

Worldview guided by least action

The principle of least action:
*A difference in energy of any kind
will level off in the least time*



Pierre Louis Maupertuis (1698-1759)

*The action
among all conceivable changes in nature
is always at a minimum.*



Gottfried Wilhelm Leibniz (1646-1716)

*The optimal
among all conceivable worlds
is the actual.*



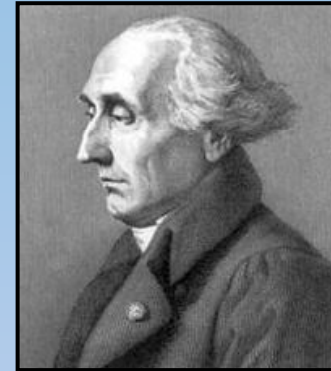
Maupertuis (1698-1759)



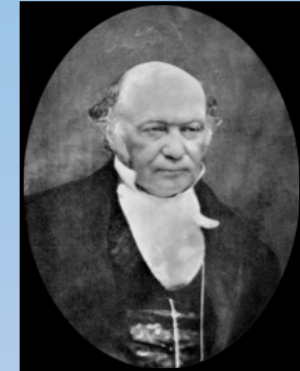
Leibniz (1646-1716)



Euler (1707-1783)

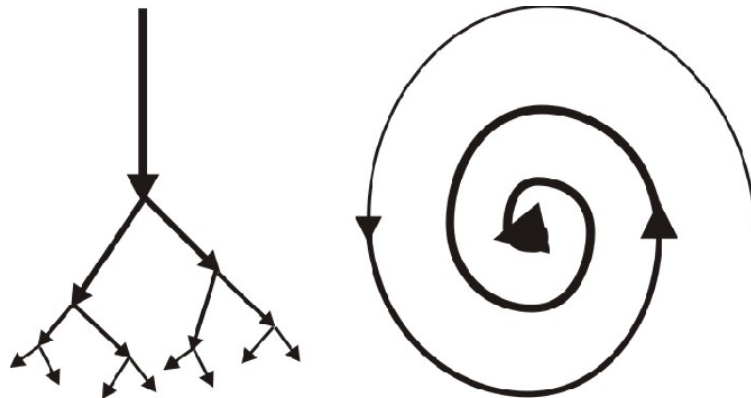


Lagrange (1736-1813)



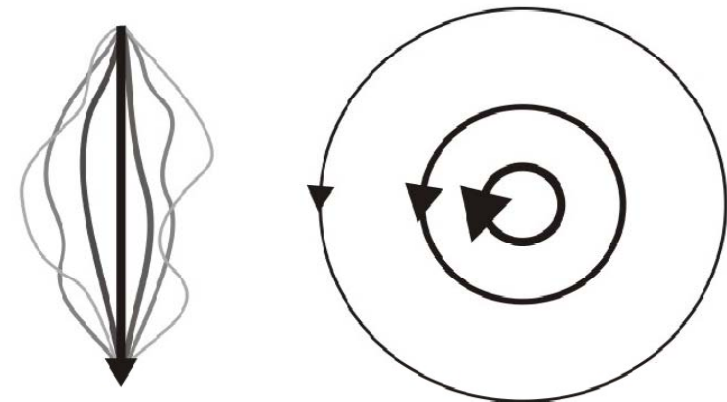
Hamilton (1805-1865)

Open and path-dependent processes



$$A = \int 2K dt = \int \mathbf{p} \cdot d\mathbf{x} = \int (-\mathbf{x} \cdot \nabla U + t \partial_t Q) dt$$

Closed and path-independent motions



$$A = \int_{t_1}^{t_2} L dt = \int_{t_1}^{t_2} (K - U) dt$$

The principle of least action

$$A = \int 2K dt = \int (-\mathbf{x} \cdot \nabla U + t \partial_t Q) dt$$

Fermat's principle: *Light takes the path of least time.*

Newton's 2nd law of motion

$$\mathbf{F} = \frac{d\mathbf{p}}{dt} = m\mathbf{a} + \mathbf{v} \frac{dm}{dt}; \quad dm = \frac{dE}{c^2} = \frac{dQ}{v^2}$$

A boby moves along the path of resultant force.

