

Article

Not peer-reviewed version

Analysis of the Causes of Electromagnetic Waves at the Same Frequency

[Junli Chen](#) *

Posted Date: 3 June 2025

doi: 10.20944/preprints202506.0136.v1

Keywords: Electromagnetic waves; photons; co-channel interference



Preprints.org is a free multidisciplinary platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This open access article is published under a Creative Commons CC BY 4.0 license, which permit the free download, distribution, and reuse, provided that the author and preprint are cited in any reuse.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

Article

Analysis of the Causes of Electromagnetic Waves at the Same Frequency

Junli Chen

Independent researchers; sxchanghe@163.com

Abstract: Electromagnetic waves are propagated by photons. Electromagnetic waves can interfere and diffract, indicating that photons will interact. This paper analyzes the electromagnetic wave through the Huygens-Fresnel principle and the size of the interaction force of photons of two waves in space. The influence of frequency, angle, and amplitude on the interaction of electromagnetic waves explains the cause of "same frequency interference" through the size of the coherence coefficient of electromagnetic waves.

Keywords: electromagnetic waves; photons; co-channel interference

1. Electromagnetic Wave

Electromagnetic waves [1] are oscillating particle waves emitted in space by oscillating in the same phase and perpendicular to each other. They are electromagnetic fields propagating in the form of fluctuations, as shown in Figure 1.

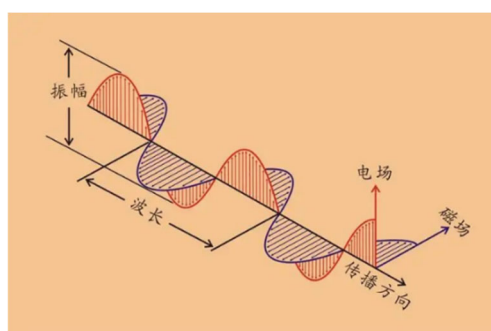


Figure 1. Electromagnetic waves.

Electromagnetic waves have wave-particle duality, and their particle form is called photons. Electromagnetic waves and photons are two sides reflected by the properties of electromagnetic waves. The electric field and magnetic field that oscillate in phase and are perpendicular to each other propagate in space in the form of waves, and the propagation direction is perpendicular to the plane composed of the electric field and the magnetic field. The rate of electromagnetic waves in vacuum is fixed to the speed of light. The electric field direction, magnetic field direction and propagation direction accompanying electromagnetic waves are perpendicular to each other, so electromagnetic waves are transverse waves. From the perspective of quantum mechanics, the energy of electromagnetic waves is presented in portions of photons, and the photons are essentially wave packets. Photons belong to bosons. Electromagnetic waves in a certain frequency range can be seen by the human eye as visible light, and sunlight is a visible radiation form of electromagnetic waves. The propagation of a wave is always accompanied by the transmission of energy. The energy passing through a unit area perpendicular to the propagation direction per unit time is called the energy flow density of the wave, which is often used to describe the intensity of the wave, and the energy flow density is proportional to the square of the amplitude.

Waves have superposition characteristics [2]. The perturbation caused by several columns of waves at the encounter point is the superposition of perturbation at the point (linear superposition of vectors, vector sum). In the area where wave propagation encounters, the vibration of particles at any point is the combined vibration of the vibration caused by each wave alone at that point, that is, in any one

At the moment, the vibration displacement of the particle at this point is the vector sum of the displacements caused by the respective waves at this point. The superposition principle of waves is one of the basic principles of physics. When several columns of waves exist in the medium at the same time, the physical amount of vibration at each point in the overlapping area of the wave is equal to the vector sum of the physical amounts caused by the columns of waves at that point. In the region where the two columns of waves overlap, any particle participates in two vibrations at the same time, and its vibration displacement is equal to the sum of the vectors of the displacements caused by the two columns of waves. When the vibration directions of the two columns of waves are on the same straight line, the sum of the vectors of the two displacements can be simplified to an algebraic sum after selecting the positive direction.

Huygens-Fresnel Principle [3]: Any point in the wave front of the spherical wave emitted from the point wave source can be regarded as the wave source of the secondary wave. These secondary waves will each contribute wave interference at the point and superimpose them together, thus forming a total wave interference. The amplitude of the secondary wave source attenuates with the propagation distance.

2. Coherence Coefficient of Electromagnetic Waves

There are currently two concepts of photons: a. When Einstein explained the photoelectric effect in 1915, his photon energy expression is hf , where h is the Planck constant and f is the frequency of the wave. b. Photons in elementary particles [5], which are propagators. The photons applied in this paper are the concept of photons in elementary particles. For the sake of distinction, we call them "microphotons". We regard electromagnetic waves as a group of microphotons that propagate along the peaks of the wave, as shown in Figure 2.

