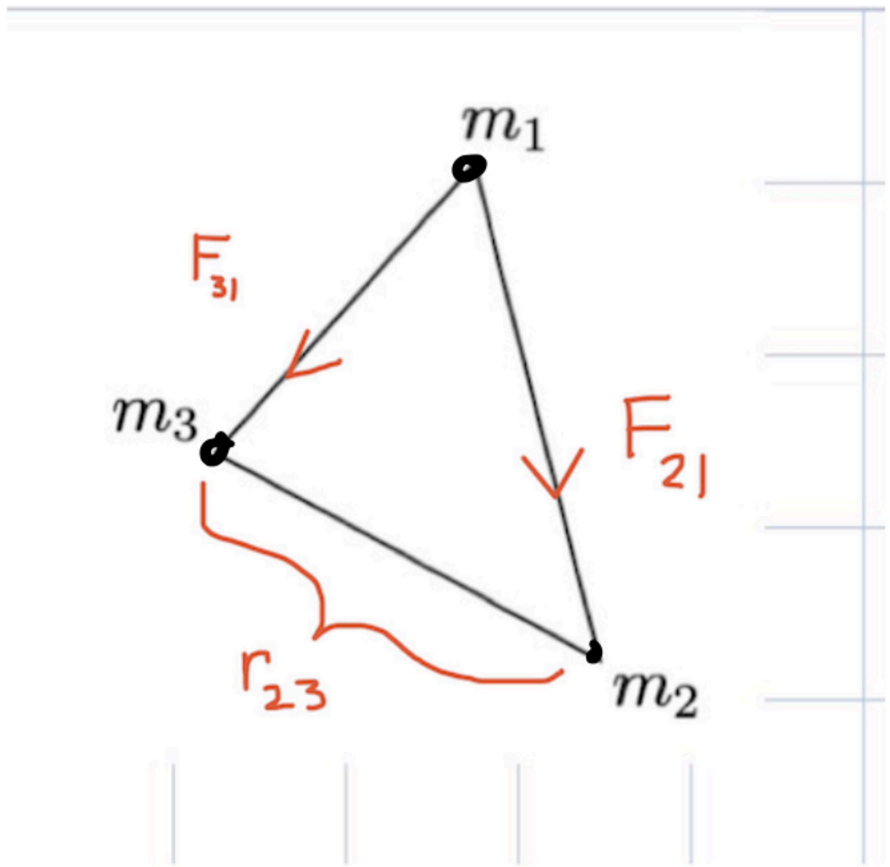


FIGURE 19. The three-body problem. The forces are along the edges of the triangle formed by the masses.

$$
\begin{aligned}
m_1\ddot{q}_1 &= F_{21} + F_{31}, \\
m_2\ddot{q}_2 &= F_{12} + F_{32}, \\
m_3\ddot{q}_3 &= F_{23} + F_{13},
\end{aligned}
$$

$$F_{ba} = -\frac{Gm_a m_b}{r_{ab}^2}\hat{q}_{ab}.$$

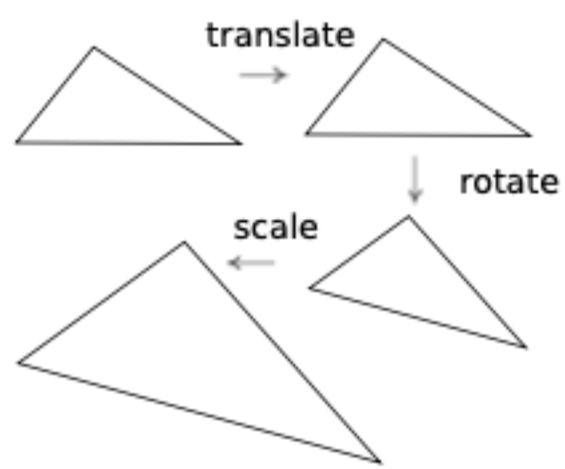
$$r_{ab} = |q_a - q_b|$$

a and b, and

$$\hat{q}_{ab} = \frac{q_a - q_b}{r_{ab}}$$

symmeteries: Galilean group:

