



**Seeking God in Einstein's
Universe
Into the Weirdness**

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This SOAR Coarse

☆ Some of the incredible wonders we've discovered about our universe:

🌍 Scale of things

🌍 Origins of the elements we're made of

🌍 Origin & evolution of the universe

🌍 Weirdness of matter & energy

☆ How I connect these to my sense of God

🌍 How weird is God?

🌍 What can we know about God?

🌍 What do others say about God?

This SOAR Course

☆ 9/7: Into the Vastness

🌍 Cosmic scales of space & time

☆ 9/14: Into the Weirdness

🌍 Origin & Evolution of the universe

🌍 Nature of Light & Matter

☆ 9/21: The Substance of Ourselves

🌍 Origin of elements we & Earth are made of

☆ 9/28: The Children of Earth

🌍 History of Earth & Life

In the Beginning ...

At $t = 0$ seconds

- 🌍 Time began
- 🌍 Space began
- 🌍 Universe began

What Started It?
~~What Started It?~~

We Don't Know!
~~We Don't Know!~~

What DO we know?

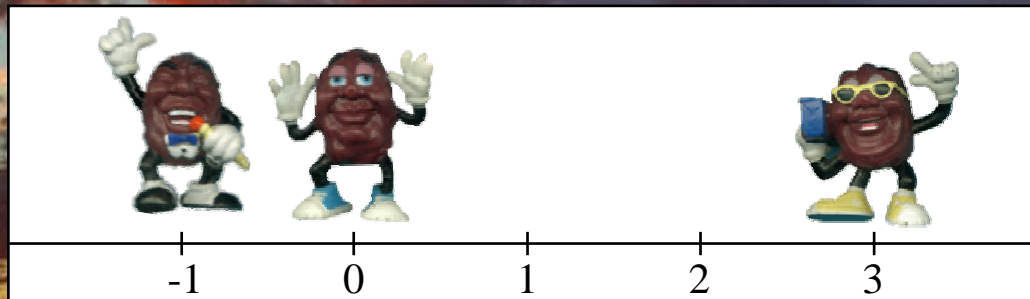
- 🌍 All galaxies are moving away from us
- 🌍 More distant galaxies moving away faster
- 🌍 Entire universe glows in microwaves

In the Beginning ...

What DO we know?

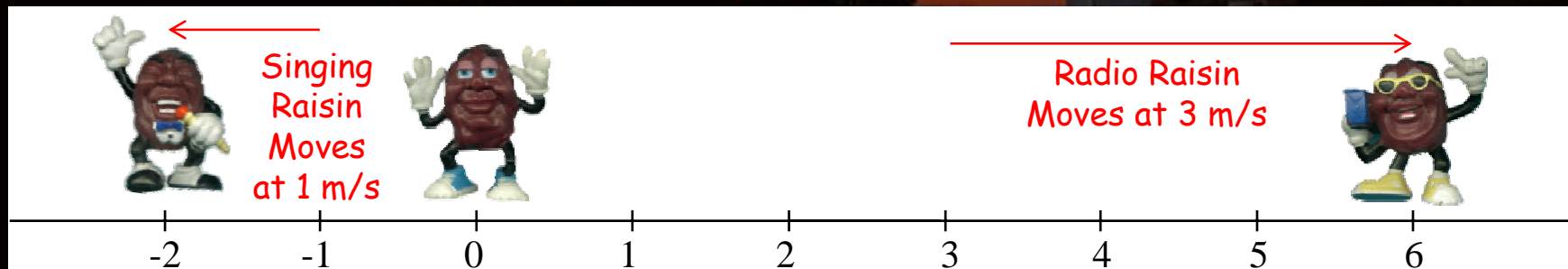
- 🌍 All galaxies are moving away from us
- 🌍 More distant galaxies moving away faster

California Raisin Cosmology



Raisins separated by meters

Distances Double in 1 sec

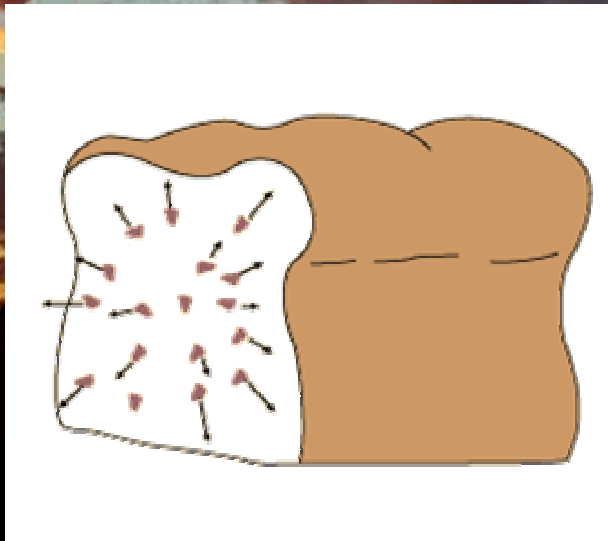


In the Beginning ...

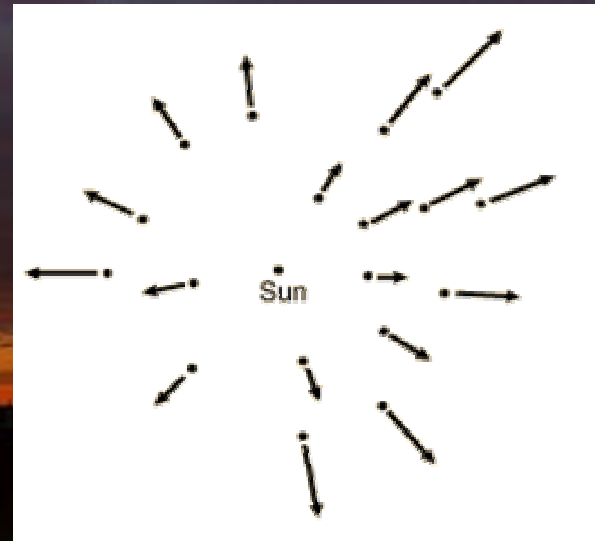
Expansion of the Universe

- 🌍 All galaxies are moving away from us
- 🌍 More distant galaxies moving away faster

... The universe is like a raisin bread!



Raisins move with dough, not through it.



Galaxies move with space, not through it!

In the Beginning ...

☆ Current Cosmological Theory

- ④ Use equations to "run time backwards"
 - › Universe gets smaller, denser, hotter
 - › Can go back to 10^{-43} sec after Big Bang

☆ Observations support Theory

- ④ Early universe is glowing ball of energy seen as Cosmic Microwave Background

... So what have we learned?