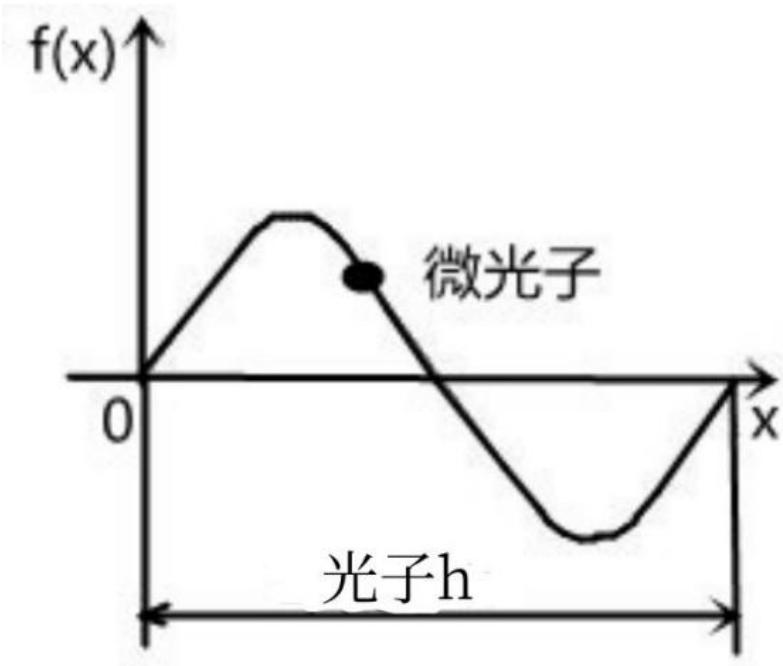


Figure 2. microphoton.

The number of photons reflects the intensity of electromagnetic waves. For the two columns of electromagnetic waves that intersect in space, we can always make their propagation direction in one

plane, as in the XY plane in Figure 3. Assume that the two columns of electromagnetic waves in the figure are p and q, and the amplitude of the electromagnetic wave electric field direction reflects the intensity of electromagnetic waves. The electric field intensity of these two columns of electromagnetic waves is A_p and A_q respectively. The propagation direction of q is used as the y-axis of the coordinate system. The angle between p and q is α . The two columns of electromagnetic waves intersect at point 0 of the coordinate system. When the two columns of electromagnetic waves intersect in space, these two groups of photons form a certain distance in space, and the distance is r. From the Huygens-Fresnel principle, it can be seen that the electric field intensity of the sub-light source attenuates with distance, and defines the coherence coefficients of the two groups of photons:

$$k = \frac{r_{\min}}{r} \quad (1)$$

Here, r_{p0} is the equivalent radius of a group of photons on the electromagnetic wave p, and r_{q0} is the equivalent radius of a group of photons on the electromagnetic wave q. Since the photon is a virtual photon, when the distance between the two groups of photons is equal to less than $r_{p0} + r_{q0}$, we believe that the two groups of photons overlap, and the coherence coefficient is the maximum 1 at this time.

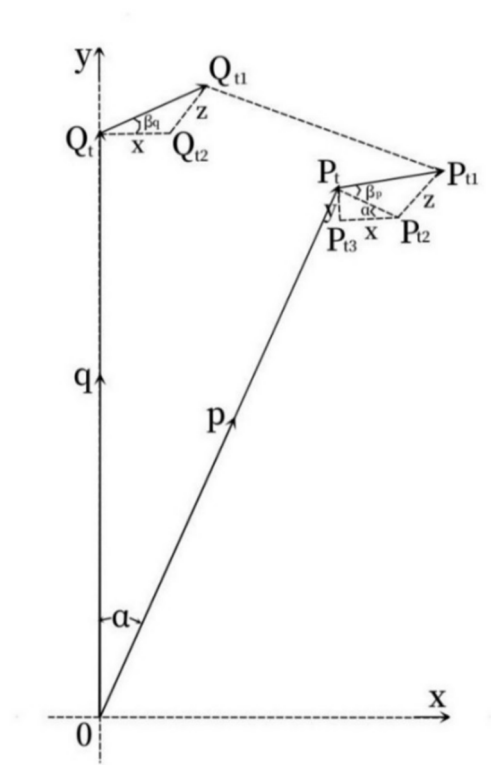


Figure 3. Coherence coefficient of photon.

It is obvious that $k \leq 1$, which reflects the ratio between the two groups of photons relative to the maximum degree of interference.

Suppose the equation of fluctuation of electromagnetic waves along their respective propagation directions is:

$$A_{pt} = A_p \cos(\omega_p t_p + \varphi_p) \quad (2)$$

$$A_{qt} = A_q \cos(\omega_q t_q + \varphi_q) \quad (3)$$

In the formula, A_{pt} and A_{qt} are the instantaneous value of the amplitude, ω is the angular frequency, and φ is the initial phase.

In Figure 3, Pt1 is the position of the photon on the electromagnetic wave p at the tP time, and qt1 is the position of the photon on the electromagnetic wave q at the tQ time,

$$P_t = ct_p \quad (4)$$

$$Q_t = ct_q \quad (5)$$

Here time t is a negative value before the intersection of the two columns of electromagnetic waves, and a positive value after the intersection. PtPt1 is the instantaneous amplitude of electromagnetic wave p at tp time, Pt1 is the position of photons on electromagnetic wave p at tP time, and the amplitude is perpendicular to the xy plane, but there is an angle with the xy plane, β_P is the angle between the position of the photon and the xy plane, QtQt1 is the instantaneous amplitude of electromagnetic wave q at tq time, Qt1 is the position of photons at tq time, β_q is the angle between the position of the photons and the xy plane, and the coordinates of the two groups of photons in the stereoscopic coordinate system are:

