BOUT++ Results

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ABSTRACT

This document highlights some results from BOUT++ simulation

metadata

evolved: ['Ni' 'rho' 'jpar']

IC: [1.00000000e-08 0.00000000e+00 0.00000000e+00]

ZMAX: 0.01

TIMESTEP: 100.0

ZMIN: 0.0

ShiftXderivs: false

restart: false

grid: /home/cryosphere/BOUT/tools/cyl_and_helimak_grids/Helimak_1_10_1x32_140_lam_n.nc

MYG: 2.0

dump_format: nc

MXG: 2.0

TwistShift: false

NOUT: 100.0

MZ: 129.0

mxstep: 10000.0

RTOL: 1e-08

type: cvode

ATOL: 1e-12

AA: 2.0

estatic: true

nu_perp: 1e-20

phi_flags: 0.0

ZeroElMass: true

apar_flags: 0.0

ShearFactor: 0.0

ZZ: 1.0

Zeff: 4.0

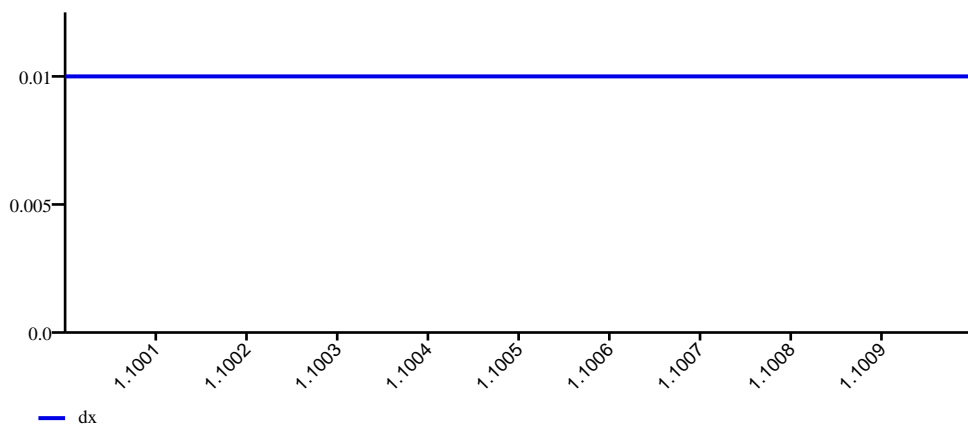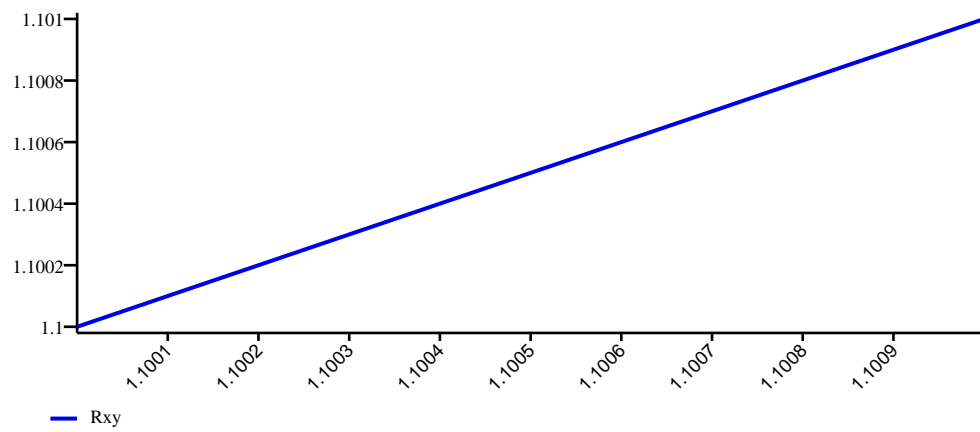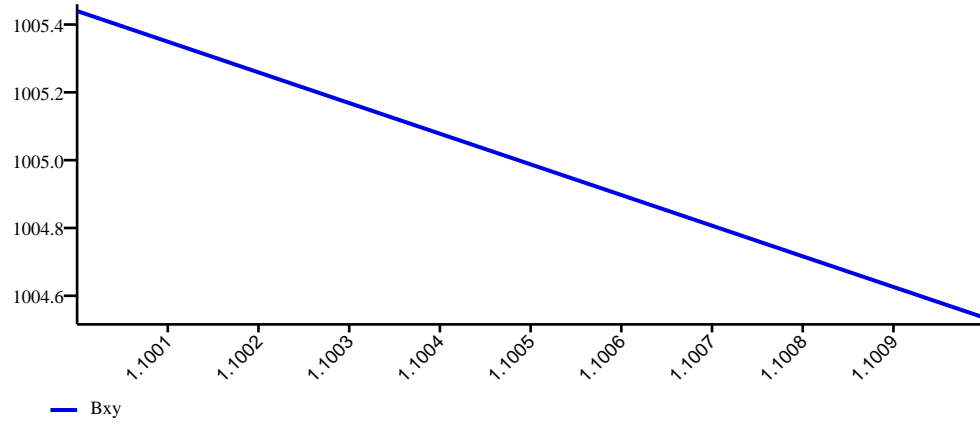ys_mode: 1.0

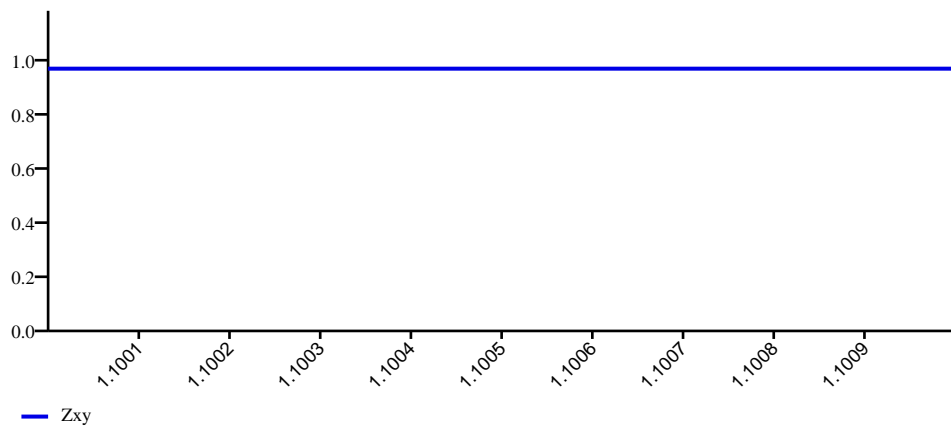scale: 1e-08

zs_opt: 3.0

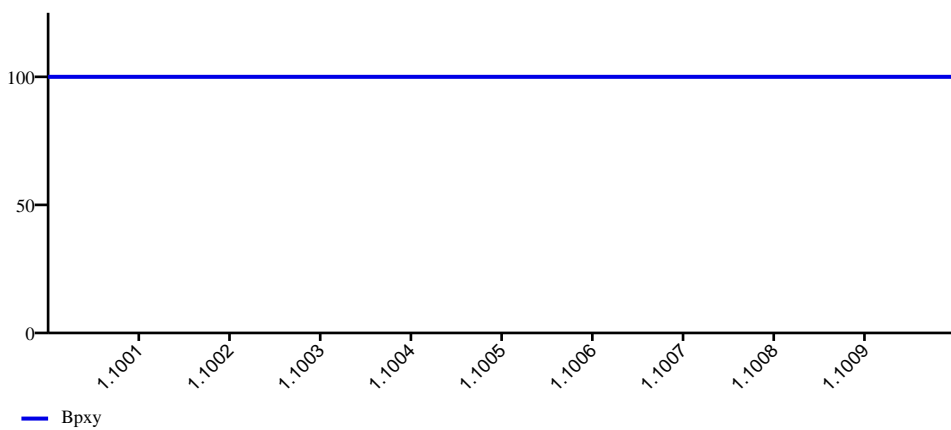xs_opt: 0.0

bndry_all: neumann
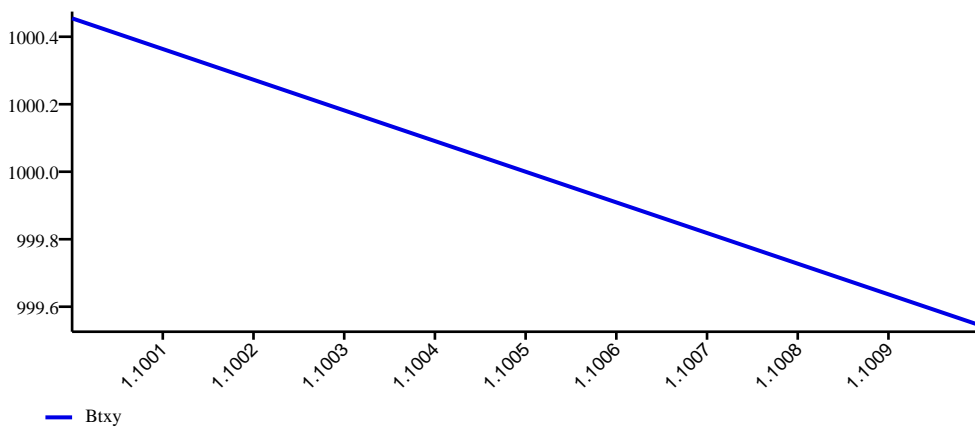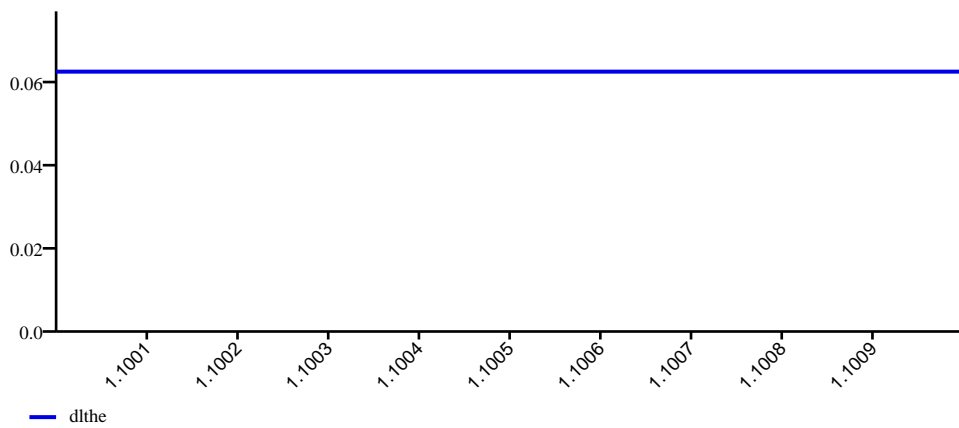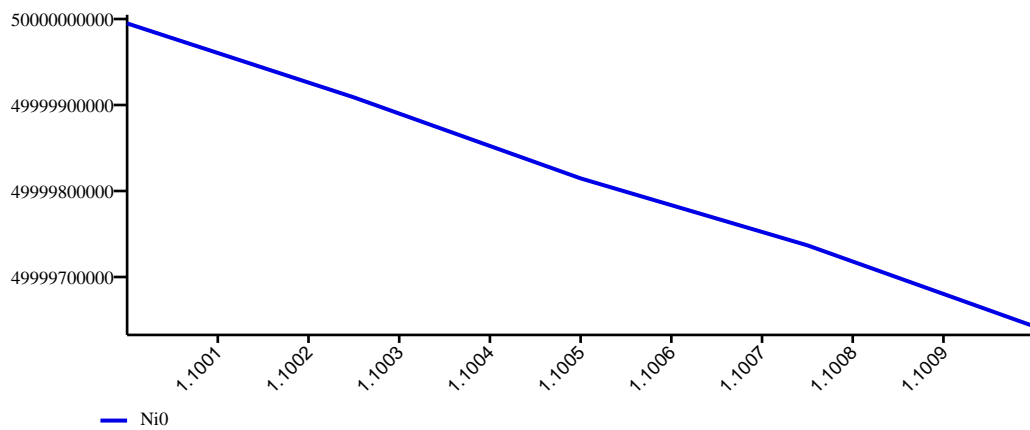
ys_opt: 2.0

zs_mode: 1.0

zs_phase: 0.5

Te_x: [10.] eV

— Bxy

— Rxy

— dx

Ti_x: [0.01] eV

bmag: [1005.43981934] gauss

hthe0: [0.31830987] m

Ni0

dlthe

Ni_x: [4.99999949e+10] cm^-3

nx: 5

ny: 32

dt: 100.0

rho_s: [0.45368987] cm

rho_i: [0.01434693] cm

rho_e: [0.0074855] cm

fmei: 0.000272301492212

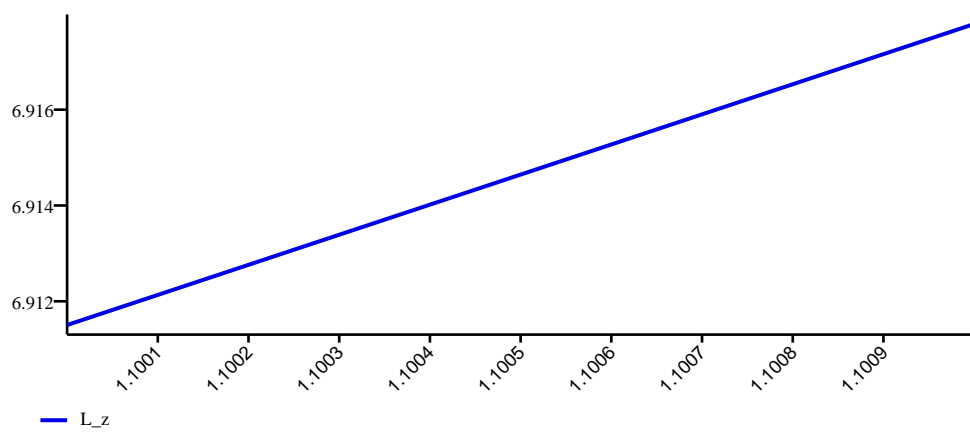lambda_ei: [13.98494053]

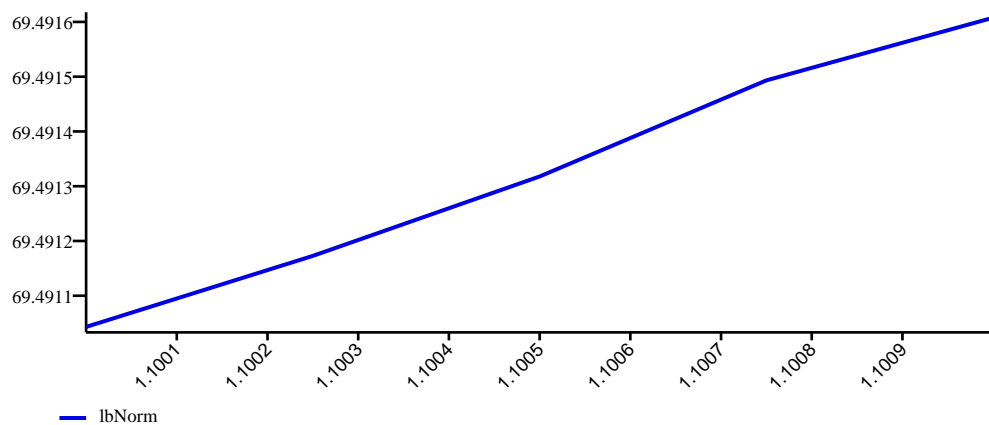lambda_ii: [3.4280262]

wci: [4816056.5]
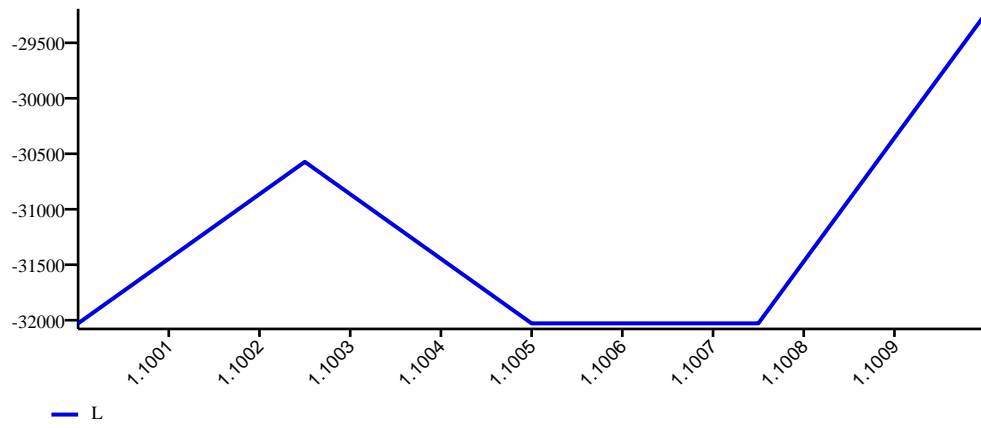
wpi: [2.08710320e+08]

wce: [1.78968289e+10]

wpe: [1.26114222e+10]

v_the: [1.32499432e+08]

v_thi: [69225.75]

c_s: [2826129.5]

v_A: [689376.5625]

nueix: [64346.30078125]

nuiix: [5793313.]

nu_hat: [0.05344315]

L_d: [0.01050761]

L_i_inrt: [144.19987488]

L_e_inrt: [1.18735200e+11]

