

$$n := 4 \cdot N$$

$$\textcolor{blue}{N} := 4$$

$$\Delta m := \left[ \begin{pmatrix} 0.966 \\ 1.532 \\ -0.024 \end{pmatrix} \begin{pmatrix} -2.548 \\ -1.488 \\ -0.544 \end{pmatrix} \begin{pmatrix} 0.014 \\ -1.309 \\ -2.049 \end{pmatrix} \begin{pmatrix} -1.813 \\ 0.052 \\ 1.034 \end{pmatrix} \begin{pmatrix} -1.622 \\ -0.842 \\ -0.664 \end{pmatrix} \begin{pmatrix} -1.531 \\ -0.137 \\ -0.048 \end{pmatrix} \begin{pmatrix} -0.948 \\ -0.716 \\ 1.41 \end{pmatrix} \begin{pmatrix} 0.202 \\ -1.023 \\ 0.583 \end{pmatrix} \begin{pmatrix} -0.458 \\ 0.173 \\ -0.305 \end{pmatrix} \begin{pmatrix} -0.411 \\ -0.839 \\ -2.087 \end{pmatrix} \begin{pmatrix} -0.384 \\ -1.284 \\ 0.348 \end{pmatrix} \begin{pmatrix} -0.37 \\ 1.575 \\ 0.348 \end{pmatrix} \begin{pmatrix} 0.032 \\ 0.926 \\ 1.866 \end{pmatrix} \begin{pmatrix} 2.421 \\ 0.903 \\ 0.608 \end{pmatrix} \begin{pmatrix} -1.108 \\ 0.057 \\ 0.047 \end{pmatrix} \begin{pmatrix} -0.156 \\ -0.246 \\ -1.384 \end{pmatrix} \begin{pmatrix} -0.156 \\ -0.246 \\ -0.202 \end{pmatrix} \right]^T$$

$$k := 0, 1 .. n - 1$$

$$\Delta m_k := rnorm(3, 0, 1)$$

$$M := \frac{1}{n} \cdot \sum_{k=0}^{n-1} \Delta m_k \quad M = \begin{pmatrix} -0.216 \\ -0.02 \\ 0.081 \end{pmatrix}$$

$$k := 0, 1 .. n - 1$$

$$\Delta m_k := \Delta m_k - M \quad \alpha_k := k \cdot \frac{2 \cdot \pi}{n} \quad no_k := \begin{pmatrix} 0 \\ -\sin(2 \cdot \alpha_k) \\ \cos(2 \cdot \alpha_k) \end{pmatrix}$$

$$\Delta m^T = \left[ \begin{pmatrix} -0.223 \\ -0.659 \\ -0.555 \end{pmatrix} \begin{pmatrix} -0.736 \\ -1.665 \\ -0.038 \end{pmatrix} \begin{pmatrix} 0.095 \\ 0.577 \\ 2.11 \end{pmatrix} \begin{pmatrix} 1.025 \\ 1.005 \\ 0.781 \end{pmatrix} \begin{pmatrix} 1.131 \\ 0.693 \\ -1.126 \end{pmatrix} \begin{pmatrix} 0.285 \\ -0.735 \\ 0.615 \end{pmatrix} \begin{pmatrix} 0.034 \\ -0.624 \\ -0.804 \end{pmatrix} \begin{pmatrix} -0.301 \\ 0.578 \\ -0.326 \end{pmatrix} \begin{pmatrix} 0.305 \\ 1.282 \\ -0.787 \end{pmatrix} \begin{pmatrix} 0.218 \\ 1.128 \\ 0.811 \end{pmatrix} \begin{pmatrix} -2.685 \\ -2.137 \\ 0.125 \end{pmatrix} \begin{pmatrix} -0.4 \\ -1.178 \\ 0.018 \end{pmatrix} \begin{pmatrix} 0.987 \\ 0.326 \\ 0.018 \end{pmatrix} \begin{pmatrix} -0.549 \\ -0.389 \\ -0.07 \end{pmatrix} \begin{pmatrix} 0.084 \\ 1.038 \\ 0.099 \end{pmatrix} \begin{pmatrix} 0.729 \\ 0.76 \\ -0.098 \end{pmatrix} \right]$$