$$P_{t1X} = A_{pt} \cos \beta_{pt} \cos \alpha + ct_p \sin \alpha \quad (6)$$

$$P_{t1Y} = A_{pt} \cos \beta_p \sin \alpha + ct_p \cos \alpha \quad (7)$$

$$P_{t1Z} = A_{pt} \sin \beta_p \quad (8)$$

$$Q_{t1X} = A_{qt} \cos \beta_q \quad (9)$$

$$Q_{t1Y} = ct_q \quad (10)$$

$$Q_{t1Z} = A_{qt} \sin \beta_q \quad (11)$$

The coherence coefficient between the two groups of photons at time t is:

$$k_t = \frac{r_{\min}}{\sqrt{(p_{t1X} - q_{t1X})^2 + (p_{t1Y} - q_{t1Y})^2 + (p_{t1Z} - q_{t1Z})^2}} \quad (12)$$

Figure 4 is a schematic diagram of photons on oblique electromagnetic waves. Each column of electromagnetic waves consists of many consecutive groups of photons, and the photons at time tP on the electromagnetic wave p are not

Only affected by the photon at the time tQ on the electromagnetic wave q, but also by the photon at the time t and the next moment, the photon at the time t on the electromagnetic wave p is the integral of the photons affected by the different moments of the electromagnetic wave q (-M-0-M) on the electromagnetic wave q. The entire electromagnetic wave p is affected by the electromagnetic wave q as the average value of the integral of the coherence coefficients of the photons on p at different moments of the photons on p at different moments of the photons.

tp and tq are respectively the time of the propagation direction of the wave, and N is the integral length.

For two columns of electromagnetic waves, we simplify the integral of the position at the point on p at the intersection point 0 to p at the same distance of the corresponding position at the intersection point on p. In this way, the upper area segment can be approximate:

The coherence coefficient k is:

$$k \approx \frac{1}{2N} \sum_{t=-N}^N \frac{r_{\min}}{\sqrt{(p_{t1X} - q_{t1X})^2 + (p_{t1Y} - q_{t1Y})^2 + (p_{t1Z} - q_{t1Z})^2}} \quad (13)$$

When the two columns are in the same direction, $tp=tq=t$; For two columns of electromagnetic waves with opposite directions: $tp=t, tq=-t$.

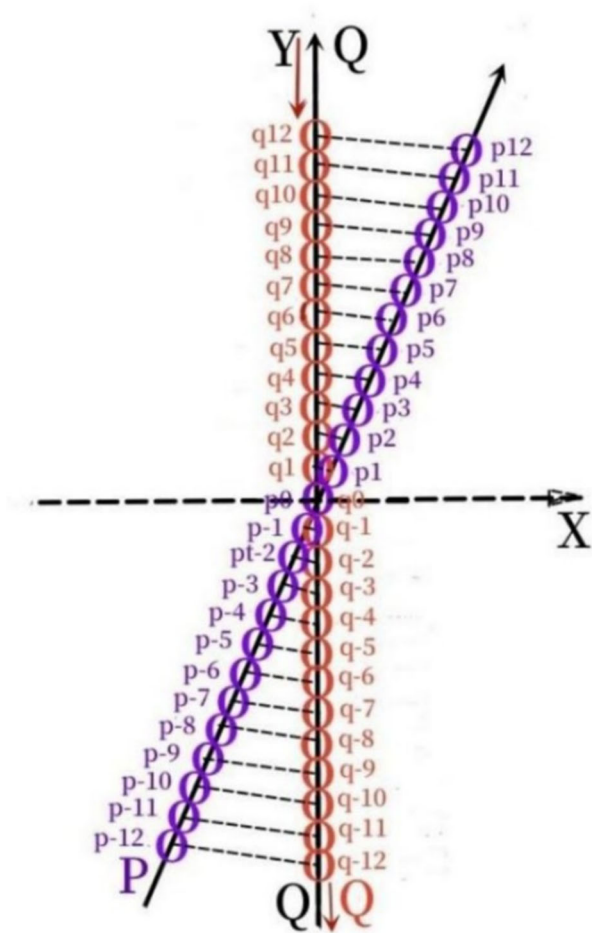


Figure 4. Coherence coefficient of electromagnetic waves.

3. Numerical Simulation

From the above analysis, we can see that the mutual influence of the two columns of electromagnetic waves is the result of a multi-parameter action, and the overall analysis is very difficult. Let us conduct a numerical simulation analysis of the subparameters.

3.1. Effect of Frequency

Assume that the amplitudes of electromagnetic waves p and q are equal to $A=0.005m$, the initial phases are equal to $\varphi=20^\circ$, the amplitude is perpendicular to the xy plane, but there is an angle with the xy plane, assuming that this angle is equal to $\beta=45^\circ$, the angles of electromagnetic waves p and q are $\alpha=30^\circ$, the angular frequency of electromagnetic wave p is fixed $\omega_p=\pi\times1015$, the angular frequency of electromagnetic wave q is $\omega_q=\pi\times1010-1018$, the interval is an order of magnitude, and the time is One period before and after the electromagnetic waves intersect, then calculate the distance r, take the minimum value of distance r as r_{min} , and calculate the average value of the coherence coefficients at each frequency. The last column in the table is the average value of the coherence coefficients at different frequencies. It can be seen from the table that when the frequency of electromagnetic waves p and q are equal, the coherence coefficient is more than twice that of other frequencies. This verifies what we usually call "same-frequency interference" [6], which explains the reason for "same-frequency interference".