~~In The Beginning There Was ...~~

At $t=10^{-43}$ Seconds There Was ...

LIGHT

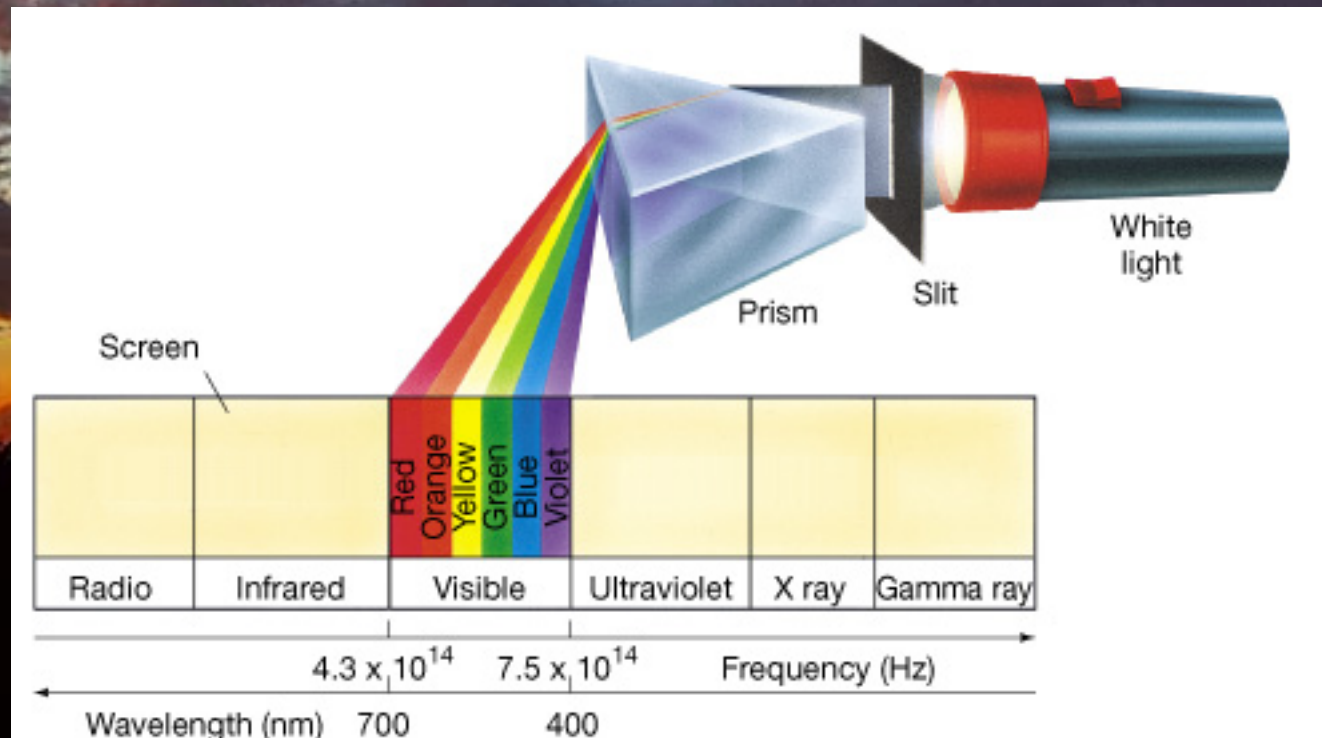
The Expansion of the Universe

After 10^{-43} seconds

* Time and Space began expanding

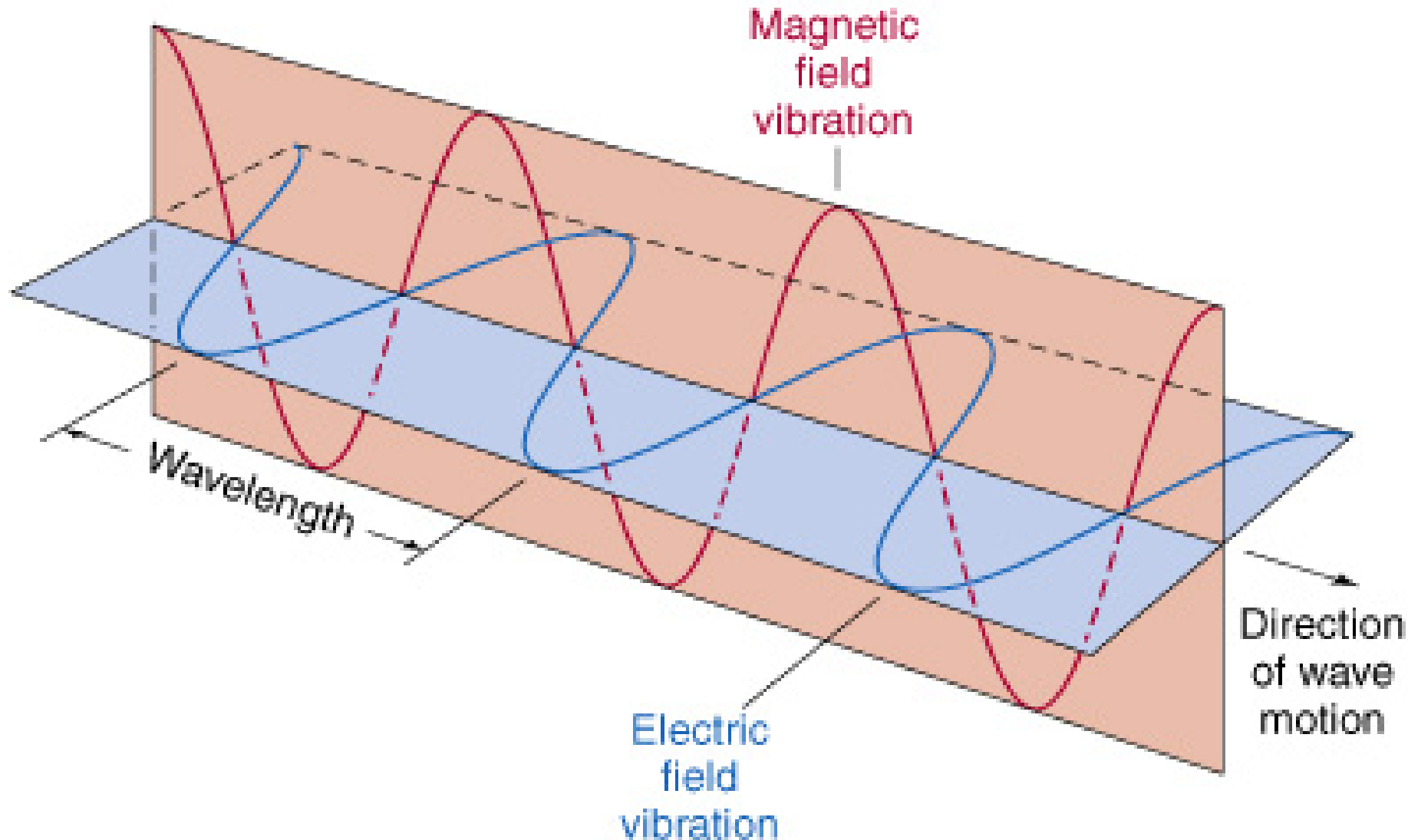
* The Universe contained Time, Space & Energy