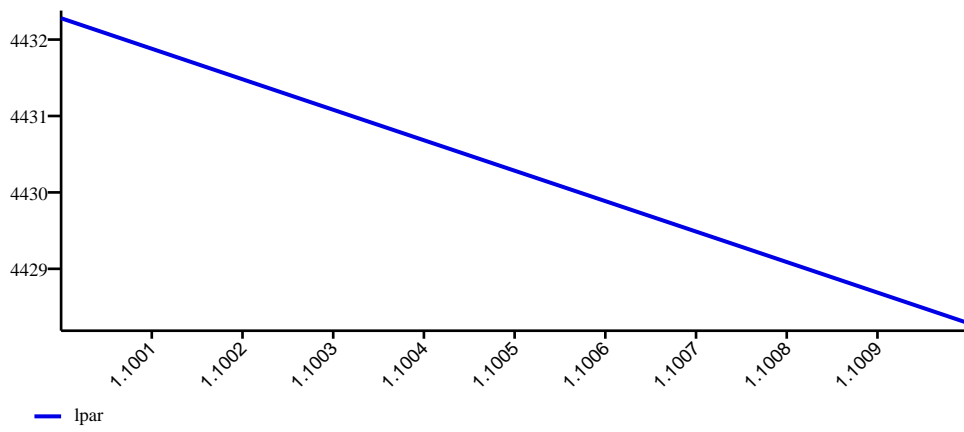Ve_x: [4.19000000e+08]

R0: 1.1004999876

dz: [0.01]

w_Ln: [4.42295823e-05]

sig_par: [134737.28125]

```cpp
int physics_run(BoutReal t) { solve_phi_tridag(rho, phi, phi_flags); if(estatic || ZeroElMass) { Apar = 0.0;
}else { solve_apar_tridag(Ajpar, Apar, apar_flags); } mesh->communicate(comms); Nit = Ni0; Tit = Ti0; Tet
= Te0; Vit = Vi0; nu = nu_hat * Nit / (Tet^1.5); mu_i = mui_hat * Nit / (Tit^0.5); kapa_Te =
3.2*(1./fmei)*(wci/nueix)*(Tet^2.5); kapa_Ti = 3.9*(wci/nuiix)*(Tit^2.5); pei = (Te0+Ti0)*Ni + (Te +
Ti)*Ni0; pe = Te0*Ni + Te*Ni0; if(ZeroElMass) { jpar = ((Te0*Grad_par_LtoC(Ni)) -
(Ni0*Grad_par_LtoC(phi)))/(fmei*0.51*nu); jpar = lowPass(jpar,8); /* for(int jx=MXG;jxngx-MXG;jx++) {
for(int jy=MYG;jyngy-MYG;jy++) { for(int jz=0;jzngz;jz++) { jpar[jx][jy][jz] = ( (Te0[jx][jy] *
(Ni[jx][jy+1][jz] - Ni[jx][jy][jz])) - (Ni0[jx][jy] * (phi[jx][jy+1][jz] - phi[jx][jy][jz])) ) / (fmei * 0.51 *
nu[jx][jy][jz] * dy[jx][jy] * sqrt(mesh->g_22[jx][jy])); } } } */ jpar.applyBoundary();
mesh->communicate(jpar); Ve = Vi - jpar/Ni0; Ajpar = Ve; }else { Ve = Ajpar + Apar; jpar = Ni0*(Vi - Ve);
} ddt(Ni) = 0.0; if(evolve_ni) { ddt(Ni) -= vE_Grad(Ni0, phi); /* ddt(Ni) -= Vpar_Grad_par(Vi, Ni0) +
Vpar_Grad_par(Vi0, Ni) + Vpar_Grad_par(Vi, Ni); ddt(Ni) -= Ni0*Div_par(Vi) + Ni*Div_par(Vi0) +
Ni*Div_par(Vi); ddt(Ni) += Div_par(jpar); ddt(Ni) += 2.0*V_dot_Grad(b0xcv, pe); ddt(Ni) -=
2.0*(Ni0*V_dot_Grad(b0xcv, phi) + Ni*V_dot_Grad(b0xcv, phi0) + Ni*V_dot_Grad(b0xcv, phi)); */
ddt(Ni) = lowPass(ddt(Ni),8); } ddt(Vi) = 0.0; if(evolve_vi) { ddt(Vi) -= vE_Grad(Vi0, phi) + vE_Grad(Vi,
phi0) + vE_Grad(Vi, phi); ddt(Vi) -= Vpar_Grad_par(Vi0, Vi) + Vpar_Grad_par(Vi, Vi0) +
Vpar_Grad_par(Vi, Vi); ddt(Vi) -= Grad_par(pei)/Ni0; } ddt(Te) = 0.0; if(evolve_te) { ddt(Te) -=
vE_Grad(Te0, phi) + vE_Grad(Te, phi0) + vE_Grad(Te, phi); ddt(Te) -= Vpar_Grad_par(Ve, Te0) +
Vpar_Grad_par(Ve0, Te) + Vpar_Grad_par(Ve, Te); ddt(Te) += 1.333*Te0*( V_dot_Grad(b0xcv, pe)/Ni0 -
V_dot_Grad(b0xcv, phi) ); ddt(Te) += 3.333*Te0*V_dot_Grad(b0xcv, Te); ddt(Te) +=
(0.6666667/Ni0)*Div_par_K_Grad_par(kapa_Te, Te); } ddt(Ti) = 0.0; if(evolve_ti) { ddt(Ti) -=
vE_Grad(Ti0, phi) + vE_Grad(Ti, phi0) + vE_Grad(Ti, phi); ddt(Ti) -= Vpar_Grad_par(Vi, Ti0) +
Vpar_Grad_par(Vi0, Ti) + Vpar_Grad_par(Vi, Ti); ddt(Ti) += 1.333*( Ti0*V_dot_Grad(b0xcv, pe)/Ni0 -
Ti*V_dot_Grad(b0xcv, phi) ); ddt(Ti) -= 3.333*Ti0*V_dot_Grad(b0xcv, Ti); ddt(Ti) +=
(0.6666667/Ni0)*Div_par_K_Grad_par(kapa_Ti, Ti); } ddt(rho) = 0.0; if(evolve_rho) { /* ddt(rho) -=
vE_Grad(rho0, phi) + vE_Grad(rho, phi0) + vE_Grad(rho, phi); ddt(rho) -= Vpar_Grad_par(Vi, rho0) +
Vpar_Grad_par(Vi0, rho) + Vpar_Grad_par(Vi, rho); */ ddt(rho) +=
mesh->Bxy*mesh->Bxy*Div_par_CtoL(jpar); /* for(int jx=MXG;jxngx-MXG;jx++) { for(int
jy=MYG;jyngy-MYG;jy++) { for(int jz=0;jzngz;jz++) { ddt(rho)[jx][jy][jz] = Bxy[jx][jy]*Bxy[jx][jy] *
(jpar[jx][jy+1][jz] - jpar[jx][jy][jz]) / (dy[jx][jy] * sqrt(mesh->g_22[jx][jy])); } } } */ } ddt(Ajpar) = 0.0;
if(evolve_ajpar) { /* for(int jx=MXG;jxngx-MXG;jx++) { for(int jy=MYG;jyngy-MYG;jy++) { for(int
jz=0;jzngz;jz++) { ddt(Ajpar)[jx][jy][jz] += (1./fmei) * (phi[jx][jy][jz] - phi[jx][jy-1][jz]) / (dy[jx][jy] *
sqrt(mesh->g_22[jx][jy])); ddt(Ajpar)[jx][jy][jz] -= (1./fmei)*(Te0[jx][jy]/Ni0[jx][jy])*(Ni[jx][jy][jz] -
Ni[jx][jy-1][jz]) / (dy[jx][jy] * sqrt(mesh->g_22[jx][jy])); } } } */ ddt(Ajpar) += (1./fmei)*Grad_par(phi,
CELL_YLOW); ddt(Ajpar) -= (1./fmei)*(Te0/Ni0)*Grad_par(Ni, CELL_YLOW); ddt(Ajpar) +=
0.51*interp_to(nu, CELL_YLOW)*jpar/Ni0; }
```
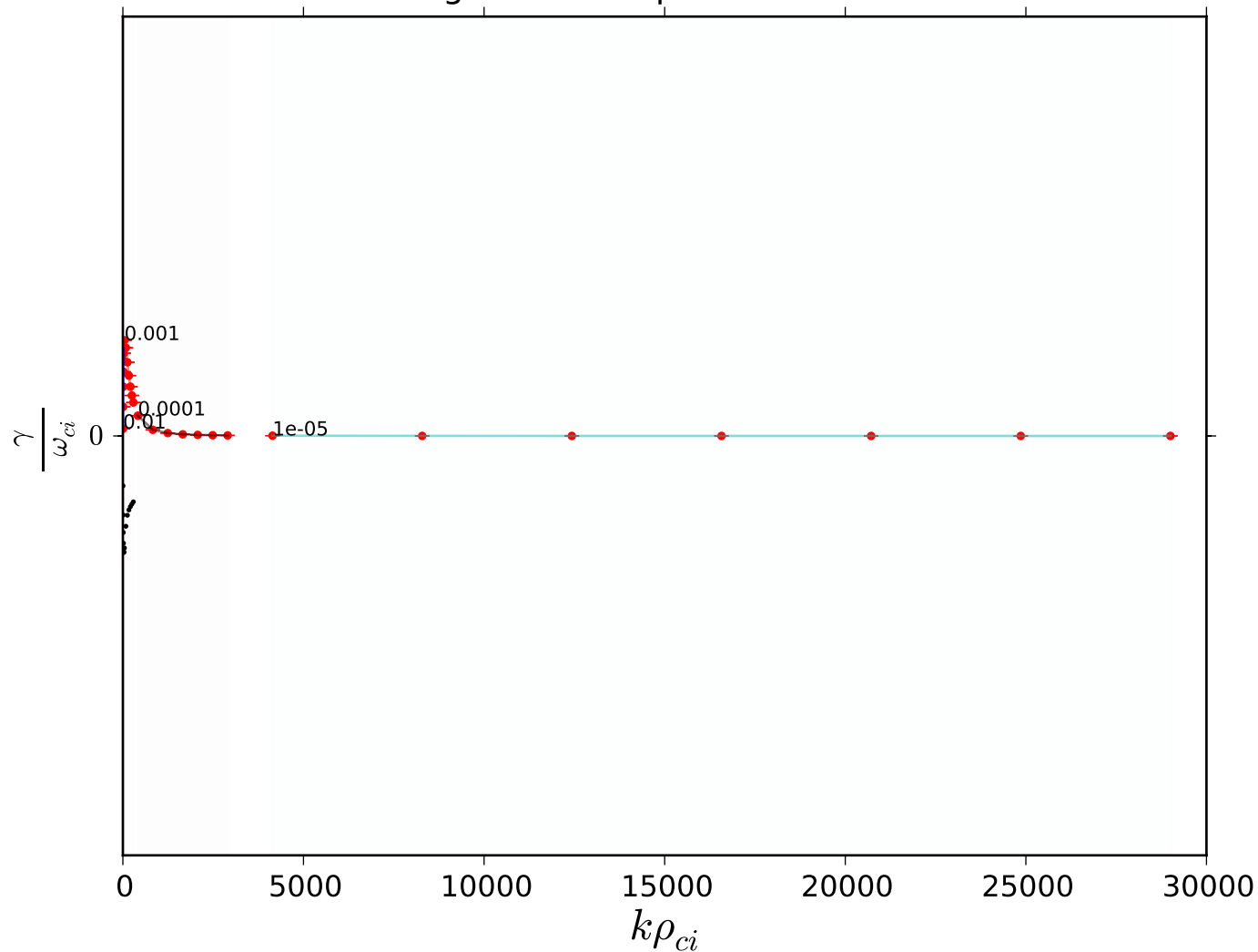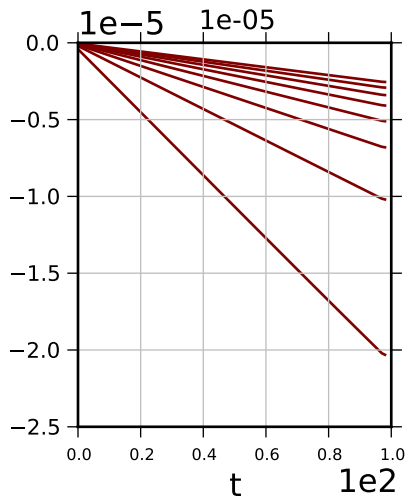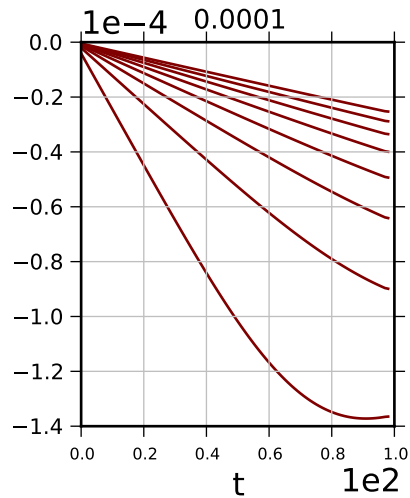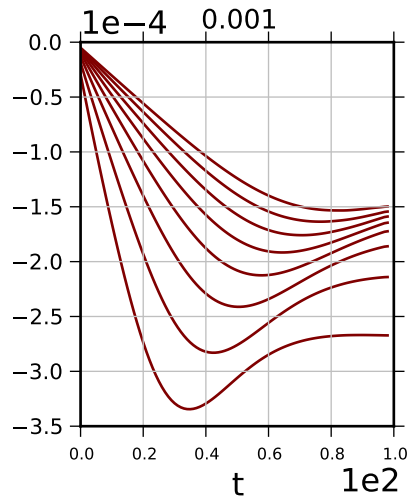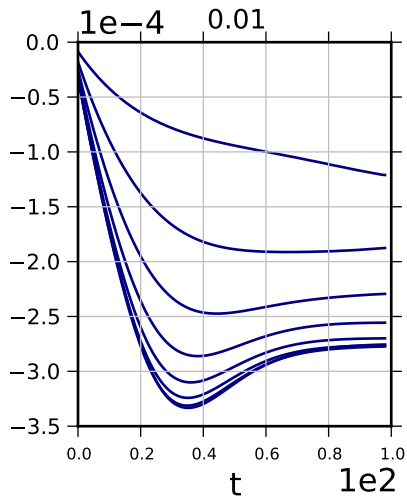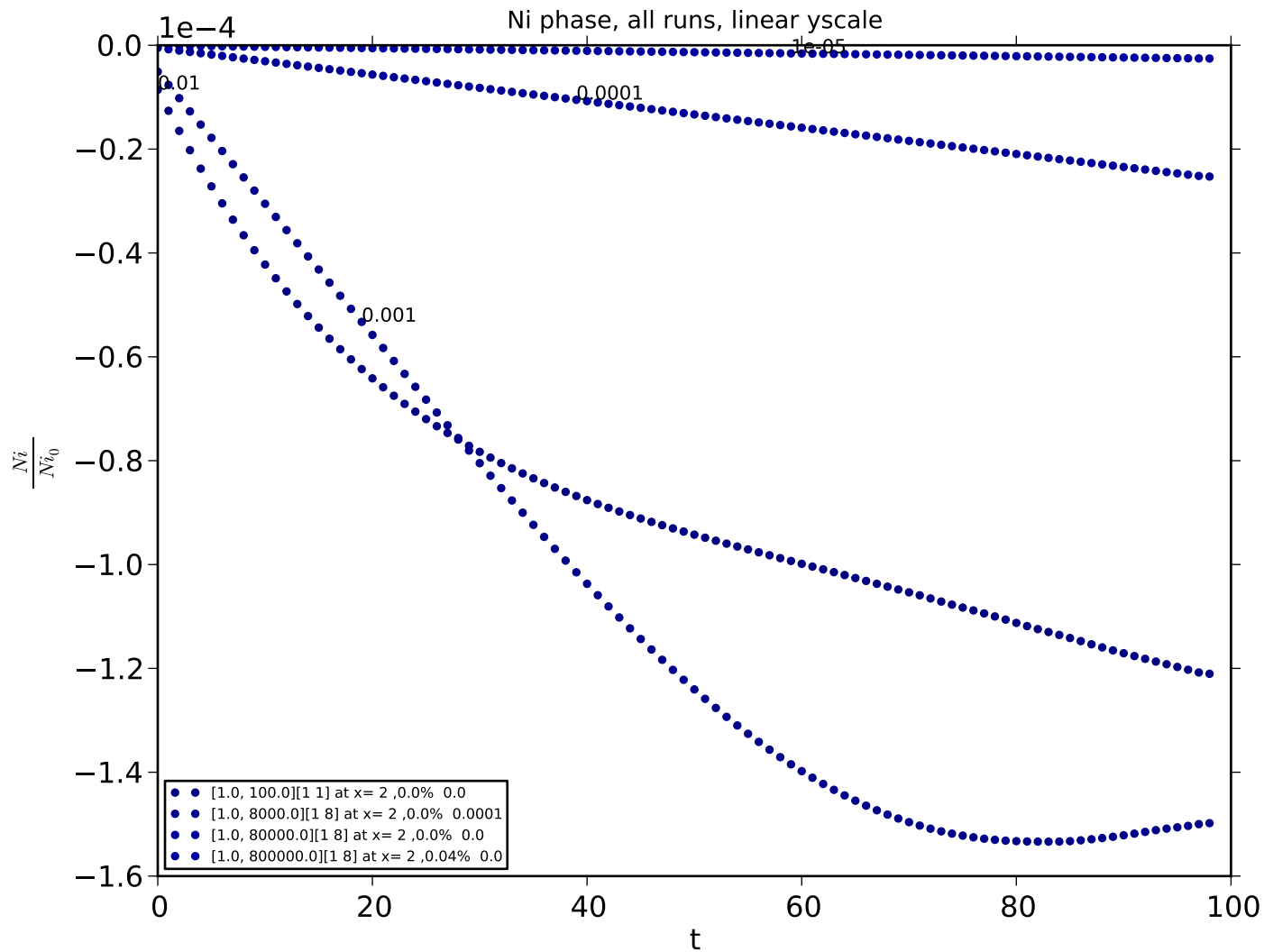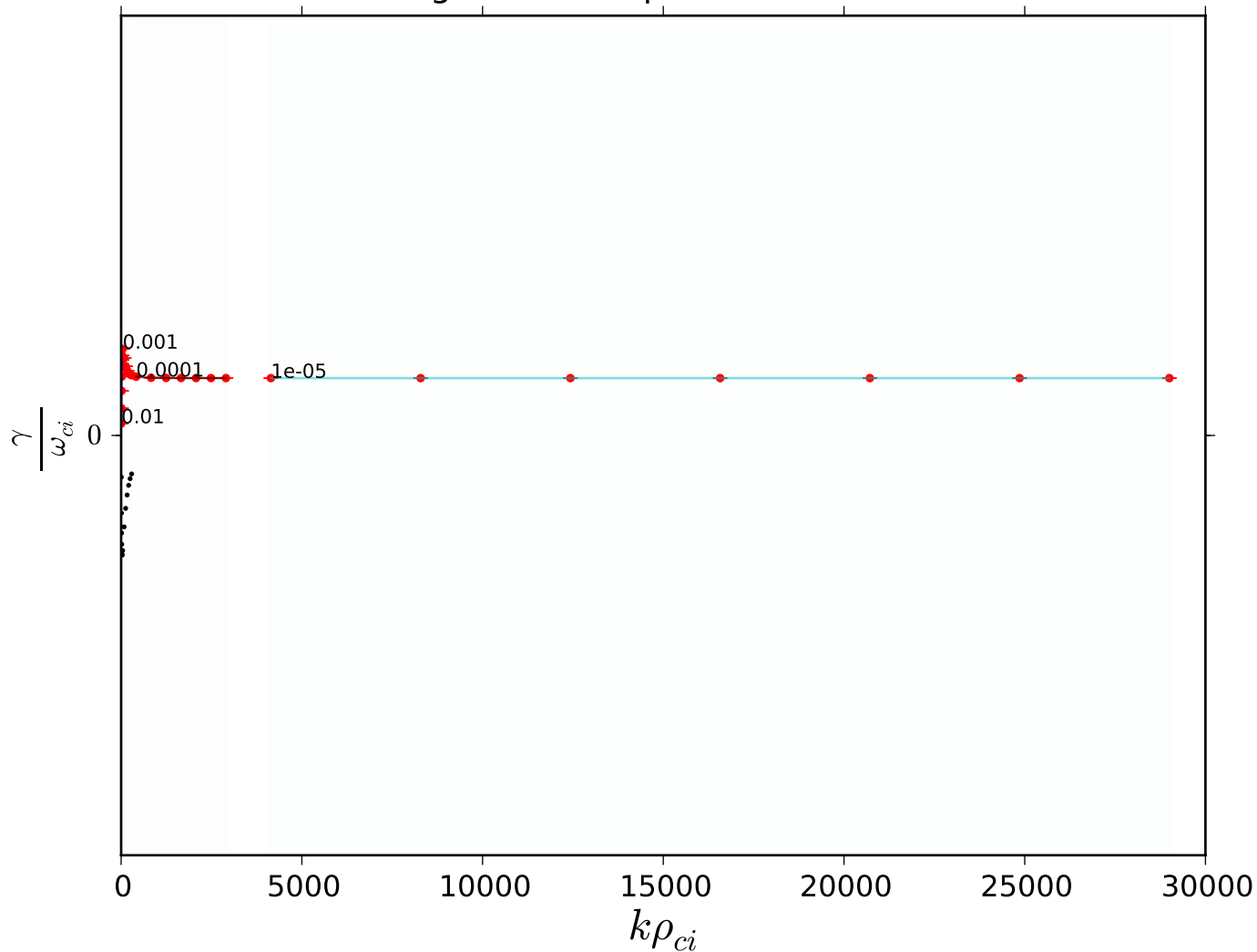
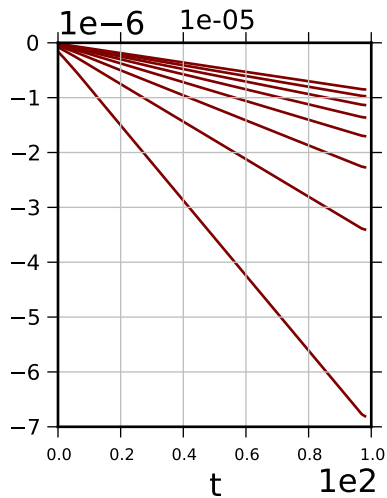n-m spectrum at t=0
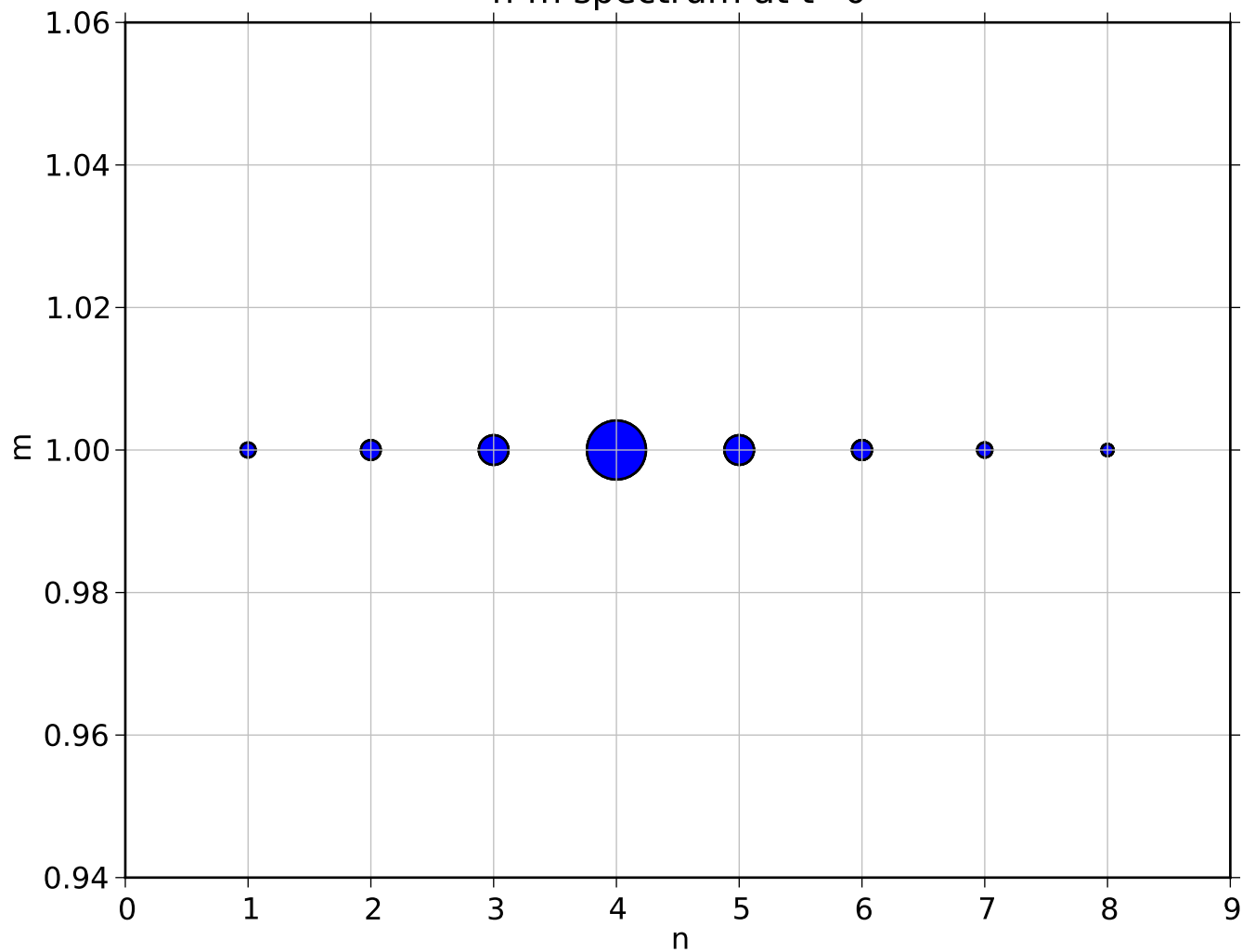
Ni spectrum at t=0, all x
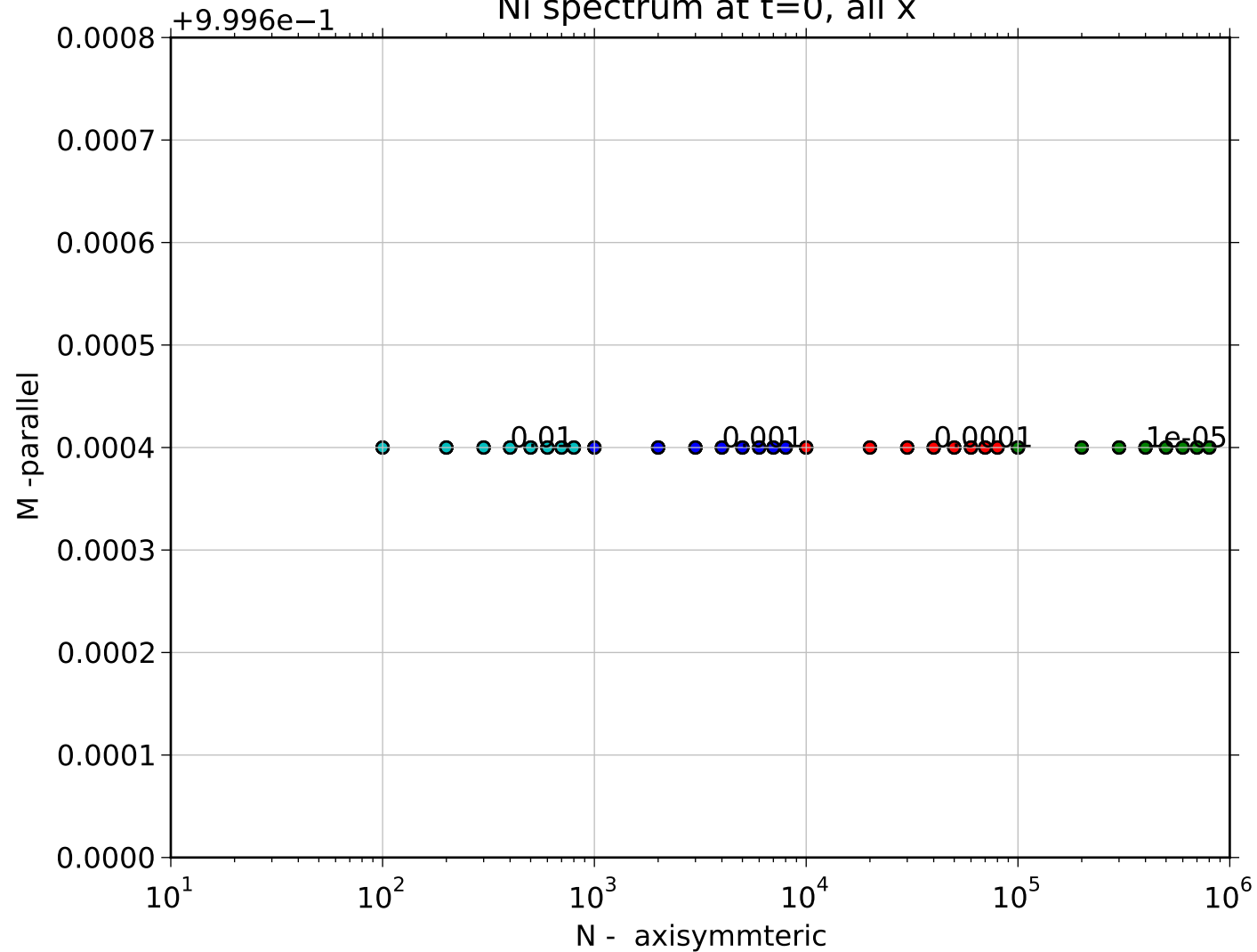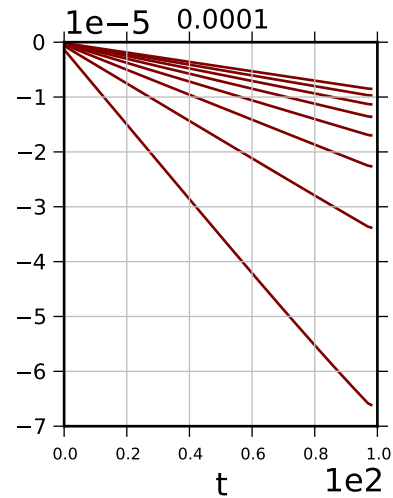
gamma computed from Ni

