```
" FILE M2 "

"PROGRAM : HO3 SS wave eq solve"

"This file is the second one of the suite working out calculations reported in :
  Comments on MECHANICS and THERMODYNAMICS of the BERNOULLI OSCILLATORS Parts I
  and II, (Google search : FEDOA Comments on), by G. Mastrocinque - Department
  of Physics - Engineering Faculty - University of Naples Federico II"

"Warning : Before this one, please be sure you have run the program
  HO3 FS wave eq solve in the same library to pick up input data"

"SECOND STEP CALCULATIONS"
<< Graphics`Legend`
Off[NIntegrate::"slwcon"]
Off[NIntegrate::"nlim"]
"INPUT DATA"
ρmax = ρmax0;
cn = cn0;
ξn;
ξfin[n];
ρ1n[ξξ];
"polynomial p[ξξ,3] (eq.(52), Fig. 3) :"
p[ξξ_, 3] = Expand[-0.16873238263778187` (-1.5819966401749899` + ξξ)
    (-1.5802811074767067` + ξξ) (-0.8553168759556176` + ξξ)
    (-0.3876611657211537` + ξξ) (-0.027948039987740668` + ξξ) ξξ^3
    (77.12646535164319` + ξξ) (2.5000005974269164` + (-3.1622775726781303` + ξξ) ξξ)]
Plot[p[ξξ, 3], {ξξ, 0, ξn}, PlotStyle → {RGBColor[0, 0, 1]},
 PlotLegend → {"p[ξ,3]"}, LegendPosition → {-0.5, -.5}, LegendShadow → None]
"correction function corr[ξ,3] (eq.(48), Fig. 4) :"
corr[ξ_, 3] = 1 + NIntegrate[p[ξξ, 3] / ρ1n[ξξ], {ξξ, 0, ξ},
    AccuracyGoal → ∞, MinRecursion → 4, MaxRecursion → 1000000];
Plot[corr[ξ, 3], {ξ, 0, ξn}, PlotStyle → {RGBColor[0, 0, 1]},
 PlotLegend → {"corr[ξ,3]"}, LegendPosition → {-0.5, -.5}, LegendShadow → None]
"Second Step density div ρmax  (eq.(51), Fig. 5) :"
ρgn[ξ_] = corr[ξ, 3]^2 ρ1n[ξ] UnitStep[-ξ + (ξn)] UnitStep[n - 2] +
    ρ1n[ξ] (1 - UnitStep[-ξ + (ξn)]);
Plot[{ρ1n[ξ], ρgn[ξ]}, {ξ, 0, ξfin[n]}, PlotStyle →
  {RGBColor[0, 0, 1], RGBColor[1, 0, 0]}, PlotLegend → {"ρ1n[ξ]", "ρgn[ξ]"},
 LegendPosition → {0.2, -.0 .2}, LegendShadow → None]
"derivative in ξ = 0  (eq.(6)) :"
∂ξ ρgn[ξ] /. ξ → 0
"correction to φ'1[ξ] (eq.(50)) :"
dif[ξ_] = ∂ξ p[ξ, 3] /
   ((1 + NIntegrate[p[ξξ, 3] / ρ1n[ξξ], {ξξ, 0, ξ}, AccuracyGoal → ∞, MinRecursion → 4,
        MaxRecursion → 1000000]) ρ1n[ξ])
Plot[dif[ξ], {ξ, 0, ξn}]
"Second Step phase grad φ'g[ξ] (eq.(50), Fig. 6) :"
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derphig[ξ_] = UnitStep[n - 2] UnitStep[ξn - ξ] √(derphi1[ξ]^2 + dif[ξ]);
Plot[{derphi1[ξ], derphig[ξ]}, {ξ, 0, 1.1 ξn},
 PlotStyle → {RGBColor[0, 0, 1], RGBColor[1, 0, 0]},
 PlotLegend → {"φ1'[ξ]", "φg'[ξ]"},
 LegendPosition → {0.2, .0 .2}, LegendShadow → None]
"plots for figs. 14 and 15  in Appendix :"
Plot[derphig[ξ]^2, {ξ, 0, ξn}, AxesLabel → {ξ, φss'[ξ]^2}]
Plot[derphig[ξ]^2, {ξ, 1.3, ξn}, AxesLabel → {ξ, φss'[ξ]^2}]
"phase difference over a complete round trip (eq.(53))"
fasdifnew = 4 NIntegrate[derphig[ξ], {ξ, 0, ξfin[n]},
   AccuracyGoal → ∞, MinRecursion → 4, MaxRecursion → 1000000];
fasdifnew / (2 π) HoldForm[2 π]
"(relative) phase error compared to expected value (cf. eq. (43)):"
relfasnew = Simplify[(fasdifnew - (n - 1) 2 π) / ((n - 1) 2 π)]
"calculate the Second Step value of ρmax solving the norm condition :"
norm = PowerExpand[2 ρmaxnew λλ] NIntegrate[ρgn[ξ], {ξ, 0, ξfin[n]},
    AccuracyGoal → ∞, MinRecursion → 4, MaxRecursion → 1000000] == 1
solρm = Solve[norm, ρmaxnew]
ρmax = (ρmaxnew /. %[[1]]);
"solution : new ρmax (eq.(54)) =="
ρmax λλ / HoldForm[λλ]
"To calculate gg[ξ], use the parameters :"
"ρmax ρgn[0] (eq.(57)) :"
(ρmax ρgn[0] / HoldForm[λλ]) λλ
"φg'[0] (eq.(58)) :"
derphig[0]
"new value of cn (eq.(59)) :"
cn = 1.1297121268888768`
"g[0] (eq.(56)):"
ρgn[0]^2 + (4 ρgn[0] derphig[0]) / (cn ρmax 2 π λλ)
"calculate the function g[ξ] (Fig. 7) : "
(const ((%% / ρnn[ξ] - ρnn[ξ]) /. ρnn[ξ] → ρgn[ξ]) /. ξ → 0) == derphig[0];
Solve[%, const];
connst = const /. %[[1]];
derphigg[ξ] == connst (gg[ξ]/ρnn[ξ] - ρnn[ξ] + σn (cn - 1)/(λλ^2 ρnn[ξ]) (∂ξ ρnn[ξ] √((∂ξ ρnn[ξ])^2)));
Solve[%, gg[ξ]];
ggg[ξ_, n] = Simplify[gg[ξ] /. %[[1]] /. ρnn[ξ] → ρgn[ξ] /.
    derphigg[ξ] → derphig[ξ] /. ∂ξ ρnn[ξ] → ∂ξ ρgn[ξ]];
Plot[ggg[ξ, n], {ξ, 0, ξn}, AxesLabel → {ξ, g[ξ, 3]}]
"SUITE OF CALCULATIONS : is in file HO3 flow and
  mass functions in the same library. Warning : the following
  programs will use data provided by the present and previuos one"
```

