Antenna model of the atom

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Abstract.

Quantum-mechanical model of the atom describes very well all known phenomena associated with atomic structure. This model provides excellent quantitative and predictive framework for understanding atomic behavior. However, it does not provide adequate physical interpretation of the observed behavior of the atom. In this article, I propose a new physical interpretation of the atomic structure based on atom's behavior as a miniature antenna. I propose and show that atom is formed from a system of binary virtual emitters of E-type and H-types, forming coherent closed electromagnetic field with zero energy emission in the far zone and continuous energy redistribution in the near zone. This important observation provides physical explanation to atomic stability. Additionally, I show that many other fundamental properties of the atom could be physically adequately explained using the new antenna model of the atom.

Introduction.

1.1 The modern quantum-mechanical model of the atom describes the structure and properties of the atom based on the following axioms: a) there is a positively-charged nucleus consisting of protons (p) and neutrons (n) in the center of every atom; b) electrons (e) move around an atom's nucleus in specific regions of space called orbitals, and the number of electrons in the ground state is equal to the charge of the nucleus (Z); c) the state of each electron in an atom is determined by quantum numbers (n, l, m_l, m_s) that defines its energy level and degree of freedom; d) the probability of finding electrons in any specific region around an atom's nucleus is determined by the square of the wave function Ψ^2 which can be thought of as amplitude of the wave represented by the electron as a function of electron coordinates; e) the emission energy of an atom has quantized values due to the presence of strictly limited energy states of electrons, whilst the difference in the energies of those states is equal to the quantum of the energy emitted (or absorbed) during the transition of an electron from one state to another [1,2,3].

As of today, the quantum-mechanical model of the atom describes, as much as possible, the known properties and behavior of the atom. However, it does not provide a physical interpretation of the following phenomena:

- Why is it that the electrons moving (i.e. undergoing changes in position with respect to the nucleus over time) around the atomic nucleus do not emit electromagnetic energy?
- What determines the structure of electron shells in an atom?

- How can the occurrence of the "atomic emission spectra" be explained using physical principles and understanding?
- How can the emission and absorption of a photon, as well as its wave-particle duality, be explained and reconciled?
- How is the energy of electromagnetic waves stored in the quantum world?
- Why do atoms effectively absorb and emit visible light, despite the size of atoms being thousands of times smaller than the wavelength of light?

The proposed antenna model of the atom, described in the following sections, preserves the axioms of the quantum-mechanical model, adequately reflects the known experimental data of the atomic structure, but, crucially, it explains the *physical basis* of atomic stability, as well as the mechanism of photon emission and absorption during transitions between stable states [4,5].

Moreover, assuming that the foundation of gravity is a physical field, the proposed antenna model of the atom allows us to understand the physical basis of atomic gravitational fields, as well as the physical basis for mechanism of gravity formation and the interaction of material bodies between each other.

Results.

Atom is a miniature antenna formed by virtual E- and H-type emitters.

2.1 In a stable state, the dynamic structure of an atom is equivalent to a system consisting of two virtual binary emitters of the electric (E-type) and magnetic (H-type) types which have a variable orientation in three dimensional space and continuously emit anti-phase coherent electromagnetic waves (Fig.1a).

2.2 The number of pairs of the virtual E-type and H-type emitters in a given atom is equal to the atomic number of a particular element (Z):

$$Z = \text{number of electrons (e)} = \text{number of protons (p)} \qquad (1)$$

2.3 Each pair of the virtual E-type and H-type emitters in an atom is formed due to oscillation and rotational motions of one electron of a given magnetic moment with respect to a corresponding proton in the nucleus, whilst the E-type and H-type emitters of this electron-proton pair have a common phase center and continuously emit anti-phase coherent electromagnetic waves of a certain frequency (Fig.1b).

2.4 The electrical sizes of L_i values of the virtual E-type and H-type emitters in each pair under complete compensation by interference of their radiation in the far zone are a multiple of the integral number of an electron's waves (λ_B) during its motion in an atom, which ensures creation of a spherical standing wave for each pair of the emitters:

$$L_i = n\,\lambda_B, \text{ where } n = 1, 2, \ldots Z \text{ are integral numbers.} \qquad (2)$$

In a stable state for each pair of E-type and H-type virtual emitters with the circumference length (L_H) for H-type and the length of the vibrator (L_E) there is an integral number of De Broglie waves to ensure formation of a standing wave (Fig.1c) [3].

2.5 Each virtual E-type and H-type emitter forms an electromagnetic field in space with similar properties (Fig. 1d) [6,7,8,9,10,11].

Fluxes of electromagnetic fields from the E-type emitter:

$$\begin{gathered} H_\varphi(\theta, r) = I_{\text{dip}} \frac{ikl \sin\theta}{4\pi r}\left(1 + \frac{1}{ikr}\right)e^{-ikr}, \\ H_\theta(\theta, r) = 0, \\ H_r(\theta, r) = 0, \\ E_r(\theta, r) = Z_0 I_{\text{dip}} \frac{l \cos\theta}{2\pi r^2}\left(1 + \frac{1}{ikr}\right)e^{-ikr}, \end{gathered} \qquad (3)$$

$$\begin{gathered} E_\theta(\theta, r) = Z_0 I_{\text{dip}} \frac{ikl \sin\theta}{4\pi r}\left(1 + \frac{1}{ikr} - \frac{1}{(kr)^2}\right)e^{-ikr}, \\ E_\varphi(\theta, r) = 0. \end{gathered} \qquad (4)$$

Fluxes of electromagnetic fields from the H-type emitter:

$$\begin{gathered} H_\varphi(\varphi, \theta, r) = I_{\text{loop}} \frac{a^2 \sin\varphi}{4r^3}(-1 + k^2r^2 - ikr)e^{-ikr}, \\ H_\theta(\varphi, \theta, r) = I_{\text{loop}} \frac{a^2 \cos\varphi \cos\theta}{4r^3}(1 - k^2r^2 + ikr)e^{-ikr}, \\ H_r(\varphi, \theta, r) = 0, \end{gathered} \qquad (5)$$

$$\begin{gathered} E_\theta(\varphi, \theta, r) = Z_0 I_{\text{loop}} \frac{(ka)^2}{4r}\left(1 + \frac{1}{ikr}\right)\sin\varphi \cdot e^{-ikr}, \\ E(\varphi, \theta, r) = Z_0 I_{\text{loop}} \frac{-(ka)^2}{4r}\left(1 + \frac{1}{ikr}\right)\cos\varphi \cos\theta \cdot e^{-ikr}, \\ E_r(\varphi, \theta, r) = 0. \end{gathered} \qquad (6)$$

where: r - the distance between the center of radiation and the observation point, l - the length of the dipole, a - the radius of the frame, I_{dip} - currents in the dipole, I_{loop} - currents in the frame, the wave number, $k = 2\pi\,\lambda$, λ - the wavelength in free space.

2.6 Under stable conditions, there is an interference of two anti-phase fluxes of electromagnetic fields from the E-type and H-type emitters from each pair, which ensures the following:

- an atom does not emit any electromagnetic energy into space (the real part of the Poynting vector flux is equal to zero);
- the energy fluxes from the E-type and H-type emitters of each pair are redistributed between these emitters in the near zone of radiation;
- the energy of the reactive electromagnetic field of the paired E-type and H-type emitters is concentrated in the near zone of radiation (the imaginary part of the Poynting vector flux is not equal to zero);
- the total energy in the near zone for a pair of the E-type and H-type emitters determines the energy state for a given atom, known as the energy level of the electron's state (s, p, d etc.) (Fig. 2a).