Dominant mode phase for Ni

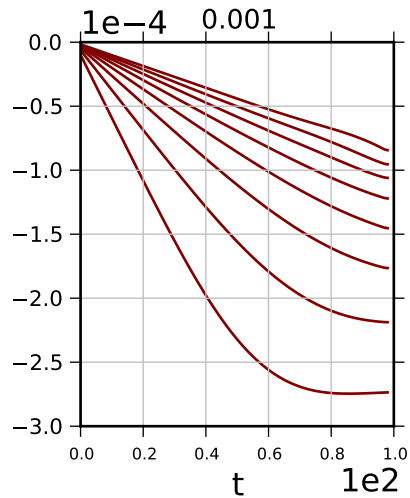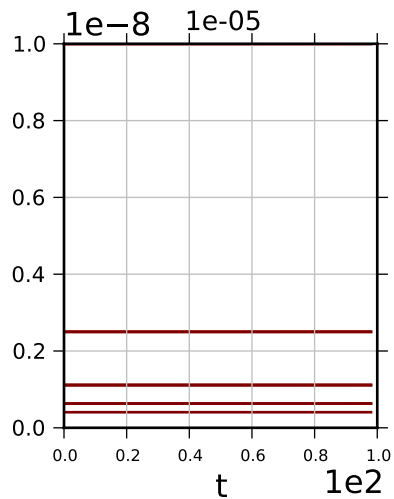Dominant mode behavior for Ni

