# Adjustment Model

measurement known unknown

unknown with initial guess

$$\begin{bmatrix} x_{i,j}' \\ y_{i,j}' \\ z_{i,j}' \end{bmatrix} = \begin{bmatrix} \rho_{i,j}\cos(\theta_{i,j})\cos(\alpha_{i,j}) \\ \rho_{i,j}\sin(\theta_{i,j})\cos(\alpha_{i,j}) \\ \rho_{i,j}\sin(\alpha_{i,j}) \end{bmatrix} = \underbrace{\mathbf{R_z}(\kappa_j)\mathbf{R_y}(\phi_j)\mathbf{R_x}(\omega_j)}_{\mathbf{M}_j} \begin{bmatrix} X_i - X_{s_j} \\ Y_i - Y_{s_j} \\ Z_i - Z_{s_j} \end{bmatrix} \quad (1)$$

$$\mathbf{M}_j = \begin{bmatrix} cos\phi_j cos\kappa_j & -cos\omega_j sin\kappa_j + sin\omega_j sin\phi_j cos\kappa_j & sin\omega_j sin\kappa_j + cos\omega_j sin\phi_j cos\kappa_j \\ cos\phi_j sin\kappa_j & cos\omega_j cos\kappa_j + sin\omega_j sin\phi_j sin\kappa_j & -sin\omega_j cos\kappa_j + cos\omega_j sin\phi_j sin\kappa_j \\ -sin\phi_j & sin\omega_j cos\phi_j & cos\omega_j cos\phi_j \end{bmatrix} \quad (2)$$

$$\rho_{i,j} = \sqrt{x_{i,j}^2 + y_{i,j}^2 + z_{i,j}^2} + a_0 \quad (3)$$

$$\theta_{i,j} = \arctan\left(\frac{y_{i,j}}{x_{i,j}}\right) + b_1\sec(\alpha_{i,j}) + b_2\tan(\alpha_{i,j}) \quad (4)$$

$$\alpha_{i,j} = \arctan\left(\frac{z_{i,j}}{\sqrt{x_{i,j}^2 + y_{i,j}^2}}\right) + c_0 \quad (5)$$

$\text{Gauss} - \text{Markov Model} \qquad \text{N OPs, s scans}$

$n = 3Ns \qquad u = u_e + u_a = 6s + 4 \qquad r = n - u = (3N - 6)s - 4$