$$\textcolor{blue}{C}(\Delta m) := \left[ \sum_{k=0}^{n-1} \frac{3 \cdot (\Delta m_k \cdot no_k) \cdot no_k - \Delta m_k}{1} \right]^1$$

$$C(\Delta m) = 4.934$$

$$Cd := C(\Delta m)$$

$$Bx(x) := \left[ \sum_{k=0}^{n-1} \frac{3 \cdot (\Delta m_k \cdot n o_k) \cdot n o_k - \Delta m_k}{\frac{3}{(1+x^2)^2}} \right] \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

$$By(x) := \left[ \sum_{k=0}^{n-1} \frac{3 \cdot (\Delta m_k \cdot n o_k) \cdot n o_k - \Delta m_k}{\frac{3}{(1+x^2)^2}} \right] \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

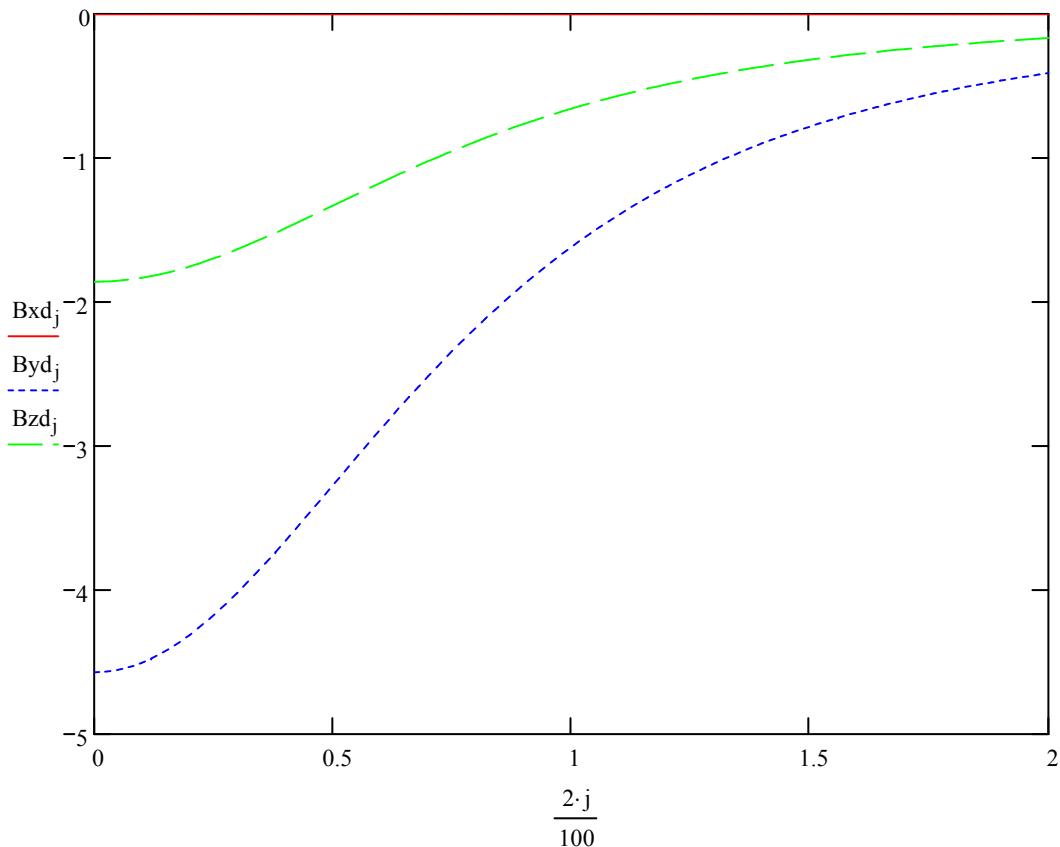
$$Bz(x) := \left[ \sum_{k=0}^{n-1} \frac{3 \cdot (\Delta m_k \cdot n o_k) \cdot n o_k - \Delta m_k}{\frac{3}{(1+x^2)^2}} \right] \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