FILE M2

PROGRAM : HO3 SS wave eq solve

This file is the second one of the suite working out calculations reported in :
Comments on MECHANICS and THERMODYNAMICS of the BERNOULLI OSCILLATORS
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- Department of Physics - Engineering Faculty - University of Naples Federico II

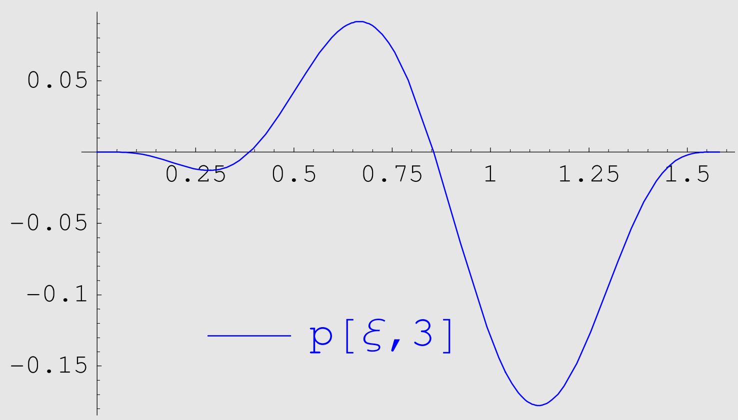
Warning : Before this one, please be sure you have run the
program HO3 FS wave eq solve in the same library to pick up input data

