Mathcad - [electron_impedance_paper_12Apr2011_mass_in_kg.xmcd]

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electron impedances 10Apr2011 - units codata 2006 except Gabrielese fine structure constant

fundamental constants

$c := 299792458 \cdot \frac{m}{s}$ $\qquad G := 6.67428 \cdot 10^{-11} \cdot \frac{m^3}{kg \cdot sec^2}$

$e := 1.602176487 \cdot 10^{-19} \cdot coul$

$hbar := 1.054571628 \cdot 10^{-34} \cdot joule \cdot sec$ $\qquad h := 2 \cdot \pi \cdot hbar$ $\qquad R_H := \frac{h}{e^2}$ $\qquad R_H = 2.5812807554 \times 10^4\, ohm$

$\mu_0 := 4 \cdot \pi \cdot 10^{-7} \cdot \frac{N}{A^2}$ $\qquad \varepsilon_0 := \frac{1}{\mu_0 \cdot c^2}$ $\qquad \varepsilon_0 = 8.8541878176 \times 10^{-12} \frac{farad}{m}$ $\qquad \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}} = 2.99792458 \times 10^8\, m \cdot s^{-1}$

monopole charge in SI units

$g := \frac{h}{e}$ $\qquad g = 4.1356673326 \times 10^{-15}\, tesla \cdot m^2$ $\qquad \frac{g}{e} = 2.5812807554 \times 10^4\, ohm$ this is Hall resistance

magnetic coupling constant in SI units

$\beta := \frac{g^2}{2 \cdot \mu_0 \cdot h \cdot c}$ $\qquad \beta = 3.4258999915 \times 10^1$ $\qquad Z_0 := \sqrt{\frac{\mu_0}{\varepsilon_0}}$ $\qquad Z_0 = 3.7673031346 \times 10^2\, ohm$

fine structure constant in SI units

$\alpha := \frac{e^2}{2\varepsilon_0 \cdot h \cdot c}$ $\qquad \frac{1}{\alpha} = 1.3703599966 \times 10^2$ $\qquad \alpha = 7.2973525385 \times 10^{-3}$

use Gabrielese value for alpha $\qquad \alpha := \frac{1}{137.035999084}$ $\qquad \alpha = 7.2973525693 \times 10^{-3}$ $\qquad \frac{1}{4 \cdot \alpha} = 3.4258999771 \times 10^1$

$\alpha \cdot \beta = 2.5000000105 \times 10^{-1}$ $\qquad \frac{1}{\alpha \cdot \beta} = 3.9999999831 \times 10^0$ $\qquad \frac{\alpha}{2 \cdot \pi} = 1.1614097329 \times 10^{-3}$ $\qquad \frac{2 \cdot \pi}{\alpha} = 8.61022576 \times 10^2$

particle masses in MeV

$m_e := 0.51099891 \cdot MeV$ $\qquad m_\mu := 1.05658367 \times 10^2\, MeV$ $\qquad m_\tau := 1776.99 \cdot MeV$ $\qquad \frac{m_\tau}{m_\mu} = 1.6818261066 \times 10^1$

$m_\pi := 139.57018 \cdot MeV$ $\qquad m_{Kplus} := 493.667 \cdot MeV$ $\qquad m_{K0} := 497.648 \cdot MeV$ $\qquad m_\eta := 547.3 \cdot MeV$

$m_{\mu calc} := \frac{3}{2} \cdot \frac{m_e}{\alpha} + m_e$ $\qquad m_{\mu calc} = 1.0554886815 \times 10^2\, MeV$ $\qquad m_{\pi calc} := \frac{4}{2} \cdot \frac{m_e}{\alpha} - m_e$ $\qquad m_{\pi calc} = 1.3953949342 \times 10^2\, MeV$

$\frac{m_\mu - m_{\mu calc}}{m_\mu} = 1.0363480819 \times 10^{-3}$ $\qquad \frac{m_\pi - m_{\pi calc}}{m_\pi} = 2.1986490689 \times 10^{-4}$ $\qquad \frac{m_n - m_p}{2 m_e} = 1.2654948716 \times 10^0$

$m_{top} := 171.2 \cdot GeV$ $\qquad m_W := 80.4 \cdot GeV$ $\qquad m_Z := 91.2 \cdot GeV$

particle masses in kG

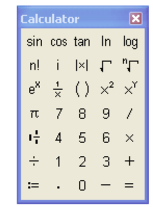
$m_e := \frac{m_e}{c^2}$ $\qquad m_e = 9.1093821527 \times 10^{-31}\, kg$ $\qquad m_{35MeV} := \frac{m_{35MeV}}{c^2}$ $\qquad m_{35MeV} = 6.2415664428 \times 10^{-29}\, kg$

$eV := 1.602176487 \cdot 10^{-19} \cdot joule$ $\qquad KeV := 1.602176487 \cdot 10^{-16} \cdot joule$

$MeV := 1.602176487 \cdot 10^{-13} \cdot joule$ $\qquad GeV := 1.602176487 \cdot 10^{-10} \cdot joule$

$zsec := sec \cdot 10^{-21}$ $\qquad mvolt := V \cdot 10^{-3}$

weber is tesla*m^2 is kg*m^2/coul*sec



$m_n := 939.565346 \cdot MeV$

$m_p := 938.272013 \cdot MeV$

$m_{nucleon} := \frac{m_n + m_p}{2}$

$m_{nucleon} = 9.389186795 \times 10^2\, MeV$

$m_{35MeV} := 3.50126232 \times 10^1\, MeV$ $\qquad \alpha^2 \cdot m_e = 2.7211384116 \times 10^1\, eV$ $\qquad \frac{m_e}{\alpha^2} = 9.595979569 \times 10^0\, GeV$

$\alpha \cdot m_e = 3.7289392088 \times 10^0\, KeV$

$m_{\pi 0} := 134.9764 \cdot MeV$ $\qquad \frac{m_\eta}{m_{\pi 0}} = 4.0547829102 \times 10^0$

$m_e = 5.1099891 \times 10^2\, KeV$

$\frac{m_e}{\alpha} = 7.0025246163 \times 10^1\, MeV$ $\qquad \frac{m_\eta}{m_\mu} = 5.1799021274 \times 10^0$

$\sqrt[3]{2} = 1.2599210499 \times 10^0$ $\qquad \frac{m_\eta}{m_\tau} = 3.0799272928 \times 10^{-1}$

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particle masses in kG

$m_e := \frac{m_e}{c^2}$ $m_e = 9.1093821527 \times 10^{-31}\,kg$ $m_{35MeV} := \frac{m_{35MeV}}{c^2}$ $m_{35MeV} = 6.2415664428 \times 10^{-29}\,kg$

$m_\mu := \frac{m_\mu}{c^2}$ $m_\mu = 1.8835313027 \times 10^{-28}\,kg$ $m_\tau := \frac{m_\tau}{c^2}$ $m_\tau = 3.1677721175 \times 10^{-27}\,kg$

$m_\pi := \frac{m_\pi}{c^2}$ $m_\pi = 2.4880642245 \times 10^{-28}\,kg$ $m_{\pi 0} := \frac{m_{\pi 0}}{c^2}$ $m_{\pi 0} = 2.4061726652 \times 10^{-28}\,kg$

$m_K := \frac{m_{Kplus}}{c^2}$ $m_K = 8.8004128212 \times 10^{-28}\,kg$ $m_{K0} := \frac{m_{K0}}{c^2}$ $m_{K0} = 8.8713805858 \times 10^{-28}\,kg$ $m_\eta := \frac{m_\eta}{c^2}$ $m_\eta = 9.7565078019 \times 10^{-28}\,kg$

$m_p := \frac{m_p}{c^2}$ $m_p = 1.6726216362 \times 10^{-27}\,kg$ $m_n := \frac{m_n}{c^2}$ $m_n = 1.6749272115 \times 10^{-27}\,kg$ $m_{nucleon} := \frac{m_{nucleon}}{c^2}$ $m_{nucleon} = 1.6737744239 \times 10^{-27}\,kg$

$m_W := \frac{m_W}{c^2}$ $m_W = 1.4332600535 \times 10^{-25}\,kg$ $m_Z := \frac{m_Z}{c^2}$ $m_Z = 1.6257875234 \times 10^{-25}\,kg$ $m_{top} := \frac{m_{top}}{c^2}$ $m_{top} = 3.0519169298 \times 10^{-25}\,kg$ $1 - \frac{m_{top}}{m_W + m_Z}$

$\lambda bar_e := \frac{hbar}{m_e \cdot c}$ $\lambda bar_e = 3.861592642 \times 10^{-13}\,m$ $\lambda bar_{35MeV} := \frac{hbar}{m_{35MeV} \cdot c}$ $\lambda bar_{35MeV} = 5.635880578 \times 10^{-15}\,m$

$\lambda bar_\mu := \frac{hbar}{m_\mu \cdot c}$ $\lambda bar_\mu = 1.867594292 \times 10^{-15}\,m$ $\lambda bar_\tau := \frac{hbar}{m_\tau \cdot c}$ $\lambda bar_\tau = 1.110456238 \times 10^{-16}\,m$

$\lambda bar_\pi := \frac{hbar}{m_\pi \cdot c}$ $\lambda bar_\pi = 1.413818934 \times 10^{-15}\,m$ $\lambda bar_{\pi 0} := \frac{hbar}{m_{\pi 0} \cdot c}$ $\lambda bar_{\pi 0} = 1.461936776 \times 10^{-15}\,m$

$\lambda bar_K := \frac{hbar}{m_K \cdot c}$ $\lambda bar_K = 3.997167384 \times 10^{-16}\,m$ $\lambda bar_{K0} := \frac{hbar}{m_{K0} \cdot c}$ $\lambda bar_{K0} = 3.965191522 \times 10^{-16}\,m$ $\lambda bar_\eta := \frac{hbar}{m_\eta \cdot c}$ $\lambda bar_\eta = 3.605462508 \times 10^{-16}\,m$

$\lambda bar_p := \frac{hbar}{m_p \cdot c}$ $\lambda bar_p = 2.103089087 \times 10^{-16}\,m$ $\lambda bar_n := \frac{hbar}{m_n \cdot c}$ $\lambda bar_n = 2.100194137 \times 10^{-16}\,m$ $\lambda bar_{nucleon} := \frac{hbar}{m_{nucleon} \cdot c}$ $\lambda bar_{nucleon} = 2.101640615 \times 10^{-16}\,m$

$\lambda bar_W := \frac{hbar}{m_W \cdot c}$ $\lambda bar_W = 2.454315461 \times 10^{-18}\,m$ $\lambda bar_Z := \frac{hbar}{m_Z \cdot c}$ $\lambda bar_Z = 2.163672841 \times 10^{-18}\,m$ $\lambda bar_{top} := \frac{hbar}{m_{top} \cdot c}$ $\lambda bar_{top} = 1.152610766 \times 10^{-18}\,m$

here gravity 20Mar2011

$m_e = 9.1093821527 \times 10^{-31}\,kg$ $\frac{G \cdot m_e^3 \cdot \lambda bar_e \cdot 10^{40}}{hbar \cdot e^2} = 7.1968235539 \times 10^{-2}\,ohm$

for now go back to photon 16Jan2011

$t_e := \frac{\lambda bar_e}{c}$ $t_e = 1.2880886556 \times 10^{0}\,zsec$ $t_\mu := \frac{\lambda bar_\mu}{c}$ $t_\mu = 6.229624001 \times 10^{-3}\,zsec$

$\omega bar_e := \frac{1}{\ldots}$ $\omega bar_e = 7.7634407825 \times 10^{20}\,s^{-1}$ $f_\mu := \frac{c}{2 \cdot \pi \cdot \lambda bar_\mu}$ $f_\mu = 2.5548081725 \times 10^{22}\,s^{-1}$

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$$\mathrm{hbar}\cdot e^{2}$$

for now go back to photon 16Jan2011

$t_e := \frac{\lambda bar_e}{c}$ $\quad t_e = 1.2880886556 \times 10^{0}\,\mathrm{zsec}$

$\omega bar_e := \frac{1}{t_e}$ $\quad \omega bar_e = 7.7634407825 \times 10^{20}\,\mathrm{s}^{-1}$

$f_e := \frac{m_e \cdot c^2}{h}$ $\quad f_e = 1.2355899759 \times 10^{20}\,\mathrm{s}^{-1}$ $\quad f_\pi := \frac{m_\pi \cdot c^2}{h}$

$W_{\gamma e} := h \cdot f_e$ $\quad W_{\gamma e} = 5.1099891 \times 10^{-1}\,\mathrm{MeV}$ $\quad W_{\gamma\pi} := h \cdot f_\pi$