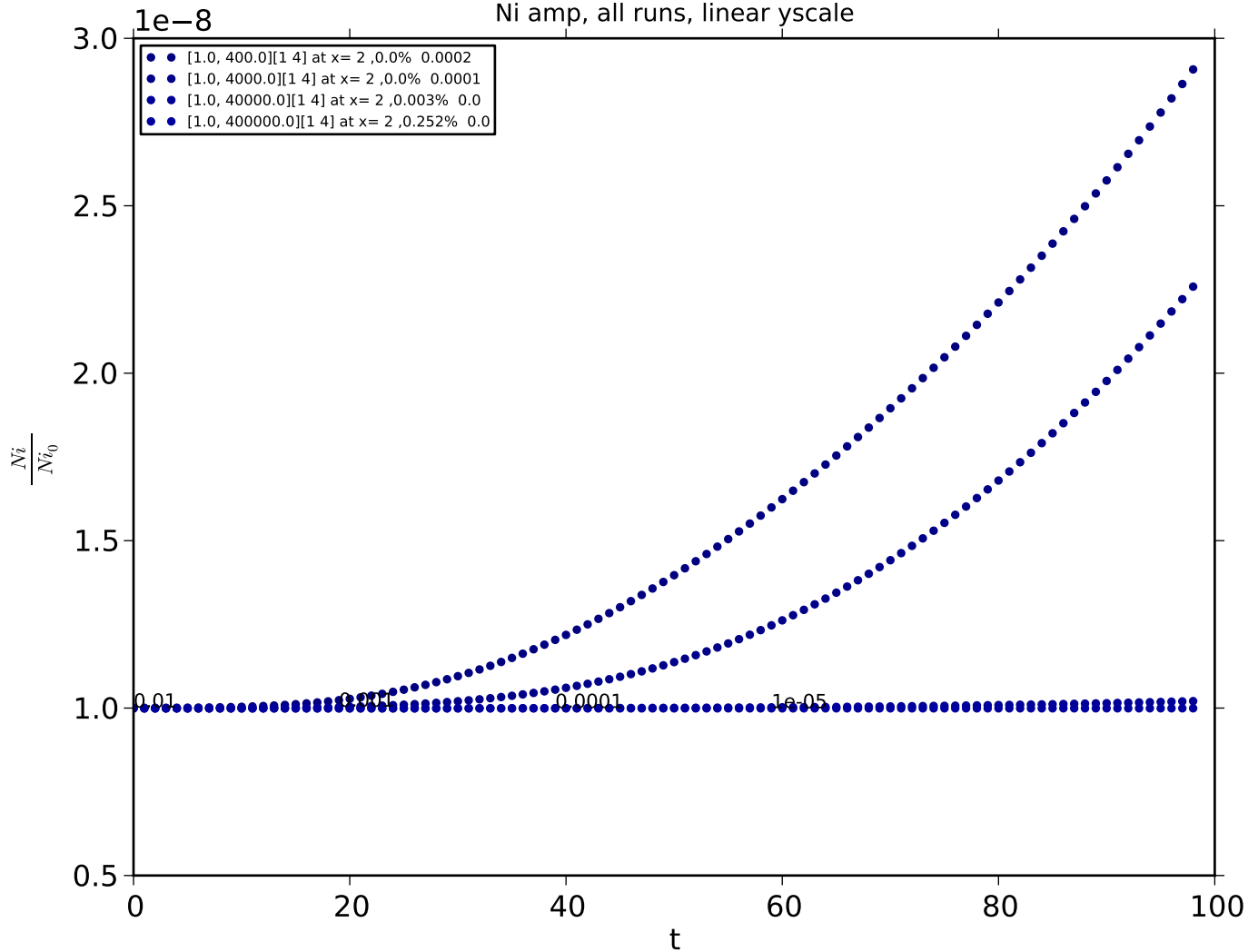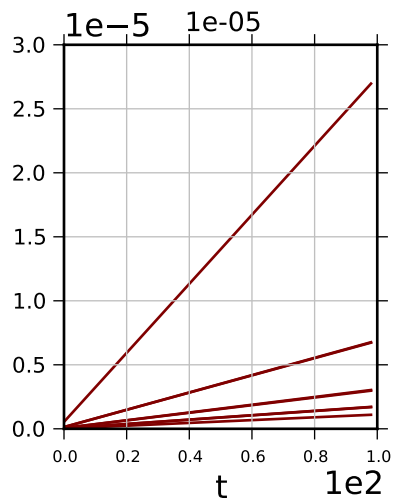Ni phase, all runs, linear yscale
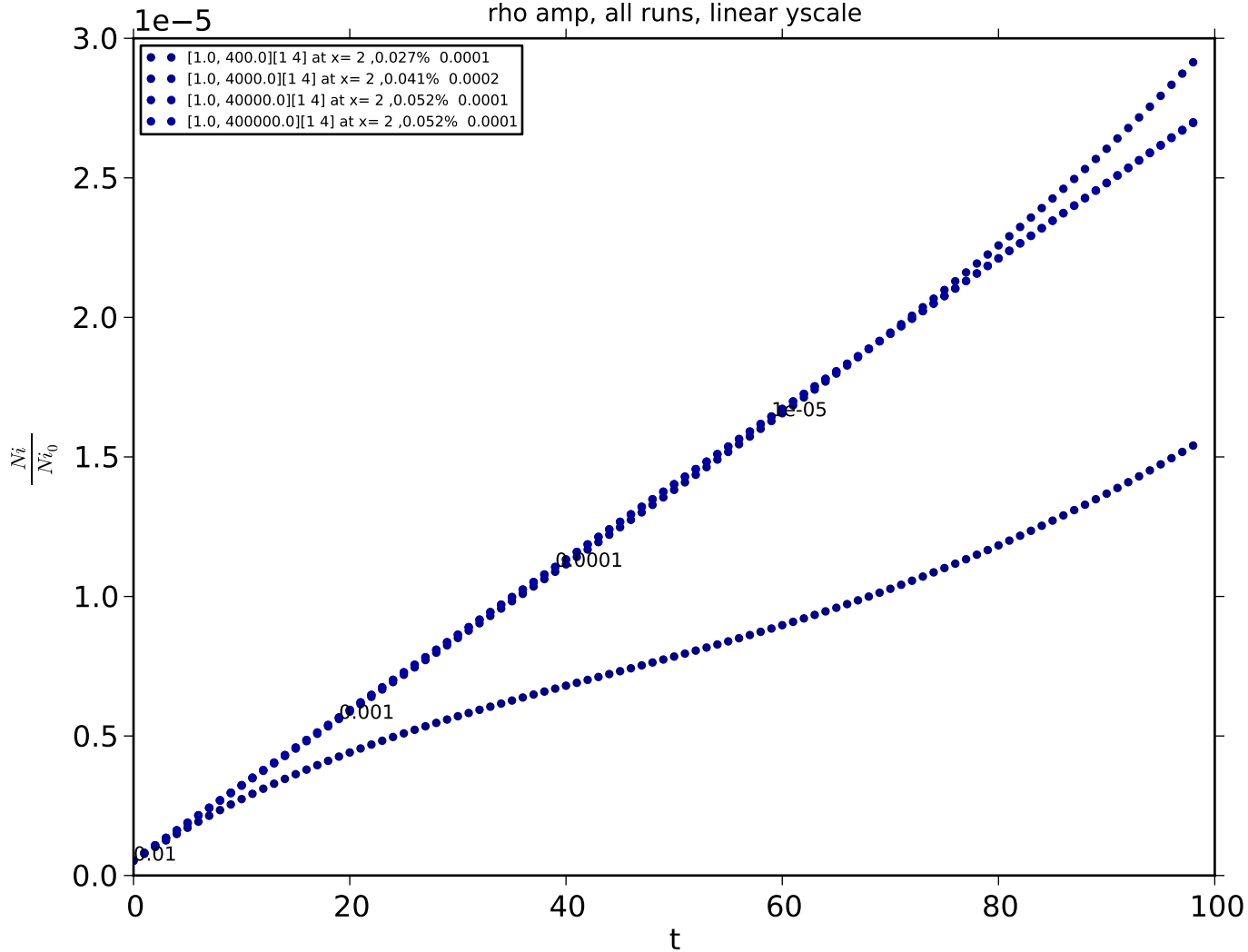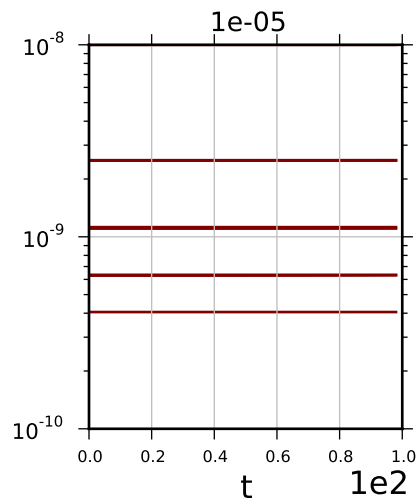
1e−4

0.01

0.0001

1e-05

0.001

$\frac{Ni}{Ni_0}$

- [1.0, 100.0][1 1] at x= 2 ,0.0% 0.0
- [1.0, 8000.0][1 8] at x= 2 ,0.0% 0.0001
- [1.0, 80000.0][1 8] at x= 2 ,0.0% 0.0
- [1.0, 800000.0][1 8] at x= 2 ,0.04% 0.0

t

gamma computed from rho

Dominant mode phase for rho
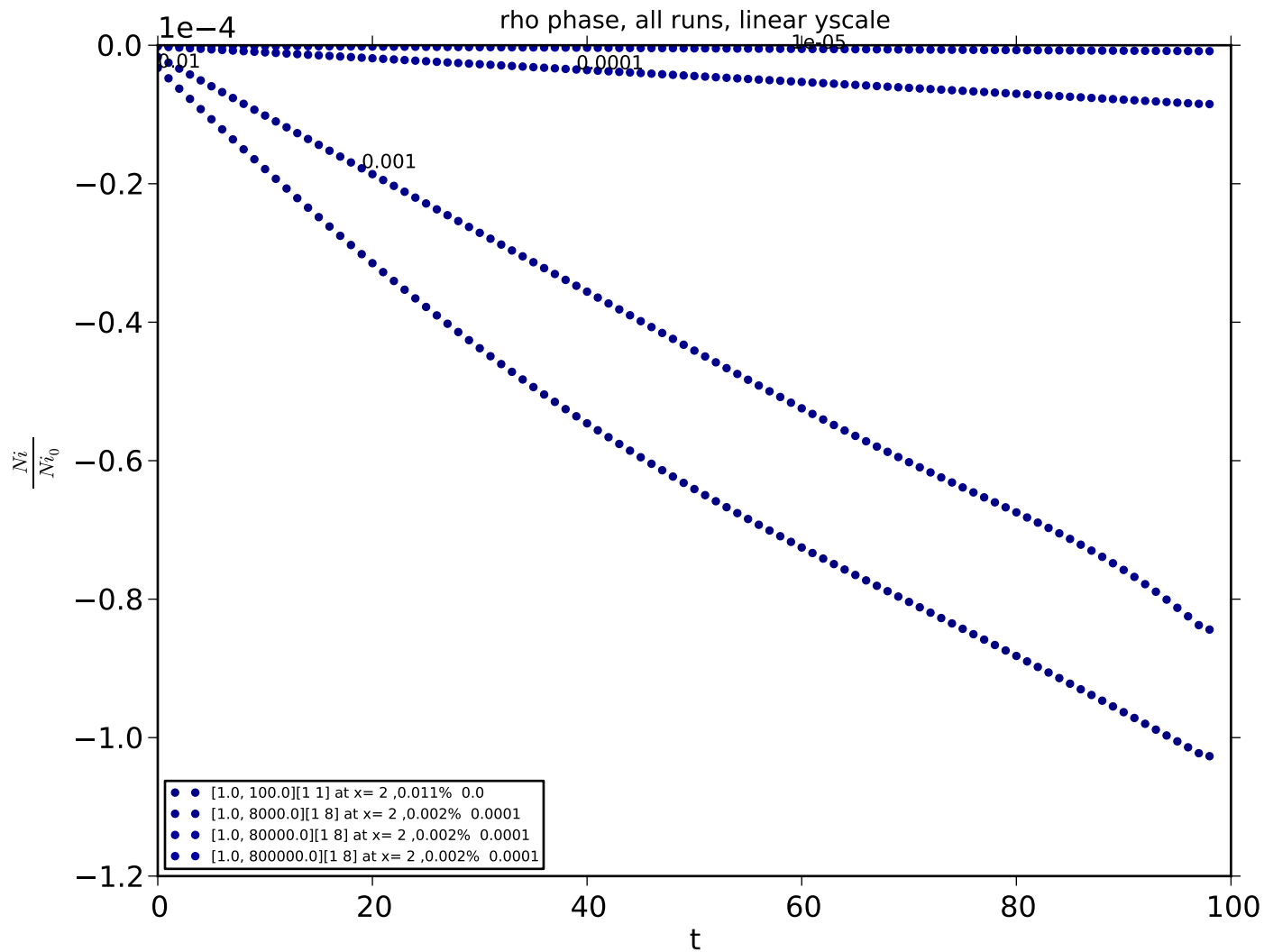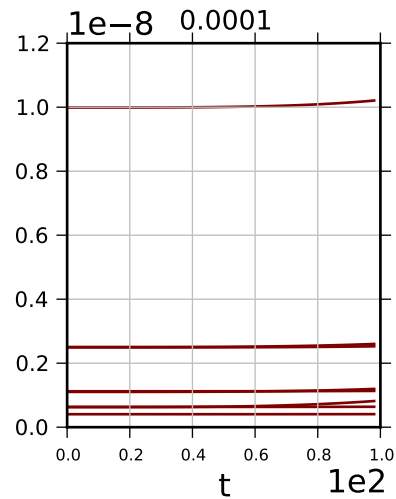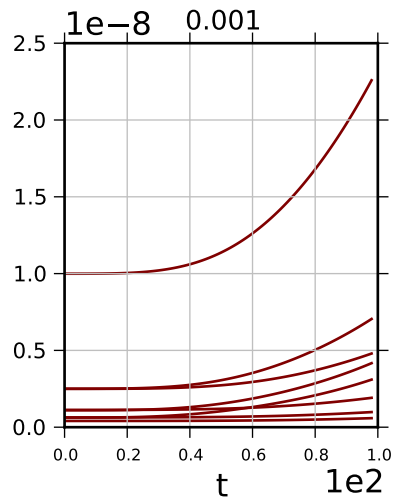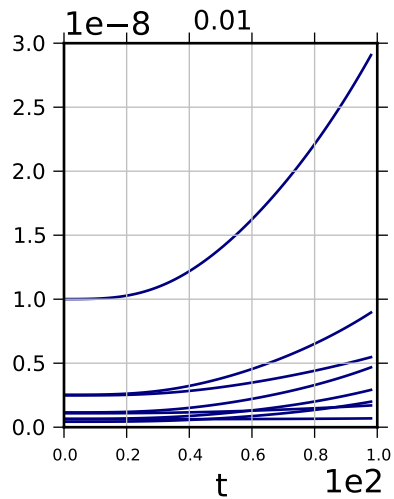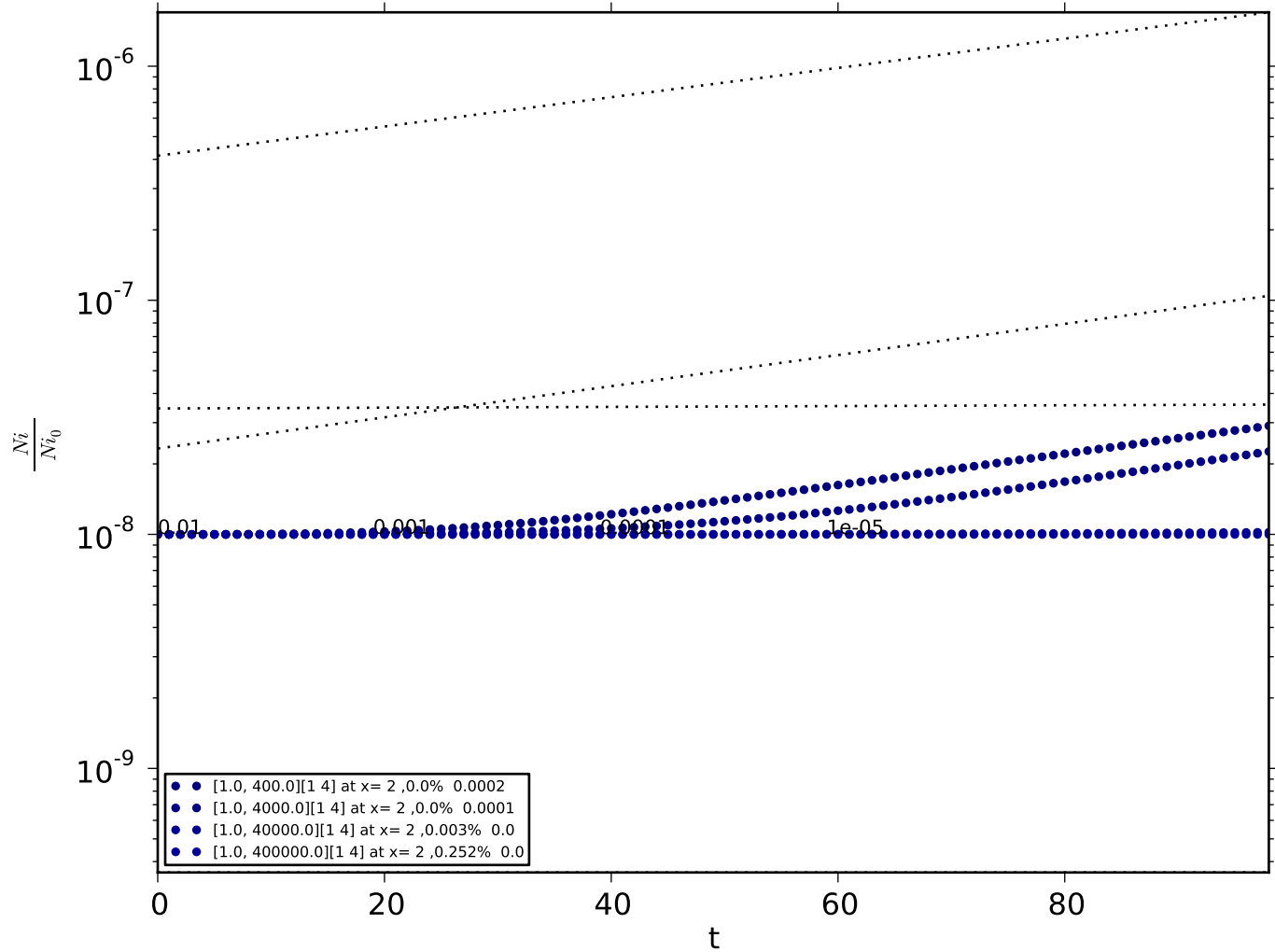
Dominant mode behavior for rho

rho phase, all runs, linear yscale

1e-4

0.01

0.001

0.0001

1e-05

$\frac{Ni}{Ni_0}$

- [1.0, 100.0][1 1] at x= 2 ,0.011% 0.0
- [1.0, 8000.0][1 8] at x= 2 ,0.002% 0.0001
- [1.0, 80000.0][1 8] at x= 2 ,0.002% 0.0001
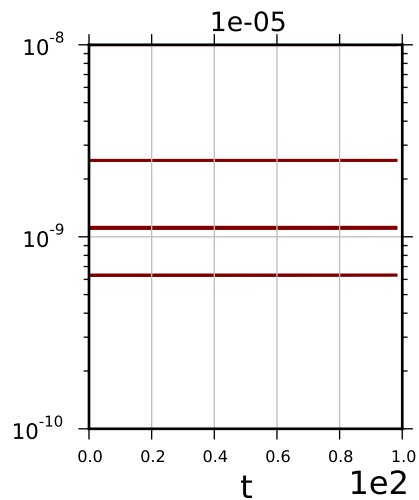- [1.0, 800000.0][1 8] at x= 2 ,0.002% 0.0001