SECOND STEP CALCULATIONS

INPUT DATA

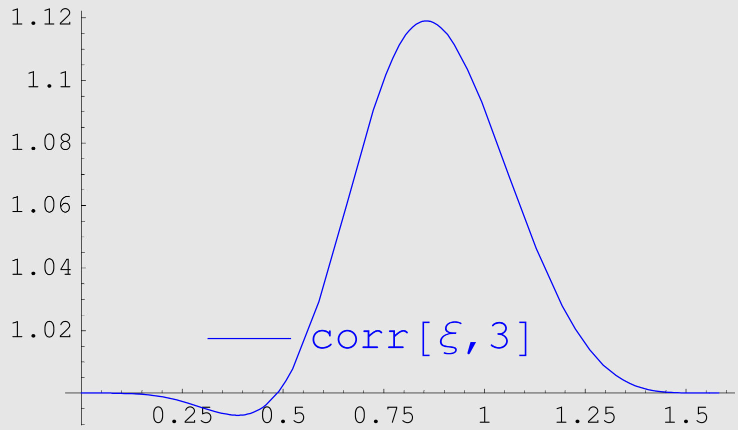
polynomial p[ξξ,3] (eq.(52), Fig. 3) :

$$0.753724\,\xi\xi^3 - 31.6913\,\xi\xi^4 + 180.144\,\xi\xi^5 - 412.776\,\xi\xi^6 + 478.746\,\xi\xi^7 - 298.301\,\xi\xi^8 + 94.8965\,\xi\xi^9 - 11.7321\,\xi\xi^{10} - 0.168732\,\xi\xi^{11}$$



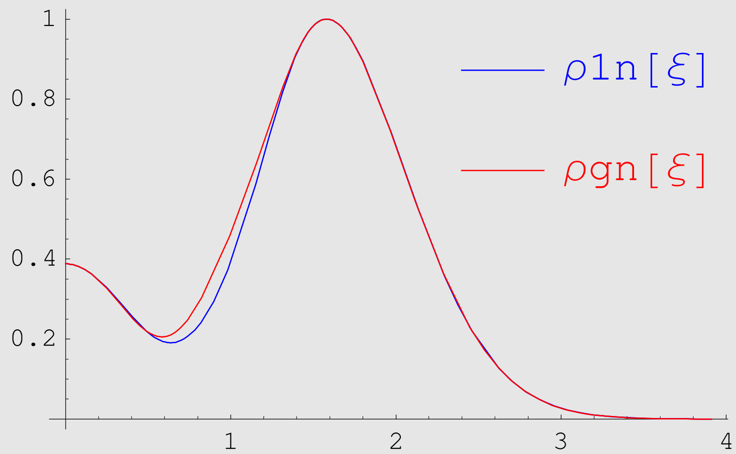
- Graphics -

correction function corr[ξ,3] (eq.(48), Fig. 4) :



- Graphics -

Second Step density div ρmax (eq.(51), Fig. 5) :



