$$\mathbf{a}_{ij} = \sum_{\substack{j \neq i \\ j=1}}^{N} \frac{G m_j \left(\mathbf{r}_j - \mathbf{r}_i\right)}{\left\|\mathbf{r}_j - \mathbf{r}_i\right\|^3}$$

$$U = -\sum_{1 \leq i \leq j \leq n} \frac{G m_i m_j}{\|\mathbf{r}_j - \mathbf{r}_i\|}$$