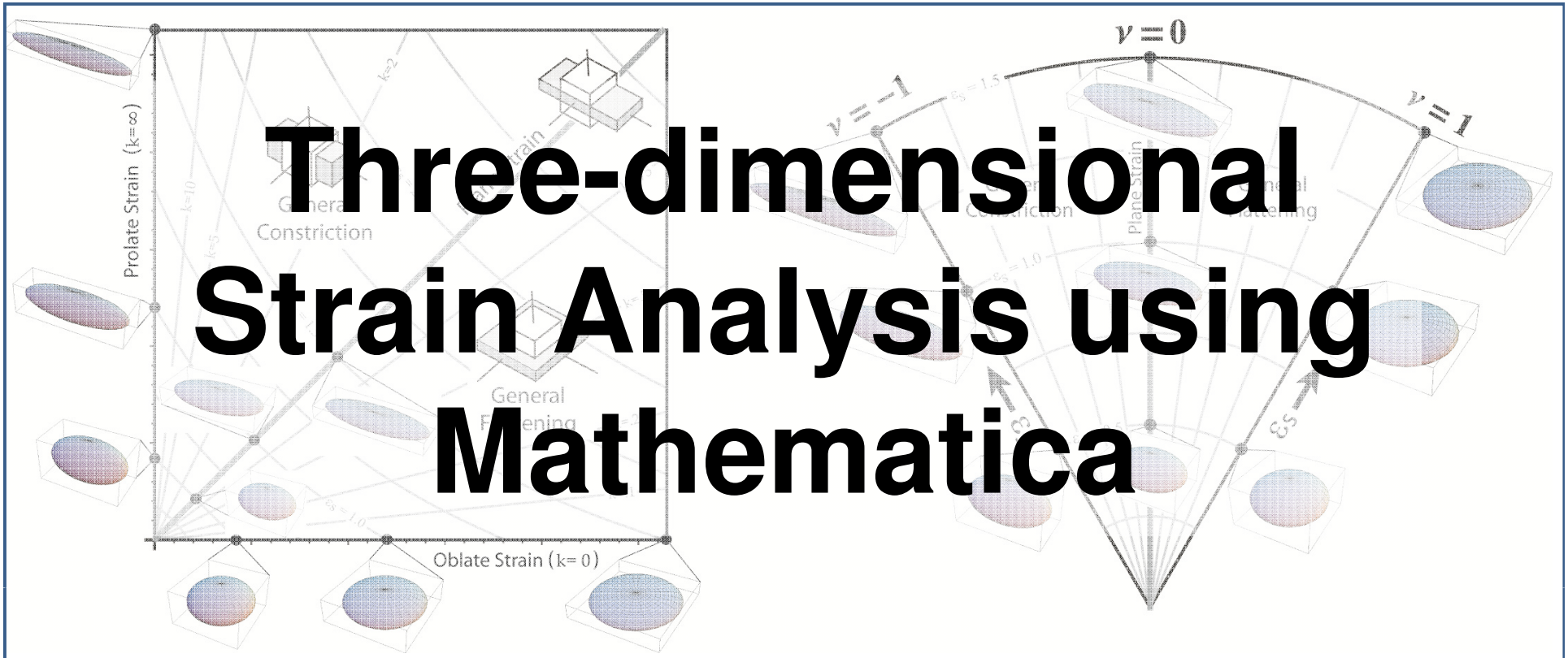

Three-dimensional Strain Analysis using Mathematica

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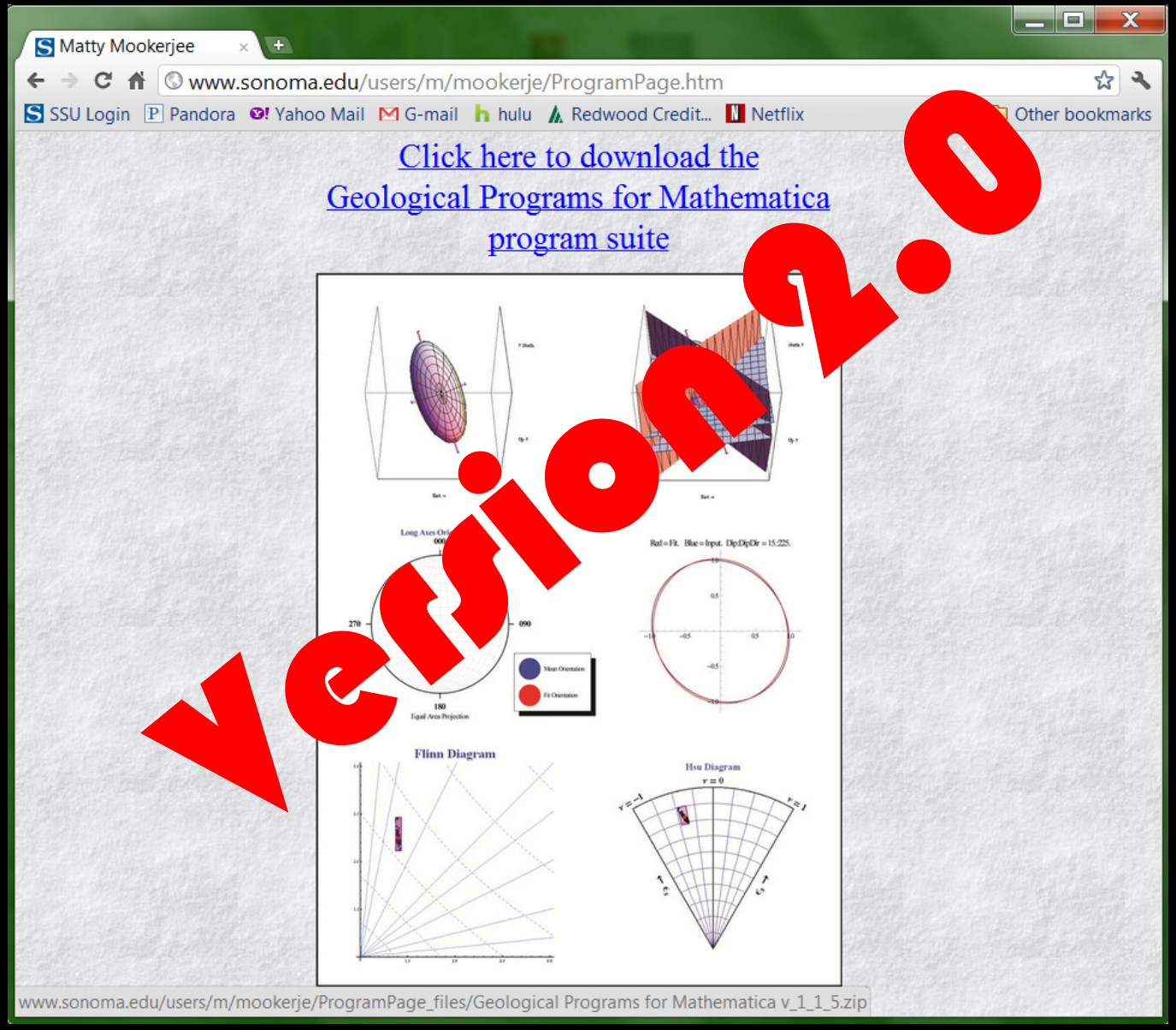
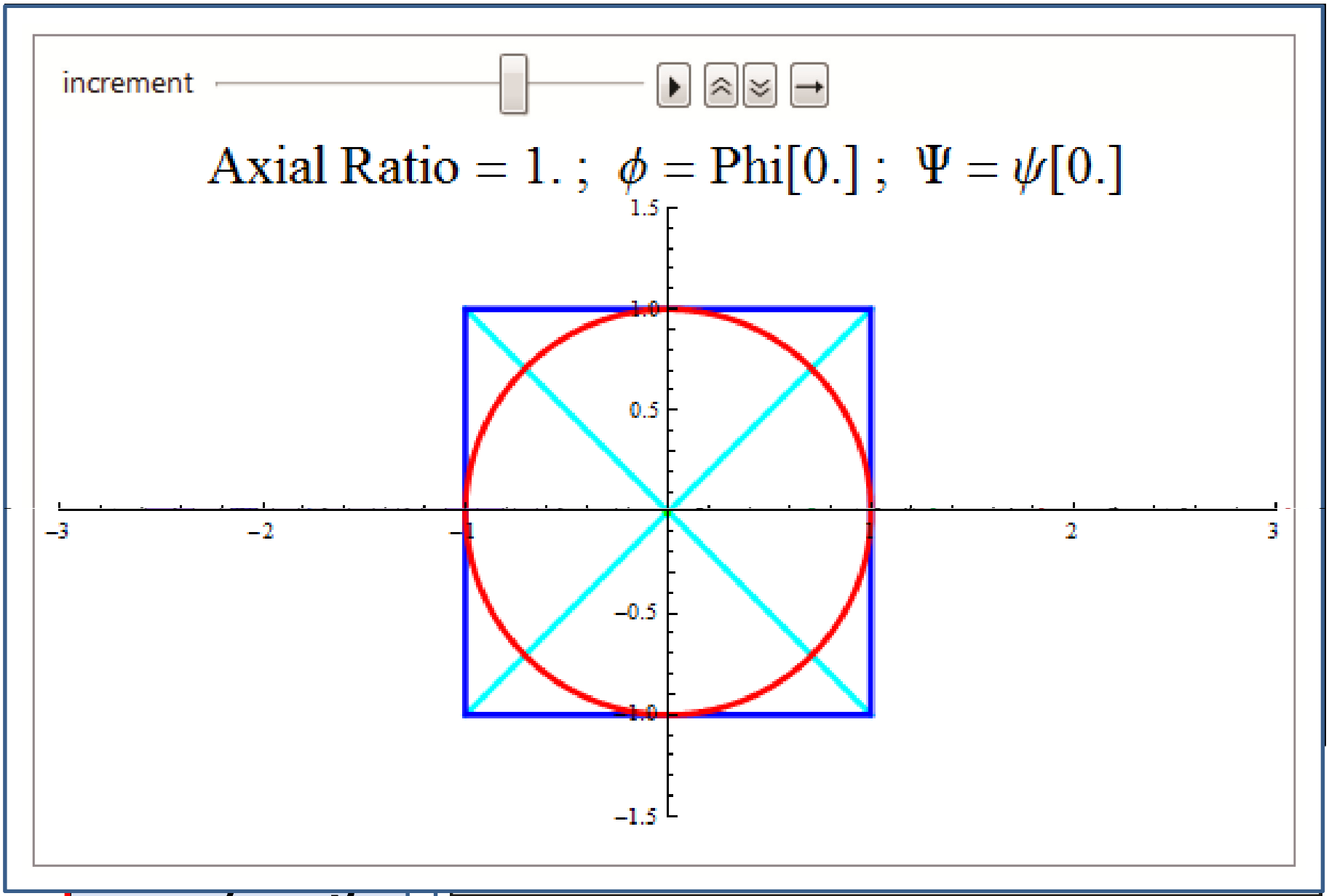
www.sonoma.edu/users/m/mookerje/ProgramPage.htm



