International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET207518

Advanced Interior Optimization Methods with Electronics Applications

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Article Info
Volume 7 Issue 5
Page Number: 97-110
Publication Issue :
September-October-2020

Article History
Accepted : 05 Sep 2020
Published : 15 Sep 2020

ABSTRACT

In a previous contribution, the mathematical-computational base of Interior Optimization Method was demonstrated. Electronics applications were performed with numerical optimization data and graphical proofs. In this evoluted-improved paper a series of electronics applications of Interior Optimization in superconductors BCS algorithms/theory are shown. In addition, mathematical developments of Interior Optimization Methods related to systems of Nonlinear Equations are proven. The nonlinear multiobjective optimization problem constitutes a difficult task to find/determine a global minimum, approximated-global minimum, or a convenient local minimum whith/without constraints. Nonlinear systems of equations principles set the base in the previous article for further development of Interior Optimization and Interior-Graphical Optimization [Casesnoves, 2016-7]. From Graphical Optimization 3D optimization stages [Casesnoves, 2016-7], the demonstration that solution of nonlinear systems of equations is not unique in general emerges. Software-engineering and computational simulations are shown with electronics superconductors [several elements, Type 1 superconductors] and electronics physics applications. Extensions to similar applications for materials-tribology models and Biomedical Tribology are explained.

Keywords : Interior Optimization Methods, Graphical Optimization, Systems of Nonlinear Equations, Electronics Superconductors.

I. INTRODUCTION

In optimization with objective functions based on nonlinear systems of equations [3,4,6,22,26], or multiobjective-parameters constraints and other conditions, the task is rather difficult. Specifically this occurs in Physics and Engineering nonlinear optimization problems [4,5,7,12-15]. Large-scale amount of empirical data for algorithms/models implementation have to be adapted/fitted to models that involve a high number of equations, nonlinear many of them [5,7,11], constraints added. Stochastic Optimization methods are used to save time and computational effort when the amount of data is large.In these cases, it is not necessary to work with all the numerical volume available.

Approximations and final refinements for mathematical models are usually performed with inverse methods [4,5,7,10,14]. Statistical-estimations/Approximations and errors testing are obtained from all alternative formulation available. In previous contributions, [3,4,5,7,10,15], Graphical Optimization was presented and applied for engineering mathematical modelling, materials erosion models [6,7], and physics of deformable solids dynamics.

However, Graphical Optimization involves the objective function visualization in 2D and 3D [3,4,7,10,11,15]. This implies that multiparameter formulas initially cannot be easily set for the 3D Graphical Optimization, unless a choice of 2 or 3 variables is done among several ones. From this apparent difficulty, a mathematical optimization and software engineering method for an objective function of high number of variables arose and is presented. It is defined as Interior-Graphical Optimization Method [Casesnoves, 2018]. This observed fact implied also that some complementary approaches to the theory of Nonlinear Equations systems could be done.

Furthermore, in this line it is proven for optimization that the solution for multiobjective optimization problems is not unique in general [3,4,11,12,13,14]. This occurs in nonlinear systems equations [22]. Mathematical development and algorithms are graphically-shown to demonstrate the former assertion [Appendix I]. The method was intended to be proven and set, at first, on simple equations at Electronics Physics field, namely BCS algorithms. Therefore, direct applications in electronics field for superconductors isotope-effect and critical temperature are presented [28].

In summary, this continued-study shows an advanced contribution for the Interior Nonlinear Optimization Method previously presented in [3]. Mathematical and computational base is explained/proven at the Superconductors Type I area. The scheme of the method is shown, with a sharp proof in applications at this electronics field. A clear demonstration that Nonlinear Systems do not have unique solution in general constitutes a supplementary mathematical frame of this paper [Appendix I].

II. MATHEMATICAL METHODS AND ALGORITHMS

In previous article this mathematical development was presented. Consider the multiobjective problem with constraints,

Find the global-local minimum for a nonlinear function,

$$f(\vec{x}) = f(x_1, x_2, \dots x_n) \quad (1)$$

subject to

$$a_1 \leq x_1 \leq b_1$$
$$a_2 \leq x_2 \leq b_2$$
.
.
.
$$a_n \leq x_n \leq b_n \quad (2)$$