The 2nd law of thermodynamics

$$dS = \frac{dQ}{T}; \quad TS = 2K; \quad S = k_B \ln P$$

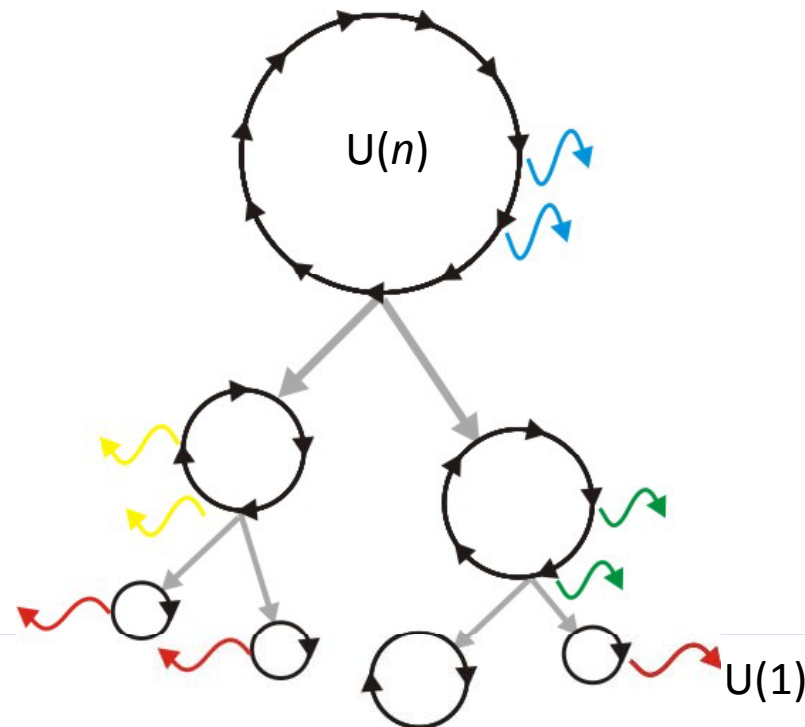
Heat flows along the path of least resistance.



Emmy Noether (1882-1935)

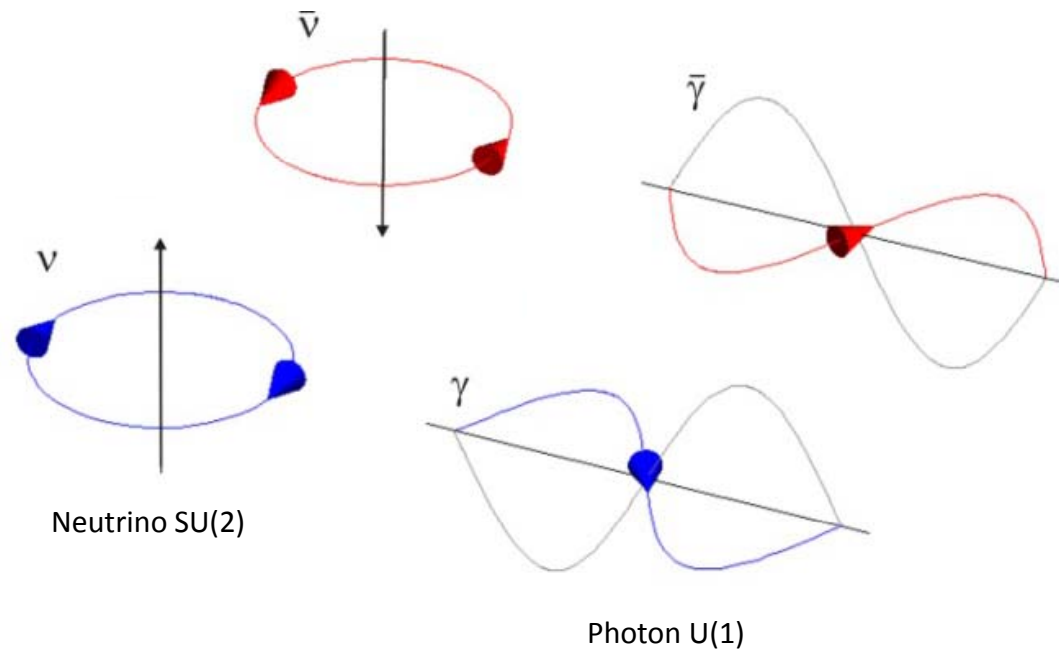
*Any differentiable symmetry of the action
of a physical system has
a corresponding conservation law.*

Nature evolves from one state to another
by consuming free energy
in spontaneous symmetry breaking processes.



