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Spectral shift caused by the Coriolis force

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Abstract

The influence of the Coriolis inertial force, generated by orbital and spin motions of distant objects, on the energies of electromagnetic radiation during the exchange of photons between them is shown. The presence of a red or blue spectral shift arising from this influence has been demonstrated, which is fully consistent with the registered data measured from the spectral observations of the stars and galaxies. Using the dependencies derived in the article, the orbital velocities, angular velocities and spectral offsets for 18 randomly selected nearby stars from our galaxy were calculated, as well as the orbital velocities, angular velocities and spectral offsets of 31 randomly selected galaxies from the visible universe. The explanation of spectral shifts accepted in astrophysics with the Doppler effect implies the moving away or approaching of the light sources, which leads to the assumption of the expansion of the universe, while the influence of the Coriolis force discussed in the article gives the same results in the spectral shifts without the need for this assumption.

Keywords: Observer, stars, galaxies, Mega galaxy, Doppler effect, inertial forces, Coriolis force, non-inertial coordinate system photons, photon energy, redshift, blue shift, Hubble's law.

I. Introduction

In the macroscale visible Universe, galaxies are distributed uniformly and isotopically in all directions. Their diameter is between $3x10^4$ ly and $2x10^5$ ly, and the distances between them are of the order of $3x10^6$ ly. They consist of billions of stars and, due to their gravitational connectivity, are distributed into clusters and superclusters[1]. It is assumed that the universe had a definite origin in time and that since then space has been expanding[2] and continues to expand at an increasing rate[3].

The nearest group of galaxies is the Local Group of galaxies, which also includes the Milky Way. It has a total diameter of approximately $8.7x10^4$ ly [4] and a total mass of the order of 2×10^{12} solar masses[5]. It consists of two collections of galaxies. The Milky Way and its moons form one part, and the Andromeda galaxy and its moons make up the other[6]. The observation is made from the Solar System, which according to the most recent data is located 7.9 ±0.9 Kpc from the galactic center of the Milky Way. The group itself is part of the larger Virgo supercluster, which is part of the Laniakea supercluster. All observable galaxies together are called Our Mega galaxy. Its size is determined by the gravitational Schwarzschild radius[7, 8]. In astronomy and cosmology, the observed spectral shift is associated with the Doppler effect, whereby when moving light sources move away, a spectral redshift is observed, and when they move closer, a spectral blue shift is observed[9,10]. Also these spectral shifts also occur with the expansion of space itself, which causes objects to move away without changing their positions. All sufficiently distant light sources show a redshift corresponding to Hubble's law of receding. In strong gravitational fields, the gravitational red spectral shift is also observed due to relativistic effects that distort space-time[11, 12, 13].

In this paper, we will show the existence of another independent root cause of red and blue spectral shifts. With it, the spectral shifts are not related to objects approaching or moving away from each other.

II. Doppler spectral shift and Hubble's law

Stars in each galaxy have dark absorption lines corresponding to the elements in their atmospheres. The spectral feature usually has an absorption line of hydrogen, calcium or magnesium. For example, for hydrogen-alpha (Hα), the stationary source line is located at exactly 656.28 nm. However, a red or blue shift of the spectral lines in the spectrum is observed. This offset is defined as:

$$z = \frac{\Delta\lambda}{\lambda_0} \qquad (1)$$

In that $\Delta\lambda = \lambda - \lambda_0$, where λ is the observed wavelength and λ_0 is the wavelength of the same spectral feature observed in a gas in the laboratory.

When $\Delta\lambda$ is a positive number we have a red spectral shift, and when $\Delta\lambda$ is a negative number we have a blue shift.

The accepted explanation is that the galaxy has a velocity component towards us or away from us, and the spectrum of the galaxy will be Doppler shifted due to the motion[14, 15, 16, 17, 18].

For this according to the Doppler effect:

$$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c} \qquad (2)$$

where v is relative velocity of the light source from us and c is the speed of light, i.e.

$$z = \frac{v}{c} \qquad (3)$$

This equation is only valid for describing a spectral shift when the recession velocity v is much smaller than the speed of light c.

