waves

Quantum superposition
Does God play Dice?

Bizarre States
of Matter



The Arts.....

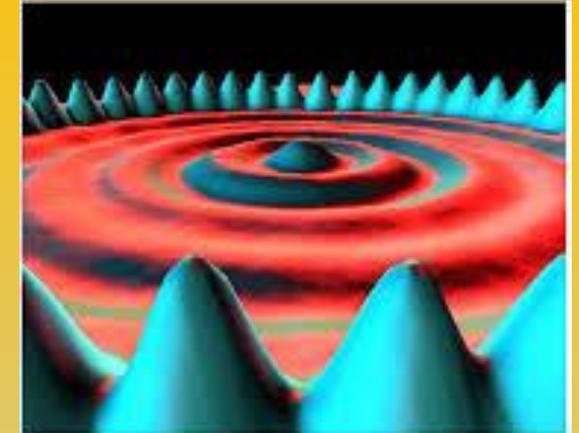


Quantum Voyages



Latrelle Bright

$$H\psi = E\psi$$



Synopsis: Guided by Sapienza, the spirit of knowledge, two voyagers enter the microscopic realm of everyday human experience. As in epic and fairy tales, the voyagers explore land after land, each tickling the viewer's imagination and, unlike fairy tales, offering glimpses of a world we believe actually resides around us. The trio confront terrifying prospects of being Dead and Alive at once, encounter electrons acting as waves, are pelleted by photons, glide through diaphanous orbitals of atoms, precess in Magnetic Resonant Imaging machines, levitate above superconducting surfaces, and navigate disordered quantum within us and the affirmation that things are never what they seem.

In the Beginning.....



Hymn of Creation, Rg Veda:

*Nor aught nor naught existed; yon bright sky
Was not, nor heaven's broad woof outstretched above.
What covered all? what sheltered? what concealed?
Was it the water's fathomless abyss?
There was not death - hence was there naught
immortal,
There was no confine betwixt day and night;
The only One breathed breathless in itself,
Other than it there nothing since has been.
Darkness there was, and all at first was veiled
In gloom profound, - an ocean without light. -
The germ that still lay covered in the husk
Burst forth, one nature, from the fervent heat.
Then first came Love upon it, the new spring
Of mind - yea, poets in their hearts discerned,
Pondering, this bond between created things
And uncreated. Comes this spark from earth,
Piercing and all-pervading, or from heaven?
Then seeds were sown, and mighty power arose -
Nature below, and Power and Will above.*

*Who knows the secret? who proclaimed it here,
Whence, whence this manifold creation sprang? -
The gods themselves came later into being. -
Who knows from whence this great creation sprang? -
He from whom all this great creation came.
Whether his will created or was mute,
The Most High seer that is in highest heaven,
He knows it, - or perchance e'en He knows not.*

Translation – Max Muller

Poetry, Visual Arts, Photography

Hubble Images – Window into Cosmos, Time

History of the Universe



THE BEGINNING

The Universe begins 13.7 billion years ago with an event known as the Big Bang. Both time and space are created in this event.

UNOBSERVABLE UNIVERSE

FRACTION OF A SECOND

Rapid expansion occurs during a billionth of a billionth of a billionth of a second – the visible Universe is the size of a grapefruit.

1 SECOND

The Large Hadron Collider at CERN is recreating the conditions that prevailed a fraction of a second after the Big Bang.

100 – 1000 SECONDS

Nuclei of hydrogen, helium, lithium and other light elements form.

300,000 YEARS

We can detect radiation from the early formation of the Universe back as far as this point. Before this, the Universe is opaque: it's as if a veil has been pulled over it.

POTENTIALLY OBSERVABLE UNIVERSE

A FEW HUNDRED MILLION YEARS

Matter clumps together under its own gravity forming the first protogalaxies and within them, the first stars.

Stars are nuclear furnaces in which heavier elements such as carbon, oxygen, silicon and iron are formed. Massive stars exploding as supernovae create even heavier elements. Such explosions send material into space ready to be incorporated into future generations of stars and planets.