This is an equation of several variables that has not, in general, unique solution. If the objective function becomes a number of nonlinear functions [12,13,14,27], such as

$$f_i(\vec{x}) = f_i(x_{1i}, x_{2i}, \dots x_{ni})$$

for i=1,....m and n≠m generally

subject to

$$a_{1i} \leq x_{1i} \leq b_{1i}$$

$$a_{2i} \leq x_{2i} \leq b_{2i}$$
$$a_{ni} \leq x_{ni} \leq b_n$$

or,

$$\begin{bmatrix} a_{1i} \\ \bullet \\ \bullet \\ a_{ni} \end{bmatrix} \leq \begin{bmatrix} x_{1i} \\ \bullet \\ \bullet \\ x_{ni} \end{bmatrix} \leq \begin{bmatrix} b_{1i} \\ \bullet \\ \bullet \\ b_{ni} \end{bmatrix}; \quad (3)$$

More complicated constraints are used in practice. Hence, (3) is a system of nonlinear equations with several variables, [12,13,14,27], that in general case do not have to be equal in number to the parameters. The unique solution is even more difficult to be find out. Optimization algorithms and software can find usually a local minimum, semi-global minimum, or a local minimum according to constraints [3-15].

Stochastic Methods can be tried also. A classical method is Monte-Carlo programs, such as GEANT type [12,13,14] used in IMRT-IMPT radiotherapy, although there are options for Monte-Carlo and Quasi-Monte-Carlo software available. Jacobian and classical Newton-Raphson methods are, for example, used to find an approximate solution. Number of methods to find solution/approximate solutions for a system of nonlinear equations are extent [27], and it is not the specific focus of this contribution. Monte-Carlo method can be considered good, because the program usually, taking continuous random values, search for an optimal solution of variables, no matter how many they are. In the past, Monte-Carlo was time-consuming, but this computational hurdle is actually at least sorted out.

Given this algorithm, the Graphical Optimization Method can be applied starting for grouping variables. That is,

If

$$f_i(\vec{x}) = f_i(x_{1i}, x_{2i}, \ldots x_{ni}) \quad (4)$$

the variables can be grouped in such a way, for instance
if we find x_1 multiplied by x_2
it is defined $x_{1s} = x_1 \cdot x_2$

or just the same parameters-grouping for sums, exponentials, etc. Matrix algebra methods are suitable for more complicated functions.

Definition I. - Interior-Graphical Optimization Method, [Casesnoves, 2018,3,7,5] is a type of Nonlinear Optimization that combines separation of variables method with subsequent stages of Graphical Optimization [Casesnoves, 2016].

What is done in mathematical concepts, is to apply the partial differential equations classical separation of variables method. With separation of variables, it is possible to optimize all the parameters in subsequent stages [Sketch 1] of 3D graphical optimization plots. At every plot, it is selected the desirable local, global, or semi-local minimum for the variable of convenience.

In such a way that the initial Graphical Optimization begins with 3 variables, namely, first, second and objective function. An optimal value is determined. The following stage one parameter with two variables is decomposed, and it is taken the optimal values, and so on. Therefore, it is easy to prove, through the multi-selection of local and approximate minima at Graphical Optimization sets, that in general the multiobjective solution for a system of nonlinear equations is not unique. In other words, it is demonstrated from 3D visualization and separation of variables, this classical mathematical assertion.

Number of graphs required depend on the number of variables of the nonlinear system of equations. The determination of optimal values not necessarily have to be minima. Optimal values taken depend of the engineering requirements for laboratory optimization, devices manufacturing, experimental plan, or similar tasks. The advantage is that the software engineering gives a fast tool to find necessary data inmediatelly with short time consuming.

III. ELECTRONICS APPLICATIONS ON SUPERCONDUCTORS

In this section a brief summary of Superconductivity towards the Transition Equation and the Isotope Effect is presented. The Superconductivity Theory framework is rather extent and with large mathematical background. It involves Quantum Theory, Molecular Chemistry, Materials Physics and other specialities. For the magnetic interaction of superconductor materials the Electromagnetic Theory is essential. All these areas converge together in Superconductors theory and applications. Which is useful to prove Interior Optimization Method are the simple equations of Transition-Temperature-Critical and Isotope Effect [1,3,4,17,18,19,23,24,25,28].

The applications of Supeconductors in Medical Technology are described extensively in literature. Main of them are Hadrontherapy (Protontherapy and/or Carbontherapy) and Nuclear Magnetic Resonance (NMR). Protontherapy [12], is a high-precision dose delivery technique based on the advantage of Bragg Peak radiation distribution. It constitutes an improvement of dosimetry compared to classical IMRT. These applications are related to the area of magnetic fields interaction with superconductors. Future applications in the future are in investigation and development.

