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Extremely low frequency ion cyclotron resonances on the surface boundaries of coherent water domains

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Abstract. Pure Water under standard pressure, temperature and dilute solution conditions contain coherent Preparata-Del Giudice domains approximately a tenth of a micron in size. Ions of charge $q = Z\,e$ can be confined to the surface boundaries of coherent water domains. Solving for the motion of ionic charges confined to surfaces in a uniform magnetic field B = *curlA* it is shown that there exist resonances scaled by the ionic cyclotron frequency $\omega c = (qB/Mc)$. The surface classical ionic motions described by the vector potential lagrangian $L = (M/2)\, v^{\mu}v\mu + (q/c)v^{\mu}A\mu$ are integrable for a spherically symmetric surface. The resulting extremely low frequency (ELF) resonant modes are only weakly damped by fluid viscosity due to the small length scales of the confining surface and these modes are of importance in biophysical processes.

1. Introduction

High frequency ionizing radiation is well known to be dangerous to the normal functional behavior of biological organisms [1]. Lower frequencies from radio frequency microwaves to acoustic frequency circuit oscillations at low intensity are considered to have virtually null biological effects. By low intensity we mean that the electromagnetic energy absorption is not sufficient to raise the condensed matter temperature of biological tissues. Typical of measures of biological tissue temperatures are Magnetic Resonance Imaging machines employing magnetic fields of the order of ten Tesla with microwave frequencies of order ten GHz. In detail, the nuclear magnetic resonant frequency of a proton that is followed by the magnetic imaging machine is $\omega_{\mathrm{NMR}} = (g|e|/2Mc)B = \gamma B$, wherein $\gamma \approx 0.2675222$ per nanosec per Tesla.

The Magnetic Resonance Image (MRI) is in fact a picture due to “hot spots” in the living biological tissue. If there tumors within biological tissue, then in the tumor neighborhood the tissue temperature may be well above the normal temperature of the living body. The tumor neighborhood may appear for example as a shadow in the MRI picture. The proton in a hot region diffuses faster than a proton in a cold region. The spin echo experiments probe hot spots by measuring the proton diffusion rates via spin echo damping and turn digitally a temperature map into a picture using a variety computer algorithms. It is however clear that not all tissue damage is accompanied by hot tissue neighborhoods.

Now let us go down perhaps eight orders of magnitude in magnetic field **B** and in frequency wherein a non-relativistic ion of charge $q = Z\,e$ and mass M has a cyclotron frequency pseudo-vector:

$$\omega_c = -\frac{Z}{M_c}|e|B \tag{1}$$

Fundamental physical mechanisms of the resonant actionof an extremely weak alternating magnetic field 40 nano Tesla at the resonant cyclotron frequency in Eq.(1) of a weak 40 milli Tesla static magnetic field in living systems was discussed theoretically[2–5] by Zhadin and coworkers. Extremely low frequency (ELF) resonant effects were also measured [6-8]. At somewhat higher magnetic fields, ELF cyclotron resonant dynamics was measured by Blackman, Liboff and coworkers in other biological systems [9–12]. Finally, in the "phantom", i.e. nonbiological system of pure water, ELF cyclotron resonances were observed [13] for the H_3O^+ ion.

2. Magnetic dynamics

For a non-relativistic particle moving in a static magnetic field

$$B(r) = curl A(r) \tag{2}$$

in free space, the vector potential lagrangian describingthe motion is given by

$$L(v,r) = \frac{1}{2}M|v|^2 + {}^{q}\!/_{c}\, v * A(r) \tag{3}$$

The momenta

$$p = \frac{dL}{dv} = Mv + \frac{q}{c}A(r) \tag{4}$$

and force

$$f = \frac{dL}{dr} = gradL = [vA(r)] \tag{5}$$

obey the lagrangian-newtonian rule that the rate of change of momentum is equal to the force

$$p = f$$

$$M\dot{v} = \frac{q}{c}[grad(v \cdot A(r)) - (v \cdot grad)A(r)] \tag{6}$$

or equivalently the magnetic force equation

$$Mv = \frac{q}{c}(v * B) \tag{7}$$

For a magnetic field uniform in space and time, the axial vector cyclotron frequency can be read from Equation (7); It is:

$$\omega_c = -\frac{qB}{Mc} \tag{8}$$

i.e. $\acute{\mathbf{v}} = w_c \times \mathbf{v}$. The mathematics required to repeat this problem for a charge constrained to move on a surface is straight forward.