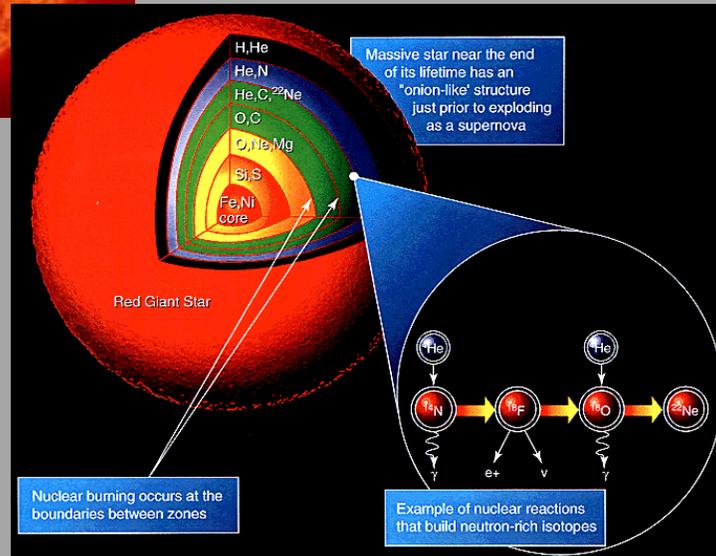
A FEW BILLION YEARS

Initially, the expansion of the Universe decelerated – but a few billion years after the Big Bang, the expansion began to accelerate. The acceleration is caused by a mysterious force known as 'dark energy', the nature of which is completely unknown.

9 BILLION YEARS

The Sun, along with planets, and all the asteroids, comets and Kuiper belt objects, form from the left behind by early generations of stars.

Fusion, Nuclear Power, Elements



[They Might be Giants](#)
[Here Comes Science](#)
[Meet the Elements](#)

[Elements](#) – Tom Lehrer

The Celebration Company proudly presents

The Effect of Gamma Rays on Man-in-the-Moon Marigolds

by Paul Zindel
directed by Latrelle Bright

"And he said this thing was so small—this part of me was so small it couldn't be seen—but it was there from the beginning of the world"

December 3–19, 2015
All shows at 8 PM
\$10 W, Th, Su
\$15 Fr, Sa

Station Theatre
223 N. Broadway Ave.
Urbana, IL
Partially funded by The Illinois Arts Council

For reservations, call 217.384.4000 or reserve online at stationtheatre.com

Tillie's atom monologue.

He told me to look at my hand, for a part of it came from a star that exploded too long ago to imagine. This part of me was formed from a tongue of fire that screamed through the heavens until there was our sun. and this part of me—this tiny part of me — was on the Sun when it itself exploded and whirled in a great storm until the planets came to be.

[Lights start up.]

And this small part of me was then a whisper of the earth. When there was life, perhaps this part of me got lost in a fern that was crushed and covered until it was coal. And then it was a diamond millions of years later — it must have been a diamond as beautiful as the star from which it had first come.

Or perhaps this part of me became lost in a terrible beast, or became part of a huge bird that flew above the primeval swamps.

And he said this thing was so small — this part of me was so small it couldn't be seen—but it was there from the beginning of the world.

And he called this bit of me an atom. And when he wrote the word, I fell in love with it.

Atom.

Atom.

What a beautiful word.

The Celebration Company at Station Theatre presents

Silent SKY

By Lauren Gunderson

February 15 - March 3 at 8:00pm
Sunday, February 25 at 3:00pm

Tickets: 20 Regular Admission
4 for \$10 on Friday, January 26th
All shows are for students and seniors