Table 1. Frequency Influence Analysis of Electromagnetic Wave Interference.

A	ωP	ωQ	φ (20°)	α(30°)	β(45°)	t	APt	P11X	P11Y	P11Z	AQt	Q11X	Q11Y	Q11Z	r	k	平均值
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	-5-1.00E-15	-0.0017101	-0.00104737	-0.00060487	-0.00120922	0.001708625	0.00120818	-3E-07	0.00120818	0.00361078	0.150067535	
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	-4-8.00E-16	-0.00414519	-0.00253852	-0.00146575	-0.00293109	0.00170892	0.001208389	-2.4E-07	0.001208389	0.00577255	0.087377111	
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	-3-6.00E-16	-0.00499695	-0.00306009	-0.00176685	-0.00353338	0.001709215	0.001208598	-1.8E-07	0.001208598	0.00620357	0.076187542	
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	-2-4.00E-16	-0.00394005	-0.00241284	-0.00139312	-0.00278604	0.00170951	0.001208806	-1.2E-07	0.001208806	0.005659162	0.090568151	
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	-1-2.00E-16	-0.00137819	-0.00084399	-0.00048731	-0.00097453	0.001709806	0.001209015	-6E-08	0.001209015	0.003036463	0.166110596	
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001710101	0.001209224	0	0.001209224	0.00062594	0.805809651
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	1	2.00E-16	0.004145188	0.002538429	0.001465597	0.00293109	0.001710396	0.001209433	6E-08	0.001209433	0.00262262	0.192322457
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	2	4.00E-16	0.004996954	0.003060057	0.001766794	0.00353338	0.001710691	0.001209641	1.2E-07	0.001209641	0.003456145	0.145939697
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.001710986	0.00120985	1.8E-07	0.00120985	0.002423234	0.208146914
0.005	3.1416E+15	3.1416E+11	0.34906585	0.52359878	0.78539816	4	8.00E-16	0.001378187	0.000844084	0.00048747	0.000974525	0.001711282	0.001210059	2.4E-07	0.001210059	0.000653305	0.77205709
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	-5-1.00E-15	-0.0017101	-0.00104737	-0.00060487	-0.00120922	0.001695332	0.001198781	-3E-07	0.001198781	0.003348011	0.150653253	
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	-4-8.00E-16	-0.00414519	-0.00253852	-0.00146575	-0.00293109	0.001698287	0.00120087	-2.4E-07	0.00120087	0.005762279	0.08753286	
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	-3-6.00E-16	-0.00499695	-0.00306009	-0.00176685	-0.00353338	0.001701241	0.001202959	-1.8E-07	0.001202959	0.00612683	0.076275954	
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	-2-4.00E-16	-0.00394005	-0.00241284	-0.00139312	-0.00278604	0.001704195	0.001205048	-1.2E-07	0.001205048	0.005564022	0.090651815	
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	-1-2.00E-16	-0.00137819	-0.00084399	-0.00048731	-0.00097453	0.001707148	0.001207136	-6E-08	0.001207136	0.003033842	0.166254132	
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001710101	0.001209224	0	0.001209224	0.00062594	0.805809651
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	1	2.00E-16	0.004145188	0.002538429	0.001465597	0.00293109	0.001713053	0.001211311	6E-08	0.001211311	0.002620435	0.194287195
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	2	4.00E-16	0.004996954	0.003060057	0.001766794	0.00353338	0.001716004	0.001213398	1.2E-07	0.001213398	0.003451609	0.146131479
0.005	3.1416E+15	3.1416E+12	0.34906585	0.52359878	0.78539816	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.001718954	0.001215484	1.8E-07	0.001215484	0.002416777	0.208703045
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	4	8.00E-16	0.001378187	0.000844084	0.00048747	0.000974525	0.001721904	0.00121757	2.4E-07	0.00121757	0.00066027	0.763913072
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	-5-1.00E-15	-0.0017101	-0.00104737	-0.00060487	-0.00120922	0.001561675	0.001104271	-3E-07	0.001104271	0.003216724	0.15680198	
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	-4-8.00E-16	-0.00414519	-0.00253852	-0.00146575	-0.00293109	0.001591488	0.001125352	-2.4E-07	0.001125352	0.005659187	0.089127416	
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	-3-6.00E-16	-0.00499695	-0.00306009	-0.00176685	-0.00353338	0.001621238	0.001146389	-1.8E-07	0.001146389	0.00653573	0.077174036	