The energy is re-distributed in the near zone for two coherent virtual emitters of E- and H-types without energy being emitted into the far zone (Fig. 2b) [12,13,14,15].

$$S = S_1 + S_2 + S_{int}, \quad S_j = \tau \operatorname{Re}[(e_j \times h^*_j)], \quad S_{int} = \tau \operatorname{Re}[(e_1 \times h^*_2) + (e_2 \times h^*_1)] \qquad (7)$$

where S_j – energy fluxes of single waves (j=1,2), S_{int} – interference flux , $\tau = c/8\pi$, c – speed of light in a vacuum, e_j and h_j – complex field strengths.

$$\int S_{int}\, d\delta_j = F\cos\delta\ \omega\ \pm\ G\sin\delta \qquad (8)$$

where F cos δ - determines the change in the interference power of each dipole depending on the local features of the radiation in the near zone, G sin δ - determines interference power transfer between dipoles, $\delta = \varphi_2 - \varphi_1$ - the difference in the initial phases of dipole moments j

$$F = (\omega/2l^3)\, p_1 p_2\, (u \sin kl + \nu \cos kl),$$
$$G = (\omega/2l^3)\, p_1 p_2\, (u \cos kl + \nu \sin kl), \qquad (9)$$
$$u = (k^2 l^2 - 1)(\cos\psi + \cos\gamma_1 \cos\gamma_2) - 2\cos\gamma_1 \cos\gamma_2$$
$$\boldsymbol{\nu} = k\,l\,(\cos\psi + 3\cos\gamma_1\cos\gamma_2)$$

Based on such effect one can explain radiationless energy transfer in the near zone from E- to H- and H- to E-types for two oriented dipoles (Fig. 1b,c) [15,16,17,18,19,20].

2.7 In a ground state, the stability of electron's motion in its orbital is ensured by negative feedback formed between the E-type and H-type emitters of one pair (electron and proton) and by the interference of their electromagnetic radiation fluxes in the far zone (Fig. 3a,b).

Stable state of an atom is ensured under the following conditions:

- certain discrete electrical sizes of the E-type and H-type emitters of each pair;

- complete interference of each pair of the E-type and H-type emitters in the far zone;

- when there is a coherent redistribution of the reactive energy flux between the E-type and H-type emitters in the near zone.

The dynamic structure of each pair of the E-type and H-type emitters corresponds to an energy level and a specific region of space with an electron's probable motion trajectory, called an atomic orbital.

2.9 The square of the wave function Ψ^2 describes the spatial position of electrons as a function of coordinates during their motion in an atom during the formation of the E-type and H-type virtual emitters of each pair, which corresponds to the known orbitals (such as s, p, d etc) [2,3].

2.10 Under certain external influences on the atom, interference of the electromagnetic field from the E-type and H-type emitters is interrupted, which leads to structural rearrangements of the atom ((Fig. 3d, Fig. 4):

- a short-term emission into space of a radio pulse with a duration determined by the time of structural adjustment and a basic frequency equal to the emission frequency of a given pair of the E-type and H-type emitters (Fig. 4b);

- a decrease in the electrical sizes L_i of the corresponding pair of the E-type and H-type virtual emitters to the next stable state;

- a new stable state of an atom is established;

- a radio pulse emitted into space is a photon that has wave-particle properties;

- the direction of emission of a radio pulse (a photon) is random and depends on the spatial orientation of the E-type and H-type emitters at the moment of their misphasing.

2.11 Absorption of a radio pulse (absorption of a photon) with a certain frequency is also carried out by the corresponding pair of the E-type and H-type virtual emitters at a resonant frequency, which leads to an increase in the reactive energy of the near zone and, accordingly, to an increase in the electrical sizes of the given pair of the E-type and H-type virtual emitters to the next stable state (Fig. 4c).

2.12 The photons emitted by an atom are radio pulses whose duration is determined by the structural rearrangement period of the corresponding pair of the E-type and H-type emitters. The basic frequency of radio pulses is determined by the resonant frequency of the E-type and H-type emitters in a stable state of an atom, and the emission direction of a radio pulse (a photon) is determined by a random spatial position of the emitters in case of interruption of their interference in the far zone of radiation, while the radio pulse (a photon) emitted by an atom has the properties of both a particle and a wave (Fig. 4d).

Atom as an antenna

Atom is a receiving and transmitting antenna with miniature electric sizes whose aperture is determined by the size of the near zone radiation of the paired virtual E-type and H-type emitters.

3.1 An atom, as electrodynamic system, consists of paired virtual emitters of the E-type and H-type dipole types with a changing spatial orientation, as well as of virtual generators and virtual resonators of open type whose function is accomplished by the near zone of radiation (L_{atom} = 0,1 nm <<λ_{light} = 400…600 nm) (Fig. 5) [21,22,23].

3.2. The emission power of a pair of atom's virtual E-type and H-type emitters is determined by the power of a calibrated virtual generator.

3.3 The stored pulsed energy of the reactive electromagnetic field is concentrated in an open-type virtual resonator – a region of the near zone of radiation whose sizes are significantly larger than the sizes of the E-type and H-type emitters, i.e. the sizes of an atom [23].

3.4 Due to the field's internal reactive energy in the near zone of each pair of the E-type and H-type emitters, an atom is equivalent to a system of antennae with a large aperture and, if the compensation of a pair of the E-type and H-type emitters is violated, the atom efficiently emits electromagnetic energy (a photon) in the form of a radio pulse as a matched antenna.

3.5 During photon absorption, an atom distorts and suppresses the field of the incident electromagnetic wave in the form of a radio pulse – of a photon in the near zone region, absorbing the energy of the external field (of a photon), whilst the virtual sizes of the receiving antenna are determined by the sizes of the near field of the E-type and H-type emitters of an atom.

3.6 Emission of a radio pulse – of a photon – leads to a decrease in the energy of the near field and, accordingly, to a sharp decrease in the electrical sizes of the corresponding pair of the virtual E-type and H-type emitters to the next stable state, while the collapse of the electron shell provides an additional shift (increase) in the frequency of the emitted radio pulse* (Doppler effect);

3.7 Absorbing a radio pulse – of a photon – leads to a sharp increase in the electrical sizes of the corresponding pair of the virtual E-type and H-type emitters to the next stable level, while the expansion of the electron shell provides an additional shift (decrease) in the frequency of the received radio pulse (Doppler effect).

During an abrupt change in the electrical sizes of the virtual E-type and H-type emitters (equivalent to the changes in the electron shell transitions) the above-mentioned effects related to the Doppler frequency shift indicate that the emission and absorption spectra of atoms are strictly not similar.

Atom as a source of the gravitational field

Currently in the theory of gravity it is widely thought that gravitational waves are emitted by moving masses and that they present themselves as changes in the gravitational field which propagate through space similar to waves. Indeed, the motion of a mass in relation to the observation point causes a change in the gravitational force. For example, when two black holes travel through the universe, gravitational waves propagate from them with a frequency of their rotation [25, 26].

There are known examples where gravity works via control signal - the laws of motion and oscillation of a body in space. Precisely these changes in the degree of gravity due to a mass motion are called gravitational waves, and there are attempts to measure them (Fig. 6 a) [27,28].

However, such definition of a gravitational wave demonstrates only a space-time change in the gravitational force, and it does not cover the structure and nature of the gravitational wave itself. From the point of view of radio engineering, such changes in a physical quantity are equivalent to an amplitude modulation of a wave, i.e. changes in the amplitude of the carrier wave via a control signal (Fig. 6b) [28,30,31].

Stationary mass with respect to the observer also creates a gravitational field and attraction force which is constant in magnitude.

Assuming that graiational field between stationary objects also has wave-like properties, then discription of a gravitational field during movement of the object will be as follows (Fig. 6c):

At this point one may ask: what is a gravitational field? How is it formed, and how does it propagate? The antenna model of the atom provides answers to these questions.

Each atom in a ground state creates a gravitational field in the surrounding space. It is both a physical and electromagnetic field formed by pairs of longitudinal coherent components of the electric and magnetic field strengths with a frequency equal to the corresponding frequency of an atom's optical spectrum and quantized amplitude. The amplitude corresponds to the energy state of an atom, whilst the gravitational field of a body is a superposition of gravitational fields of all the atoms included in a given body.