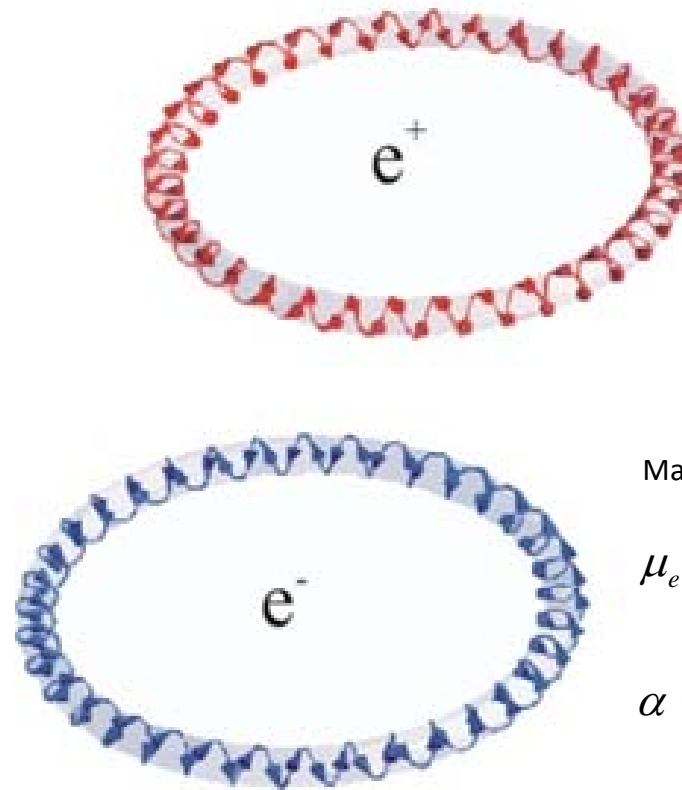
World in terms of actions

The absolutely least action



World in terms of actions

Electron and positron are least-action paths wound from multiples of the most elementary action.



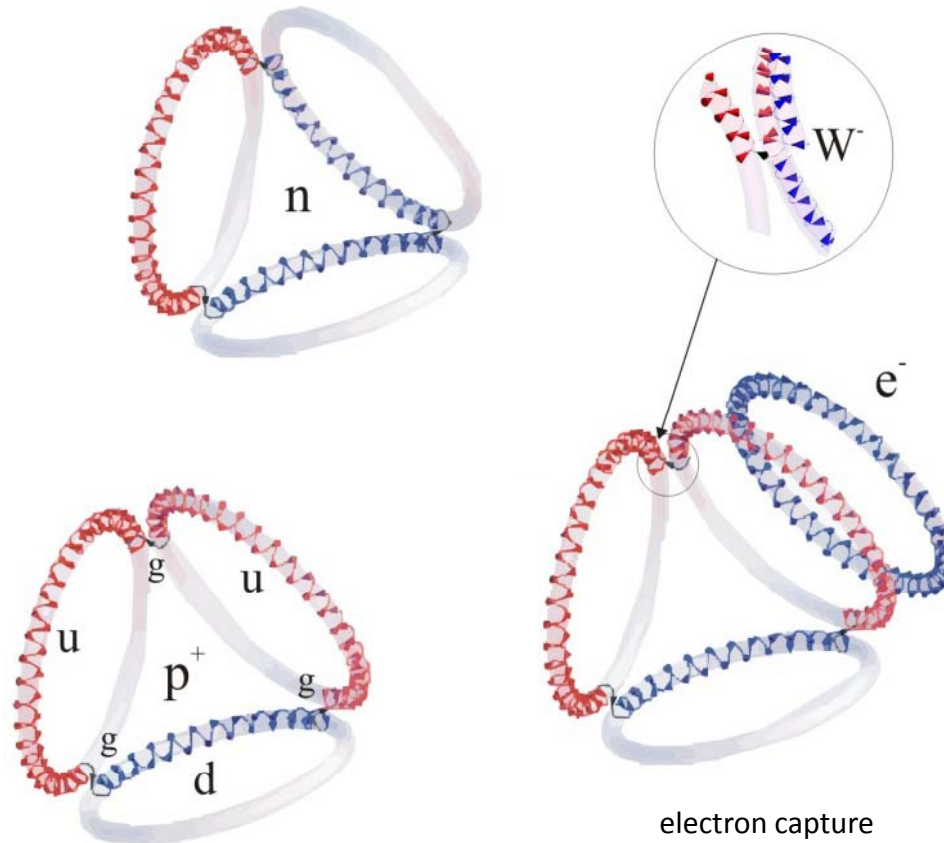
Magnetic moment

$$\mu_e = \frac{e\hbar}{m_e} + \frac{\alpha}{2\pi};$$

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \quad \text{Fine-structure constant}$$