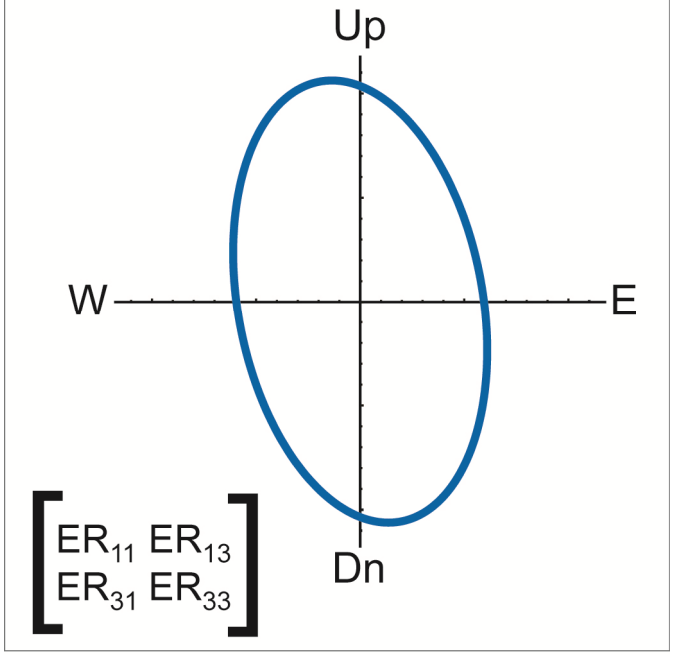


Section Data th

2D Pure vs Sim

Plot Range for Lode's Ratio is -1 to 1
Lode's Ratio contour interal is 0.25

$$GE = \begin{bmatrix} \lambda_{xx} & \gamma_{xy} & \gamma_{xz} \\ \gamma_{xy} & \lambda_{yy} & \gamma_{yz} \\ \gamma_{xz} & \gamma_{yz} & \lambda_{zz} \end{bmatrix}$$



$$ER = \begin{bmatrix} 1 & 0 & 0 \\ 0 & Cos[DipDir - 90^\circ] & -Sin[DipDir - 90^\circ] \\ 0 & Sin[DipDir - 90^\circ] & Cos[DipDir - 90^\circ] \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & Cos[90 - Dip] & -Sin[90 - Dip] \\ 0 & Sin[90 - Dip] & Cos[90 - Dip] \end{bmatrix}$$

$$EM = \begin{bmatrix} ER_{11} & ER_{13} \\ ER_{31} & ER_{33} \end{bmatrix} \Big/ \left(\left(Det \begin{bmatrix} ER_{11} & ER_{13} \\ ER_{31} & ER_{33} \end{bmatrix} \right)^{\frac{1}{2}} \right)^{4}$$

(Mookerjee & Nickleach, 2011 – JSG)

Assembling the Error Function

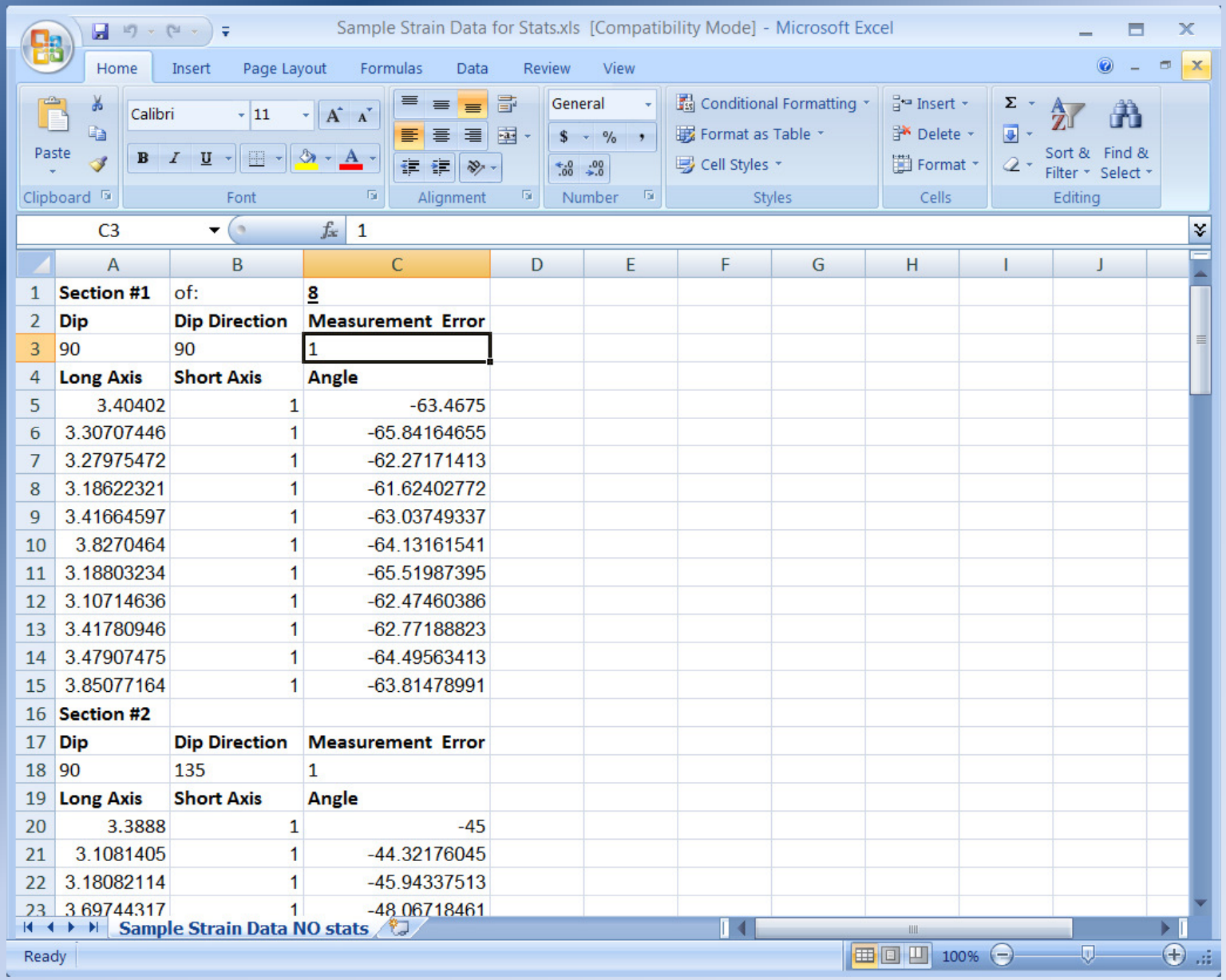
$$DM = \begin{bmatrix} Cos[\phi] & -Sin[\phi] \\ Sin[\phi] & Cos[\phi] \end{bmatrix} \cdot \begin{bmatrix} \sqrt{\frac{1}{Rf^2}} & 0 \\ 0 & \frac{1}{\sqrt{\frac{1}{Rf^2}}} \end{bmatrix} \cdot \begin{bmatrix} Cos[\phi] & Sin[\phi] \\ -Sin[\phi] & Cos[\phi] \end{bmatrix}$$

