In[849]:=
```
Clear["Global`*"]
```

In[850]:=
```
KK3x3 = {{k1arm[-1], 0, 0}, {0, 2 * k1arm[0], 0}, {0, 0, k1arm[1]}};
KK5x5 = {{k1arm[-2], 0, 0, 0, 0}, {0, k1arm[-1], 0, 0, 0},
   {0, 0, 2 * k1arm[0], 0, 0}, {0, 0, 0, k1arm[1], 0}, {0, 0, 0, 0, k1arm[2]}};
BB3x3 = {{0, k3arm[-1], 0}, {k2arm[0], 0, k3arm[0]}, {0, k2arm[1], 0}};
BB5x5 = {{0, k3arm[-2], 0, 0, 0},
   {k2arm[-1], 0, k3arm[-1], 0, 0}, {0, k2arm[0], 0, k3arm[0], 0},
   {0, 0, k2arm[1], 0, k3arm[0]}, {0, 0, 0, k2arm[2], 0}};
M3x3 = Inverse[KK3x3].BB3x3;
M5x5 = Inverse[KK5x5].BB5x5;
```

In[856]:=
```
k1arm[n_] :=
 -3 i μ Cosh[H qarm[n]] If[n == 0, 0, 1] + (i n^2 ρ ω^2 Cosh[H qarm[n]] If[n == 0, 0, 1])/k^2 -
  i k γ Cosh[H qarm[n]] Garm[n] × If[n == 0, 0, 1] +
  (i g ρ Cosh[H qarm[n]] Garm[n] × If[n == 0, 0, 1])/k -
  (i n^2 ρ ω^2 Cosh[H k] Garm[n] × If[n == 0, 1, 0])/k^3 -
  (3 i μ Cosh[H qarm[n]] Garm[n] × If[n == 0, 1, 0])/k +
  (i n^2 ρ ω^2 Cosh[H qarm[n]] Garm[n] × If[n == 0, 1, 0])/k^3 +
  2 i μ Cosh[H k] If[n == 0, H, 1] - (i n^2 ρ ω^2 Cosh[H k] If[n == 0, H, 1])/k^2 +
  i k γ Cosh[H k] Garm[n] × If[n == 0, H, 1] - (i g ρ Cosh[H k] Garm[n] × If[n == 0, H, 1])/k +
  (i μ Cosh[H qarm[n]] If[n == 0, 0, 1] qarm[n]^2)/k^2 +
  (i μ Cosh[H qarm[n]] Garm[n] × If[n == 0, 1, 0] qarm[n]^2)/k^3 -
  (i n^2 ρ ω^2 If[n == 0, 1, 0] Sinh[H k])/k^3 + i k γ If[n == 0, H, 1] Sinh[H k] -
  (i g ρ If[n == 0, H, 1] Sinh[H k])/k + 2 i μ Garm[n] × If[n == 0, H, 1] Sinh[H k] -
  (i n^2 ρ ω^2 Garm[n] × If[n == 0, H, 1] Sinh[H k])/k^2 -
  (i k^2 γ If[n == 0, 0, 1] Sinh[H qarm[n]])/qarm[n] + (i g ρ If[n == 0, 0, 1] Sinh[H qarm[n]])/qarm[n] -
  (i k γ Garm[n] × If[n == 0, 1, 0] Sinh[H qarm[n]])/qarm[n] +
  (i g ρ Garm[n] × If[n == 0, 1, 0] Sinh[H qarm[n]])/(k qarm[n]) -
  (3 i μ Garm[n] × If[n == 0, 0, 1] × qarm[n] Sinh[H qarm[n]])/k +
  1/k^3 i n^2 ρ ω^2 Garm[n] × If[n == 0, 0, 1] × qarm[n] Sinh[H qarm[n]] +
```