$B_{\gamma e} := \sqrt{W_{\gamma e} \cdot \frac{\mu_0}{\pi \cdot \lambda bar_e^{\,3}}}$ $\quad B_{\gamma e} = 7.5412870516 \times 10^{8}\,\mathrm{tesla}$ $\quad B_{\gamma\pi} := \sqrt{W_{\gamma\pi} \cdot \frac{\mu_0}{\pi \cdot \lambda bar_\pi^{\,3}}}$ $\quad B_{\gamma\pi} = 5.6258843701 \times 10^{13}\,\mathrm{tesla}$

$\Phi_{B\gamma e} := B_{\gamma e} \cdot \left(\pi \cdot \lambda bar_e^{\,2}\right)$ $\quad \Phi_{B\gamma e} = 3.5328749169 \times 10^{-16}\,\mathrm{m}^2\,\mathrm{tesla}$ $\quad \Phi_{B\gamma\pi} := B_{\gamma\pi} \cdot \left(\pi \cdot \lambda bar_\pi^{\,2}\right)$ $\quad \Phi_{B\gamma\pi} = 3.5328749169 \times 10^{-16}\,\mathrm{m}^2\,\mathrm{tesla}$

$W_{\gamma e} := \frac{2 \cdot \pi \cdot \lambda bar_e^{\,3}}{\mu_0} \cdot B_{\gamma e}^{\,2}$ $\quad W_{\gamma e} = 1.02199782 \times 10^{0}\,\mathrm{MeV}$ $\quad W_{\gamma\pi} := \frac{2 \cdot \pi \cdot \lambda bar_\pi^{\,3}}{\mu_0} \cdot B_{\gamma\pi}^{\,2}$ $\quad W_{\gamma\pi} = 2.7914036 \times 10^{2}\,\mathrm{MeV}$

$E_{\gamma e} := c \cdot B_{\gamma e}$ $\quad E_{\gamma e} = 2.2608209817 \times 10^{17}\,\frac{\mathrm{volt}}{\mathrm{m}}$ $\quad \frac{W_{\gamma\pi}}{m_\pi} = 1.7975103575 \times 10^{17}\,\mathrm{m}^2\,\mathrm{s}^{-2}$

$\Phi_{E\gamma e} := E_{\gamma e} \cdot \left(\pi \cdot \lambda bar_e^{\,2}\right)$ $\quad \Phi_{E\gamma e} = 1.0591292552 \times 10^{-1}\,\mathrm{mvolt}\cdot\mathrm{mm}$

$t_\mu := \frac{\lambda bar_\mu}{c}$ $\quad t_\mu = 6.229624001 \times 10^{-3}\,\mathrm{zsec}$

$f_\mu := \frac{c}{2 \cdot \pi \cdot \lambda bar_\mu}$ $\quad f_\mu = 2.5548081725 \times 10^{22}\,\mathrm{s}^{-1}$

$f_\mu := \frac{m_\mu \cdot c^2}{h}$ $\quad f_\mu = 2.5548081725 \times 10^{22}\,\mathrm{s}^{-1}$

$W_{\gamma\mu} := h \cdot f_\mu$

$B_{\gamma\mu} := \sqrt{W_{\gamma\mu} \cdot \frac{\mu_0}{\pi \cdot \lambda bar_\mu^{\,3}}}$ $\quad B_{\gamma\mu} = 3.2241357036 \times 10^{13}\,\mathrm{tesla}$

$\Phi_{B\gamma\mu} := B_{\gamma\mu} \cdot \left(\pi \cdot \lambda bar_\mu^{\,2}\right)$ $\quad \Phi_{B\gamma\mu} = 3.5328749169 \times 10^{-16}\,\mathrm{m}^2\,\mathrm{tesla}$

$W_{\gamma\mu} := \frac{2 \cdot \pi \cdot \lambda bar_\mu^{\,3}}{\mu_0} \cdot B_{\gamma\mu}^{\,2}$ $\quad W_{\gamma\mu} = 2.11316734 \times 10^{2}\,\mathrm{MeV}$

$\frac{W_{\gamma\mu}}{m_\mu} = 1.7975103575 \times 10^{17}\,\mathrm{m}^2\,\mathrm{s}^{-2}$

$\frac{1}{\alpha} = 1.3703599908 \times 10^{2}$

Calculator

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$Z_0 = 3.7673031346 \times 10^{2}\,\mathrm{ohm}$

graphics here $\quad \mathrm{Work} := \int \mathrm{F}\,dx$ $\quad \mathrm{Impulse} := \int \mathrm{F}\,dt$ $\quad \mathrm{mdot} := \frac{\mathrm{hbar}}{\lambda bar_e^{\,2}} \cdot \frac{\lambda bar_e^{\,2}}{e^2}$

define the flux quanta and their associated field intensities, electric dipole moments, and dipole energies

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define the flux quanta and their associated field intensities, electric dipole moments, and dipole energies

$\Phi_{B1} := \frac{h}{e}$ $\Phi_{B1} = 4.1356673326 \times 10^{-15}\,\text{tesla}\cdot\text{m}^2$ $B_1 := \frac{\Phi_{B1}}{\pi\cdot \text{ƛbar}_e^{\,2}}$ $B_1 = 8.828009833 \times 10^{9}\,\text{tesla}$

$\Phi_{B2} := g$ $\Phi_{B2} = 4.1356673326 \times 10^{-15}\,\text{tesla}\cdot\text{m}^2$ $c\cdot B_1 = 2.6465707671 \times 10^{18}\,\frac{\text{volt}}{\text{m}}$

$\Phi_{E1} := \frac{h\cdot c}{e}$ $\Phi_{E1} = 1.2398418751 \times 10^{0}\,\text{mvolt}\cdot\text{mm}$ $E_1 := \frac{\Phi_{E1}}{\pi\cdot \text{ƛbar}_e^{\,2}}$ $E_1 = 2.6465707671 \times 10^{18}\,\frac{\text{volt}}{\text{m}}$

$\Phi_{E2} := \frac{e}{\varepsilon_0}$ $\Phi_{E2} = 1.809512651 \times 10^{-2}\,\text{volt}\cdot\mu\text{m}$ $E_2 := \frac{\Phi_{E2}}{\pi\cdot \text{ƛbar}_e^{\,2}}$ $E_2 = 3.8625919811 \times 10^{16}\,\frac{\text{volt}}{\text{m}}$

$\frac{E_1}{E_2} = 6.8517999831 \times 10^{1}$ $\frac{1}{2\alpha} = 6.8517999542 \times 10^{1}$

$d_{Bohr1} := \frac{g\cdot \text{hbar}}{\mu_0\cdot m_e\cdot c^2}$ $d_{Bohr1} = 4.2391764 \times 10^{-30}\,\text{m}\,\text{coul}$ $E_{\gamma e} = 2.2608209817 \times 10^{17}\,\frac{\text{volt}}{\text{m}}$ $\alpha\left(\frac{E_1}{E_{\gamma e}}\right)^2 = 1.0000000042 \times 10^{0}$

$d_{Bohr2} := e\cdot \text{ƛbar}_e$ $d_{Bohr2} = 6.1869529329 \times 10^{-32}\,\text{m}\,\text{coul}$ $\frac{d_{Bohr1}}{d_{Bohr2}} = 6.8517999831 \times 10^{1}$ $4\alpha\left(\frac{E_{\gamma e}}{E_2}\right)^2 = 1.0000000042 \times 10^{0}$

$\mu_B := \frac{e\cdot \text{ƛbar}_e\cdot c}{2}$ $\mu_B = 9.2740091365 \times 10^{-24}\,\frac{\text{joule}}{\text{tesla}}$

$d_{Bohr1}\cdot E_1 = 7.0025246458 \times 10^{1}\,\text{MeV}$ $d_{Bohr2}\cdot E_1 = 1.02199782 \times 10^{0}\,\text{MeV}$

$2\mu_B\cdot B_1 = 1.02199782 \times 10^{0}\,\text{MeV}$

$d_{Bohr1}\cdot E_2 = 1.02199782 \times 10^{0}\,\text{MeV}$ $d_{Bohr2}\cdot E_2 = 1.4915756772 \times 10^{-2}\,\text{MeV}$

$\alpha\left(\frac{B_1}{B_{\gamma e}}\right)^2 = 1.0000000042 \times 10^{0}$ $\left(\frac{B_1}{B_{\gamma e}}\right)^2 = 1.3703599966 \times 10^{2}$

$\lambda := \frac{\Phi_{B1}^{\,2}}{\mu_0\cdot\pi\cdot m_e\cdot c^2}$ $\lambda = 5.2917720794 \times 10^{-11}\,\text{m}$ $\frac{\lambda}{\text{ƛbar}_e} = 1.3703599966 \times 10^{2}$

$\frac{2}{172} = 1.1627906977 \times 10^{-2}$

magnetic and electric dipole moments in terms of magnetic and electric charges:

$\mu_{eBohr} := \frac{e\cdot \text{hbar}}{2m_e}$ $\mu_{eBohr} = 9.2740091365 \times 10^{-24}\,\frac{\text{joule}}{\text{tesla}}$

$\mu_B := \frac{h^2}{4\pi g\, m_e}$ $\mu_B = 9.2740091365 \times 10^{-24}\,\frac{\text{joule}}{\text{tesla}}$

$d_{eBohr} := \frac{g\cdot \text{hbar}}{\mu_0\cdot m_e\cdot c^2}$ $d_{eBohr} = 4.2391764 \times 10^{-30}\,\text{m}\,\text{coul}$ $\frac{d_{eBohr}}{e} = 2.6458860397 \times 10^{-11}\,\text{m}$ $\frac{d_{eBohr}}{e\cdot \text{ƛbar}_e} = 6.8517999831 \times 10^{1}$

$d_B := \frac{h^2}{2\pi e\mu_0\cdot m_e\cdot c^2}$ $d_B = 4.2391764001 \times 10^{-30}\,\text{m}\,\text{coul}$

$d_{eBohr} := \frac{e\cdot \text{hbar}}{2\cdot m_e\cdot c}$ $d_{eBohr} = 3.093476466 \times 10^{-32}\,\text{m}\,\text{coul}$ $\frac{d_{eBohr}}{e} = 1.9307963209 \times 10^{-13}\,\text{m}$ $\frac{d_{eBohr}}{e\cdot \text{ƛbar}_e} = 5 \times 10^{-1}$

$\Phi_B := \frac{h}{e}$ $\Phi_B = 4.1356673326 \times 10^{-15}\,\text{m}^2\cdot\text{A}^{-1}\cdot\text{kg}\cdot\text{s}^{-2}$

$e := 1.602176487\cdot 10^{-19}\cdot\text{coul}$

$g := \frac{h}{e}$ $g = 4.1356673326 \times 10^{-15}\,\text{tesla}\cdot\text{m}^2$

$\Phi := \frac{h}{\ldots}$ $\Phi = 4.1356673326 \times 10^{-15}\,\text{tesla}\cdot\text{m}^2$ $B := \frac{\Phi_B}{\ldots}$ $B = 8.828009833 \times 10^{9}\,\text{tesla}$

$\Phi_B := \frac{h}{e}$ $\Phi_B = 4.1356673326 \times 10^{-15}\, m^2 \cdot A^{-1} \cdot kg \cdot s^{-2}$

$e := 1.602176487 \cdot 10^{-19} \cdot coul$

$g := \frac{h}{e}$ $g = 4.1356673326 \times 10^{-15}\, tesla \cdot m^2$

$\Phi_B := \frac{h}{e}$ $\Phi_B = 4.1356673326 \times 10^{-15}\, tesla \cdot m^2$ $B := \frac{\Phi_B}{\pi \cdot \lambda bar_e^{\,2}}$ $B = 8.828009833 \times 10^{9}\, tesla$

$\Phi_{E1} := \frac{h \cdot c}{e}$ $\Phi_{E1} = 1.2398418751 \times 10^{0}\, mvolt \cdot mm$ $E_1 := \frac{\Phi_{E1}}{\pi \cdot \lambda bar_e^{\,2}}$ $E_1 = 2.6465707671 \times 10^{18}\, \frac{volt}{m}$

$\Phi_{E2} := \frac{e}{\varepsilon_0}$ $\Phi_{E2} = 1.809512651 \times 10^{-2}\, volt \cdot \mu m$ $E_2 := \frac{\Phi_{E2}}{\pi \cdot \lambda bar_e^{\,2}}$ $E_2 = 3.8625919811 \times 10^{16}\, \frac{volt}{m}$

$\mu_B := \frac{e \cdot \lambda bar_e \cdot c}{2}$ $\mu_B = 9.2740091365 \times 10^{-24}\, \frac{joule}{tesla}$

$d_{Bohr1} := \frac{g \cdot hbar}{\mu_0 \cdot m_e \cdot c^2}$ $d_{Bohr1} = 4.2391764 \times 10^{-30}\, m\, coul$