2.1. Gaussian Surface Constraint

The Gauss differential geometry of two dimensional surfaces in three dimensions is a well known example of differential geometry. For a given coordinate patch one chooses the equation of the surface to be:

$$\mathrm{r} = R(x^1, x^2) \Rightarrow \mathrm{d}r = e_\mu\, \mathrm{d}x_\mu \tag{9}$$

wherein the Einstein summation convention is employed. The metric distances on the surface depend on the arclength $ds^2 = |d\mathbf{r}|^2$,

$$ds^2 = g_{\mu\nu}\, dx^\mu\, dx^\nu \Rightarrow g_{\mu\nu} = e_\mu\, e_\nu \tag{10}$$

For a given point on the surface, the vectors (e_1, e_2) are abasis for the tangent plane while the dual vectors ($\mathbf{e}^1$, $\mathbf{e}^2$)are a basis for the cotangent plane, wherein, $\mathbf{e}_\mu \cdot \boldsymbol{e}_v = \delta_\mu^v$

$$e_\mu = g_{\mu\nu}\, e^\nu \qquad \text{and} \qquad e_\mu = g^{\mu\nu} e_\nu \tag{11}$$

The unit vector normal to the surface at a given point is

$$\mathrm{N} = \frac{\mathrm{e}_1 \times\_ \mathrm{e}_2}{\cdot g}$$

$$g = |\mathrm{e}_1 \times \mathrm{e}_2|^2 = g_{11} g_{22} - g_{12} g_{21} = \det[g_{\mu\nu}] \tag{12}$$

The vector area element of the surface is thereby

$$\mathrm{d}^2\Sigma = (\mathrm{e}_1 \mathrm{dx}_1) \times (\mathrm{e}_2 \mathrm{dx}^2) = \mathrm{N}^{\nu g \mathrm{dx}^1 dx^2} = \mathrm{Nd}^2\Sigma \tag{13}$$

Any vector tangent or cotangent to the surface at a pointmay be written as

$$V = V^\mu\, e_\mu = V_\nu\, e_\nu \tag{14}$$

When parallel transporting a vector along the surface onemust rotate the basis vectors (say) in the tangent plane:

$$\begin{aligned} &\mathrm{dV} = (\mathrm{dV}^\mu)\mathrm{e}_\mu + V^\nu (d\mathrm{e}_\nu) \\ &\mathrm{de}_\nu = \Gamma \mu \mathrm{d}x^\lambda \mathrm{e}_\mu \\ &d\mathrm{V} = (DV^\mu) e_\mu \\ &DV^\mu = dV^\mu + \Gamma^{\mu\nu\lambda} V^\nu dx^\lambda \end{aligned} \tag{15}$$

The small rotation of the tangent plane basis vectors (e1, e2) defines the connection coefficients in the second term on the right hand side of Equation (15).

2.2. Equations of Motion

The constraint of having the non-relatistic charged particle moving on a surface can be described by the vector potential lagrangian Eq.(3) confined to the Gaussian surface[14, 15]

$$L(v,x) = \frac{M}{2} g\mu\nu(x) v^\mu v^\nu + \frac{q}{c} v^\mu A\mu(x) \tag{16}$$

wherein: $$V^\mu = \mathrm{X}^\mu \tag{17}$$

The canonical momenta and force components in the cotangent plane are respectively:

$$\begin{aligned} &p_\mu = \frac{\partial L}{\partial v^\mu} = M g_{\mu\nu}(x) x^{\cdot\nu} + \frac{q}{c} A_\mu(x) \\ &\int \mu = \frac{\partial L}{\partial x^\mu} \\ &\int \mu = \frac{M}{|2} \partial_\mu g_{\alpha\beta}(x)(v^\alpha v^\beta) + \frac{q}{c} v^\nu \partial_\mu A v(x) \end{aligned} \tag{18}$$

The lagrangian equations of motion sets the rate of change of momentum equal to the force

$$p_\mu = \int \mu \Rightarrow a^{\cdot\cdot} \frac{Dv^\mu}{\mathrm{d}t} = v^{\cdot\mu} + \Gamma^\mu{}_{\lambda\sigma} v^\lambda v^\sigma \tag{19}$$

wherein:

$$\Gamma^\mu{}_{\lambda\sigma} = \frac{1}{2} g^{\mu\nu}(\partial_\lambda g_{\nu\sigma} + \partial_\sigma g_{\nu\lambda} - \partial_\nu g_{\lambda\sigma}) \tag{20}$$

and a mass times acceleration equal to the magnetic cyclotron force on the ion

$$B_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \Rightarrow Ma^\mu = \frac{q}{c} B^{\mu\nu} v_\nu \cdot \tag{21}$$

With a tensor rotational velocity

$$\Omega_{\mu\nu} = -\frac{qB_{\mu\nu}}{Mc} \tag{22}$$

one finds cyclotron rotations

$$\frac{Dv^\mu}{\mathrm{d}t} + \Omega^\mu{}_\nu(x)v = 0 \tag{23}$$

In terms of the magnetic field component $B_\perp$ = **N B** normal to the confining surface,

$$B_{\mu\nu} = Vg\,?_{\mu\nu}\, N \cdot B = E_{\mu\nu} B_? \tag{24}$$

The equations of motion of the charged ion confined to a surface can also be written in Hamilton-Jacobi form.