According to Hubble and Humason, the greater the distance of a galaxy from us, the greater the redshift of its spectral lines. If the redshift is due to a relative velocity between the galaxy and us, it shows that the farther away a galaxy is, the faster it is moving away from us. This is known as Hubble's law

$$v = H_0\, d \qquad (4)$$

where v is the relative velocity of the galaxy in km/s, d is the distance to the galaxy in Mpc, and H_0 is the Hubble constant, accepted today as 70 km/s/Mpc.

The fact that all galaxies appear to be moving away from us suggests that the universe is expanding uniformly and that the distance between all galaxies is increasing everywhere.

A typical velocity measurement for a galaxy might be, for example, 12540 ± 120 km/s, which according to (3) corresponds to a redshift $z = v/c = 12540/3x10^5 = 0.0418$. The velocity inaccuracy corresponds to a redshift inaccuracy of $120/3x10^5 = 0.0004$, so the full measurement is $z = 0.0418 \pm 0.0004$. This law is very important in understanding the size of the universe.

Although it is possible to find the distances of the stars in our galaxy by parallax, and also the distance of some of the nearest galaxies to us by the Cepheid variables, Hubble's law provides a way to measure the distances to distant galaxies[19, 20, 21, 22, 23, 24, 25].

III. Photons and the Coriolis force

The energy of the photons sent or received is described by Planck's formula

$$E = \frac{hc}{\lambda} \qquad (5),$$

where h is Planck's constant and λ is the wavelength of the photons. Once generated, photons of wavelength λ and speed c in absolute vacuum propagate uniformly and rectilinearly without loss of energy. The momentum of the photons P is also conserved according to the de Broglie equation[26].

$$P = \frac{h}{\lambda} \qquad (6)$$

Photons as an object have no mass at rest. However, they have an impulse of the force P with which they affect the other objects and a corresponding amount of motion mc, which they retain throughout their entire time of motion. This is because the modulus of the speed of light c is an invariant in all coordinate systems.

At planetary, interstellar and galactic distances, emitted photons from planetary, stellar, galactic and other objects move in non-inertial coordinate systems[27]. In this case, these are rotating with a total angular velocity $\overrightarrow{\omega_1}$ in the central parts and a total angular velocity $\overrightarrow{\omega_2}$ in the periphery, planets, stars, galaxies or other similar objects.

Every moving material object in a non-inertial system is affected by the Coriolis force. If the linear relative velocity of an object moving in a straight line is $\vec{V}$ and the angular velocity of a non-inertial system is $\overrightarrow{\boldsymbol{\Omega}}$, then the Coriolis force is:

$$\vec{F_c} = 2m\overrightarrow{\Omega} \times \vec{V} \qquad (7).$$

In that

$$2\vec{\Omega} \times \vec{V} \quad = \vec{a}_c = \vec{a}_1 + \vec{a}_2 = \vec{\Omega} \times \vec{V} + \vec{\Omega} \times \vec{V} \qquad (8)$$

where $\vec{a}_c = \vec{a}_1 + \vec{a}_2$ is the Coriolis acceleration.

Here $\vec{a}_1$ is related to the change in relative velocity $\vec{V}$ by direction due to transfer rotation and $\vec{a}_2$ is related to the change in magnitude of transfer velocity $\vec{\Omega}$ due to relative motion.

According to these considerations, moving photons with speed *c* generated by a light source moving in a non-inertial system are also affected by the Coriolis force[27]:

$$\vec{F_c} = 2m\vec{\Omega} \times \vec{c} \qquad (9),$$

where $\vec{\Omega}$ is the mean orbital angular velocity of the light source. There is no minus sign in (9), since this sign was historically introduced for convenience in describing the mechanical phenomena affected by the Coriolis force in the northern hemisphere of the Earth. With the Coriolis force acting on photons in interstellar and galactic travel, this convenience is unnecessary.

Since *c* is an invariant constant, we can represent equation (9) in the form:

$$\vec{F_c} = 2mc\vec{\Omega} \qquad (10).$$

Since photons have a relative motion that does not depend on the motion of the source of their generation, according to the special theory of relativity, and at the same time their speed is an invariant constant, then in equation (8) part of the Coriolis acceleration $\boldsymbol{\vec{a}_1}$ is equal to zero and therefore, we can write equation (10) in the form:

$$\vec{F_c} = mc\vec{\Omega} \qquad (11),$$

The Coriolis force is a reaction force and the work done by it on the object depends on, apart from the angular velocity modulus, the direction of rotation of the system and the direction of the linear motion of the object[28].

