**Spacetime Distances**

$$(\text{Spacetime distance})^2 = c^2(\text{time interval})^2 - (\text{space interval})^2$$

1. **"Timelike" worldline**: $(\text{Spacetime distance})^2 > 0$
2. **"Null" worldline**: $(\text{Spacetime distance})^2 = 0$
3. **"Spacelike" worldline**: $(\text{Spacetime distance})^2 < 0$

**Arrow of Time**

- Symmetry is broken!
  - Space: Reversible
  - Time: Irreversible
- Why should **time** be so special in four dimension?
  - Relativistic theory (which unifies space and time and treats “spacetime” as the fundamental object) does not tell us that time must be special.
  - In fact, almost all fundamental theories of physics posses time reversibility.
  - Only “empirical” theories (such as thermodynamics) posses time irreversibility.
  - E.g., 2nd law of thermodynamics – entropy always either increases or stays constant.

**The 2nd Law of Thermodynamics**

- The 2nd law of thermodynamics states:
  - Heat always flows from hot to cold, when no extra work is done to the system.
  - How do know it? We know it from experiences.
- This law results in the increase of **entropy**, which is given by the amount of heat per unit temperature.