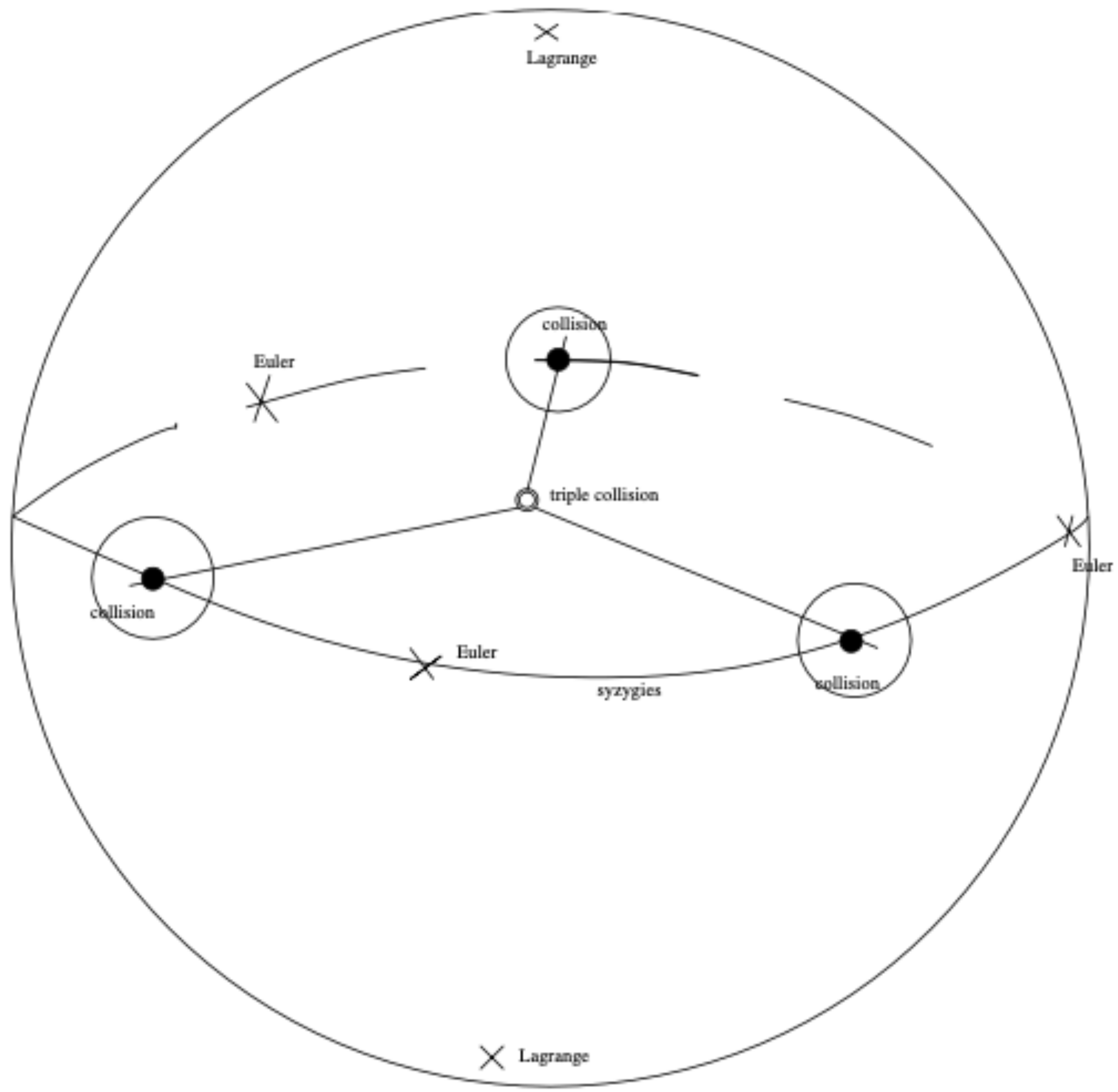
$$
\begin{aligned}
q_a(t) &\mapsto q_a(t) + c \text{ (space translation)} \\
q_a(t) &\mapsto R(q_a(t)) \text{ (space rotation or reflection)} \\
q_a(t) &\mapsto q_a(t - t_0) \text{ (time translation)} \\
q_a(t) &\mapsto q_a(-t) \text{ (time reflection)} \\
q_a(t) &\mapsto q_a(t) + tv \text{ (boost).}
\end{aligned}
$$


