We and Universe: Before and after 2020

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We and Universe: The Nobel Prize in Physics 2011



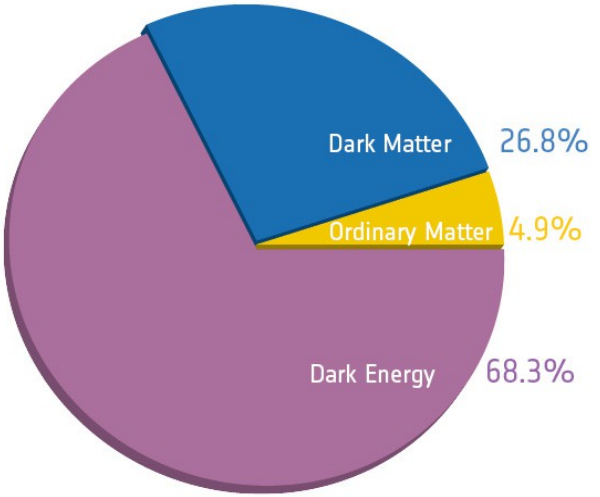
The Nobel Prize in Physics 2011 was divided, one half awarded to Saul Perlmutter, the other half jointly to Brian P. Schmidt and Adam G. Riess "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae."

What this give us?

Dark Energy, Modification of General Relativity etc

What we know?

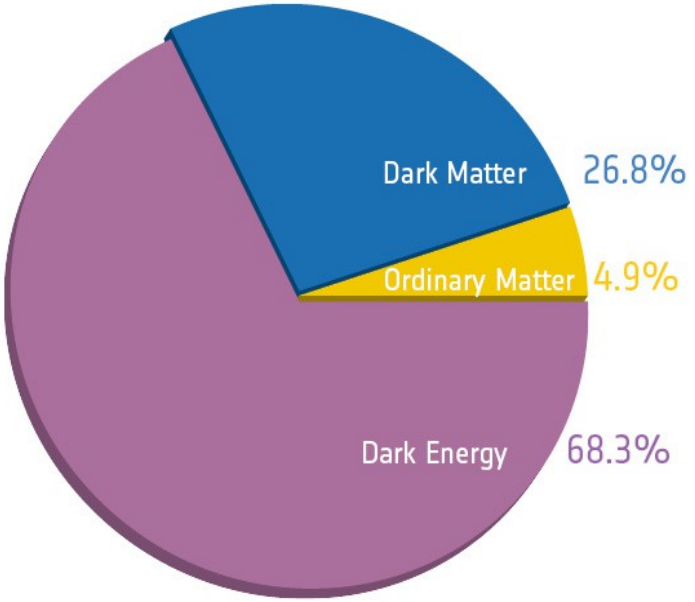
Still we are not certain what we know



The accelerated expansion is model independent result.

We and Universe: The Nobel Prize in Physics 2011 consequences

Large scale universe



Dark energy has enough negative pressure to work against gravity.

Models of dark energy – cosmological constant(the first dark energy model), varying cosmological constant models, quintessence, phantom, k-essence (scalar field representations), ghost dark energy, holographic dark energy (the energy density is parametrised), Chaplygin gas (dark energy and dark matter joint model with a non-linear EoS)…