$$\frac{i\,\mu\,\text{Garm}[n]\times\text{If}[n==0,0,1]\,\text{qarm}[n]^3\,\text{Sinh}[H\,\text{qarm}[n]]}{k^3}$$

```
k3arm[n_] := -(i ρ Cosh[H qarm[1 + n]] Garm[1 + n] × If[1 + n == 0, 0, 1] / k) +
  i ρ Cosh[H k] Garm[1 + n] × If[1 + n == 0, H, 1] / k +
  i ρ If[1 + n == 0, H, 1] Sinh[H k] / k - i ρ If[1 + n == 0, 0, 1] Sinh[H qarm[1 + n]] / qarm[1 + n] -
  i ρ Garm[1 + n] × If[1 + n == 0, 1, 0] Sinh[H qarm[1 + n]] / (k qarm[1 + n])
k2arm[n_] := -(1/k) i ρ Cosh[H qarm[-1 + n]] Garm[-1 + n] × If[-1 + n == 0, 0, 1] +
  i ρ Cosh[H k] Garm[-1 + n] × If[-1 + n == 0, H, 1] / k +
  i ρ If[-1 + n == 0, H, 1] Sinh[H k] / k - i ρ If[-1 + n == 0, 0, 1] Sinh[H qarm[-1 + n]] / qarm[-1 + n] -
  i ρ Garm[-1 + n] × If[-1 + n == 0, 1, 0] Sinh[H qarm[-1 + n]] / (k qarm[-1 + n])
```

In[689]:=
```
Garm[n_] :=
 (k (-2 Cosh[H k] If[n == 0, 1, 0] × qarm[n] - 2 k If[n == 0, H, 1] × qarm[n] Sinh[H k] +
     k^2 If[n == 0, 0, 1] Sinh[H qarm[n]] + If[n == 0, 0, 1] qarm[n]^2 Sinh[H qarm[n]])) /
 (-k^2 Cosh[H qarm[n]] If[n == 0, 0, 1] × qarm[n] + 2 k^2 Cosh[H k]
    If[n == 0, H, 1] × qarm[n] - Cosh[H qarm[n]] If[n == 0, 0, 1] qarm[n]^3 +
   2 k If[n == 0, 1, 0] × qarm[n] Sinh[H k] - k^2 If[n == 0, 1, 0] Sinh[H qarm[n]] -
   If[n == 0, 1, 0] qarm[n]^2 Sinh[H qarm[n]])
```

In[690]:=
```
qarm[0] := 1/H Sqrt[k^2 H^2];
qarm[-1] := 1/H Sqrt[k^2 H^2 - αω^2];
qarm[1] := 1/H Sqrt[k^2 H^2 - αω^2];
qarm[-2] := 1/H Sqrt[k^2 H^2 - 4 αω^2];
qarm[2] := 1/H Sqrt[k^2 H^2 - 4 αω^2];
```

In[695]:=
```
λx = 1;
ω = Sqrt[μ / ρ] (αω/H);
γ = μ H αγ;
μ = (ρ g H) / αg;
```

In[699]:=
```
KK3x3a = Simplify[Simplify[KK3x3] /. k → kk/H];
KK5x5a = Simplify[Simplify[KK5x5] /. k → kk/H];
BB3x3a = Simplify[Simplify[BB3x3] /. k → kk/H];
BB5x5a = Simplify[Simplify[BB5x5] /. k → kk/H];

M3x3a = Simplify[g * Inverse[KK3x3a].BB3x3a];
```

In[•]:=
```
limiteαγ3x3 = Limit[M3x3a, αγ → 0];
limiteαγ5x5 = Limit[M5x5a, αγ → 0];
```