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	-2-4.00E-16	-0.00394005	-0.00241284	-0.00139312	-0.00278604	0.001650925	0.00116738	-1.2E-07	0.00116738	0.005512527	0.091498641	
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	-1-2.00E-16	-0.00137819	-0.00084399	-0.00048731	-0.00097453	0.001680546	0.001188325	-6E-08	0.001188325	0.0030076	0.167704707	
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001710101	0.001209224	0	0.001209224	0.00062594	0.805809651
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	1	2.00E-16	0.004145188	0.002538429	0.001465597	0.00293109	0.001739588	0.001230075	6E-08	0.001230075	0.002598662	0.194095538
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	2	4.00E-16	0.004996954	0.003060057	0.001766794	0.00353338	0.001769007	0.001250877	1.2E-07	0.001250877	0.003450647	0.146067516
0.005	3.1416E+15	3.1416E+13	0.34906585	0.52359878	0.78539816	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.001798356	0.001271629	1.8E-07	0.001271629	0.002352935	0.214365799
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	4	8.00E-16	0.001378187	0.000844084	0.00048747	0.000974525	0.001827633	0.001292332	2.4E-07	0.001292332	0.00073385	0.698817862
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	-5-1.00E-15	-0.0017101	-0.00104737	-0.00060487	-0.00120922	0.000174497	0.000123388	-3E-07	0.000123388	0.001874042	0.269144826	
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	-4-8.00E-16	-0.00414519	-0.00253852	-0.00146575	-0.00293109	0.000487914	0.000345008	-2.4E-07	0.000345008	0.004603832	0.095584541	
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	-3-6.00E-16	-0.00499695	-0.00306009	-0.00176685	-0.00353338	0.000799406	0.000565265	-0.000565265	0.000750509	0.008718845		
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	-2-4.00E-16	-0.00394005	-0.00241284	-0.00139312	-0.00278604	0.001107742	0.000783292	-1.2E-07	0.000783292	0.004988974	0.101188545	
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	-1-2.00E-16	-0.00137819	-0.00084399	-0.00048731	-0.00097453	0.001411707	0.000998228	-6E-08	0.000998228	0.0027428	0.183885568	
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001209224	0	0.001209224	0.00062594	0.805809651	
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	1	2.00E-16	0.004145188	0.002538429	0.001465597	0.00293109	0.002001745	0.001415148	6E-08	0.001415148	0.00338736	0.211152962
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	2	4.00E-16	0.004996954	0.003060057	0.001766794	0.00353338	0.00228549	0.001616085	1.2E-07	0.001616085	0.002980304	0.169240707
0.005	3.1416E+15	3.1416E+14	0.34906585	0.52359878	0.78539816	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.002560214	0.001810345	1.8E-07	0.001810345	0.001804287	0.279550192
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	4	8.00E-16	0.001378187	0.000844084	0.00048747	0.000974525	0.002824835	0.00199746	2.4E-07	0.00199746	0.001616807	0.311965875
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	-5-1.00E-15	-0.0017101	-0.00104737	-0.00060487	-0.00120922	-0.001710101	-0.001209224	-3E-07	0.00120922	0.000625863	0.805909603	
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	-4-8.00E-16	-0.00414519	-0.00253852	-0.00146575	-0.00293109	-0.004145188	-0.00293109	-2.4E-07	0.00293109	0.001517182	0.332451055	
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	-3-6.00E-16	-0.00499695	-0.00306009	-0.00176685	-0.00353338	-0.004996954	-0.00353338	-1.8E-07	0.00353338	0.00182966	0.275778149	
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	-2-4.00E-16	-0.00394005	-0.00241284	-0.00139312	-0.00278604	-0.003940054	-0.002786039	-1.2E-07	0.00278604	0.001442129	0.349752927	
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	-1-2.00E-16	-0.00137819	-0.00084399	-0.00048731	-0.00097453	-0.001378187	-0.000974525	-6E-08	0.00097453	0.000504436	0.999906619	
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001710101	0.001209224	0	0.001209224	0.00062594	0.805809651
0.005	3.1416E+15	3.1416E+15	0.34906585	0.52359878	0.78539816	1	2.00E-16	0.004145188	0.002538429	0.001							