The classical Critical Temperature Equation BCS for superconductors reads,

$$M^{\alpha} T_C = K ; \qquad (K=E \text{ in Figures}) \qquad (5)$$

Where K is a constant, M Atomic Mass (AMU), and T_C is critical temperature (Kelvin). From the stage when the solid reaches critical temperature, the superconductivity effect begins. T_C varies for every isotope element within a defined mass element, although not excessively in magnitude.

This equation, although simple, remains useful. It was taken to illustrate Interior Optimization Method in simple way. The evolution of this equation, for example, [20], involves extent mathematical background and mathematical-physics theory. It is sufficient to prove the Interior Optimization Method with this classical equation [18,19,23,24,25,28].

Taking decimal of Neperian logarithms the equation (5) can be linearized for setting graphics related to different isotopes with corresponding atomic proper mass. In the literature [18,19,23,24,25,28]., it is frequent data analysis of BCS equation with linearization plots for comparisons. To set the nonlinear system of equations, the algorithm selected with 100 equations reads,

for (i=1, ...n) , i=100

$$[M_i]^{\alpha} T_C - K_i = 0 \text{ , Tc fixed for simulations}$$

$$A_i = [M_i]^{\alpha} \text{ for first stage of optimization, Fig. 1} \qquad (6)$$

where i is the corresponding number within the range of simulations. For example, range of simulations for M [1,18,19,22,24] is,

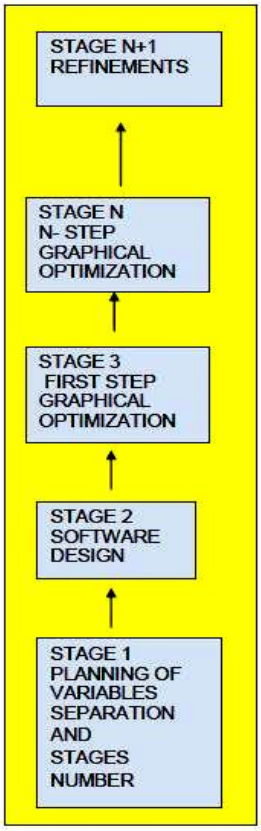
$$M \in [198.0 , 203.4] \qquad (7)$$

In the same way, range of constraints can be seen in axes ranges of Figs 1-6. That is, 100 divisions in M range, (7) that comprise the variation of atomic mass for all Hg isotopes within. Therefore, with equation (6), a nonlinear system of equations is set. The variables are to get optimized.

The method is Interior-Graphical Optimization, that will be proven accurate and useful for (6). It was taken Hg, Pb, and Cr superconductivity values from literature. Extrapolation to large and complicated Electronic Physics equations, Electronics, or any type of system can be guessed from this application.

IV. SOFTWARE ENGINEERING AND MATRIX ALGEBRA ALGORITHMS IMPLEMENTATION

The algebraic software developed for this contribution had various programming difficulties to adapt the programs on Chebyshev L_1 norm for objective function. Additional complications were the algebra changes in the subroutines to get functional the program for surface Graphical_Optimization visualization. This requires mathematical changes-background. The software was developed in Matlab and is almost equivalent for FREEMAT also. These numerical data are all for this contribution. Programming was selected to use subroutines that let rotate 3D images to obtain best visualization. With this tool it was possible to see in images the sharp minimum zone to prove the mathematical statements. Freemat also offers this possibility in 3D surfactal implementation.



Range for surfactal simulations Delanuay tiles was 100. In previous contributions, higher values were taken for high-accuracy [3,5,7,10,12,13,14,15]. However, optimization programs were designed for double precision, since were based on engineering software of extent number of previous publications [3-16].

Below Sketch 1. Brief of Interior Optimization Method stages. Any error at initial stages could cause significant bias in results. The algorithms are not general for a single program. Usually, the software has to be adapted on the particular Nonlinear/Linear System(s) of the function(s).

To check complementarily the numerical results, both Fortran and F# subroutines in optimization were used. While Fortran proved to match the Graphical Optimization results, F# showed restrictions and obviously, limits that discarded this type of language for accurate results in nonlinear optimization. None of these numerical data were included in publication.

V. Hg COMPUTATIONAL GRAPHICAL-INTERIOR OPTIMIZATION RESULTS

The results are shown in Tables and Graphics as the previous paper [3]. The numerical applications are presented for Hg, Pd, and Cr. Pb has approximate atomic mass to Hg, while Cr atomic mass is about ¼ compared to Hg and Pb. Numerical results matches values in the literature for natural Hg. However, alpha value is lower than the classical magnitude of 0.5.

Residuals can be considered acceptable, although not of high-precision accuracy. The time consuming for

designing program is extremely short. The time for selecting optimal values is also very short with the Matlab graphical cursor. In engineering practice, this is a significant advantage that gives many options for fast on-site superconductivity data management at laboratory. Results confirm useful utility of equation (5).

