Numerical solution of master equation corresponding to Schumann waves

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Abstract

Following a hypothesis by Marciak-Kozlowska, 2011, we consider one-dimensional Schumann wave transfer phenomena. Numerical solution of that equation was obtained by the help of Mathematica.

Introduction

The measured frequencies of Schuman and brainwaves are nearly the same. [Persinger]. It is worth to underline that both calculated curves give a rather good description of the measured frequencies of Schuman and brain waves , see Marciak-Kozlowska [2][3]

Following a hypothesis by Marciak-Kozlowska, 2011, we consider one-dimensional Schumann wave transfer phenomena. Numerical solution of that equation was obtained by the help of Mathematica.

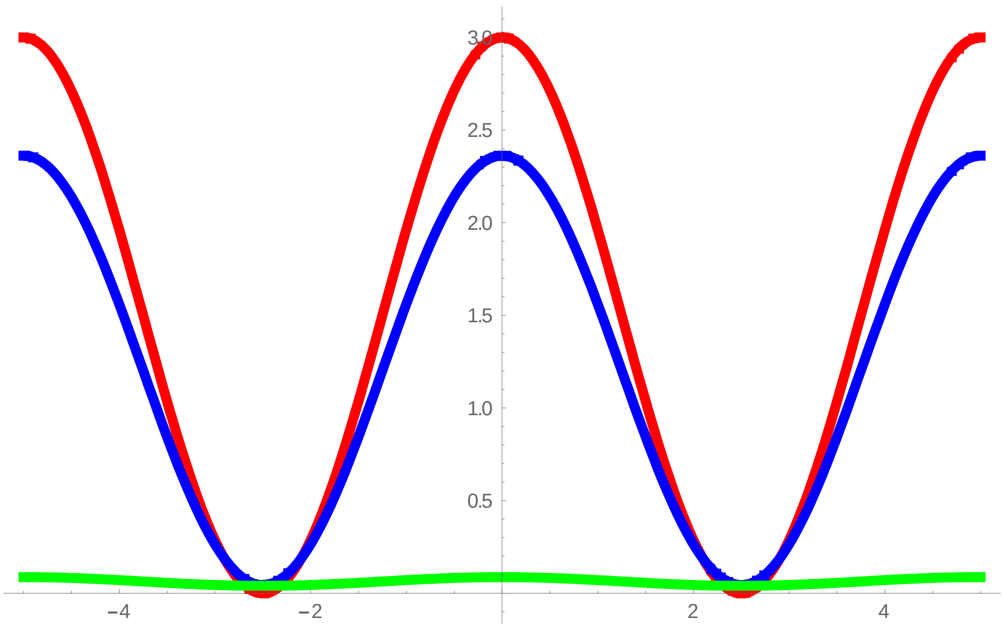
A hyperbolic master equation for Schuman wave phenomena was formulated [4][5], where in this equation m is the mass of the neuron, $\hbar$ - is the Planck constant, V is potential and υ is the velocity propagation of the Schumann wave in the brain.

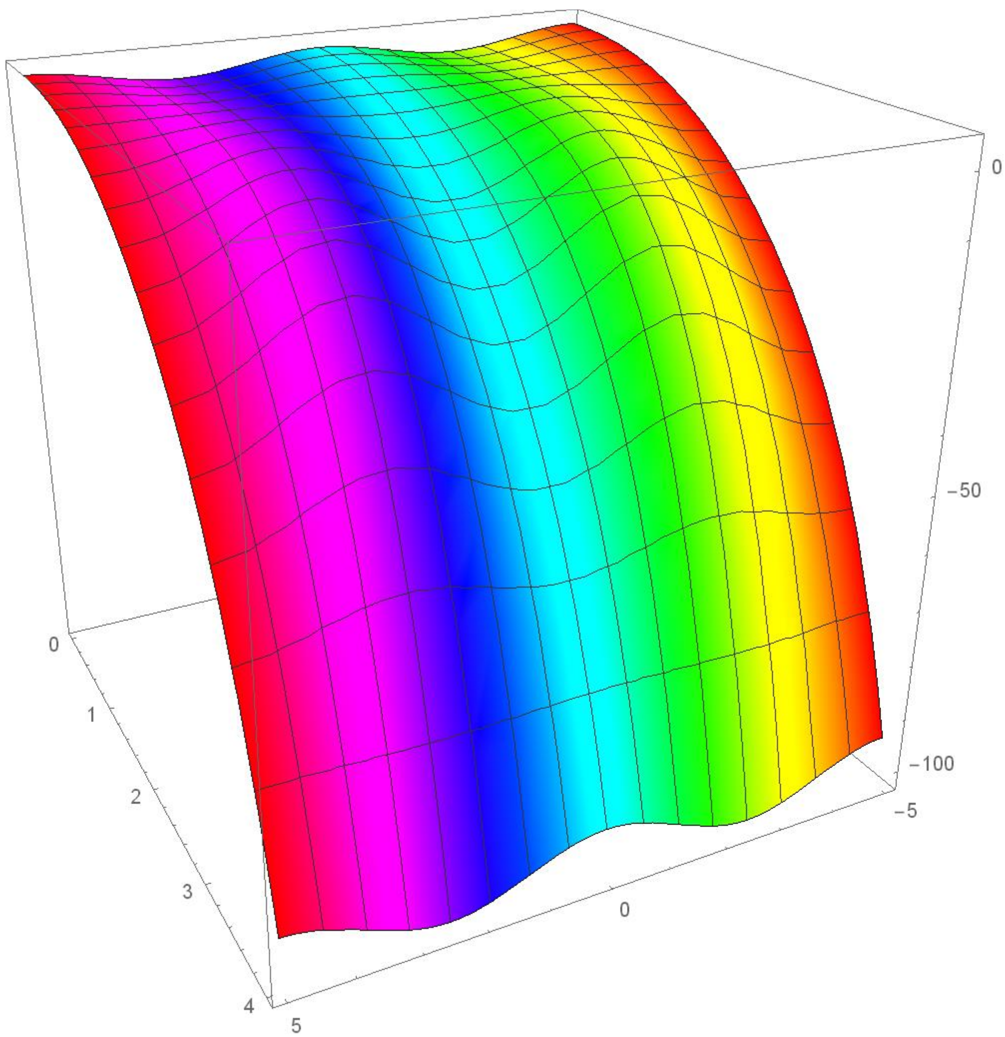
Now we will obtain its numerical solution without having to recourse to Klein-Gordon equation as its approximation. Instead, we will look for direct numerical solution and its plot using Mathematica 9.[6]