$$\sum_{i=1}^{n} (DM_{11,i} - EM_{11,i})^2 + (DM_{12,i} - EM_{12,i})^2 + (DM_{22,i} - EM_{22,i})^2$$

n = number of sectional data planes

Minimize this function in terms of the elements of the general ellipsoid matrix, λ_{xx}, λ_{yy}, λ_{zz}, γ_{xy}, γ_{xz}, γ_{yz}

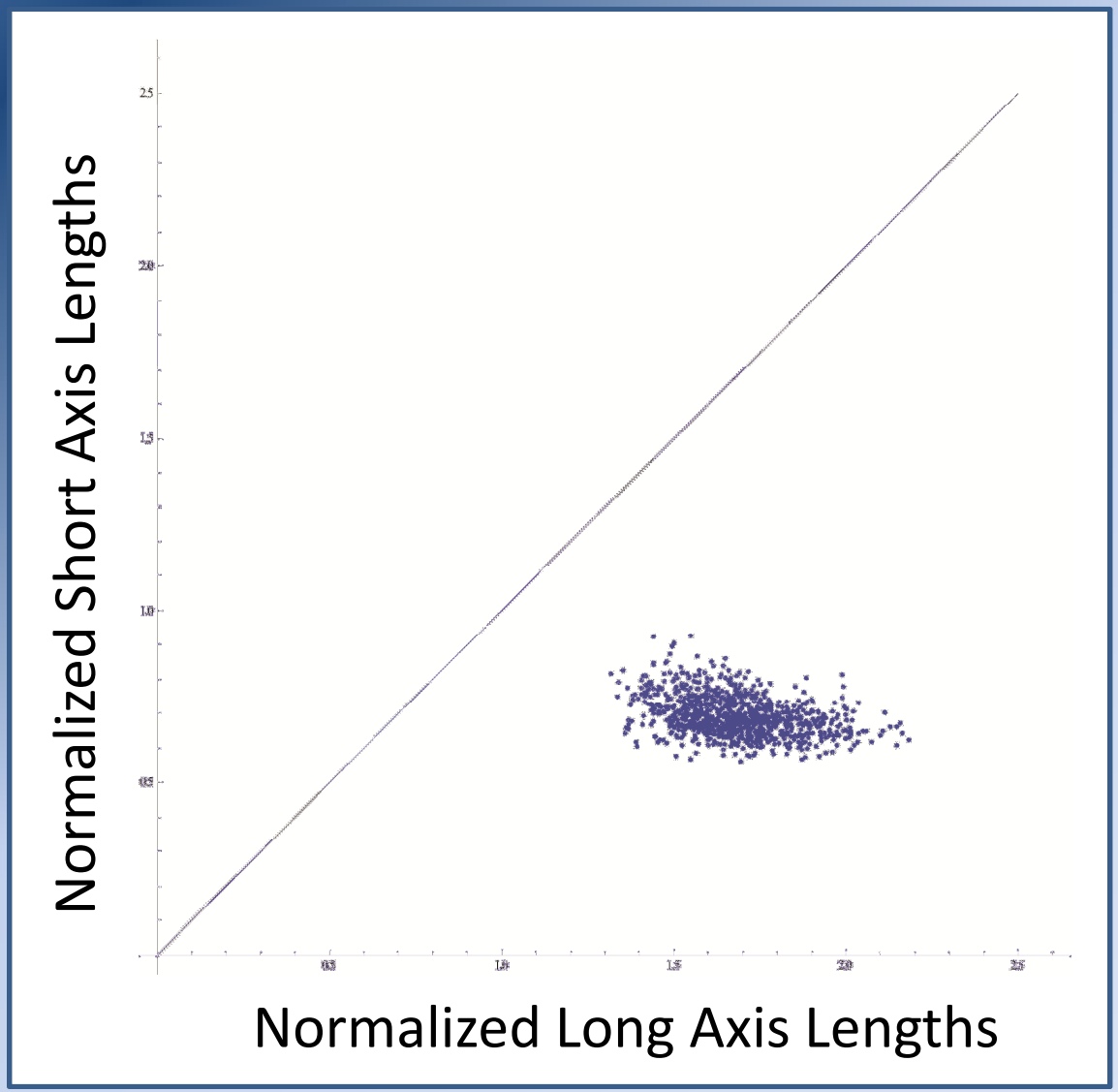
Input Data Screen Shot



	A	B	C	D	E	F	G	H	I	J
1	**Section #1**	of:	**8**							
2	**Dip**	**Dip Direction**	**Measurement Error**							
3	90	90	1							
4	**Long Axis**	**Short Axis**	**Angle**							
5	3.40402	1	-63.4675							
6	3.30707446	1	-65.84164655							
7	3.27975472	1	-62.27171413							
8	3.18622321	1	-61.62402772							
9	3.41664597	1	-63.03749337							
10	3.8270464	1	-64.13161541							
11	3.18803234	1	-65.51987395							
12	3.10714636	1	-62.47460386							
13	3.41780946	1	-62.77188823							
14	3.47907475	1	-64.49563413							
15	3.85077164	1	-63.81478991							
16	**Section #2**									
17	**Dip**	**Dip Direction**	**Measurement Error**							
18	90	135	1							
19	**Long Axis**	**Short Axis**	**Angle**							
20	3.3888	1	-45							
21	3.1081405	1	-44.32176045							
22	3.18082114	1	-45.94337513							
23	3.69744317	1	-48.06718461							