TABLE I
SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS I		
ISOTOPE TYPE (BY ATOMIC MASS)	K OPTIMAL	OBJECTIVE FUNCTION RESIDUAL (Chebyshev Optimization Norm)
200.7 (NATURAL)	57.06	0.5891
199.9	57.06	0.5891
202.0	57.06	0.5891
203.2	57.06	0.5891

Table I.-The first stage of Interior Optimization. In X and Y axes, are set the constant K and the parameter A that comprises M^{α}. That is, $A= M^{\alpha}$ in Fig 1, X axis. The values are taken almost from all references related to Hg critical temperature for superconductors [1,3,17,18,19,23,24,25,28]. T_C value is fixed for natural Hg in simulations and at Z axis it is deployed the Objective Function without taking absolute value. T_C for natural Hg is fixed because it is searched optimal values for all isotopes conditioned to the Tc of the natural Hg. The results for optimal alpha are in Table II. These values were taken with the cursor in the most easy and simple way. It tooks about 15 minutes. Programs construction were performed in 2 hours based on previous software [3,5-16] with matrix algebra modifications.

TABLE II
SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS II		
Hg ISOTOPE TYPE (BY ATOMIC MASS)	OPTIMAL ALPHA	FIXED T_C (Kelvin)
200.7 (NATURAL)	0.1455	4.154
199.9	0.1455	4.154
202.0	0.1455	4.154
203.2	0.1455	4.154

Table II.- The second stage of Interior Optimization. In X and Y axes, are set the constant α and the parameter M. That is, previously was optimized $A= M^{\alpha}$. The values are taken almost from all references related to Hg critical temperature for superconductors. T_C value is fixed for natural Hg and at Z axis it is deployed the Objective Function without taking absolute value. The results for optimal K and residuals are in Table I. These values were taken with the cursor in the most easy and simple way. It tooks about 10 minutes.

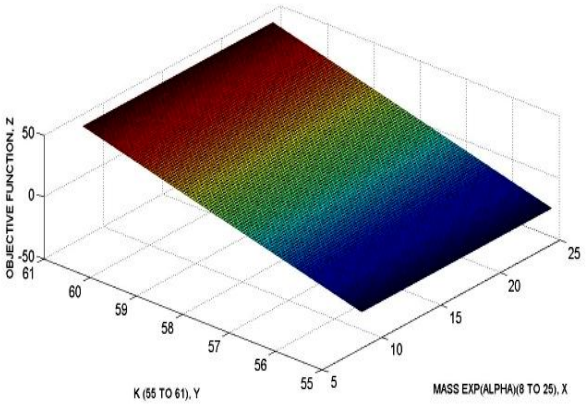


Fig. 1.-First stage of Interior-Graphical optimization. It was determined the optimal K value and the optimal $A= M^{\alpha}$ value. Information and tools that can be used/obtained with imaging-surfactal subroutines are detailed in [3,7,10,11,15]. Note that absolute value was not taken at Chebyshev objective function, as a tentative intend to observe the values distribution.

For Pb and Cr L_1 Norm is taken in absolute value for objective function.

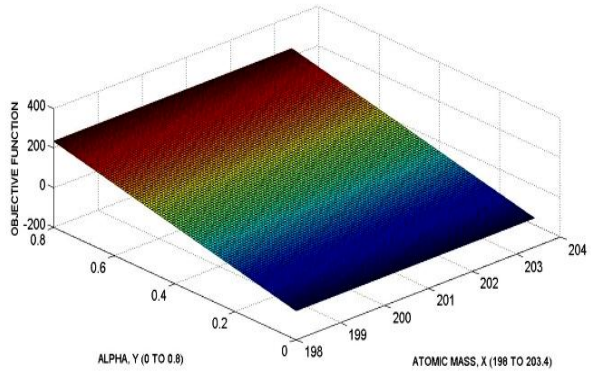


Fig 2. - Second stage of Interior-Graphical Optimization. It was determined the optimal M value and the optimal α value. Information and tools that can be used/obtained with imaging-surfactal subroutines are detailed in [3,4,7, 10,11,15].

VI. Pb COMPUTATIONAL GRAPHICAL-INTERIOR OPTIMIZATION RESULTS

The results for Pb are shown in Table III and Figs. 3 and 4. Atomic mass of Pb is similar to Hg. However, alpha value is lower [Tables I, II for comparison].

Residuals can be considered acceptable, although not of high-precision accuracy, with short time consuming. Results confirm useful utility of equation (5), and show in graphics a sharp minimum line-zone at graphical optimization surface .