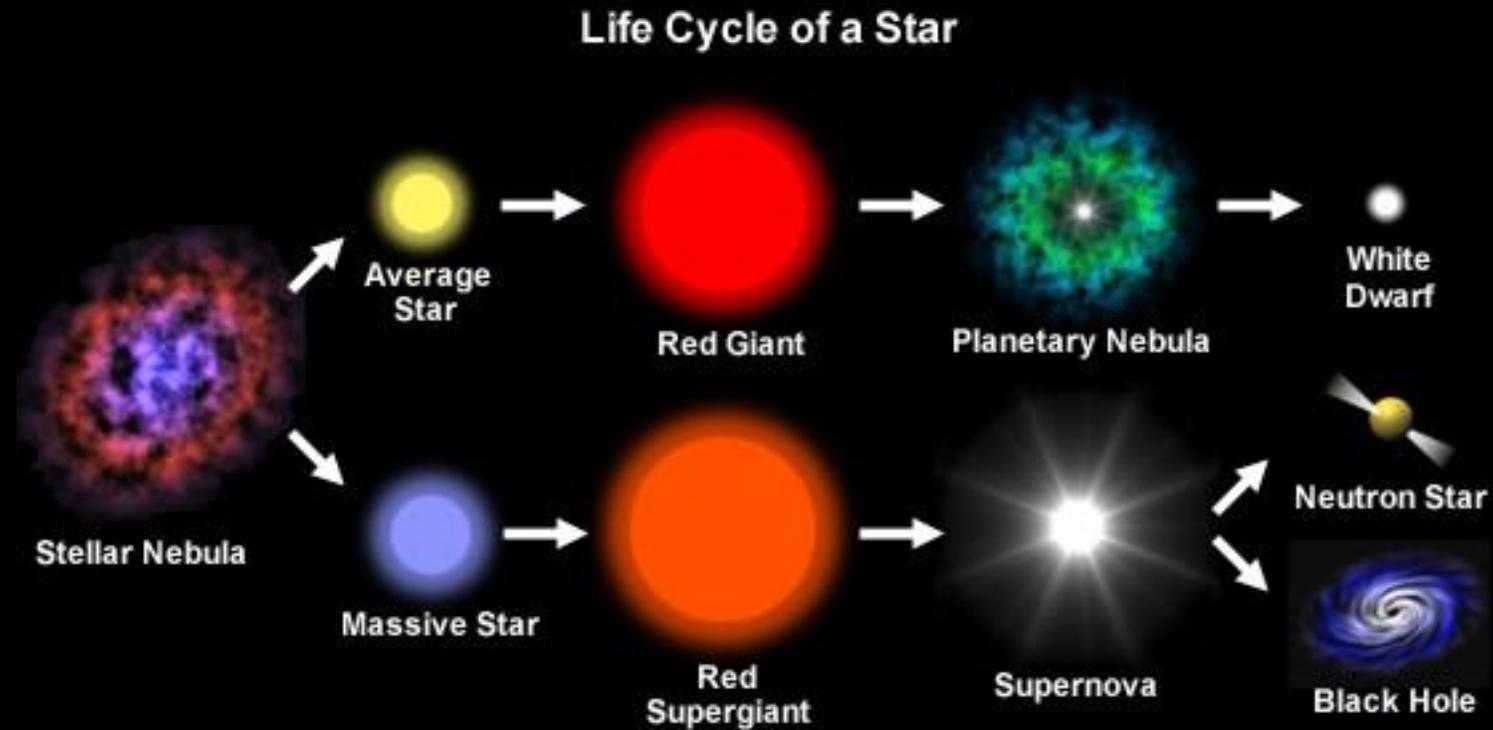
Directed by Katie Burke

The Station Theatre

Receive Tickets at
402.384.4000
or visit us online at
stationtheatre.com

223 N. Broadway, Urbana

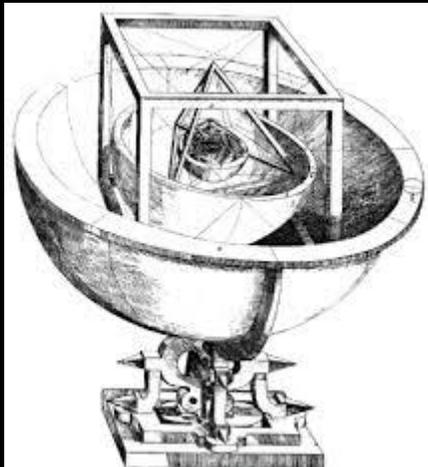
Stellar Life Cycle



Planets



Planetary Music



Saturn 19 -- 23 -- 19 Jupiter 35 -- 38 -- 35 Mars 65* -- 72 -- 65*

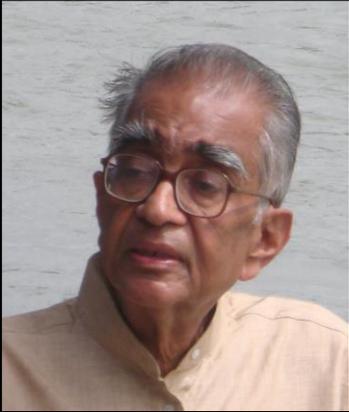
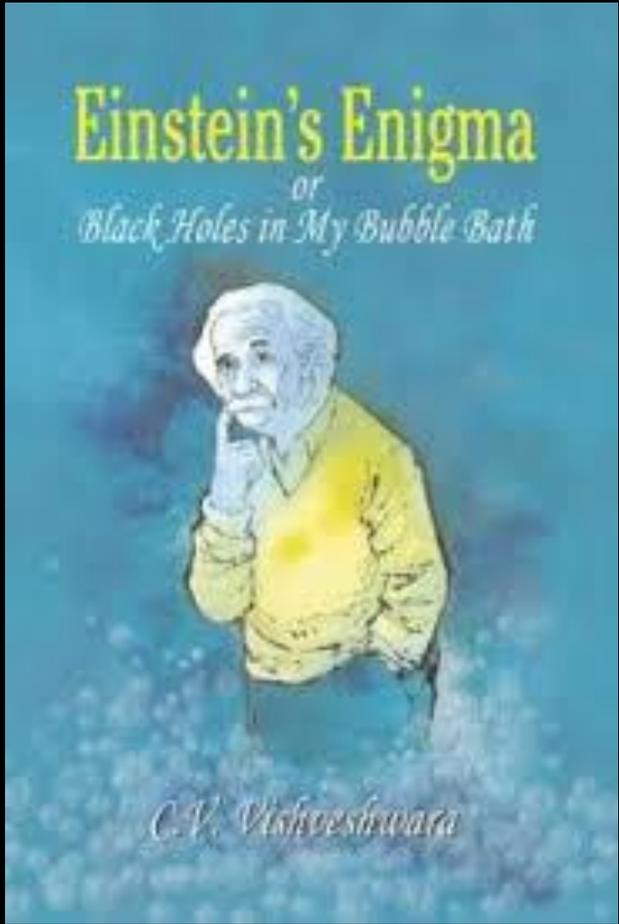
79 -- 80 -- 79
Earth

88 -- 88* -- 88 93 -- 108 -- 93
Venus Mercury