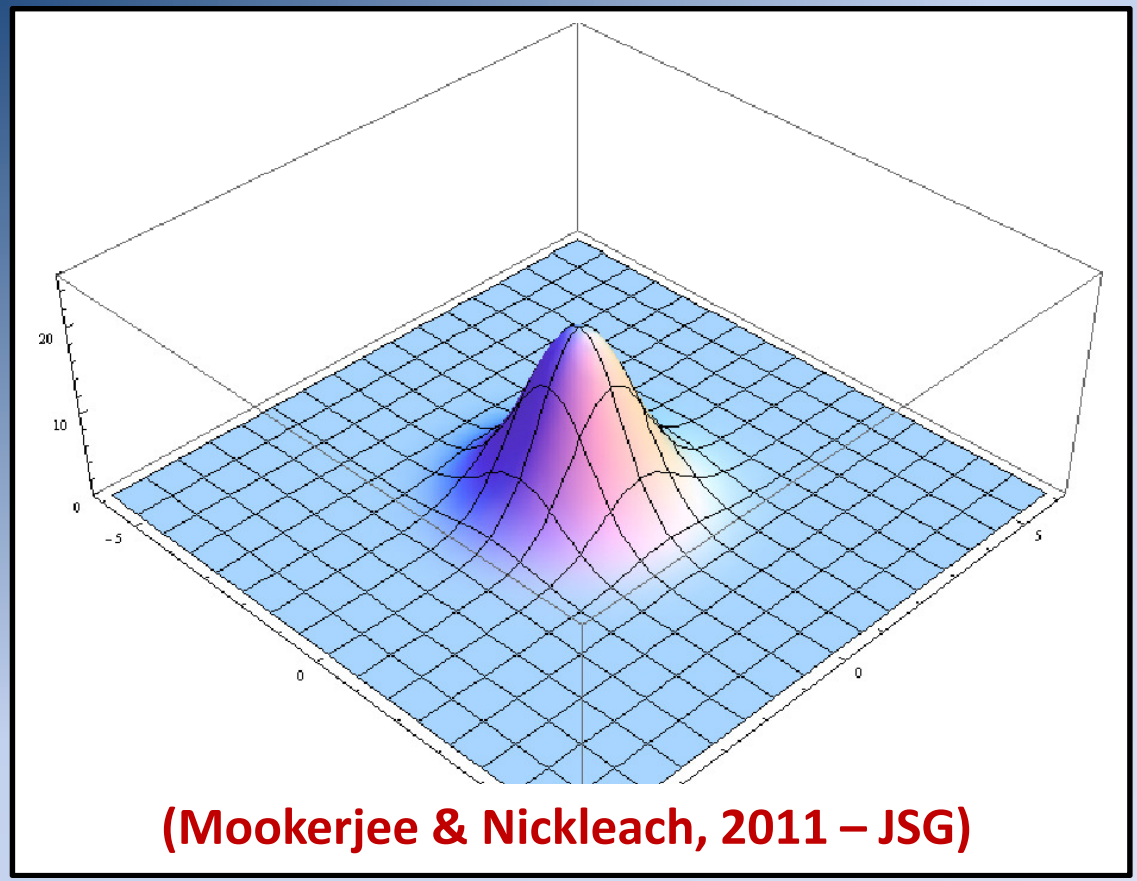
Statistical Analysis

Kernel Density Estimation



Kernel Density Estimation

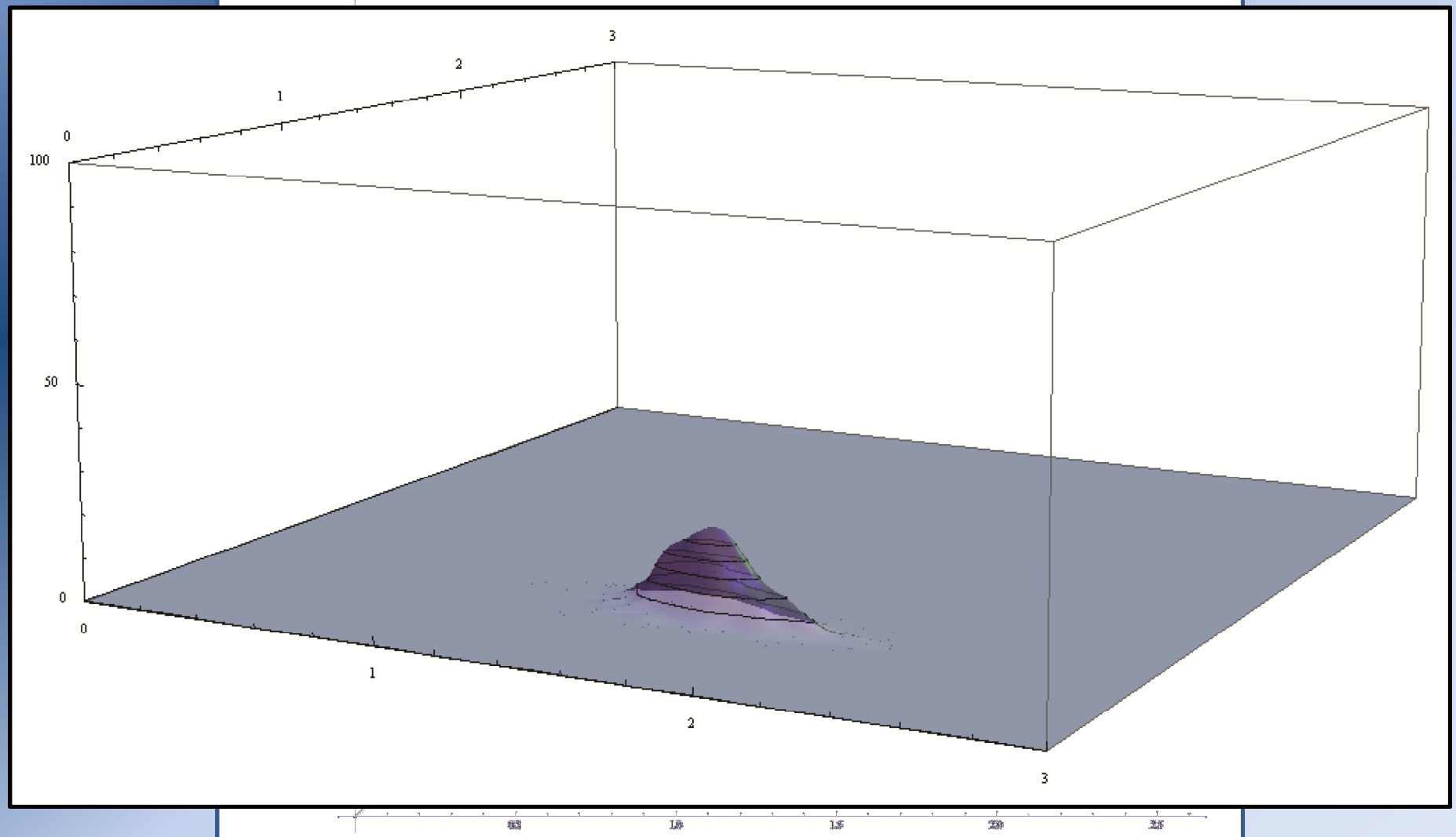
$$KDE[\lambda_1, \lambda_3] = \frac{1}{2\pi \times N \times h_1 \times h_3} * \sum_{i=1}^{N} \exp\left[-\frac{1}{2}\left(\left(\frac{\lambda_1 - L_{1,i}}{h_1} \right)^2 + \left(\frac{\lambda_3 - L_{3,i}}{h_3} \right)^2 \right) \right]$$



(Mookerjee & Nickleach, 2011 – JSG)

$$h_i = 4 \times 1.06 \times \min\{\sqrt{Var(L_i)}, IQR_i / 1.34) \times N^{-1/5}$$