TABLE IIIII
SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS II		
Pb ISOTOPE TYPE RANGE (BY ATOMIC MASS)	K OPTIMAL	OBJECTIVE FUNCTION RESIDUAL (Chebyshev Optimization Norm)
208 (NATURAL)	31.62	0.5303
[204,208]	31.62	0.5303

Table III.-The first stage of Pb Interior Optimization. In X and Y axes, are set the constant K and the parameter A that comprises M^{α}. That is, $A= M^{\alpha}$ in Fig 3. The values are taken almost from all references related to Pb critical temperature for superconductors. T_C value is fixed for natural Pb in simulations and at Z axis it is deployed the Objective Function taking absolute value. T_C for Pb is fixed because it is searched optimal values for all isotopes conditioned to the Tc of the natural Pb.

TABLE IVV
SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS III		
Pb ISOTOPE TYPE RANGE (BY ATOMIC MASS)	OPTIMAL ALPHA	FIXED T_C (Kelvin)
208 (NATURAL)	0.0404	7.197
[204,208]	0.0404	7.197

Table IV.- The second stage of Pb Interior Optimization. In X and Y axes Fig 4, are set the constant α and the parameter M. That is, previously was optimized $A= M^{\alpha}$.

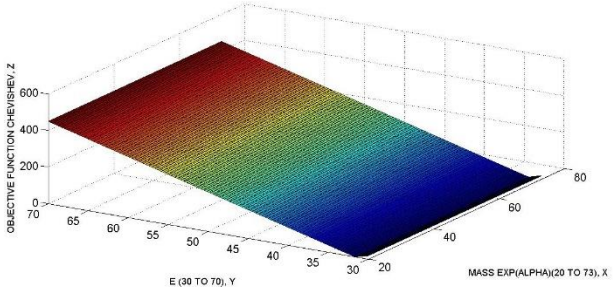


Fig. 3.-First stage of Pb Interior-Graphical optimization. It was determined the optimal K value and the optimal $A= M^{\alpha}$ value. Information and tools that can be used/obtained with imaging-surfactal subroutines are detailed in [3,4,7,10,11,15].

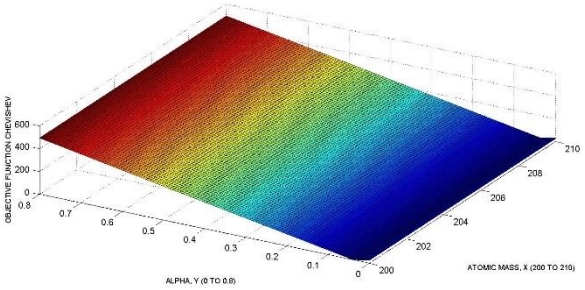


Fig. 4.- Second stage of Pb Interior-Graphical Optimization. It was determined the optimal M value and the optimal α value.

VII. Cr COMPUTATIONAL GRAPHICAL-INTERIOR OPTIMIZATION RESULTS

The results for Cr are shown in Tables V and VI and Figs. 5 and 6. Atomic mass of Cr is not similar to Hg or Pb. Alpha value obtaine is about 1/3 [Tables I-IV for comparison]. Residuals are also good.

Residuals can be considered the best obtained in this study, with short time consuming. Results confirm useful utility of equation (5), and show in graphics a sharp minimum line-zone at graphical optimization surface [Appendix I].

TABLE V. SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS V		
Cr ISOTOPE TYPE RANGE (BY ATOMIC MASS)	K OPTIMAL	OBJECTIVE FUNCTION RESIDUAL (Chebyshev Optimization Norm)
52 (NATURAL)	33.33	0.1111
[50,52]	33.33	0.1111

Table V.-The first stage of Cr Interior Optimization. In X and Y axes, are set the constant K and the parameter A that comprises M^{α}. That is, $A= M^{\alpha}$ in Fig 5. The values are taken almost from all references related to Cr critical temperature for superconductors. T_C value is fixed for natural Cr in simulations and at Z axis it is deployed the Objective Function taking absolute value. T_C for Cr is fixed in 3 K.

TABLE VI
SOFTWARE ENGINEERING OPTIMIZATION

NUMERICAL INTERIOR OPTIMIZATION RESULTS VI		
Cr ISOTOPE TYPE RANGE (BY ATOMIC MASS)	OPTIMAL ALPHA	FIXED T_C (Kelvin)
52 (NATURAL)	0.3636	3
[50,52]	0.3636	3

Table VI.- The second stage of Cr Interior Optimization. In X and Y axes Fig 6, are set the constant α and the parameter M. That is, previously was optimized $A= M^{\alpha}$.