translate
rotate
scale

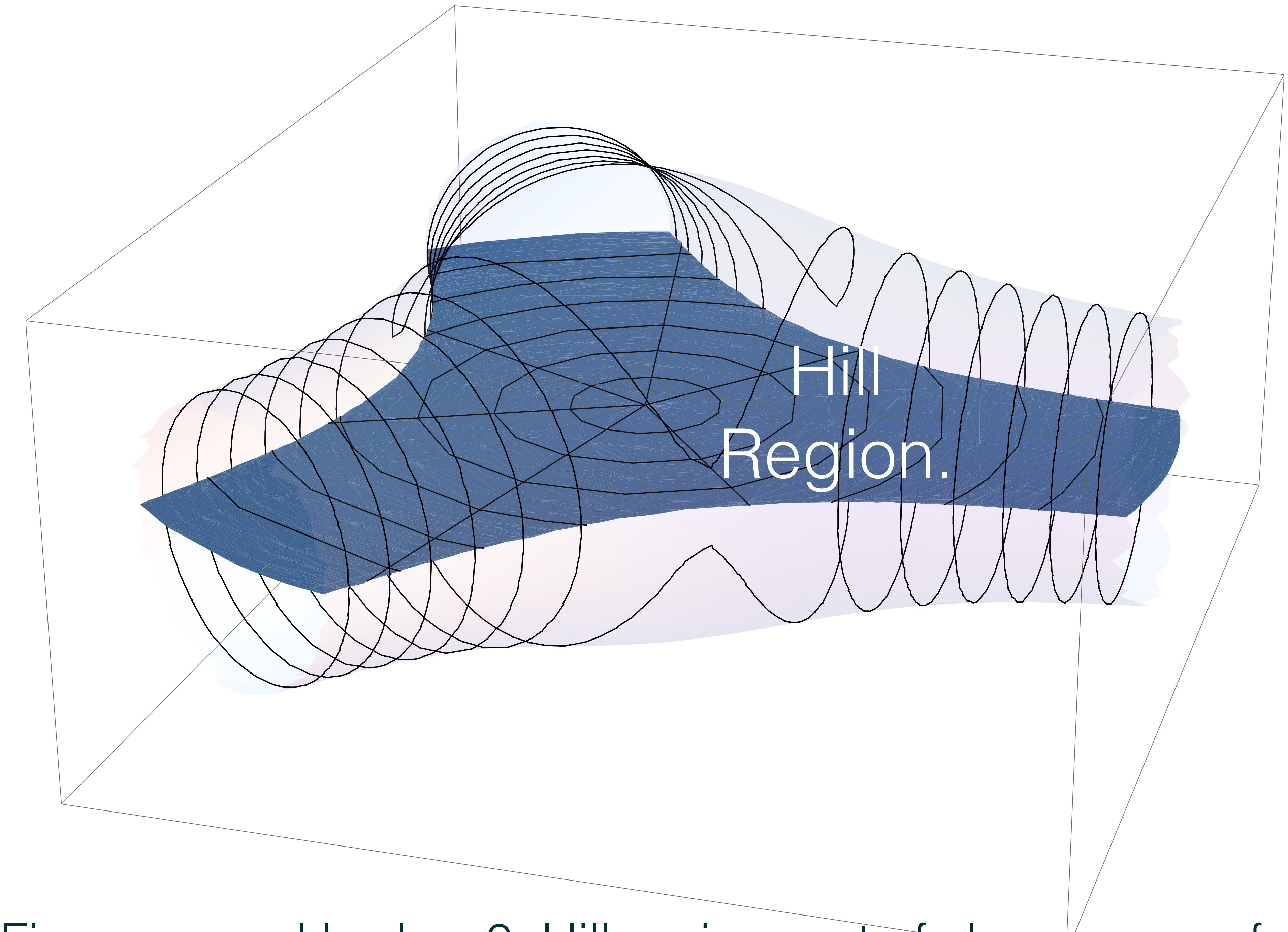
$$
\begin{aligned}
E(q,\dot q) &= K(\dot q) - U(q) \\
&= \frac{1}{2}\Sigma m_a |\dot q_a|^2 - \Sigma_{a<b} f_{ab}(r_{ab}) \\
&= \text{ energy (for time translations)}
\end{aligned}
$$

$$
P = \Sigma m_a \dot q_a = \text{ linear momentum (for space translations)}
$$

$$
J = \Sigma m_a q_a \wedge \dot q_a = \text{ angular momentum (for space rotations) .}
$$



Lagrange
collision
Euler
triple collision
Euler
collision
Euler
collision
syzygies
Lagrange



Fix energy = H =-h < 0. Hill region:part of shape space for which there is a v and H(q,v) = -h. Domain where motion occurs. Identical to region with U(q) > +h