4.1 In a ground state of an atom:

- in the far zone of radiation of each pair of the virtual E-type and H-type emitters, two anti-phase fluxes of electromagnetic fields interfere destructively. An atom does not emit electromagnetic energy into space, and the energy fluxes are distributed between the E-type and H-type emitters of each pair;
- the energy of reactive electromagnetic fields of all the paired E-type and H-type emitters of an atom with its own oscillation frequency is concentrated in the near zone;
- in the radial direction, uncompensated longitudinal coherent components of the electromagnetic fields of each pair of E-type and H-type emitters, however, remain (Fig. 7a).

Formation of an atom's gravitational field due to the total energy of the reactive electromagnetic fields in the near zone of an atom:

4.2 The space in the near zone of radiation of all the paired E-type and H-type emitters in an atom with concentrated reactive fluxes of the electromagnetic energy, is equivalent to space charge of the 3rd type – "W" with the following properties (Fig. 7b):

a) the value of the space charge W is the total energy of the reactive electromagnetic field in the near zonw of all the virtual E-type and H-type emitters of an atom;

b) in space, the reactive electromagnetic field of the space charge W is formed by the radially directed longitudinal E-type and H-type field components of all the pairs of the E-type and H-type emitters, which decreases inversely to the square of the distance – $1/R^2$ (Fig. 7a);

c) the space charges W_n (n = 1, 2.....N) of different atoms interact with each other through these longitudinal electromagnetic fields and are always attracted (Fig. 7b);

d) the gravity force of two space charges W_1 and W_2 for two different atoms is directed along the straight line connecting these charges. It is directly proportional to their value, i.e. to the energy of the reactive field of the near field, and is inversely proportional to the square of the distance between them;

e) if the space charges W_n do not affect each other, in this case their action obeys the superposition principle.

An atom is a source of the gravitational field of a substance (the reactive electromagnetic field in the near field of an atom creates a gravitational field) (Fig. 7d).

Discussion.

- the total energy of the reactive electromagnetic field W_n in the near zone of the atom "n" is equivalent to the gravitational mass of an atom. ($M_n = W_n$) (Fig. 7d);
- the gravitational mass of an atom depends on the quantity of the paired E-type and H-type emitters in the atom, and it is proportional to the inertial mass of the atom;
- the inertial mass, "m", of an atom is formed from electromagnetic fields that fills the atomic space. These fields counteracts and prevents changes in the dynamic characteristics of electron-proton pairs:

    a) dynamic structure of the atom is formed of electron-proton pairs and electromagnetic field in the space between protons and electrons;

    b) when outside force acts on the atom, dynamic characteristics of the atom are also changed. The electromagnetic field forms a new shifted electromagnetic field, which interacts with electron-proton pairs, making new side force which opposes the outside force that initially caused changes in electron-proton pairs.

c) the resulting inertial mass, “m”, is proportional to the sum of charges squared of all electron-proton pairs (Fig. 7a).

Additionally, the resulting opposing force is independent of the charges that form it but always acts in opposite direction to the outside force that caused it. This can be described by equation:

$$m = \sum_{1}^{n} \frac{\mu}{8\pi} \frac{e^2}{r} , \qquad (9)$$

where: m –inertial mass, $\mu -$ magnetic constant, $e -$ charge of the electron, r – radius of the atom

- the reactive electromagnetic field created in space by the longitudinal E-type and H-type components and reactive fields of an atomic nucleus is equivalent to the gravitational field of an atom;
- the resultant carrier wave of an atom’s gravitational wave is multimodal. It has a discrete spectrum which corresponds to the spectrum of the atom, and is determined by the number of stable energy states of electrons in the atom (Fig.7d);
- during the transition of an atom from one stable state to another, for example, when a photon is emitted, the gravitational wave corresponding to the given level disappears during emission, and when a new stable state of the atom is established, it appears with a new frequency;
- the amplitudes of the emitted gravitational (electromagnetic) waves are determined by the energy of the reactive field in the near zone of an atom, i.e. by the known energy levels of an atom. Therefore, when stable states of an atom change, it causes changes of the level of the corresponding gravitational waves, which leads to quantization of the levels of the gravitational waves;
- the resultant gravitational wave emitted by an atom is a superposition of the waves emitted by all its paired E-type and H-type emitters, whilst the frequencies of these waves are discrete and correspond to the emission spectrum of the given atom, and the levels of the gravitational waves are quantized in accordance with the energy levels of atoms;

- the physical basis of gravity between two atoms, m_1 and m_2, is as follows:

a) In a stable state, the atom m1 does not emit electromagnetic radiation. The electromagnetic field is redistributed in the near zone. However, there are uncompensated pulsating electric and magnetic fields in the radial direction with the longitudinal components E and H. These fields are the gravitational field of the atom m1, which decreases inversely with the square of the distance from the atom.

b) When another atom, m_2, is in the gravitational field of atom m_1, it experiences longitudinal electromagnetic forces created by m1. During this process, the longitudinal electromagnetic forces m1 change the dynamic characteristics movements and the interaction of electrons and protons m_2.

Consequently, the electromagnetic field m_2 is distorted and forms a new altered electromagnetic field, which must interact with the electrons and protons m_2 through a new additional lateral force. This lateral force is directed against the force that causes it, it is directed to the atom m1 and leads to the attraction of m_2 to m_1. This lateral force is what we call gravity between two atoms.

- when light waves from external sources fall into the region of gravitational waves, which are multimodal electromagnetic waves, interference occurs that leads to a change in the direction of external light. This explains the well-known fact that the distribution of light changes in the gravitational field

References.

1. Lifshitz E.M., and Sykes Landau (JB). Quantum Mechanics; Non-relativistic Theory. Pergamon Press, 1965.
2. Sommerfeld A. Atom structure and spectra. Volume 1 –GITTL, 1956.
3. Shpolsky E.V. Atomic physics. Volume 2. Fundamentals of quantum mechanics and the structure of the electron shell of an atom 4th ed. Nauka, 1974
4. Yatskevich V.A. "The development of the technology to create energy plants for direct conversion of the energy of the atom into electrical and thermal energy." Proceedings of the Second International Conference "Alternative energy sources for big cities" October 10, 2006 Moscow
5. Yatskevich V.A. "Creating power plants for direct conversion of internal energy into thermal and electrical energy". Proceedings of the IV International Conference "Alternative energy sources for big cities." 347-356 / October 21, 2010, Moscow
6. Weinstein L.A. Electromagnetic waves. M. Sov. radio, 1957, 581 s
7. Sazonov D. M. Antennas and microwave devices: a Textbook for radio specialialist universities. Higher School, 1988.
8. Fujimoto K., James J.R. Mobile Antenna System Handbook. Artech House, 2004
9. Vendik O.G., Pakhomov I.A., "Electric and magnetic fields in the Fresnel zone of a microradiator composed of electric and magnetic dipoles," ZhTF Journal of Technical Physics, Volume 75, no. 11, pp. 86 - 91.
10. Fradin A.Z. Antenna feeder devices. Communication, 1977
11. Kanda M.Y., Douglas M.G., Mendivil E.D., Ballen M., Gessner A.V., Chou Ch.-K. IEEE Trans on Microwave Theory and Techniques. 2004. Vol. 52. N 8. P. 2013--2020
12. Stepanov N. S. Wave interference. Physical Encyclopedia: [in 5 vol.] / Ch. ed. A.M. Prokhorov. Soviet Encyclopedia; Great Russian Encyclopedia, 1988-1999
13. Afanasyev S.A., Sementsov D. I., "Energy flows during the interference of electromagnetic waves", UFN, 178: 4 (2008), 377–384
14. Belichenko V.P., Zapasnoy A. S., Shestakov P. V., "Control of the magnitude and spatial distribution of interference energy flows in near fields of systems of identical radiators", Opt. Spectrosc., 2015, 118: 4, 605
15. Kolokolov A.A., Skrotskii G V Sov. Phys. Usp. 35 1089 (1992)
16. Sidorenkov V.V., Tolmachev V.V. Vest. MSTU. Ser. Instrumentation (1) 43 (1992)
17. Sidorenkov V.V., Tolmachev V.V., Fedotova S.V. In Izv. RAS, Ser. physical 61,237 (1997)
18. Yatskevich V.A. Patent Device for measuring the amplitude and phase of the microwave signals No. SU 1180811 A, IPC G 01 R 29 | 08.
19. Yatskevich V.A. Patent Measuring probe No. SU 1215061 A, IPC: 4G 01 R 29/08.
20. Yatskevich V.A. A method for measuring the phase of the field distribution of the antenna SU 1552133 A, IPC: G 01 R 29/10.
21. Bohren C.F. How can a particle absorb more than the light incident on it? Am J Phys, 51 # 4. Apr. 1983. p. 323.
22. Paul H., Fischer R. Light Absorption by a dipole. SOV.PHYS.USP 26 (10). Oct. 1983. P. 923-926.
23. Erkin A. Efficient reception of signals by electrically small antennas, - magazine "CHIP NEWS" # 7, 2004.
24. Abbott B.P. (LIGO Scientific Collaboration and Virgo Collaboration) et al. Observation of Gravitational Waves from a Binary Black Hole Merger (Eng.) Physical Review Letters: journal. - 2016. - Vol. 116, no. 6.
25. Abbott B.P. GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence (Eng.) Physical Review Letters: journal. – 2016 15 June (vol. 116, no. 24). - P. 241103.
26. B. P. Abbott (LIGO Scientific Collaboration and Virgo Collaboration) et al. Observation of Gravitational Waves from a Binary Black Hole Merger (Eng.) Physical Review Letters: journal. - 2016. - Vol. 116, no. 6.