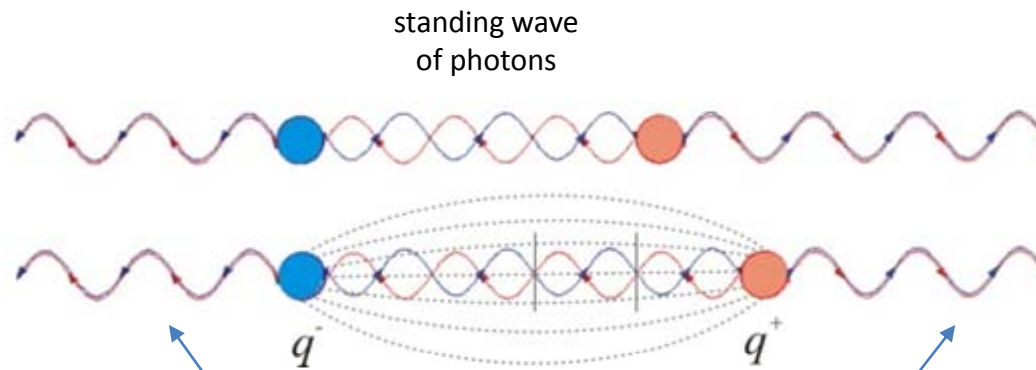
World in terms of actions

Proton (p) and neutron (n) are least-action paths
assembled from quarks and gluons
wound from multiples of the most elementary action.



World in terms of actions

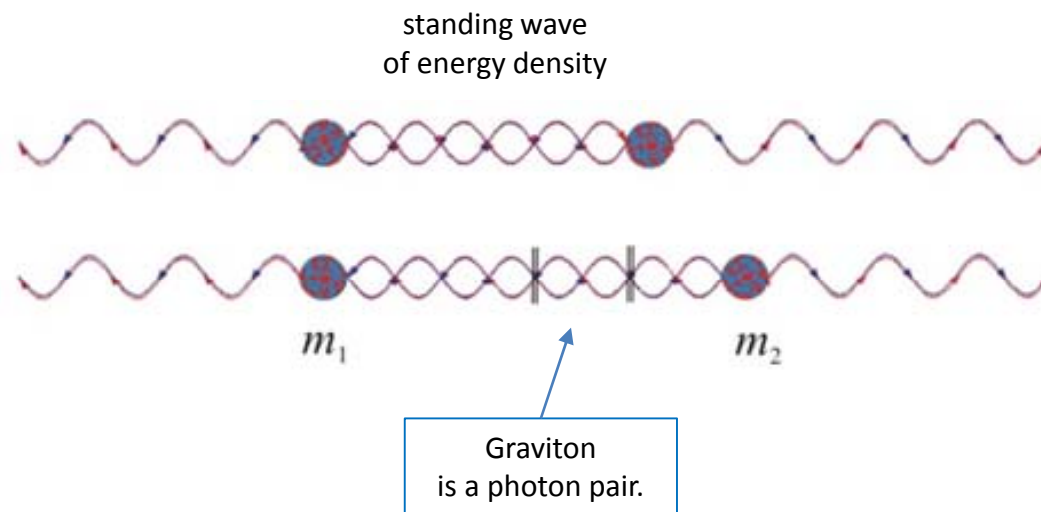
Coulomb force
as a difference in energy density



Along the dipole axis there is
no electromagnetic field but still
density of energy is finite.