Mathematica code:

```
SetOptions[Plot,ImageSize->500,PlotRange->All,PlotPoints->nP*2,PlotStyle->{Blue,Thickness[0.01]}];{s=1/100,nP=100}
{nN=3,l=1,l1={Red,Blue,Green},l2={0,1/2,1}}
f[u_]:=2*b*a/c^2;f[u]
eKG=D[u[x,t],{t,2}]+a*D[u[x,t]/c,{t,1}]-D[u[x,t],{x,2}]+f[u]==0
fIC1[f1_]:=u[x,0]==f1;fIC2[f2_]:=(D[u[x,t],t]/.t->0)==f2;
fBC1[c_,f1_]:=(D[u[x,t],x]/.x->c)==f1;
fBC2[d_,f2_]:=(D[u[x,t],x]/.x->d)==f2;
{fIC1[f1],fIC2[f2],fBC1[c,f1],fBC2[d,f2]};
params5={a->1,b->1,c->-1,aN->1.5};{c5=-5,d5=5,tF5=4,xI5=c5,xF5=d5,f15=aN*(1+Cos[2*Pi*x/d5]),f25=0,f35=0,f45=0,eKG5=N[eKG/.params5],ic5=N[{fIC1[f15],fIC2[f25]}/.params5],bc5=N[{fBC1[c5,f35],fBC2[d5,f45]}/.params5]}
sol5=NDSolve[Flatten[{eKG5,ic5,bc5}],u,{x,xI5,xF5},{t,0,tF5},MaxStepSize->s,PrecisionGoal->2]
Do[g[i]=Plot[Evaluate[u[x,l2[[i]]]/.sol5],{x,xI5,xF5},PlotStyle->{l1[[i]],Thickness[0.01]}],{i,1,nN}];Show[Table[g[i],{i,1,nN}]]
Plot3D[Evaluate[u[x,t]/.sol5],{x,xI5,xF5},{t,0,tF5},ColorFunction->Function[{x,y},Hue[x]],BoxRatios->1,ViewPoint->{1,2,1},PlotRange->All,PlotPoints->{20,20},ImageSize->500]
Animate[Plot[Evaluate[u[x,t]/.sol5,{x,xI5,xF5}],PlotRange->{-3,3}],{t,0,tF5},AnimationRate->0.5]
```

Graphical plot:


3.0
2.5
2.0
1.5
1.0
0.5
−4
−2
2
4


0
−50
−100
−5
0
5
0
1
2
3
4

References:

[1] Persinger M, Schumann resonances frequencies found within quantitative electroencephalographic activity implications for Earth- Brain Interactions. *Int. Letters of Chemistry, Physics, Astronomy*, vol 30,2014

[2] Kozlowski M Marciak-Kozlowska J, Heisenberg Uncertainty Principle and Human Brain. *Neuroquantology* .vol 11 ,2013

[3] Kozlowski M, Marciak-Kozlowska J, Schumann Resonance and Brain Waves: A quantum description. *Neuroquantology,* vol13, 2015