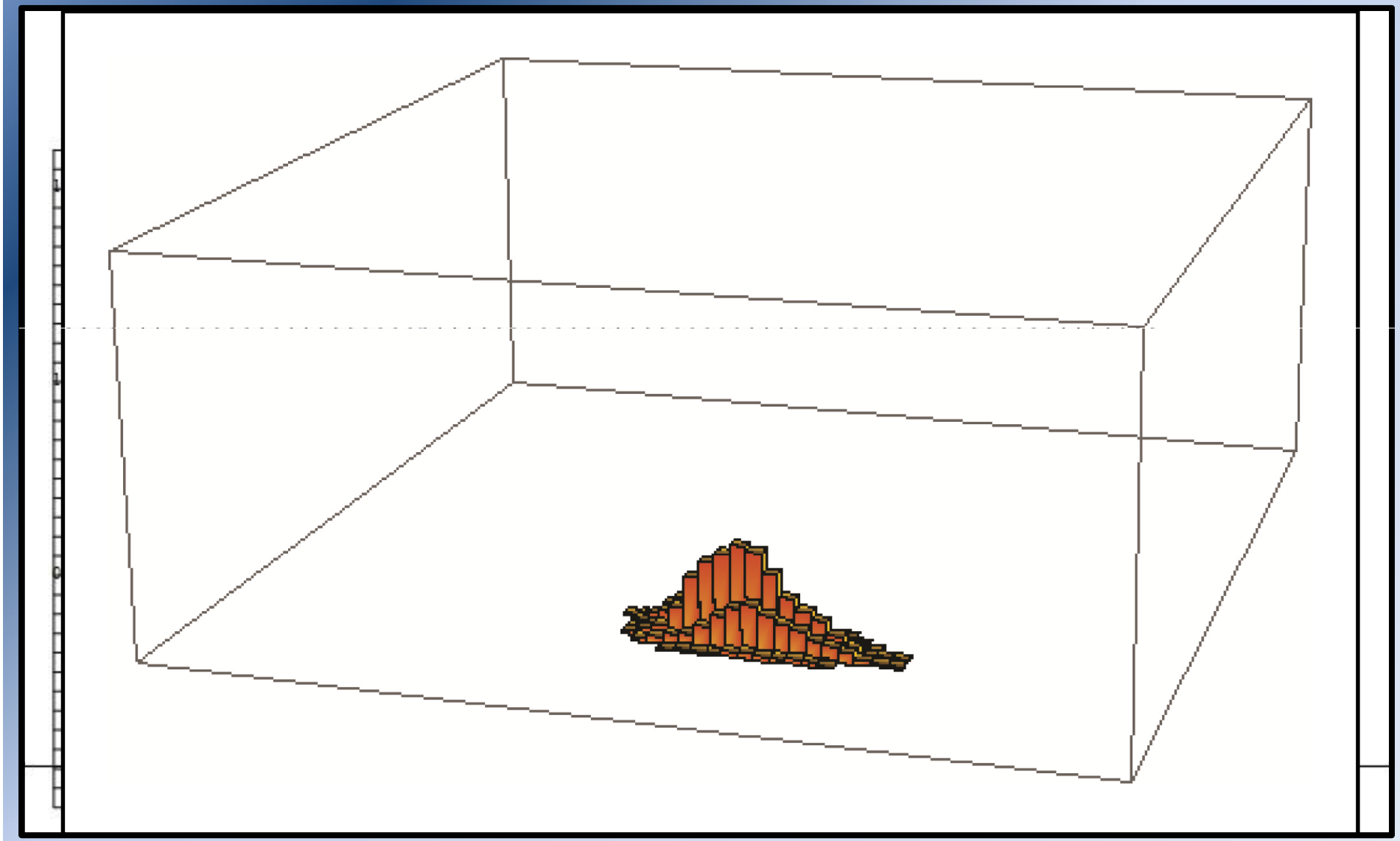
Kernel Density Estimation



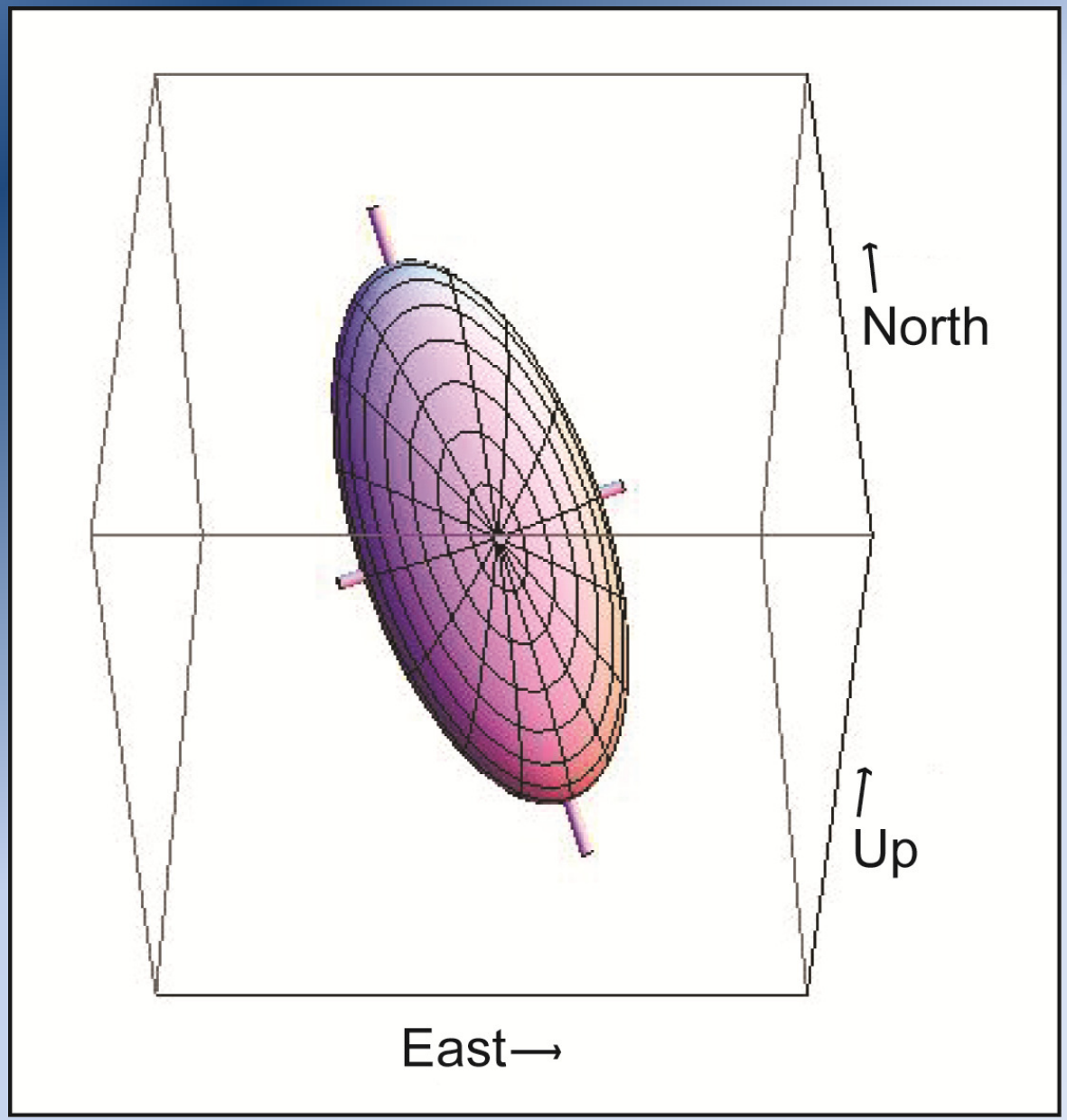
Normalized Long Axis Lengths

Kernel Density Estimation

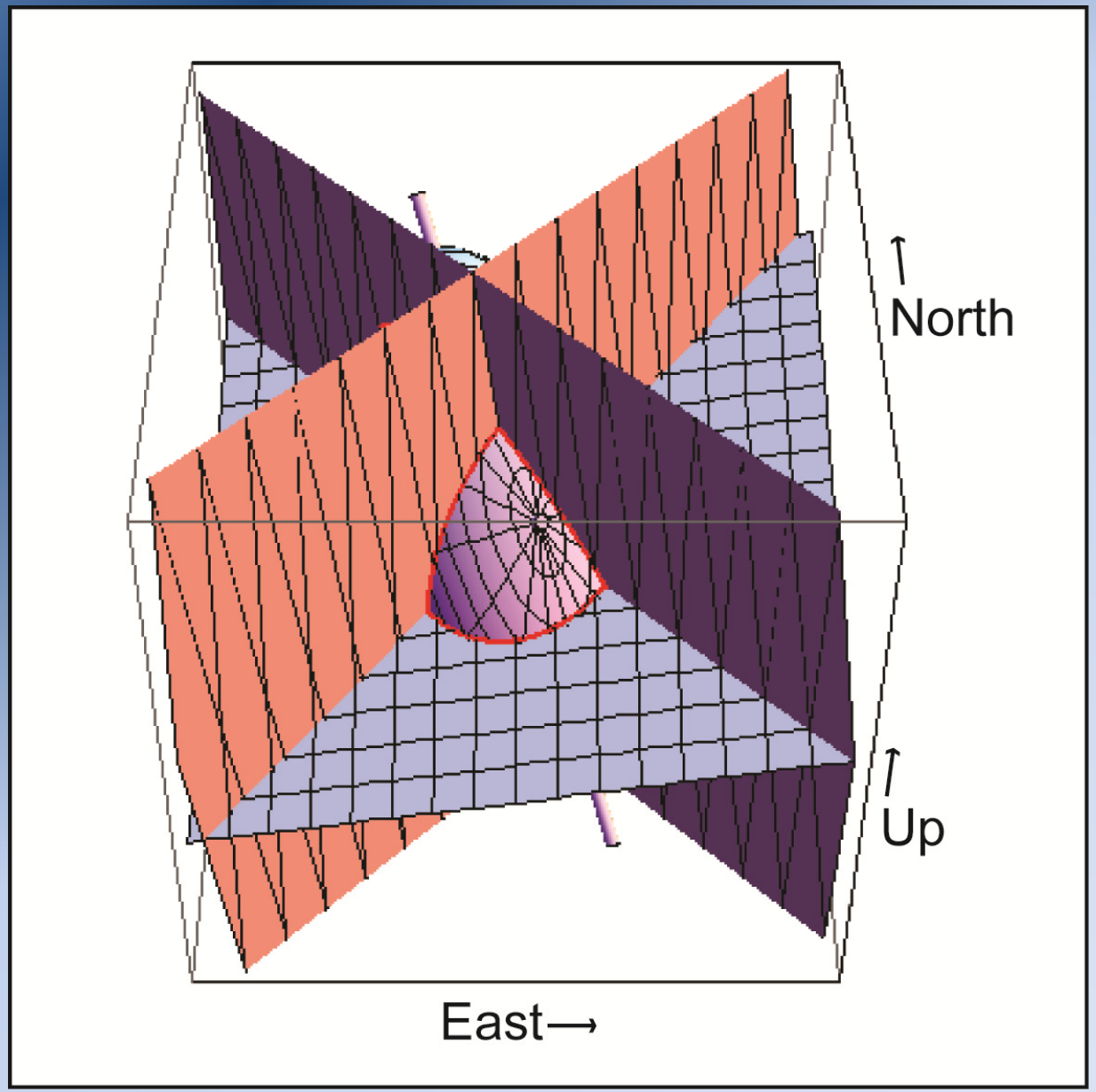
95% Volume



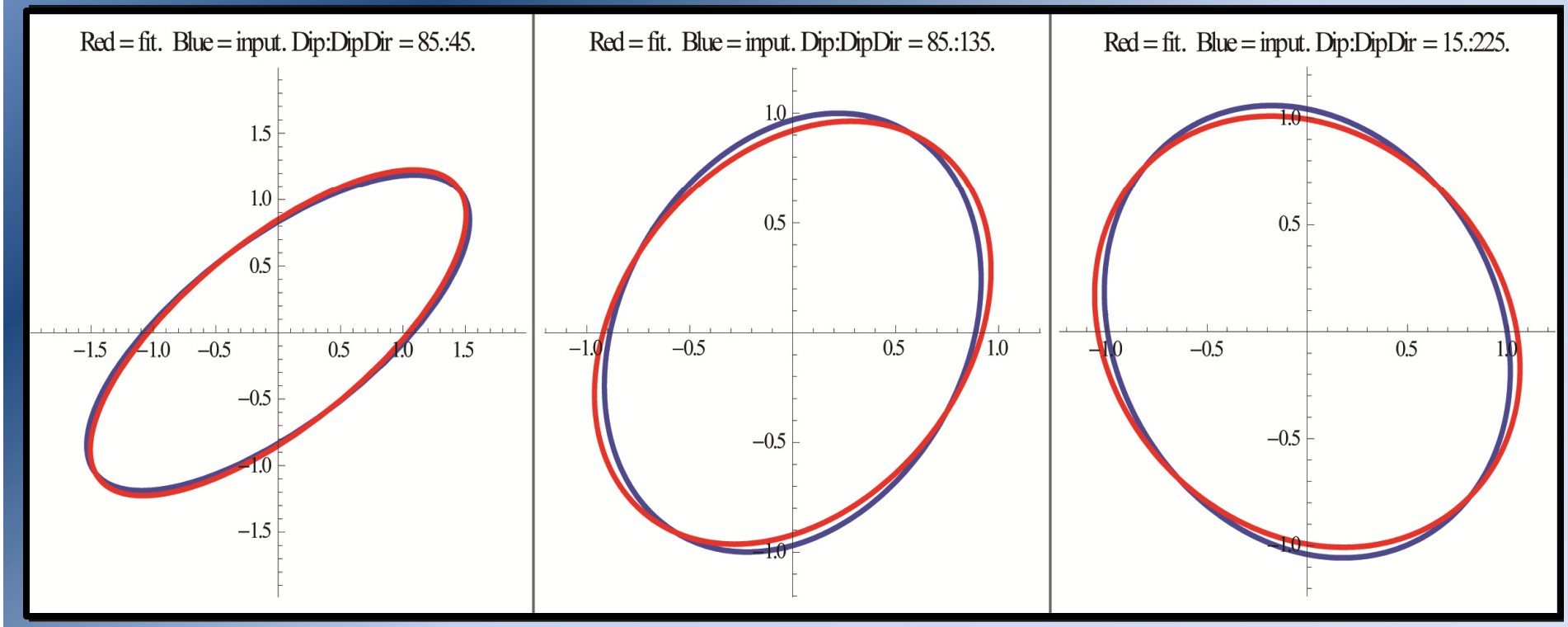