Alternative approach

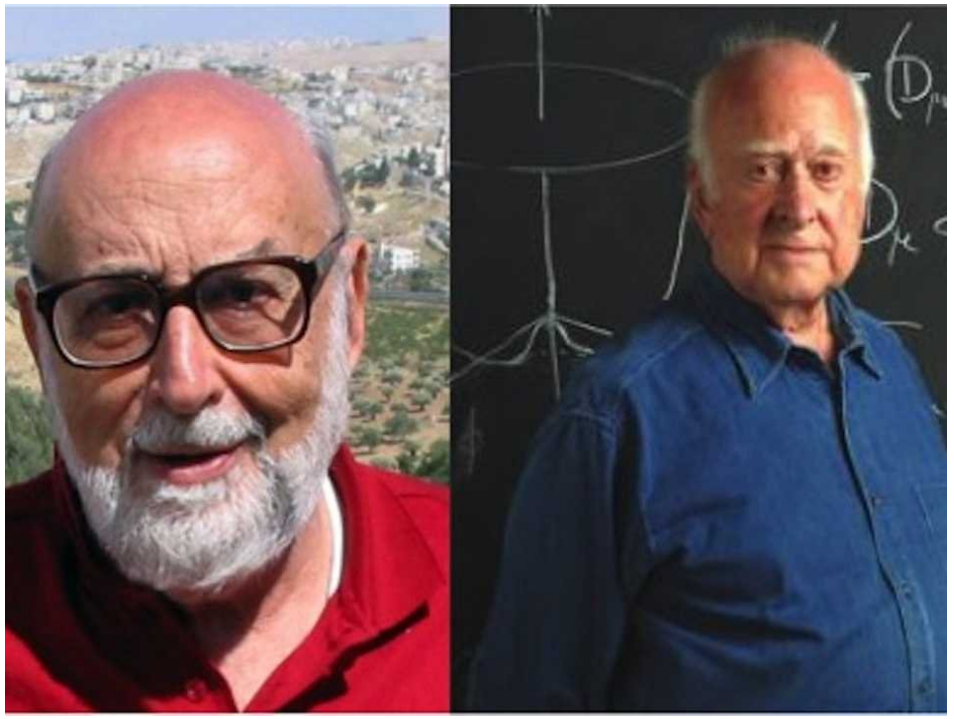
a modification of gravity

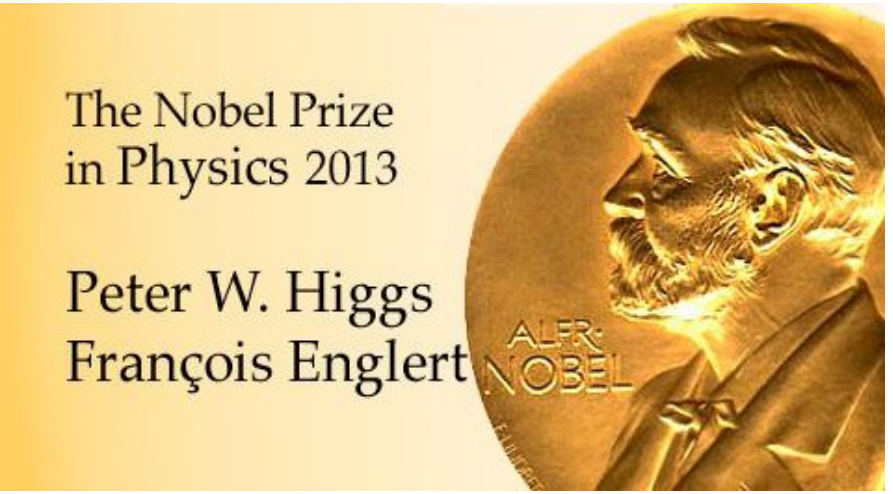
$$R_{ab} - \frac{1}{2}Rg_{ab} = \frac{8\pi G}{c^4}T_{ab}.$$

ALBERT EINSTEIN'S GENERAL THEORY OF RELATIVITY, 1916

The accelerated expansion is model independent result.

We and Universe: The Nobel Prize in Physics 2013



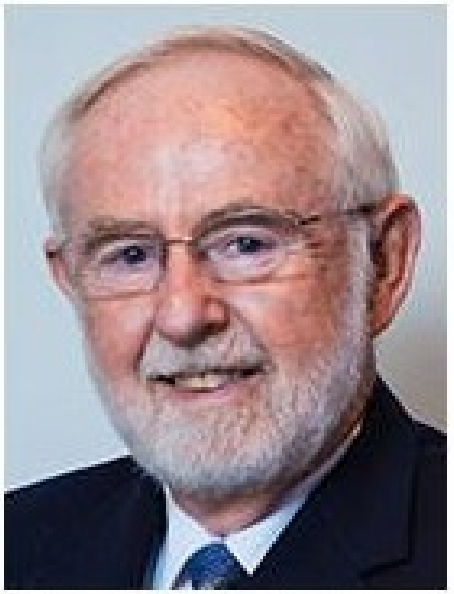


The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider."

Why we do not talk about other options?

It is very costly and the community works to unlock the dark matter problem.

We and Universe: The Nobel Prize in Physics 2015



The Nobel Prize in Physics 2015 was awarded jointly to Takaaki Kajita and Arthur B. McDonald "for the discovery of neutrino oscillations, which shows that neutrinos have mass."

A neutrino is a fermion that interacts only via the weak subatomic force and gravity. It is electrically neutral. The rest mass is so small that it thought to be zero.

The mass of the neutrino is much smaller than that of the other known elementary particles.

Neutrinos typically pass through normal matter unimpeded and undetected.

