Ultrasonic, Mechanical Excitation of Free and Weakly Coupled Electron States in Electro-Conductive Materials in relation to Wave-Particle Duality and Matter-Wave properties

A working assumption (or hypothesis) here is that it is possible to influence, excite and increase mobility of weakly coupled and relatively free electron states, through ultrasonic methods (meaning acoustically and mechanically). It is proposed that this can be achieved by vibrating certain electrically conductive material, electrode, galvanic or electrochemical cells and similar metal parts where electric charges, voltages and currents are either being generated, consumed, charged and/or discharged.

As is known today, an ordinary and arbitrary mechanical, acoustic or ultrasonic excitation would not produce such mentioned results. Only the mechanical or electromechanical, ultrasonic excitation of specific natural internal, parametric and other resonant states of electro-conductive materials (at the specific resonant frequencies) would increase free electrons mobility and produced electric current (including influence on associated voltages and charges).

We will start from the following citation (see below), which describes an approximate model of metals, crystals, electrically conductive materials, and similar solid matter structures:

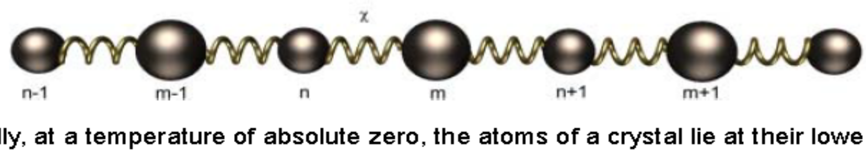
Chapter 4 : Phonons and Crystal vibration

Types of Vibrations in Crystals

	Name	Field
	Electron	—
	Photon	Electromagnetic wave
	Phonon	Elastic wave
	Plasmon	Collective electron wave
	Magnon	Magnetization wave
–	Polaron	Electron + elastic deformation
–	Exciton	Polarization wave

Normal modes of crystal vibrations

Many solid materials, including all metals, are composed of atoms arranged in a lattice arrangement called crystals. There are a variety of crystal structures like cubic, hexagonal, cubic with an atom in the center of the cube, called body centered cubic, cubic with an atom in the center of each face of the cube, called face centered cubic, and others. The particular structure depends on the relative sizes of the atoms that are nestled together to form the crystal. The reason that materials take crystal form is that these neat geometrical structures represent the lowest energy configuration of the collection of atoms making up the material. To dislodge an atom from the crystal structure requires the addition of energy.



Theoretically, at a temperature of absolute zero, the atoms of a crystal lie at their lowest energy position without moving at all. As thermal energy is added to the crystal it is manifest by vibration of the atoms about this equilibrium location. Within the limits of fairly small vibrations the electric forces bonding the atoms together stretch or compress a bit to a higher energy configuration. Each atom acts as though it were connected to its neighbors by little springs. The added energy is stored in the crystal as the kinetic energy of the atoms in motion and the potential energy of the compressed or stretched springs.

Starting Assumptions and Hypothesis Foundations

1. Electrons, Photons, Phonons, Plasmons, Magnons, Solitons etc. are all matter-wave groups, or wave-packets of certain form of matter and fields, having motional energy like energy-moment properties of moving particle. Until a certain level, the mentioned wave packets could be analogically treated as particles, having group and phase velocity, wavelength, frequency, some spinning or angular moment properties, and linear moment properties (in contemporary physics described under Wave-Particle Duality of matter).

2. The mentioned matter-wave properties and parallelism (or analogy) of all matter-wave packets with corresponding equivalent particles, is manageable using the same mathematics (around Analytic Signal modeling). This is the part of the content or meaning of the particle-wave duality. There is no need or factual evidence forcing us to have different mathematical or physics-related theories, structures and models specifically valid only for Electrons, or Photons, Phonons, Plasmons, Magnons, Solitons... Probabilistic and Statistics related approach here should not be an essential, exclusive and best modeling strategy.

3. All of the mentioned matter-wave packets (such as, Electrons, Photons, Phonons, Plasmons, Magnons, Solitons etc.) are in some way (more or less) coincidently or synchronously present and mutually electromechanically and electromagnetically coupled. We could only have some mathematical, conceptual modeling preferences and facilities to treating them separately (like being mutually isolated and independent). For instance, mechanical and acoustical vibrations and waves in solid liquid and gaseous media are oscillatory motions of masses, atoms and molecules. As we know, all atoms have very much essential electromagnetic structure or nature (at least having positive and negative electric charges with orbital and magnetic spinning moments). Consequently, mechanical, acoustic and thermodynamic vibrations, motions and manifestations will always be electromechanically coupled with internal electromagnetic nature of atoms.