The energy was
in the form of
electromagnetic
radiation
...light



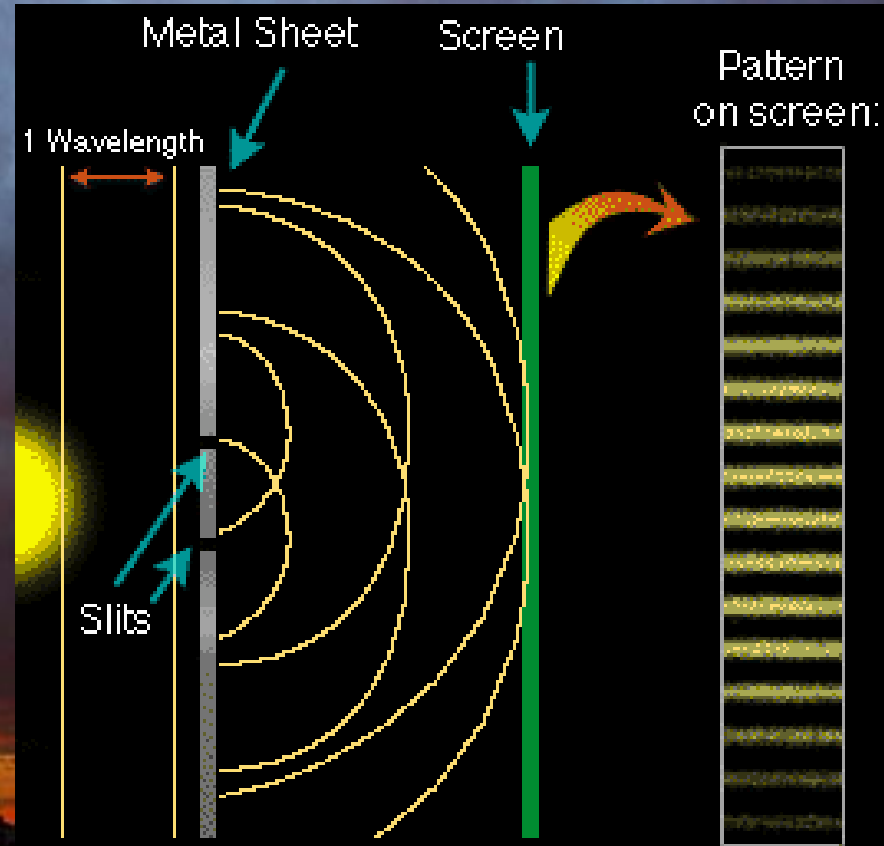
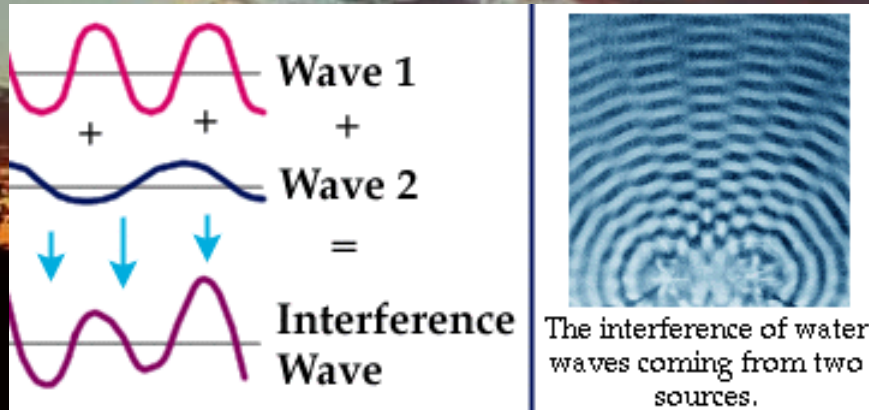
The Nature of Light

Light is an electromagnetic wave...



Light Acts As A Wave

Light shows interference
(addition of waves)
and diffraction
(bending around corners)
like water waves.



The light waves from the left pass through the slits; the waves from the two slits interfere with each other, forming a pattern (right image) on the screen.

But that's not ALL light is ...

Light Acts As A Particle

Light pushes dust out
of the solar system like
a stream of particles.

Ion tail shaped by
solar magnetic field.

Dust tail shaped by
sunlight pushing dust
away from the sun.



Wave-Particle Duality

Light is a wave **AND** a particle!

⊕ Exists as both natures ...

until it interacts with matter.

⊕ Manifests one nature

appropriate to the interaction.

⋃ Becomes a particle hitting comet dust.

⋃ Becomes a wave passing through a slit.

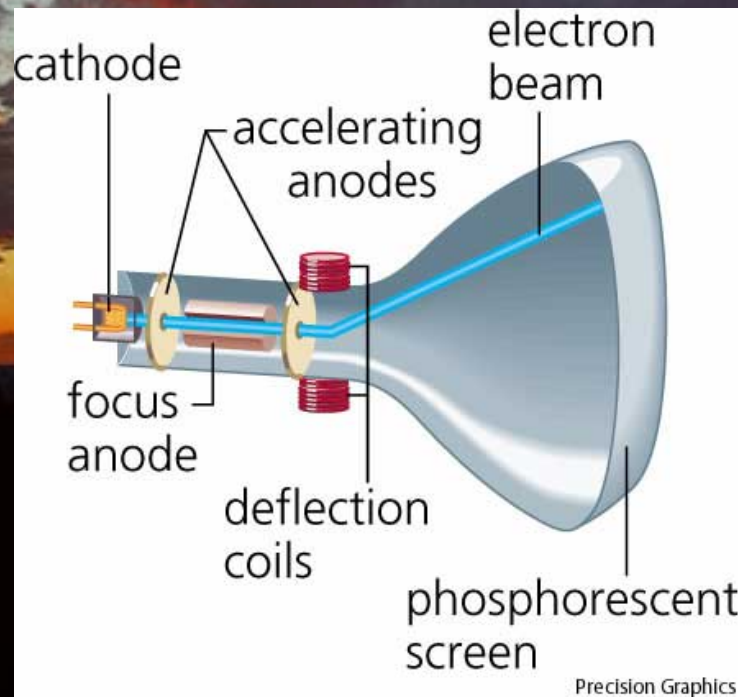
How can it be BOTH at ONCE?

