The fabric of space as an electron-positron lattice and its implications for GRT. ver2. Aug2010

R. G. Grantham†, (in collaboration with M. Simhony) ‡

† R. Guy Grantham MRSC, Lincoln, UK. E-mail: rgg@epola.org
‡ Menahem Simhony, Emeritus Prof., The Hebrew University, Jerusalem. Co-author of Section 1; Author of the paperback book, (ref 5) - on which this article is largely based.

Abstract
A solid lattice structure of the vacuum as bound electrons and positrons, analogous to a polycrystalline ionic salt, was proposed and termed the 'epola' by Menahem Simhony in 1973 and argument is provided for validity of this model. Application of the model leads to a physical interpretation of the bending of space detailed by GRT and provides explanations for gravitation and inertia as electromagnetic effects of the lattice with justification for de Broglie waves.

1. The real meaning of E=mc²

The iconic formula, $E=mc^2$, commonly attributed to Albert Einstein for his expression of mass-energy equivalence, has far deeper roots in physics and was first developed by Isaac Newton[1] (as the square root of elastic energy per unit of volume divided by mass density) to calculate the speed of sound in air propagated by the elastic vibrations of air's constituents parts.

In general, the propagation of elastic waves in many materials was found to be proportional to the square root ratio of the binding energy to the mass per building unit of the material. This velocity also depends on several factors which can be accounted for by the introduction of proportionality factors.

The physical meaning of the equation $E=mc^2$ is revealed by ionic crystals with densely packed structure, interlaced face centred cubic (fcc) lattices, where the proportionality factor is unity.

For example[2], the sodium chloride (Na^+Cl^-) ionic lattice, where the binding energy per ion pair E is 7.9 eV and the average mass is 58.45 atomic mass units (u) per ion pair, the average velocity of elastic waves in all crystallographic directions was experimentally found to be 3.6 km/s.

The electrical charge, e, of an electron is 1.6×10^{-19} Coulombs. One electron volt (eV) is the energy gained by an electron on crossing one volt of electrical potential difference.

Charge: $e = 1.6 \times 10^{-19}$ C
Potential: $V = 1 J/C$
Energy: $eV = \text{charge} \times \text{potential} = 1.6 \times 10^{-19}$ J
$1 J = 1 kg.m^2/s^2$

In the interlaced fcc Na^+Cl^- rock-salt lattice;

$$\text{Energy, } E_{NaCl} = 7.9 \text{ eV} = 1.26\times10^{-18} \text{ kg.m}^2/\text{s}^2$$
$$\text{Mass, } m_{NaCl} = 58.45 \text{ u} = 9.71\times10^{-26} \text{ kg}$$
$$E_{NaCl} / m_{NaCl} = 1.30 \times 10^7 \text{ m}^2/\text{s}^2$$
$$\sqrt{(E/m)} = 3.6 \times 10^3 \text{ m/s}$$

This is the measured velocity of sound in a rock-salt single crystal averaged over all six modes of vibration[3].

Applying the same logic to an interlaced fcc electron-positron lattice, both e^- and e^+ have equal mass and E is 1.02MeV, as determined by C. D. Anderson's experiment in 1932 that discovered and confirmed the existence of the positron, we obtain (showing only 2 decimal places):

$$E = 1.02 \times 10^6 \text{ eV} = 1.63 \times 10^{-13} \text{ kg.m}^2/\text{s}^2$$
$$m = m_e + m_p = 2 \times 9.11 \times 10^{-31} \text{ kg} = 1.82 \times 10^{-30} \text{ kg}$$
$$E/m = 8.99 \times 10^{16} \text{ m}^2/\text{s}^2$$
$$\sqrt{(E/m)} = \underline{3.0 \times 10^8 \text{ m/s}}$$

The sum of mass per lattice pair is twice the electron mass, and the velocity is calculated at 3×10^5 km/s, corresponding with the measured velocity of light and other wavelengths of electromagnetic radiation.

Absorption of energy nE frees a mass nm of particle PAIRS from the bound lattice. This is not a "mass-energy equivalence". It connects the mass m of a pair, freed from bonds in their lattice (Na^-Cl^+, e^-e^+ lattice) or fallen into them, with the energy absorbed or emitted for it in the lattice.