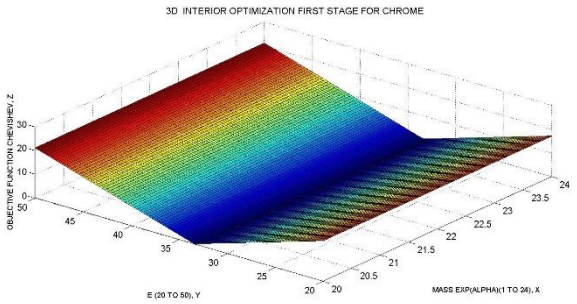


Fig. 5. - First stage of Cr Interior-Graphical optimization. It was determined the optimal K value and the optimal $A= M^{\alpha}$ value. Information and tools that can be used/obtained with imaging-surfactal subroutines are detailed in [3,4,7,10,11,15,28].

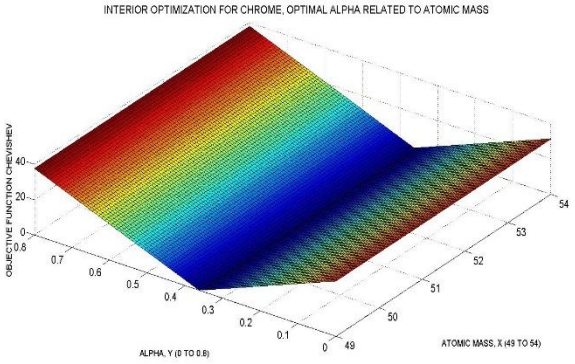


Fig. 6. - Second stage of Cr Interior-Graphical Optimization. It was determined the optimal M value and the optimal α value.

VIII. DISCUSSION AND CONCLUSIONS

The Interior Optimization Method base with algorithms and mathematical definitions that was explained/presented formally in [3], was developed and proven for several elements of Type I superconductors. The nonlinear systems of equations linked to the theoretical algorithmic-construction assertion that a System of Nonlinear Equations has not, in general, a unique solution was proven. The research was focused on superconductivity for Hg, Pb, and Cr, with acceptable results.

As a demonstration of the mathematical and practical engineering applications, electronics in superconductors equations were presented. Computational electronics simulations with 3D graphical optimization images were made correctly. Numerical results were explained in tables and schemes.

Numerical results match the usual values published in literature for Hg superconductivity effect [1,3,18,19,23,24,25,28]. In alpha Hg value determination, the magnitude differs from the common 0.5 value set classically. Not always, however, 0.5 alpha value is calculated in all publications of the literature studied [1,3,18,19,23,24,25,28]. The results for Pb show a small value of alpha, with good residual. The results for Cr show an excellent residual and an alpha value of about 0.4.

In Cr and Pb graphical Optimization, the proposed assertion of the author to prove that the uniquieness of Nonlinear Systems solution generally is comfirmed [Appendix I]

In summary, original method of Interior Optimization was developed with examples of practical electronics applications in superconductor electronics field. The non-existence, in general, of uniqueness of solutions for a system of nonlinear equations from Graphical Optimization Method was demonstrated. Applications in other areas of Electronic Physics, Physics, Bioengineering, Medical Radiation-diagnosis Technology and Engineering emerge from this Interior Optimization Method.

In Materials Tribology and Biotribology the usage of this method is similar with the Graphical Optimization technique that was published in previous contributions [3-21]. For example, as it was presented for medical devices implants optimization [15].

IX. SCIENTIFIC ETHICS STANDARDS

Interior Graphical-Optimization Methods were created by Francisco Casesnoves on 3rd November 2018, while he was preparing his Doctoral Thesis defence. First implementation of algorithms and verification of simulations were carried out in the morning of April 1st, 2020. This second article has previous paper information and figures, whose inclusion is essential to make the contribution understandable. This study was carried out, and their contents are done according to the European Union Technology and Science Ethics. Reference, 'European Textbook on Ethics in Research'. European Commission, Directorate-General for Research. Unit L3. Governance and Ethics. European Research Area.

Science and Society. EUR 24452 EN [26]. This research was completely done by the author, the software, calculations, images, mathematical propositions and statements, reference citations, and text is original for the authors. When anything is taken from a source, it is adequately recognized. Ideas from previous publications were emphasized due to a clarification aim, [29,30].