We don't know ... but it is!

The Structure of Matter

☆ Electrons act like particles

- ⊕ sweeping e^- beam creates TV pictures
 - ⤵ e^- collide with phosphorescent molecules
 - ⤵ knock molecules into excited state
 - ⤵ light emitted when molecule falls to lower state



The Structure of Matter

☆ Electrons act like waves

🌐 Quantum Tunneling

⤵ Energy barrier

👉 reflects particles

👉 waves penetrate

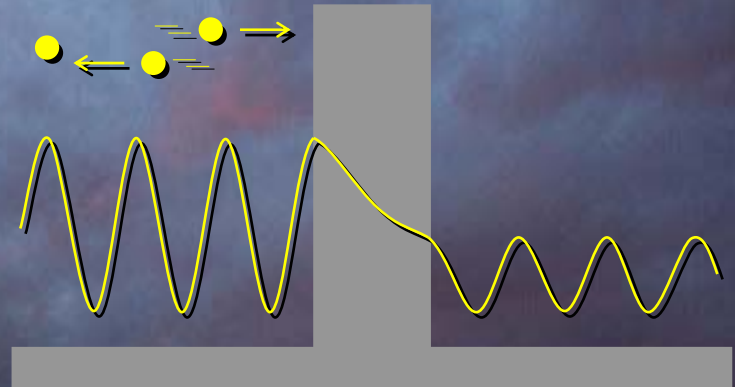
🐾 waves exist everywhere

... can find position beyond barrier

🐾 like oranges spontaneously
leaving fruit bowl

🐾 but oranges are too big!

... only subatomic particles do this!



Lower energy



The Structure of Matter

☆ Electrons act like waves

🌐 Quantum Tunneling

› Energy barrier

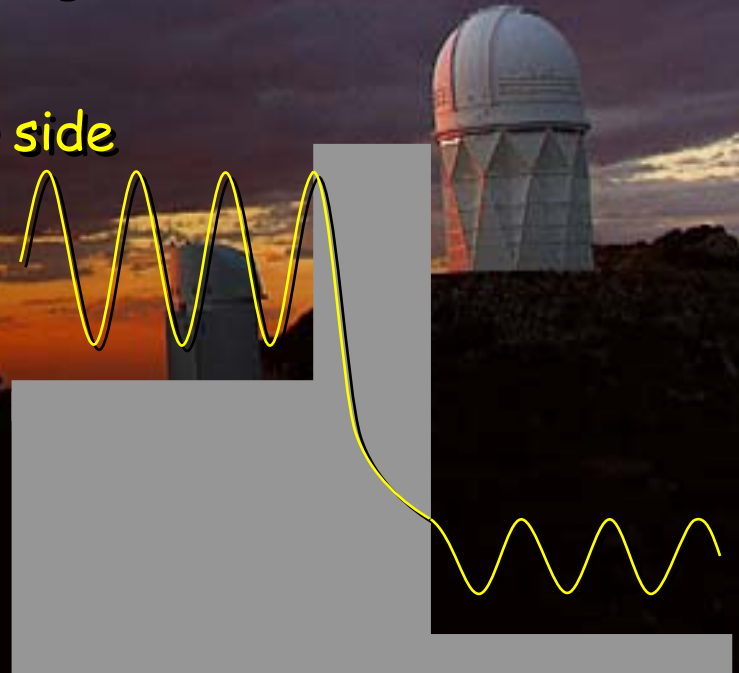
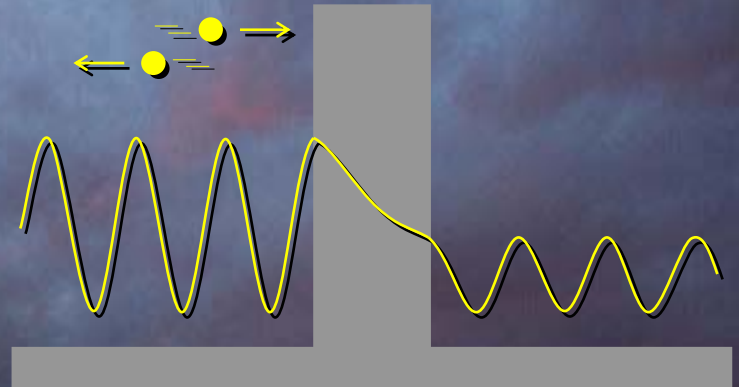
👉 reflects particles

👉 waves penetrate

🐼 like oranges spontaneously leaving fruit bowl

› Probability of tunneling

👉 increases for lower energy on far side



The Structure of Matter

☆ Flash Memory

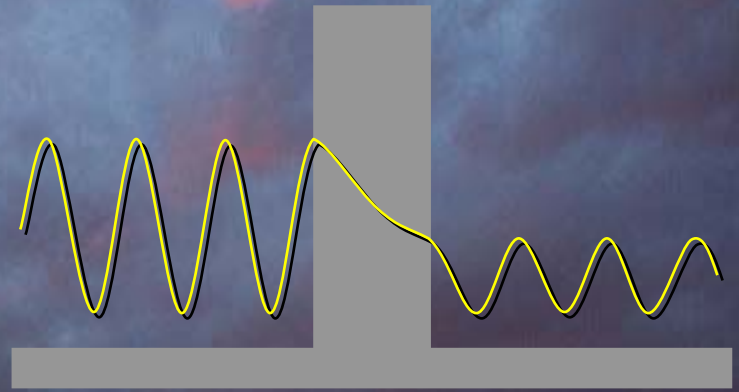
🌐 Storing (No Power)

› Both sides at same energy

☞ low probability of tunneling

☞ 67% (2/3) of charge will leak off in 100 years

(Prob. of any e^- tunneling $\sim 10^{-23}$)