Clearly, 8eV cannot and does not turn into sodium and chlorine atoms to "create" a mass of 58.5u and 1.02 MeV cannot and does not "create" or turn into an electron AND positron. Since 1932, with up to a million times higher energy devices developed, nobody has ever "created" or "destroyed" a SINGLE electron or positron. If something is found that was not found before, it does not imply it has been created for or on that occasion.

Recognising the analogy, it was considered by M. Simhony that the vacuum contains electrons and positrons elastically bound together in a face centred cubic lattice structure as a polycrystalline solid.

In 1973, such a lattice was termed the 'e-po-la' by M. Simhony and evaluated by him as the epola model of vacuum space.[4]

2. The electron positron lattice, the epola.

The interlaced face-centred-cubic (fcc) structures of each ion of the electron positron lattice provide a simple cubic unit cell of alternate electrons and positrons which is both the closest cubic packing (ccp) mode and one of two closest hexagonal packing (chp) modes. The alkali halides are composed of two ions of different mass and different ionic radius yielding six modes of vibration. However, the electron and positron are of identical mass and size offering only three modes of vibration across sides and diagonals of the unit cell, with Cauchy relations C12, C44 equal. In a polycrystalline lattice the averaging of bulk deformation velocities across all faces in any direction is warranted and the very small dimensions of the epola, compared to electromagnetic wavelengths about or above the Compton wavelength, avoid dispersion.

For a lattice to condense from ions or ion pairs, it must comply with Earnshaw's Theorem and be held together not only by mutual electrostatic attraction and repulsion but must be stabilised by a different short range repulsive force. Simhony suggested that this derived from the other known attribute of the electron and positron, their intrinsic magnetic spin moments and perhaps from internal structure of the leptons analogous to the orbital magnetic moments of the electron shells of the alkali halide ions[5]. The calculated lattice constant of the epola at 4.4fm +/- 0.5fm was derived by Simhony using the Madelung constant for the interlaced fcc cell, without the complications of partial covalent bonding or Van der Waals forces yet, by allowing a wide tolerance for grain boundaries and other unquantifiable parameters, also accepts the structural constants of the body centred cubic (bcc) caesium chloride (CsCl) lattice in the alternative chp mode. The electrons and positrons were presumed to be small 'hard' quantum particles, $\leq$ 0.1fm radius, compatible with their experimentally determined scattering radius and the mass density of nucleons, thus endowing highly elastic properties to the relatively long bonds.

At the calculated lattice dimensions, the epola mass density is 10^{13} kg/m^3 with the enormous energy density of -9.6x10^{20} GJ/m^3 or -270 PWh/mm^3. (Shown here in the correct chemical convention, with a negative sign for binding energy).

3. Consequences of the epola

The Michelson-Morley experiment (1887) is effectively an *experimentum crucis* for the epola model of M. Simhony. The propagation of light by vibratory waves of an elastically bound particulate medium qualifies simple Doppler shifts to apply so that the length of each interfering path is the same when measured as the number of wavelengths. Resolution by a null-adjusted interferometer is lost except over the small difference in wave numbers due to a real difference in time between the full lengths travelled but is not applicable to the total distance of multiple path-lengths. The small seasonal and diurnal effects seen in the later experiments by Miller–Morley and by others were to be expected. The corrections for simple Doppler shifts over both legs correspond to the Einstein-Lorenz relativistic correction[6]. The M-M experiment does confirm that winds are not formed in the light carrying medium. The velocity of light does not depend upon motion of source nor of receiver, as is true for wave propagation in a physical medium that is not 'dragged' by the Earth.

Many quantum and relativistic effects can be explained by the electrically neutral, unobservable, polycrystalline elastic lattice of bound electrons and positrons as the propagation medium of light throughout vacuum space. The epola model provides physical explanations for quantisation of atomic orbitals and quantisation of energy, of Planck's postulate, and allows derivation of Planck's constant. The definition of photons and half-wave clusters of epola particles in the spectrum of electromagnetic radiation provides a physical basis for Heisenberg's uncertainty principle, particle–wave duality and explains frequency invariance of electromagnetic waves. Zero point energy and the cosmic microwave background (or foreground) temperature can be related to the random thermal vibrations of the epola particles. However, Einstein's postulate for the constancy of the speed of light in vacuum, now defined as constant, must be questioned for allowing differing local values in the cosmos to be interpreted as time dilation.

