```
restart : with(Physics[Vectors]); Setup(mathematicalnotation = true)
```

```
[&x, `+`, `.`, ChangeBasis, ChangeCoordinates, Component, Curl, DirectionalDiff, Divergence,
    Gradient, Identify, Laplacian, ∇, Norm, Setup, diff]
```

$$[mathematicalnotation = true] \tag{1}$$

Лагранжиан системы двух зарядов с точностью до второго порядка

(анти - Дарвиновский)

координаты зарядов

$\vec{r}_a$:

$\vec{r}_b$:

Вектор от заряда источника поля к пробному заряду

$R_{ba\_} := \vec{r}_a - \vec{r}_b$

$$\overrightarrow{R_{ba}} := \vec{r}_a - \vec{r}_b \tag{2}$$

его длина

$R_{ba} := \|R_{ba\_}\|$

$$R_{ba} := \left\|\vec{r}_a - \vec{r}_b\right\| \tag{3}$$

R_{ba}

$$\left\|\vec{r}_a - \vec{r}_b\right\| \tag{4}$$

вектор направления от заряда источника поля к пробному заряду

$n_{ba\_} := \dfrac{R_{ba\_}}{R_{ba}}$

$$\overrightarrow{n_{ba}} := \frac{\vec{r}_a - \vec{r}_b}{\left\|\vec{r}_a - \vec{r}_b\right\|} \tag{5}$$

$$L_a := K - \frac{e_a \cdot e_b}{R_{ba}} - \frac{e_a \cdot e_b}{2 \cdot c^2} \cdot \left(\frac{1}{R_{ba}} \cdot \left(\left(v_{a\_} - v_{b\_}\right) \cdot \left(v_{a\_} - v_{b\_}\right) - \left(\left(n_{ba\_}\right) \cdot \left(v_{a\_} - v_{b\_}\right) \right)^2 \right) + n_{ba\_} \cdot \left(a_{a\_} - a_{b\_}\right) \right)$$

$$L_a := K - \frac{e_a\, e_b}{\left\|\vec{r}_a - \vec{r}_b\right\|} - \frac{e_a\, e_b \left(\dfrac{\left\|\vec{v}_a - \vec{v}_b\right\|^2 - \dfrac{\left(\left(\vec{r}_a - \vec{r}_b\right) \cdot \left(\vec{v}_a - \vec{v}_b\right) \right)^2}{\left\|\vec{r}_a - \vec{r}_b\right\|^2}}{\left\|\vec{r}_a - \vec{r}_b\right\|} + \dfrac{\left(\vec{r}_a - \vec{r}_b\right) \cdot \left(\vec{a}_a - \vec{a}_b\right)}{\left\|\vec{r}_a - \vec{r}_b\right\|} \right)}{2\, c^2} \tag{6}$$

$$\frac{\partial}{\partial v_{a\_}} L_a$$

$$-\frac{e_a e_b \left(2\vec{v}_a - 2\vec{v}_b - \frac{2\left(\left(\vec{r}_a - \vec{r}_b\right)\cdot\left(\vec{v}_a - \vec{v}_b\right)\right)\left(\vec{r}_a - \vec{r}_b\right)}{\left\|\vec{r}_a - \vec{r}_b\right\|^2}\right)}{2\left\|\vec{r}_a - \vec{r}_b\right\| c^2} \tag{7}$$

$$\frac{\partial}{\partial r_{a\_}} L_a$$

$$\frac{e_a e_b \left(2\vec{r}_a - 2\vec{r}_b\right)}{2\left\|\vec{r}_a - \vec{r}_b\right\|^3} \tag{8}$$

$$-\frac{1}{2c^2}\left(e_a e_b\left(\frac{1}{\left\|\vec{r}_a - \vec{r}_b\right\|}\left(\frac{\left(\left(\vec{r}_a - \vec{r}_b\right)\cdot\left(\vec{v}_a - \vec{v}_b\right)\right)^2\left(2\vec{r}_a - 2\vec{r}_b\right)}{\left\|\vec{r}_a - \vec{r}_b\right\|^4}\right.\right.\right.$$

$$\left.\left.\left.-\frac{2\left(\left(\vec{r}_a - \vec{r}_b\right)\cdot\left(\vec{v}_a - \vec{v}_b\right)\right)\left(\vec{v}_a - \vec{v}_b\right)}{\left\|\vec{r}_a - \vec{r}_b\right\|^2}\right)\right.\right.$$

$$\left.-\frac{\left(\left\|\vec{v}_a - \vec{v}_b\right\|^2 - \frac{\left(\left(\vec{r}_a - \vec{r}_b\right)\cdot\left(\vec{v}_a - \vec{v}_b\right)\right)^2}{\left\|\vec{r}_a - \vec{r}_b\right\|^2}\right)\left(2\vec{r}_a - 2\vec{r}_b\right)}{2\left\|\vec{r}_a - \vec{r}_b\right\|^3}\right.$$

$$\left.\left.-\frac{\left(\left(\vec{r}_a - \vec{r}_b\right)\cdot\left(\vec{a}_a - \vec{a}_b\right)\right)\left(2\vec{r}_a - 2\vec{r}_b\right)}{2\left\|\vec{r}_a - \vec{r}_b\right\|^3} + \frac{\vec{a}_a - \vec{a}_b}{\left\|\vec{r}_a - \vec{r}_b\right\|}\right)\right)$$

$$\frac{\partial}{\partial r_{a\_}} R_{ba}$$

$$\frac{2\vec{r}_a - 2\vec{r}_b}{2\left\|\vec{r}_a - \vec{r}_b\right\|} \tag{9}$$

$$\frac{\partial}{\partial r_{a\_}} R_{ba\_}$$

$$1 \tag{10}$$

$$\frac{\partial}{\partial r_{a\_}} r_{a\_}$$

$$1 \tag{11}$$