

GLITTERS DEBATE: Mach vs. Boltzmann, Kinetic Theory

Ludwig Boltzmann (1844–1906) was a mathematician, defender of women in academia and in 1890 the Chair of Theoretical Physics at the University of Munich. He spent 14 years developing a statistical concept of nature that included a kinetic theory of gases.

Ernst Mach (1838–1916) was famous for his work on shock waves and a strict application of phenomenalism that recognized only sensations as real.

Mach attended a lecture given by Ludwig Boltzmann on the kinetic theory of gases at the Imperial Academy of Science in Vienna. Mach famously said to Boltzmann “I don’t believe atoms exist.” So began the debate.

The kinetic theory of gases is the study of the microscopic behavior of molecules and the interactions which lead to macroscopic relationships and behaviors.

Boltzmann lays out these ideas about the behavior of tiny bodies based on their macro effects:

1. a large number of small bodies (molecules) separated by space which is large compared to the size of the bodies
2. the bodies move randomly and with a speed distribution that does not change while the temperature is stable
3. the bodies collide with others but otherwise do not exert significant forces on others
4. the bodies obey Newton’s laws of motion

Mach insists that only things that can be seen and experienced are real. He does not allow for the inductive leap from macro behavior to accepting the existence of atoms and molecules.

TOPIC TEAMS

1A. TEAM MACH, AFFIRMATIVE: experience is the source of ideas and knowledge. There is no reality beyond what we can see and touch.

1N. TEAM BOLTZMANN, NEGATIVE: Wrong – there must be smaller components that make up the world we see and touch.

2N. TEAM MACH,, NEGATIVE: Atoms do not exist.

2A. TEAM BOLTZMANN, AFFIRMATIVE: We can study the macroscopic behaviors of atoms and molecules and make conclusions about these masses of tiny bodies. The kinetic theory of gases predicts the speed of diffusion based on the temperature of a medium.

PROCEDURE

Research the issue together and come up with lists of examples to support your topic and position. Prepare logical arguments. You may not subscribe to the view you have been assigned. You don't need to believe in a cause to argue for (or against) that cause.

Everyone is expected to participate in the research and strategy of the debate. Decide who who will do most of the talking during the debate and support your team with examples and other support.

SCHEDULE

1A: two minutes, present case.

1N: two minutes, present case.

Two minute break to prepare rebuttals and summaries

1N: two minutes, rebuttal. Defend opposing arguments and defeat supporting arguments without adding new information.

1A: two minutes, rebuttal and summary.

2A: two minutes, present case.

2N: two minutes, present case.

Two minute break to prepare rebuttals and summaries

2N: two minutes, rebuttal and summary. Defend opposing arguments and defeat supporting arguments without adding new information.

2A: two minutes, rebuttal and summary.

DISCUSSION

Present your judgements. the winner is the one who has presented the strongest case. Ask yourself:

who communicated clearly?

who refuted the opponent's arguments best?

Final note:

Einstein paper on Brownian Motion in 1905 that the statistical fluctuations of atoms allowed measurement of their existence without direct individuated sensory evidence. This marks the turning point in the acceptance of atomic theory and subsequent work in quantum theory.