4. Let us come back to the multiple, structural and spatial matrix of mass-spring elements, representing metals, solid bodies and crystals. Masses in such models are atoms, or molecules, or maybe some bigger agglomerations of atoms connected with <u>attractive fields presented as equivalent springs</u>. Springs here, are attractive, cohesion, adhesion and Van der Waal's forces based on electrostatic and magneto-static attractions between atoms. For instance, particles (meaning atom masses) with magnetic moments are mutually attracting, and the surrounding free electron clouds are in some way mutually repulsing, this way keeping the spatial matrix of mass-spring elements relatively stable (or solid). Such mass-spring formations will have many natural, parametric and resonant (electromechanically coupled) frequencies or resonant modes.

5. The bottom line of an oversimplified modeling (of metals' mechanical structure) is that masses or atoms (within mentioned solid structures) are relatively stable and fixed particles mutually connected with springs, each of them being surrounded (or enveloped) with shells of relatively free-electron clouds or electron states that are weakly connected to mentioned atom masses. This is the background and simplified modeling situation for having electro-conductivity (as well as to have all other kinds of matter-wave motions inside metals, realized when atoms are

mutually communicating with Electrons, Photons, Phonons, Plasmons, Magnons, Solitons etc.). All of mentioned matter wave groups or packets are mutually and coincidently present, connected, or coupled in the same solid body. Here, we should not forget that solutions of Classical Wave Equations are always present in pairs (like inwards and outwards traveling waves, propagating in mutually opposed spatial-temporal directions). "Quantum Entanglement" effects could often mutually connect mentioned matter-wave packet-pairs, (meaning Electrons, Photons, Phonons, Plasmons, Magnons, Solitons etc., are always being created as mutually coupled pairs). Unfortunately, contemporary Physics still did not make such generalizations or uniting concepts, but regardless of our theories, we know that Nature or our Universe is already united, without need to respect all of our, still evolving theories.

6. Let us now imagine that (in a certain way) we make an external, mechanical, ultrasonic excitation of the mass-spring spatial matrix (of a certain electro-conductive body). This external mechanical mass excitation could be produced with an attached piezoelectric transducer (or resonator), or by laser pulsing agitation (or by creating different oscillators and resonators based on oscillations and waves of Electrons, Photons, Phonons, Plasmons, Magnons, Solitons etc.).

7. First, we need to ask ourselves about the most probable frequency-intervals or spectral domains where natural and parametric (mass spring), mechanical and electromechanical resonant states of metal bodies exist. The reason is that we then have better chances to produce and detect new, exotic, challenging and still non-discovered effects in solid matter, appearing around the existing natural resonant states of the relevant matter structure (here meaning spatial matrix of mass-spring oscillators).

   Mechanical, thermodynamic, molecular, electro-mechanic and atomic micro mass's spectral domains (based on spring-mass, or inductance-capacitance conceptualization) are known to be in a deep infrared spectrum and in the MHz domain of frequencies. Of course, every different metal or crystal, or even liquid and plasma state, will have different (mechanical) resonant frequency modes but part of such resonant states will be in a MHz domain.

   What will happen if we externally agitate metal masses with MHz resonators operating over the relevant parametric, mechanical and natural resonant states of internal mass-spring matrix structure? Masses or atoms will start resonating (as particles) and will achieve large oscillating amplitudes, velocities and forces (depending on resonant states conditions, like operating in series or parallel resonance). Since free electron clouds and weakly connected electron states surround the mentioned atom masses, then the applied stimulating mechanical resonance will also create increased mobility of such free electron states. This should have an influence on all related electric currents, voltages, charging and discharging effects (depending on the subject matter). The condition required to excite and produce these enhanced electric-current and voltage properties would be to produce an external mechanical, resonant agitation of conductors, relevant to the specific internal mechanical resonant zones (meaning in specific MHz frequencies).

   As we can find in various references, it is already known that MHz domain ultrasonic excitation (at the correct natural, mass-spring, and parametric resonating frequencies) of electrodes in *batteries significantly enhances the produced current and voltage, or accumulated power, and optimizes the charging and discharging properties. Something similar is also measured when electrolyte is ultrasonically vibrated in electrochemical and galvanic cells. It is also known that laser or photonic excitation of liquids and solids produces similar acoustic and matter-wave effects as in the already mentioned situations.*

8. We should expect acoustically (or ultrasonically) enhanced electrical properties in applications related to ***batteries (or accumulators) charging and discharging, in optimizing electrochemical and galvanic or electrolytic reactions, in electrolysis, in maximizing Compton and Photoelectric effects, and in familiar situations related to lasers and photovoltaic cells***. We can always expect certain electric resistance decrease (or in some cases increase like in NTC and PTC resistive elements) in electro-conductive metals (and other matter states) under the relevant MHz, resonant excitation of internal natural resonant modes. In other words, internal mechanical resonant states or modes should be (intrinsically and coincidently), coupled with similar resonant states of electromagnetic nature. In case of correct resonant excitation of photovoltaic (or solar) cells, we could (still hypothetically) expect that the incident photons will create a higher amount of electron flow (because electromechanical and parametric resonance effects will periodically reduce gaps between nonconductive and conductive zones, and current of electrons will be increased). This also means that the efficiency of solar cells would be significantly increased.