Kepler's Music of the Spheres in common music notation, along with relative MIDI notes.
Based on the notation in Joselyn Godwin's *Harmonies of Heaven and Earth*
* denotes slightly sharpened note.

throned. In this most beautiful temple
any better position from which he can
the Sun sits as upon a royal throne
which circle round him.

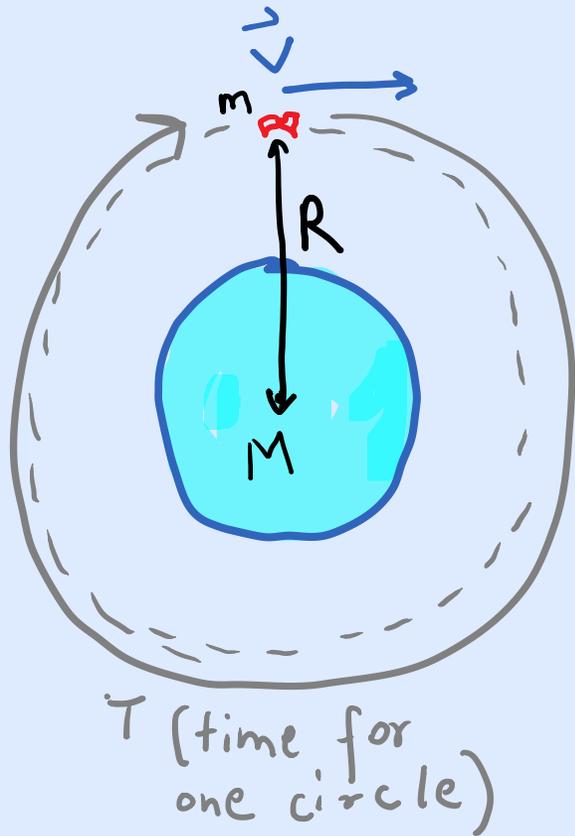
-Copernicus



Space Travel



Orbit distance, rotation rate, speed



The larger the orbit radius, the slower the rotation speed and the longer it takes to complete a circle