[4] Marciak-Kozłowska, J. & Kozlowski, M., Klein-Gordon Equation for Consciousness Schumann Field. *Journal of Consciousness Exploration & Research* | July 2017 | Volume 8 | Issue 6 | pp. 441-446

[5] Marciak-Kozłowska, J. & Kozlowski, M., On the Interaction of the Schumann Waves with Human Brain. *Journal of Consciousness Exploration & Research* | February 2017 | Volume 8 | Issue 2 | pp. 160-167

[6] Inna Shingareva & Carlos Lizárraga-Celaya. *Solving Nonlinear Partial Differential Equations with Maple and Mathematica*. 2011 Springer-Verlag / Wien, New York

In[60]:=
```
SetOptions[Plot, ImageSize → 500, PlotRange → All,
  PlotPoints → nP * 2, PlotStyle → {Blue, Thickness[0.01]}];
{s = 1 / 100, nP = 100}
{nN = 3, l = 1, l1 = {Red, Blue, Green}, l2 = {0, 1 / 2, 1}}
f[u_] := 2 * b * a / c^2; f[u]
eKG = D[u[x, t], {t, 2}] + a * D[u[x, t] / c, {t, 1}] - D[u[x, t], {x, 2}] + f[u] == 0
fIC1[f1_] := u[x, 0] == f1; fIC2[f2_] := (D[u[x, t], t] /. t → 0) == f2;
fBC1[c_, f1_] := (D[u[x, t], x] /. x → c) == f1;
fBC2[d_, f2_] := (D[u[x, t], x] /. x → d) == f2;
{fIC1[f1], fIC2[f2], fBC1[c, f1], fBC2[d, f2]};
params5 = {a → 1, b → 1, c → -1, aN → 1.5};
{c5 = -5, d5 = 5, tF5 = 4, xI5 = c5, xF5 = d5, f15 = aN * (1 + Cos[2 * Pi * x / d5]), f25 = 0,
  f35 = 0, f45 = 0, eKG5 = N[eKG /. params5], ic5 = N[{fIC1[f15], fIC2[f25]} /. params5],
  bc5 = N[{fBC1[c5, f35], fBC2[d5, f45]} /. params5]}
sol5 = NDSolve[Flatten[{eKG5, ic5, bc5}], u, {x, xI5, xF5},
   {t, 0, tF5}, MaxStepSize → s, PrecisionGoal → 2]
Do[g[i] = Plot[Evaluate[u[x, l2[[i]]] /. sol5], {x, xI5, xF5},
    PlotStyle → {l1[[i]], Thickness[0.01]}], {i, 1, nN}];
Show[Table[g[i], {i, 1, nN}]]
Plot3D[Evaluate[u[x, t] /. sol5], {x, xI5, xF5},
  {t, 0, tF5}, ColorFunction → Function[{x, y}, Hue[x]], BoxRatios → 1,
  ViewPoint → {1, 2, 1}, PlotRange → All, PlotPoints → {20, 20}, ImageSize → 500]
Animate[Plot[Evaluate[u[x, t] /. sol5, {x, xI5, xF5}], PlotRange → {-3, 3}],
  {t, 0, tF5}, AnimationRate → 0.5]
```