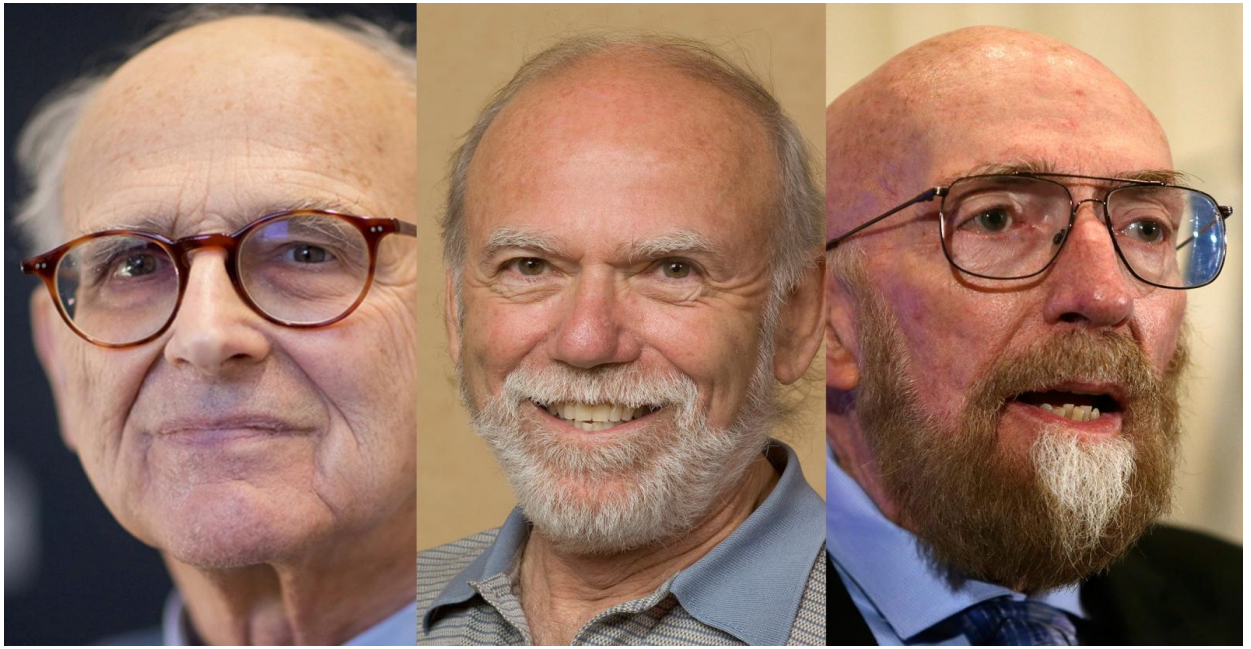
Scientific interest

Neutrinos are also useful for probing astrophysical sources beyond the Solar System.

Use of the neutrino is in the observation of supernovae, the explosions that end the lives of highly massive stars.

The rest mass of the neutrino is an important test of cosmological and astrophysical theories.

We and Universe: The Nobel Prize in Physics 2016 or GW150914



The Nobel Prize in Physics 2017 was divided, one half awarded to Rainer Weiss, the other half jointly to Barry C. Barish and Kip S. Thorne "for decisive contributions to the LIGO detector and the observation of gravitational waves."

Gravitational waves are disturbances in the curvature of spacetime.

Gravitational waves transport energy as gravitational radiation, a form of radiant energy similar to electromagnetic radiation.

Blackhole binaries emit gravitational waves during their in-spiral, merger, and ring-down phases. The largest amplitude of emission occurs during the merger phase.

We and Universe: The Nobel Prize in Physics 2019

The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos" with one half to James Peebles "for theoretical discoveries in physical cosmology", the other half jointly to Michel Mayor and Didier Queloz "for the discovery of an exoplanet orbiting a solar-type star."

James Peebles has major theoretical contributions to primordial nucleosynthesis, dark matter, the cosmic microwave background, and structure formation.

Big Bang nucleosynthesis is the production of nuclei other than those of the lightest isotope of hydrogen during the early phases of the Universe.

The CMB is electromagnetic radiation which is a remnant from an early stage of the Universe.

A hint that one of the next Nobel Prize will be for Inflation

We and Universe: The Nobel Prize in Physics 2020

The Nobel Prize in Physics 2020 was divided, one half awarded to Roger Penrose "for the discovery that black hole formation is a robust prediction of the general theory of relativity", the other half jointly to Reinhard Genzel and Andrea Ghez "for the discovery of a supermassive compact object at the center of our galaxy."

But what about other options?

What about other options?

What do we know about our Universe?

We practically certain about 4% of our Universe. We did not solve even the half of the problems

Why? Because probably we do not ask clever questions to get answers.

What do we know about structure formation?

Gravity helps to have structure formation.

BUT

When structure formation theories have been developed we did not know about Dark Energy (antigravity).

Now, what about the structure formation process when antigravity creates observable objects from very dense regions in our Universe?

We had such ideas however time was not correct to talk about it (see **Viktor Ambartsumian**)

We and Universe: After 2020

Can third generation

(2030s) Einstein Telescope
(2030s) Cosmic Explorer

and Space based

(2035) TianQin
(2030s?) Taiji (gravitational wave observatory)
(2027) Deci-hertz Interferometer Gravitational wave Observatory (DECIGO)
(2034) Laser Interferometer Space Antenna (Lisa Pathfinder, a development mission, was launched December 2015)

gravitational-wave detectors bring new knowledge?

What is the role of Machine Learning?

First we should understand what we have and what we want to do and then teach the machine to do the job

The Nobel Prize for Cosmic Inflation?

Probably yes

Thank You for Your attention

Those who have more specific questions or ideas and eventually wish to live a message can contact me at **khurshudyan@ice.csic.es**