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XI. AUTHOR'S BIOGRAPHY

Francisco Casesnoves is Engineering and Natural Sciences PhD by Talllinn University of Technology (started thesis in 2016, thesis defence/PhD earned Defence in December 2018, official graduate Diploma 2019), Estonia, and computational-engineering/physics independent researcher at COE, MSc-BSc, Physics/Applied-Mathematics (Public Eastern-Finland-University), Graduate-with-MPhil, in Medicine and Surgery (Public Madrid University Medicine School). Casesnoves studied always in public-educational institutions. His education/scientific vocation was motivated very young, by Profs Candida Navamuel and Isabel Vela, in Renaissance-Humanism ideas—later on with the motivation manuscripts of Nobel and Von Helmholtz prizes Santiago Ramon y Cajal. His constant service to International Scientific Community and Estonian technological progress (2016-present) commenced in 1985 with publications in Medical Physics, with further specialization in optimization methods in 1997 at Finland—at the moment approximately 100 recognized publications with 50 papers. His main branch is Computational-mathematical Nonlinear/Inverse Optimization. His service to International Scientific community also comprises the publication of two recent books with Estonian affiliation, the first is the computational dynamics book, 'The Numerical Reuleaux Method' (200 pages, first part book, 2019), the second is a sociological and medical philosophy book (300 pages, 2019). Casesnoves best-achievement is the Numerical Reuleaux Method in dynamics and nonlinear-optimization. This Numerical Reuleaux Method constitutes, among others, an advance in Space Aerodynamics Computational Methods and Bioengineering. Casesnoves speaks, reads, and writes Estonian language at B1-2 levels, with corresponding official diplomas. Also participates/registers in sporting Estonian activities such as Tallinn Marathon. Casesnoves played as defender and middle-fielder at Junior Madrid Football League, and as physician is supporting agnostic healthy life and all sporting activities. Casesnoves publications are always according to International Scientific Standards. He sets his medical technology papers, specially in cancer radiotherapy methods, always in open access for benefit and use of any public health system according to the Fundamental Right for health care. Recently has written new mathematical modelling radiotherapy articles affiliated to Estonia, Tallinn (2019). Casesnoves scientific service since 2016 to the Free and Independent Republic of Estonia for technological development (and also at Riga technical University, Power Electrical and Electronics Department) is about 22 physics-engineering earticles, two books, and 1 industrial project associated to Europa Union EIT Health Program (Tartu University, 2017). In EIT Europa Union Program, Tartu University, Casesnoves developed his invention of the radiotherapy conformal wedge based on AAA radiotherapy model (Anisotropic Analytical Algorithm) with implemented Software-Engineering ja simulations in Matlab-Freemat, Fortran, and F#.

Cite this article as :

Francisco Casesnoves, "Advanced Interior Optimization Methods with Electronics Applications", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 5, pp. 97-110, September-October 2020. Available at doi : https://doi.org/10.32628/IJSRSET207518
Journal URL : http://ijsrset.com/IJSRSET207518