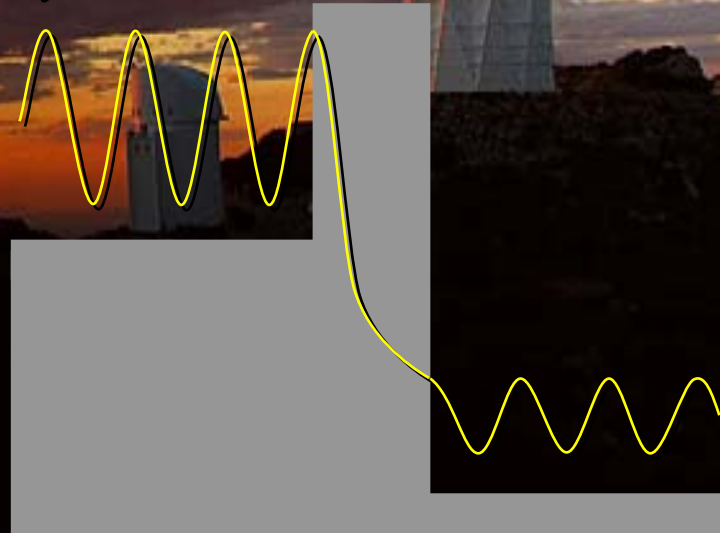


🌐 Writing/Erasing (With Power)

☞ increase probability of tunneling

☞ 67% (2/3) of charge will leak off in 10^{-6} seconds

(Prob. of any e^- tunneling $\sim 10^{-5}$)



Wave-Particle Duality

“The essential marvel of the divine milieu is the ease with which it assembles and harmonizes within itself qualities which appear to us to be contradictory.”

Teilhard de Chardin

The Divine Milieu

What does this say about God?

☆ What are God's wave & particle natures?

🌍 Imminence & Transcendence?

🌍 Christian personal God & Buddhist "no God"?

🌍 Loving & Non-interfering?

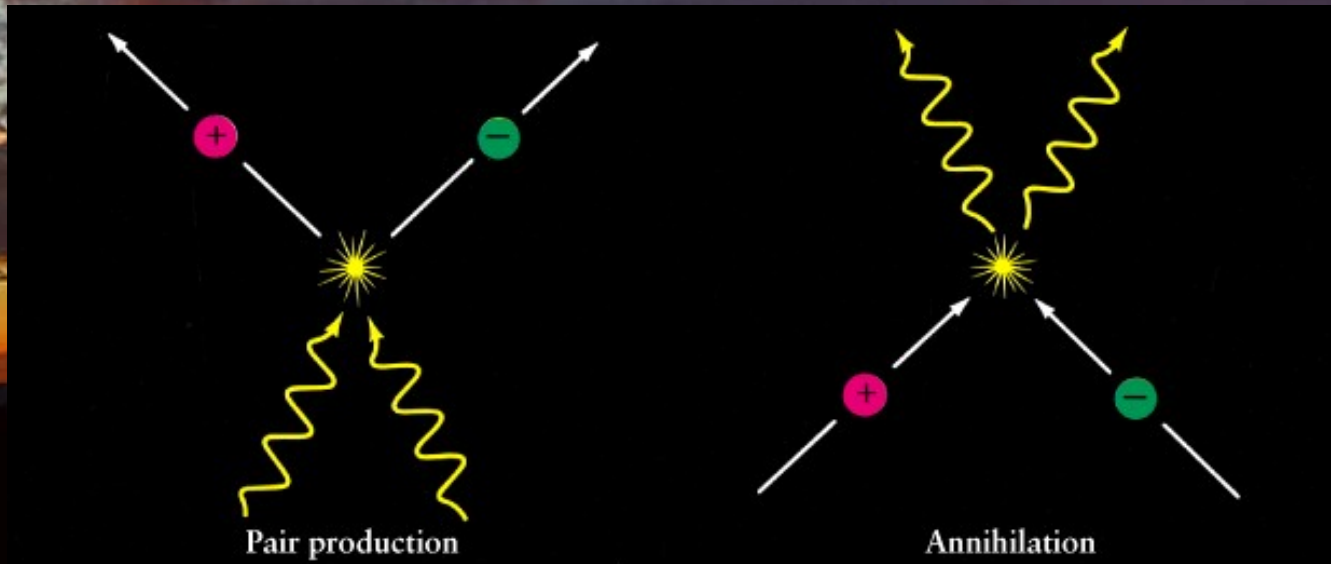
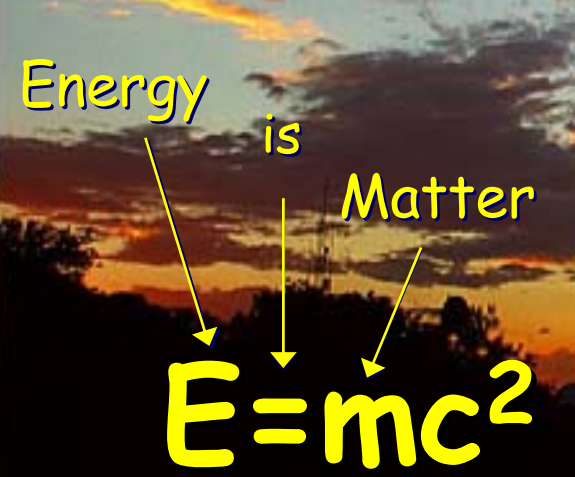
🌍 Can we even know?

... or must we rest in unknowing?

The Expansion of the Universe

- * The universe cooled as it expanded
 - * Particles "condensed" out of the light
 - * Light & Matter are the same stuff ...

All matter is frozen energy!



Light becomes
Particles ...

Particles become
Light

The Early Universe

- * Universe was a sea of light and particles
 - * Protons, neutrons, electrons ...
- * Universe was uniformly bright
 - * Light coming from reactions everywhere ...
 - * The universe was opaque