27. Yunes N., Siemens X. Gravitational-Wave Tests of General Relativity with Ground-Based Detectors and Pulsar-Timing Arrays. Living Reviews in Relativity. - 2013. - T. 16. - S. 9.
28. Lit. Frisch S. Optical spectra of atoms. M .; L., 1963;
29. Sobelman I.I. Introduction to the theory of atomic spectra. 2nd ed. M., 1977;
30. Progress in atomic spectroscopy. N. Y., 1978-1979. Pt. A, B;
31. Elyashevich M.A. Atomic and molecular spectroscopy. 2 ed. M., 2000.

Figure legends

Figure 1. Antenna model of the atom.

A. The atomic structure is equivalent to a system consisting of a set of binary (paired) anti-phase emitters of the electric (E-type) and magnetic (H-type) type with a common phase center for each pair, The number of pairs of these binary emitters is equal to the element number (Z).
B. The virtual emitters of the E-type and H-type in each pair are formed due to oscillation and rotational motions of one electron in relation to a corresponding proton of the nucleus.
C. In a stable state, for each pair of E-type and H-type virtual emitters, with the length (L_H) of the circumference for H-type and the length (L_E) of the oscillator, there is an integral number of De Broglie waves to satisfy the formation of a standing wave.
D. Dependency of the amplitude of active and reactive electromagnetic field of E-type and H-type emitters with distance R.

Figure 2. The distribution of electromagnetic energy fluxes in space from individual and combined E-type and H-type emitters.

A. The distribution of fluxes of electromagnetic energy in space from individual and combined E- and H-types of emitters. Radiation zones: 1- near Zone, 2- intermediate zone (Fresnel zone), 3- far radiation zone (Fraunhofer zone).
B. Interference effects in the system of two arbitrarily oriented radiating dipoles in a near zone. Anti-phase interference of signals from E- and H-type emiters in the far zone results in energy re-distribution in the near zone.
C. An example of formation of narrow radiation pattern due to partial interference in the far zone from E- and H-type of emiters. Dipole and frame as an example of E- and H-type emitters that form the radiation patterns in the far zone of three types: dipole alone, frame alone and paired dipole – frame.

Figure 3. Formation of a radio signal in the space and in the tract from two coherent emiters

A. In the ground state, there is a non-radiative energy transfer between the emitters of the E-type and H-type of each pair (n= 1, 2…Z) without detectable radiation in the far zone (P = 0). The pulsed power of the reactive electromagnetic field is concentrated in the near field of radiation. We can physically interpret the far zone as not having any detectable photon emission.
B. Addition of radiosignals in space from two coherent emiters with a common phase centre and narrow radiation pattern.
C. formation of signals in UWB cabels during addition of two hormonic oscillations, $X_1(t)$ and $X_2(t)$:
-frequency and amplititude are equal, phase shift $\Delta\phi = 0$ - signal is added,
-frequency and amplititude are equal, phase shift $\Delta\phi = \pi$ - signal is subtracted,
-frequency and amplititude are equal, phase shift $\Delta\phi_1 = 0$ and $\Delta\phi_2 = \pi$ with interval T leads to radio impulse formation.

Figure 4. Process of emission of a photon from the atom

A. In-phase wave addition in the far zone with equal path difference produces directional radiation and antiphase wave addition in the far zone with equal path difference mutually compensates for the radiation.
B. In the near zone, the reactive energy is redistributed between E- and H-type emitters. Dynamic structure of each pair of E- and H-types emiters has a corresponding energy level E_n, where n = 1,2…Z as well as space with a probable trajectory of electron movement, an orbital.

C. The energy of emitted photon is equal to the difference between energies of stationary states. When interference of ani-phase signals is interupted a short impulse is emitted in space with frequency being determined by the time it takes for atomic rearrangements for a given pair of E- and H-types emitters.
D. During external influences on the atom, there is a short term emission of a radio impulse (photon) in space over a short interval τ, determined by the duration of the rearrangements and frequency of addition $\nu_{kn.}$

Figure 5. Atom is an antenna with small electric sizes whose aperture is determined by the sizes of the near zone of radiation of the paired virtual E-type and H-types emitters

Figure 6. Structure of the gravitational waves

A. Interpretation of a registered gravitational wave signals by Abbott et al., 2016 [24-26].
B. An example of amplitude modulation (AM) of electric signal.
C. Gravitational field during relative movement of two masses, m_1 and $m_{2.}$ Changes in the distance between bodies m_1 and m_2 during rotation of m_2. Structure of the graviatational field G (t) during changes in the distance and changes in the attraction force between bodies m_1 and $m_{2.}$

Figure 7. Atom is the source of the gravitational field due to the energy of the reactive electromagnetic fields in the near zone of the atom

A. Gravitational mass of the atom is accumulated in the near zone of radiation of all of its paired E- and H-type emitters and their cobined field creates gravitational field of the atom.
B. Capacity charge of third degree W_1 and W_2 from atom 1 and 2, made from reactive fields in the near zone create mutually attractive forces $F_1 = F_2$ between atoms.
C. Mutually attractive forces F_1, F_2 and F_3 from three atoms 1, 2 and 3 because of their capacity charges W_1, W_2 and W_3 are directed straight across towards each other are governed by superposition principles.
D. Gravitational waves emitted by an atom with atomic number Z = 4 are a superposition of a longitudinally scalar electromagnetic field with a discrete frequency ν_1 ... ν_4 and a quantized amplitude G_1 ... G_4 emitted from all pairs of E- and H-type emitters:

- the frequency of gravitational waves, ν_1 ... ν_4, have discrete numbers and correspond to optical spectra of atomic emission;
- gravitational waves levels G_1 ... G_4 are quantised similar to the corresponding electron level quantisation;
- the resulting gravitational wave is multi-modal.

