11.5 In K and K', we have

$$x_0 = \gamma(x_0' + \beta x_{\parallel}'), \text{ or } ct = \gamma(ct' + \beta x_{\parallel}'),$$

Where $\beta = v/c$, $\gamma = (1-\beta^2)^{-1/2}$. Then,

$$c\frac{dt}{dt'} = \gamma(c + \beta u_{\parallel}') \text{ or } \frac{dt}{dt'} = \gamma\left(1 + \frac{\vec{u}\cdot\vec{v}}{c^2}\right).$$

Since $\vec{u}_{\parallel} = \dfrac{\vec{u}_{\parallel}' + \vec{v}}{1 + \vec{u}\cdot\vec{v}/c^2}$, we can apply the time derivative to get acceleration $\vec{a}_{\parallel}$ as

$$\vec{a}_{\parallel} = \frac{d\vec{u}_{\parallel}}{dt} = \frac{d}{dt'}\left(\frac{\vec{u}_{\parallel}' + \vec{v}}{1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}}\right)\frac{dt'}{dt} = \left[\frac{\vec{a}_{\parallel}'}{1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}} - \frac{\vec{u}_{\parallel}' + \vec{v}}{\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^2}\frac{\vec{a}'\cdot\vec{v}}{c^2}\right]\frac{1}{\gamma\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)}$$

Notice that $(\vec{u}_{\parallel}' + \vec{v})\,\vec{a}'\cdot\vec{v} = \vec{a}_{\parallel}'(\vec{u}_{\parallel}' + \vec{v})\cdot\vec{v} = \vec{a}_{\parallel}'(\vec{u}'\cdot\vec{v} + v^2)$, we have

$$\vec{a}_{\parallel} = \vec{a}_{\parallel}'\left[\frac{1}{1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}} - \frac{(\vec{u}'\cdot\vec{v} + v^2)/c^2}{\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^2}\right]\frac{1}{\gamma\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)}$$

$$= \frac{1 - v^2/c^2}{\gamma\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^3}\vec{a}_{\parallel}' = \frac{(1 - v^2/c^2)^{3/2}}{(1 + \vec{u}'\cdot\vec{v}/c^2)^3}\vec{a}_{\parallel}'$$

Similarly, in the perpendicular direction,

$$\vec{a}_{\perp} = \frac{d\vec{u}_{\perp}}{dt} = \frac{d}{dt'}\left(\frac{\vec{u}_{\perp}'}{\gamma_v\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)}\right)\frac{dt'}{dt} = \left[\frac{\vec{a}_{\perp}'}{1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}} - \frac{\vec{u}_{\perp}'}{\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^2}\frac{\vec{a}'\cdot\vec{v}}{c^2}\right]\frac{1}{\gamma_v^2\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)}$$

$$= \frac{\left(1 - \frac{v^2}{c^2}\right)}{\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^3}\left(\vec{a}_{\perp}' + \frac{1}{c^2}\left[\vec{a}_{\perp}'(\vec{u}'\cdot\vec{v}) - \vec{u}_{\perp}'(\vec{a}'\cdot\vec{v})\right]\right)$$

The expression in the square brackets can be written as

$$\vec{a}_{\perp}'(\vec{u}'\cdot\vec{v}) - \vec{u}_{\perp}'(\vec{a}'\cdot\vec{v}) = \left(\vec{a}'(\vec{u}'\cdot\vec{v}) - \vec{u}'(\vec{a}'\cdot\vec{v})\right) - \left(\vec{a}_{\parallel}'(\vec{u}'\cdot\vec{v}) - \vec{u}_{\parallel}'(\vec{a}'\cdot\vec{v})\right) = \vec{v}\times(\vec{a}'\times\vec{u}')$$

Since the last term is in the parallel direction.

Therefore.
$$\vec{a}_{\perp} = \frac{\left(1 - \frac{v^2}{c^2}\right)}{\left(1 + \frac{\vec{u}'\cdot\vec{v}}{c^2}\right)^3}\left[\vec{a}_{\perp}' + \frac{\vec{v}}{c^2}\times(\vec{a}'\times\vec{u}')\right].$$