t

Dominant mode amp for Ni
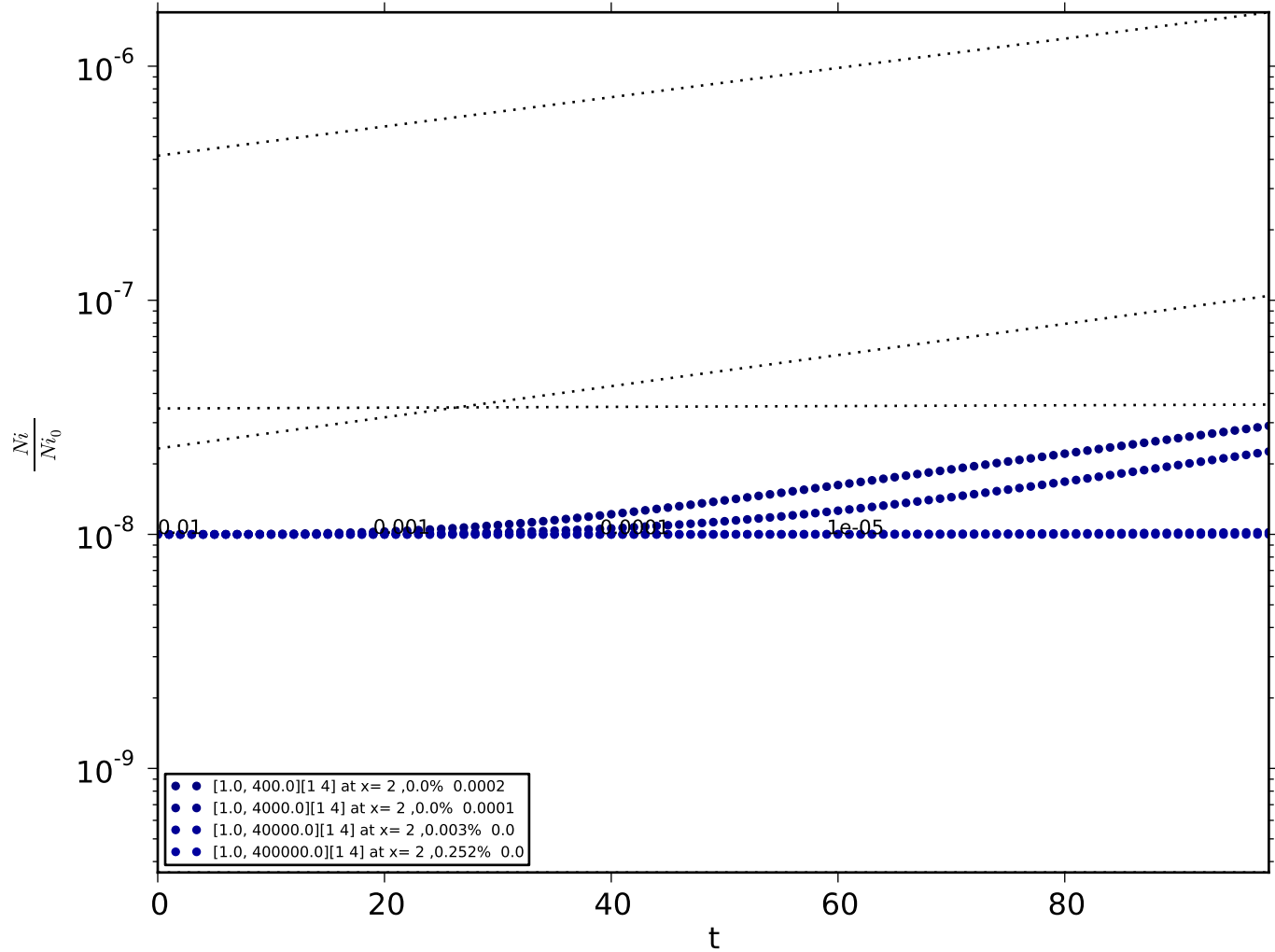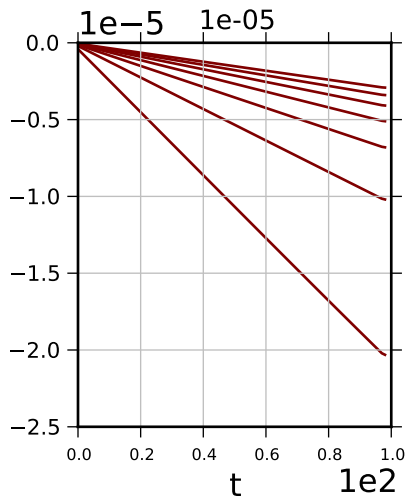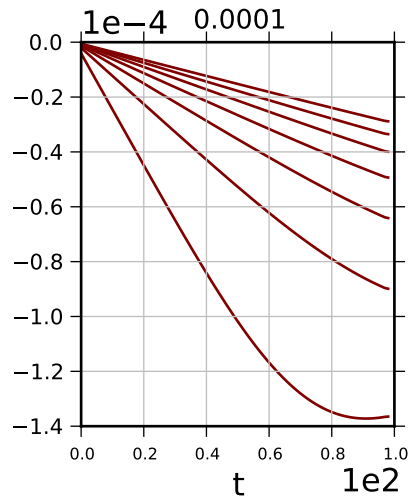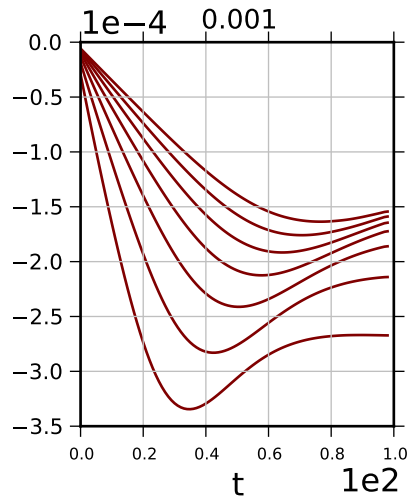
Dominant mode behavior for Ni

Ni amp, all runs, linear yscale

Legend:
- [1.0, 400.0][1 4] at x= 2 ,0.0% 0.0002
- [1.0, 4000.0][1 4] at x= 2 ,0.0% 0.0001
- [1.0, 40000.0][1 4] at x= 2 ,0.003% 0.0
- [1.0, 400000.0][1 4] at x= 2 ,0.252% 0.0

Y-axis: $\frac{Ni}{Ni_0}$

X-axis: t

Dominant mode amp for rho
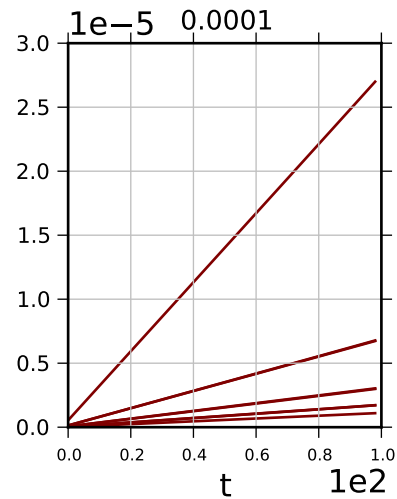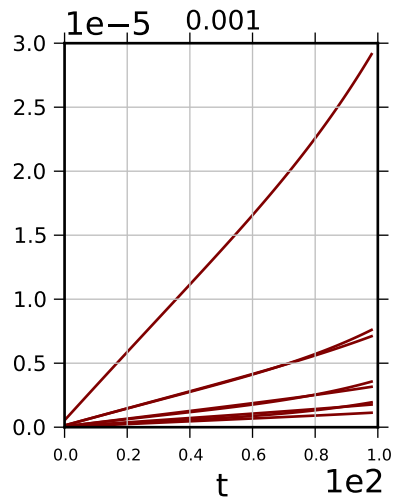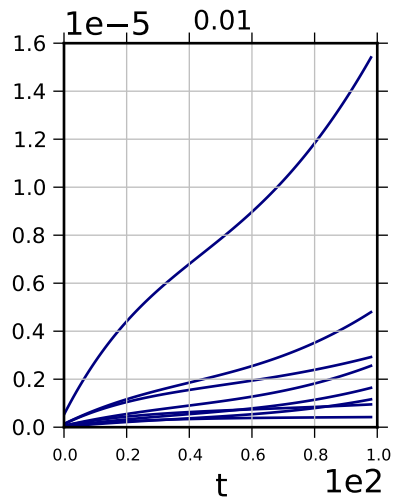
Dominant mode behavior for rho

rho amp, all runs, linear yscale
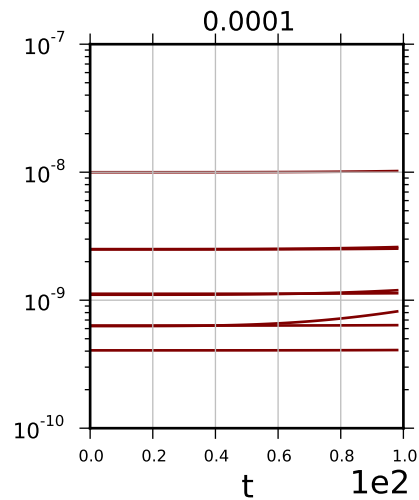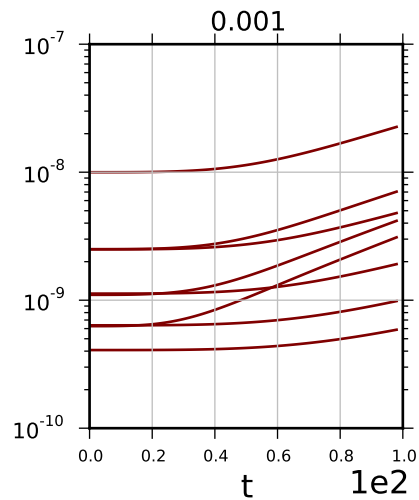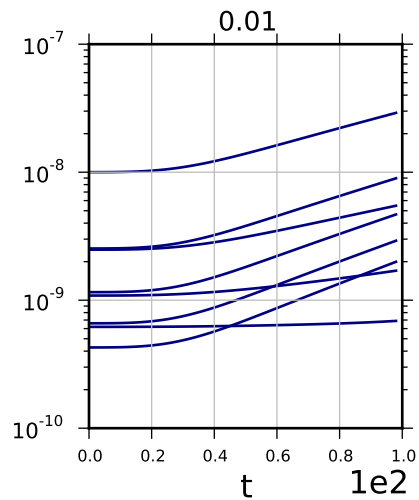
Legend:
- [1.0, 400.0][1 4] at x= 2 ,0.027% 0.0001
- [1.0, 4000.0][1 4] at x= 2 ,0.041% 0.0002
- [1.0, 40000.0][1 4] at x= 2 ,0.052% 0.0001
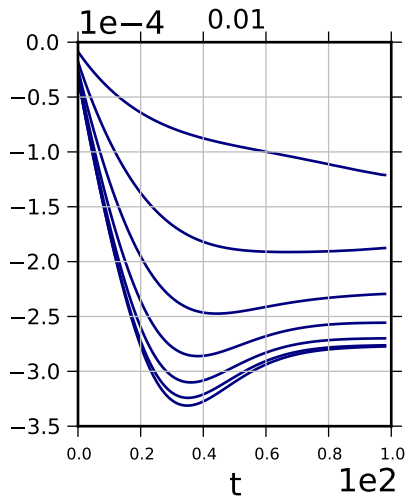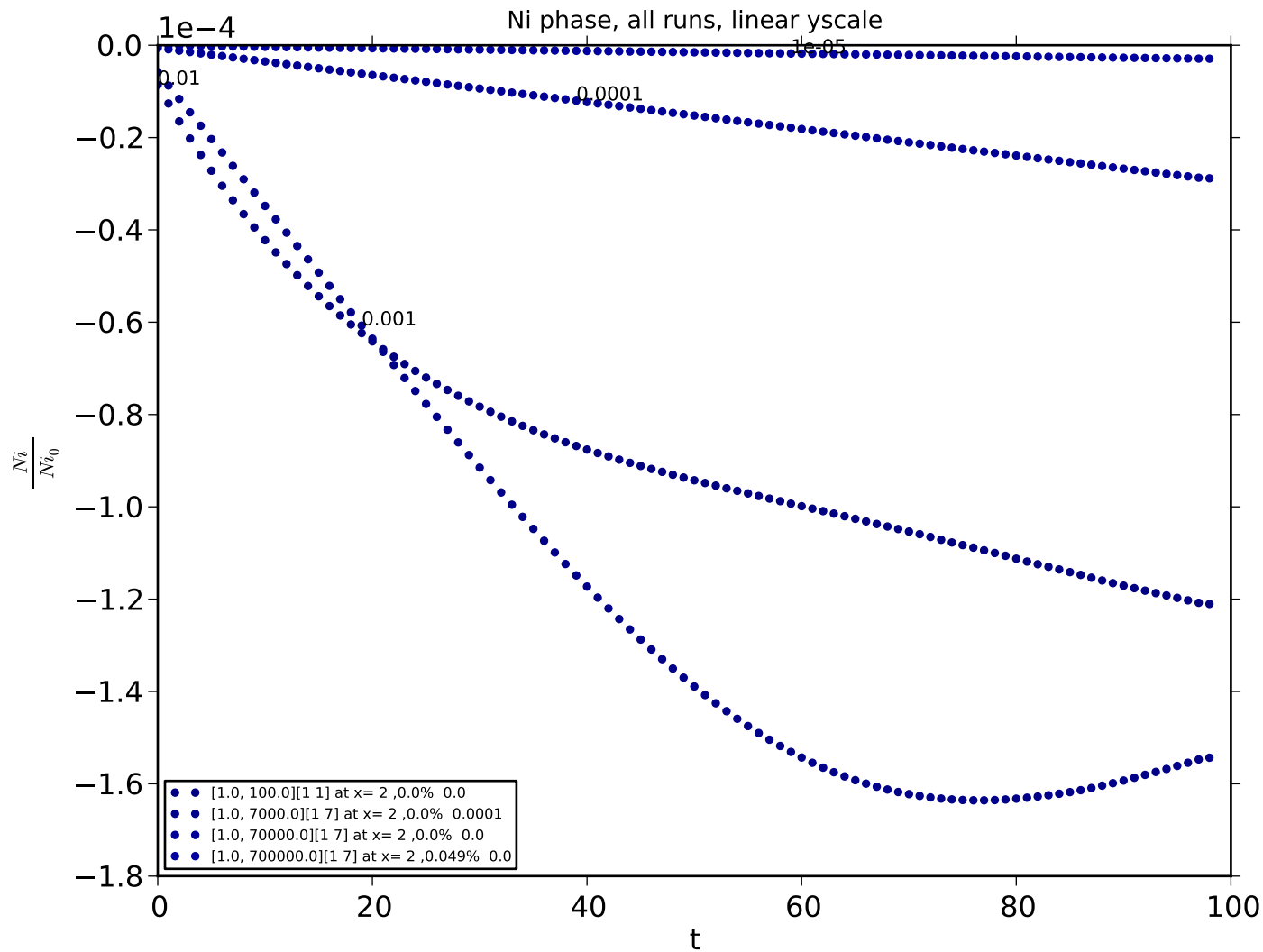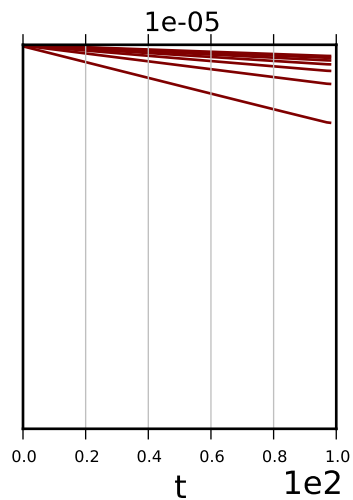- [1.0, 400000.0][1 4] at x= 2 ,0.052% 0.0001

Dominant mode amp for Ni
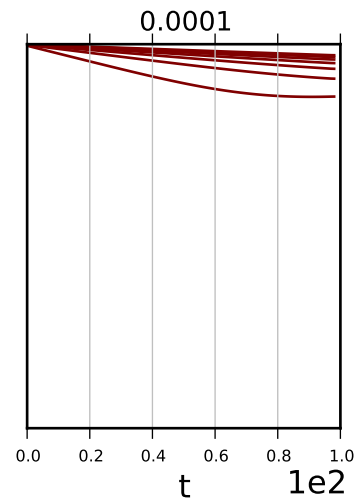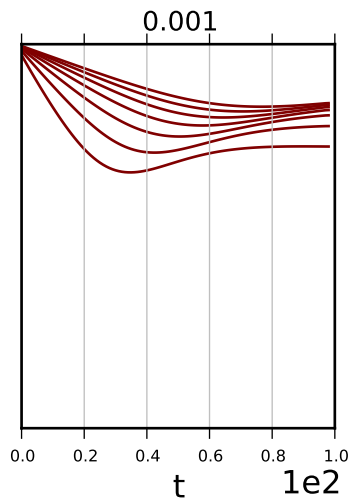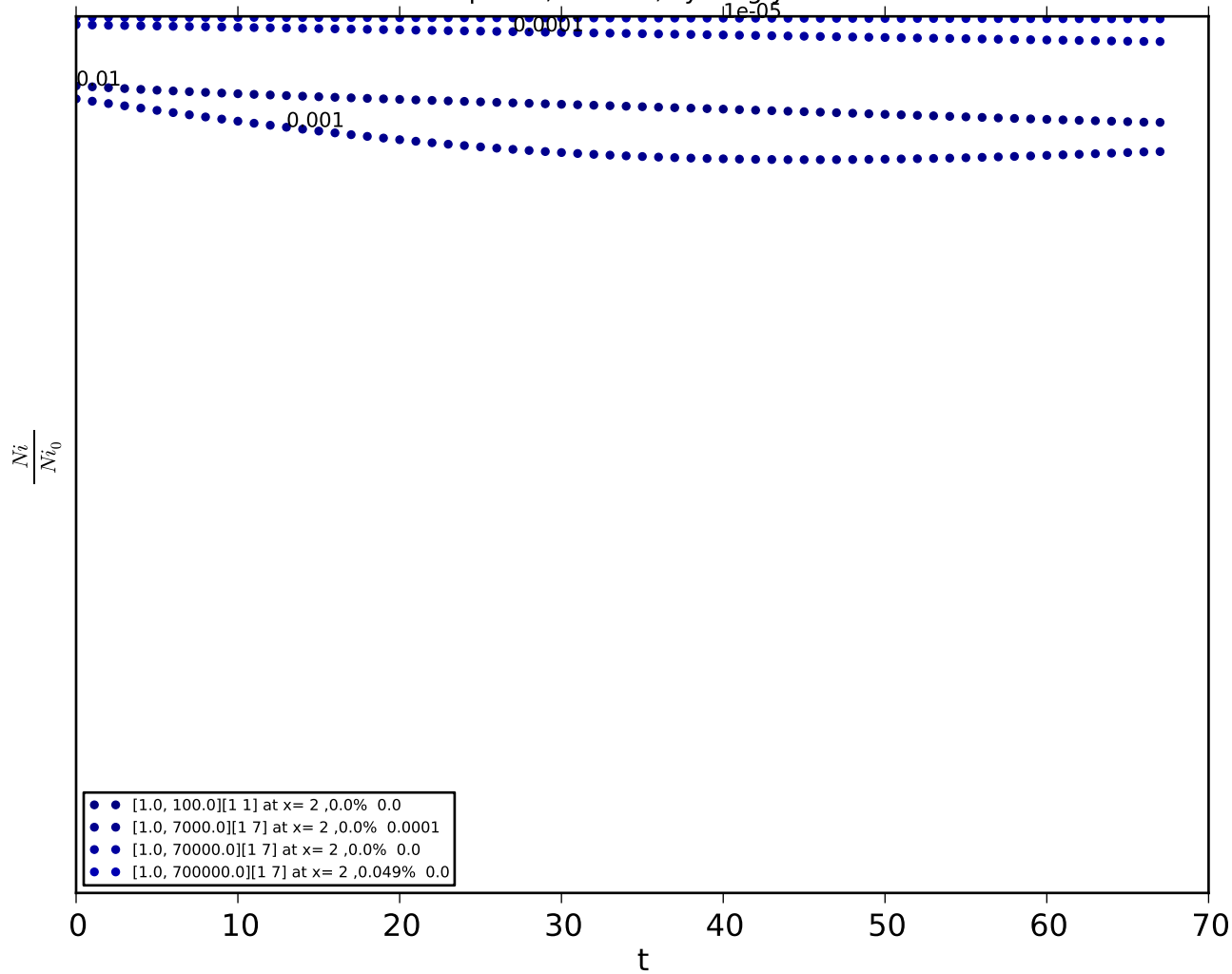
Dominant mode behavior for Ni

