Manual Linear Regression for CBI-CME Velocity Analysis

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Original Data, No Zeros

The slope m and intercept b of the best-fit line are given by:

$$m = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} = \frac{-0.04}{1.09 \times 10^{-10}} = -361{,}169{,}714.05$$

$$b = \bar{y} - m\bar{x} = 727.764 - (-361{,}169{,}714.05)(6.08 \times 10^{-7}) = 947.50$$

The correlation coefficient r is:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \cdot \sum(y_i - \bar{y})^2}} = \frac{-0.04}{\sqrt{(1.09 \times 10^{-10})(1.54 \times 10^{8})}} = -0.30$$

The corresponding p-value is:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = \frac{-0.30\sqrt{590}}{\sqrt{1-(-0.30)^2}} \approx -7.64$$

$$p = 2 \cdot P(T > |t|) \approx 2 \cdot P(T > 7.64) \approx 2 \cdot 5.6 \times 10^{-14} = 1.12 \times 10^{-13}$$

Results

- Slope: $m = -361{,}169{,}714.05$
- Intercept: $b = 947.50$
- Correlation coefficient: $r = -0.30$
- p-value: $p \approx 1.1 \times 10^{-13}$

180° Position Angle Shift From Original Data, No Zeros

The slope m and intercept b are calculated as:

$$m = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sum(x_i - \bar{x})^2} = \frac{-0.005}{5.40 \times 10^{-11}} = -105{,}969{,}191.42$$

$$b = \bar{y} - m\bar{x} = 727.76 - (-105{,}969{,}191.42)(4.55 \times 10^{-7}) = 775.98$$

The correlation coefficient is:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \cdot \sum(y_i - \bar{y})^2}} = \frac{-0.005}{\sqrt{(5.40 \times 10^{-11})(1.54 \times 10^{8})}} = -0.06$$

The corresponding p-value is:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} = \frac{-0.06\sqrt{590}}{\sqrt{1-(-0.06)^2}} \approx -1.46$$

$$p = 2 \cdot P(T > |t|) \approx 2 \cdot P(T > 1.46) \approx 2 \cdot 0.072 = 0.144$$

Results

- Slope: $m = -105{,}969{,}191.42$
- Intercept: $b = 775.98$
- Correlation coefficient: $r = -0.06$
- p-value: $p \approx 0.144$