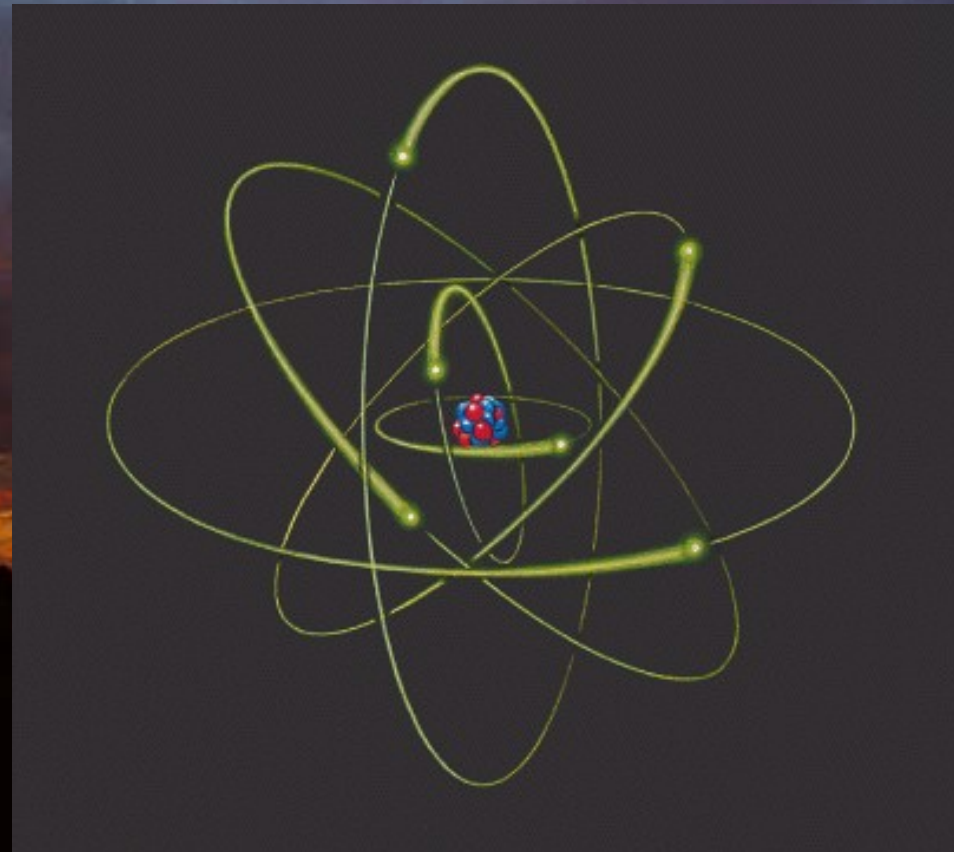
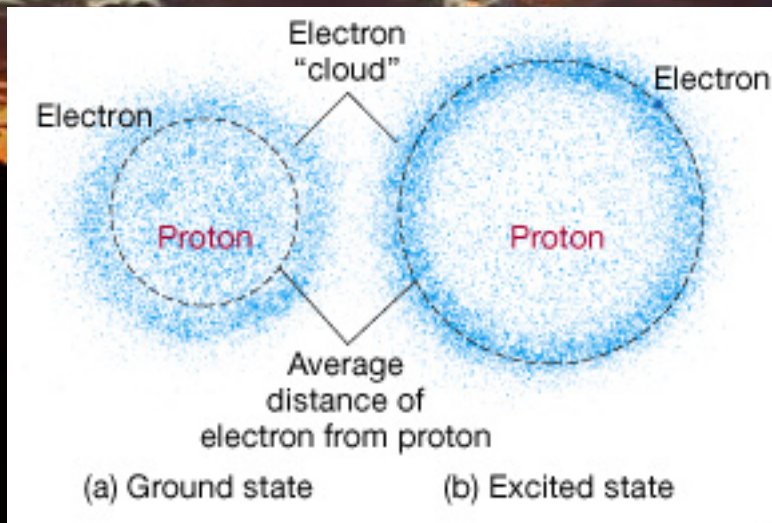
After a few hundred thousand years of cooling, atoms began to form ...

Atoms

* Nucleus of Protons (+) and Neutrons (0)

* Surrounding cloud of Electrons (-)

