Будем ***вычислять*** **производные**

$$m\frac{d}{dt}\left(\frac{d\vec{r}}{d\tau}\right)=m\frac{d}{dt}\left(\frac{\vec{\mathrm{v}}}{\sqrt{1-\left(\mathrm{v}^2/\mathrm{c}^2\right)}}\right)=$$

$$=\frac{m}{\sqrt{1-\left(\mathrm{v}^2/\mathrm{c}^2\right)}}\frac{d\vec{\mathrm{v}}}{dt}+m\vec{\mathrm{v}}\left[-\frac{1}{2}\left(1-\frac{\mathrm{v}^2}{\mathrm{c}^2}\right)^{-3/2}\left(-\frac{2\left|\vec{\mathrm{v}}\right|}{\mathrm{c}^2}\frac{d\left|\vec{\mathrm{v}}\right|}{dt}\right)\right]=$$

$$=\tilde{m}\vec{a}+m\frac{\vec{\mathrm{v}}}{\mathrm{c}^2}\frac{\left|\vec{\mathrm{v}}\right|}{\sqrt{1-\left(\mathrm{v}^2/\mathrm{c}^2\right)}^3}\frac{d\left|\vec{\mathrm{v}}\right|}{dt}=\tilde{m}\vec{a}+m\left|\vec{\mathrm{v}}\right|\vec{e}_\tau\frac{\left|\vec{\mathrm{v}}\right|}{c^2\sqrt{1-\left(\mathrm{v}^2/\mathrm{c}^2\right)}^3}\left|\vec{a}_\tau\right|=$$

$$=\tilde{m}\vec{a}+\tilde{m}\mathrm{v}^2\frac{\vec{a}_\tau}{c^2\left(1-\left(\mathrm{v}^2/\mathrm{c}^2\right)\right)}=\tilde{m}\vec{a}+\tilde{m}\vec{a}_\tau\frac{\mathrm{v}^2}{c^2-\mathrm{v}^2}$$