Since *mc*= P, then after the next substitution from equation (6) and (11) we get:

$$\vec{F_c} = \frac{h}{\lambda}\vec{\Omega} \qquad (12)$$

The work done by the Coriolis force Fc on the moving photons during their journey through a distance R is:

$$A_c = F_c R \qquad (13)$$

Therefore, considering (12) we obtain for the work done by the Coriolis force:

$$A_c = \frac{h}{\lambda} \Omega R \qquad (14)$$

The work A_c goes to change their kinetic energy E in (1) by dE. Therefore:

$$A_c = dE \qquad (15)$$

Thus we can write that the changed energy Ec' is:

$$E_c' = \frac{hC}{\lambda} - A_c \qquad (16)$$

Considering (14) we get:

$$E_c' = \frac{hC}{\lambda} - \frac{h}{\lambda} \Omega R \qquad (17)$$

If we multiply the rightmost term of equality (17) by c/c, then after conversion and taking into account (5) we obtain for Ec' the equation:

$$E_c' = E(1 - \Omega \frac{R}{C}) \qquad (18).$$

The larger R and **Ω** are, the smaller the energy of the photons arriving at the observer.

Since the ratio R/C in (18) is actually the time t for the photons to travel from their source to the observer, we can write (18) in the form:

$$E_c' = E(1 - \Omega t) \qquad (19)$$

The longer the travel time of the photons, the longer they will be with less energy. The observer will register it as a redshift in the spectrum. This is the case when, for example, the observer is in the central parts of the Galaxy, and the emitting object is in the periphery.

If the observer O and the light object swap places or the angular velocity is in the opposite direction, then the spectral shift will be in the blue end because the work done by the Coriolis force will increase the energy of the photons and will be valid:

$$E_c'' = E(1 + \Omega \frac{R}{C}) \qquad (20),$$

respectively

$$E_c'' = E(1+ \Omega t) \qquad (21)$$

According to (1), taking into account (5), for the spectral shift we get:

$$z = \frac{E_{emit} - E_{obs}}{E_{obs}} \qquad (22)$$

where $E_{emit} = E$ is the photon energy at the source,

and $E_{obs} = Ec'$ OR Ec'' is the photon energy at the observer affected by the Coriolis force.

If we make substitutions in (22) bearing in mind (18) that Ec' is actually the energy of the photons arriving at the Observer when he is located in the central parts of a non-inertial system, then after transformations we get:

$$z = z_c' = \frac{1}{1- \Omega\frac{R}{c}} - 1 \qquad (23)$$

By definition

$$\Omega = \frac{Vo}{R} \qquad (24),$$

where Vo is the relative orbital velocity of the light source relative to the center of rotation, and R is the distance to this center.

The source of light in most cases can be a star, a combination of stars, galaxies or clusters of galaxies.

Depending on the direction of orbit relative to the observer, we may have either a red or blue spectral shift.

Therefore, after replacing **Ω** in (23) according to (24) and making the necessary reductions, we get:

$$z_c' = \frac{Vo}{c} \qquad (25)$$

We get a similar result when the observer and the source change places or when the source's orbiting direction is opposite. Then:

$$z_c'' = - \frac{Vo}{c} \qquad (26)$$

An extremely interesting result!

The red spectral shift Zc' and the blue spectral shift Zc" caused by the Coriolis force are determined only by the ratio of the relative orbital speed of the light source to the speed of light in vacuum.

Similarly, these spectral shifts are also obtained from the Doppler effect according to (3), but where *v* is the recession velocity along the observation beam!

How can an observed phenomenon (the spectral shift) have two possible genesis?

Obviously, only one explanation is true!

Assuming that the spectral shift is related to the Doppler effect, i.e. that the luminous object is moving away or closer, it leads to the logical conclusion that the universe is expanding or that space is expanding!?

The explanation of the observed spectral shift with the influence of the Coriolis force leads to a stationary model of the universe, where everywhere in the universe the various objects such as planets, stars, galaxies, etc. revolve around some common center and are relatively stationary.