Electrons' "orbits" or
"clouds" determined
by their energy

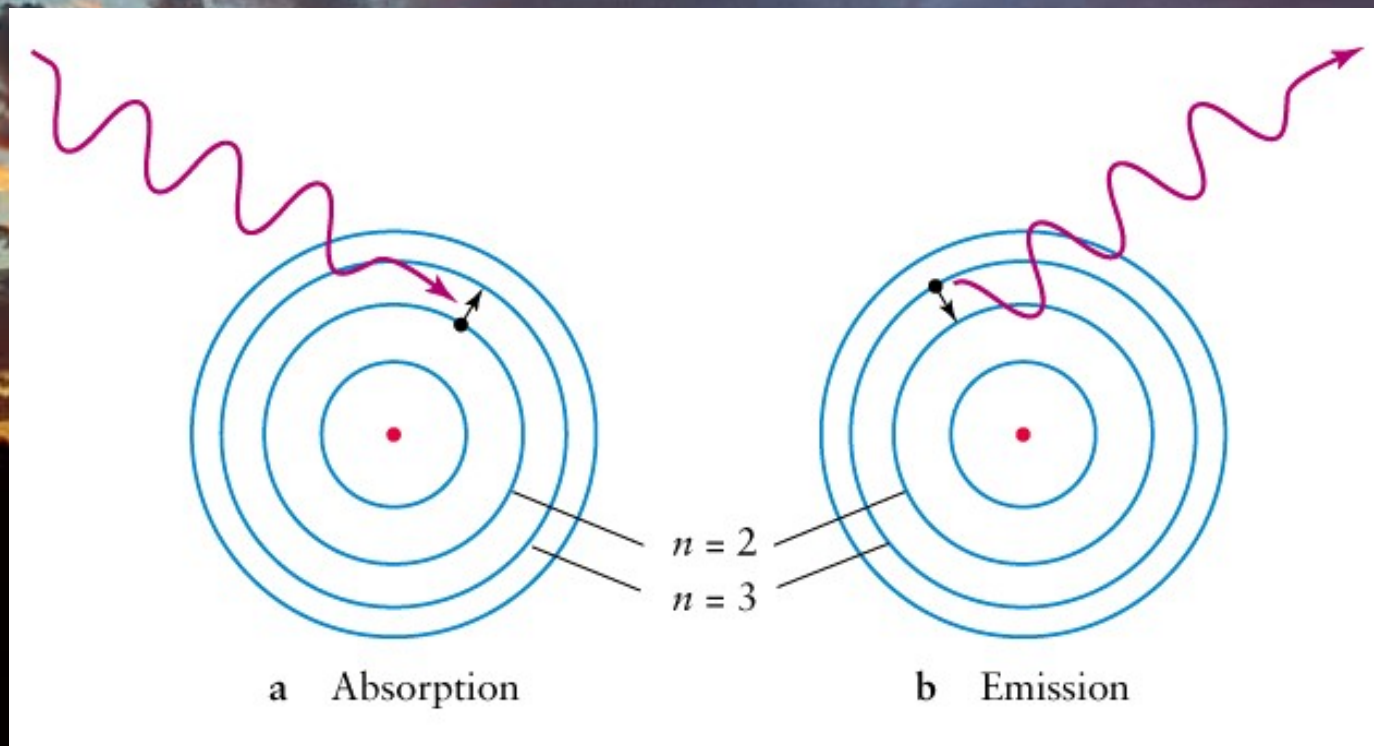


Atoms & Light

Atoms Absorb and Emit Light

- * To change electron energy

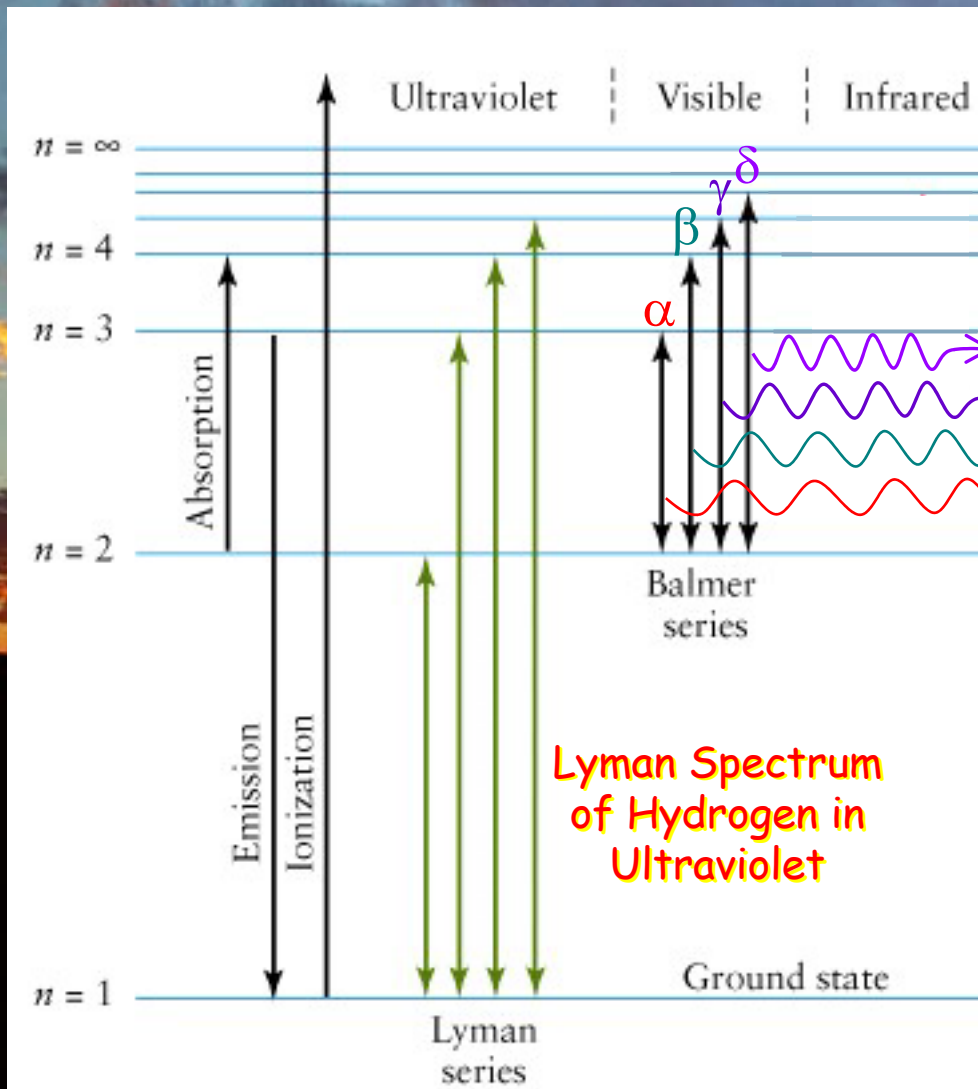
- * Light energy = energy change



Not all light can interact with every atom

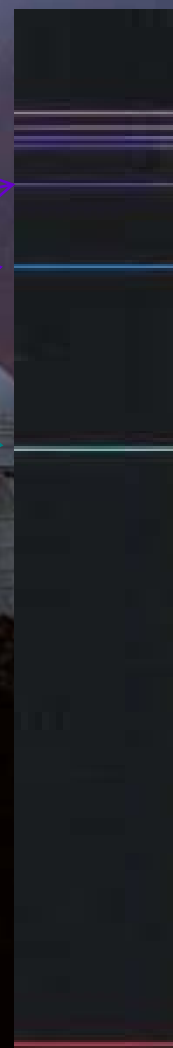
Atoms & Light

Each element emits & absorbs a unique spectrum



Balmer Spectrum of Hydrogen

Red in astronomical images is Balmer Alpha



The First Night

300,000 years after the Big Bang ...

Atoms of Hydrogen (75%) and Helium (25%)

- * Absorbed some light

- * Most light traveled freely without interacting with any matter.

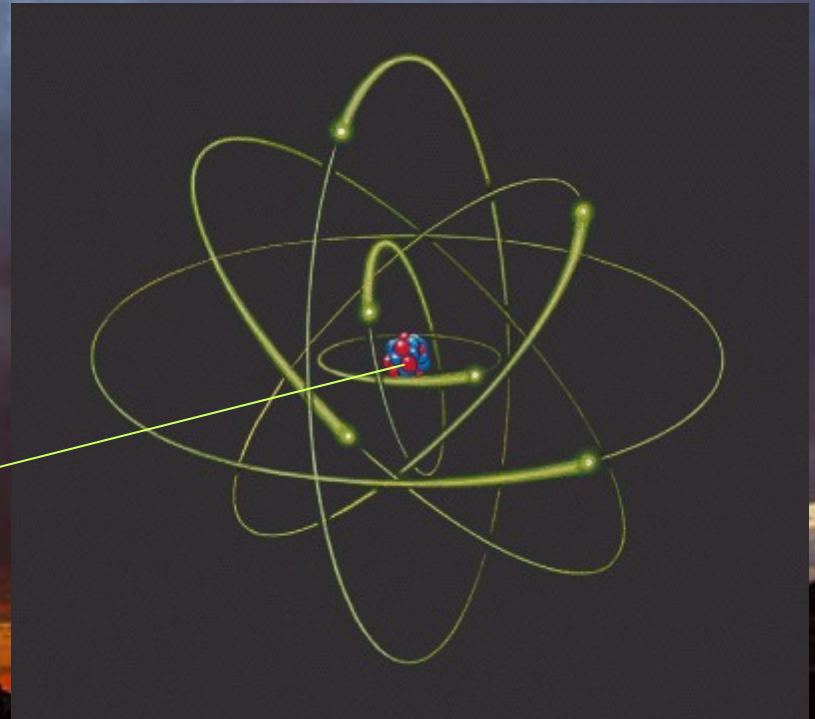
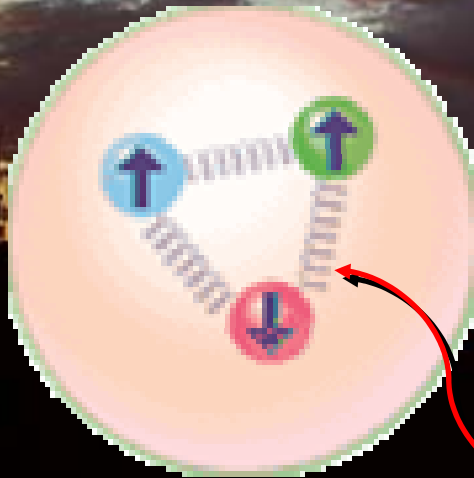
- * Universe became transparent