Graphical Output



Graphical Output

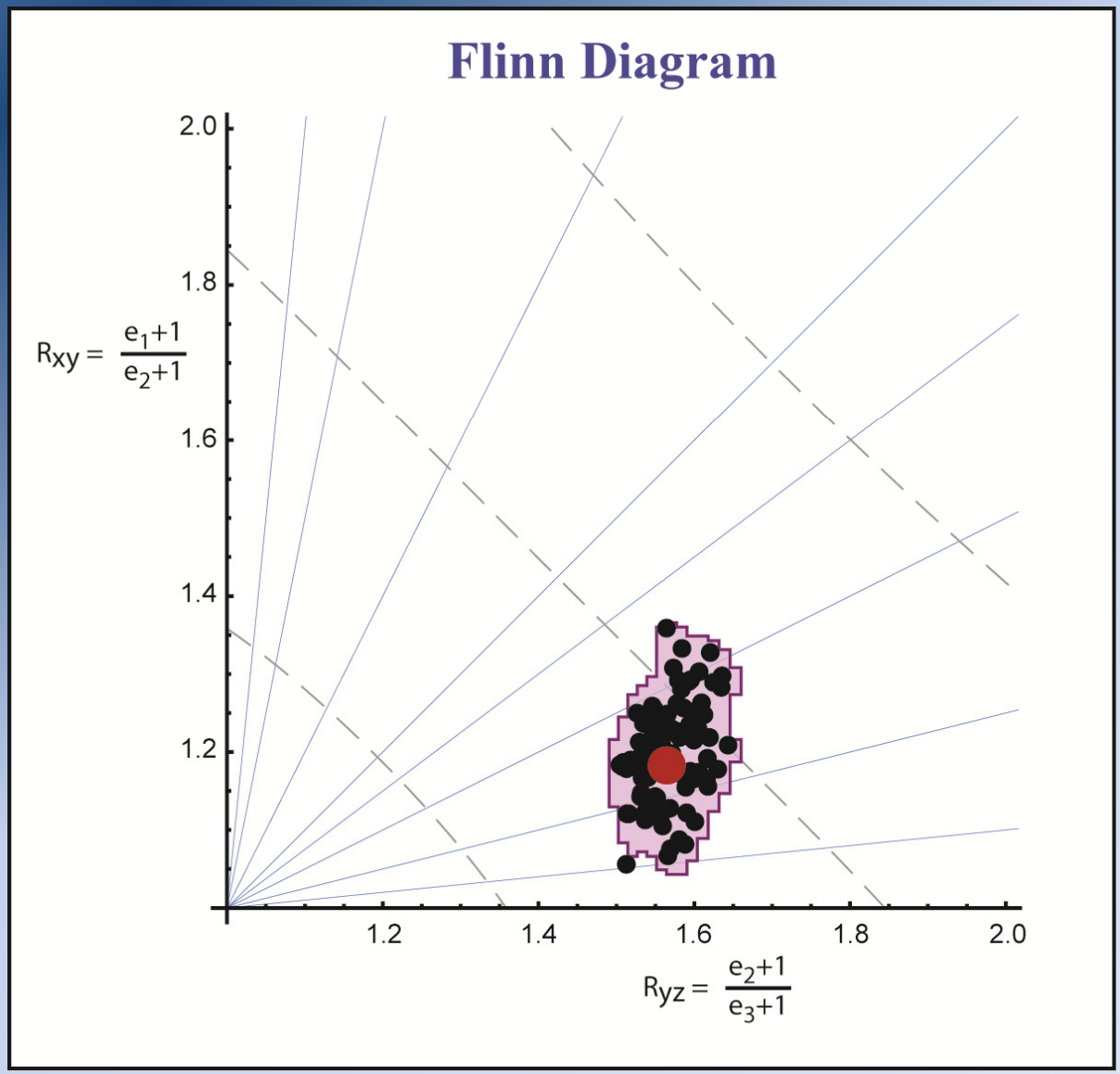


Graphical Output



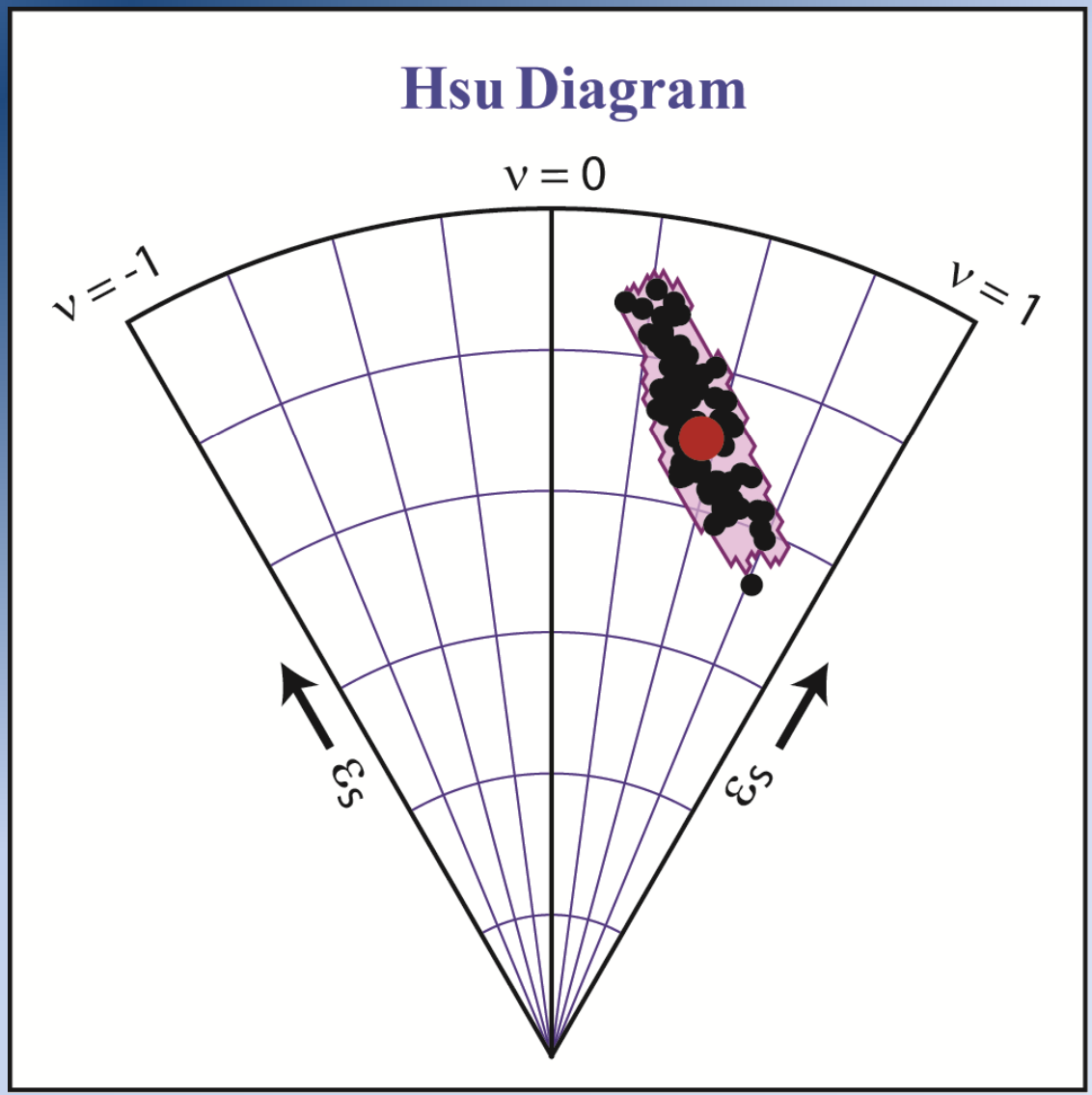
Graphical Output

Flinn Diagram with Error Region



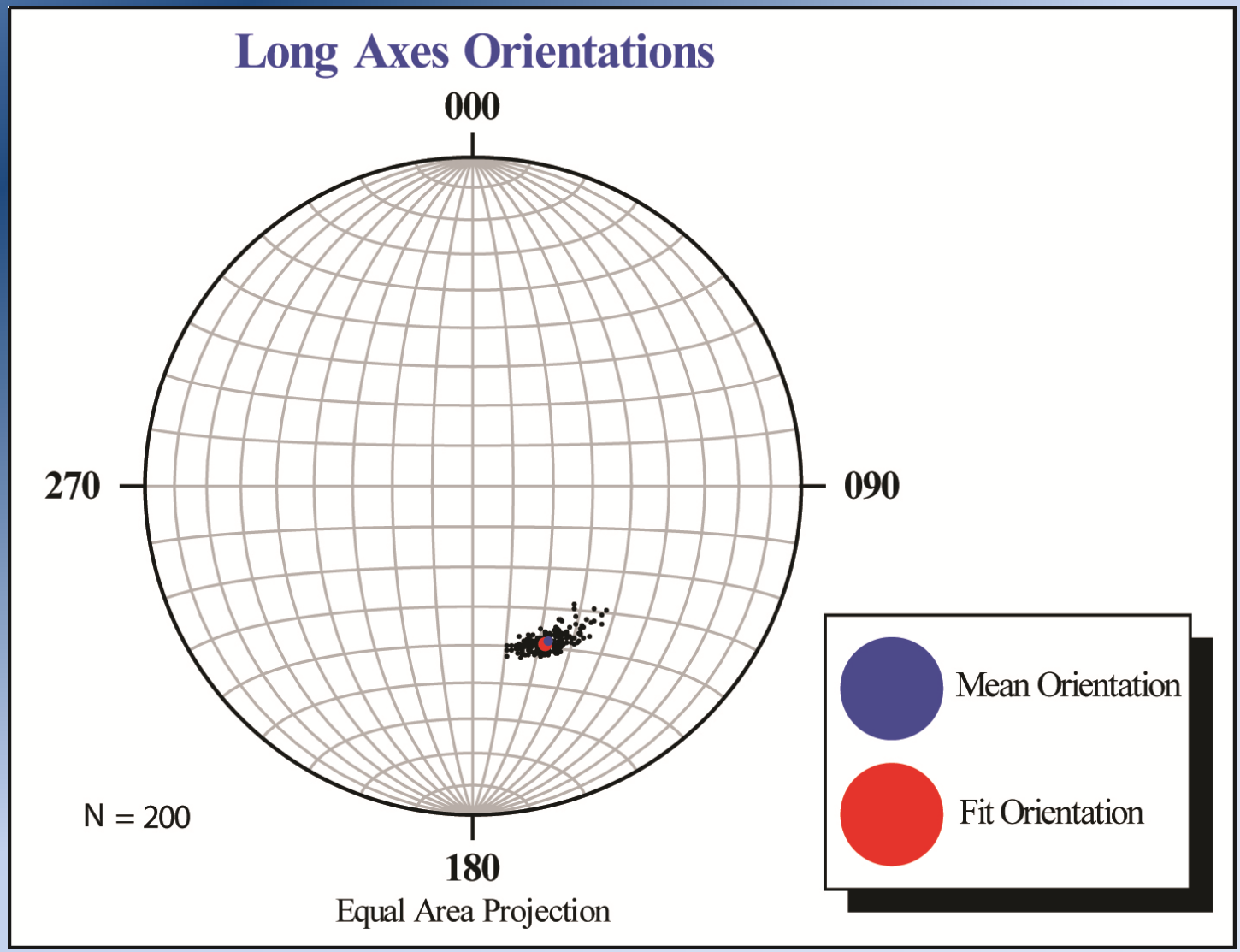
Graphical Output

