N-Body Problem

Newton's law of gravity (inverse square law)

In vector form,

$\vec{F} =$

Newton's law of gravity assumes

ONLY valid

Why does it work for planets?

If the gravitational force for an actual body can be written as the force for a point mass, then

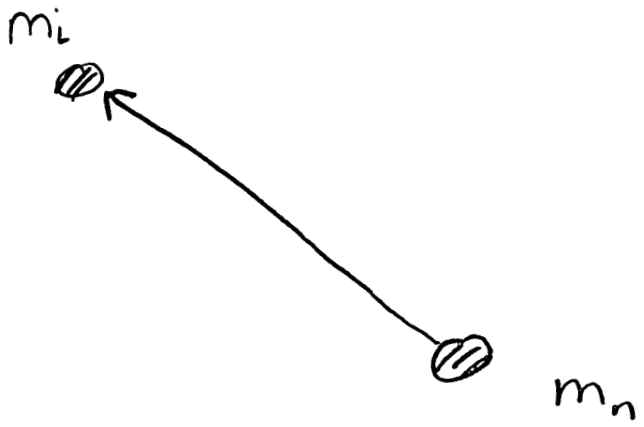
Planets work because

N-Body Problem

Assume

- Gravity is the only force
- System of n bodies $(m_1, m_2, \cdots, m_n)$
- spherically symmetric masses

Note



Force on m_i due to m_n is

$\bar{F}_n =$

Sum all forces

Now we can write EOM from Newton's second law

$$^{I}\frac{d}{dt}(m_i \bar{v}_i) = \bar{F}$$

Assume constant mass.

$$^{I}\frac{d}{dt}(m_i \bar{v}_i) =$$

If we have n bodies, can we solve $\bar{r}_i(t)$?

To know $\bar{r}_i(t)$, need to find $\bar{r}_j(t)$

To solve, we need to know the vector positions + velocities of all the bodies.

Do we really care about $\bar{r}_i, \bar{r}_g$?

what do we really care about?

We have expressions for $\ddot{\bar{r}}_i$ and $\ddot{\bar{r}}_g$

$$\ddot{\bar{r}}_{gi} = -G \sum_{\substack{j=1 \\ j \neq i}}^{n} \frac{m_j}{r_{ji}^3} \bar{r}_{ji} + G \sum_{\substack{j=1 \\ j \neq g}}^{n} \frac{m_j}{r_{jg}^3} \bar{r}_{jg}$$

If $n \geq 3$, still can't solve. Need

What happens if $n = 3$ (remove α)?

How about 2? 2nd order DE with one unknown position!