$j := 0, 1..100$

$$Bxd_j := Bx\left(\frac{2 \cdot j}{100}\right)$$

$$Byd_j := By\left(\frac{2 \cdot j}{100}\right)$$

$$Bzd_j := Bz\left(\frac{2 \cdot j}{100}\right)$$



a := runif(n, 0, 16)

$$a^T = (11.852 \ 9.926 \ 12.872 \ 9.217 \ 14.585 \ 11.643 \ 10.685 \ 5.04 \ 4.893 \ 1.737 \ 13.62 \ 2.478 \ 1.27 \ 10.256 \ 8.721 \ 6.544)$$

$$\text{sort}(a)^T = (1.27 \ 1.737 \ 2.478 \ 4.893 \ 5.04 \ 6.544 \ 8.721 \ 9.217 \ 9.926 \ 10.256 \ 10.685 \ 11.643 \ 11.852 \ 12.872 \ 13.62 \ 14.585)$$

k := 0 .. n - 1

$$P_0_k := k$$

$$p_k := \text{vergleich}(\text{sort}(a)_k, a)_0$$

$$p^T = (12 \ 9 \ 11 \ 8 \ 7 \ 15 \ 14 \ 3 \ 1 \ 13 \ 6 \ 5 \ 0 \ 2 \ 10 \ 4)$$

$$\text{zeilen}(p) = 16$$

k := 0 .. n - 1

$$\Delta 2m_k := \Delta m_{p_k}$$

$$\Delta 2m^T = \left[ \begin{pmatrix} 0.987 \\ 0.326 \\ -0.07 \end{pmatrix} \begin{pmatrix} 0.218 \\ 1.128 \\ 0.811 \end{pmatrix} \begin{pmatrix} -0.4 \\ -1.178 \\ 0.018 \end{pmatrix} \begin{pmatrix} 0.305 \\ 1.282 \\ -0.787 \end{pmatrix} \begin{pmatrix} -0.301 \\ 0.578 \\ -0.326 \end{pmatrix} \begin{pmatrix} 0.729 \\ 0.76 \\ -0.098 \end{pmatrix} \begin{pmatrix} 0.084 \\ 1.038 \\ 0.099 \end{pmatrix} \begin{pmatrix} 1.025 \\ 1.005 \\ 0.781 \end{pmatrix} \begin{pmatrix} -0.736 \\ -1.665 \\ 0.781 \end{pmatrix} \begin{pmatrix} -0.549 \\ -0.389 \\ -0.038 \end{pmatrix} \begin{pmatrix} 0.034 \\ -0.624 \\ -0.755 \end{pmatrix} \begin{pmatrix} 0.285 \\ -0.735 \\ -0.804 \end{pmatrix} \begin{pmatrix} -0.223 \\ -0.659 \\ -0.555 \end{pmatrix} \begin{pmatrix} 0.095 \\ 0.577 \\ 0.577 \end{pmatrix} \begin{pmatrix} -2.685 \\ -2.137 \\ 2.11 \end{pmatrix} \begin{pmatrix} 1.131 \\ 0.693 \\ 0.125 \end{pmatrix} \begin{pmatrix} 0.729 \\ 0.693 \\ -1.126 \end{pmatrix} \right]$$