From equations (25) and (26) it follows that for equation (4) representing Hubble's law to be applicable, instead of the relative recession velocity v the orbital velocity of the galaxies around our galactic center Vo must be considered.

Then the modified equation (4) will look like this:

$$Vo = H_o\, d \quad (27)$$

where Vo is the orbital velocity of the studied galaxy according to (25) and (26) in km/s, d is the distance to it in Mpc, and H_o is the orbital constant in km/s/Mpc.

IV. Data

Table 1 shows calculations determining the orbital velocity of 18 randomly selected nearby stars at distances from 4.247 to 25.040 ly, arranged in ascending order. Fourteen of them are blue-shifted and the remaining four are red-shifted. According to (24), their angular velocity around the center of our galaxy has an average arithmetic value of $2.73 \times 10^{-12}\ s^{-1}$. The orbital velocities of all stars calculated by (25) and (26), and hence their spectral offset due to the influence of the Coriolis force, match the recession velocity and spectral offset results in the Simbad and NED NASA databases[29, 30].

Table 1

No	Stars	Radial Velocity by Simbad & NED-NASA databases v , km/s	Distance by Simbad & NED - NASA databases R, ly	Spectral shift z by Simbad & NED-NASA databases	Orbital velocity calculated in the article $Vo=c*z$, km/s	Angular velocity calculated in the article $\Omega = Vo/R$, s^{-1}	Spectral shift $z= Vo/c$ calculated in the article	Type of the star
1	Proxima Centauri(V645 Centauri)	-20.58	4.25	-0.000069	-20.69	$-2.19x10^{-12}$	-0.000069	a red dwarf star
2	α Centauri A (HD 128620)	-15.25	4.34	-0.000051	-15.29	$-1.62x10^{-12}$	-0.000051	bilong to triple star system
3	α Centauri B (HD 128621)	-22.59	4.34	-0.000075	-22.48	$-2.38x10^{-12}$	-0.000075	bilong to triple star system
4	Barnard's Star (BD+04°3561a)	-110.11	5.96	-0.000367	-110.02	$-1.16x10^{-11}$	-0.000367	a red dwarf star
5	Wolf 359 (CN Leonis)	19.57	7.86	0.000065	19.49	$-2.06x10^{-12}$	0.000065	a red dwarf star
6	Lalande 21185 (BD+36°2147)	-84.64	8.30	-0.000282	-84.54	$-8.94x10^{-12}$	-0.000282	a red dwarf star
7	Sirius A	-5.50	8.60	-0.000018	-5.40	$-5.70x10^{-13}$	-0.000018	binary star system
8	Ross 248 (HH Andromedae)	-77.51	10.31	-0.000259	-77.65	$-8.21x10^{-12}$	-0.000259	proper-motion star
9	Epsilon Eridani	16.38	10.48	0.000055	16.49	$-1.74x10^{-12}$	0.000055	main-sequence star
10	Ross 128 (FI Virginis)	-30.66	11.01	-0.000102	-30.58	$-3.23x10^{-12}$	-0.000102	an old disk star
11	61 Cygni A	-65.82	11.40	-0.000220	-65.95	$-6.97x10^{-12}$	-0.000220	a binary star system
12	Procyon A	-4.51	11.46	-0.000015	-4.50	$-4.75x10^{-12}$	-0.000015	a binary star system
13	Groombridge 34 A	11.73	11.62	0.000039	11.69	$-1.24x10^{-12}$	0.000039	a binary star system
15	Epsilon Indi A	-40.04	11.87	-0.000134	-40.17	$-4.25x10^{-12}$	-0.000134	a main-sequence star
14	Tau Ceti	-16.60	11.91	-0.000055	-16.49	$-1.74x10^{-12}$	-0.000055	a single star
16	YZ Ceti	28.27	12.12	0.000094	28.18	$-2.98x10^{-12}$	0.000094	a red dwarf star
17	Altair	-26.60	16.73	-0.000089	-26.68	$-2.82x10^{-12}$	-0.000089	main-sequence star
18	Vega	-20.60	25.04	-0.000069	-20.69	$-2.19x10^{-12}$	-0.000069	a variable star