Details

$$\begin{aligned} \downarrow F &= ma \\ \frac{GmM}{R^2} &= m \left(\frac{v^2}{R} \right) \end{aligned}$$

$$\frac{GM}{R} = v^2, \quad v = \frac{2\pi R}{T}$$

Satellites: Low/Medium Earth Orbit, Geosynchronous

A medium Earth orbit (MEO) satellite travels at about 6500 miles/hour (1.8 miles/sec). A satellite in low Earth orbit (LEO) travels at about

- A. 700 miles/hour**
- B. 5 miles/sec**
- C. It depends a lot on its altitude**

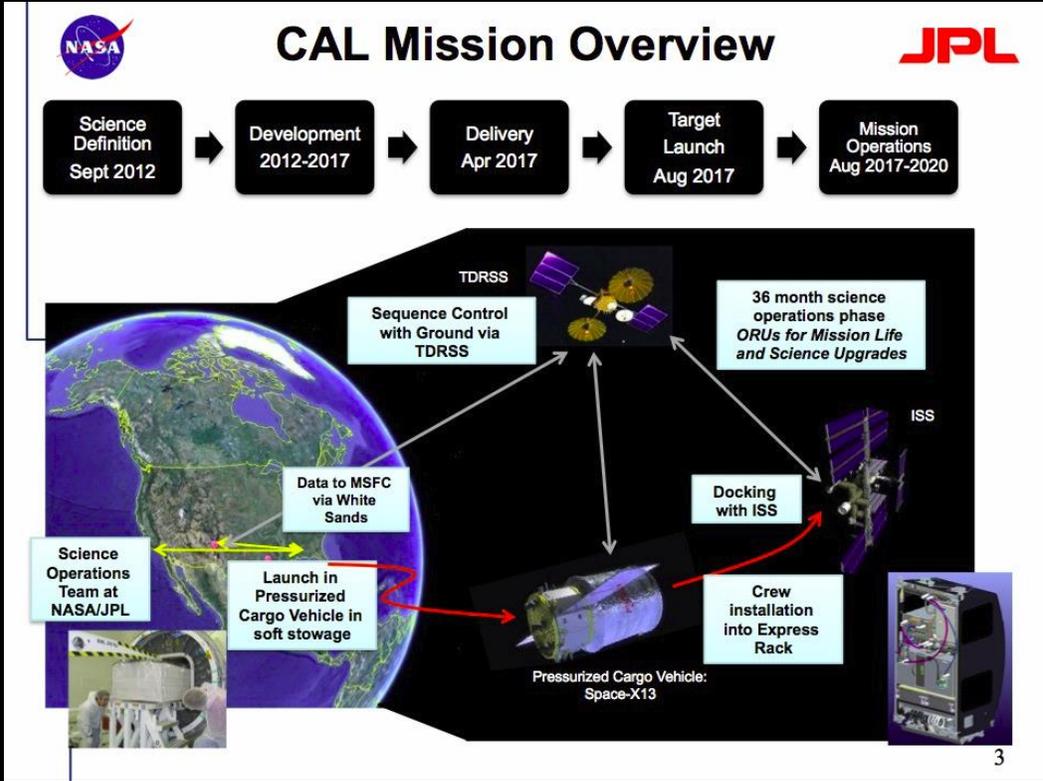
A satellite in low Earth orbit (LEO) is travelling at about

A. 700 miles/hour

B. 5 miles/sec

C. It depends a lot on its altitude

- **5 miles/sec at an altitude around 100 miles**
- **Escape velocity: 7 miles/sec**
- **Earth radius is 4000 miles**
- **Spy satellites can only view a given area for about a minute**



Cosmos and Film



International Space Station



[Mike Hopkins from space](#)



"Space Oddity"

Ground Control to Major Tom
Ground Control to Major Tom
Take your protein pills
and put your helmet on

Ground Control to Major Tom
Commencing countdown,
engines on
Check ignition
and may God's love be with you

[spoken]

Ten, Nine, Eight, Seven, Six, Five,
Four, Three, Two, One, Liftoff

This is Ground Control
to Major Tom
You've really made the grade
And the papers want to know whose
shirts you wear
Now it's time to leave the capsule
if you dare