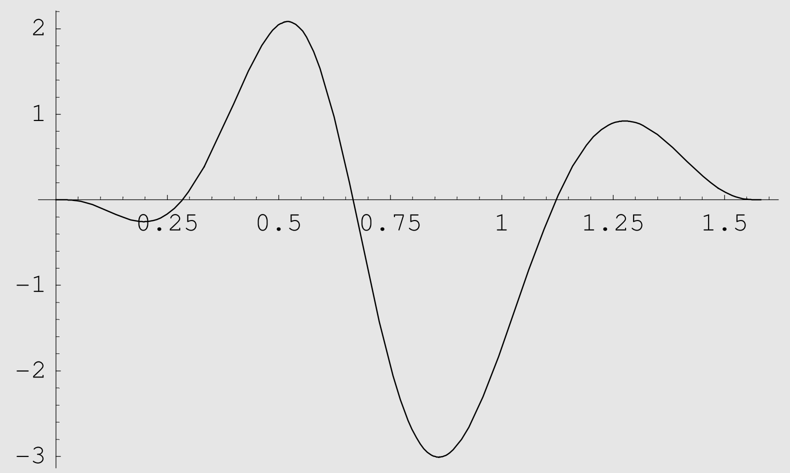
- Graphics -

derivative in ξ = 0 (eq.(6)) :

2.70866×10^{-6}

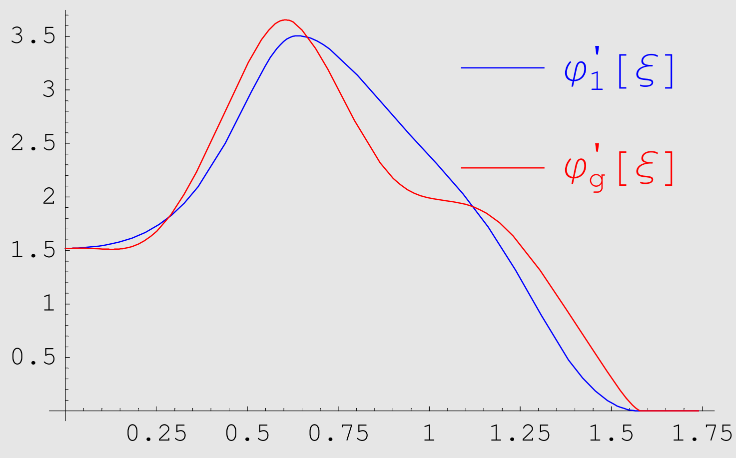
correction to $\varphi_1'[\xi]$ (eq.(50)) :

$$\left(2.26117\,\xi^2 - 126.765\,\xi^3 + 900.72\,\xi^4 - 2476.66\,\xi^5 + 3351.22\,\xi^6 - 2386.41\,\xi^7 + 854.068\,\xi^8 - 117.321\,\xi^9 - 1.85606\,\xi^{10}\right) \Big/ \left(\left(1 + \text{NIntegrate}\left[\frac{\text{p}[\xi\xi, 3]}{\rho\text{1n}[\xi\xi]}, \{\xi\xi, 0, \xi\}, \text{AccuracyGoal} \to \infty, \text{MinRecursion} \to 4, \text{MaxRecursion} \to 1000000\right]\right) \text{InterpolatingFunction}[\{\{0., 3.91112\}\}, <>][\xi]\right)$$



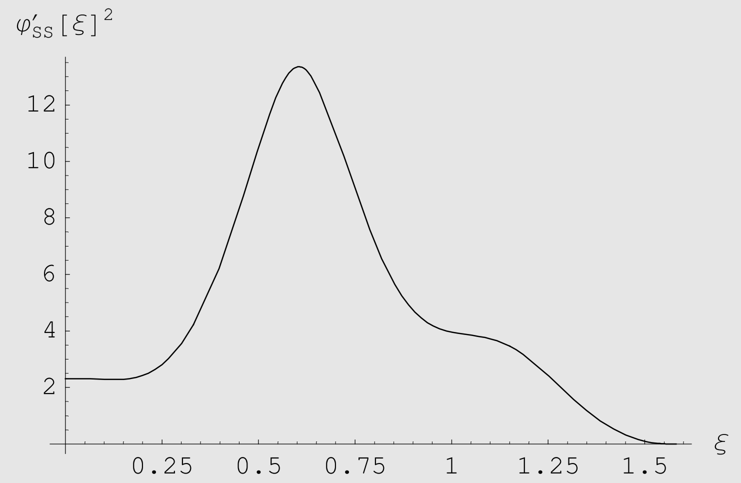
- Graphics -

Second Step phase grad $\varphi_g'[\xi]$ (eq.(50), Fig. 6) :