$d_{Bohr2} := e \cdot \lambda bar_e$ $d_{Bohr2} = 6.1869529329 \times 10^{-32}\, m\, coul$

calculate energies associated with these fields, charges, and dipole moments

$2\mu_B \cdot B = 1.02199782 \times 10^{0}\, MeV$

$d_{Bohr2} \cdot E_2 = 1.4915756772 \times 10^{1}\, KeV$ $d_{Bohr1} \cdot E_2 = 1.02199782 \times 10^{0}\, MeV$ $d_{Bohr1} \cdot E_1 = 7.0025246458 \times 10^{1}\, MeV$

$d_{Bohr2} \cdot E_1 = 1.02199782 \times 10^{0}\, MeV$

$e \cdot E_2 \cdot \lambda bar_e = 1.4915756772 \times 10^{1}\, KeV$ $e \cdot E_1 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\, MeV$ $\frac{g}{\mu_0} \cdot B \cdot \lambda bar_e = 7.0025246458 \times 10^{1}\, MeV$

$\pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_2^{\,2} = 1.4915756772 \times 10^{1}\, KeV$ $\pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_1 \cdot E_2 = 1.02199782 \times 10^{0}\, MeV$ $\pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_1^{\,2} = 7.0025246458 \times 10^{1}\, MeV$

$\pi\, \lambda bar_e^{\,3} \sqrt{\frac{\varepsilon_0}{\mu_0}}\, E_1 \cdot B = 7.0025246458 \times 10^{1}\, MeV$

$\pi\, \lambda bar_e^{\,3} \sqrt{\frac{\varepsilon_0}{\mu_0}}\, E_2 \cdot B = 1.02199782 \times 10^{0}\, MeV$

$\frac{\pi\, \lambda bar_e^{\,3}}{\mu_0} \cdot B^2 = 7.0025246458 \times 10^{1}\, MeV$

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calculate energies associated with these fields, charges, and dipole moments

$$2\mu_B \cdot B = 1.02199782 \times 10^{0}\,\mathrm{MeV}$$

$$d_{Bohr2} \cdot E_2 = 1.4915756772 \times 10^{1}\,\mathrm{KeV} \qquad d_{Bohr1} \cdot E_2 = 1.02199782 \times 10^{0}\,\mathrm{MeV} \qquad d_{Bohr1} \cdot E_1 = 7.0025246458 \times 10^{1}\,\mathrm{MeV}$$

$$d_{Bohr2} \cdot E_1 = 1.02199782 \times 10^{0}\,\mathrm{MeV}$$

$$e \cdot E_2 \cdot \lambda bar_e = 1.4915756772 \times 10^{1}\,\mathrm{KeV} \qquad e \cdot E_1 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\,\mathrm{MeV} \qquad \frac{g}{\mu_0} \cdot B \cdot \lambda bar_e = 7.0025246458 \times 10^{1}\,\mathrm{MeV}$$

$$\pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_2^{\,2} = 1.4915756772 \times 10^{1}\,\mathrm{KeV} \qquad \pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_1 \cdot E_2 = 1.02199782 \times 10^{0}\,\mathrm{MeV} \qquad \pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_1^{\,2} = 7.0025246458 \times 10^{1}\,\mathrm{MeV}$$

$$\pi \lambda bar_e^{\,3} \sqrt{\frac{\varepsilon_0}{\mu_0}} E_1 \cdot B = 7.0025246458 \times 10^{1}\,\mathrm{MeV}$$

$$\pi \lambda bar_e^{\,3} \sqrt{\frac{\varepsilon_0}{\mu_0}} E_2 \cdot B = 1.02199782 \times 10^{0}\,\mathrm{MeV}$$

$$\frac{\pi \lambda bar_e^{\,3}}{\mu_0} \cdot B^2 = 7.0025246458 \times 10^{1}\,\mathrm{MeV}$$

$$\frac{2 \cdot \pi \lambda bar_e^{\,3}}{\mu_0} \cdot B_1^{\,2}$$

$$4 \cdot \alpha^2 = 2.1300541808 \times 10^{-4}$$

$$\frac{1}{\sqrt{\frac{\varepsilon_0}{\mu_0}}} = 3.7673031346 \times 10^{2}\,\mathrm{ohm}$$

$$m_\pi = 1.552927686 \times 10^{-15}\,\mathrm{m}^{-2} \cdot \mathrm{s}^2\,\mathrm{MeV}$$

$$\frac{2 \cdot \pi \lambda bar_e^{\,3}}{\mu_0} \cdot B_1^{\,2} - m_e \cdot c^2 = 1.3953949401 \times 10^{2}\,\mathrm{MeV}$$

$$\frac{2}{4} \cdot \pi \cdot \varepsilon_0 \lambda bar_e^{\,3} \cdot E_1 \cdot E_2 = 5.1099891 \times 10^{-1}\,\mathrm{MeV}$$

$$m_{\pi Calc} := \frac{2 \cdot \pi \lambda bar_e^{\,3}}{\mu_0} \cdot B_1^{\,2} - m_e \cdot c^2$$

$$4 \cdot m_e = 2.2742518634 \times 10^{-17}\,\mathrm{m}^{-2} \cdot \mathrm{s}^2\,\mathrm{MeV}$$

$$\frac{m_\pi \cdot c^2 - m_{\pi Calc}}{m_\pi \cdot c^2} = 2.198606792 \times 10^{-4}$$

$$\mu_{\mu Bohr} := \frac{e \cdot hbar}{2m_\mu} \qquad ratio_\mu := \frac{\Phi_{B1}}{\mu_{\mu Bohr}} \qquad ratio_\mu = 9.2206597917 \times 10^{10}\,\frac{\mathrm{kg}}{\mathrm{coul}^2} \qquad m_{nucleonCalc} := \sin\left(\frac{\pi}{4}\right) \cdot ratio_\mu \cdot e^2 \cdot c^2$$

$$\frac{m_{nucleon} \cdot c^2 - m_{nucleonCalc}}{m_{nucleon} \cdot c^2} = 6.7276821123 \times 10^{-5} \qquad m_{nucleonCalc} = 9.3885551204 \times 10^{2}\,\mathrm{MeV}$$

Forces to be considered:

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Forces to be considered:

Inertial

$$F_{inertial} := m_e \cdot \frac{d^2}{dt_e^2}\lambda bar_e + \left(\frac{d}{dt_e}m_e\right)\cdot\left(\frac{d}{dt_e}\lambda bar_e\right) + \frac{d^2}{dt_e^2}m_e \cdot \lambda bar_e$$

$mdot := \frac{m_e}{t_e}$ $mdot = 7.0720148907 \times 10^{-10}\, kg \cdot s^{-1}$ $rdot := \frac{\lambda bar_e}{t_e}$ $rdot = 2.99792458 \times 10^{8}\, m \cdot s^{-1}$

$F_{inertial} := mdot \cdot rdot$ $F_{inertial} \cdot \lambda bar_e = 5.1099891 \times 10^{-1}\, MeV$

Centripetal

$F_{centri} := m_e \cdot \omega bar_e^2 \cdot \lambda bar_e$ $F_{centri} \cdot \lambda bar_e = 5.1099891 \times 10^{-1}\, MeV$

Gravity

$F_{grav} := G \cdot \frac{m_e \cdot m_e}{\lambda bar_e^2}$ $F_{grav} \cdot \lambda bar_e = 8.9516986501 \times 10^{-40}\, eV$

Electromagnetic

$$F_{EM} := e \cdot E_1 + e \cdot E_2 + e \cdot c \cdot B_1 + g \cdot \frac{B_1}{\mu_0} + \left(\frac{g}{\mu_0 \cdot c}\right) \cdot E_1 + \left(\frac{g}{\mu_0 \cdot c}\right) \cdot E_2$$

$e \cdot E_1 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\, MeV$ $e \cdot c \cdot B_1 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\, MeV$

$e \cdot E_2 \cdot \lambda bar_e = 1.4915756772 \times 10^{-2}\, MeV$

$e \cdot c \cdot B_1 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\, MeV$

$g \cdot \frac{B_1}{\mu_0} \cdot \lambda bar_e = 7.0025246458 \times 10^{1}\, MeV$

$\left(\frac{g}{\mu_0 \cdot c}\right) \cdot E_1 \cdot \lambda bar_e = 7.0025246458 \times 10^{1}\, MeV$ $\frac{g}{\mu_0} \cdot B_1 \cdot \lambda bar_e = 7.0025246458 \times 10^{1}\, MeV$

$\left(\frac{g}{\mu_0 \cdot c}\right) \cdot E_2 \cdot \lambda bar_e = 1.02199782 \times 10^{0}\, MeV$

Coulomb forces

$$F_{coul} := \frac{1}{4\pi \cdot \varepsilon_0} \cdot \frac{e^2}{\lambda bar_e^2} + \frac{g^2}{4 \cdot \pi \cdot \mu_0 \lambda bar_e^2}$$

$\frac{1}{\pi \cdot \varepsilon_0} \cdot \frac{e^2}{\lambda bar_e} = 1.4915756772 \times 10^{-2}\, MeV$ $\frac{g^2}{\pi \cdot \mu_0 \lambda bar_e} = 7.0025246458 \times 10^{1}\, MeV$

Magnetic Dipole

$\mu_B := \frac{e \cdot hbar}{2m_e}$ $\mu_B = 9.2740091365 \times 10^{-24}\, \frac{joule}{tesla}$ $2\mu_B \cdot B_1 = 1.02199782 \times 10^{0}\, MeV$

$F_{dipole} := \frac{3 \cdot \mu_0 \cdot \mu_B^2}{4 \cdot \pi \lambda bar_e^4}$ $4F_{dipole} \cdot \lambda bar_e = 1.1186817579 \times 10^{-2}\, MeV$ $\frac{e \cdot E_2 \cdot \lambda bar_e}{4F_{dipole} \cdot \lambda bar_e} = 1.3333333333 \times 10^{0}$

Electric dipoles

$d_{Bohr1} := \frac{g \cdot hbar}{2}$ $d_{Bohr1} = 4.2391764 \times 10^{-30}\, m\, coul$ $E_1 := \frac{\Phi_{E1}}{\ldots 2}$ $E_1 = 2.6465707671 \times 10^{18}\, \frac{volt}{m}$

$rdot = 2.99792458 \times 10^{8}\, m \cdot s^{-1}$

$mdot_{centripetal} := \frac{m_e \cdot \omega bar_e^2 \cdot \lambda bar_e}{rdot}$ $mdot_{centripetal} = 7.0720148907 \times 10^{-10}\, kg \cdot s^{-1}$

$mdot_{electricLorentz1} := \frac{e \cdot E_1}{rdot}$ $mdot_{electricLorentz1} = 1.4144029781 \times 10^{-9}\, kg \cdot s^{-1}$

$mdot_{electricLorentz2} := \frac{e \cdot E_2}{rdot}$ $mdot_{electricLorentz2} = 2.0642794326 \times 10^{-11}\, kg \cdot s^{-1}$

$mdot_{magneticLorentz1} := \frac{e \cdot c \cdot B_1}{rdot}$ $mdot_{magneticLorentz1} = 1.4144029781 \times 10^{-9}\, kg \cdot s^{-1}$

$mdot_{monopoleLorentz1} := \frac{g \cdot \frac{B_1}{\mu_0}}{rdot}$ $mdot_{monopoleLorentz1} = 9.6912063017 \times 10^{-8}\, kg \cdot s^{-1}$

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Electric dipoles

$d_{Bohr1} := \dfrac{g \cdot hbar}{\mu_0 \cdot m_e \cdot c^2}$ $\quad d_{Bohr1} = 4.2391764 \times 10^{-30}\, m\, coul$ $\quad E_1 := \dfrac{\Phi_{E1}}{\pi \cdot \lambda bar_e^{\,2}}$ $\quad E_1 = 2.6465707671 \times 10^{18}\, \dfrac{volt}{m}$

$d_{Bohr2} := e \cdot \lambda bar_e$ $\quad d_{Bohr2} = 6.1869529329 \times 10^{-32}\, m\, coul$ $\quad E_2 := \dfrac{\Phi_{E2}}{\pi \cdot \lambda bar_e^{\,2}}$ $\quad E_2 = 3.8625919811 \times 10^{16}\, \dfrac{volt}{m}$

$\mu_B := \dfrac{e \cdot \lambda bar_e \cdot c}{2}$ $\quad \dfrac{d_{Bohr1}}{d_{Bohr2}} = 6.8517999831 \times 10^{1}$ $\quad \dfrac{1}{2\alpha} = 6.8517999542 \times 10^{1}$ $\quad \dfrac{E_1}{E_2} = 6.8517999831 \times 10^{1}$