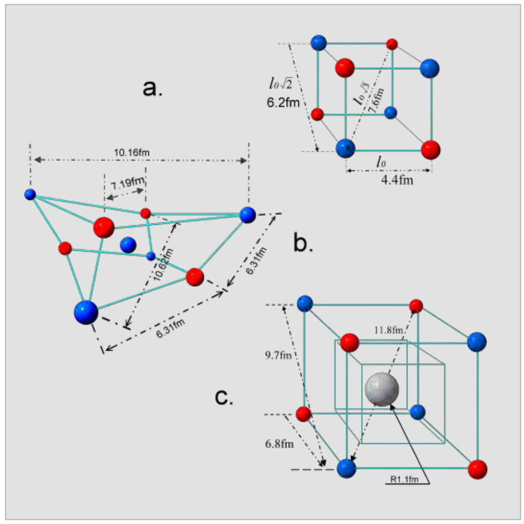

Figure 1. Expansion of an epola cell by SRR of guest particle. a. Epola unit cell. b Guest electron in centre of cell; c. Neutron

The separate cells of the elastic lattice hosting individual particles, the nuclei and orbital electrons of atomic matter, are in their empty rest state much smaller than the separation distances of the subatomic particles of an atom or ion, as was shown by Rutherford's scattering experiments (1911). The mass density of the epola aggregation state of matter is 10 billion times more dense than water, almost half a billion times more dense than osmium but a hundred thousand times less dense than nuclear matter. Between every component of atomic matter, external to the nucleus, there are millions or billions of epola particle cells that provide and control the mechanisms for motion due to charge interactions, inertia and gravitation.

The natural consequences of an electron-positron lattice, explain many of the postulates and assumptions for the physical behaviours of matter outside a nucleus, justifying claims for validity of the epola model and presenting new implications and understanding for the study of physics, including gravitational attraction and inertia.

4. The Gravitational Interaction

Any epola cell that is invaded by a 'hard' particle with mass, e.g. lepton, nucleon, nucleus, is necessarily distorted by electrostatic forces but is expanded by the mutual interactions of that guest and the surrounding bound electrons and positrons due their short range repulsion (SRR) forces. These

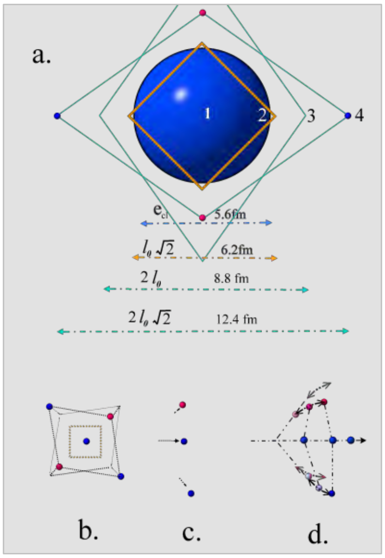

Figure 2

a. Dimensions:
1 Classical 'electrostatic' electron.
2 Empty epola cell.
3 Positrons on cell face;
4 electrons on cell face, guest electron in 'gate'.

b. Expansion of cell with electron in centre

c. Motion of cell nodes as electron enters cell face

d. Elastic vibrations of the nodes established as an electron passes through a cell face.

effects are illustrated in Figures 1&2.

The SRR of a particle is considered not to extend beyond a radius of two lattice constants but the effect of the expansion is shared over successive 'onion-skin' layers of epola particles as their displacements due to mutual SRR are shared and reduced by an increasing number of bound particles with increasing spherical radius, in compliance with the Gauss's inverse square law.

Every guest particle in the epola is continuously surrounded by a 'gravitational field' of expanded cells, the degree of expansion reducing by the inverse square law of distance but extending, potentially, to the extremes of the universe. Where two guest particles are hosted nearby in the lattice, the restoration of size of the cells reaches out from each to a saddle point in the line of sight between them where it can no longer reduce, whilst in all other directions the reduction of the effect continues. This imbalance in the tensions (bond energy) of the surrounding lattice pushes the two particles toward the saddle point that lies at the centre of masses, closer to the larger particle in proportion to their masses. The particles are not 'attracted to each other' nor is there a force of attraction emanating from a particle.