2.3. The Hamilton-Jacobi Equation

The energy of the confined ion is purely kinetic

$$E = v^{\mu - \partial L} - L = \underline{1} \mathrm{Mg}_{\mu\nu} v^\mu v^\nu \tag{25}$$

in virtue of Equation (16). Written in terms of the Hamiltonian

$$E = H(p, x) \tag{26}$$

Hamilton’s equations of motion are thereby:

$$(\mathrm{x}^{\cdot\mu}) = \frac{\partial \mathrm{H}}{\partial \mathrm{p}_\mu} \text{ and } p^{\cdot}{}_\mu = -\frac{\partial H}{\partial x^\mu} \tag{27}$$

For the integrable case of a spherical surface in a uniform magnetic field we shall solve the mechanical problem employing the Hamilton-Jacobi equation for the ac- tion $W(x, t)$,

$$-\frac{\partial W}{\partial t} = H \;\; p = \frac{\partial W}{\partial x}, x \tag{28}$$

he orbits the ion on the confining surface can be obtained from the first order differential equations $M \dot{x}^\mu = g^{\mu\nu} \partial_\nu W\,(q/c) A^\mu$ rather than the second order differential Equations (22) and (23).

2.4. Spherical Ordered Water Domain Surface

For a spherical surface of radius R of confinement for one finds cyclotron rotations

$$\mathrm{ds}^2 = \mathrm{R}^2\,(\mathrm{d}\theta^2 + \sin^2\theta \mathrm{d}\varphi^2) \tag{29}$$

wherein the uniform magnetic field **B** points from the south pole to the north pole. Thus, with B=|**B**|,

$$\mathrm{B}_? = \mathrm{B}\sin\theta \tag{30}$$

The lagrangian is thereby

$$L = \frac{1}{2} MR^2 \vartheta^{\cdot 2} + \sin^2 \vartheta \varphi^{\cdot 2} + \frac{q}{c}(\vartheta^{\cdot} A_\theta + \varphi^{\cdot} A_\varphi) \tag{31}$$

We choose a gauge for the uniform magnetic field in three dimensional space A = (1/2)B × r yielding:

$$A_\theta = \mathrm{e}_\theta \cdot A = 0 \text{ and } A\varphi = \mathrm{e}_\varphi \cdot A = \frac{BR^2}{2} \sin^2 \vartheta \tag{32}$$

Thus, the lagrangian and hamiltonian for the ion confined to the spherical surface are, respectively,

$$L = \frac{1}{2} MR^2 \vartheta^2 + \sin^2 \vartheta \varphi^{\cdot 2} + \frac{qBR^2}{2c} \sin^2 \vartheta \varphi \tag{33}$$

By symmetry, the angular momentum about the magnetic is conserved from rotational symmetry. From the viewpoint of Hamilton Jacobi theory for the action W (θ, φ, t), i.e.

$$-\frac{\partial W}{\partial t} = H \quad p_\theta = \frac{\partial W}{\partial \vartheta}, \; p_\varphi = \frac{\partial W}{\partial \varphi}, \vartheta \tag{34}$$

we show integrability by seeking a solution wherein the energy E and angular momentum J ar uniform in time

$$W(\theta,\varphi,t) = -Et + J\varphi + S(\theta, E, J) \tag{35}$$

Employing the effective "potential" defined by

$$U(\vartheta, J) = \frac{J^2}{2MR^2 \sin^2 \vartheta} - \frac{1}{2^{\omega_c J}} + \frac{1}{8MR} \omega_c^2 \sin^2 \vartheta^2 \tag{36}$$

One finds for the action in the energy representation obeying the Hamilton Jacobi equation

$$E = \frac{1 \partial S}{2MR^2} \partial \vartheta^2 + U(\vartheta, J) \tag{37}$$

The orbit of the ion as a function of time θ(t), φ(t) is computed from the action via the implicit equations:

$$t = \frac{\partial S(\vartheta, E, J)}{\partial E}$$

$$\varphi = \frac{\partial S(\vartheta, E, J)}{\partial J} \tag{38}$$

The solution to the Hamilton-Jacobi equation may then be reduced to quadratures

$$S(\vartheta, E, J) = \int^{\theta}{}_{\theta_0} q \frac{}{2MR^2 E - U(\dot{\vartheta}, J) \mathrm{d}\vartheta} \tag{39}$$

The action corresponding to a closed curve on the spherical surface

$$\tilde{S}(E, J) =^{I} q \frac{}{2MR^2 E - U(\vartheta, J) \mathrm{d}\vartheta} \tag{40}$$

3. Conclusion

This work need more development in fundamental physics, and open to a new understanding of many strange biological phenomena, in particular not linear phenomena that influence ad example mind brain body connections, effects of transdermic drug, that are without chemical reactions as also very low dosis of drug far from concentration in blood in the Benveniste Experiment.

Bioelectrical function seems play a key role not only in heart with ECG but also in all internals organs that seems governed by electrical state of meridians connected that change their electric parameters in answer to any kind of strong and very low signals as showed in the article and in the review by Scaluia Valenzi et coll. http://ibb.kpi.ua/article/view/140255.

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