$d_{Bohr1} \cdot E_1 = 7.0025246458 \times 10^{1}\, MeV$

$d_{Bohr1} \cdot E_2 = 1.02199782 \times 10^{0}\, MeV$ $\quad c \cdot B_1 = 2.6465707671 \times 10^{18}\, \dfrac{volt}{m}$

$d_{Bohr2} \cdot E_1 = 1.02199782 \times 10^{0}\, MeV$

$d_{Bohr2} \cdot E_2 = 1.4915756772 \times 10^{-2}\, MeV$

$F_{inertial} := m_e \cdot \dfrac{1}{t_e^{\,2}} \cdot \lambda bar_e$

$F_{inertial} = 2.1201367271 \times 10^{-1}\, N$

now calculate mechanical impedances, plot along with electrical impedance:

procedure is to equate the given force with the inertial force = mdot x rdot = mdot x v. From earlier in this worksheet

inertial = centripetal $\quad oZ_{centri} := \dfrac{hbar}{\lambda bar_e^{\,2}}$ $\quad oZ_{centri} = 7.0720148907 \times 10^{-10}\, kg \cdot s^{-1}$

inertial = elecCoul $\quad oZ_{elecCoul} := \dfrac{m_e \cdot e^2}{4 \cdot \pi \cdot \varepsilon_0 \cdot hbar \cdot \lambda bar_e}$ $\quad oZ_{elecCoul} = 5.1606985816 \times 10^{-12}\, kg \cdot s^{-1}$

inertial = magCoul $\quad oZ_{magCoul} := \dfrac{m_e \cdot g^2}{4\pi\, \mu_0 \cdot hbar \cdot \lambda bar_e}$ $\quad oZ_{magCoul} = 2.4228015754 \times 10^{-8}\, kg \cdot s^{-1}$

centri gives mdot x rdot = m x v^2 / r
or mdot = m x rdot^2/r x rdot = m x rdot/r
substituting rdot = h/mr
gives mdot = h/r^2

elec coul gives mdot x rdot = e^2/4 pi eps r^2
or mdot = e^2/4 pi eps r^2 rdot
again rdot = h/mr to give
mdot = m e^2/4 pi eps h r

mag coul gives mdot x rdot = g^2/4 pi mu r^2
or mdot = g^2/4 pi mu r^2 rdot
again rdot = h/mr to give
mdot = m g^2/4 pi mu h r

qE1 Lorentz gives mdot x rdot = eE1
or mdot = eE1/ rdot
again rdot = h/mr to give
mdot = mr eE1/ h
ditto qE2

$\dfrac{e^2}{4\pi \cdot \varepsilon_0 \cdot \lambda bar_e^{\,2}} = 1.5471385128 \times 10^{-3}\, N$

$\dfrac{g^2}{4\pi\, \mu_0 \cdot \lambda bar_e^{\,2}} = 7.2633763955 \times 10^{0}\, N$

$e \cdot E_1 = 4.2402734542 \times 10^{-1}\, N$

$\dfrac{\dfrac{g^2}{4\pi\, \mu_0 \cdot \lambda bar_e^{\,2}}}{\dfrac{e^2}{4\pi \cdot \varepsilon_0 \cdot \lambda bar_e^{\,2}}} = 4.6947163008 \times 10^{3}$

$\dfrac{1}{4\alpha^2} = 4.6947162612 \times 10^{3}$

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now calculate mechanical impedances, plot along with electrical impedance:

procedure is to equate the given force with the inertial force = mdot x rdot = mdot x v. From earlier in this worksheet

inertial = centripetal $\quad oZ_{centri} := \frac{hbar}{\lambda bar_e^2} \quad oZ_{centri} = 7.0720148907 \times 10^{-10}\,kg\cdot s^{-1}$

inertial = elecCoul $\quad oZ_{elecCoul} := \frac{m_e\cdot e^2}{4\cdot\pi\cdot\varepsilon_0\cdot hbar\cdot\lambda bar_e} \quad oZ_{elecCoul} = 5.1606985816 \times 10^{-12}\,kg\cdot s^{-1}$

inertial = magCoul $\quad oZ_{magCoul} := \frac{m_e\cdot g^2}{4\pi\,\mu_0\cdot hbar\cdot\lambda bar_e} \quad oZ_{magCoul} = 2.4228015754 \times 10^{-8}\,kg\cdot s^{-1}$

inertial = qE1Lorentz $\quad oZ_{qE1} := m_e\cdot\lambda bar_e\cdot e\cdot\frac{E_1}{hbar} \quad oZ_{qE1} = 1.4144029781 \times 10^{-9}\,kg\cdot s^{-1}$

inertial = qE2Lorentz $\quad oZ_{qE2} := m_e\cdot\lambda bar_e\cdot e\cdot\frac{E_2}{hbar} \quad oZ_{qE2} = 2.0642794326 \times 10^{-11}\,kg\cdot s^{-1}$

inertial = qvBLorentz $\quad oZ_{qvBLorentz1} := e\cdot B_1 \quad oZ_{qvBLorentz1} = 1.4144029781 \times 10^{-9}\,kg\cdot s^{-1}$

inertial = gBLorentz $\quad oZ_{gB} := \frac{g\cdot B_1}{2\mu_0\cdot hbar}\cdot m_e\cdot\lambda bar_e \quad oZ_{gB} = 4.8456031509 \times 10^{-8}\,kg\cdot s^{-1}$

inertial = gvE1Lorentz $\quad oZ_{gvE1Lorentz} := \frac{g\cdot E_1}{2\mu_0\cdot c^2} \quad oZ_{gvE1Lorentz} = 4.8456031509 \times 10^{-8}\,kg\cdot s^{-1}$

inertial = gvE2Lorentz $\quad oZ_{gvE2Lorentz} := \frac{g\cdot E_2}{2\mu_0\cdot c^2} \quad oZ_{gvE2Lorentz} = 7.0720148907 \times 10^{-10}\,kg\cdot s^{-1}$

inertial = magDipole $\quad oZ_{magDipole} := \frac{3\mu_0\,m_e\cdot\mu_B^2}{4\cdot\pi\cdot hbar\cdot\lambda bar_e^3} \quad oZ_{magDipole} = 3.8705239362 \times 10^{-12}\,kg\cdot s^{-1}$

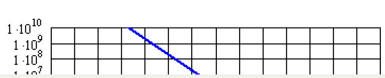
inertial = elecDipole $\quad oZ_{elecDipole} := \frac{3m_e\cdot d_B^2}{4\cdot\pi\cdot\varepsilon_0\cdot hbar\cdot\lambda bar_e^3} \quad oZ_{elecDipole} = 7.2684047263 \times 10^{-8}\,kg\cdot s^{-1}$

mechanical impedances

$n := 000..2000 \quad r_n := 10^{-0.01n}\cdot m \quad j := \sqrt{-1} \quad B_{1_n} := \frac{\Phi_{B1}}{\pi\cdot(r_n)^2} \quad E_{1_n} := \frac{\Phi_{E1}}{\pi\cdot(r_n)^2} \quad E_{2_n} := \frac{\Phi_{E2}}{\pi\cdot(r_n)^2}$

inertial = centripetal $\quad Zmech_{centri_n} := \frac{hbar}{(r_n)^2}$

inertial = elecCoul $\quad Zmech_{elecCoul} := \frac{m_e\cdot e^2}{\ldots}$



elec coul gives mdot x rdot = e^2/4 pi eps r^2
or mdot = e^2/4 pi eps r^2 rdot
again rdot = h/mr to give
mdot = m e^2/4 pi eps h r

mag coul gives mdot x rdot = g^2/4 pi mu r^2
or mdot = g^2/4 pi mu r^2 rdot
again rdot = h/mr to give
mdot = m g^2/4 pi mu h r

qE1 Lorentz gives mdot x rdot = eE1
or mdot = eE1/ rdot
again rdot = h/mr to give
mdot = mr eE1/ h
ditto qE2

qvB Lorentz gives mdot x rdot = erdotB
or mdot = eB

gB Lorentz gives mdot x rdot = gB
or mdot = gB/ rdot
again rdot = h/mr to give
mdot = mr gB/ h

gvE1 Lorentz gives mdot x rdot = g rdot E1
or mdot = gE1
ditto gvE2

mag dipole gives mdot x rdot = mu muB^2/4 pi r^4
or mdot = mu muB^2/4 pi r^4 rdot
again rdot = h/mr to give
mdot = m mu muB^2/4 pi r^3 h

elec dipole gives mdot x rdot = mu muB^2/4 pi r^4
or mdot = mu muB^2/4 pi r^4 rdot
again rdot = h/mr to give
mdot = m mu muB^2/4 pi r^3 h

$\frac{e}{4\pi\cdot\varepsilon_0\cdot\lambda bar_e^2} = 1.5471385128 \times 10^{-3}\,N$

$\frac{\frac{4\pi\,\mu_0\cdot\lambda bar_e^2}{e^2}}{4\pi\cdot\varepsilon_0\cdot\lambda bar_e^2} = 4.6947163008 \times 10^3$

$\frac{g^2}{4\pi\,\mu_0\cdot\lambda bar_e^2} = 7.2633763955 \times 10^0\,N$

$\frac{1}{4\alpha^2} = 4.6947162612 \times 10^3$

$e\cdot E_1 = 4.2402734542 \times 10^{-1}\,N$

$\frac{g}{e} = 2.5812807554 \times 10^4\,ohm$

$\frac{\alpha}{\pi} = 2.3228194658 \times 10^{-3}$

$tesla := \frac{kg}{coul\cdot sec}$

$\frac{\pi}{\alpha} = 4.30511288 \times 10^2$

$\frac{1}{4\pi\cdot\alpha} = 1.0904978318 \times 10^1$

$\frac{oZ_{elecCoul}}{oZ_{magDipole}} = 1.3333333333 \times 10^0$

$\frac{oZ_{elecDipole}}{oZ_{magCoul}} = 3 \times 10^0$

$MeV = 1.602176487 \times 10^{-13}\,m^2\cdot kg\cdot s^{-2}$

$Energy_n := \frac{h\cdot c}{(2\pi r)_n} \quad Energy_{1241} = 5.0720839372 \times 10^5\,eV \quad Energy_{1200} = 3.161526205 \times 10^{-14}\,m^2\cdot kg\cdot s^{-2}$

$Energy_n := \frac{h\cdot c}{1.602176487 \times 10^{-19}\cdot(2\pi r)_n} \quad Energy_{1241} = 5.0720839372 \times 10^5\,m^2\cdot kg\cdot s^{-2}$

$unk := \frac{hbar}{e^2}$

$r_{1241} = 3.8904514499 \times 10^{-13}\,m \quad \lambda bar_e = 3.8615926417 \times 10^{-13}\,m \quad mdot_{centri} := \frac{hbar}{\lambda bar_e^2}$

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mechanical impedances

$n := 000 .. 2000$ $\qquad r_n := 10^{-0.01n} \cdot m$ $\qquad j := \sqrt{-1}$ $\qquad B_{1_n} := \frac{\Phi_{B1}}{\pi \cdot (r_n)^2}$ $\qquad E_{1_n} := \frac{\Phi_{E1}}{\pi \cdot (r_n)^2}$ $\qquad E_{2_n} := \frac{\Phi_{E2}}{\pi \cdot (r_n)^2}$

inertial = centripetal $\qquad Zmech_{centri_n} := \frac{hbar}{(r_n)^2}$

inertial = elecCoul $\qquad Zmech_{elecCoul_n} := \frac{m_e \cdot e^2}{4 \cdot \pi \cdot \varepsilon_0 \cdot hbar \cdot r_n}$

inertial = magCoul $\qquad Zmech_{magCoul_n} := \frac{m_e \cdot g^2}{4\pi \mu_0 \cdot hbar \cdot r_n}$

inertial = qE1 $\qquad Zmech_{qE1_n} := m_e \cdot r_n \cdot e \cdot \frac{E_{1_n}}{hbar}$

inertial = qE2 $\qquad Zmech_{qE2_n} := m_e \cdot r_n \cdot e \cdot \frac{E_{2_n}}{hbar}$

inertial = qvBLorentz $\qquad Zmech_{qvBLorentz1_n} := e \cdot B_{1_n}$

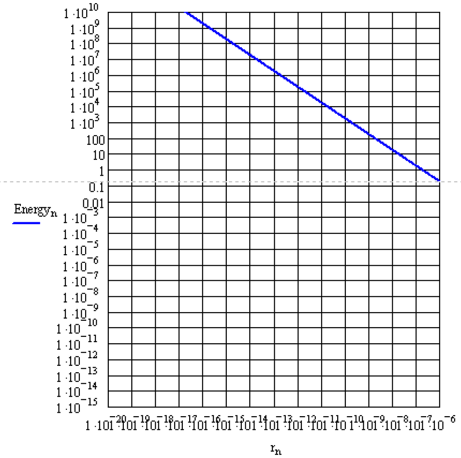
inertial = gB $\qquad Zmech_{gB_n} := \frac{g \cdot B_{1_n}}{2\mu_0 \cdot hbar} \cdot m_e \cdot r_n$

inertial = gvE1Lorentz $\qquad Zmech_{gvE1Lorentz_n} := \frac{g \cdot E_{1_n}}{2\mu_0 \cdot c^2}$

inertial = gvE2Lorentz $\qquad Zmech_{gvE2Lorentz_n} := \frac{g \cdot E_{2_n}}{2\mu_0 \cdot c^2}$