Where several or many particles are locally accumulated, despite intervening atomic distances of very many epola cells, the effect on the epola is cumulative, because every bound epola particle is sensitive to all electromagnetic forces, responding to all interactions, at 'c', the speed of its bulk deformation waves, and always seeking an equilibrium position relative to neighbouring lattice particles.

Where a light wave propagates in the region of an intense gravitational field, the line of half-wave clusters built by Huygens's wave principle will be deformed toward the gravitating body (**Figure 3**) because more epola particles will be encountered for energy transfer during the half-period of the wave outermost from the body, where the deformation velocity is greater, than nearer to the body on the inside of the light wave's path whilst the active half-wave cluster is formed Large accumulations of matter, such as occur as a star, produce a highly significant distortion of the surrounding lattice generating intense gravitational effects. The lattice cells nearer to a star are dilated so that the energy density of the epola is significantly reduced compared to cells at a greater radius. The bulk deformation velocity and the speed of light are reduced with proximity and the geodesic path of light around a star is curved as described by the curving of space in General Relativity Theory. This effect is counter-intuitive to our normal experience of refraction of visible light in transparent materials and our knowledge of Snell's Law, leading some to expect higher density of the lattice.

Light is propagated in the 'vacuum' medium of the epola, but impeded by transparent solids containing the charge centres of their atomic electrons and nuclei. The propagation of light waves through matter is diverted, dispersed and refracted by extended epola pathways within these aggregations of atomic matter. Where electrons are excited by appropriate frequencies, energy packets, 'photons' from the waves are absorbed and lost or re-emitted. The overall effect is to delay the light, to reduce intensity, and to differentially delay wavelengths, the higher frequencies more significantly.

When the wavelength of light or other electro-magnetic radiation is small in comparison with inter-atomic distances in a transparent material, light speed still is reduced by another mechanism. In the case of X-rays and gamma rays, when absorption is negligible, the refraction approaches that given merely by the increased mass density due to the epola plus the hosted matter particles. The mass of the epola is ~1×10^{10} g/cm^3 whilst the density of a glass block may be 3g/cm^3. The local density is increased by 3×10^{-10} parts, so that the velocity of bulk deformation waves (light speed) is inversely reduced as the square root of the density, by a 1.7×10^{-5} part or less than two thousandths of one percent.

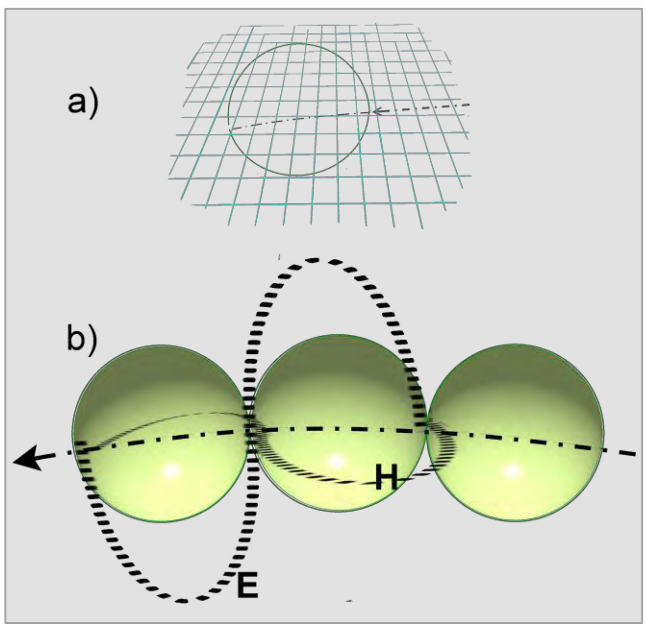

Figure 3

Geodesic path of a light wave in a strong gravitational field

a Distortion of underlying epola, larger cells with lower deformation velocity.

b Asymmetric axes of spherical half-wave clusters of the epola vibration wave of a light ray, indicating E and H fields.

5. Inertia and Momentum

Particles that move through the epola, as do all bodies on and of the Earth, must require their expanded host cell to allow passage through to the next cell in line by sufficient opening of the gate of the cell face ahead. We can approximate the conditions required by considering a hosted electron moving through the lattice. The increase in cell face size due to an electron and its SRR force can be ascertained approximately from the spacing of adjacent leptons of an empty epola cell as illustrated in Figure 2.

