Physics with neutrons 2 / Instrumentation with neutrons

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Exercise sheet 12
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Exercise 12.1

A Monte-Carlo simulation of the MIRA instrument yielded the following scattering vectors and energy transfers (excerpt):

$Q_x\ \left(\text{Å}^{-1}\right)$	$Q_y\ \left(\text{Å}^{-1}\right)$	$Q_z\ \left(\text{Å}^{-1}\right)$	$E\ (meV)$
1.366	1.381	-0.0118	0.0793
1.382	1.376	0.00470	-0.0503
1.370	1.382	0.00827	0.0257
1.381	1.372	0.00863	-0.0337
1.371	1.387	0.0144	0.0455
1.376	1.379	-0.0144	0.0124
1.381	1.375	-0.000820	-0.0319
1.356	1.392	-0.0133	0.179
1.379	1.382	-0.00761	0.000948
1.402	1.357	0.0131	-0.184

a) Calculate the resolution matrix M in the standard coordinate system, which has the axes $\langle \boldsymbol{Q} \rangle$, $\langle \boldsymbol{Q} \rangle_\perp$, Q_z, and E. Here $\langle \boldsymbol{Q} \rangle$ is the mean scattering vector and $\langle \boldsymbol{Q} \rangle_\perp$ is in-plane perpendicular to the mean scattering vector. Q_z is the "up" vector perpendicular to the scattering plane.

b) What are the half-widths at half-maximum along the corresponding resolution function's principal axes? The resolution function is given by:

$$R\left(\delta\boldsymbol{Q}, \delta E\right) \propto \exp\left(-\frac{1}{2}\begin{pmatrix} \delta\boldsymbol{Q} \\ \delta E \end{pmatrix}^t \cdot M \cdot \begin{pmatrix} \delta\boldsymbol{Q} \\ \delta E \end{pmatrix}\right).$$