$$\pi'(\mathbf{x}, \mathbf{p}) = \frac{1}{Z'} \exp\{-U(\mathbf{x}) - K(\mathbf{p})\}$$
$$= \frac{1}{Z'} \exp\left\{-U(\mathbf{x}) + \frac{1}{2}\mathbf{p}^\top \mathbf{M}^{-1}\mathbf{p}\right\}$$