The non-radiating atomic orbitals of Bohr, and Pauli's exclusion of similar quantum state in the same wave, are explained by whole numbers of de Broglie waves of the electron, preceded by circularly closed accompanying waves (AW) of the epola at the speed of light acting as a wave-guide so that the electron is always surrounded by a moving half-wave cluster of its Compton wave.

The ground state electron of the hydrogen atom (Figure 4) is described by one de Broglie wavelength[7] around the circumference of the orbital. This wavelength is as many times larger than the Compton wavelength of the electron as the ratio of the velocity of light to the velocity of the electron. This is in agreement with measurement of the speed of the electron compared to light speed and Sommerfeld's definition in 1916 of the fine structure constant by the value ~1/137.

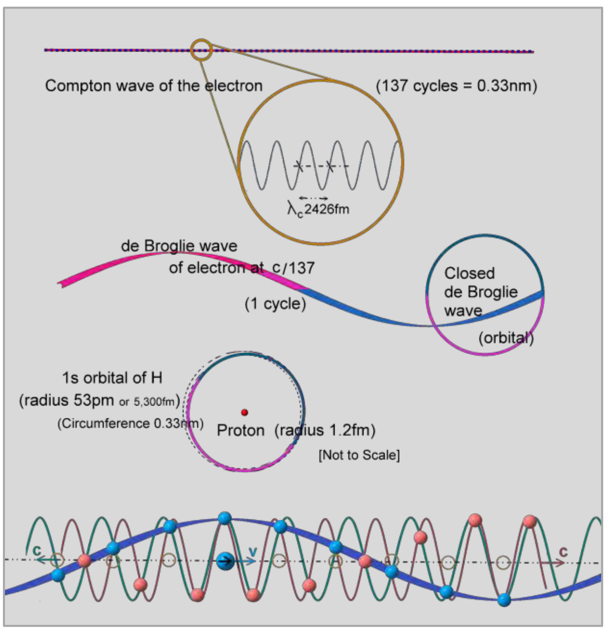

Figure 4
Hydrogen s1 orbital as Compton and, de Broglie waves in the vibrations of epola particles accompanying the electron.

When a guest particle moves through a sequence of shared epola cell faces, the elastically bound particles are caused to vibrate, setting up accompanying waves (AWs) and wave patterns around the guest. The resistance to acceleration of a guest particle by the billions of neighbouring lattice particles is experienced as inertia. However, when a guest particle is induced to move by its affiliations and interactions to other matter particles or forces, then moving distortions of the lattice establish AWs of vibrations in the lattice with kinetic energy supplied externally to the bound epola particles by the accelerating force ostensibly applied to the body of guest particles. Likewise, to reduce velocity or momentum, energy must be removed from the AWs. Energy contained in the AW preceding the particle, now leading in the 'wrong direction', must be transferred to other guests of the lattice or lost as electro-magnetic radiation else as heat in random thermal vibrations of the epola particles.

Accurate calculation of expanded cell size and inertial effects should take into account the existing velocity of the particle due to the underlying motion of the Earth through the bound epola, estimated to be of the order of 300km/s (~c/1000) by allowing for the motion of the Sun around the galaxy and the Earth around the Sun. These compensations can be classed as Relativistic effects. Considerations that the epola might be 'dragged' and static with respect to the Earth can be dismissed by the evidence of experiments conducted by Oliver Lodge (1909).[8]

When velocity of a guest particle approaches 'c' then the ability of the epola to respond is reduced as the AW takes the form of a shock wave and the effective mass of the particle and of the body increases disproportionately, in accord with Relativity Theory. Superluminal speed would be allowed for a particle, if sufficient energy were supplied to shatter the epola bonds. However, the epola will present velocity limits to life well before then due to heating effect, approximating to the formula due to Planck using the Boltzmann constant: $V.q=E=kT$ where k = 8.6×10^{-5}eV.K^{-1} and to molecularly and atomically bound bodies due to ionisation. (See Appendix).