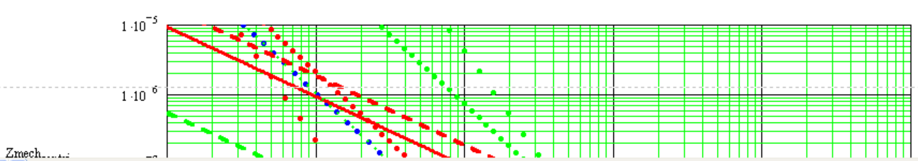
inertial = magDipole $\qquad Zmech_{magDipole_n} := \frac{3\mu_0 m_e \cdot \mu_B^2}{4 \cdot \pi \cdot hbar \cdot (r_n)^3}$

inertial = elecDipole $\qquad Zmech_{elecDipole_n} := \frac{3m_e \cdot d_B^2}{4 \cdot \pi \cdot \varepsilon_0 \cdot hbar \cdot (r_n)^3}$



$Zmech_{qvBLorentz1_{1000}} = 2.109143256 \times 10^{-14} kg \cdot s^{-1}$

$r_{1000} = 1 \times 10^{-10} m$



$\frac{Z_{elecDipole}}{oZ_{magCoul}} = 3 \times 10^0$

$Energy_n := \frac{h \cdot c}{(2\pi r)_n}$ $\qquad Energy_{1241} = 5.0720839372 \times 10^5 eV$ $\qquad Energy_{1200} = 3.161526205 \times 10^{-14} m^2 \cdot kg \cdot s^{-2}$

$Energy_n := \frac{h \cdot c}{1.602176487 \times 10^{-19} \cdot (2\pi r)_n}$ $\qquad Energy_{1241} = 5.0720839372 \times 10^5 m^2 \cdot kg \cdot s^{-2}$

$unk := \frac{hbar}{e^2}$

$r_{1241} = 3.8904514499 \times 10^{-13} m$ $\qquad \lambda bar_e = 3.8615926417 \times 10^{-13} m$ $\qquad mdot_{centri} := \frac{hbar}{\lambda bar_e^2}$

$$Z_{E_n} := \frac{Z_0 \cdot \left| 1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^2}{(j \cdot r_n)^2} \right|}{\left| 1 + \frac{\lambda bar_e}{j \cdot r_n} \right|}$$

$Z_{centri} := \frac{h}{\lambda bar_e^2} \cdot \frac{\lambda bar_e^2}{e^2}$ $\qquad \frac{h}{e^2} = 2.5812807554 \times 10^4 ohm$

$Z_{centri} := \frac{hbar}{\lambda bar_e^2} \cdot \frac{\lambda bar_e^2}{e^2}$

$$Z_{M_n} := \frac{Z_0 \cdot \left| 1 + \frac{\lambda bar_e}{j \cdot r_n} \right|}{\left| 1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^2}{(j \cdot r_n)^2} \right|}$$

$R_H = 2.5812807554 \times 10^4 m^2 \cdot A^{-2} \cdot kg \cdot s^{-3}$

$R_H = 2.5812807554 \times 10^4 ohm$

$\mu_0 \cdot \varepsilon_0 = 1.1126500561 \times 10^{-17} m^{-2} \cdot s^2$

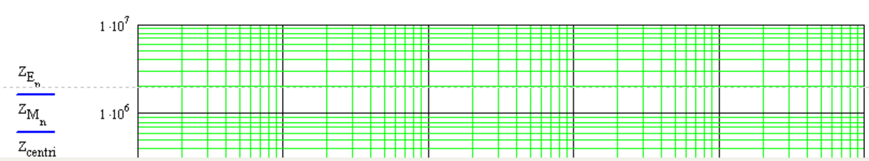
$1 \cdot c^2 = 8.9875517874 \times 10^{16} m^2 \cdot s^{-2}$

$\frac{1}{\mu_0 \cdot \varepsilon_0} = 8.9875517874 \times 10^{16} m^2 \cdot s^{-2}$

$c^2 \cdot (\mu_0 \cdot \varepsilon_0) = 10 \times 10^{-1}$

$c := \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$

$c = 2.99792458 \times 10^8 m \cdot s^{-1}$



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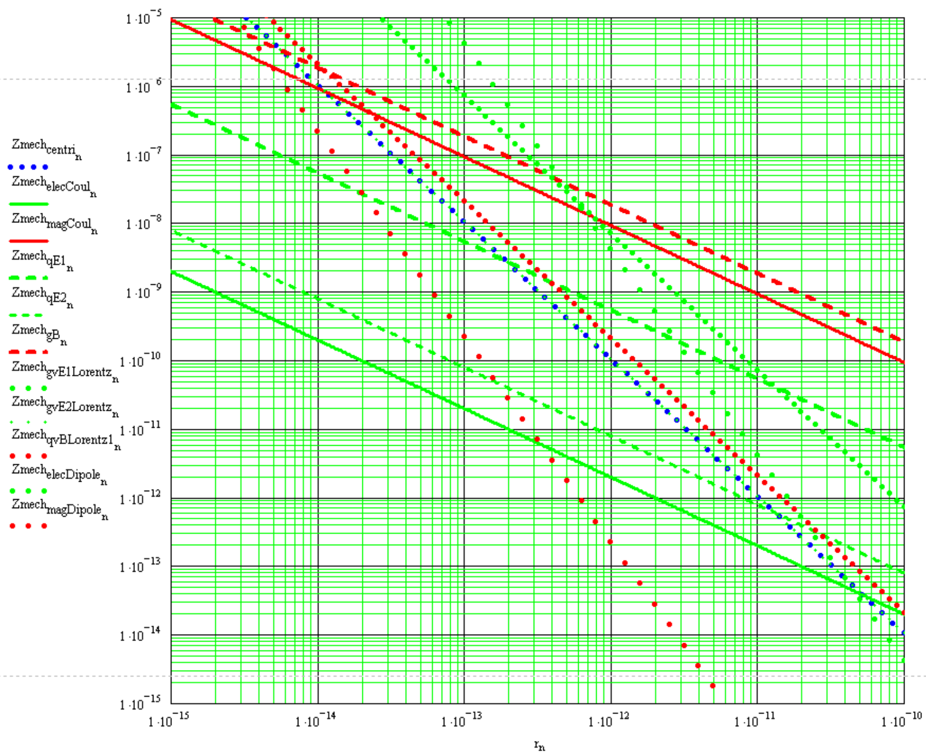
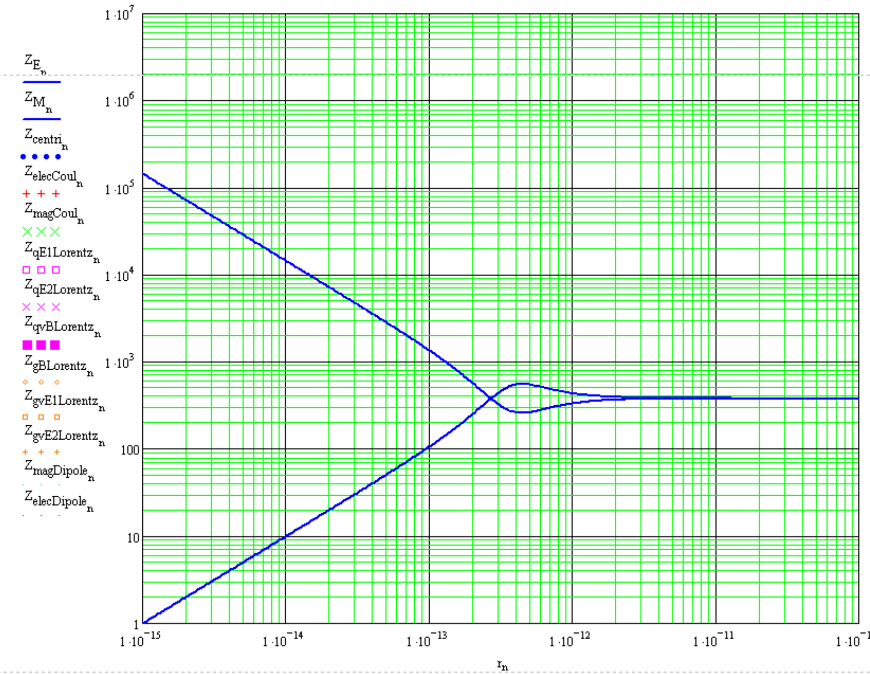
inertial – elecDipole

$Zmech_{elecDipole_n} := \frac{\ldots}{4\cdot\pi\cdot\varepsilon_0\cdot hbar\cdot(r_n)^3}$

$c = 2.99792458 \times 10^8\ m\cdot s^{-1}$





$c = 2.99792458 \times 10^8\ m\cdot s^{-1}$

$\lambda bar_e = 3.8615926417 \times 10^{-13}\ m$

$ohm := \frac{coul^2\cdot s}{m\cdot kg}$

$ohm := \frac{(m^2)\cdot kg}{coul^2\cdot s}$

$R_H = 2.5812807554 \times 10^4\ ohm$

$R_H = 2.5812807554 \times 10^4\ m^3\cdot A^{-4}\cdot kg^2\cdot s^{-6}\ ohm$

now electrical impedances

$n := 1..2000$ $\quad r_n := 10^{-0.01n}\cdot m$ $\quad j := \sqrt{-1}$ $\quad B_{1_n} := \frac{\Phi_{B1}}{\pi\cdot(r_n)^2}$ $\quad E_{1_n} := \frac{\Phi_{E1}}{\pi\cdot(r_n)^2}$ $\quad E_{2_n} := \frac{\Phi_{E2}}{\pi\cdot(r_n)^2}$ $\quad R_H := \frac{h}{e^2}$

$\frac{c\cdot m_e\cdot\lambda bar_e}{hbar} = 1 \times 10^0$

$\frac{e^2}{\lambda bar_e^2}$

$\frac{g}{e} = 2.5812807554 \times 10^4\ ohm$

use the immediate above to calculate impedances at reduced compton wavelength below

$g = 4.1356673326 \times 10^{-15}\ m^2\cdot kg\cdot s^{-1}\ \frac{1}{coul}$

$Energy_n := \frac{h\cdot c}{(2\pi r)_n}$ $\quad Energy_{1241} = 5.0720839372 \times 10^5\ eV$ $\quad r_{1241} = 3.8904514499 \times 10^{-13}\ m$

$Energy_n := \frac{hbar\cdot c}{1.602176487 \times 10^{-19}\cdot r_n}$ $\quad Energy_{1241} = 5.0720839372 \times 10^5\ m^2\cdot kg\cdot s^{-2}$ $\quad \lambda bar_e = 3.8615926417 \times 10^{-13}\ m$

$\Gamma_n := \frac{(r_n)^2}{e^2}$

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now electrical impedances

$c = 2.99792458 \times 10^{8}\, m \cdot s^{-1}$

$n := 1..2000$ $\quad r_n := 10^{-0.01n} \cdot m$ $\quad i := \sqrt{-1}$ $\quad B1_n := \frac{\Phi_{B1}}{\pi \cdot (r_n)^2}$ $\quad E1_n := \frac{\Phi_{E1}}{\pi \cdot (r_n)^2}$ $\quad E2_n := \frac{\Phi_{E2}}{\pi \cdot (r_n)^2}$ $\quad R_H := \frac{h}{e^2}$

$Energy_n := \frac{h \cdot c}{(2\pi r)_n}$ $\quad Energy_{1241} = 5.0720839372 \times 10^{5}\, eV$ $\quad r_{1241} = 3.8904514499 \times 10^{-13}\, m$

$Energy_n := \frac{hbar \cdot c}{1.602176487 \times 10^{-19} \cdot r_n}$ $\quad Energy_{1241} = 5.0720839372 \times 10^{5}\, m^2 \cdot kg \cdot s^{-2}$ $\quad \lambda bar_e = 3.8615926417 \times 10^{-13}\, m$

$coul^2 \cdot s$

$\frac{c \cdot m_e \cdot \lambda bar_e}{hbar} = 1 \times 10^{0}$ $\quad \frac{e^2}{\lambda bar_e^2}$ $\quad \frac{g}{e} = 2.5812807554 \times 10^{4}\, ohm$

use the immediate above to calculate impedances at reduced compton wavelength below