Table 2. Analysis of the angle influence of electromagnetic wave interference.

A	ω	Φ (20°)	α(间隔15°)	β(45°)	t	At	P11X	P11Y	P11Z	Q11X	Q11Y	Q11Z	r	S1	
0.005	3.14159E+15	0.34906585	0	0.785398163	-5	-1.00E-15	-0.001710101	-0.001209224	-0.00000003	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	-4	-8.00E-16	-0.004145188	-0.00293109	-0.00000024	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	-3	-6.00E-16	-0.004996954	-0.00353338	-0.00000018	-0.00353338	-0.00353338	-2E-07	-0.00353338	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	-2	-4.00E-16	-0.003940054	-0.002786039	-0.00000012	-0.002786039	-0.002786039	-1E-07	-0.002786039	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	-1	-2.00E-16	-0.001378187	-0.000974525	-0.00000006	-0.000974525	-0.000974525	-6E-08	-0.000974525	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	0	0.00E+00	0.001710101	0.001209224	0.00000000	0.001209224	0.001209224	0	0.001209224	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	1	2.00E-16	0.004145188	0.00293109	0.00000006	0.00293109	0.00293109	6E-08	0.00293109	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	2	4.00E-16	0.004996954	0.00353338	0.00000012	0.00353338	0.00353338	1.2E-07	0.00353338	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	3	6.00E-16	0.003940054	0.002786039	0.00000018	0.002786039	0.002786039	1.8E-07	0.002786039	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0	0.785398163	4	8.00E-16	0.001378187	0.000974525	0.00000024	0.000974525	0.000974525	2.4E-07	0.000974525	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	-5	-1.00E-15	-0.001710101	-0.001168098	-0.00031326	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.00031565	0.805907168
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	-4	-8.00E-16	-0.004145188	-0.002831278	-0.000758854	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.000765152	0.332463381
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	-3	-6.00E-16	-0.004996954	-0.00341303	-0.00091468	-0.00353338	-0.00353338	-2E-07	-0.00353338	0.000922385	0.275790432
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	-2	-4.00E-16	-0.003940054	-0.002786039	-0.000721196	-0.002786039	-0.002786039	-1E-07	-0.002786039	0.000727294	0.167691699
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	-1	-2.00E-16	-0.001378187	-0.000941335	-0.000974525	-0.000974525	-0.000974525	-6E-08	-0.000974525	0.0009484592	0.9999548592
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	0	0.00E+00	0.001710101	0.001168021	0.00031297	0.001209224	0.001209224	0	0.001209224	0.000315671	0.805855443
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	1	2.00E-16	0.004145188	0.002831231	0.00075888	0.00293109	0.00293109	6E-08	0.00293109	0.000765164	0.332458098
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	2	4.00E-16	0.004996954	0.003413014	0.000914622	0.00353338	0.00353338	1.2E-07	0.00353338	0.000922389	0.27578922
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	3	6.00E-16	0.003940054	0.002691153	0.000721254	0.002786039	0.002786039	1.8E-07	0.002786039	0.00072729	0.167691118
0.005	3.14159E+15	0.34906585	0.261799388	0.785398163	4	8.00E-16	0.001378187	0.000941381	0.000252458	0.000974525	0.000974525	2.4E-07	0.000974525	0.000254386	0.999997127
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-0.001710101	-0.001047369	-0.000604872	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.000652863	0.406454979
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-0.004145188	-0.002538519	-0.001465753	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.001517182	0.167669409
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-0.004996954	-0.003060087	-0.001766846	-0.00353338	-0.00353338	-2E-07	-0.00353338	0.001828966	0.139086817
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-0.003940054	-0.00241284	-0.001393123	-0.002786039	-0.002786039	-1E-07	-0.002786039	0.001441229	0.176395495
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-0.001378187	-0.000843994	-0.000487315	-0.000974525	-0.000974525	-6E-08	-0.000974525	0.000504386	0.504296043
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001209224	0	0.001209224	0.00062594	0.406404569
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	1	2.00E-16	0.004145188	0.002538429	0.001465597	0.00293109	0.00293109	6E-08	0.00293109	0.001517229	0.167664261
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	2	4.00E-16	0.004996954	0.003060057	0.001767894	0.00353338	0.00353338	1.2E-07	0.00353338	0.001828981	0.139085636
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.002786039	1.8E-07	0.002786039	0.001442113	0.176397389
0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	4	8.00E-16	0.001378187	0.000844084	0.000487315	0.000974525	0.000974525	2.4E-07	0.000974525	0.000504386	0.504326211
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	-5	-1.00E-15	-0.001710101	-0.000855262	-0.000855262	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.000855262	0.274910507
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	-4	-8.00E-16	-0.004145188	-0.002072764	-0.002072764	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.002243232	0.113401231
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	-3	-6.00E-16	-0.004996954	-0.002498604	-0.002498604	-0.00353338	-0.00353338	-2E-07	-0.00353338	0.002704235	0.094069129
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	-2	-4.00E-16	-0.003940054	-0.001970112	-0.001970112	-0.002786039	-0.002786039	-1E-07	-0.002786039	0.002132277	0.119302054
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	-1	-2.00E-16	-0.001378187	-0.000689136	-0.000689136	-0.000974525	-0.000974525	-6E-08	-0.000974525	0.00074837	0.341073257
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	0	0.00E+00	0.001710101	0.00085505	0.00085505	0.001209224	0.001209224	0	0.001209224	0.0009255	0.4009255
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	1	2.00E-16	0.004145188	0.002072636	0.002072636	0.00293109	0.00293109	6E-08	0.00293109	0.002243237	0.113396307
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	2	4.00E-16	0.004996954	0.002498562	0.002498562	0.00353338	0.00353338	1.2E-07	0.00353338	0.002704267	0.094067999
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	3	6.00E-16	0.003940054	0.001970154	0.001970154	0.002786039	0.002786039	1.8E-07	0.002786039	0.002132244	0.11930387
0.005	3.14159E+15	0.34906585	0.785398163	0.785398163	4	8.00E-16	0.001378187	0.000689263	0.000689263	0.000974525	0.000974525	2.4E-07	0.000974525	0.000745739	0.341117806
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	-5	-1.00E-15	-0.001710101	-0.000648372	-0.001047369	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.001208964	0.210415692
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	-4	-8.00E-16	-0.004145188	-0.001465753	-0.002538519	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.002930883	0.086794674
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	-3	-6.00E-16	-0.004996954	-0.001766846	-0.003060087	-0.00353338	-0.00353338	-2E-07	-0.00353338	0.003533224	0.071997977
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	-2	-4.00E-16	-0.003940054	-0.001393123	-0.00241284	-0.002786039	-0.002786039	-1E-07	-0.002786039	0.002785935	0.091310464
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	-1	-2.00E-16	-0.001378187	-0.000843994	-0.000487315	-0.000974525	-0.000974525	-6E-08	-0.000974525	0.000974473	0.261048724
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	0	0.00E+00	0.001710101	0.000604612	0.001047429	0.001209224	0.001209224	0	0.001209224	0.001209224	0.210370485
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	1	2.00E-16	0.004145188	0.001465597	0.002538519	0.00293109	0.00293109	6E-08	0.00293109	0.002931038	0.086790058
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	2	4.00E-16	0.004996954	0.001766794	0.003060057	0.00353338	0.00353338	1.2E-07	0.00353338	0.003533276	0.071996918
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	3	6.00E-16	0.003940054	0.001393175	0.00241287	0.002786039	0.002786039	1.8E-07	0.002786039	0.002785883	0.09132167
0.005	3.14159E+15	0.34906585	1.047197551	0.785398163	4	8.00E-16	0.001378187	0.00048747	0.000844084	0.000974525	0.000974525	2.4E-07	0.000974525	0.000974317	0.261090488
0.005	3.14159E+15	0.34906585	1.308996939	0.785398163	-5	-1.00E-15	-0.001710101	-0.00031326	-0.001168098	-0.001209224	-0.001209224	-3E-07	-0.001209224	0.001471905	0.172827071
0.005	3.14159E+15	0.34906585	1.308996939	0.785398163	-4	-8.00E-16	-0.004145188	-0.000758854	-0.002831278	-0.00293109	-0.00293109	-2E-07	-0.00293109	0.003568387	0.071288505
0.005	3.14159E+15	0.34906585	1.308996939	0.785398163	-3</										

