BOWRING FORMULAS

- VALID FOR LINES UP TO 150 km
- USES CONFORMAL PROJECTION OF ELLIPSOID ON A SPHERE CALLED GAUSSIAN PROJECTION OF SECOND KIND
  - SCALE FACTOR TO BE 1 AT START OF LINE
  - 1ST & 2ND DERIVATIVES OF SCALE FACTOR WRT φ SET TO ϕ
  - GEODESIC FROM ELLIPSOID PROJECTED TO CORRESPONDING LINE ON SPHERE WHERE SPHERICAL TRIG EMPLOYED
- DIRECT & INVERSE SOLUTION NON-ITERATIVE
- COMMON EQUATIONS:

$$A = (1 + e'^2 \cos^4 \varphi_1)^{1/2}$$

$$B = (1 + e'^2 \cos^2 \varphi_1)^{1/2}$$

$$C = (1 + e'^2)^{1/2}$$

$$w = A(\lambda_2 - \lambda_1)/2$$

$$\Delta\varphi = \varphi_2 - \varphi_1$$

$$\Delta\lambda = \lambda_2 - \lambda_1$$

- DIRECT PROBLEM

$$\sigma = \frac{\Delta B^2}{aC}$$

$$\lambda_2 = \lambda_1 + \frac{1}{A} \tan^{-1}\left(\frac{A \tan\sigma \sin\alpha_{12}}{B \cos\varphi_1 - \tan\sigma \sin\varphi_1 \cos\alpha_{12}} \right)$$

$$D = \frac{1}{2} \sin^{-1}\left[\sin\sigma \left(\cos\alpha_{12} - \frac{1}{A} \sin\varphi_1 \sin\alpha_{12} \tan\omega \right) \right]$$

$$\varphi_2 = \varphi_1 + 2D \left[B - \frac{3}{2} e'^2 D \sin\left(2\varphi_1 + \frac{4}{3} BD \right) \right]$$

$$\alpha_2 = \tan^{-1}\left[\frac{-B \sin\alpha_{12}}{\cos\sigma \left(\tan\sigma \tan\varphi_1 - B \cos\alpha_{12} \right)} \right]$$

- INVERSE PROBLEM

$$D = \frac{\Delta\varphi}{2B} \left[1 + \frac{3e'^2}{4B^2} \Delta\varphi \sin\left(2\varphi_1 + \frac{2}{3} \Delta\varphi \right) \right]$$

$$E = \sin D \cos\omega$$

$$F = \frac{1}{A} \sin\omega \left(B \cos\varphi_1 \cos D - \sin\varphi_1 \sin D \right)$$

$$\tan G = \frac{F}{E}$$

$$\sin \sigma/2 = (E^2 + F^2)^{1/2}$$

$$\tan H = \left[\frac{1}{A} (\sin \phi_1 + B \cos \phi_1 \tan D) \tan \omega \right]$$

$$\alpha_1 = G - H$$

$$\alpha_2 = G + H \pm 180^\circ$$

$$s = \frac{aC\sigma}{B^2}$$