Ni amp, all runs, log yscale

$\frac{Ni}{Ni_0}$

0.01   0.001   0.0001   1e-05

- [1.0, 400.0][1 4] at x= 2 ,0.0% 0.0002
- [1.0, 4000.0][1 4] at x= 2 ,0.0% 0.0001
- [1.0, 40000.0][1 4] at x= 2 ,0.003% 0.0
- [1.0, 400000.0][1 4] at x= 2 ,0.252% 0.0

t

Dominant mode amp for Ni

Dominant mode behavior for Ni

Ni amp, all runs, log yscale

$$\frac{Ni}{Ni_0}$$

0.01 0.001 0.0001 1e-05

Legend:
- [1.0, 400.0][1 4] at x= 2 ,0.0% 0.0002
- [1.0, 4000.0][1 4] at x= 2 ,0.0% 0.0001
- [1.0, 40000.0][1 4] at x= 2 ,0.003% 0.0
- [1.0, 400000.0][1 4] at x= 2 ,0.252% 0.0

t

Dominant mode phase for Ni

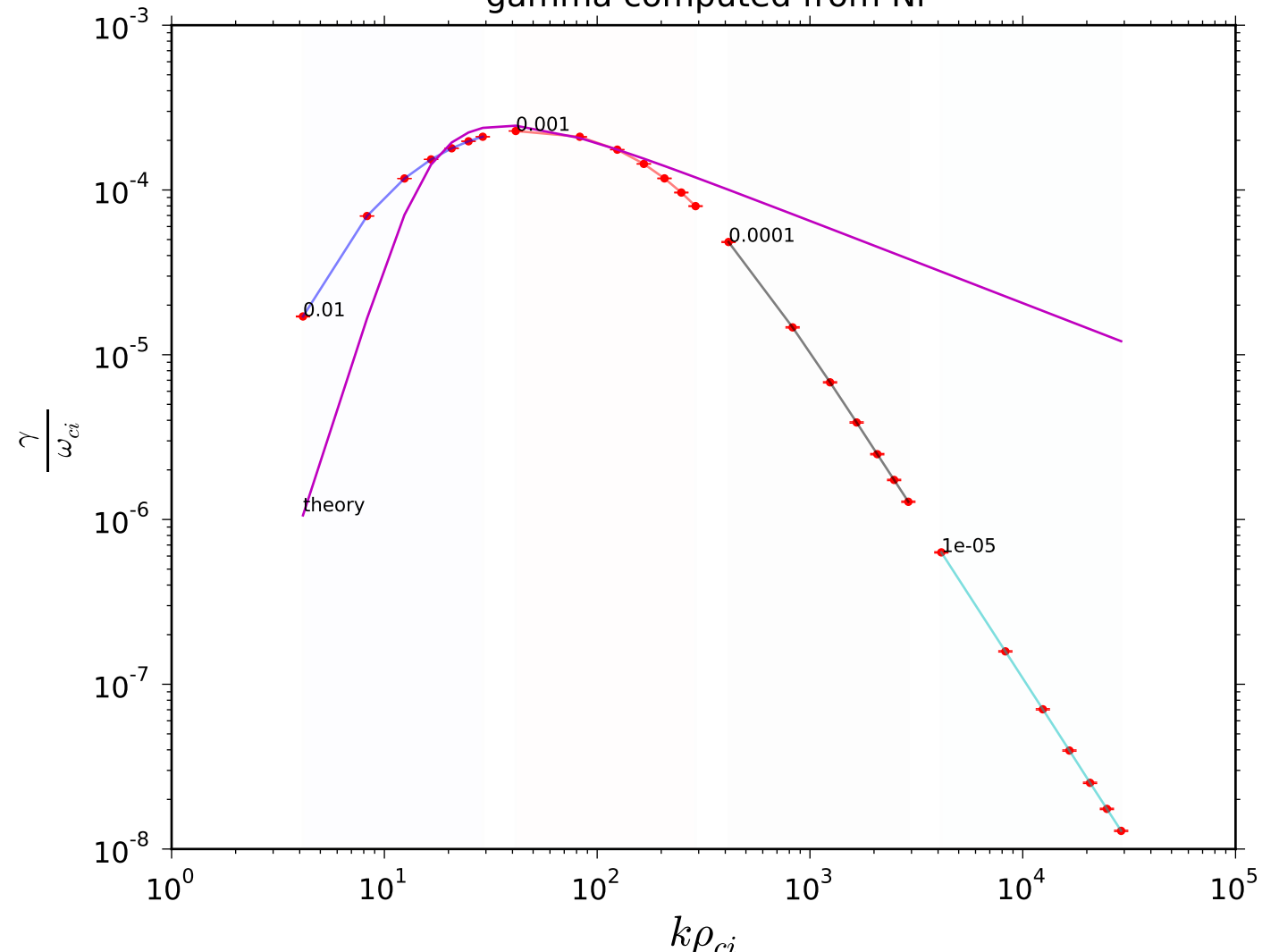Dominant mode behavior for Ni

Ni phase, all runs, linear yscale

0.01

0.0001

1e-05

0.001

$\frac{Ni}{Ni_0}$

t

Legend:
- [1.0, 100.0][1 1] at x= 2 ,0.0% 0.0
- [1.0, 7000.0][1 7] at x= 2 ,0.0% 0.0001
- [1.0, 70000.0][1 7] at x= 2 ,0.0% 0.0
- [1.0, 700000.0][1 7] at x= 2 ,0.049% 0.0
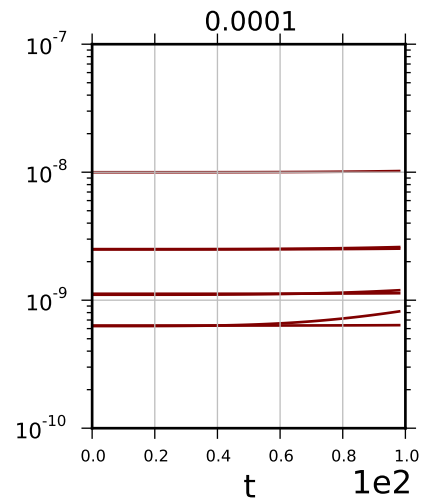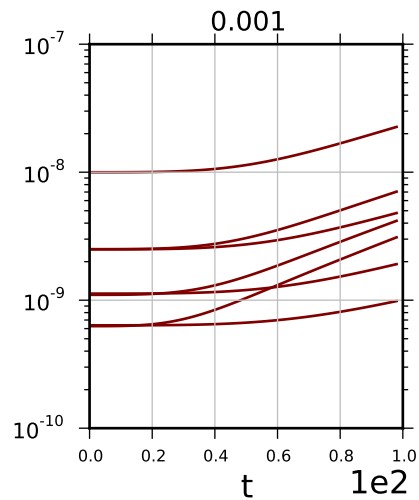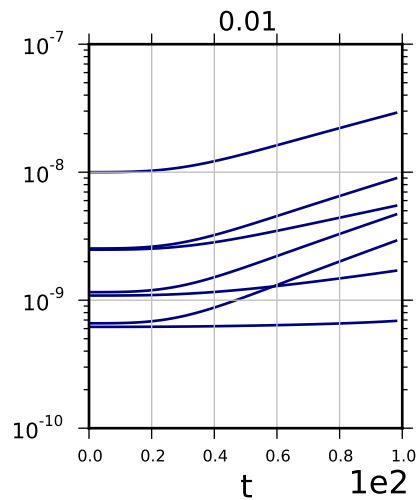
Dominant mode phase for Ni
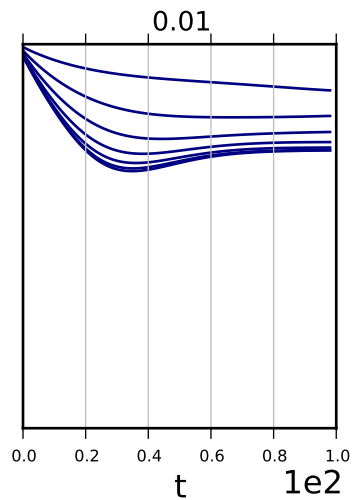
Dominant mode behavior for Ni

Ni phase, all runs, symlog yscale
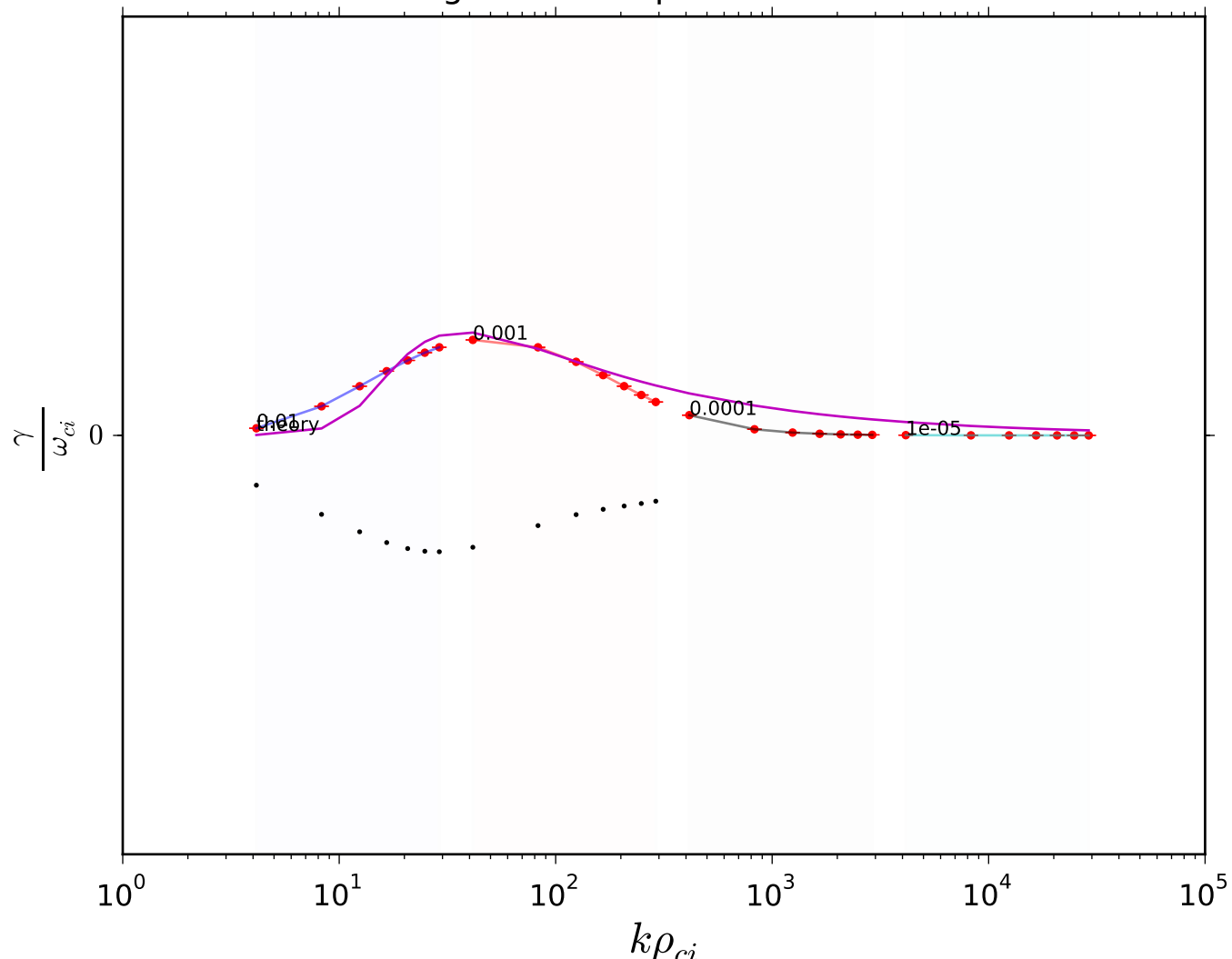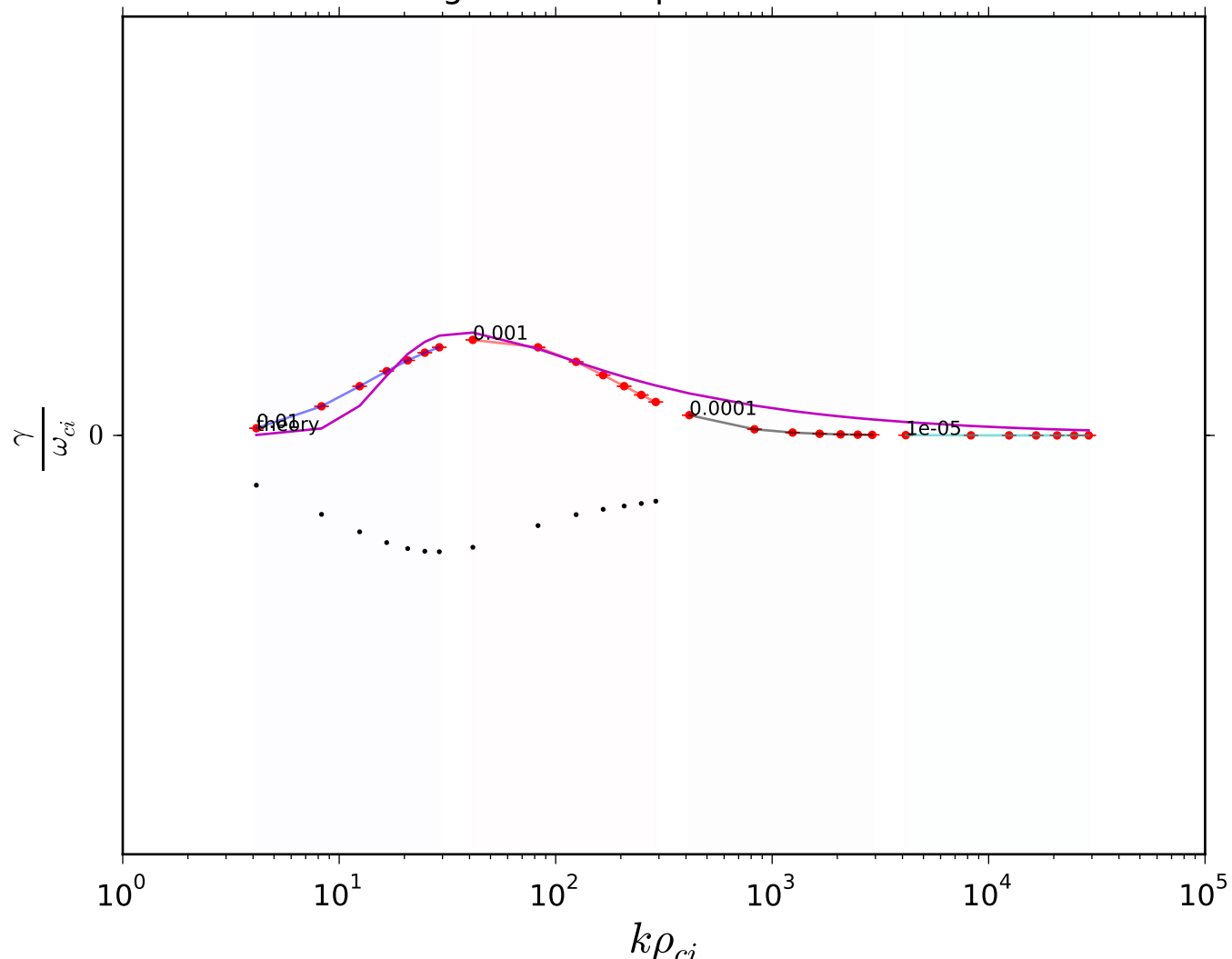
- [1.0, 100.0][1 1] at x= 2 ,0.0% 0.0
- [1.0, 7000.0][1 7] at x= 2 ,0.0% 0.0001
- [1.0, 70000.0][1 7] at x= 2 ,0.0% 0.0
- [1.0, 700000.0][1 7] at x= 2 ,0.049% 0.0