This is Major Tom to Ground Control
I'm stepping through the door
And I'm floating
in a most peculiar way
And the stars look very different today

For here
Am I sitting in a tin can
Far above the world
Planet Earth is blue
And there's nothing I can do

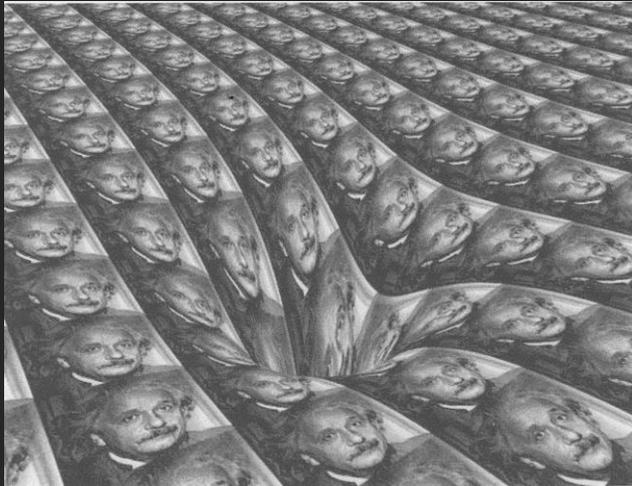
Though I'm past
one hundred thousand miles
I'm feeling very still
And I think my spaceship knows which way to go
Tell my wife I love her very much
she knows

Ground Control to Major Tom
Your circuit's dead,
there's something wrong
Can you hear me, Major Tom?
Can you hear me, Major Tom?
Can you hear me, Major Tom?
Can you....

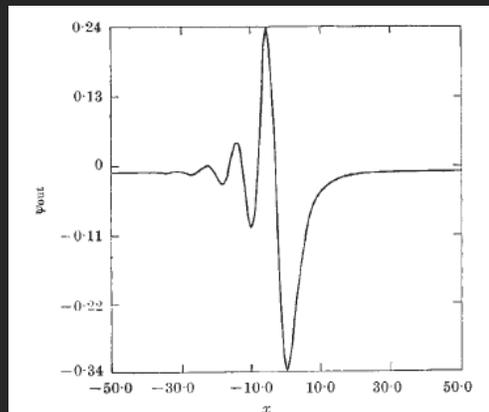
Here am I floating
round my tin can
Far above the Moon
Planet Earth is blue
And there's nothing I can do.

Homage to David Bowie
Chris Hadfield

Discovery of Gravitational Waves!!!!

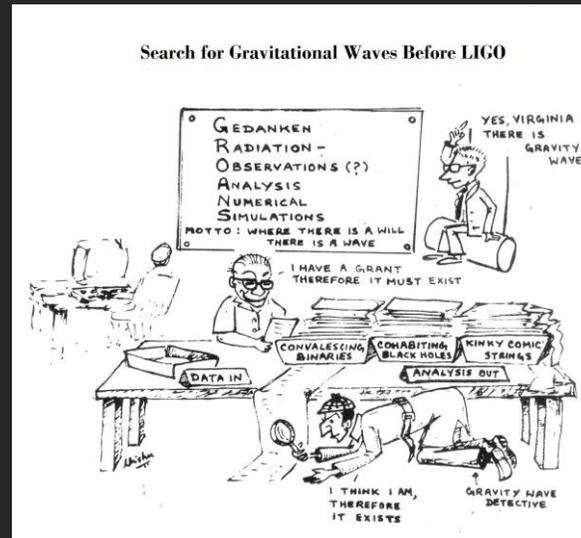
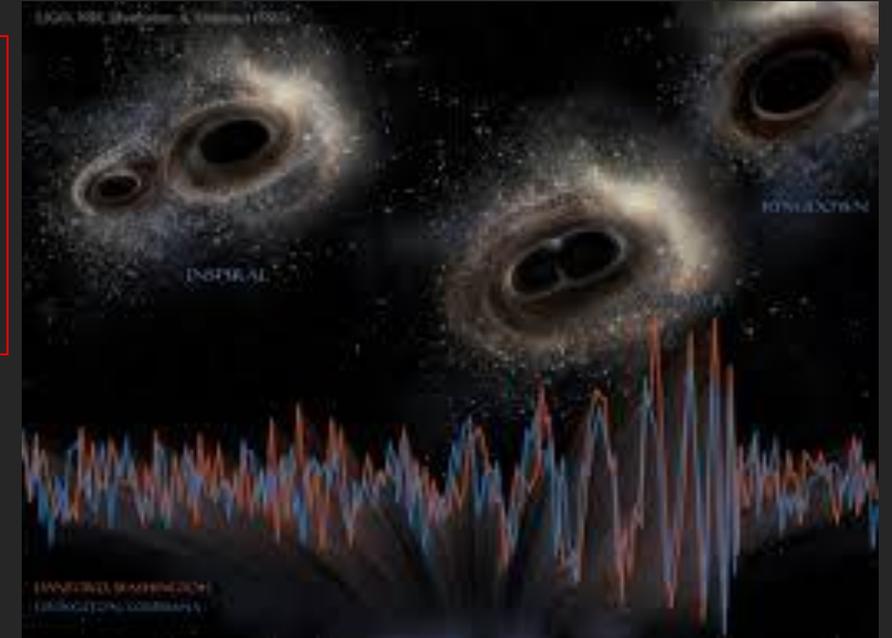