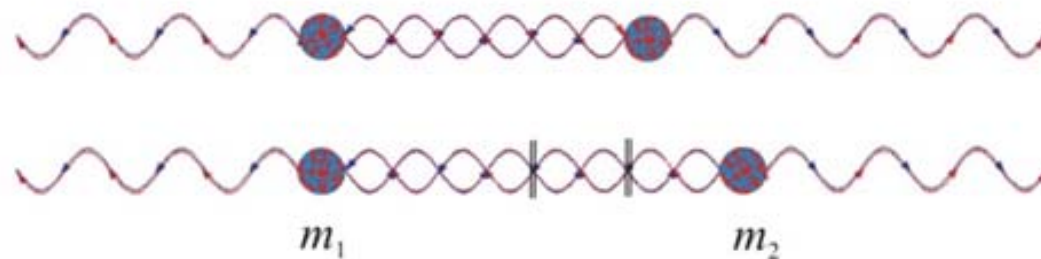
World in terms of actions

Gravity as a force
due to differences in energy densities

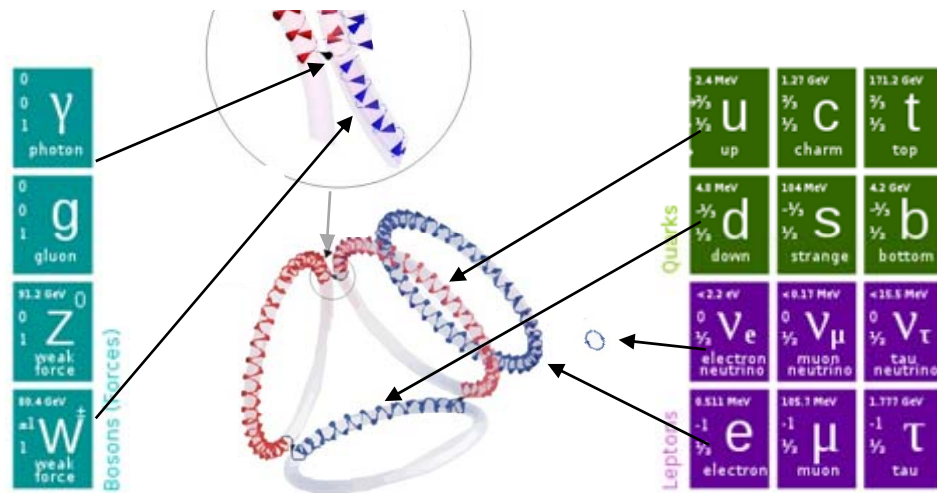


World in terms of actions

*No force is more fundamental than any other
but all are manifestations of energy density differences.*



*No particle is more fundamental than any other
but all are multiples of the absolutely least action.*



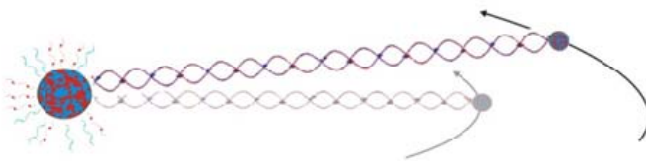
Particles of Standard Model are all composed of the most elementary actions in the ground and higher harmonic states.

S1. The Universe is expanding.

A1. The Universe is expanding, when bound forms of energy (mass) are transformed to free form of energy (radiation).

The action is at minimum when $d_t 2K = -\mathbf{v} \cdot \nabla U + \partial_t Q$
energy disperses in least time through spherical surfaces. $\square \rho(r), \Omega = 1$.

Stars, pulsar, black holes, galaxies etc.
make the machinery that transforms compactly
curved actions to sparse, straight actions.

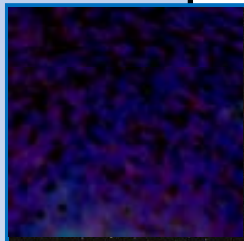
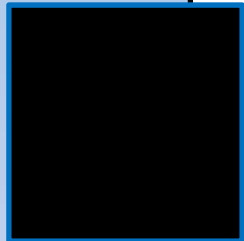
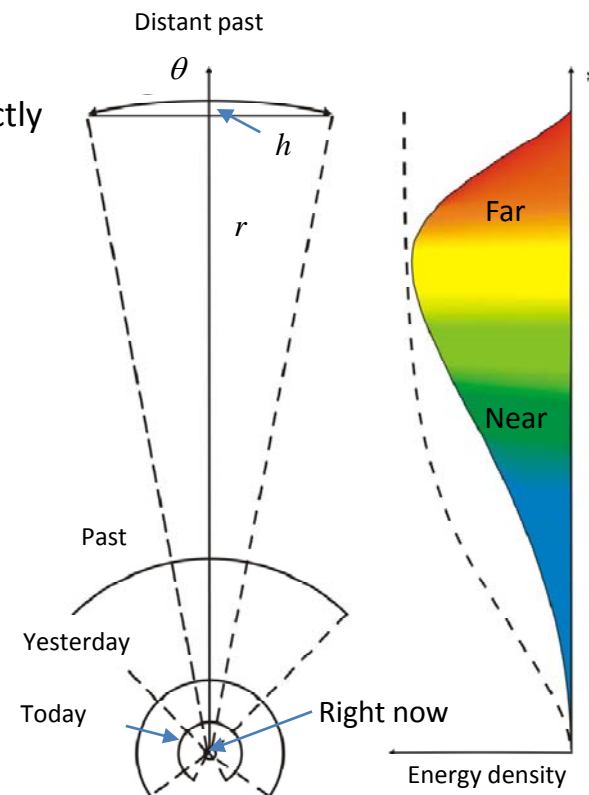


Mass of Universe within a sphere
and in a spherical cap are equal.

$$M = \int_0^R \rho 4\pi r^2 dr = \int_0^R \frac{1}{2\pi G t^2} 4\pi r^2 dr = \frac{2c^2 R}{G}$$