6. Equivalence of inertial and gravitational mass

The equivalence of inertial and gravitational mass is explained by the common cause of expansion of the host epola cell and the neighbouring cells by and for any guest particle. A particle is induced to move with a particular velocity by the dynamic opening of one gating face of the hosting cell either by appropriate timing and phasing of a compression wave (peristaltic wave) in the elastically bound epola or statically by proximity of another series of expanded cells. Inertial action gifted to guests by the lattice however must imply that the individual bound particles of the epola already possess some kind of implicit inertia or reluctance to move and to resist instantaneous relocations with a finite bulk deformation velocity and this topic is addressed in a subsequent paper by this author[9].

7. Conclusions

Vacuum space can be represented by a poly-crystalline solid lattice of elastically bound electrons and positrons as described by the epola model of M. Simhony.

The epola model is supported by its comprehensive explanations of the physical mechanisms of interactions outside a nucleus that can be assigned to Huygens' waves and de Broglie waves in the vibrations of a real but unobservable elastic lattice of electromagnetic particles. In particular, the success of the model in explaining the anomalies of physics, quantum and relativistic effects and physical mechanisms for gravitation and inertia suggests that the empty curved space of General Relativity Theory is better described by a real medium. It is *in* this medium, rather than *through* this that electromagnetic waves are self-propagated and where the momentum of quanta of energy (photons) is transferred by the motions of real particles, with E and H fields defined by particle displacements and orientations in a bound structure.

The speed of light resulting as the average bulk deformation velocity of the medium is expected to differ with binding energy, thus with bond length, so that the 'curvature of space' around a gravitating mass indicates that the speed of light in vacuum is not constant but is a function of binding energy density and/or the mass density of the local medium of propagation related by the equation $c = \sqrt{(E/m)}$.

Standard models of quantum physics seek evidence of a Higgs mechanism[10] for gravitation and inertia but a solid elastic lattice of electrons and positrons provides a ready explanation.

8. Acknowledgements

1, Menahem Simhony of Haifa, Israel. Mentor and friend, author of the epola model. Recognising the kindness and hospitality of himself and of his family and for his permission to make the 'paperback' (ref.5) freely available. Now approaching 90 years of age, he still takes a great interest but has largely retired from active development of his epola model. He is given to quote the words of Cicero; *"Feci quod potui, faciant meliora potentes" (I have done what I can, let those who can do better)*, and invites development of the epola model by others.

2. Ian Montgomery, Melbourne, Australia. For his assistance and continued support. By his perspicacity, patience and critical appraisal, deputising for William of Ockham.

3. Pete Moore, Houston, TX. Chemist and mathematician, who recognised the logic of the epola model. For his support and derivations of distorted epola cell sizes.

9. References

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7 This de Broglie wavelength (332pm) x α = Compton wavelength (2.43pm) = circumference of Classical electron (2.83fmx2pi) x1/α .
The epola lattice cell constant l_0 is calc'd as 4.4+/- 0.5fm. The radius of the Compton half-wave cluster in the epola (2426/4fm) spans 137 epola cells. (606/4.40= 137.7; 606/4.42=1/α; α=0.00729735, 1/α = 137.036)

8 Oliver Lodge, The Ether of Space, Harper & Brothers (1909).

9 R.G.Grantham, Paper for submission to London PIRTXII, 2010, "Implications of an electron-positron-lattice model of space for EM waves and a possible reconciliation of QM with RT."

10 Higgs mechanism:
see http://www.phy.uct.ac.za/courses/phy400w/particle/higgs.htm

APPENDIX

Velocity limits in the epola...

M. Simhony, 'The Electron-Positron Lattice Space'(1990), page 91A. (The paperback book, ref5a, above).

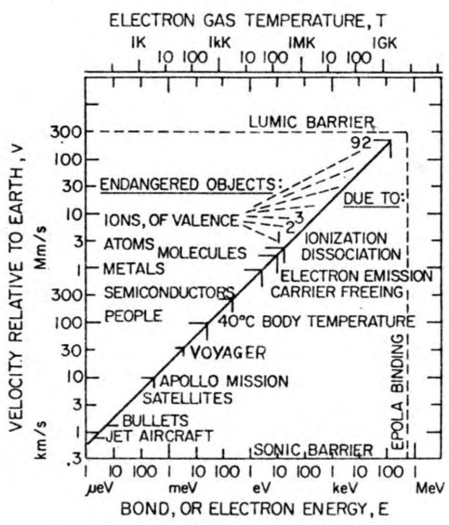

Figure 5. Approximate Velocity Limits in the Epola