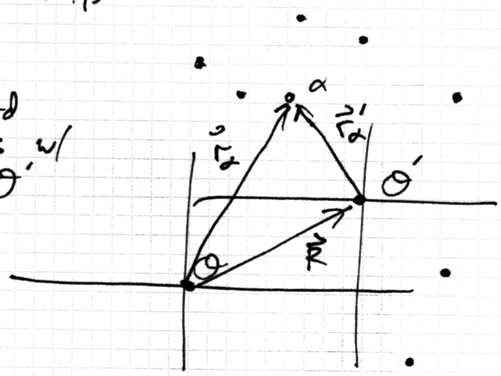
Thm 9.13

by 9.9 : $0 = \sum_\alpha \vec{F}_\alpha^{(e)} + \sum_\alpha \sum_{\substack{\beta \\ \alpha\neq\beta}} \vec{f}_{\alpha\beta}$

- by 9.1, $\sum_\alpha \sum_{\substack{\beta \\ \alpha\neq\beta}} \vec{f}_{\alpha\beta} = 0$, so $\sum \vec{F}_\alpha^{(e)} = 0$

- Consider two coord systems w/ origins O and O'



$\vec{r}_\alpha = \vec{r}_\alpha' + \vec{R}$

Sum of torques about O is : $\vec{\tau}_O = \sum_\alpha \left[\vec{r}_\alpha \times \vec{F}_\alpha^{(e)}\right]$ by 9.31

about O' : $\vec{\tau}_{O'} = \sum_\alpha \left[\vec{r}_\alpha' \times \vec{F}_\alpha^{(e)}\right]$

so $\vec{\tau}_O = \sum_\alpha \left[(\vec{r}_\alpha' + \vec{R}) \times \vec{F}_\alpha^{(e)}\right]$

$= \sum_\alpha (\vec{r}_\alpha' \times \vec{F}_\alpha^{(e)}) + \sum_\alpha \vec{R} \times \vec{F}_\alpha^{(e)}$

$= \vec{\tau}_{O'} + \vec{R} \times \underbrace{\sum_\alpha \vec{F}_\alpha^{(e)}}_{= 0 \text{ by assumption (above}}$

$= \vec{\tau}_{O'}$