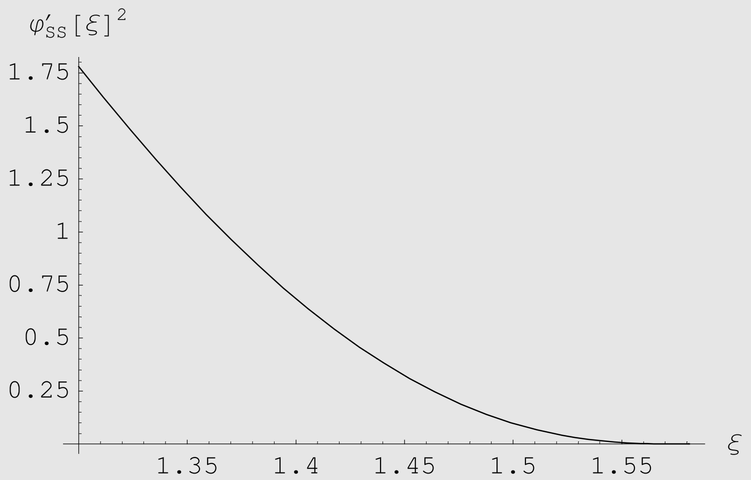


- Graphics -

plots for figs. 14 and 15 in Appendix :



- Graphics -



- Graphics -

phase difference over a complete round trip (eq.(53))

2. (2 π)

(relative) phase error compared to expected value (cf. eq. (43)):

-2.00164×10^{-7}

calculate the Second Step value of ρmax solving the norm condition :

$$\frac{0.439654\sqrt{h}\,\rho\text{maxnew}}{\sqrt{m}\sqrt{\nu c}} == 1$$

$$\left\{\left\{\rho\text{maxnew}\to\frac{2.27452\sqrt{m}\sqrt{\nu c}}{\sqrt{h}}\right\}\right\}$$

solution : new ρmax (eq.(54)) ==

$$\frac{0.362}{\lambda\lambda}$$

To calculate gg[ξ], use the parameters :

ρmax ρgn[0] (eq.(57)) :

$$\frac{0.140509}{\lambda\lambda}$$

$\varphi_g'[0]$ (eq.(58)) :

1.51954

new value of cn (eq.(59)) :

1.12971

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g[0] (eq.(56)):
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1.0688
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calculate the function g[ξ] (Fig. 7) :
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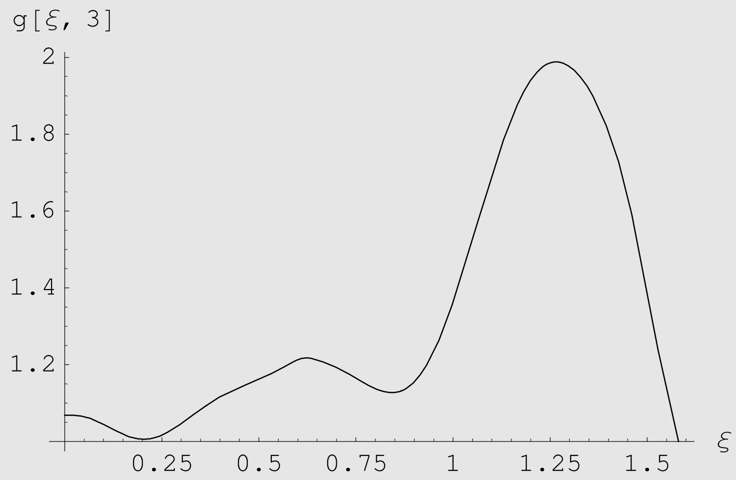


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- Graphics -
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