gamma computed from Ni

gamma computed from Ni

gamma computed from Ni

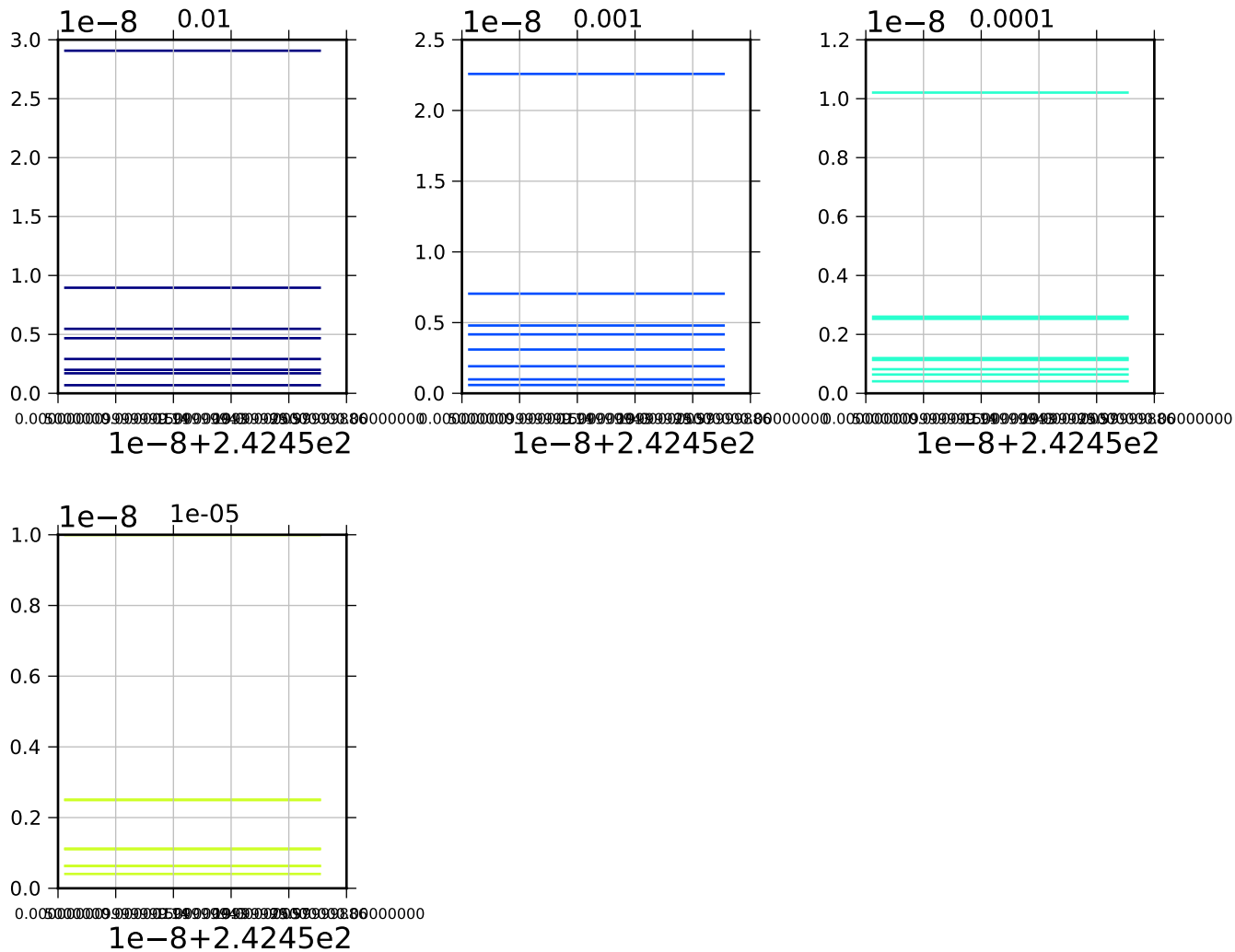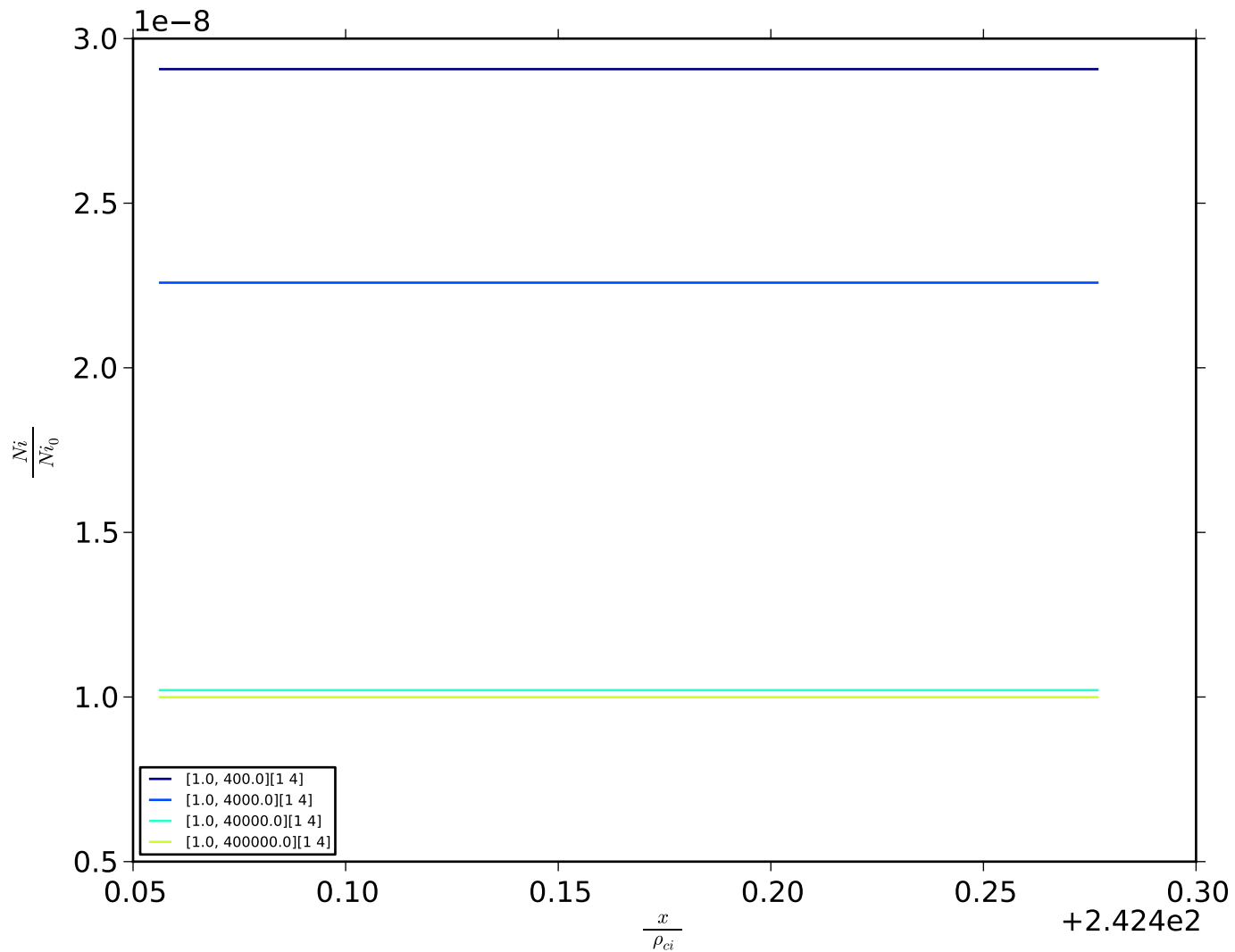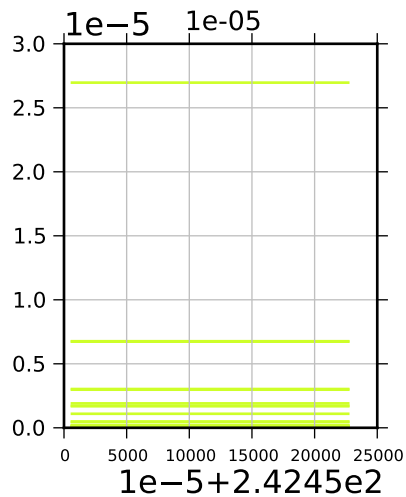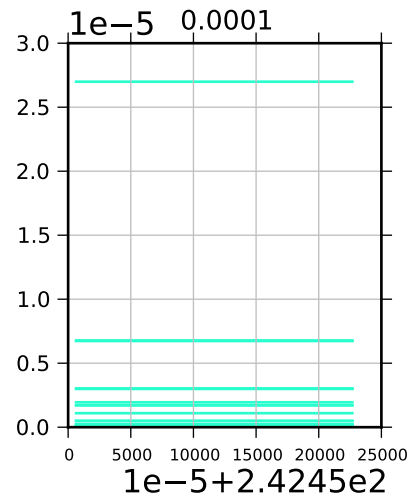gamma computed from rho

