## Про силу притяжения

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У меня получилась следующая система

$$\begin{cases} \ddot{\boldsymbol{r}}_1 = \frac{Gm_2(\boldsymbol{r}_2 - \boldsymbol{r}_1)}{|\boldsymbol{r}_2 - \boldsymbol{r}_1|^3} \\ \ddot{\boldsymbol{r}}_2 = \frac{Gm_1(\boldsymbol{r}_1 - \boldsymbol{r}_2)}{|\boldsymbol{r}_1 - \boldsymbol{r}_2|^3} \end{cases}$$

Преобразовал в такую систему

$$egin{cases} \dot{m{r}}_1 = m{a} \ \dot{m{r}}_2 = m{b} \ \dot{m{a}} = rac{Gm_2(m{r}_2 - m{r}_1)}{|m{r}_2 - m{r}_1|^3} \ \dot{m{b}} = rac{Gm_1(m{r}_1 - m{r}_2)}{|m{r}_1 - m{r}_2|^3} \end{cases}$$

Ввёл такие обозначения:

$$egin{aligned} oldsymbol{c} &pprox oldsymbol{r}_1 \ oldsymbol{d} &pprox oldsymbol{r}_2 \ oldsymbol{e} &pprox oldsymbol{a} \ oldsymbol{f} &pprox oldsymbol{b} \end{aligned}$$

По методу Рунге-Кутта:

$$egin{aligned} oldsymbol{c}_{n+1} &= oldsymbol{c}_n + rac{1}{6}h(oldsymbol{g}_1 + 2oldsymbol{g}_2 + 2oldsymbol{g}_3 + oldsymbol{g}_4) \ oldsymbol{d}_{n+1} &= oldsymbol{d}_n + rac{1}{6}h(oldsymbol{h}_1 + 2oldsymbol{h}_2 + 2oldsymbol{h}_3 + oldsymbol{h}_4) \ oldsymbol{e}_{n+1} &= oldsymbol{e}_n + rac{1}{6}h(oldsymbol{e}_1 + 2oldsymbol{e}_2 + 2oldsymbol{e}_3 + oldsymbol{e}_4) \end{aligned}$$

$$m{f}_{n+1} = m{f}_n + rac{1}{6}h(m{f}_1 + 2m{f}_2 + 2m{f}_3 + m{f}_4)$$

Для коэффициентов  $g_1, .., g_4$ :

$$egin{aligned} m{g}_1 &= m{a}_n \ m{g}_2 &= m{a}_n + rac{1}{2}hm{g}_1 \ m{g}_3 &= m{a}_n + rac{1}{2}hm{g}_2 \ m{g}_4 &= m{a}_n + hm{g}_3 \end{aligned}$$

Для коэффициентов  $h_1, .., h_4$ :

$$egin{aligned} m{h}_1 &= m{b}_n \ m{h}_2 &= m{b}_n + rac{1}{2}hm{h}_1 \ m{h}_3 &= m{b}_n + rac{1}{2}hm{h}_2 \ m{h}_4 &= m{b}_n + hm{h}_3 \end{aligned}$$

Для коэффициентов  $k_1,..,k_4$ :

$$egin{aligned} oldsymbol{k}_1 &= rac{Gm_2(oldsymbol{d}_n - oldsymbol{c}_n)}{|oldsymbol{d}_n - oldsymbol{c}_n|^3} \ oldsymbol{k}_2 &= rac{Gm_2\left(\left(oldsymbol{d}_n + rac{1}{2}holdsymbol{h}_1
ight) - \left(oldsymbol{c}_n + rac{1}{2}holdsymbol{g}_1
ight)
ight)}{\left|\left(oldsymbol{d}_n + rac{1}{2}holdsymbol{h}_2
ight) - \left(oldsymbol{c}_n + rac{1}{2}holdsymbol{g}_2
ight)
ight)}{\left|\left(oldsymbol{d}_n + rac{1}{2}holdsymbol{h}_2
ight) - \left(oldsymbol{c}_n + rac{1}{2}holdsymbol{g}_2
ight)
ight|^3} \ oldsymbol{k}_4 &= rac{Gm_2\left((oldsymbol{d}_n + holdsymbol{h}_3
ight) - \left(oldsymbol{c}_n + holdsymbol{g}_3
ight)}{\left|\left(oldsymbol{d}_n + holdsymbol{h}_3
ight) - \left(oldsymbol{c}_n + holdsymbol{g}_3
ight)
ight|^3} \end{aligned}$$

Для коэффициентов  $l_1, ..., l_4$ :

$$\boldsymbol{l}_1 = \frac{Gm_1(\boldsymbol{c}_n - \boldsymbol{d}_n)}{|\boldsymbol{c}_n - \boldsymbol{d}_n|^3}$$

$$l_2 = \frac{Gm_1\left(\left(\boldsymbol{c}_n + \frac{1}{2}h\boldsymbol{g}_1\right) - \left(\boldsymbol{d}_n + \frac{1}{2}h\boldsymbol{h}_1\right)\right)}{\left|\left(\boldsymbol{c}_n + \frac{1}{2}h\boldsymbol{g}_1\right) - \left(\boldsymbol{d}_n + \frac{1}{2}h\boldsymbol{h}_1\right)\right|^3}$$

$$l_3 = \frac{Gm_1\left(\left(\boldsymbol{c}_n + \frac{1}{2}h\boldsymbol{g}_2\right) - \left(\boldsymbol{d}_n + \frac{1}{2}h\boldsymbol{h}_2\right)\right)}{\left|\left(\boldsymbol{c}_n + \frac{1}{2}h\boldsymbol{g}_2\right) - \left(\boldsymbol{d}_n + \frac{1}{2}h\boldsymbol{h}_2\right)\right|^3}$$

$$l_4 = \frac{Gm_1\left(\left(\boldsymbol{c}_n + h\boldsymbol{g}_3\right) - \left(\boldsymbol{d}_n + h\boldsymbol{h}_3\right)\right)}{\left|\left(\boldsymbol{c}_n + h\boldsymbol{g}_3\right) - \left(\boldsymbol{d}_n + h\boldsymbol{h}_3\right)\right|^3}$$