**The Expansion of the Universe and the Waveguide Connection of Everyone with Everyone**

Vladimir Aksayskiy vladimir.aksayskiy@mail.ru

**Abstract**

Looking at the gravitational field line as a waveguide allows us to combine our knowledge of the behavior of the group and phase velocities of waves in waveguides with Kepler's laws. Maybe, they will bring us closer to a world where everyone is connected to everyone here and now.

**Text**

The idea of expansion of the visible Universe is used in some cosmological models of the world, for example, in the Big Bang model. Hubble's empirical rule, which is now given the status of a cosmological law, is considered proof of the reality of expansion. According to Hubble's law, all galaxies scatter and move away from each other at a speed proportional to the distance from the observer.

The reasons for the expansion of the universe are widely discussed among curious people.

However, it seems equally important and interesting to discuss the consequences of the expansion of the universe.

It is alarming that gravity is unable to keep galaxies from drifting apart. It is necessary to identify the cause as soon as possible - I will call it anti-gravity - because the galaxies are running away with acceleration - and try to use it in their anthropic interests.

Otherwise, we will have to say goodbye to the dream of contacts with other galaxies, which are now running away from our galaxy - and our galaxy from them - at a speed proportional to the Doppler redshift of the lines in their spectra.

A world where everything is farther and farther from everyone does not seem attractive.

And one more thing, - the postulates of general relativity limit the scope of the Hubble law with a radius of $c/H_0=1.44\cdot10^{10}$ ly, - the speed of light cannot be surpassed by galaxies, - so if we sit with our hands folded, then in the unattainable limit we will face a very heavy world of universal self-isolation. In the expression for the radius, c=speed_of_light=$2.998\cdot10^{8}$ m/s, $H_0$=Hubble_constant=$2.2\cdot10^{-18}$ Hz, ly=light_year=$9.461\cdot10^{15}$ m.

To many inquisitive people, the Doppler interpretation of redshift does not seem to be the only one.

One of them asked to explain - how to take into account the change in the course of time due to the expansion of the universe? - after all, in his understanding, in a more compact universe, gravity will be different, and this should affect time and, of course, the red and blue shifts.

It seems that he marked a serious gap in experimental physics, since we have to state:

- in real physical measurements they are not taken into account in any way.
- in theories, such as thermodynamics, general relativity ... is not taken into account in any way - there is no time in them. In the 4-metric, time is hidden in a timelike interval, which is treated as if it were spatial.

This is not objectionable - it has the dimension of length [c*t]=[(m/s)*s]=[m].

If you wish, you can add another timelike interval [$a$*$t^2$]=[($m/s^2$)*$s^2$]=[m], here $a$ is the acceleration of the expansion of the Universe.

- in the known dynamic models of the various stages of the expansion of the Universe - they do not take into account in any way, - perhaps because no one knows how to measure the change in the course of time, i.e. derivative of time with respect to time.

The "change in the course of time" in the evolution of the Universe may be related to the time derivative of frequency $df/dt=10^4$ $s^{-2}$ in a single, simple-looking, but surprisingly original formula in the famous article by B.P. Abbott et 1119 al.

https://arxiv.org/ftp/arxiv/papers/1602/1602.03837.pdf

A well-known scientist - who wished to remain anonymous - asked: "Does this mean that a gravitational wave (GW) propagates with a variable frequency, feeling the expansion of the Universe during its propagation?". I suppose he has several answers - well, or physical analogies.
The following images with changing curvature immediately surfaced in my memory:
- source and receiver of surface acoustic waves on an inflating balloon,
- a waveguide with a variable cross section.
According to my feelings, the question of "change in the course of time" in the evolution of the Universe deserves attention - you just need to learn how to define this "change". It looks like we'll have to come up with a way to measure the derivative of time - for example, by information. Information is the same attribute of our discrete world as space and time - and yet we have learned how to measure them quantitatively.
On the topic of the waveguide: I like the view of the gravitational field line as a waveguide. It allows us to combine our knowledge of the behavior of the group and phase velocities of waves in waveguides with Kepler's laws.
In any waveguide - acoustic, electromagnetic, gravitational ... - the group velocity is the velocity of wave energy transfer, and the phase velocity is the transfer rate of information about them. Their product is a constant for a given wave type, and their ratio is determined by the parameters of the waveguide, - moreover, the phase $v_{ph}$ is greater than the group $v_{gr}$, - information is transmitted faster than energy.
$c^2=v_{gr}\cdot v_{ph}=const$
$v_{ph} > v_{gr}$
The GW phase velocity in the gravitational waveguide of a celestial body can be estimated from the formula:
$v_{ph}=g\cdot t$, here g is the free fall acceleration, t is the period, the time of its revolution in the Keplerian orbit around the central body.
For the Earth around the Sun:
$v_{ph}=g\cdot t= (9.8\ m/s^2)\cdot(1\ yr)=3.1\cdot10^8\ m/s$,
it is slightly faster than the speed of light.
For the Sun around the core of our galaxy:
$v_{ph}=g\cdot t= (274.1\ m/s^2)\cdot(240\cdot10^6\ yr)=2.1\cdot10^{18}\ m/s$,
it is much greater than the speed of light - and perhaps even more than the above estimate - because the gravitational acceleration for the Sun is a calculated value obtained using the apparent diameter of the Sun, its halo of luminescence, which, it is possible, exceeds the real one by at least 2 orders.
In the history of European civilization, Roger Boscovich is considered the first propagandist of the idea of a physical line of force - then his follower, Mikhail Faraday, picked it up and applied it in experiments. Since then and until now, the idea lives and develops in various guises - it can be seen even in superstrings and the metagalaxy as a neural network.
The phenomenon of increasing the phase velocity of waves in a waveguide has long been used in technology, for example, for the development of acoustic and electromagnetic lenses, in particular centimeter-range lenses - so it seems that gravitational ones are not far off.
Hopefully, they will bring us closer to a world where everyone is connected to everyone here and now.

Briefly and popularly about the phenomenon of increasing the phase velocity in the waveguide - in the book Kock W.E. Sound Waves and Light Waves (1965) or on pages 80-82 in the book - Kock W. Sound and light waves. 1966 (russian).
http://techlibrary.ru/