Out[60]= $\left\{\frac{1}{100}, 100\right\}$

Out[61]= $\left\{3, 1, \{■, ■, ■\}, \left\{0, \frac{1}{2}, 1\right\}\right\}$

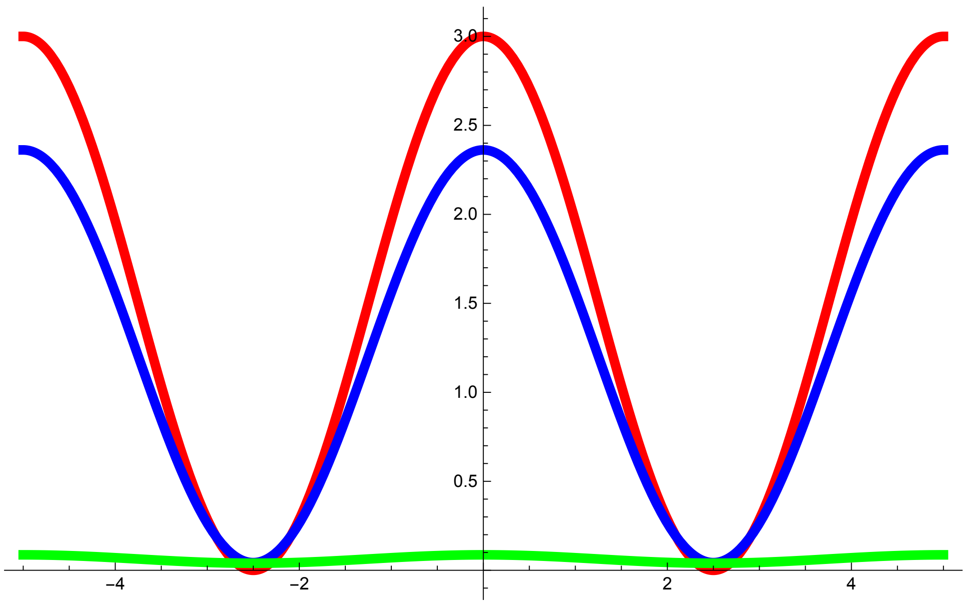
Out[62]= $\frac{2\,a\,b}{c^2}$

Out[63]= $\frac{2\,a\,b}{c^2} + \frac{a\,u^{(0,1)}[x, t]}{c} + u^{(0,2)}[x, t] - u^{(2,0)}[x, t] == 0$

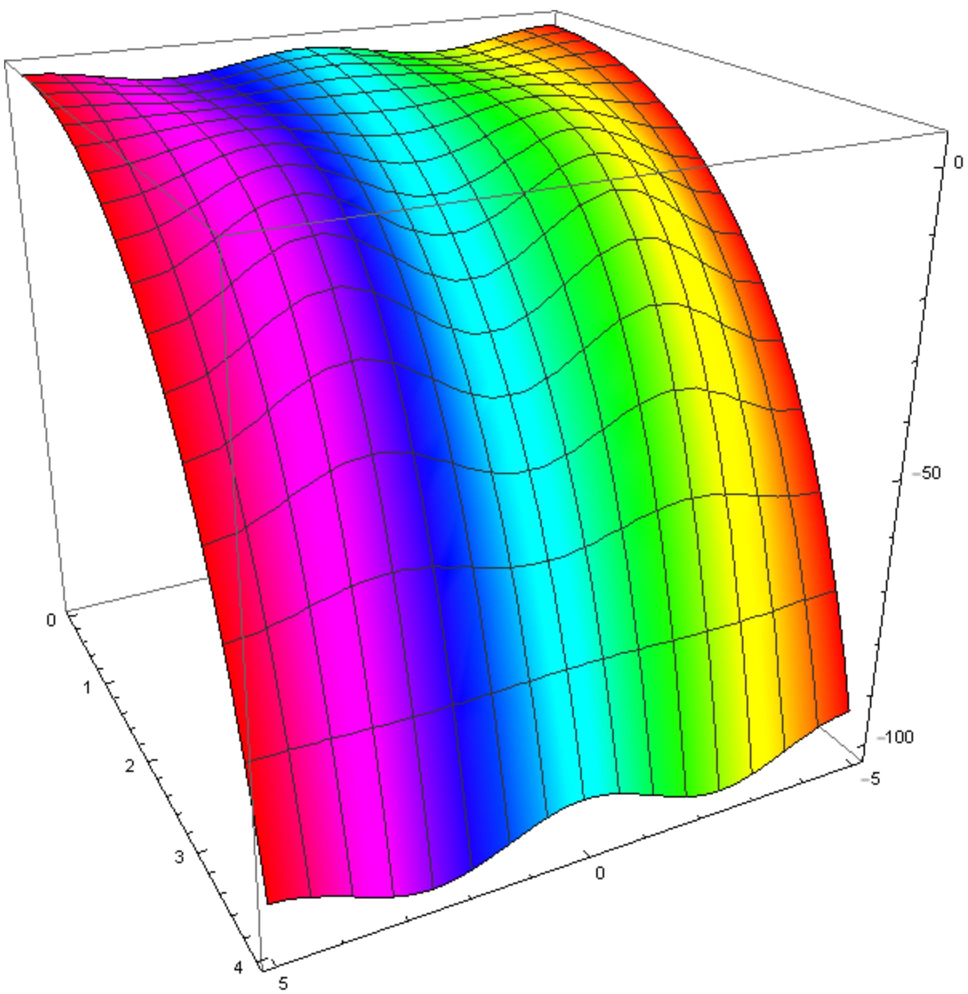
Out[68]= $\left\{-5, 5, 4, -5, 5, aN\left(1 + Cos\left[\frac{2\,\pi\,x}{5}\right]\right), 0, 0,\right.$
$0, 2. - 1.\,u^{(0,1)}[x, t] + u^{(0,2)}[x, t] - 1.\,u^{(2,0)}[x, t] == 0.,$
$\{u[x, 0.] == 1.5\,(1. + Cos[1.25664\,x]), u^{(0,1)}[x, 0.] == 0.\},$
$\left.\{u^{(1,0)}[-5., t] == 0., u^{(1,0)}[5., t] == 0.\}\right\}$

Out[69]= {{u → InterpolatingFunction[Domain: {{-5., 5.}, {0., 4.}} Output: scalar]}}

Out[70]=



Out[71]=



Out[72]=