$g = 4.1356673326 \times 10^{-15}\, m^2 \cdot kg \cdot s^{-1} \cdot \frac{1}{coul}$

$\Gamma_n := \frac{(r_n)^2}{e^2}$

inertial = centripetal

$Zelec_{centri_n} := \frac{\Gamma_n \cdot h}{(r_n)^2}$ $\quad Zelec_{centri_n} := \frac{h}{e^2}$ $\quad Z_{centri_n} := \frac{h}{e^2}$

$Zelec_{centri} := \frac{h}{e^2}$ $\quad Zelec_{centri} = 2.5812807554 \times 10^{4}\, ohm$ $\quad \frac{Zelec_{centri}}{R_H} = 1 \times 10^{0}\, m^{-2} \cdot A^{2} \cdot kg^{-1} \cdot s^{3}\, ohm$

inertial = qvBLorentz

$Zelec_{qvBLorentz1_n} := \Gamma_n \cdot e \cdot B1_n$ $\quad Zelec_{qvBLorentz1_n} := \frac{\Phi_{B1}}{e}$ $\quad Z_{qvBLorentz_n} := \frac{\Phi_{B1}}{e}$

$Zelec_{qvBLorentz} := \frac{\Phi_{B1}}{e}$ $\quad Zelec_{qvBLorentz} = 2.5812807554 \times 10^{4}\, ohm$ $\quad \frac{Zelec_{qvBLorentz}}{R_H} = 1 \times 10^{0}\, m^{-2} \cdot A^{2} \cdot kg^{-1} \cdot s^{3}\, ohm$

inertial = gvE1Lorentz

$Zelec_{gvE1Lorentz_n} := \frac{\Gamma_n \cdot g \cdot E1_n}{\mu_0 \cdot c^2}$ $\quad Zelec_{gvE1Lorentz_n} := \frac{g \cdot \Phi_{E1}}{\mu_0 \cdot e^2 \cdot c^2}$ $\quad Z_{gvE1Lorentz_n} := \frac{g \cdot \Phi_{E1}}{\mu_0 \cdot e^2 \cdot c^2}$

$Zelec_{gvE1Lorentz} := \frac{g \cdot \Phi_{E1}}{\mu_0 \cdot e^2 \cdot c^2}$ $\quad Zelec_{gvE1Lorentz} = 1.7686419436 \times 10^{6}\, ohm$ $\quad \frac{Zelec_{gvE1Lorentz}}{R_H} = 6.8517999831 \times 10^{1}$

$\frac{1}{2\alpha} = 6.8517999542 \times 10^{1}$

inertial = gvE2Lorentz

$Zelec_{gvE2Lorentz_n} := \frac{\Gamma_n \cdot g \cdot E2_n}{\mu_0 \cdot c^2}$ $\quad Zelec_{gvE2Lorentz_n} := \frac{g \cdot \Phi_{E2}}{\mu_0 \cdot e^2 \cdot c^2}$ $\quad Z_{gvE2Lorentz_n} := \frac{g \cdot \Phi_{E2}}{\mu_0 \cdot e^2 \cdot c^2}$

$Zelec_{gvE2Lorentz} := \frac{g \cdot \Phi_{E2}}{\mu_0 \cdot e^2 \cdot c^2}$ $\quad Zelec_{gvE2Lorentz} = 2.5812807554 \times 10^{4}\, ohm$ $\quad \frac{Zelec_{gvE2Lorentz}}{R_H} = 1 \times 10^{0}$

inertial = elecCoul

$Zelec_{elecCoul_n} := \frac{\Gamma_n \cdot m_e \cdot e^2}{\varepsilon_0 \cdot hbar \cdot r_n}$ $\quad Zelec_{elecCoul_n} := \frac{r_n \cdot m_e}{\varepsilon_0 \cdot hbar}$ $\quad Z_{elecCoul_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{1}{\varepsilon_0}$

$Zelec_{elecCoul} := \frac{1}{\varepsilon_0 \cdot c}$ $\quad Zelec_{elecCoul} = 3.7673031346 \times 10^{2}\, ohm$ $\quad \frac{Zelec_{elecCoul}}{2\alpha \cdot R_H} = 9.9999999579 \times 10^{-1}$

inertial = magCoul

$Zelec_{magCoul_n} := \frac{\Gamma_n \cdot m_e \cdot g^2}{\mu_0 \cdot hbar \cdot r_n}$ $\quad Zelec_{magCoul_n} := \frac{r_n \cdot m_e \cdot R_H^2}{\mu_0 \cdot hbar}$ $\quad Z_{magCoul_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{R_H^2}{\mu_0}$

$Zelec_{magCoul} := \frac{R_H^2}{\mu_0 \cdot c}$ $\quad Zelec_{magCoul} = 1.7686419436 \times 10^{6}\, ohm$ $\quad \frac{Zelec_{magCoul}}{R_H} = 6.8517999831 \times 10^{1}$

inertial = qE1

$Zelec_{qE1_n} := \Gamma_n \cdot m_e \cdot r_n \cdot e \cdot \frac{E1_n}{hbar}$ $\quad Zelec_{qE1_n} := m_e \cdot (r_n) \cdot \frac{\Phi_{E1}}{e \cdot hbar}$ $\quad Z_{qE1_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{\Phi_{E1}}{e}$

$Zelec_{qE1} := \frac{\Phi_{E1}}{e \cdot c}$ $\quad Zelec_{qE1} = 2.5812807554 \times 10^{4}\, ohm$ $\quad \frac{Zelec_{qE1}}{R_H} = 10 \times 10^{-1}$

inertial = qE2

$Zelec_{qE2_n} := \Gamma_n \cdot m_e \cdot r_n \cdot e \cdot \frac{E2_n}{hbar}$ $\quad Zelec_{qE2_n} := m_e \cdot (r_n) \cdot \frac{\Phi_{E2}}{e \cdot hbar}$ $\quad Z_{qE2_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{\Phi_{E2}}{e}$

$Zelec_{qE2} := \frac{\Phi_{E2}}{e \cdot c}$ $\quad Zelec_{qE2} = 3.7673031346 \times 10^{2}\, ohm$ $\quad \frac{Zelec_{qE2}}{2\alpha \cdot R_H} = 9.9999999579 \times 10^{-1}$

inertial = gB

$Zelec_{gB_n} := \frac{\Gamma_n \cdot g \cdot B1_n}{\mu_0 \cdot hbar} \cdot m_e \cdot r_n$ $\quad Zelec_{gB_n} := \frac{r_n \cdot g \cdot (m_e \cdot \Phi_{B1})}{\mu_0 \cdot e^2 \cdot hbar}$ $\quad Z_{gB_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{g \cdot \Phi_{B1}}{\mu_0 \cdot e^2}$

$Zelec_{gB} := \frac{g \cdot \Phi_{B1}}{\mu_0 \cdot e^2 \cdot c}$ $\quad Zelec_{gB} = 1.7686419436 \times 10^{6}\, ohm$ $\quad \frac{Zelec_{gB}}{R_H} = 6.8517999831 \times 10^{1}$

inertial = magDipole

$Zelec_{magDipole_n} := \frac{\Gamma_n \cdot 4\mu_0 \cdot m_e \cdot \mu_B^2}{\ldots}$ $\quad Zelec_{magDipole_n} := \frac{4\mu_0 \cdot m_e \cdot \mu_B^2}{e^2 \cdot hbar \cdot (r_n)}$ $\quad Z \ldots := \frac{4\mu_0 \cdot m_e \cdot \mu_B^2}{\ldots}$

$Zelec_{magDipole} := \frac{4\mu_0 \cdot m_e \cdot \mu_B^2}{e^2 \cdot hbar \cdot \lambda bar_e}$ $\quad Zelec_{magDipole} = 3.7673031346 \times 10^{2}\, ohm$ $\quad \frac{Zelec_{magDipole}}{Z_0} = 1 \times 10^{0}$

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inertial = gB $\quad Zelec_{gB_n} := \frac{\Gamma_n \cdot g \cdot B1_n}{\mu_0 \cdot hbar} \cdot m_e \cdot r_n \quad Zelec_{gB_n} := \frac{r_n \cdot g \cdot (m_e \cdot \Phi_{B1})}{\mu_0 \cdot e^2 \cdot hbar} \quad Z_{gB_n} := \frac{m_e \cdot r_n}{hbar} \cdot \frac{g \cdot \Phi_{B1}}{\mu_0 \cdot e^2} \quad Zelec_{gB} := \frac{g \cdot \Phi_{B1}}{\mu_0 \cdot e^2 \cdot c} \quad Zelec_{gB} = 1.7686419436 \times 10^6\ ohm \quad \frac{Zelec_{gB}}{R_H} = 6.8517999831 \times 10^1$

inertial = magDipole $\quad Zelec_{magDipole_n} := \frac{\Gamma_n \cdot 4\mu_0 m_e \cdot \mu_B^2}{hbar \cdot (r_n)^3} \quad Zelec_{magDipole_n} := \frac{4\mu_0 m_e \cdot \mu_B^2}{e^2 \cdot hbar \cdot (r_n)} \quad Z_{magDipole_n} := \frac{4\mu_0 m_e \cdot \mu_B^2}{c^2 \cdot hbar \cdot (r_n)} \quad Zelec_{magDipole} := \frac{4\mu_0 m_e \cdot \mu_B^2}{e^2 \cdot hbar \cdot \lambda bar_e} \quad Zelec_{magDipole} = 3.7673031346 \times 10^2\ ohm \quad \frac{Zelec_{magDipole}}{Z_0} = 1 \times 10^0$

inertial = elecDipole $\quad Zelec_{elecDipole_n} := \frac{\Gamma_n m_e \cdot d_B^2}{\varepsilon_0 \cdot hbar \cdot (r_n)^3} \quad Zelec_{elecDipole_n} := \frac{m_e \cdot d_B^2}{\varepsilon_0 \cdot e^2 \cdot hbar \cdot (r_n)} \quad Z_{elecDipole1_n} := \frac{m_e \cdot d_{Bohr1}^2}{\varepsilon_0 \cdot e^2 \cdot hbar \cdot (r_n)} \quad Zelec_{elecDipole1} := \frac{m_e \cdot d_{Bohr1}^2}{\varepsilon_0 \cdot e^2 \cdot hbar \cdot \lambda bar_e} \quad Zelec_{elecDipole1} = 1.7686419436 \times 10^6\ ohm \quad \frac{Zelec_{elecDipole1}}{R_H} = 6.8517999831 \times 10^1$

$c = 2.99792458 \times 10^8\ m \cdot s^{-1} \quad \frac{\lambda bar_e}{2\alpha} = 2.6458860286 \times 10^{-11}\ m \quad Z_{elecDipole2_n} := \frac{m_e \cdot d_{Bohr2}^2}{\varepsilon_0 \cdot e^2 \cdot hbar \cdot (r_n)} \quad Zelec_{elecDipole2} := \frac{m_e \cdot d_{Bohr2}^2}{\varepsilon_0 \cdot e^2 \cdot hbar \cdot \lambda bar_e} \quad Zelec_{elecDipole2} = 3.7673031346 \times 10^2\ ohm \quad \frac{Zelec_{elecDipole2}}{2\alpha \cdot R_H} = 9.9999999579 \times 10^{-1}$

$\lambda bar_e \cdot 2\alpha = 5.6358805971 \times 10^{-15}\ m \quad \lambda bar_e = 3.8615926417 \times 10^{-13}\ m$

$\alpha := \frac{1}{4 \cdot \pi \cdot \varepsilon_0} \cdot \frac{e^2}{hbar \cdot c} \quad \alpha = 7.2973525385 \times 10^{-3} \quad m_p = 1.6726216362 \times 10^{-27}\ kg \quad \frac{1}{c \cdot \varepsilon_0} = 3.7673031346 \times 10^2\ ohm \quad d_{Bohr1} := \frac{g \cdot hbar \cdot c^2}{\mu_0 \cdot m_e} \quad d_{Bohr1} = 3.4242408226 \times 10^4\ m^4 \cdot s^{-4} \cdot co$

$R_{oo} := \frac{\pi^3 \cdot m_e \cdot e^4}{(\varepsilon_0^2) \cdot hbar^3 \cdot c} \quad R_{oo} = 6.7520172527 \times 10^{11}\ m^{-1} \quad \frac{4 \cdot \pi \cdot \alpha}{R_{oo}} = 1.3581309566 \times 10^{-13}\ m \quad \lambda_p := \frac{hbar}{m_p \cdot c} \quad \lambda_p = 2.1030890866 \times 10^{-16}\ m \quad \lambda_\mu := \frac{hbar \cdot c}{m_\mu} \quad \lambda_\mu = 1.6785100414 \times 10^2\ m^3 \cdot s^{-2} \quad d_{Bohr2} := e \cdot \lambda bar_e \quad d_{Bohr2} = 6.1869529329 \times 10^{-32}\ coul \cdot \quad r_{1000} = 1 \times 10^{-10}$