freq computed from Ni
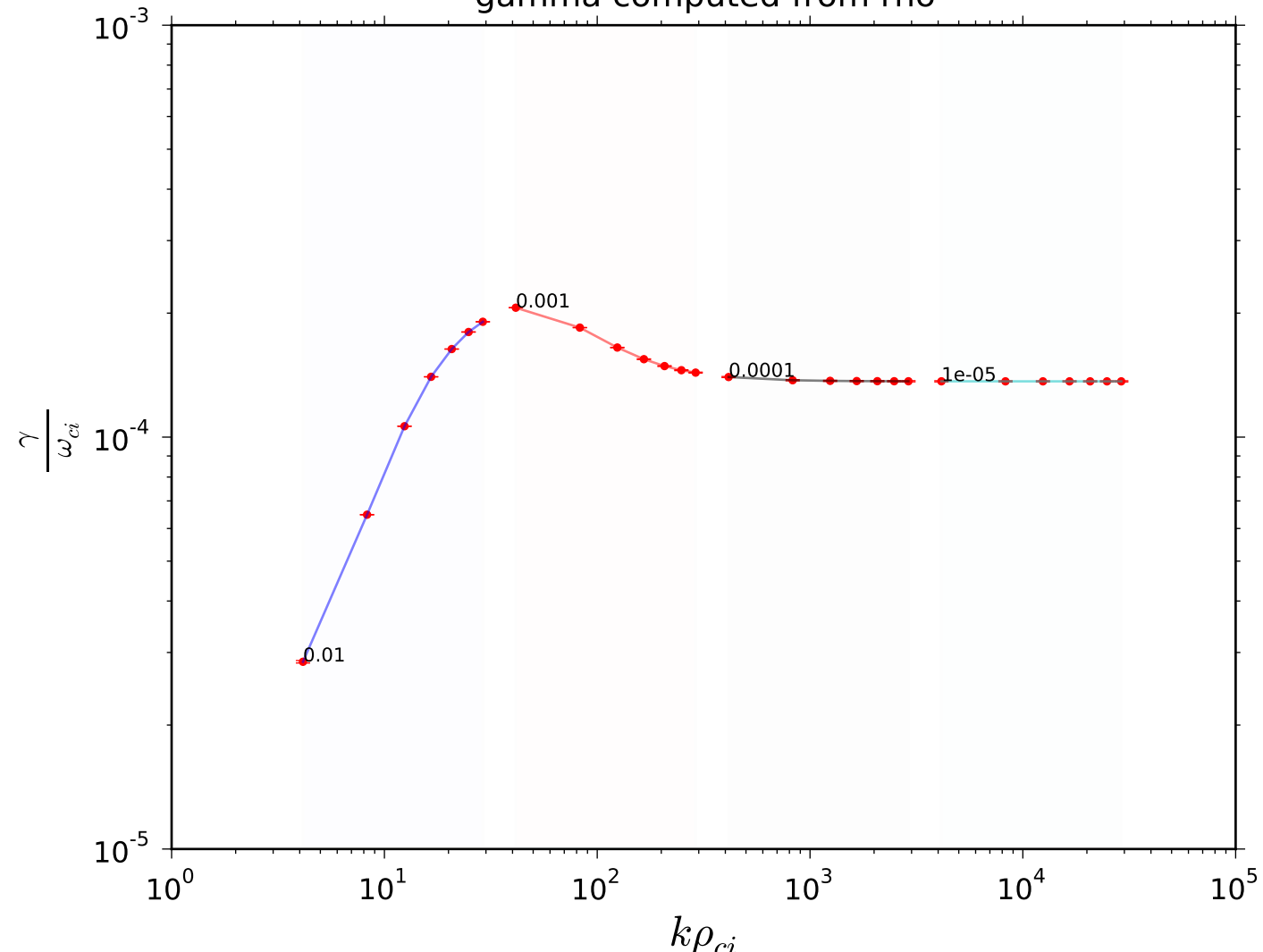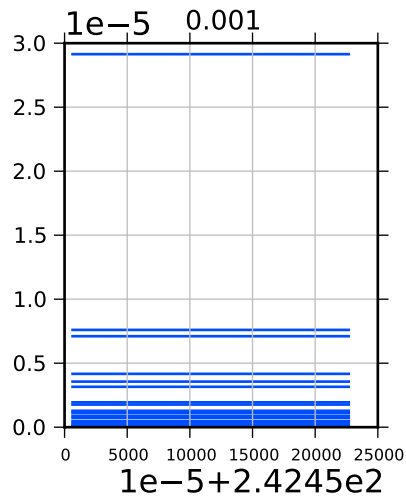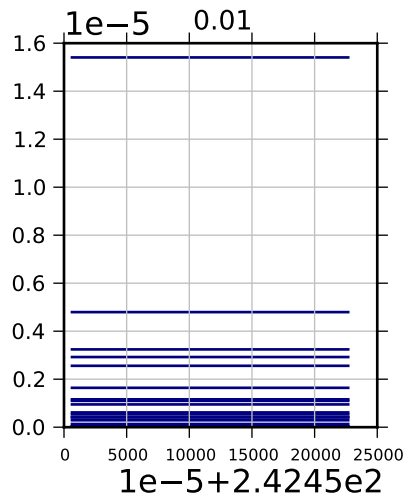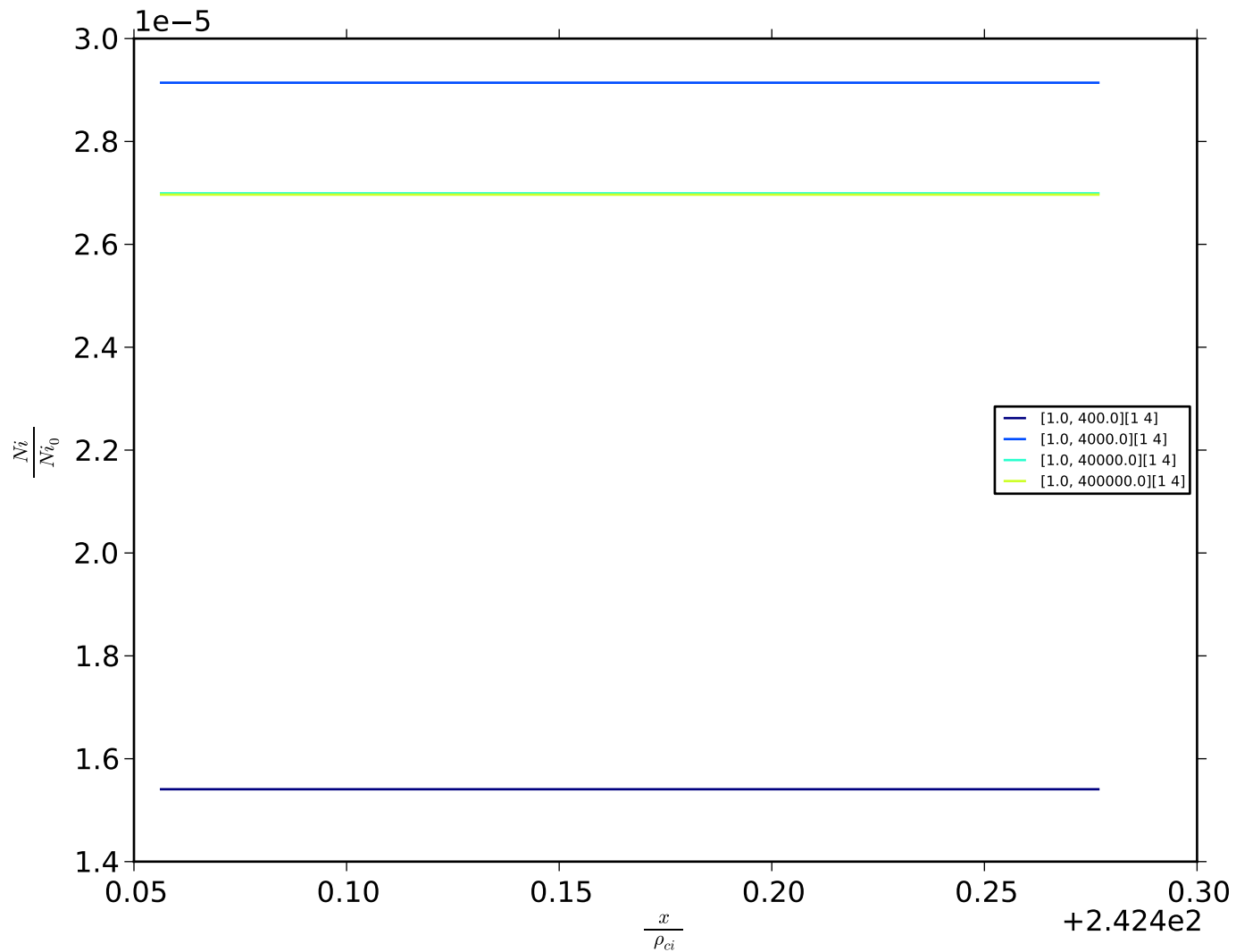
freq computed from Ni
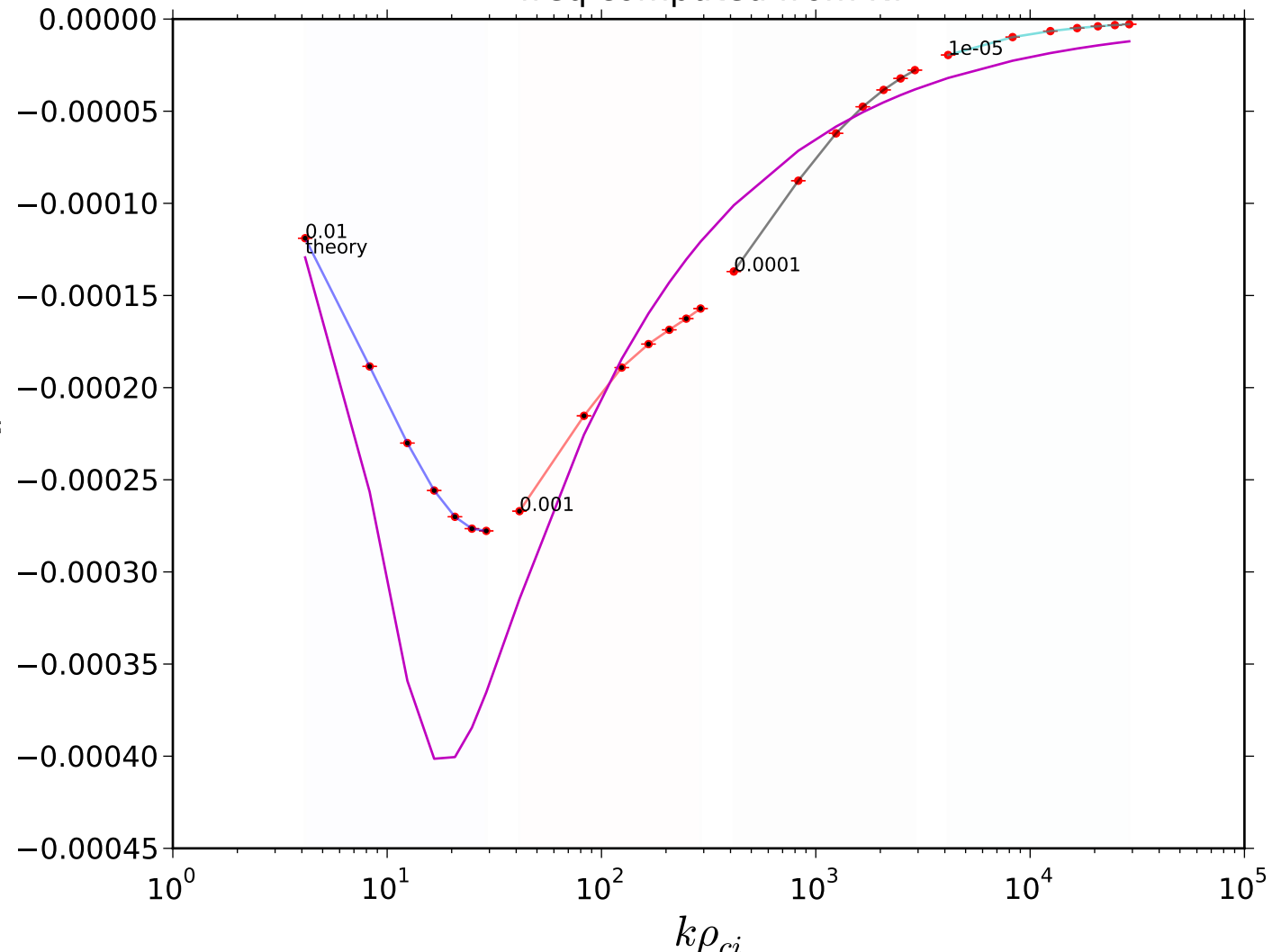
freq computed from rho
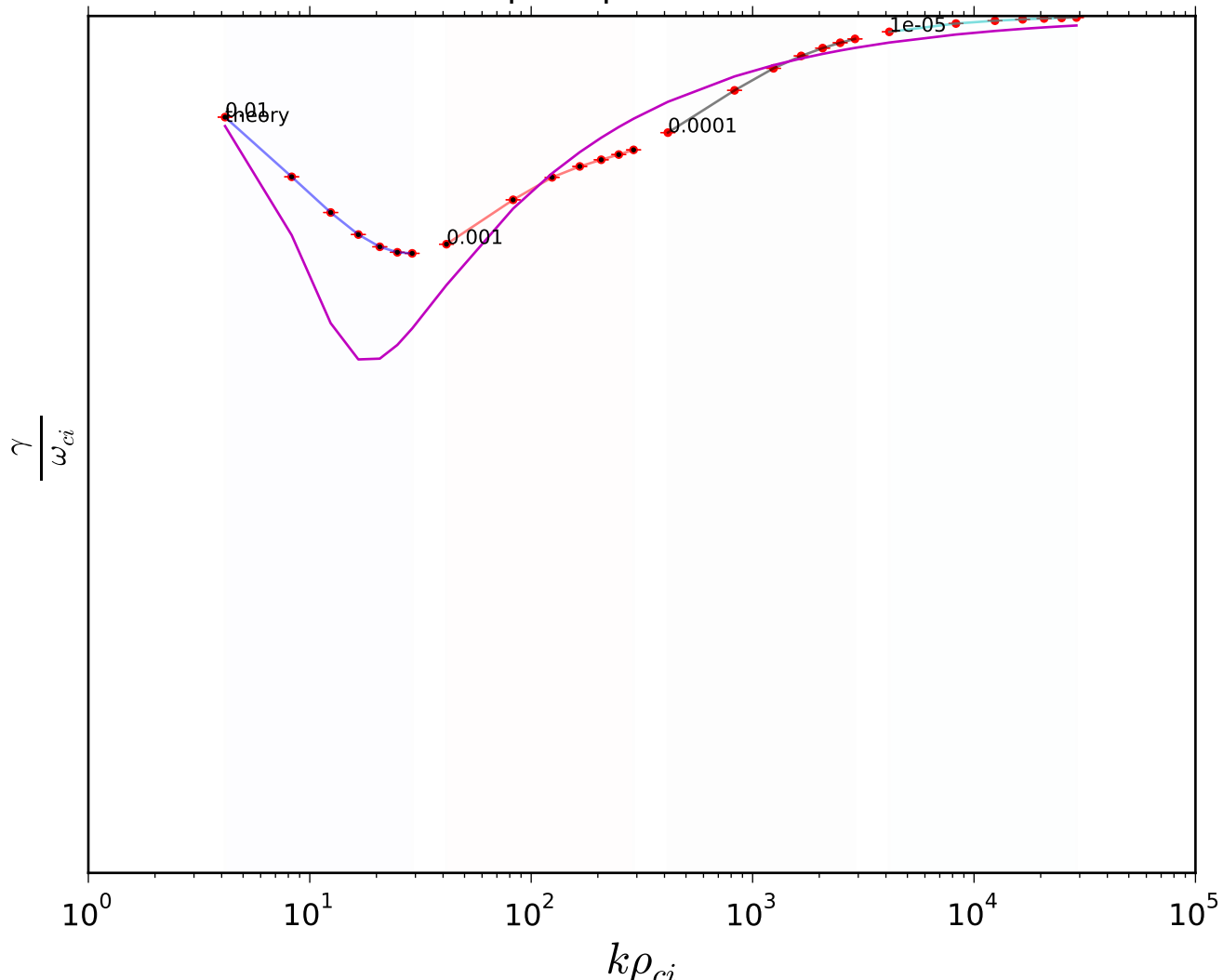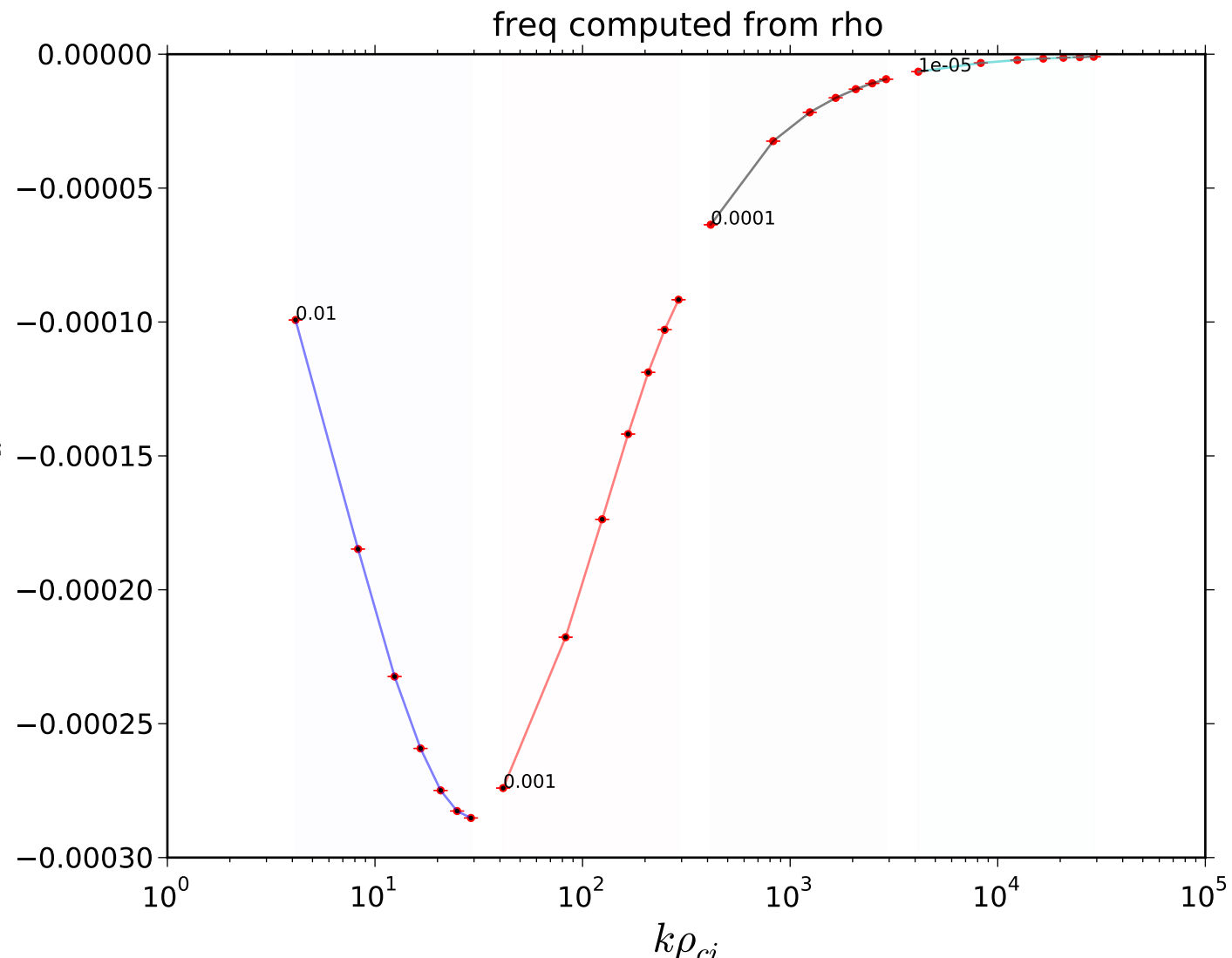
freq computed from Ni
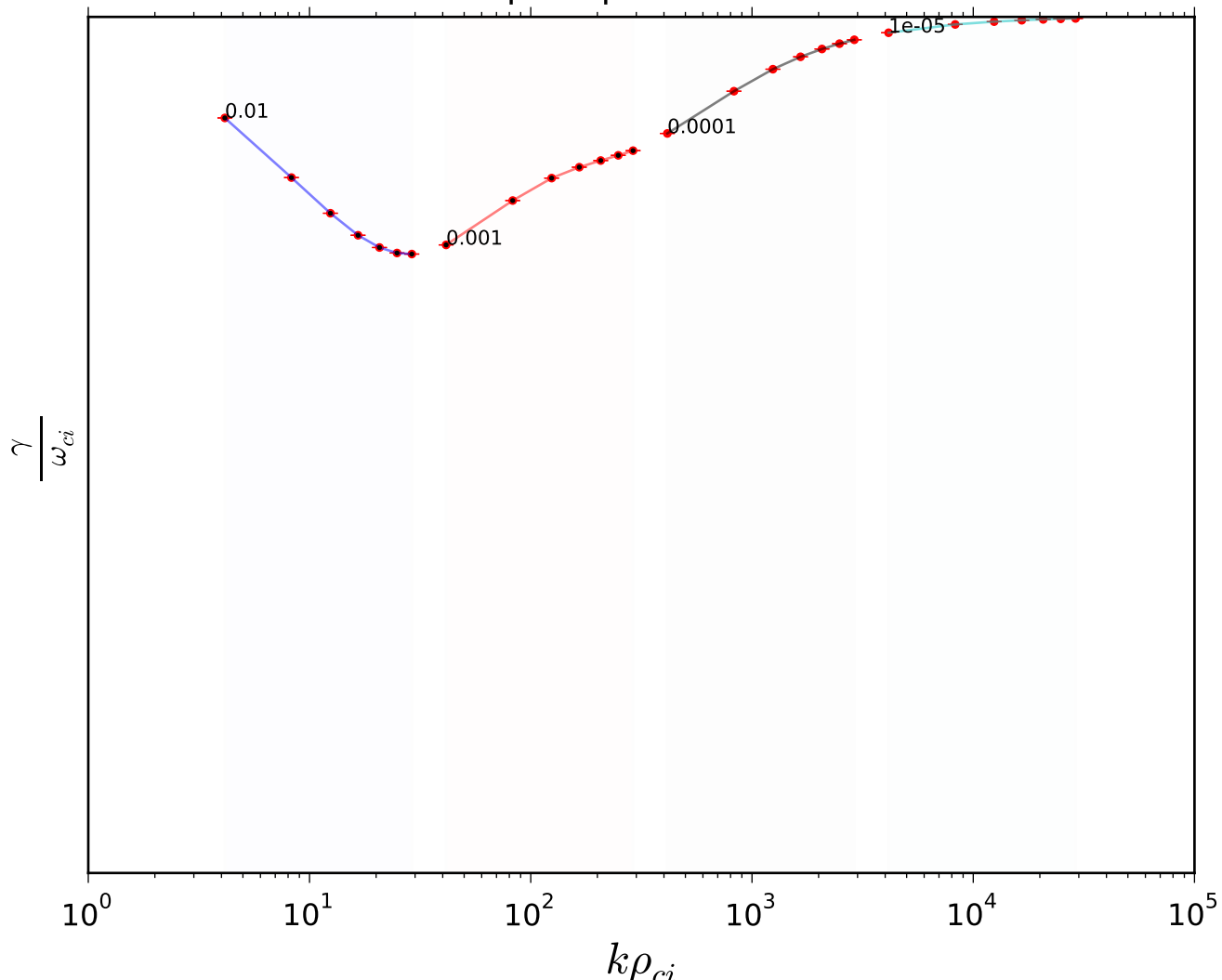
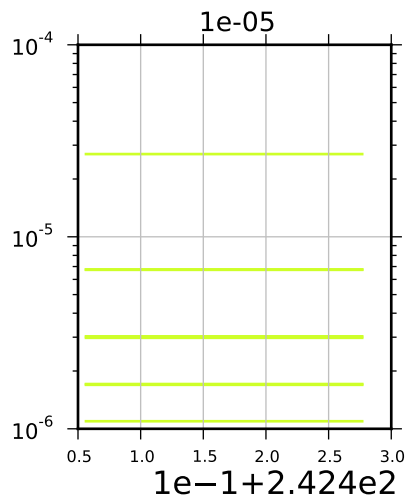Dominant mode behavior for Ni
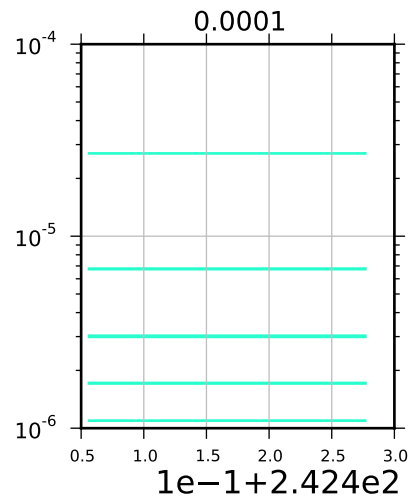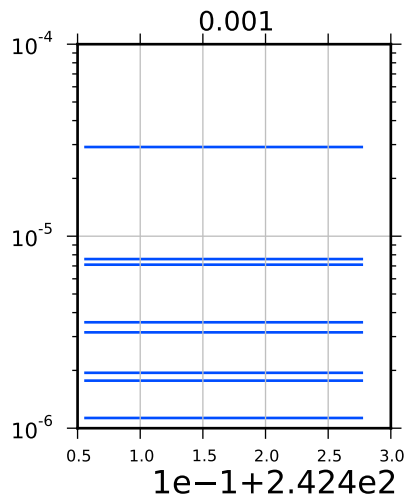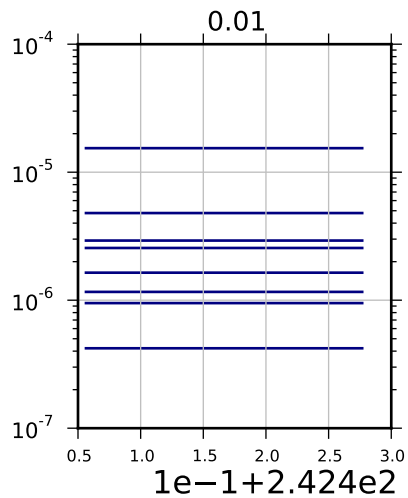
Dominant mode behavior for Ni

Dominant mode behavior for Vi

Dominant mode behavior for Vi

Dominant mode behavior for rho

Dominant mode behavior for rho