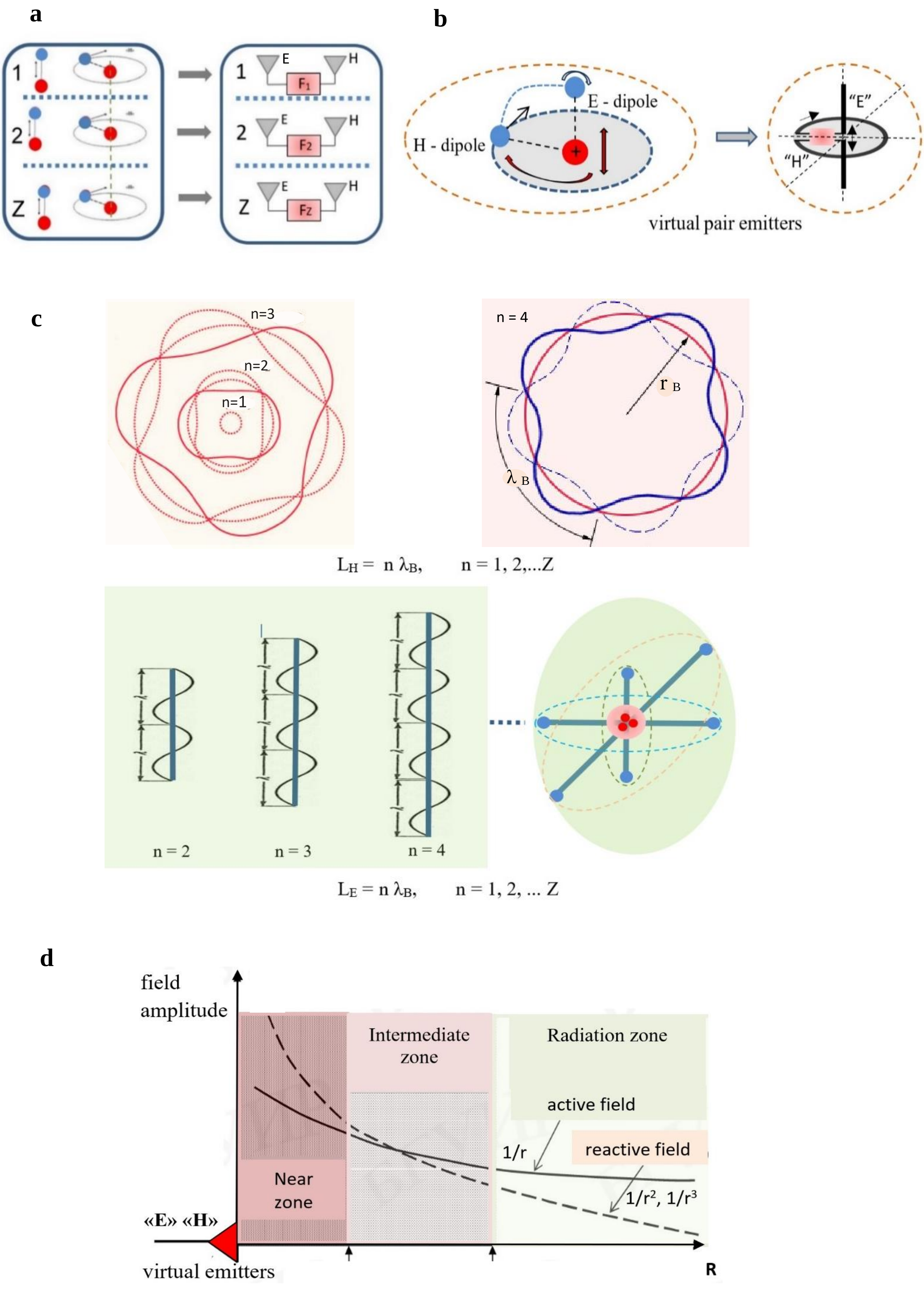

a
b
c
d
E
H
F1
F2
Fz
1
2
Z
E - dipole
H - dipole
"E"
"H"
virtual pair emitters
n=3
n=2
n=1
n = 4
r B
λ B
LH = n λB, n = 1, 2,...Z
n = 2
n = 3
n = 4
LE = n λB, n = 1, 2, ... Z
field
amplitude
Intermediate
zone
Radiation zone
active field
1/r
reactive field
Near
zone
1/r², 1/r³
«E» «H»
virtual emitters
R

Figure 1

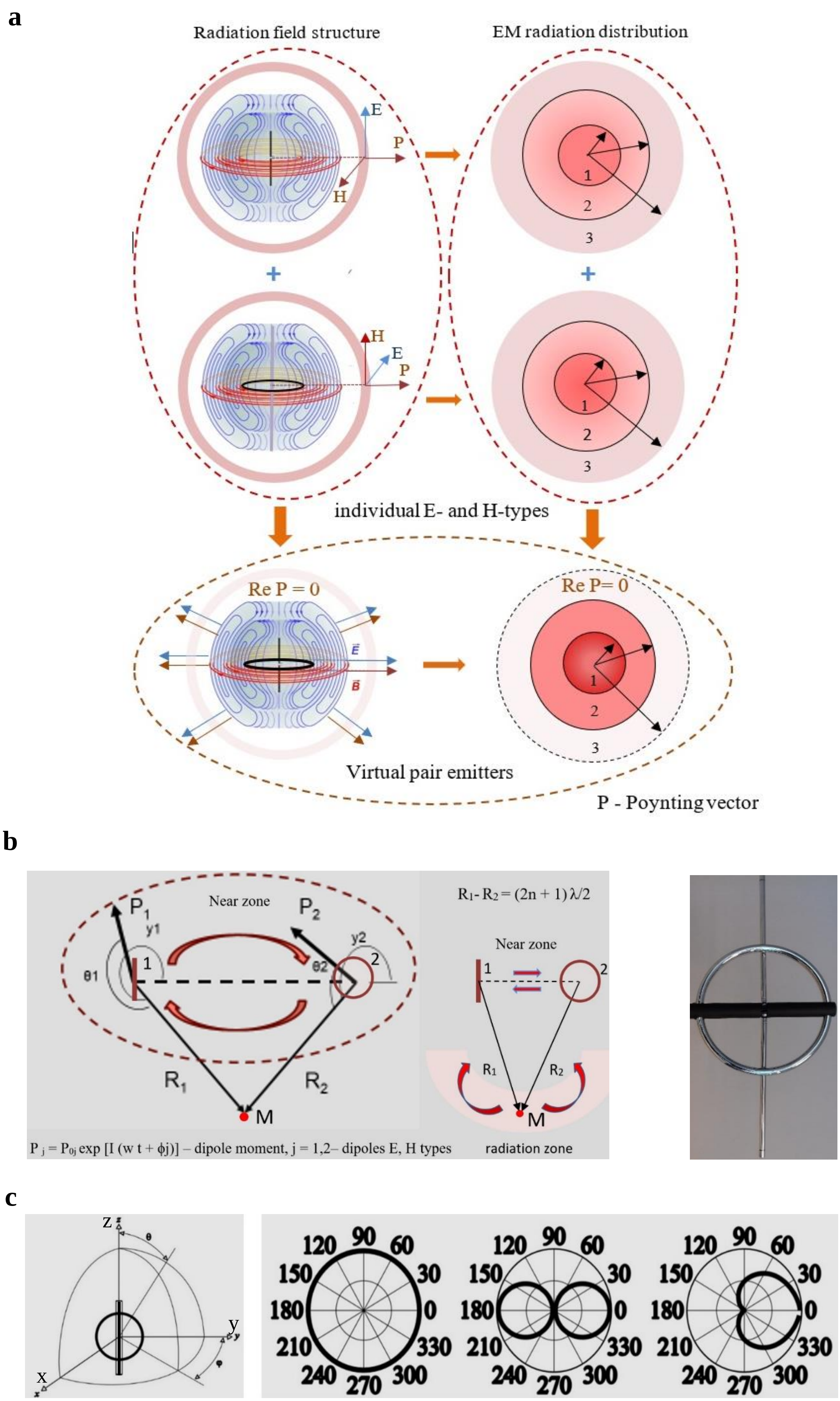

a
Radiation field structure
EM radiation distribution
individual E- and H-types
Re P = 0
Re P= 0
Virtual pair emitters
P - Poynting vector
b
Near zone
R1- R2 = (2n + 1) λ/2
P j = P0j exp [I (w t + ϕj)] – dipole moment, j = 1,2– dipoles E, H types
radiation zone
c