In[•]:=
```
upval = 300;
div = 100;
αγval = 0;
αgval = 1;
αωval = 1.5;
H = 1;
For[i = 0, i < upval, i += 1;
  bb = (1 * i / div);
  state3x3 = False;
  For[r = 1, r < 3, r++,
   For[t = 1, t < 3, t++,
    If[(Chop[(limiteαγ3x3 /. {αω → N[αωval], kk → N[bb], αg → N[αgval]})]][[
       r, t]] === Indeterminate, state3x3 = True]
   ]
  ];
  state5x5 = False;
  For[r = 1, r < 3, r++,
   For[t = 1, t < 3, t++,
    If[(Chop[(limiteαγ5x5 /. {αω → N[αωval], kk → N[bb], αg → N[αgval]})]][[
       r, t]] === Indeterminate, state5x5 = True]
   ]
  ];
  If[state3x3, eigen3x3 = 10^(16), eigen3x3 =
    N[Eigenvalues[(limiteαγ3x3 /. {αω → N[αωval], kk → N[bb], αg → N[αgval]}),
      Method → "Direct"]]];
  If[state5x5, eigen5x5 = 10^(16), eigen5x5 =
    N[Eigenvalues[(limiteαγ5x5 /. {αω → N[αωval], kk → N[bb], αg → N[αgval]}),
      Method → "Direct"]]];
  inveigen3x3[i] = 1 / Max[Re[eigen3x3]];
  inveigen5x5[i] = 1 / Max[Re[eigen5x5]];
 ];
lista3x3 = Table[{(1 * i / div), inveigen3x3[i]}, {i, 1, upval}];
lista5x5 = Table[{(1 * i / div), inveigen5x5[i]}, {i, 1, upval}];
```

In[•]:=
```
vet3x3 = {};
For[ll = 0, ll < Length[lista3x3], ll += 1;
  AppendTo[vet3x3, lista3x3[[ll]][[2]]]
 ];
ord3x3 = Sort[vet3x3];
ac3x3 = ord3x3[[2]];
N[ac3x3]
pos3x3 = (Position[lista3x3, ac3x3] - {{0, 1}}) // Flatten;
k3x3 = N[Extract[lista3x3, pos3x3]]
```

In[•]:=
```
vet5x5 = {};
For[ll = 0, ll < Length[lista5x5], ll += 1;
  AppendTo[vet5x5, lista5x5[[ll]][[2]]]
 ];
ord5x5 = Sort[vet5x5];
ac5x5 = ord5x5[[3]];
N[ac5x5]
pos5x5 = (Position[lista5x5, ac5x5] - {{0, 1}}) // Flatten;
k5x5 = N[Extract[lista5x5, pos5x5]]

β = 0;
For[α = 0, α < 622 / 100, α += 2 / 10;
 Print["αg= ", N[α]];
 β += 1;
 p = 0;
 nn = 0;
 For[jj = 0, jj < 155 / 100, jj += 1 / 100;
  p += 1;
  Print["αω= ", N[jj]];
  upval = 250;
  div = 100;
  αγval = 0;
  nn = N[jj];
  For[i = 0, i < upval, i += 1;
   bb = (1 * i / div);
   stateARM = False;
   For[r = 1, r < 3, r++,
    For[t = 1, t < 3, t++,
     If[(Chop[(ARMMadim /. {αω → nn, kk → N[bb], αγ → N[αγval], αg → N[α]})]) [[
         r, t]] === Indeterminate, stateARM = True]
    ]
   ];
   If[stateARM, eigenARM = 10^(16), eigenARM =
     N[Eigenvalues[(ARMMadim /. {αω → nn, kk → N[bb], αγ → N[αγval], αg → N[α]}),
       Method → "Direct"]]];
   inveigenARM[i] = 1 / Max[Re[eigenARM]];
  ];
  stato = False;
  listaARM[p] = Table[{(1 * i / div), inveigenARM[i]}, {i, 1, upval}];
  vet = {};
  For[ll = 0, ll < Length[listaARM[p]], ll += 1;
   AppendTo[vet, listaARM[p][[ll]][[2]]]
  ];
  ord = Sort[vet];
  Print[N[ord[[1]]]];
  If [ord[[1]] == 10^(-16), stato = True];
  If[stato, acr[p] = ord[[2]], acr[p] = ord[[1]]];
```

```
  pos = (Position[ listaARM[p], acr[p]] - {{0, 1}}) // Flatten;
   kcr[p] = N[Extract[ listaARM[p], pos]];
  Print["k= ", N[kcr[p]], " a= ", PowerExpand[acr[p]]];
  αωad[p] = jj;
 ];
 listaac[β] = Table[{αωad[jj], acr[jj]}, {jj, 1, p}];
 listakc[β] = Table[{αωad[jj], kcr[jj]}, {jj, 1, p}];
]
graficoa = Table[listaac[α], {α, 1, β}];
graficok = Table[listakc[α], {α, 1, β}];
```