$a_0 := 4 \cdot \pi \varepsilon_0 \cdot \frac{hbar^2}{m_e \cdot e^2} \quad a_0 = 5.2917720794 \times 10^{-11}\ m \quad R_{oo} \cdot a_0 \cdot 4 \cdot \alpha = 1.0429416056 \times 10^0 \quad \frac{a_0}{\alpha} = 7.2516327688 \times 10^{-9}\ m \quad Z_{M_n} := \frac{Z_0 \cdot |1|}{\left|1 + \frac{\lambda bar_e}{j \cdot r_n}\right|}$

$\lambda bar_e := \frac{hbar}{m_e \cdot c} \quad \lambda bar_e = 3.8615926417 \times 10^{-13}\ m \quad \frac{a_0}{\lambda bar_e} = 1.3703599966 \times 10^2 \quad \frac{511000\alpha^2}{2 \cdot 13.6} = 1.0004206592 \times 10^0 \quad \frac{511000 \cdot 4\alpha}{14900} = 1.0010596368 \times 10^0$

$r_e := \frac{e^2}{4 \cdot \pi \varepsilon_0 \cdot m_e \cdot c^2} \quad r_e = 2.8179402867 \times 10^{-15}\ m \quad \frac{\lambda bar_e}{r_e} = 1.3703599966 \times 10^2 \quad Z_{E_n} := \frac{Z_0 \cdot \left|1 + \frac{\lambda bar_e}{j \cdot r_n}\right|}{|1|}$

$\frac{\alpha \cdot h \cdot c}{4 \cdot \pi a_0} = 1.3605691943 \times 10^1\ eV \quad 1.4915756772 \times 10^{-2}\ MeV$

$\frac{1}{R_{oo}} = 1.4810388697 \times 10^{-12}\ m \quad \frac{4\pi \lambda bar_e}{\alpha^2} = 9.1126704933 \times 10^{-8}\ m \quad \frac{h \cdot c}{a_0} = 2.3429615949 \times 10^4\ eV \quad \frac{2.3429615949 \times 10^4\ eV}{1.4915756772 \times 10^{-2}\ MeV} = 1.5707963268 \times 10^0 \quad \frac{\pi}{2} = 1.5707963268 \times 10^0$

$a_0 \cdot R_{oo} = 3.5730136378 \times 10^1 \quad \frac{\pi}{\varepsilon_0} \cdot \frac{hbar^2}{m_e \cdot c^2 \cdot g^2} = 2.8179402867 \times 10^{-15}\ m \quad \frac{g^2}{4 \cdot \pi \varepsilon_0 \cdot m_e \cdot c^2} = 1.8775965263 \times 10^{-6}\ m^5 \cdot A^{-4} \cdot kg^2 \cdot s^{-6}$

$\lambda bar_e := \frac{hbar}{4\alpha^2 \cdot m_e \cdot c} \quad \lambda bar_e = 1.8129081922 \times 10^{-9}\ m \quad \lambda bar_e := \frac{hbar}{m_e \cdot c} \quad \lambda bar_e = 3.8615926417 \times 10^{-13}\ m$

$\frac{m_e}{4 m_{nucleon} \alpha^2} = 2.5550614391 \times 10^0$

$Z_0 \cdot \left|1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^2}{(j \cdot r_n)^2}\right| \quad Z_{..} := \frac{Z_0 \cdot \left|1 + \frac{\lambda bar_e}{j \cdot r_n}\right|}{\ldots} \quad x_n := 1.09 \log\left(\frac{r_n}{\lambda bar_e}\right) \quad m_{..} = 1.6726216362 \times 10^{-27}\ kg$

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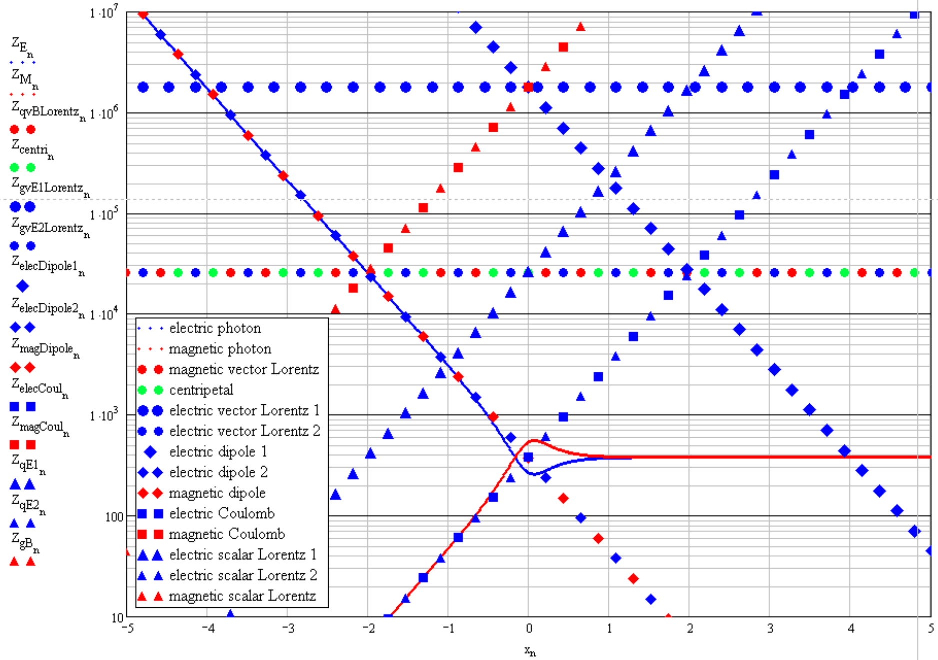
$$Z_{E_n} := \frac{Z_0 \cdot \left| 1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2} \right|}{\left| 1 + \frac{\lambda bar_e}{j \cdot r_n} \right|} \qquad Z_{M_n} := \frac{Z_0 \cdot \left| 1 + \frac{\lambda bar_e}{j \cdot r_n} \right|}{\left| 1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2} \right|}$$

$$x_n := 1.09 \log\left(\frac{r_n}{\lambda bar_e}\right)$$

$$\frac{m_e}{4 m_{nucleon} \alpha^2} = 2.5550614391 \times 10^0$$

$$m_p = 1.6726216362 \times 10^{-27}\ \mathrm{kg}$$



$$Imp_{magDipole_n} := \frac{4\mu_0 m_e \cdot \mu_B^{\,2}}{e^2 \cdot hbar \cdot (r_n)}$$

$$Imp_{gvE1Lorentz_n} := \frac{g \cdot \Phi_{E1}}{\mu_0 \cdot e^2 \cdot c^2}$$

$$r_{strong} := \frac{\frac{4\mu_0 m_e \cdot \mu_B^{\,2}}{e^2 \cdot hbar}}{\frac{g \cdot \Phi_{E1}}{\mu_0 \cdot e^2 \cdot c^2}}$$

$$r_{strong} = 8.2254014818 \times 10^{-17}\ \mathrm{m}$$

$$\lambda bar_p = 2.1030890866 \times 10^{-16}\ \mathrm{m} \qquad \lambda bar_{nucleon} = 2.1016406147 \times 10^{-16}\ \mathrm{m}$$

$$\frac{\lambda bar_p}{r_{strong}} = 2.5568224131 \times 10^0 \qquad \frac{\lambda bar_{nucleon}}{r_{strong}} = 2.5550614391 \times 10^0$$

$$\frac{\sqrt{2}\,\lambda bar_p}{r_{strong}} = 3.6158929333 \times 10^0 \qquad \frac{\sqrt{2}\,\lambda bar_{nucleon}}{r_{strong}} = 3.6134025399 \times 10^0$$

$$\frac{\lambda bar_p}{\sqrt{2} \cdot r_{strong}} = 1.8079464666 \times 10^0 \qquad \frac{\lambda bar_{nucleon}}{\sqrt{2} \cdot r_{strong}} = 1.80670127 \times 10^0$$

$$\frac{\lambda bar_p}{\sqrt{3} \cdot r_{strong}} = 1.4761821085 \times 10^0 \qquad \frac{\lambda bar_{nucleon}}{\sqrt{3} \cdot r_{strong}} = 1.4751654097 \times 10^0$$

$$\frac{\sqrt{2}\,\lambda bar_p}{\pi \cdot r_{strong}} = 1.150974468 \times 10^0 \qquad \frac{\sqrt{2}\,\lambda bar_{nucleon}}{\pi \cdot r_{strong}} = 1.1501817512 \times 10^0$$

$$\frac{\lambda bar_{nucleon}}{\pi \cdot r_{strong}} = 8.1330131588 \times 10^{-1}$$

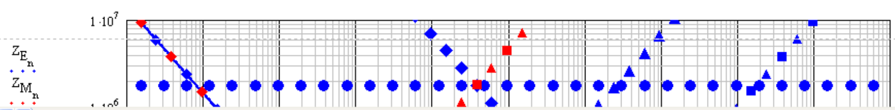
$$\frac{\pi \cdot r_{strong}}{\sqrt{\frac{3}{2}} \cdot \lambda bar_{nucleon}} = 1.0039287592 \times 10^0$$

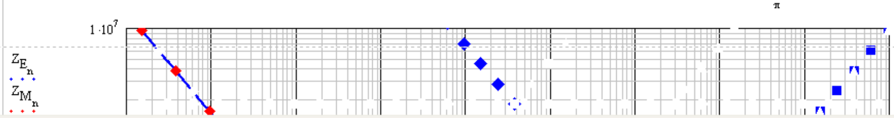
$$\frac{\sqrt{\frac{3}{2}}\,\lambda bar_{nucleon}}{\pi \cdot r_{strong}} = 9.9608661552 \times 10^{-1}$$

$$1 - \frac{\sqrt{\frac{3}{2}}\,\lambda bar_{nucleon}}{\pi \cdot r_{strong}} = 3.9133844786 \times 10^{-3}$$

$$\frac{\alpha}{\pi} = 2.322819456 \times 10^{-3}$$

$$\frac{1 - \frac{\sqrt{\frac{3}{2}}\,\lambda bar_{nucleon}}{\pi \cdot r_{strong}}}{\frac{\alpha}{\pi}} = 1.6847561994 \times 10^0$$