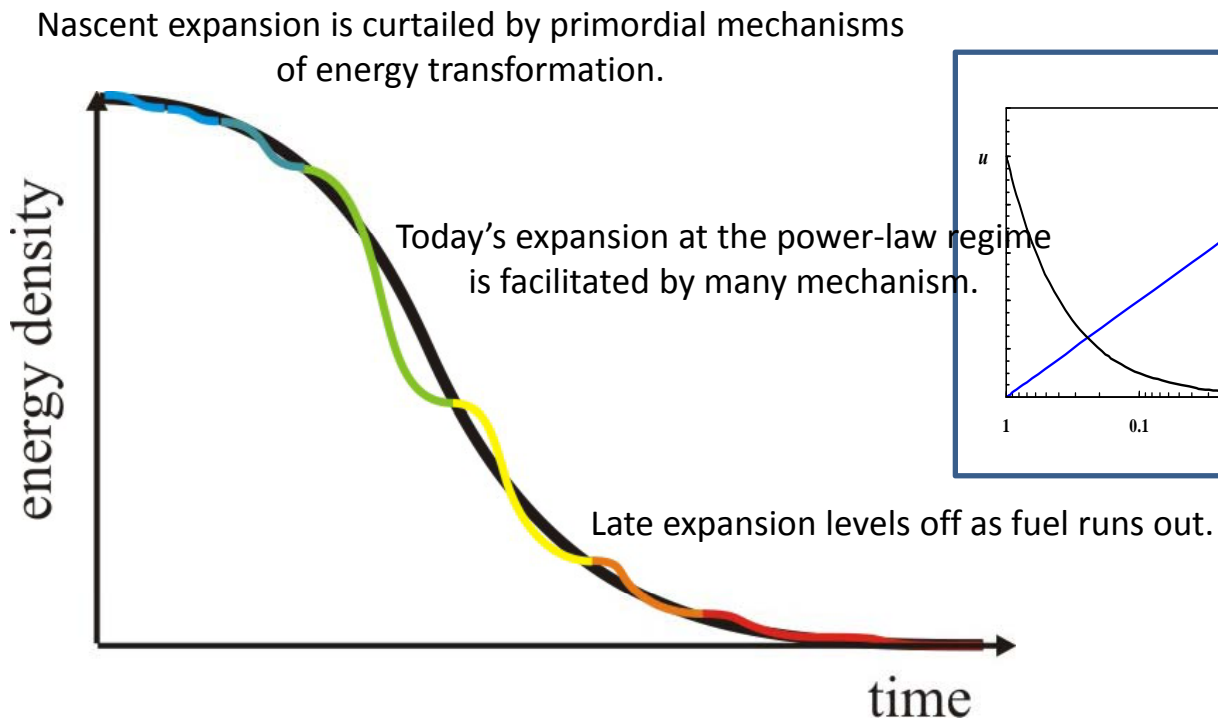
$$= \int_0^R \frac{1}{2\pi G} 4\pi r^2 \sin^2(\theta/4) dr.$$

Apparent size of a galaxy
is a monotonous function.



S2. The Universe is expanding at an increasing rate.

A2. Natural processes follow sigmoid curves when consuming skewed distributions of bound forms of energy.

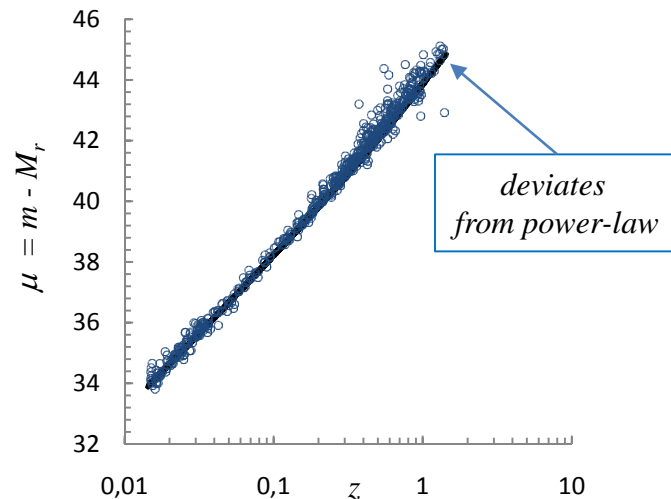


S3. Dark energy powers the increasing expansion.

A3. When mass transforms to photons, the balance is maintained by change in the kinetic energy, not by *ad hoc* dark energy.