$$C(\Delta m) = 4.934$$

$$C(\Delta 2m) = 6.11$$

$$\Delta m^T = \left[ \begin{pmatrix} -0.223 \\ -0.659 \\ -0.555 \end{pmatrix} \begin{pmatrix} -0.736 \\ -1.665 \\ -0.038 \end{pmatrix} \begin{pmatrix} 0.095 \\ 0.577 \\ 2.11 \end{pmatrix} \begin{pmatrix} 1.025 \\ 1.005 \\ 0.781 \end{pmatrix} \begin{pmatrix} 1.131 \\ 0.693 \\ -1.126 \end{pmatrix} \begin{pmatrix} 0.285 \\ -0.735 \\ 0.615 \end{pmatrix} \begin{pmatrix} 0.034 \\ -0.624 \\ -0.804 \end{pmatrix} \begin{pmatrix} 0.304 \\ 0.578 \\ -0.326 \end{pmatrix} \begin{pmatrix} -0.301 \\ 0.578 \\ -0.787 \end{pmatrix} \begin{pmatrix} 0.305 \\ 1.282 \\ 0.811 \end{pmatrix} \begin{pmatrix} 0.218 \\ 1.128 \\ 0.125 \end{pmatrix} \begin{pmatrix} -2.685 \\ -2.137 \\ 0.018 \end{pmatrix} \begin{pmatrix} -0.4 \\ -1.178 \\ 0.018 \end{pmatrix} \begin{pmatrix} 0.987 \\ 0.326 \\ -0.07 \end{pmatrix} \begin{pmatrix} -0.549 \\ -0.389 \\ -0.755 \end{pmatrix} \begin{pmatrix} 0.084 \\ 1.038 \\ 0.099 \end{pmatrix} \begin{pmatrix} 0.729 \\ 0.693 \\ -0.098 \end{pmatrix} \right]$$

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 $\Delta m := \begin{cases} P \leftarrow P_0 \\ \text{for } m \in 0..1000 \\ \quad a \leftarrow \text{runif}(n, 0, 16) \\ \quad \text{for } k \in 0..n-1 \\ \quad \quad p_k \leftarrow \text{vergleich}(\text{sort}(a)_k, a)_0 \\ \quad \quad \text{for } k \in 0..n-1 \\ \quad \quad \quad \Delta 2m_k \leftarrow \Delta m_{p_k} \\ \quad \quad P \leftarrow P_0 \text{ if } C(\Delta 2m) < C(\Delta m) \\ \quad \quad \Delta m \leftarrow \Delta 2m \text{ if } C(\Delta 2m) < C(\Delta m) \\ \end{cases} \Delta m \end{cases}$ 

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$$C(\Delta m) = 0.334$$

$$C(\Delta 2m) = 6.11$$

$$\Gamma(n-1) = 8.718 \times 10^{10}$$

$$\Delta m^T = \begin{bmatrix} (0.034) & (-2.685) & (0.084) & (0.095) & (0.729) & (0.285) & (1.025) & (-0.549) & (-0.4) & (0.987) & (1.131) & (-0.301) & (0.305) & (0.218) & (-0.736) & (-0.223) \\ (-0.624) & (-2.137) & (1.038) & (0.577) & (0.76) & (-0.735) & (1.005) & (-0.389) & (-1.178) & (0.326) & (0.693) & (0.578) & (1.282) & (1.128) & (-1.665) & (-0.659) \\ (-0.804) & (0.125) & (0.099) & (2.11) & (-0.098) & (0.615) & (0.781) & (-0.755) & (0.018) & (-0.07) & (-1.126) & (-0.326) & (-0.787) & (0.811) & (-0.038) & (-0.555) \end{bmatrix}$$