$\Omega_{average}$ = $-2.73x10^{-12}$ s^{-1}

blue shift

red shift

1 PC $3.0857x10^{16}$ m C= $2.9979x10^{8}$ m/s

1 ly = $9.4607x10^{15}$ m 1 ly = 0.306601394 pc

1 pc = 3.261563777 ly 1 ly = $3.066x10^{-7}$ Mpc

NED -NASA https://ned.ipac.caltech.edu/Documents/Guides/Searches

SIMBAD https://simbad.cds.unistra.fr/simbad/sim-fbasic

Table 2 shows calculations determining the orbital velocity of 31 randomly selected galaxies at distances from 0.637 to 279.000 Mpc, arranged in ascending order. Two of them are blue-shifted and the remaining twenty-nine are red-shifted. According to (24), their angular velocity around the center of Our galaxy has an average arithmetic value of $1.93x10^{-18}$ s^{-1}. The orbital velocities of all galaxies calculated by (25) and (26), and hence their spectral offset due to the influence of the Coriolis force, match the recession velocity and spectral offset results in the Simbad database and NED NASA[29, 30]. However, the Hubble constant calculated by formula (4), according to the indicated databases, has an average arithmetic value of 52.81 km/s/Mpc!?

Table 2

No	GALAXIES	Radial Velocity by Simbad & NED-NASA databases v, km/s	Distance by Simbad & NED -NASA databases R, Mpc	Hublle constant H_0=V/R km/s/Mpc	Measured spectral shift z by Simbad & NED-NASA databases	Orbital velocity calculated in the article $V_o = c^*z$, km/s	Angular velocity calculated in the article $\Omega = Vo/R$, s^{-1}	Spectral shift z= Vo/c calculated in the article	Type of galaxy
1	2	3	4	5	6	7	8	9	10
1	M81	-39.000	0.637	-61.22	-0.000130	-38.973	$-1.98x10^{-18}$	-0.000130	a grand-design spiral galaxy
2	NGC 55	131.909	2.100	62.81	0.000440	131.909	$2.04x10^{-18}$	0.000440	Galaxy towards a Group of Galaxies
3	NGC 2403	133.000	2.690	49.44	0.000440	131.909	$1.59x10^{-18}$	0.000440	spiral galaxy
4	M98	-142.000	2.790	-50.90	-0.000470	-140.902	$-1.64x10^{-18}$	-0.000470	intermediate spiral galaxy
5	ESO349-G031	227.842	3.210	70.98	0.000760	227.842	$2.30x10^{-18}$	0.000760	Active Galaxy Nucleus Candidate
6	NGC 253	242.832	3.440	70.59	0.000810	242.832	$2.29x10^{-18}$	0.000810	Seyfert Galaxy
7	NGC 247	155.892	3.520	44.29	0.000520	155.892	$1.440x10^{-18}$	0.000520	Low Surface Brightness Galaxy
8	IC 1574	359.751	4.920	73.12	0.001200	359.751	$2.37x10^{-18}$	0.001200	irregular galaxy
9	NGC 59	362.749	5.300	68.44	0.001210	362.749	$2.22x10^{-18}$	0.001210	Galaxy towards a Group of Galaxies
10	NGC 5474	262.019	5.670	46.21	0.000870	260.819	$1.49x10^{-18}$	0.000870	spiral galaxy
10	AndIV	254.824	6.110	41.71	0.000850	254.824	$1.35x10^{-18}$	0.000850	Andromeda IV -- Galaxy
11	M101	243.000	6.400	37.97	0.000811	243.132	$1.23x10^{-18}$	0.000811	Pinwheel Galaxy
12	NGC 45	467.676	7.100	65.87	0.001560	467.676	$2.13x10^{-18}$	0.001560	Low Surface Brightness Galaxy
13	M51	465.000	7.200	64.58	0.001551	464.978	$2.09x10^{-18}$	0.001551	Whirlpool Galaxy
14	M94	307.887	7.820	39.37	0.001030	308.786	$1.28x10^{-18}$	0.001030	spiral galaxy
15	NGC 24	554.616	8.100	68.47	0.001850	554.616	$2.22x10^{-18}$	0.001850	Galaxy towards a Group of Galaxies
16	UGC 12894	335.768	8.200	40.95	0.001120	335.768	$1.33x10^{-18}$	0.001120	Dwarf Irregular Galaxy
17	M96	893.000	9.600	93.02	0.002983	894.281	$3.020x10^{-18}$	0.002983	L-type Active Galaxy Nucleus
18	MCG-04-02-003	671.535	9.800	68.52	0.002240	671.535	$2.22x10^{-18}$	0.002240	Active Galaxy Nucleus Candidate
19	ESO409-IG015	737.489	10.400	70.91	0.002460	737.489	$2.30x10^{-18}$	0.002460	Active Galaxy Nucleus Candidate
20	M91	486.000	11.920	40.77	0.001620	485.664	$1.32x10^{-18}$	0.001620	L-type Active Galaxy Nucleus
21	M105	907.000	18.600	48.76	0.003030	908.371	$1.58x10^{-18}$	0.003030	elliptical galaxy
22	M49	980.921	19.450	50.43	0.003270	980.321	$1.63x10^{-18}$	0.003270	elliptical galaxy
23	M104	1090.945	21.180	51.51	0.003640	1091.245	$1.67x10^{-18}$	0.003640	spiral galaxy
24	M60	1110.132	21.200	52.36	0.003700	1109.232	$1.70x10^{-18}$	0.003700	Galaxy in Pair of Galaxies
25	M58	1516.950	19.100	79.42	0.005073	1520.847	$2.58x10^{-18}$	0.005073	Seyfert Galaxy
26	M99	2406.000	40.600	59.26	0.008030	2407.333	$1.92x10^{-18}$	0.008030	grand design spiral galaxy
27	NGC 5091	3602.007	56.900	63.30	0.012010	3600.507	$2.05x10^{-18}$	0.012010	spiral galaxy
28	NGC 7618	4985.549	69.100	72.15	0.016630	4985.549	$2.34x10^{-18}$	0.016630	elliptical g всичко е от а
29	N57	5360.000	74.800	71.66	0.017880	5360.289	$2.32x10^{-18}$	0.017880	The Ring Nebula
30	N61	8070.000	116.000	69.57	0.026919	8070.113	$2.25x10^{-18}$	0.026919	intermediate barred spiral galaxy
31	2dFGRS S839Z607	18287.312	279.000	65.55	0.061000	18287.340	$2.12x10^{-18}$	0.061000	2dF Galaxy Redshift Survey
			H_0 Average =	52.81			Ω Average = $1.93x10^{-18}$	s^{-1}	