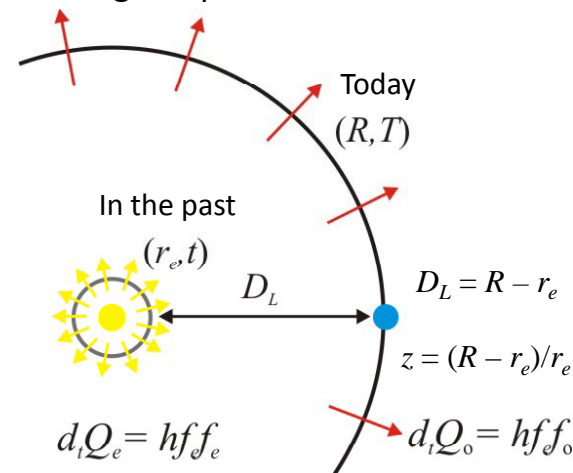
The action is at minimum when $d_t 2K = -\mathbf{v} \cdot \nabla U + \partial_t Q$

Type 1A supernovae data shows that brightness falls faster than light shifts red.



$$\mu = m - M_r = 5 \log \frac{R}{r_r} + 2.5 \log \left(\frac{z^2}{1+z} \right) \quad \text{take log} \quad \leftarrow$$

Flux of energy disperses in least time through a spherical shell.



$$\begin{aligned} F_o &= \frac{d_t Q_o}{4\pi D_L^2} = F_r \frac{d_t Q_o / 4\pi D_L^2}{d_t Q_r / 4\pi D_r^2} \cong F_r \frac{h f_e f_o r_r^2}{h f_e f_e D_L^2} \\ &= F_r \frac{1}{1+z} \frac{r_r^2}{R^2} \frac{(1+z)^2}{z^2} = F_r \frac{r_r^2}{R^2} \frac{1+z}{z^2} \end{aligned}$$

S4. Most of matter is dark.

A4. Galaxies bend light and rotate according to the least action not due to *ad hoc* dark matter.

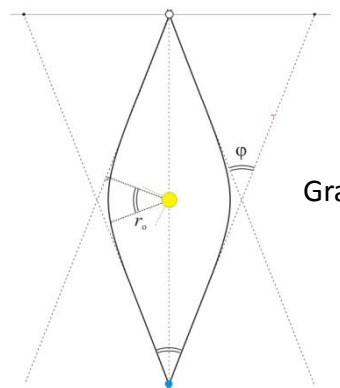
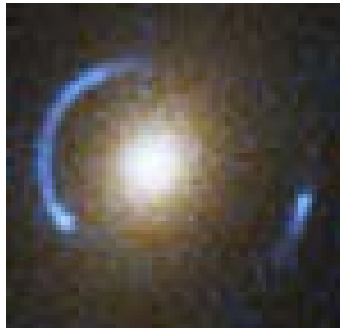
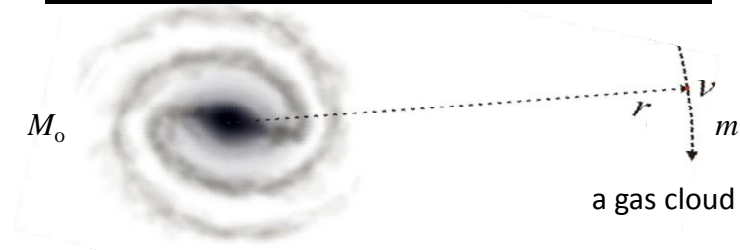
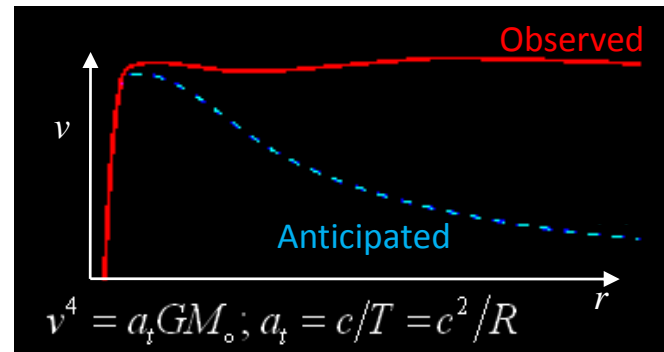


Image ring

Gravitational lens

The action is at minimum when

$$d_t L = \frac{hf}{c^2} r^2 \omega^2 = \frac{2\pi^2 GM_\odot}{c^2 r} hf = \phi hf$$



a gas cloud

The action is at minimum when

$$2K = -U \Leftrightarrow mv^2 = \frac{GmM_\odot}{r} \Rightarrow v^4 = a_t GM_\odot$$

$$\text{Universal acceleration } a_t = \frac{c^2}{R} = \frac{GM}{R^2} = \frac{v^2}{r}$$

