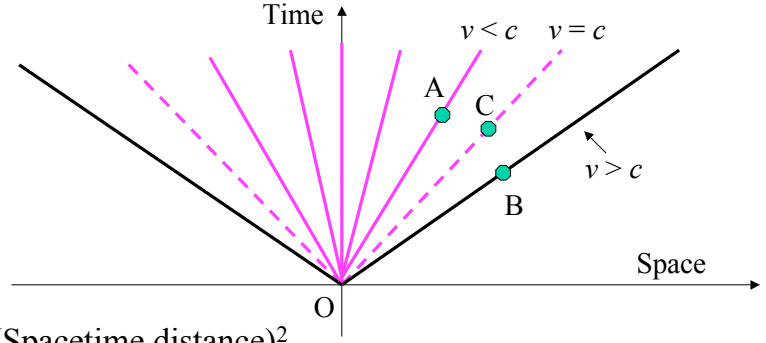
Spacetime Distances



(Spacetime distance)^2

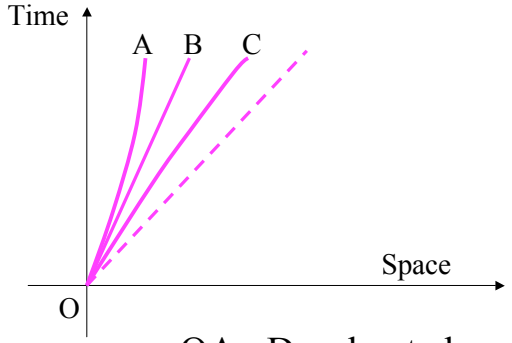
= c^2(**time** interval)^2 – (space interval)^2

OA 1. "Timelike" worldline : (Spacetime distance)$^2 > 0$

OC 2. "Null" worldline : (Spacetime distance)$^2 = 0$

OB 3. "Spacelike" worldline : (Spacetime distance)$^2 < 0$

Acceleration and Deceleration

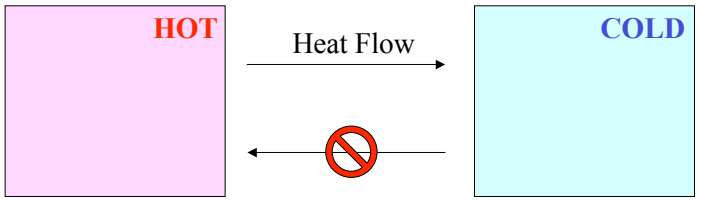


- OA : Decelerated
- OB : Constant velocity
- OC : Accelerated

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**.