Table 3. Amplitude influence analysis of electromagnetic wave interference.

AP	AQ	ω	$\phi(20^\circ)$	$\alpha(30^\circ)$	$\beta(45^\circ)$	t	APt	PtX	PtY	PtZ	AQ	QtX	QtY	QtZ	r	k	
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-1.7101E-06	-1.19722E-06	-8.6442E-07	-1.20922E-06	-0.001710101	-0.001209224	-0.0000003	-0.001209224	0.00170839	0.295240129
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-1.44519E-06	-2.6584E-06	-1.67339E-06	-2.93109E-06	-0.00145188	-0.00293109	-0.00000024	-0.00293109	0.00414236	0.121796495
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-4.96955E-06	-3.15E-06	-1.92257E-06	-3.53338E-06	-0.00496954	-0.00353338	-0.00000018	-0.00353338	0.004992229	0.102136436
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-3.94005E-06	-2.47278E-06	-1.45994E-06	-2.78604E-06	-0.003940054	-0.002786039	-0.00000012	-0.002786039	0.003936335	0.128136437
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-1.37819E-06	-8.73964E-07	-5.39224E-07	-7.14525E-07	-0.001378187	-0.000974525	-0.00000006	-0.000974525	0.00373688	0.366326825
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	1.7101E-06	1.94722E-06	8.64612E-06	1.20922E-06	0.001710101	0.001209224	0	0.001209224	0.001708505	0.295221797
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	1	2.00E-16	4.14519E-06	2.5684E-06	1.51751E-06	2.93109E-06	0.00145188	0.00293109	0.00000006	0.00293109	0.004141299	0.121794623
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	2	4.00E-16	4.96955E-06	3.12E-06	1.87061E-06	3.53338E-06	0.00496954	0.00353338	0.00000012	0.00353338	0.00499225	0.101034207
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	3	6.00E-16	3.94005E-06	2.50278E-06	1.5489E-06	2.78604E-06	0.003940054	0.002786039	0.00000018	0.002786039	0.003936314	0.128137127
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	4	8.00E-16	1.37819E-06	8.73964E-07	6.35109E-07	7.14525E-07	0.001378187	0.000974525	0.00000024	0.000974525	0.001378818	0.366324376
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-1.7101E-05	-1.06222E-05	-6.30593E-05	-1.20922E-05	-0.001710101	-0.001209224	-0.0000003	-0.001209224	0.00169405	0.297740889
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-1.44519E-05	-2.5504E-05	-1.48633E-05	-2.93109E-05	-0.00145188	-0.00293109	-0.00000024	-0.00293109	0.004106455	0.122828085
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-4.96955E-05	-3.069E-05	-1.78228E-05	-3.53338E-05	-0.00496954	-0.00353338	-0.00000018	-0.00353338	0.004950301	0.101890374
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-3.94005E-05	-2.41878E-05	-1.40341E-05	-2.78604E-05	-0.003940054	-0.002786039	-0.00000012	-0.002786039	0.003903276	0.129221717
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-1.37819E-05	-8.46994E-06	-4.92459E-06	-7.14525E-06	-0.001378187	-0.000974525	-0.00000006	-0.000974525	0.001365316	0.369429529
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	1.7101E-05	1.94722E-05	6.94612E-06	1.20922E-05	0.001710101	0.001209224	0	0.001209224	0.001694156	0.297722211
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	1	2.00E-16	4.14519E-05	2.5417E-05	1.47074E-05	2.93109E-05	0.00145188	0.00293109	0.00000006	0.00293109	0.004106519	0.122826183
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	2	4.00E-16	4.96955E-05	3.066E-05	1.77708E-05	3.53338E-05	0.00496954	0.00353338	0.00000012	0.00353338	0.004950322	0.101889936
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	3	6.00E-16	3.94005E-05	2.42178E-05	1.08061E-05	2.78604E-05	0.003940054	0.002786039	0.00000018	0.002786039	0.003903255	0.129222442
0.000005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	4	8.00E-16	1.37819E-05	8.55964E-06	6.08047E-06	7.14525E-06	0.001378187	0.000974525	0.00000024	0.000974525	0.001365232	0.369446784
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-0.000171011	-0.00014872	-6.0721E-05	-0.00120922	-0.001710101	-0.001209224	-0.0000003	-0.001209224	0.001551658	0.325063805
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-0.000414519	-0.00025387	-0.000146782	-0.000293109	-0.00145188	-0.000293109	-0.00000024	-0.00293109	0.003761309	0.134099072
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-0.000499955	-0.00030609	-0.000176825	-0.000353338	-0.00496954	-0.00353338	-0.00000018	-0.00353338	0.004534234	0.111239966
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-0.000394005	-0.000241338	-0.000139406	-0.000278604	-0.003940054	-0.002786039	-0.00000012	-0.002786039	0.003573211	0.141079236