NED -NASA https://ned.ipac.caltech.edu/Documents/Guides/Searches

SIMBAD https://simbad.cds.unistra.fr/simbad/sim-fbasic

\# Blueshift 1 PC = $3.09x10^{16}$ m c = $2.9979x10^{8}$ m/s

\# Redsift 1 MPC = $3.09x10^{22}$ m 1ly = $9.46x10^{15}$ m

V. Conclusion

We have proved that the influence of the Coriolis inertial force caused by orbital and spin motions of distant objects on the energies of electromagnetic radiations when photons are exchanged between them, according to (24) and (25), causes a red or blue spectral shift in the observation, fully corresponding of the observed values in the Simbad and NED NASA databases[29, 30]. From relations (19) and (21) it is clearly seen that whether the spectral shift is towards the red end or the blue end of the spectrum depends only on the direction of the angular velocity. From the dependences derived in the article and calculated orbital velocities, angular velocities and spectral shifts for 18 randomly selected nearby stars of our galaxy, as well as the orbital velocities, angular velocities and spectral shifts of 31 randomly selected galaxies from the visible universe, it logically follows that the universe is not expanding. In our opinion, the main cause of spectral shift in the observation of stars and galaxies in the visible universe is not the Doppler effect. For this effect to be valid, it is necessary that the observable stars and galaxies are approaching the observer or moving away from him according to (3). Unfortunately, such movements have been accepted without reliable and unequivocal evidence for this. For example, if the universe is expanding continuously, then why, relative to an Earth-based observer located only 7.9 Kpc from the center of the Milky Way, do we observe a spectral blue shift of galaxies M81 and M98 shown in Table 2?

Here we should note that according to the new conception, in the modified Hubble law described in (27), which gives a dependence between the orbital speed of a given galaxy around our galactic center and the distance to the galaxy, the statement about the increase in the expansion rate of the universe with increasing distance drop out.

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