...darkness fell for the first time.

The Structure Of Matter

Matter at the Subatomic Scale

Protons & Neutrons in Nucleus are made of Quarks held together dynamically by the exchange of gluons.



Gluons are active, like springs.

Quarks: Fundamental Constituents of Matter

Quarks cannot exist alone

④ Carry $1/3$ of an electric charge

④ Decay if alone

④ Exist only in relationship to other quarks to create protons, neutrons, atoms,

... all matter

All matter, at its most fundamental level, must exist in relationship to exist at all!



Quark, quark!

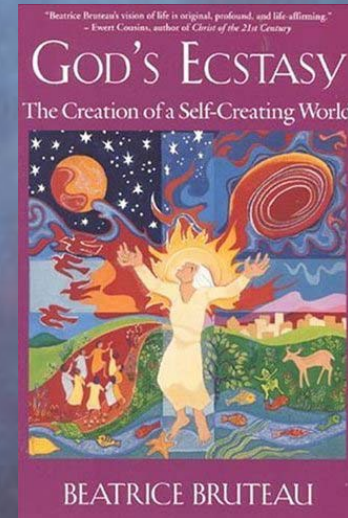
Beatrice Bruteau: God's Ecstasy

God Exists as "The One."

- Absolute,
- Infinite,
- Necessary to all other existence,
- Exists in every possible way of being ...

... must also exist as "The Many."

*God, the Ground of All
Being, must exist in
relationship to exist at all.*



God: The Ground of All Being

Beatrice Bruteau

*"Being is really Be-ing;
it is not really a noun but a verb. ...
To-exist is dynamic, not static."*

*"Dynamic be-ing means more-being,
being more. Endlessly more. Every
kind of "more."*

Being must be both one and many."

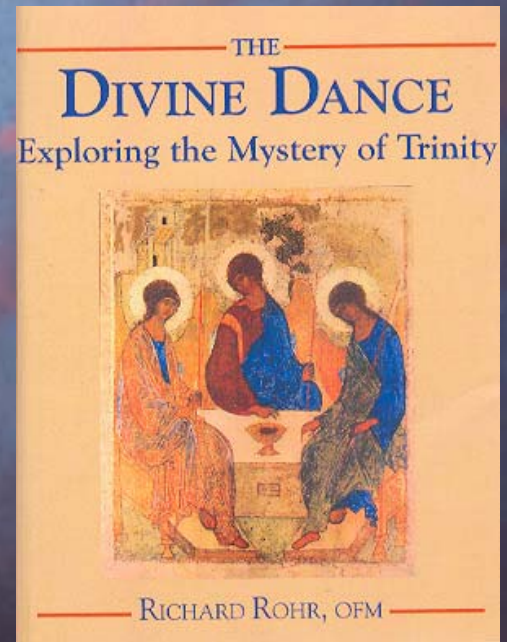
God's Ecstasy

Beatrice Bruteau

*"The Trinity is both one and many;
Being is present there as Persons;
the Persons are necessary and
infinite; the Persons are both
enstatic and ecstatic; and the
Persons are Being-communicating"*

The Universe is God's Ecstasy

Trinity



☆ Perichoresis = Dancing

🌐 Developed by "Eastern Fathers"

› Didymous the Blind (313-398)

› Basil the Great (329-379)

› Gregory of Nazianzus (325-389)

"Whatever is going on in God is a flow that's like a dance and God is not a dancer, God is the dance, itself."

- Richard Rohr

Perichoresis: Divine Dance

☆ Relationship is the theology of the Trinity

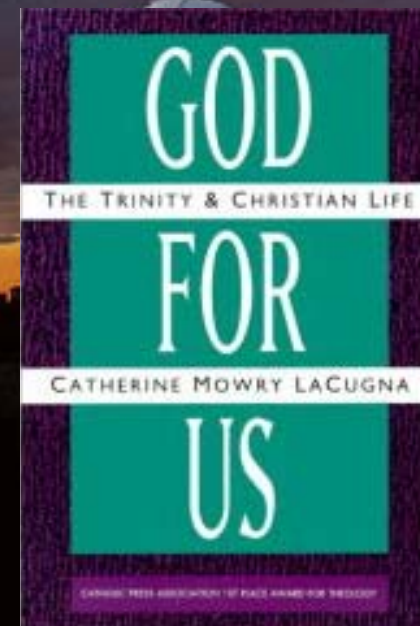
🌐 God for us - Father: Total Giving

🌐 God with us - Son invites us into the dance

🌐 God within us - Holy Spirit allows someone else to love through us - participation in God

“Whatever is happening in God cannot be just an inner, hidden secret. It has to be reflected in the outer universe”

- Catherine LaCugna



So what have we learned?

The universe dances.

God is the dance.

So dance!

My Dancing Day

☆ Traditional English Carol (c. 1400-1700)

Tomorrow shall be my dancing day,
I would my true love would so chance
To see the legend of my play,
To call my love to dance

In a manger laid and wrapped I was,
so very poor this was my chance.
Betwixt an ox and a silly poor ass
to call my true love to my dance.

Then was I born to a virgin pure.
From her I took fleshy substance.
Thus was I knit to human nature
To call my love to dance.

Then later on baptized I was.
The holy ghost on me did glance.
The Father's voice heard from
above, to call my love to dance.

Sing O my love, O my love, my love, my love, my love,
This have I done for my true love.