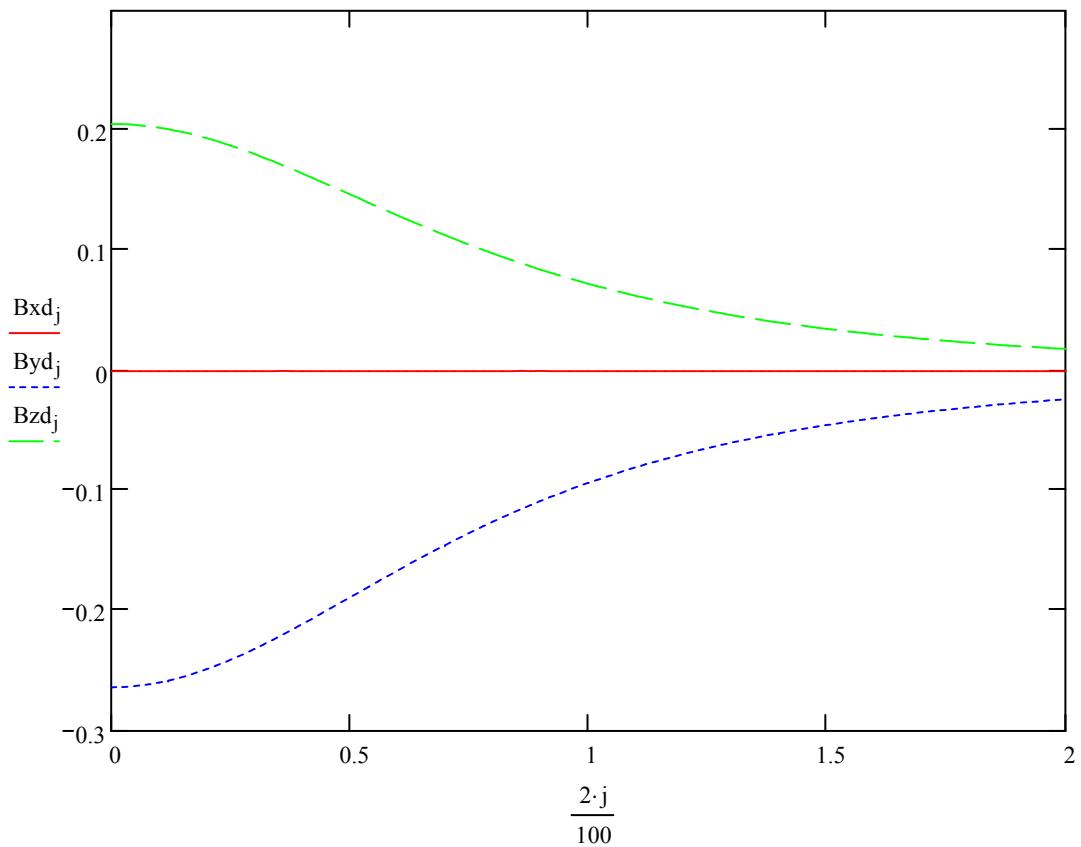
$$Bx(x) := \begin{bmatrix} n-1 & \frac{3 \cdot (\Delta m_k \cdot no_k) \cdot no_k - \Delta m_k}{(1+x^2)^{\frac{3}{2}}} \end{bmatrix} \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad By(x) := \begin{bmatrix} n-1 & \frac{3 \cdot (\Delta m_k \cdot no_k) \cdot no_k - \Delta m_k}{(1+x^2)^{\frac{3}{2}}} \end{bmatrix} \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \quad Bz(x) := \begin{bmatrix} n-1 & \frac{3 \cdot (\Delta m_k \cdot no_k) \cdot no_k - \Delta m_k}{(1+x^2)^{\frac{3}{2}}} \end{bmatrix} \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

$$j := 0, 1..100$$

$$Bxd_j := Bx\left(\frac{2 \cdot j}{100}\right)$$

$$Byd_j := By\left(\frac{2 \cdot j}{100}\right)$$

$$Bzd_j := Bz\left(\frac{2 \cdot j}{100}\right)$$



$$C(\Delta m) = 0.334$$

$$\frac{C(\Delta m)}{Cd} = 0.068$$