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-0.000137819	-8.44264E-05	-4.87782E-05	-7.14525E-05	-0.001378187	-0.000974525	-0.00000006	-0.000974525	0.001250562	0.403328981
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	0.000171011	0.000104722	6.94612E-05	0.000120922	0.001710101	0.001209224	0	0.001209224	0.001551767	0.325041112
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	1	2.00E-16	0.000414519	0.00025387	0.000146906	0.000293109	0.00145188	0.000293109	0.00000006	0.00293109	0.003761374	0.134096755
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	2	4.00E-16	0.000499955	0.00030609	0.000176773	0.000353338	0.00496954	0.00353338	0.00000012	0.00353338	0.004534235	0.111239434
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	3	6.00E-16	0.000394005	0.000241368	0.000139418	0.000278604	0.003940054	0.002786039	0.00000018	0.002786039	0.003573189	0.141080091
0.0005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	4	8.00E-16	0.000137819	8.45164E-05	4.89341E-05	7.14525E-05	0.001378187	0.000974525	0.00000024	0.000974525	0.0012505497	0.40334944
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-0.001710101	-0.001047369	-0.000604872	-0.001209224	-0.001710101	-0.001209224	-0.0000003	-0.001209224	0.000625863	0.805994282
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-0.004145188	-0.002538519	-0.001451573	-0.000293109	-0.00145188	-0.000293109	-0.00000024	-0.00293109	0.001511782	0.332450568
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-0.004999541	-0.003060087	-0.001760946	-0.003533338	-0.00496954	-0.003533338	-0.00000018	-0.003533338	0.001828966	0.275777745
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-0.003940054	-0.00241284	-0.001393123	-0.002786039	-0.003940054	-0.002786039	-0.00000012	-0.002786039	0.004534031	0.11123826
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-0.001378187	-0.000843994	-0.000487315	-0.000974525	-0.001378187	-0.000974525	-0.00000006	-0.000974525	0.000504436	0.999905154
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	0.001710101	0.001047219	0.000604612	0.001209224	0.001710101	0.001209224	0	0.001209224	0.00062594	0.80588047
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	1	2.00E-16	0.004145188	0.002538429	0.001455597	0.000293109	0.00145188	0.000293109	0.00000006	0.00293109	0.001517299	0.33244036
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	2	4.00E-16	0.00499954	0.00306057	0.00176794	0.00353338	0.00496954	0.00353338	0.00000012	0.00353338	0.001828981	0.275775403
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	3	6.00E-16	0.003940054	0.00241287	0.001393175	0.002786039	0.003940054	0.002786039	0.00000018	0.002786039	0.001442113	0.349756181
0.005	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	4	8.00E-16	0.001378187	0.000844084	0.00048747	0.000974525	0.001378187	0.000974525	0.00000024	0.000974525	0.000504389	0.999997488
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-5	-1.00E-15	-0.017101007	-0.010472335	-0.006046379	-0.012092238	-0.001710101	-0.001209224	-0.0000003	-0.001209224	0.015517742	0.032503956
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-4	-8.00E-16	-0.041451879	-0.025384108	-0.01465566	-0.002931094	-0.004145188	-0.00293109	-0.00000024	-0.00293109	0.037614012	0.013499577
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-3	-6.00E-16	-0.04999541	-0.0306006	-0.01766705	-0.035333802	-0.00496954	-0.00353338	-0.00000018	-0.00353338	0.045340016	0.011123826
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-2	-4.00E-16	-0.039400538	-0.024127863	-0.013930298	-0.027860387	-0.003940054	-0.002786039	-0.00000012	-0.002786039	0.035752527	0.014107741
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	-1	-2.00E-16	-0.013781868	-0.008439666	-0.004872678	-0.009745252	-0.001378187	-0.000974525	-0.00000006	-0.000974525	0.012505854	0.040332152
0.05	0.005	3.14159E+15	0.34906585	0.523598776	0.785398163	0	0.00E+00	0.017101007	0.010472185	0.006046119	0.012092238	0.001710101	0.001209224				

5. Elementary particles - Baidu Encyclopedia ,
<https://baike.baidu.com/item/%E5%9F%BA%E6%9C%AC%E7%B2%92%E5%AD%90/79521?fr=aladdin>
Application date 2023.1.27.

6. Same frequency interference-Baidu Encyclopedia ,
<https://baike.baidu.com/item/%E5%90%8C%E9%A2%91%E5%B9%B2%E6%89%B0/6509379?fr=aladdin>
Quote date January 27, 2023.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.