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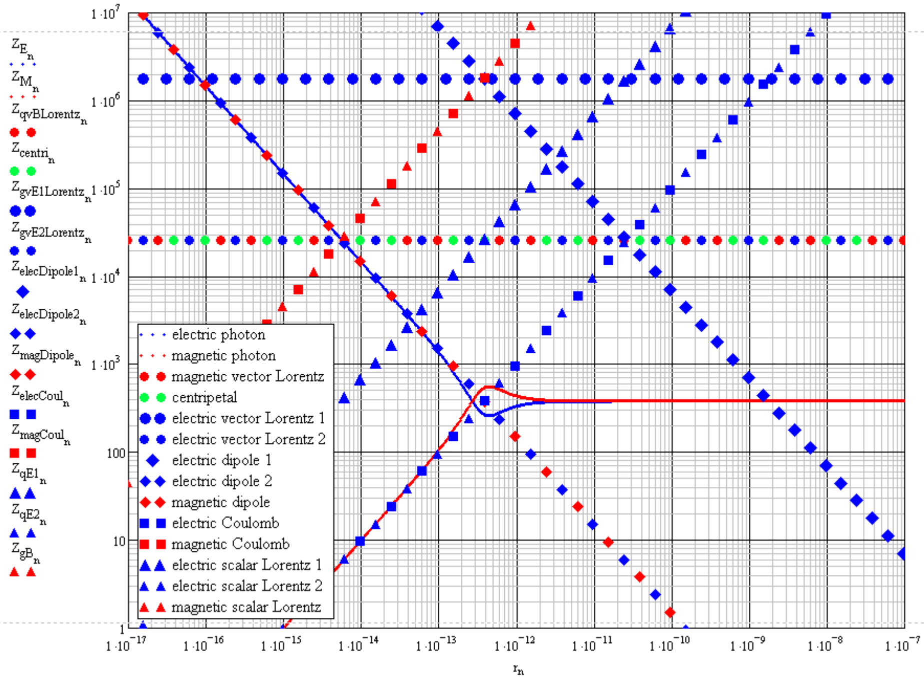
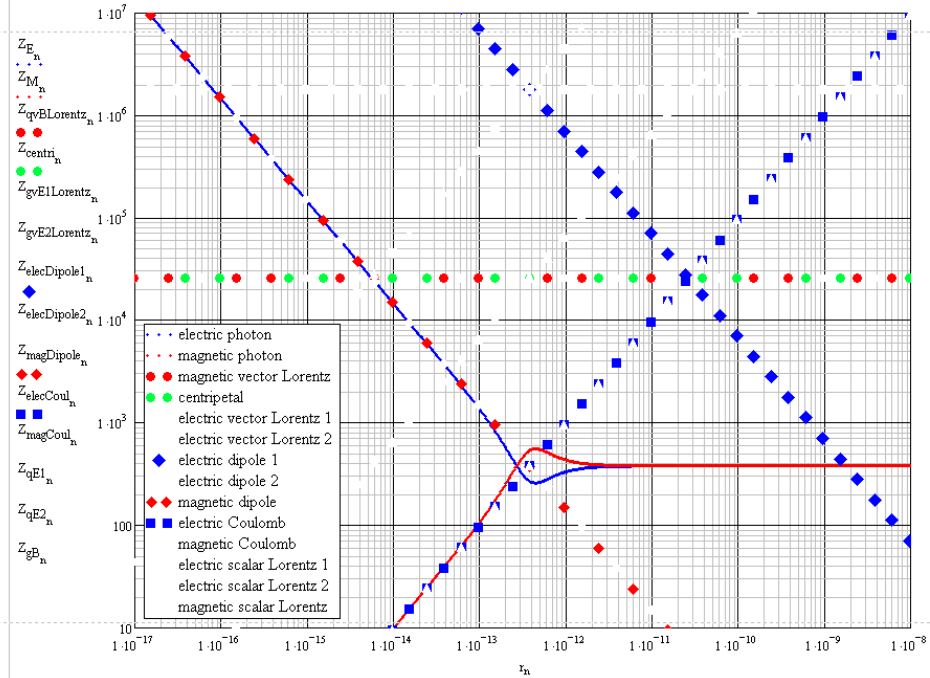
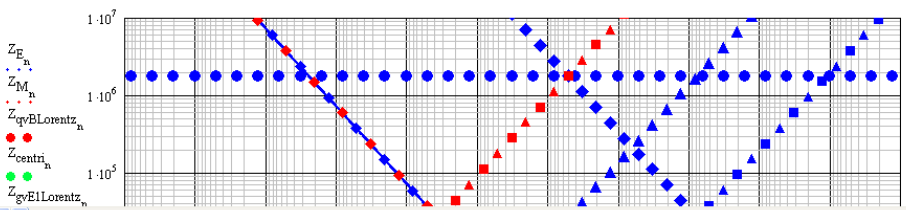
$\frac{\ }{\pi \cdot r_{strong}} = 8.1330131588 \times 10$ $\frac{\ \ r_{strong}}{\frac{\alpha}{\pi}} = 1.6847561994 \times 10^{0}$





$Z_{minus1_n} := 4 \cdot \alpha^{2} \cdot Z_{centri_n}$

$Z_{minus2_n} := 8 \cdot \alpha^{3} \cdot Z_{centri_n}$



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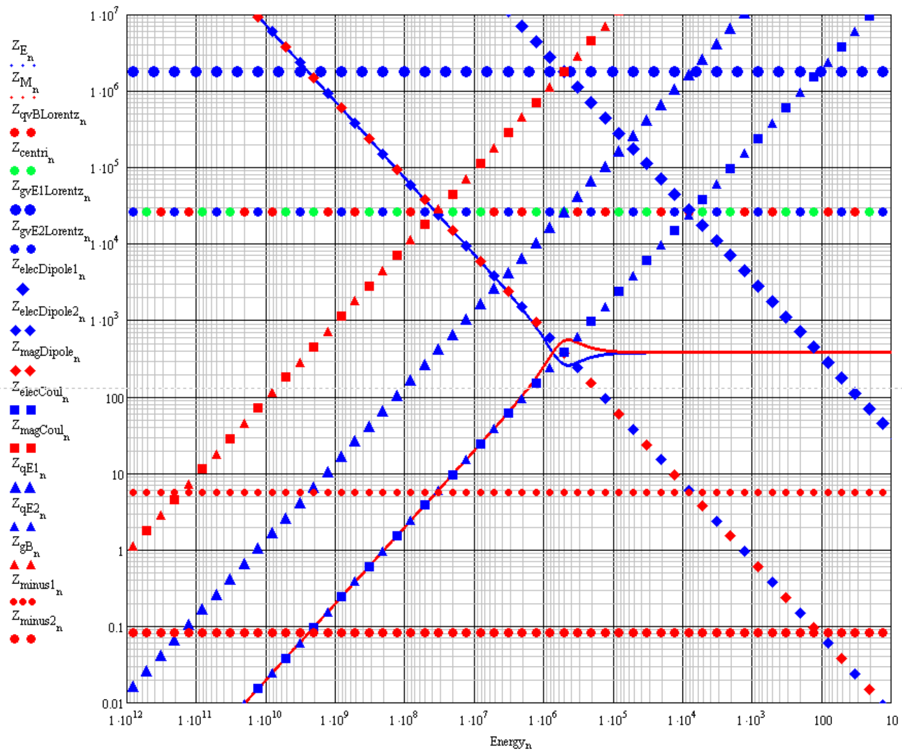

$$\frac{Z_0}{2\alpha} - 2\alpha\cdot Z_0 = 2.5807309286 \times 10^4\ \text{ohm}$$

$$\frac{Z_0}{2\alpha} = 2.5812807554 \times 10^4\ \text{ohm}$$

$$Z_0 = 3.7673031346 \times 10^2\ \text{ohm}$$

$$2\alpha\cdot Z_0 = 5.4982678186 \times 10^0\ \text{ohm}$$

$$\lambda bar_e := \frac{hbar}{m_e\cdot c}$$

$n := 1 .. 2000$ $\qquad r_n := 10^{-0.01n}\cdot m$

$$Z_0\cdot\left|1 + \frac{\lambda bar_e}{j\cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2} + \frac{\lambda bar_e^{\,3}}{(j\cdot r_n)^3}\right|$$

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$Energy_n$

$Z_0 = 3.7673031346 \times 10^{2}\ \text{ohm}$

$2\alpha\cdot Z_0 = 5.4982678186 \times 10^{0}\ \text{ohm}$

$\lambda bar_e := \frac{hbar}{m_e\cdot c}$ $\qquad n := 1..2000 \qquad r_n := 10^{-0.01n}\cdot m$

$$Z1_{E_n} := \left(Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|\right)$$

$$Z3_{E_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}+\frac{\lambda bar_e^{\,3}}{(j\cdot r_n)^3}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}$$

$$Z_{E_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}$$

$$Z_{M_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}$$

$$Z_{HallSeries_n} := \frac{Z_0}{2\cdot\alpha}$$

$$Z1_{M_n} := \frac{Z_0}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}$$

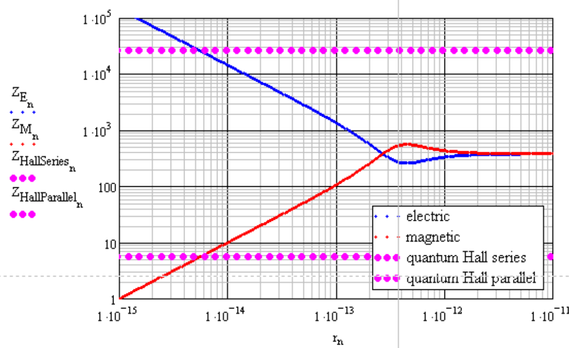
$$Z3_{M_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}+\frac{\lambda bar_e^{\,3}}{(j\cdot r_n)^3}\right|}$$

$$\frac{1}{2\cdot\alpha} = 6.8517999831 \times 10^{1}$$

$$Z_{HallParallel_n} := 2\alpha\cdot Z_0$$

$$Z1_{E_n} := \left(Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|\right)$$

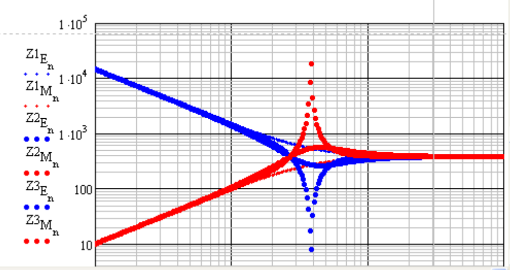
$$Z2_{E_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}$$



sin(■)

$$Z1_{M_n} := \frac{Z_0}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}$$

$$Z2_{M_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}$$



$$Z3_{E_n} := \frac{Z_0\cdot\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}+\frac{\lambda bar_e^{\,3}}{(j\cdot r_n)^3}\right|}{\left|1+\frac{\lambda bar_e}{j\cdot r_n}+\frac{\lambda bar_e^{\,2}}{(j\cdot r_n)^2}\right|}$$

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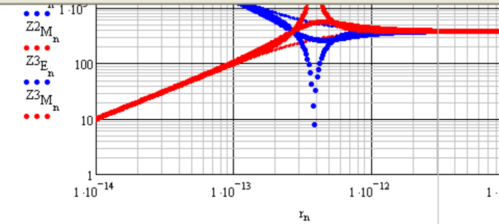
$$Z3_{E_n} := \frac{Z_0 \cdot \left|1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2} + \frac{\lambda bar_e^{\,3}}{(j \cdot r_n)^3}\right|}{\left|1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2}\right|}$$

$$Z3_{M_n} := \frac{Z_0 \cdot \left|1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2}\right|}{\left|1 + \frac{\lambda bar_e}{j \cdot r_n} + \frac{\lambda bar_e^{\,2}}{(j \cdot r_n)^2} + \frac{\lambda bar_e^{\,3}}{(j \cdot r_n)^3}\right|}$$



$$R_H := \frac{h}{e^2}$$

$R_H = 2.5812807554 \times 10^{4}\ \text{ohm}$

$\frac{1}{\alpha} = 1.3703599966 \times 10^{2}$

$Z_0 = 3.7673031346 \times 10^{2}\ \text{ohm}$

$$Z1_{E\alpha} := \left(Z_0 \cdot \left|1 + \frac{1}{j \cdot 2\alpha}\right|\right)$$

$$Z1_{M\alpha} := \frac{Z_0}{\left|1 + \frac{1}{j \cdot 2\alpha}\right|}$$

$Z1_{E\alpha} = 2.5815556542 \times 10^{4}\ \text{ohm}$

$Z1_{M\alpha} = 5.4976823317 \times 10^{0}\ \text{ohm}$

$R_H = 2.5812807554 \times 10^{4}\ \text{ohm}$

$Z1_{E\alpha} + Z1_{M\alpha} = 2.5821054224 \times 10^{4}\ \text{ohm}$

$$Z_{E2\alpha} := \frac{Z_0 \cdot \left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2}\right|}{\left|1 + \frac{1}{j \cdot 2\alpha}\right|}$$

$$Z_{M2\alpha} := \frac{Z_0 \cdot \left|1 + \frac{1}{j \cdot 2\alpha}\right|}{\left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2}\right|}$$

$Z_{E2\alpha} = 2.5807310457 \times 10^{4}\ \text{ohm}$

$Z_{M2\alpha} = 5.4994389794 \times 10^{0}\ \text{ohm}$

$Z_{E2\alpha} + Z_{M2\alpha} = 2.5812809896 \times 10^{4}\ \text{ohm}$

$R_H = 2.5812807554 \times 10^{4}\ \text{ohm}$

$$\frac{1}{\frac{1}{Z_{E2\alpha}} + \frac{1}{Z_{M2\alpha}}} = 5.4982673197 \times 10^{0}\ \text{ohm}$$

$Z_{series} := Z_{E2\alpha} + Z_{M2\alpha}$

$$Z_{parallel} := \frac{1}{\frac{1}{Z_{E2\alpha}} + \frac{1}{Z_{M2\alpha}}}$$

$$\frac{Z_{series}}{Z_{parallel}} = 4.6947171528 \times 10^{3}$$

$$\frac{1}{4 \cdot \alpha^2} = 4.6947163008 \times 10^{3}$$

$$\frac{4\alpha^2 \cdot R_H}{Z_{E\ldots} \cdot Z_{\ldots}} = 1.0002130281 \times 10^{0}$$

$$Z3_{E\alpha} := \frac{Z_0 \cdot \left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2} + \frac{1}{(j \cdot 2\alpha)^3}\right|}{\left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2}\right|}$$

$$Z3_{M\alpha} := \frac{Z_0 \cdot \left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2}\right|}{\left|1 + \frac{1}{j \cdot 2\alpha} + \frac{1}{(j \cdot 2\alpha)^2} + \frac{1}{(j \cdot 2\alpha)^3}\right|}$$

$Z3_{E\alpha} = 2.5812806383 \times 10^{4}\ \text{ohm}$

$Z3_{M\alpha} = 5.4982680681 \times 10^{0}\ \text{ohm}$

$Z2_{E\alpha} + Z2_{M\alpha} = \blacksquare\ \text{ohm}$

$R_H = 2.5812807554 \times 10^{4}\ \text{ohm}$