Figure 2

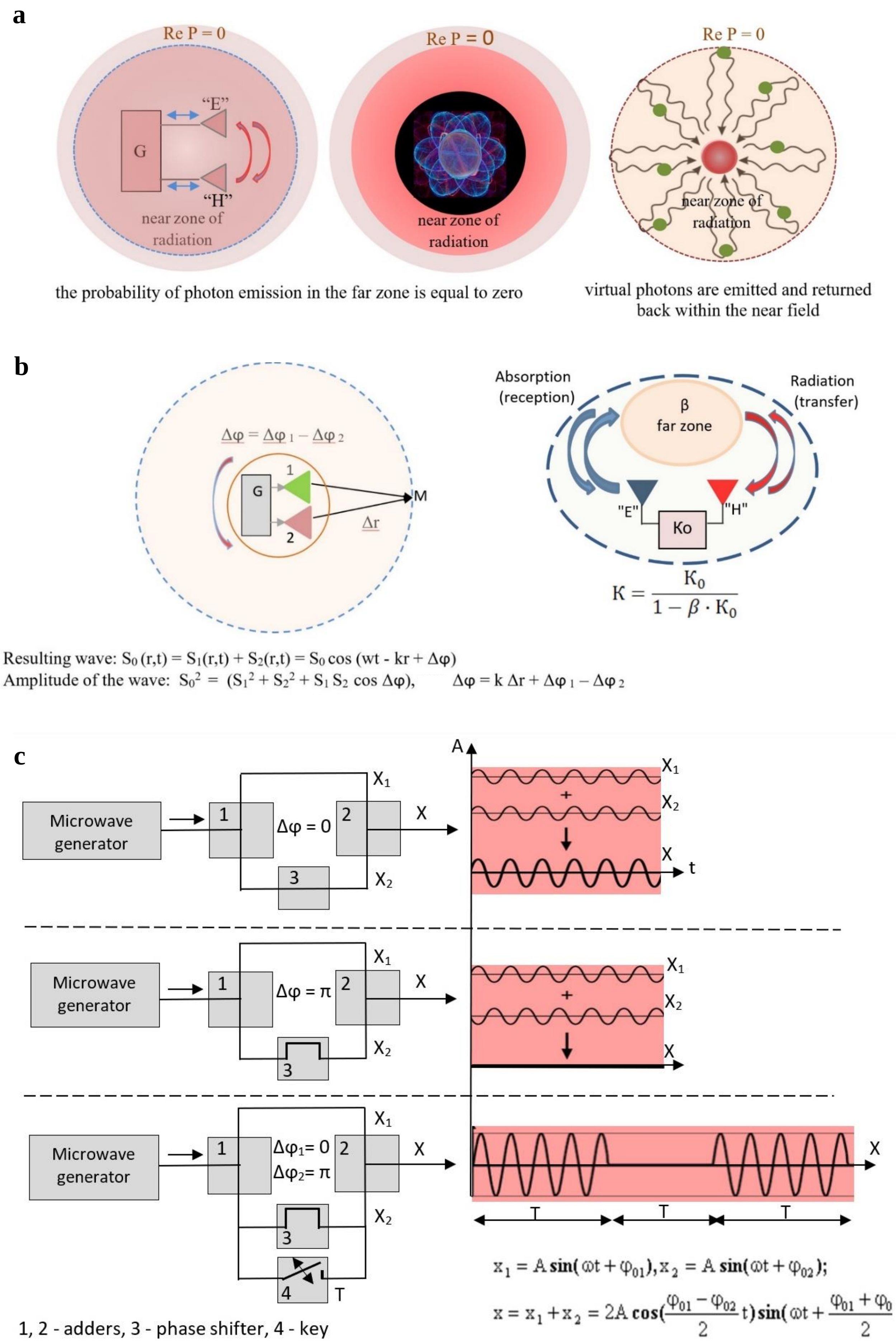
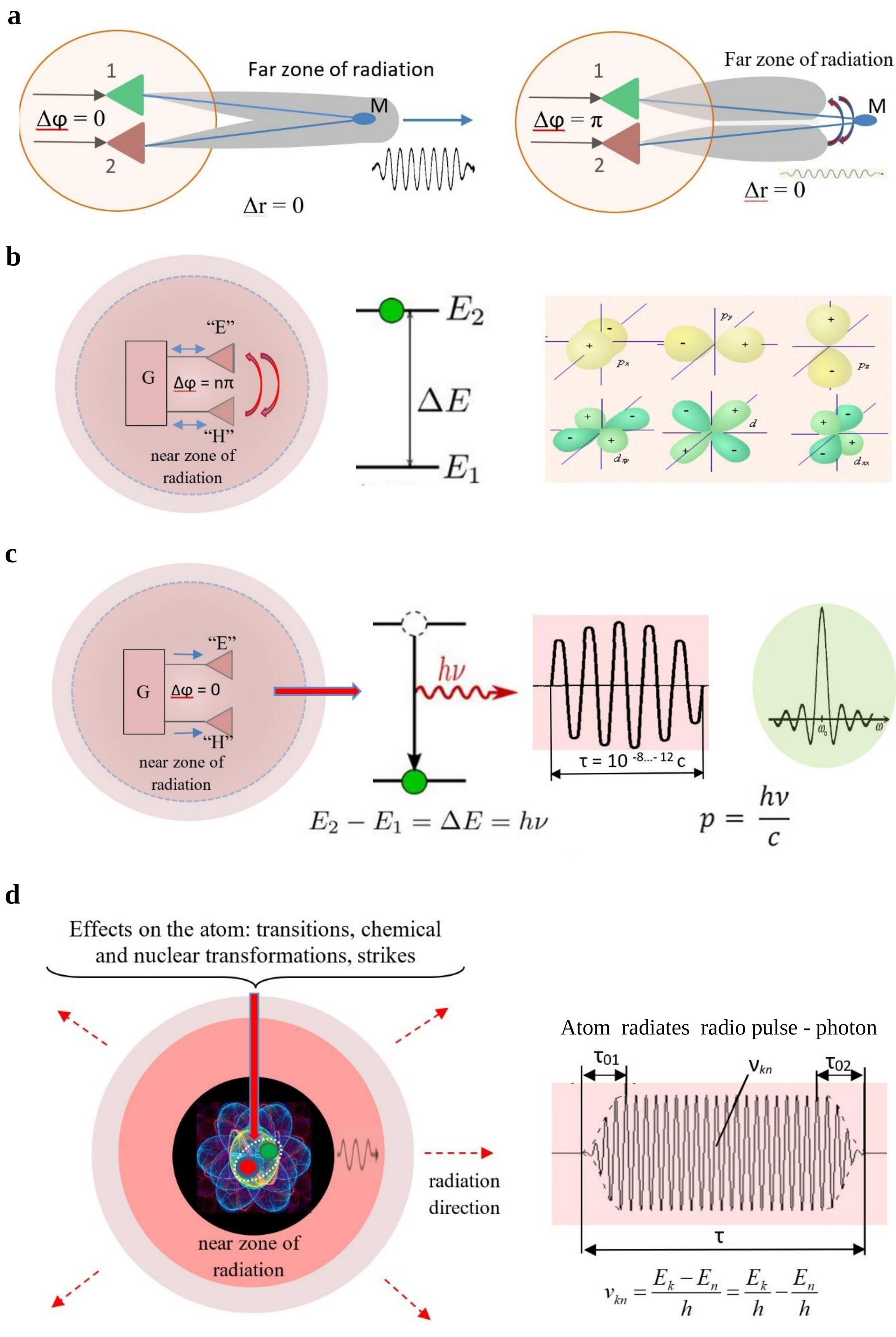
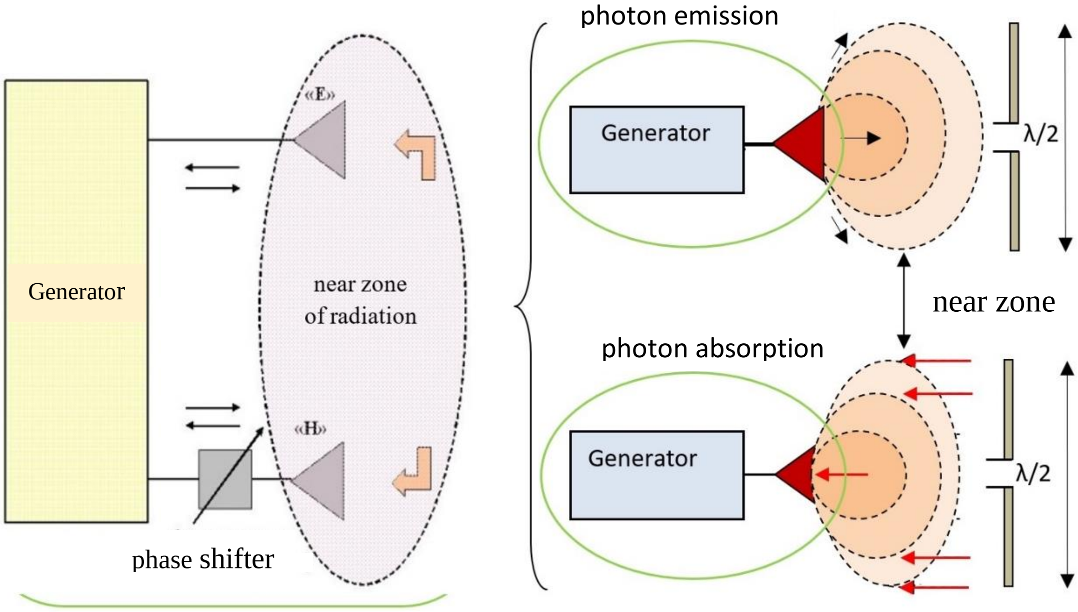

