The formula for κ^* on page 6 should be

$$\kappa^* = -w^T \left[\nabla_x^0 q_{ij} v\right] v + \frac{\nabla_x^0 r_u v}{r_{uu}^0} w^T \left[\partial_u^0 q_{ij}\right] v > 0 \qquad (3.2)$$