Space-time curvature



CVV - QNM '70; Cartoon

Feb 2016:
LIGO announces
detection from
two blackholes
merging

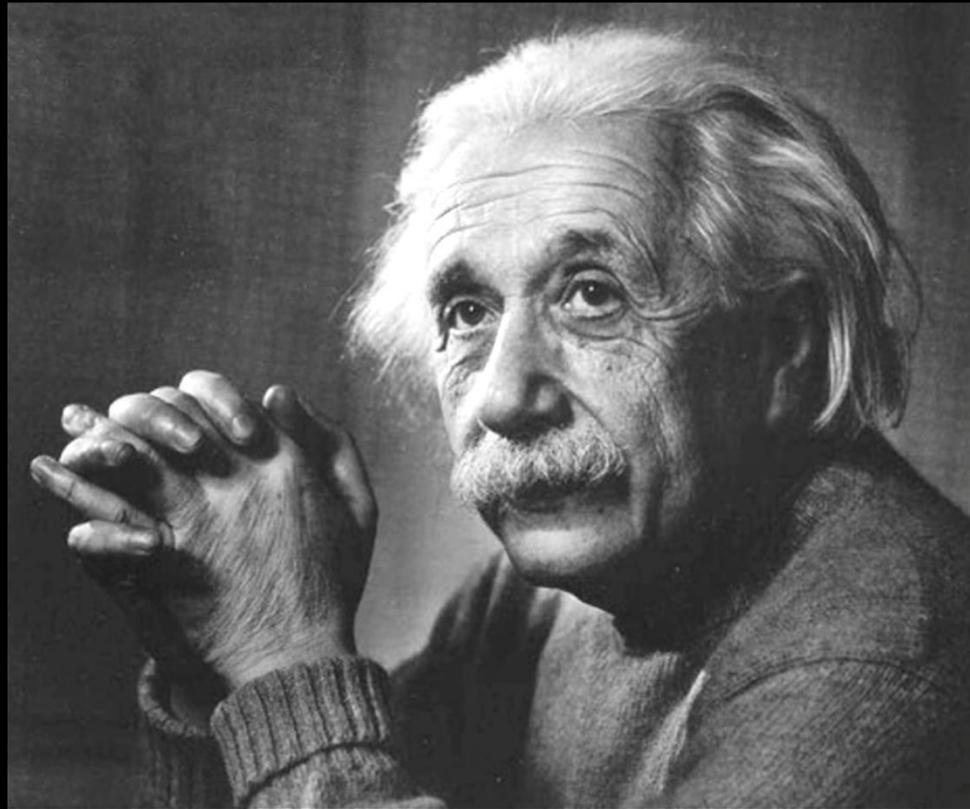


Universe in Motion



SNK Photography

Kirstie Simson, Dance, CoLab



“Out yonder there is an immense cosmos that stands before us like a great eternal riddle, at least partially accessible to our inspection and thinking. The contemplation of this cosmos beckons like a liberation”

- Albert Einstein