XII. APPENDIX I

GRAPHICAL-NUMERICAL DEMONSTRATION OF VALIDITY OF ALGORITHM AND METHOD

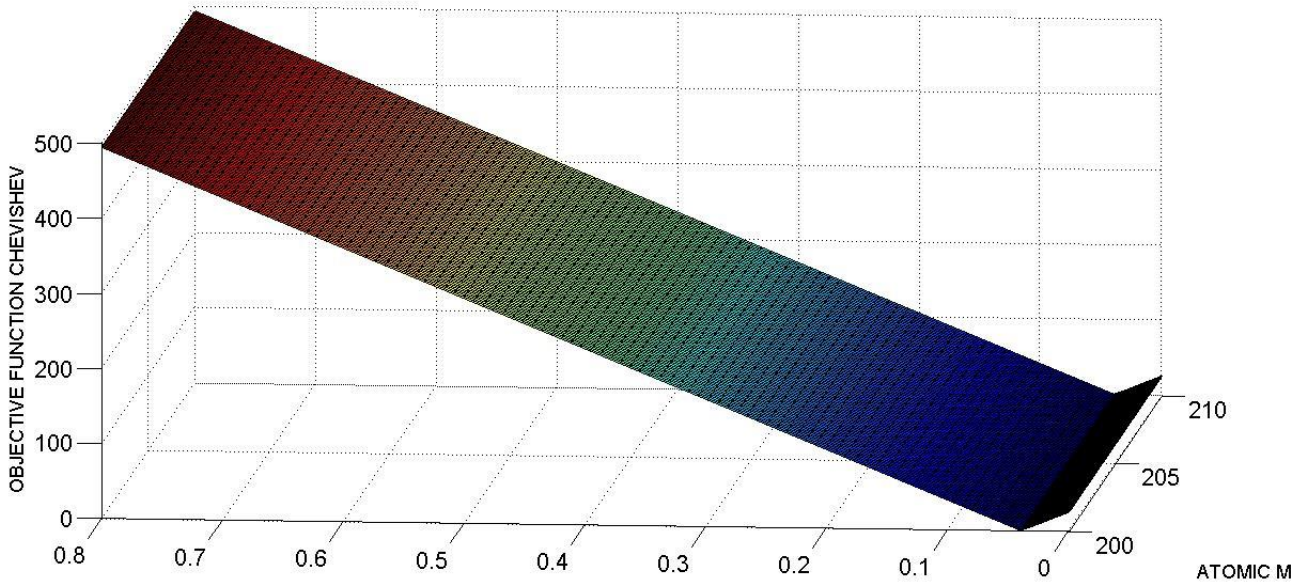

Figure 1. Appendix I.-This image corresponds to stage 2 of Pb optimization. The validity of the simple BCS equation is sharply proven. It is shown a global minimum line, tangent of surface at z=0 level. In this tangent line, the alpha value remains constant for all different atomic masses of the isotopes. Mathematically this means that the algorithm works for several elements of Type I superconductors. That is,

$$M\,\alpha\ TC\ -\ E \approx 0$$

Usually a residual is found in optimization task. However, the initial BCS algorithms have been improved significantly with an extended mathematical background. This matter will be developed in upcoming contributions.

In the following Figure II. Appendix I, can be checked the same proof for Cr element. The non-uniquieness solution of a Nonlinear System of equations can be seen proven at the minimum tangent line observed at these graphics.

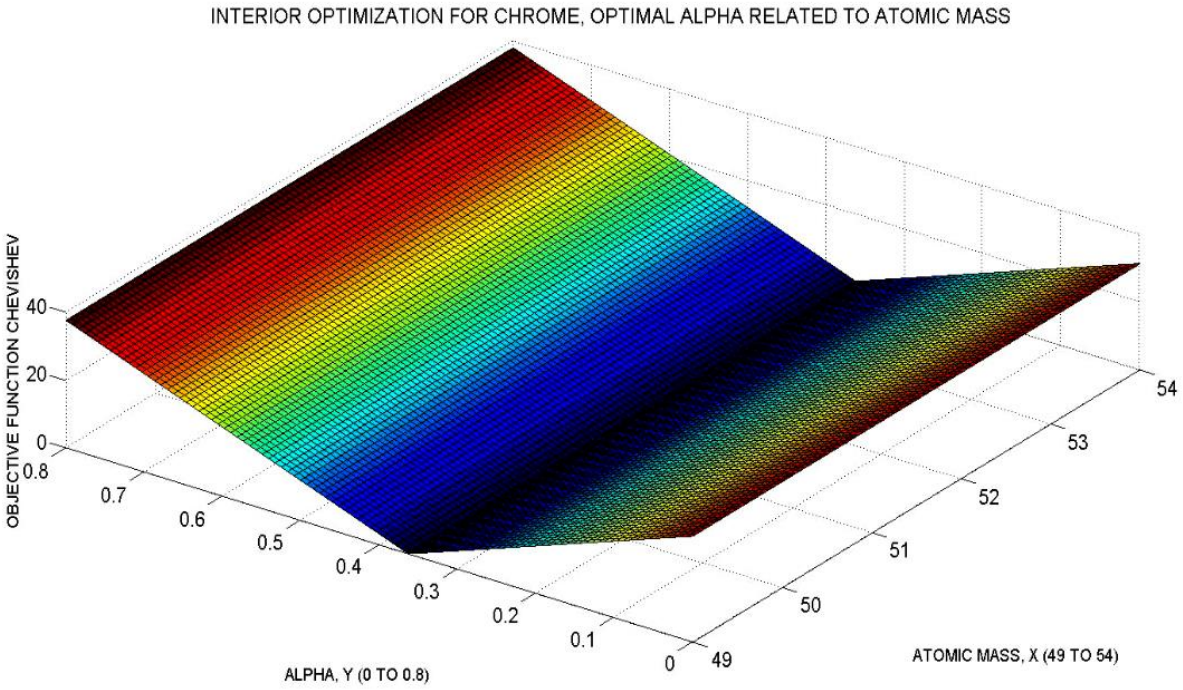

Figure 2. Appendix I.-This image corresponds to stage 2 of Cr optimization. The validity of the simple BCS equation is sharply proven. The tangent of minimum values separates two parts of the interior-optimization surface. The reason is the programming design with Chevishev L1 Norm taken in absolute value.