Hsu Diagram with Error Region

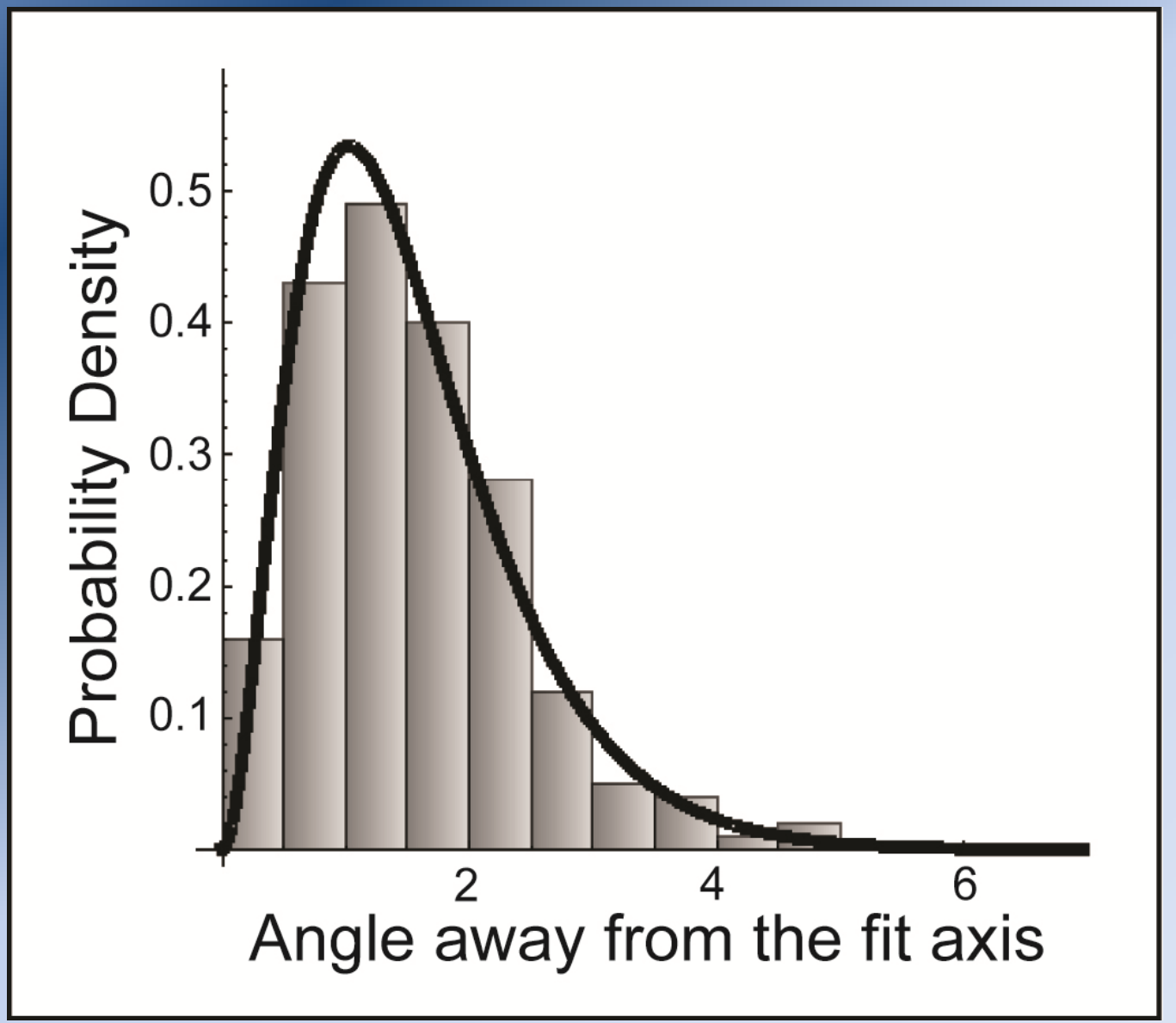


Graphical Output

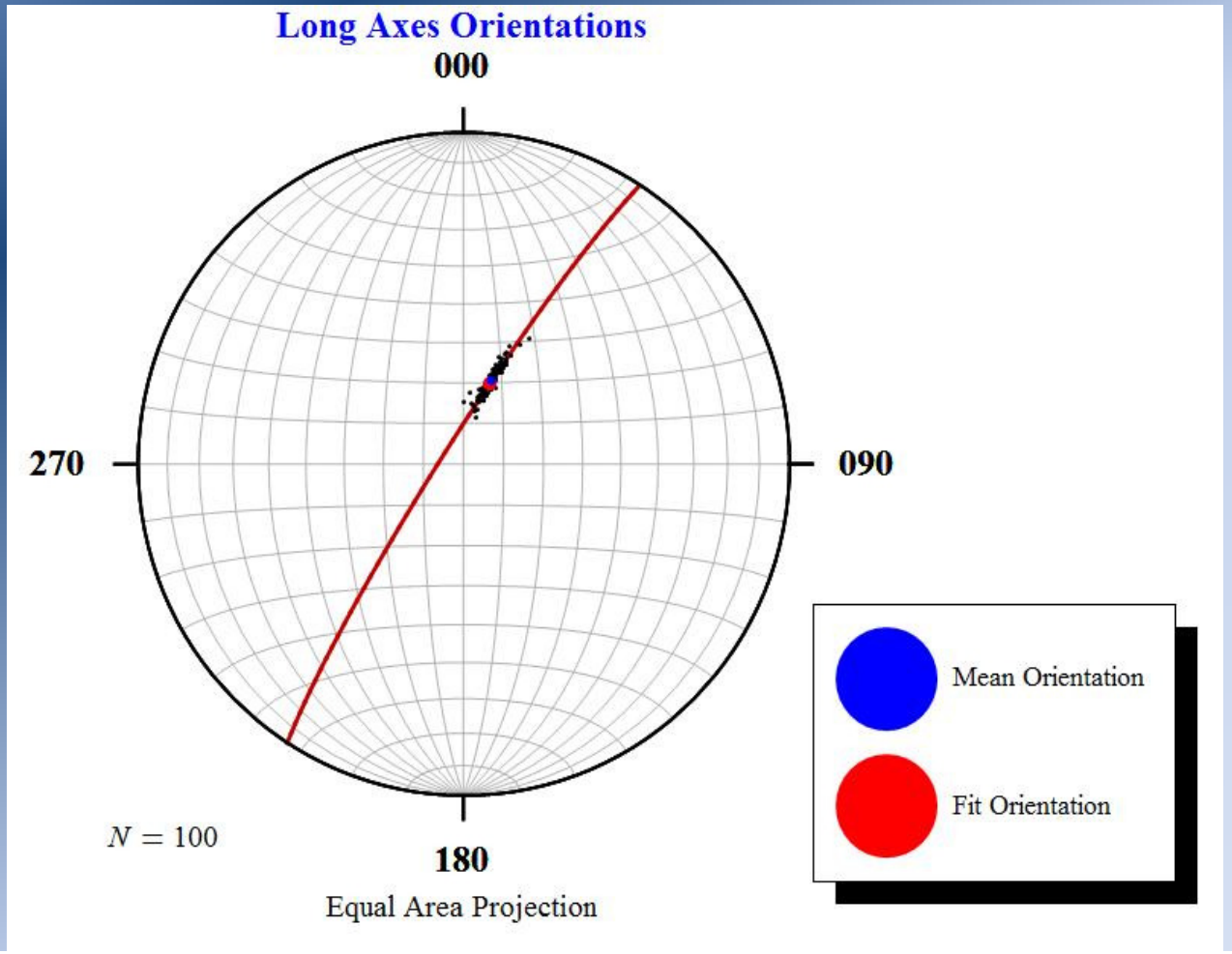
Axes Orientation Data



Best-Fit Gamma Distributions



Best-Fit Plane for Axes Distributions



The Trend:Plunge of the Mean Orientation = 18.9049°:68.325°

The Trend:Plunge of the Fit Orientation = 18.2759°:69.1741° with a 95% error angle = 9.22132°

The Dip:Dip Direction of the Fit Plane = 84.5979°:302.759° and a Mean Difference Angle of: 0.657062°

Example Data Set with Error Regions