The formula for $\kappa^{*}$ on page 6 should be

$$
\begin{equation*}
\kappa^{*}=-w^{T}\left[\nabla_{x}^{0} q_{i j} v\right] v+\frac{\nabla_{x}^{0} r_{u} v}{r_{u u}^{0}} w^{T}\left[\partial_{u}^{0} q_{i j}\right] v>0 \tag{3.2}
\end{equation*}
$$