a
Re P = 0
"E"
"H"
G
near zone of radiation
Re P = 0
near zone of radiation
Re P = 0
near zone of radiation
the probability of photon emission in the far zone is equal to zero
virtual photons are emitted and returned back within the near field
b
Δφ = Δφ 1 − Δφ 2
G
1
2
M
Δr
Absorption (reception)
Radiation (transfer)
β far zone
"E"
"H"
Ko
K = K0 / (1 − β · K0)
Resulting wave: S0 (r,t) = S1(r,t) + S2(r,t) = S0 cos (wt - kr + Δφ)
Amplitude of the wave: S0² = (S1² + S2² + S1 S2 cos Δφ), Δφ = k Δr + Δφ 1 − Δφ 2
c
Microwave generator
1
Δφ = 0
2
3
X1
X2
X
A
t
+
Microwave generator
1
Δφ = π
2
3
X1
X2
X
Microwave generator
1
Δφ1= 0
Δφ2= π
2
3
4
X1
X2
X
T
1, 2 - adders, 3 - phase shifter, 4 - key
x1 = A sin(ωt + φ01), x2 = A sin(ωt + φ02);
x = x1 + x2 = 2A cos((φ01 − φ02)/2 t) sin(ωt + (φ01 + φ0)/2

Figure 3



a
1
2
Δφ = 0
Far zone of radiation
M
Δr = 0
Δφ = π
Far zone of radiation
M
Δr = 0
b
“E”
G
Δφ = nπ
“H”
near zone of radiation
E_2
ΔE
E_1
c
“E”
G
Δφ = 0
“H”
near zone of radiation
$h\nu$
τ = 10 -8...-12 c
$E_2 - E_1 = \Delta E = h\nu$
$p = \frac{h\nu}{c}$
d
Effects on the atom: transitions, chemical and nuclear transformations, strikes
near zone of radiation
radiation direction
Atom radiates radio pulse - photon
τ_{01}
ν_{kn}
τ_{02}
τ
$\nu_{kn} = \frac{E_k - E_n}{h} = \frac{E_k}{h} - \frac{E_n}{h}$

Figure 4

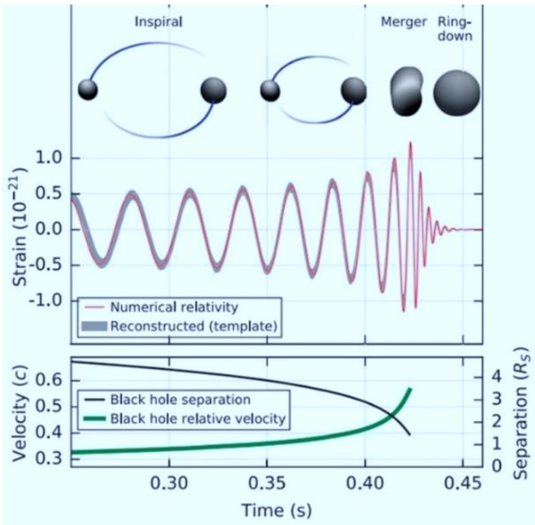


Generator
«E»
near zone
of radiation
«H»
phase shifter
photon emission
Generator
λ/2
near zone
photon absorption
Generator
λ/2

Figure 5

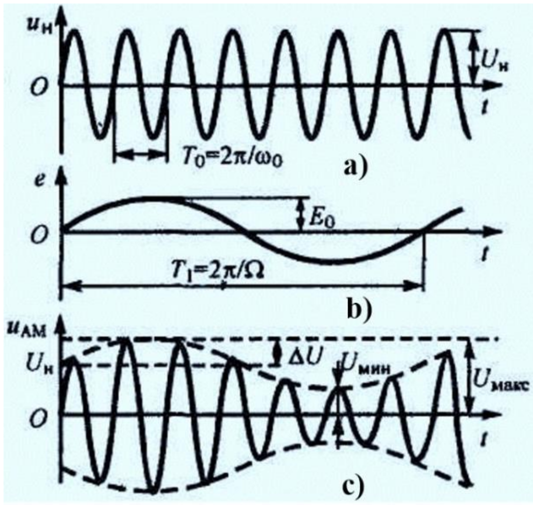
a

Interpretation of a registered gravitational wave



Gravitational radiation in the fusion of black holes
(figure from Abbott et al.,2016)

