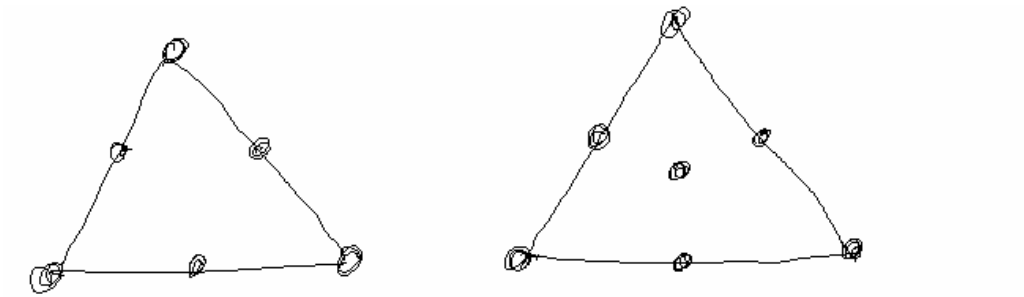
Lagrange Elements

H. Strauss

Triangular Elements



Standard Lagrange 2nd Order Element

2nd Order diagonal mass element (G. Cohen, P. Joly, J.E. Roberts, SIAM J. Num. An 38, 2047 (2001)

Arbitrary order

2nd – 3rd order

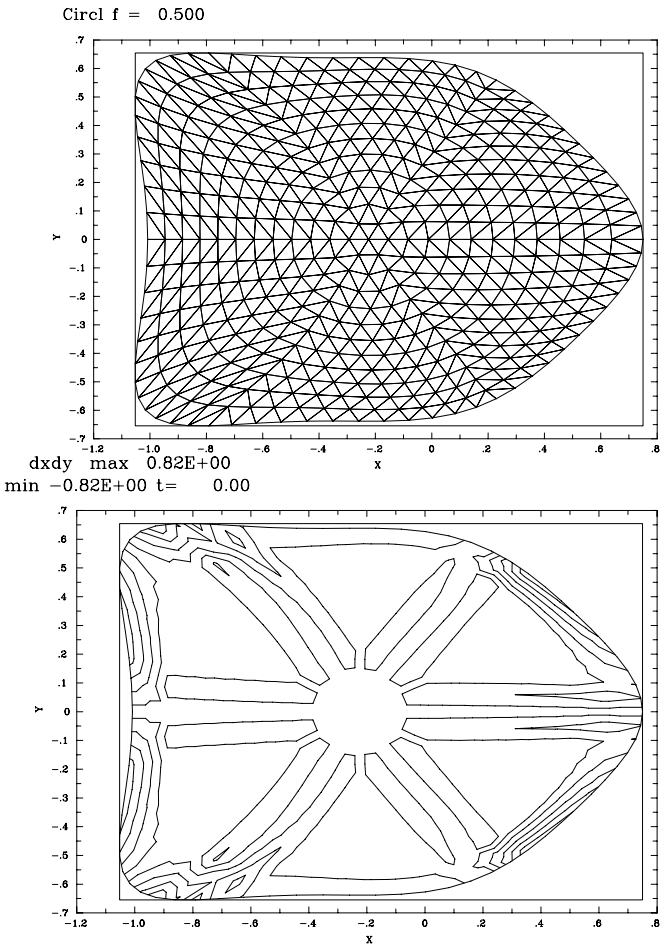
Non diagonal mass matrix

Diagonal mass matrix
nodes = quadrature points (also SEL)

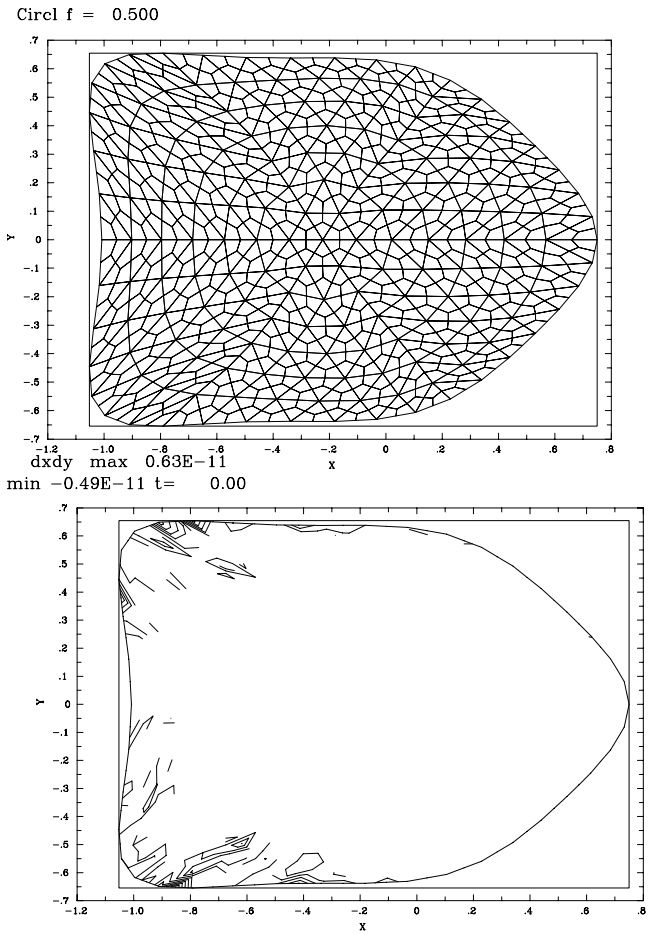
$$\lambda_i^a = \delta_i^a \qquad \int \lambda^a \lambda^b dA = \sum_{quadpts} w_i \lambda_i^a \lambda_i^b = w_a \delta^{ab}$$

Linear element accuracy depends on mesh

$$f = \frac{\partial}{\partial R}\frac{\partial r}{\partial Z} - \frac{\partial}{\partial Z}\frac{\partial r}{\partial Z}$$



Linear elements



2nd order Cohen et al. elements

Application to M3D

- Elements implemented in M3D-OMP
- M3D-MPP (jin Chen, Linda Sugiyama)
- 2nd order diagonal mass elements used in some ELM simulations
- No systematic comparison with linear elements
- Slower than linear elements
- Smaller timestep for same size mesh
- Linear elements seem more robust for ELM simulations