Kepler's 2nd law

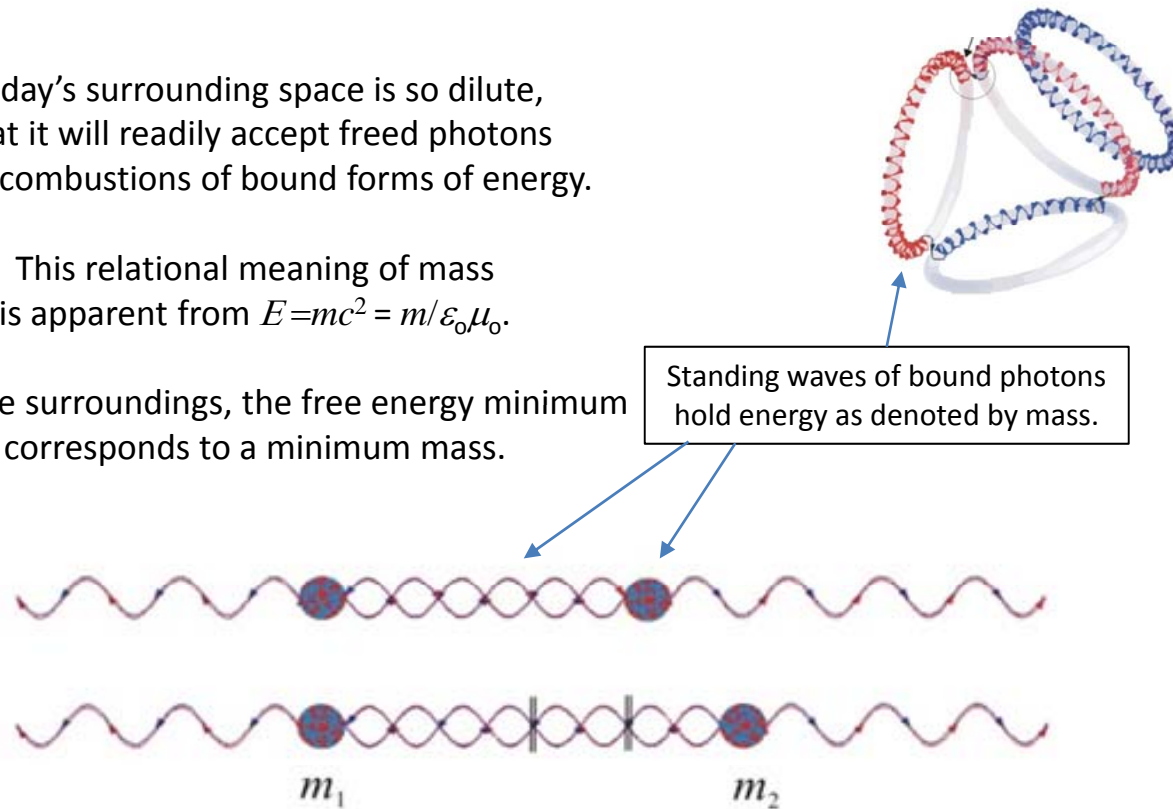
S5. Higgs field gives mass to particles.

A5. Since mass is a measure of energy in terms of photons that the surrounding free space may accept, it is not the Higgs field but the energy density of free space that assigns mass to particles.

Today's surrounding space is so dilute, that it will readily accept freed photons from combustions of bound forms of energy.

This relational meaning of mass is apparent from $E=mc^2 = m/\epsilon_0\mu_0$.

In sparse surroundings, the free energy minimum corresponds to a minimum mass.



What's wrong in general (relativity)?

No theory that cherishes symmetry, invariance, normalized probability, intact topology or any other conserved character is a representative of reality.

Reality is not simply static reversible dynamics but irrevocable changes that as flows of energy mould the energy landscape.



Obsession with computability confines physics to determinism – and when found impossible, incomprehensible indeterminism is invoked instead.



Observations, by the words of Pascual Jordan, not only disturb what is to be measured, they produce it.

There is nothing utterly unbearable with uncertainty since intractable processes are not random processes, but nature searches and naturally selects the paths of least time when equating differences in energy of any kind.

What is physics?

Physics, like any other discipline, is beguiled by upholding ambiguity in its most central concepts: space and time.

A flow of time is an open flow of energy that freed from a spatially-closed form of energy.

Physics in its deterministic and reductionist form is aversive to many – and for good reasons – as it is an incomplete explanation of nature.

However, as such there is nothing inherent in physics that would prevent physics from pursuing non-deterministic and holistic account of nature.