b



$U_{AM}(t) = U_H\,(1+m\times E_0(t))\,\cos(\omega_0 t + \varphi_0)$

c

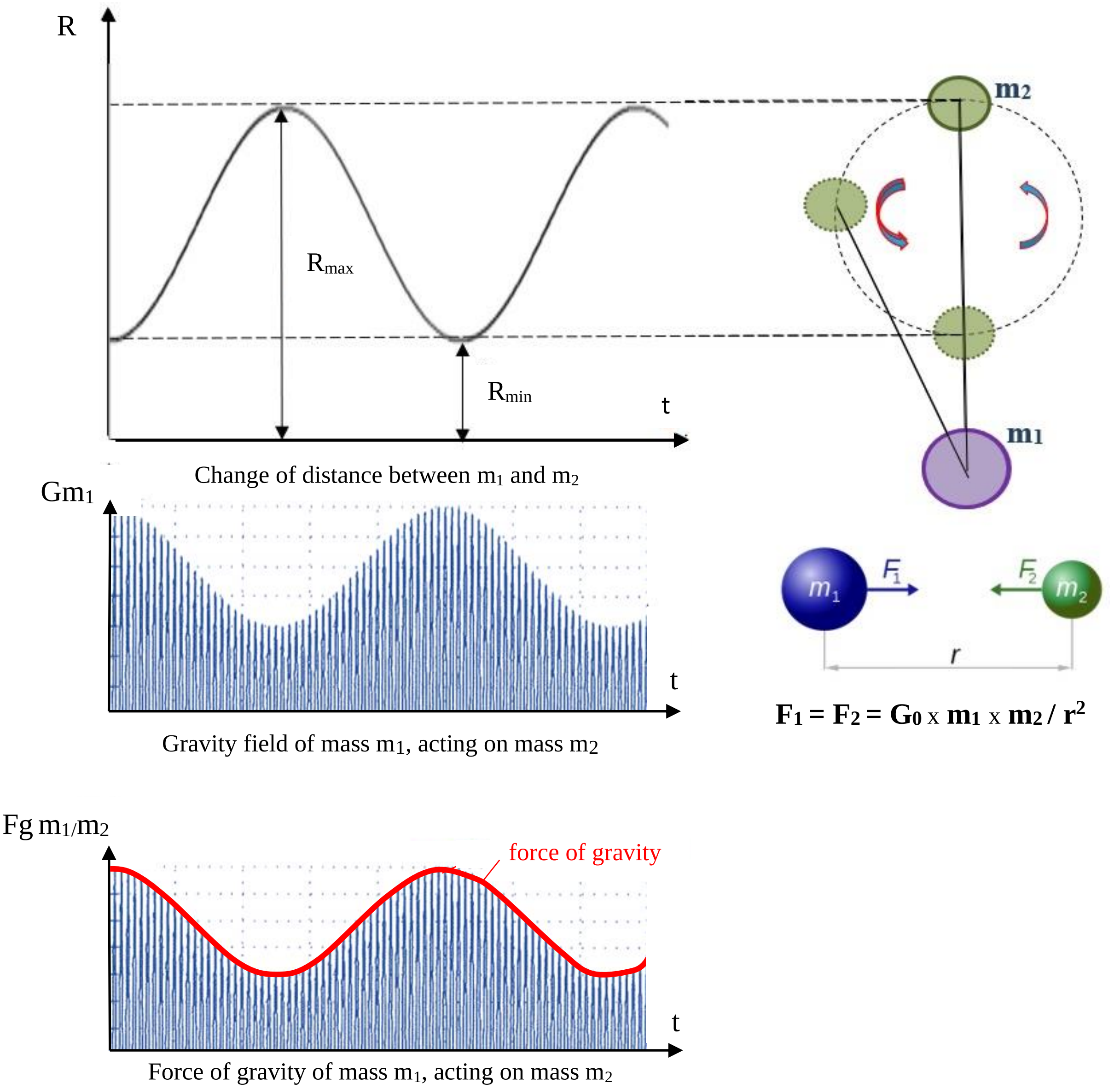
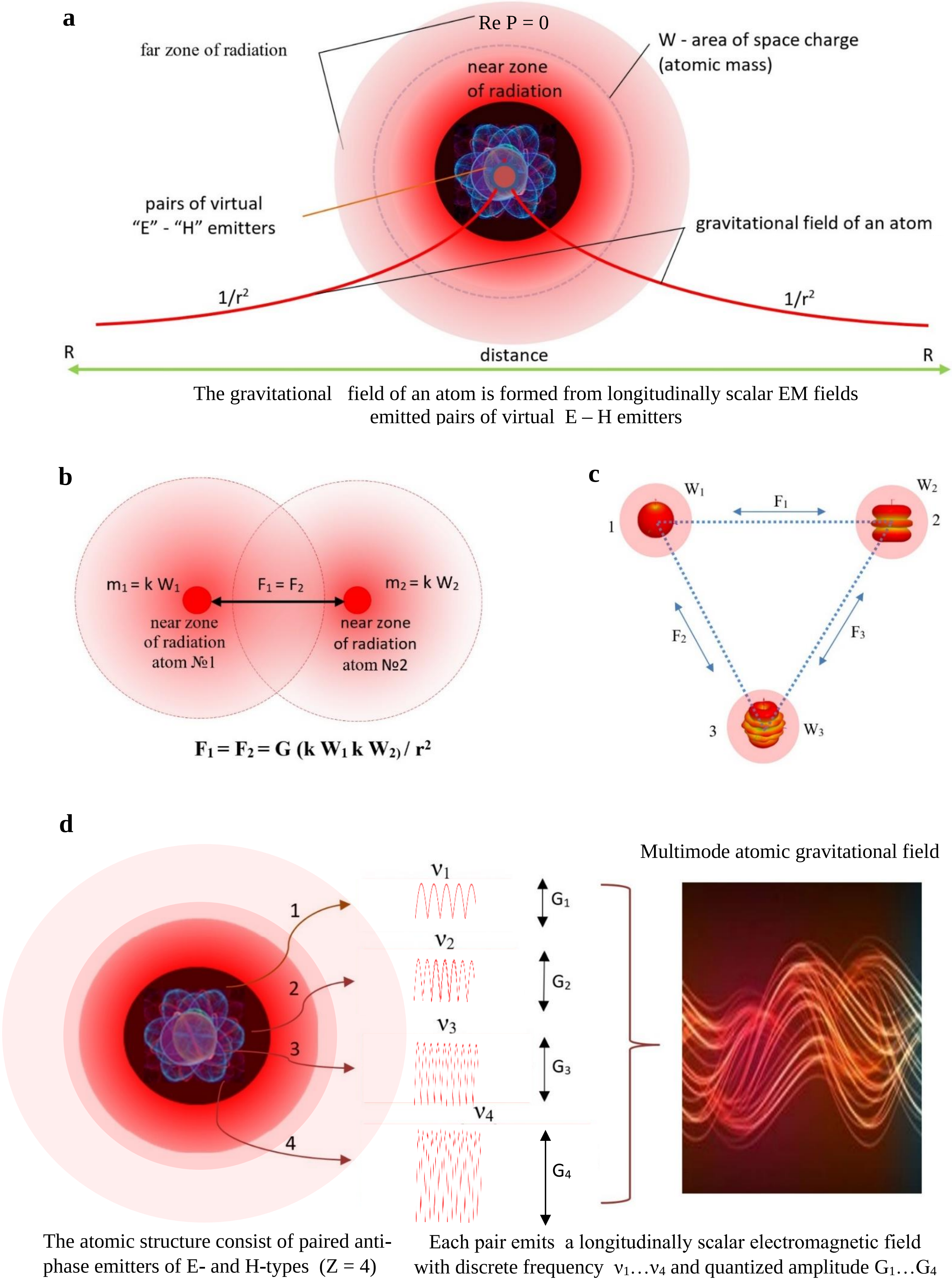


Figure 6



a
far zone of radiation
Re P = 0
W - area of space charge
(atomic mass)
near zone
of radiation
pairs of virtual
"E" - "H" emitters
gravitational field of an atom
1/r²
1/r²
R
distance
R
The gravitational field of an atom is formed from longitudinally scalar EM fields
emitted pairs of virtual E – H emitters
b
m₁ = k W₁
F₁ = F₂
m₂ = k W₂
near zone
of radiation
atom №1
near zone
of radiation
atom №2
F₁ = F₂ = G (k W₁ k W₂) / r²
c
W₁
F₁
W₂
1
2
F₂
F₃
3
W₃
d
Multimode atomic gravitational field
ν1
ν2
ν3
ν4
G₁
G₂
G₃
G₄
1
2
3
4
The atomic structure consist of paired anti-
phase emitters of E- and H-types (Z = 4)
Each pair emits a longitudinally scalar electromagnetic field
with discrete frequency ν₁…ν₄ and quantized amplitude G₁…G₄

Figure 7